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General surgery

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Оглавление

PREFACE

Over a decade has elapsed since the earlier Russian edition of the manual was published. A number of dramatic changes have taken place in surgery at large, which invariably have affected the syllabus and methods of teaching general surgery in medical schools. This manual is aimed at meeting the needs of English-speaking medical students and house officers in their preparations for practical classes and clinical training in general surgery.

The ability to use in everyday practice the knowledge both acquired during lectures and from textbooks, is of vital necessity for everyone involved in whichever health care subspecialty. To aid students to acquire this knowledge is the major aim of the manual.

Mastery of such parts of general surgery as asepsis and antisepsis; blood transfusion; haemorrhage; fundamentals of resuscitation and anaesthetics is a prerequisite for being a health care professional irrespective of the speciality.

Each of these chapters contains explanations and instructions as to what and how a physician should do in each case.

The routine methods of clinical examination of patients is one of the priorities of general surgery course. The manual highlights the general principles of clinical examination of surgical patients as well as the criteria to assess patients with surgical infection, trauma, vascular diseases or tumours.

This manual will help students acquire basic knowledge and practical skills for their everyday professional activities.

Medical knowledge is constantly changing. As new information becomes available, changes in treatment, procedures and the use of drugs become necessary. The editors, the author and the publishers have, as far as it is possible, taken care to ensure that the information given in this text is accurate and up to date. However, readers are strongly advised to confirm that the information, especially with regard to drug usage, complies with current legislation and standards of practice.

Chapter I. ASEPSIS AND ANTISEPSIS

In surgery, infections are very common and may even lead to death in spite of a high quality of operative technique. The prevention of such a complication in surgical practice is therefore a major challenge which should be based on the principles of asepsis and antisepsis.

The measures to prevent an infection from entering a wound are referred to as *asepsis,* while those to cause the exclusion or destruction of harmful microbes are generally called *antisepsis.*

The two principles represent the united whole in the prophylaxis of surgical infections. They have to be considered in terms of the interrelationship between the source of infection, its mode of transmission and the susceptibility of the body.

The *source* is taken to mean the place of dwelling, growth and proliferation of microorganisms. Relative to the patient the source of infection can be either *exogenous* (from outside) or *endogenous*(from within the body).

The main sources of *exogenous infections* include patients with purulent inflammation or «healthy» carriers of the microbes, and occasionally animals.

The *modes of transmission* from exogenous sources are usually as follows: airborne, direct contact and implantation (fig. A).

The major *sources* of *endogenous infections* incorporate chronic infections outside the area of the operation (e.g. skin diseases, dental or tonsillar conditions) or of the organs operated

on as is (e.g. appendicitis, cholecystitis, osteomyelitis), as well as the oral, intestinal and respiratory saprophytes (fig. B).

Among the *modes of transmission* of endogenous infections are direct contact, lymphoand haematogenous spread.

To successfully prevent an infection, it is necessary to affect each stage of the infectious process, i.e. the source of infection, the mode of transmission, and the host.

ASEPSIS

A surgical hospital contains the main functional blocks which are as follows: a surgical block, surgery departments, plaster and treatment rooms and dressing-rooms.

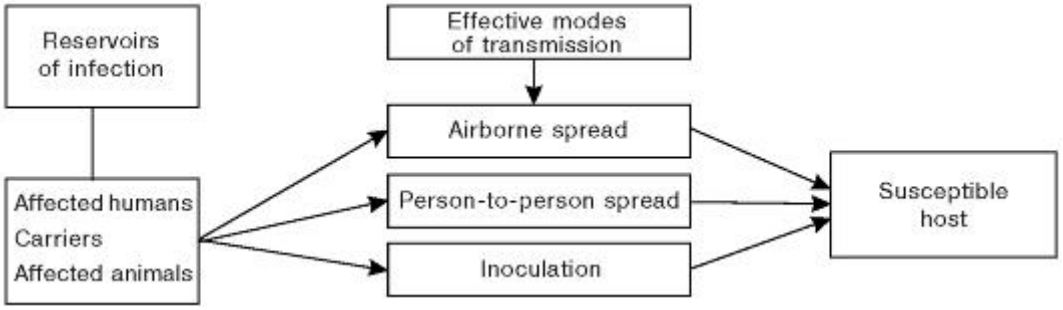

Fig. A. Extrinsic infection.

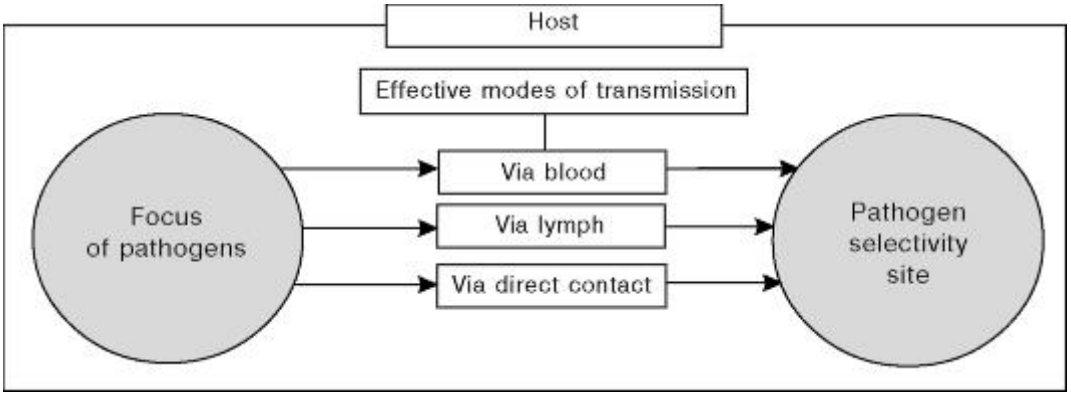

Fig. B. Intrinsic infection.

An operating unit houses special rooms for operating on patients. It has to be isolated from surgery departments on a separate floor or detachment of the building and be connected with the them by a corridor.

To provide the regimen of sterility, there are the four special functional zones in the surgical block:

1. The sterile zone, i.e. the operating theatre (to operate on patients), scrub-up room (for preoperative cleansing surgeons' hands and arms) and the room for sterilisation (to sterilise the instruments to be used during the operation).

2. The clean zone, i.e. the rooms for personal hygiene and changing clothes of the staff.

3. The technical zone, i.e. the rooms where apparatus for air-conditioning or oxygen supplying and vacuum devices are stored.

4. The dirty zone, i.e. the sister's room, the room of the head of surgery and the one for dirty clothes etc.

The operating theatres equipped for using laminated sterile conditioned air are needed for the following types of operation: tissue grafting with subsequent application of immune suppressors, implantation of prosthetics, operations for burns.

Setting of a special isolator box with laminated air flow is possible in the operation rooms built long ago.

The compounds that have antibacterial effects fall into two main groups - chemotherapeutic agents (see «Antiseptics») and chemical agents for disinfection and sterilisation.

The compounds for disinfection and sterilisation are used to prevent microbes from entering the wound, i.e. to affect their transmission. Several chemical antibacterial agents can be applied as both a chemotherapeutic agents and those for disinfection and sterilisation (e.g. chlorhexidine, hydrogen peroxide).

Among the chemical agents for disinfection and sterilisation commonly used in surgical practice are as follows:

Trade name	Formulation	Indications	Notes
Iodine	1-5% alcohol solutions of iodine	Cleaning the skin around the wound, cleansing superficial wounds and bruises, and the operative field.	Lugole's solution is used for the sterilisation of catgut.
lodinate	Iodine plus sulphate; contains about 4,5% free iodine	Cleaning the operative site	Before use it has to be dissolved in distilled water in the ratio of 1:4,5
Povidon - iodine	A combination of iodine (0,1 - 1%) and polivinylpir-rolidon	Scrubbing the hands and cleaning the operative site.	
Chloramine B	1 -3% solutions	Disinfecting the hands, items used for patient care, non-metallic instruments, rooms	
Formic acid		Cleaning hands before operations, washing surgical instruments and gloves.	Special solutions of the formic acid are prepared e.g. in combination with hydrogen peroxide (pervomur)
Mercury dichloride	Mercury dichloride1:1000	Disinfecting rubber gloves, patient care items	This solution is seldom used (mainly in the outpatient set-up) due to its toxicity
Ethyl alcohol	70% and 96% solutions.	Disinfecting hands, operative site, and optical instruments, suturing material.	

Formaldehyde	Formaldehyde (36,5-37,5%)	Disinfecting gloves, instruments catheters drainage systems (2-5% solution)	
Triple solution	Formaldehyde - 20 g, carbolic acid or phenol - 10 g, sodium carbonate - 30 g, distilled water - up to 1000 ml.	Disinfecting gloves, instruments and drainage systems	A very effective disinfectant
Carbolic acid	Phenol (3-5% solution)	Disinfecting items of patient care	
Roccal (Roccal)	1% or 10% alkyl diethyl benzyl ammonia chloride	Sterilising instruments (1: 1000; exposition period 30 minutes), gloves, drainages (1:4000; exposition period - 24 hours)	To prevent the instruments from corrosion sodium carbonate is added to the «working» solution in the ratio of 2 g/l.
Chlorhexidine	Cleaning the operative site and disinfecting instruments (70% solution alcohol; 1: 400; exposition period - 2 minutes)		

Prevention of microorganisms' contact with the wound

Prevention of the contact (contagious) infection requires that everything that touches the wound be sterile. This is achieved via disinfection of instruments, as well as cleaning the surgeon's hands and operative site. Sterilisation of the suturing material prevents both contact and implant infection of wounds.

Sterilising instruments, operating sheets, towels and dressing materials involves the following stages:

stage 1 - preparation of the materials,

stage 2 - preparing for sterilisation itself,

stage 3 - sterilisation,

stage 4 - safe-keeping of the materials sterilised.

All these stages are to be performed in accordance with specific standards ^Sterilisation and disinfection of materials for medical use».

Sterilisation of instruments

Stage 1 - *preparation of the materials* - is aimed at thorough mechanical cleansing of instruments; removal of pyogenic compounds and destruction of hepatitis viruses. The person responsible for this should always wear gloves.

The instruments that were used but not infected will be washed under running water separately with a brush for 5 minutes. In contrast, blood-stained equipment must be washed

immediately (without subsequent drying!), then soaked in one of special washing solutions, warmed to a temperature of 50 °C for 15-20 minutes, syringes being dismantled before washing.

The formulations of the washing solutions are as follows:

• *Solution A*

Perhydrol - 20 g washing detergent - 5 water - 975 ml.

• *Solution B* 2,5% hydrogen peroxide - 200 ml washing detergent - 5 water - 795 ml.

After soaking the instruments, particularly their corners and folds, instruments are washed with brush in the same solution and then rinsed in warm water for 5 minutes and in distilled for another. The instruments are then packed into a drying air steriliser under the temperature of 85 °C; thereupon these are ready for sterilisation.

The instruments contaminated with pus or intestinal contents are first soaked in enamel containers with 5% lysol for 30 minutes, then washed in the same solution with brush, rinsed with running water and soaked in one of the washing solutions; the further steps are as given above.

It is noteworthy that the equipment used to operate on patient with anaerobic infection should be soaked in a special solution that contains hydrogen peroxide (6%) and washing agent (0,5%) for 1 hour, then washed with a brush in the same solution before boiling for 90 minutes (it is only after this that the instruments will be ready for thorough sterilisation as is the case with instruments which have not been infected).

Injection needles are washed by first attaching syringes to them using warm water and 1% sodium hydrocarbonate, the canal being emptied with a mandrin and washed with 0,5% liquid ammonia and running water. The needle with its mandrin still in is then boiled for 30 minutes in 2% sodium bicarbonate and after 8-12 hours boiling is repeated in distilled water for 40 more minutes and dried. After this, the canal of the needle is to be dried by pushing in ether or alcohol with a syringe. The needles which have been contaminated with pus are thoroughly washed, the canal washed with running water and then soaked for an hour in 5% lysol, simultaneously washing the canal with lysol with the aid of a syringe before proceeding as in the case if the instruments have not been contaminated.

Drug and blood transfusion sets need to be washed thoroughly to prevent post-transfusion reactions and complications. Recently, these have been made disposable (to be used only once), which are sterilised by the producer. The other sets that can be resterilised will be dismantled immediately after use - the glass side, droppers and plastic tubes - to be thoroughly washed with running water by pressing on the plastic side to clear away any blood remnants. Certain parts of the system are soaked for 2 hours in a special solution (1% sodium bicarbonate and 1% ammonium solution) which had previously been warmed to the temperature of 60 °C. The other parts of the set should be boiled for 30 minutes in distilled water after washing with running water, washed again with water under pressure on the plastic tube to force out any blood stains, and boiled once again for 20 more minutes in distilled water. Thereafter, this set is arranged and packed for sterilisation.

Currently, medical *gloves are* disposable and previously sterilised by the manufacturer. If plastic gloves are to be used several times, those stained with blood are not disposed but washed under running water until all the blood is washed away, dried with a towel and soaked for 30 minutes in 0,5% ammonium or in a washing solution A or B. They are then to be washed with running water, dried, and packed for sterilisation.

To make sure the materials are free of blood stains following presterilisation, the benzidine test is applied. Three drops of 1% benzidine and hydrogen peroxide are put on the material or instrument tested; a bluish-green coloration suggests the presence of blood. This requires that washing (stage 1) be repeated.

Stage 2 - *arrangement and package for sterilisation.* For sterilisation in an air-drying steriliser the instruments are arranged in a metallic box, vertically and in one layer with the lid open but lying by its side. Dismantled syringes are wrapped in two layers of special thick paper.

For the sterilisation in an autoclave (steam under pressure) the instruments are wrapped into towels or cotton cloth made into bag and arranged on a metal tray or net. Sets of instruments for typical operations on the heart, lung, bone, vessels are sterilised together; they are arranged on special trays and wrapped in sheets.

The cylinder and piston of the syringe are wrapped separately into gauze napkins then into a cotton bag, which is then placed into the dressing box. The sets are wrapped in cotton napkins and put in the steriliser.

Dried rubber gloves are sprinkled with talcum powder both inside and outside, arranged in pairs in gauze napkins and placed in a separate dressing box.

Stage 3 - *sterilisation.* Sterilisation of instruments, syringes (with the inscription «200 °C»), needles, glass containers is done with an dry-air oven (fig. 1). The materials are freely arranged on the steriliser's shelf and the apparatus switched on. With its doors open the steriliser is heated to a temperature of 80-85 °C to dry its interior and the instruments for 30 minutes. The doors are then closed and the temperature increased to 180 °C and maintained automatically; within 60 minutes the materials are sterilised. After switching off and cooling to 70-50 °C the door is opened, the metal container with the instruments is covered with its sterile lid. Within the next 15-20 minutes when the steriliser is cool the materials can then be removed.

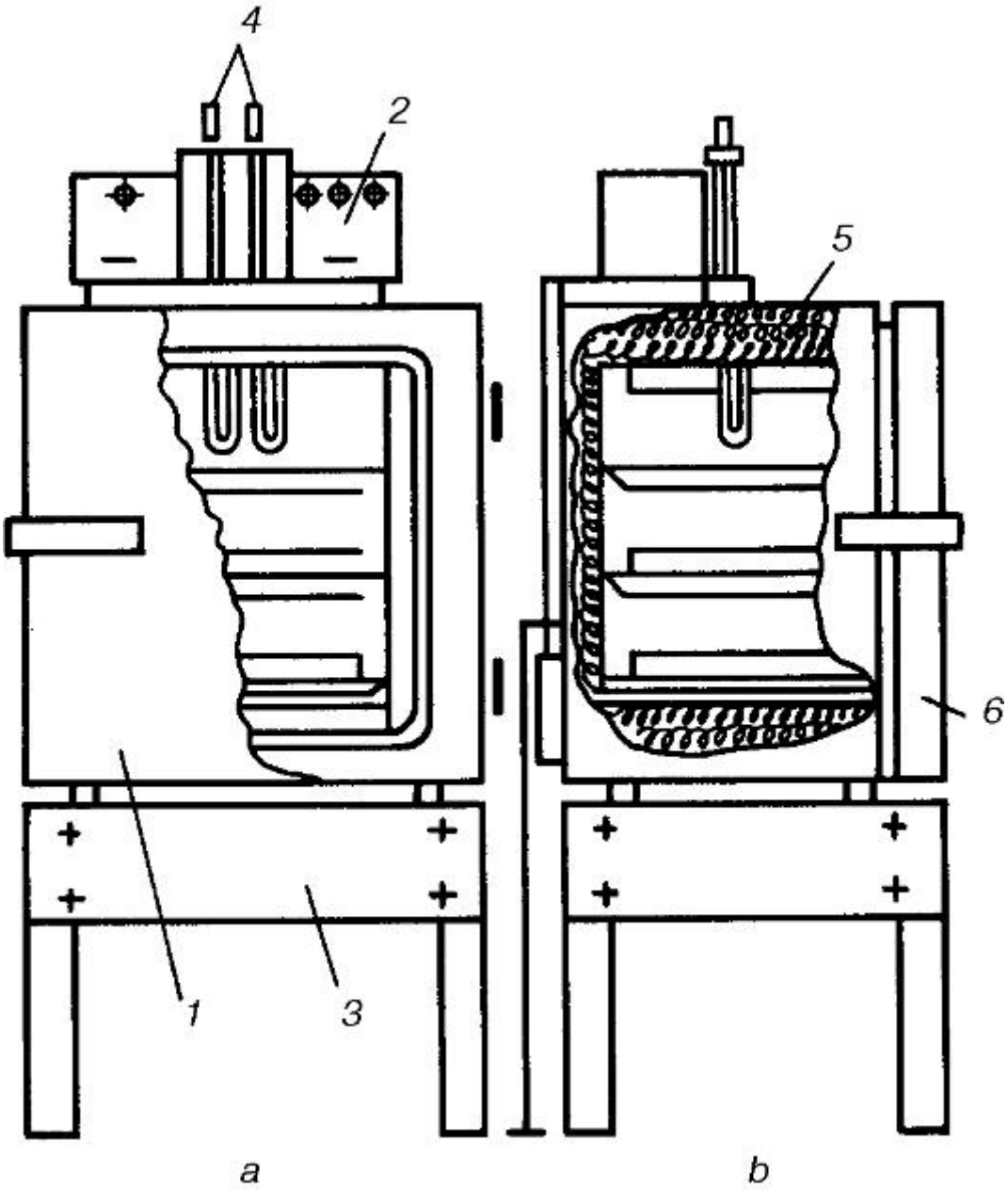

Fig. 1. Dry heat steriliser.

a - anterior view; *b* - lateral view; *1* - body; *2* - control panel; *3* - support; *4* - thermometers (direct contact and transistor thermal regulators); *5* - electric heaters; *6* -door.

Whilst working with the dry-air oven steriliser safety measures must be taken: the apparatus must be earthed, after sterilisation the door can be opened only when the temperature has reduced to 70-50 °C. It is forbidden to use a faulty apparatus.

Sterilisation of instruments can be done in an autoclave (fig. 2). The wrapped up materials are packed into the sterilising chamber. If the items are packed into a dressing box, then its lattice should be opened. Dressing boxes and other containers must be placed freely to allow an equal distribution of the steam.

Surgical instruments are sterilised within 20 minutes at 2 atmospheres (1 atmosphere = 1,013 x10^5pa) which is the equivalent of 132,9 °C. The starting time for sterilisation is counted from the start of the required pressure. Plastic drainage tubes are sterilised at 1,1 atmospheres (steam temperature of 120 °C) for 45 minutes. When the dressing box is removed from the autoclave after sterilisation, its opening is closed immediately.

Sterilisation in the dry-air oven and autoclave are considered as the main methods. Boiling as a method of sterilisation is used in small centres, where there are no centralised sterilisation systems. Stationary or portable electrical heaters are used to sterilise instruments, glass objects, plastic drainage tubes, catheters and gloves. Distilled water is used to raise the point of boiling; 20 g of sodium hydrocarbonate per 1liter of water is added to destroy the bacterial sheath (2% solution). The bottom of the water heater is lined with a thin layer of material made up of cotton wool and gauze to absorb sediments onto it and not onto the instruments.

Dismantled, instruments are put on special nettrays and lowered by hooks down into the boiler such that their handles are left outside the boiler, which is then closed. Sterilisation time is 40 minutes from the onset of boiling. At the end of sterilisation the net tray with instruments is raised by the hooks, allowed to drain and brought to a special table, which had been previously covered with a sterile sheet folded into four layers. The operating theatre nurse arranges the instruments on a big sterile table. Instruments contaminated with pus and intestinal contents, after special cleaning as stated above can be sterilised by boiling for 90 minutes using a different boiler.

Instruments used for a patient with gas gangrene have to be handled carefully, with thorough cleaning and subsequent fractional sterilisation by boiling. They are boiled for an hour, removed from the boiler and left to stand at room temperature for 12-24 hours (to allow the spores to geminate), and then boiled again for another one hour.

The main method used to sterilise plastic items (gloves, catheters, drainage tubes) is autoclaving. In very rare cases they are boiled for 15 minutes

Sterilisation of instruments that cannot stand heat (endoscopes, thoracoscopes, laparoscopes, the set of instruments used for artificial blood circulation or for heart-lung bypass), are done in special gas sterilises (fig. 3). Materials for sterilisation are put in airtight sterilisation chambers filled with ethylene dioxide. Exposition time is 16 hours with the temperature of 18 °C. A mixture of ethylene dioxide and methylene bromide under the temperature of 55 °C can also be used to sterilise within 6 hours.

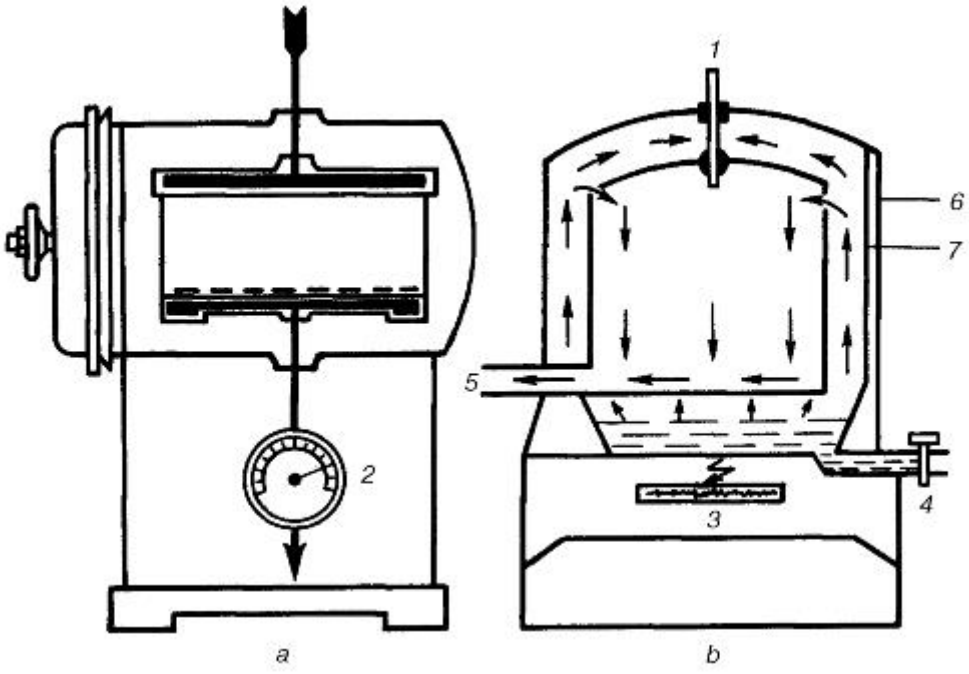

Fig. 2. Steam steriliser (autoclave).

a - lateral view; *b* - anterior view; *1* - thermometer; *2* - manometer; *3* - heater; *4* - inlet tap; *5* - outlet; *6* - external wall; *7* - internal wall.

Sterilisation of optical instruments (laparo-scopes, thoracoscopes, and choledochoscopes) can be done in alcohol solutions of chlorhexidine and pervomur. Sterilisation of apparatus and instruments, using chemical compounds should be done in metallic containers with covers to prevent evaporation and pollution of the air in the room. In the absence of special containers they are sterilised in containers made of enamel or glass. The instruments are covered with water such that all of them are under the water and covered with the lid.

In emergency, when it is not possible to sterilise the instruments using any of the above-stated methods, sterilisation can be achieved by burning. 15-20 ml of alcohol are poured into a metallic pan or dish, several instruments are put inside and the alcohol is burned. The burning method is not very reliable, can cause fire and explosion (in the presence of vapours of ether, etc). Because of these the method of burning is used only in extreme conditions, strictly taking fire safety measures.

When cutting instruments (scalpels, scissors) are sterilised in the ordinary way, they turn blunt, so it is better they are sterilised without heat. After pre-sterilisation they are put into 96% of ethyl alcohol for 30 minutes or in triple solution for 3 hours. Cutting instruments are allowed to boil for only a short period of time. The blades of scalpel are wrapped in gauze and placed on separate net tray and boiled for 10 minutes without adding sodium bicarbonate, and then they are put in 96% ethyl alcohol for 30 minutes.

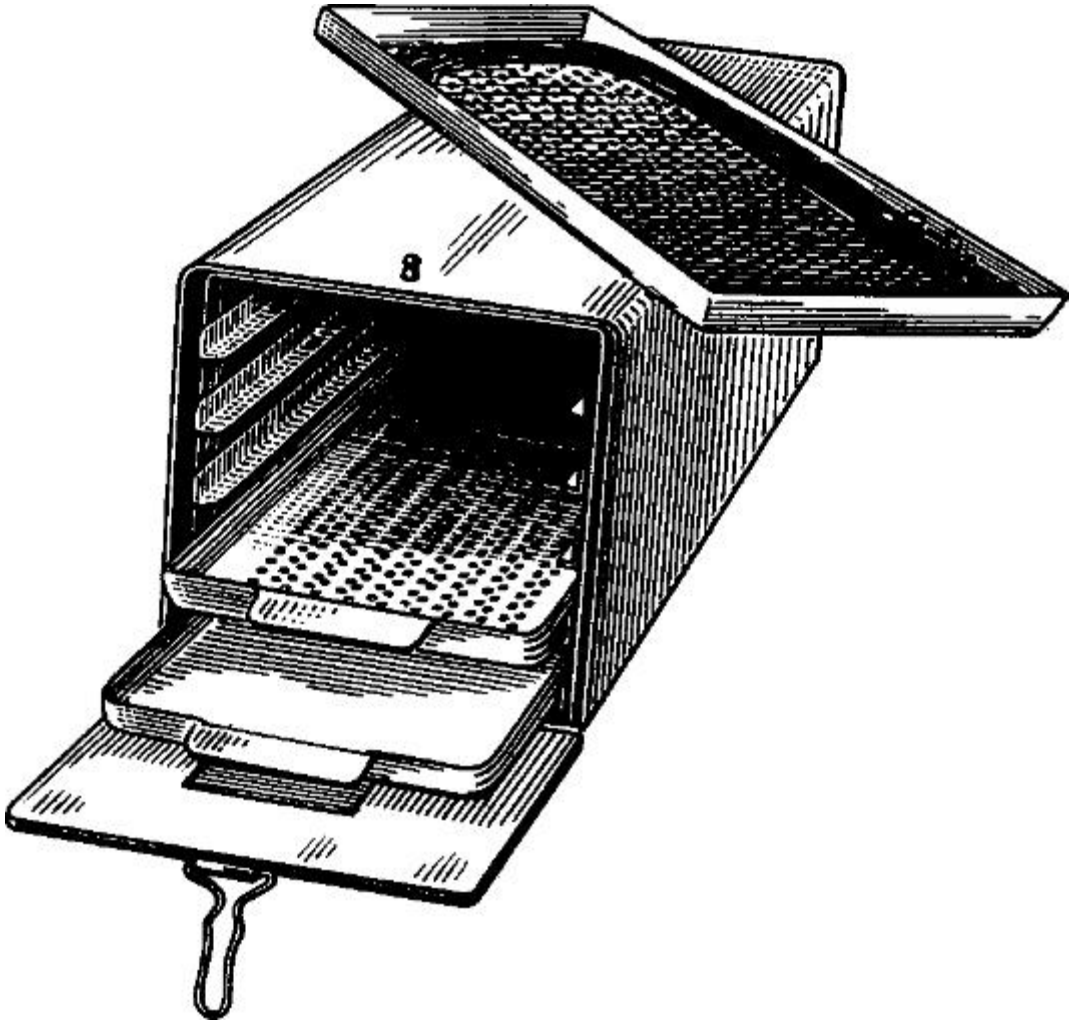

Fig. 3. Gas steriliser.

Stage 4 - *Keeping the sterilised materials.* Sterile materials are kept in special containers. Sterile and non-sterile items may not be kept at the same container. Materials can stay sterile in a dressing box, which has not yet been opened for 48 hours. If before packing in the dressing box the materials were wrapped in (towels, sheets or napkins) as is the case with rubber drains), then

they can stay sterile for 3 days. In cases of centralised sterilisation syringes can be sterile for 25 days.

Sterilisation of dressing materials, operating sheets and suturing materials

Stage 1 - *presterilisation.* Dressing materials include gauze balls, towels, pack, and swabs. They are used during operation and dressing mainly for keeping the wound dry, stopping bleeding, for drainage or for packing the wound. Dressing material is prepared from gauze and cotton wool and rarely from viscose and linen. They have to have the following characteristics:

1) they should be biologically and chemically inert and void of any negative effects on wound healing;

2) they should have good hygroscopic, or water absorbing, properties;

3) they should have a few free threads from outside; this will prevent pieces of thread from falling into the wound as these can act as foreign bodies in the wound;

4) they should be soft, elastic and not traumatise the wound;

5) they should be easy to sterilise without loosing its qualities;

6) they should be cheap, considering its wide use. Annually, 200 metres of gauze and 225 pieces of bandage are normally spent per a surgical bed. Appendectomy alone, for example, requires about 7 metres of gauze.

Dressing materials are prepared from gauze that has been cut into smaller sizes. They are folded in a way that the cut edges are folded inside so that the threads do not hung freely outside. Enough material is always prepared so that there is always some reserved. To facilitate easy counting during operation they are arranged in a particular order before sterilisation: 50-100 cotton wool balls in one gauze wrapper. Ten swabs tied in one pack. Operation clothes include the following: surgical gowns, towels, sheets, napkins, masks, caps, and boot-covers, which are normally made of cotton. Operation materials that are used several times (non-disposable) have to be marked and given to the laundry separately from those that are in the special bag. The gowns should not have pockets or belts. Gowns, bed sheets, napkins, towels for sterilisation are folded in rolls to make them easy to spread when using.

Stage 2 - *package and preparation of materials for sterilisation.* Dressing materials and operation sheets are packed in special containers (dressing boxes) (fig. 4). For the lack of such boxes they can be sterilised in thick cloth-bag.

In a universal package, the dressing box contains a set of materials for a typical minor operation (e.g. appendectomy, herniorrhaphy, phlebectomy).

In specific packages, the dressing box contains the set of materials for a specific operation (e.g. pneumonectomy, stomach resection). In a typical pack the dressing boxes contain packs of the same material (e.g. box of gowns, box of napkins, box of swabs).

The dressing box is first inspected to make sure it is in good condition, and is then lined with a sheet whose ends hang outside. Further, the dressing materials are arranged in a vertical position in sectors of packets. The materials should not be arranged too close to each other to allow for circulation of the steam. An indicator of the sterilisation regime is placed inside (maximum thermometer, a melting material, or a test tube with test-microbes), the ends of the sheet are folded to cover, and the dressing box covered and locked with a padlock. A labelled plaster indicating the type of material is pasted on the box, and after sterilisation, the date and name of the one who did the sterilisation is added.

When the items for sterilisation are packed in a bag, they should not be arranged too tight, and the bag is tied with a special metallic tie. The bag is put into another bag and tied. When it is necessary to use the sterilised materials in the bag, it is placed on a table; the nurse

assistant opens the first bag and pulls it down. The theatre nurse then opens the inner bag with sterile hands and removes the sterile items from it.

Stage 3 - *sterilisation.* It is noteworthy that an autoclave may be used only after it has been certified and the person in charge of the autoclave needs to be qualified appropriately. Using the steam-electric steriliser, one has to follow the exact instructions and safety measures.

- The equipment must be earthened.
- Faulty equipment should never be used.
- When in use, the equipment should be under control.
- Do not add water after the equipment has been switched on.

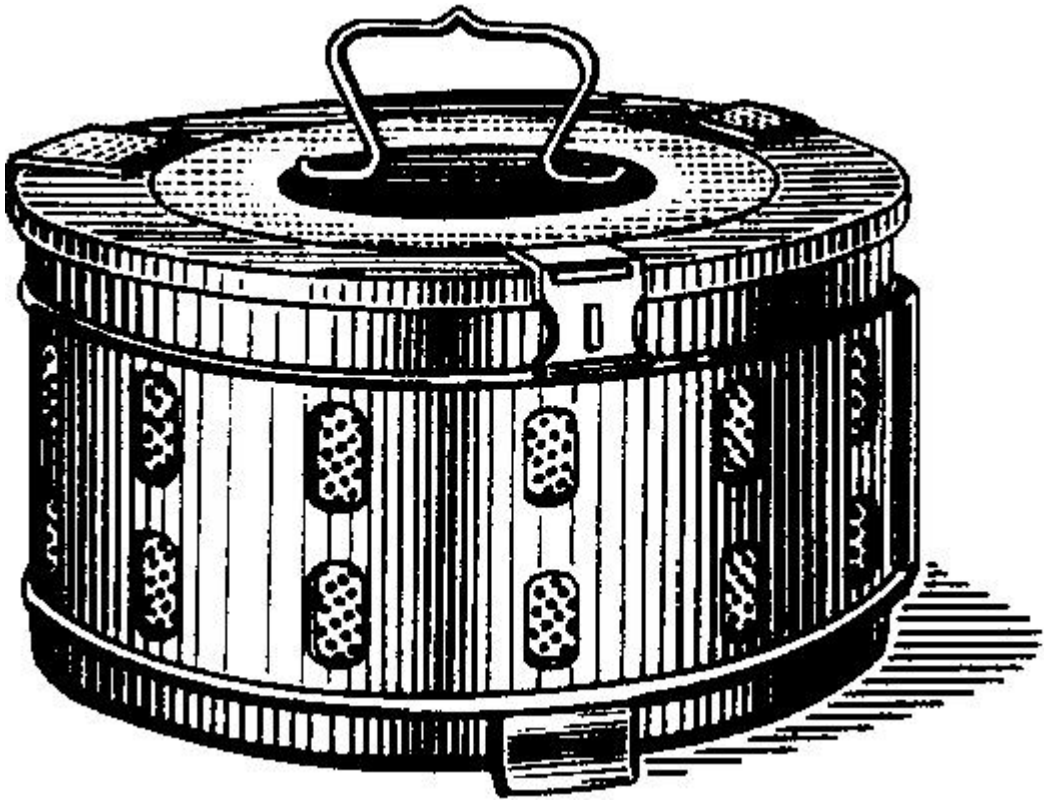

Fig. 4. Schimmelbusch's steriliser.

After sterilisation the apparatus should be switched off, and the ventilator closed not to let any more air into the sterilisation chamber.

The cover of the sterilisation chamber is opened only when the arrow of the manometer has reached the zero mark.

Sterilisation time is counted from the time when the manometer reaches the required pressure. Dressing materials and operation sheets are sterilised for 20 minutes at 2 atmospheres (temperature 132,9 °C).

Stage 4 - *keeping the sterilised materials.* After sterilisation ends the sterilisation chamber is emptied, dressing boxes are removed, all openings are immediately closed and brought to a special table for sterile materials. Dressing boxes are kept locked in a special room. With an intact dressing box dressing materials and sheets can stay sterile for 48 hours after sterilisation has completed. Dressing materials and sheets sterilised in the bag can stay sterile for only 24 hours.

Control of sterility

The sterility of the items and the working regime of the steam steriliser can be controlled either by a direct or indirect method.

Direct methods

• Inoculation of medium with a swab of the dressing material.

To inoculate medium with a swab, open the dressing box in the operating theatre, using a sterile instrument. Soak a piece of sterile gauze in normal saline which is passed several times on the material to be tested, then drop the piece of gauze into a sterile test tube and send it to the microbiological laboratory

• Bacteriological tests.

A test tube that contains reference non-pathogenic cultured microorganisms known to die, if exposed to a certain temperature, is used. Place the test tube inside the dressing box and send it to the laboratory after sterilisation is over. Absence of bacterial growth implies that the items are sterile.

The swabs should be taken from once every 10 days.

Indirect methods

• Control of sterility of materials is done each time they have been sterilised. Compounds with known specific melting points are used for this purpose: benzoic acid (120 °C), resorcinol (119 °C), antipyrin (110 °C). These compounds are kept in ampoules. They can also be put into test tubes (0,5 g each), and closed with gauze plug. One or two ampoules are placed in between the layers of materials to be sterilised. Melting of the powdered compound into a liquid mass implies that the temperature in the box was at least as high as the melting point of the compound. If sterilisation is performed at 2 atmospheres (temperature 132,9 °C), compounds with higher melting points are used: ascorbic acid (187-192 °C), succinic acid (180-184 °C), pilocarpine hydrochloride (200 °C), thiourea (180 °C).

Thermometry is known to be the most objective indirect methods of sterility control. In each dressing box 1 or 2 thermometers are placed in between the layers of materials to be sterilised. The readings will indicate the maximum temperatures but not the exposition time, i.e. for how long such a temperature was maintained in the chamber. Hence this method does not preclude the use of direct methods like the bacteriological test.

Suturing material

Materials from different sources (e.g. metallic brace, clips and wires) are used in sewing tissues together during operations. There are more than forty types of suturing materials: widely used are those made of silk, nylon, catgut, vicryl, metallic braces.

Both resolvable and non-resolvable threads may be used. *Natural resolvable* threads are made of catgut. To lengthen the resolution time of catgut, metallic compounds are impregnated into them (chromic and silver catguts). The examples of *synthetic resolvable* sutures are dexon, vicryl and oxylon.

Non-resolvable natural sutures include sutures made of natural silk, cotton, yarn; their *synthetic*equivalents are dacron, nylon, ftolon, silk, kapron, etc.

Suturing material should meet the main requirements as follows:

• have smooth level surface without causing additional damage to the tissues;

• have good manipulating qualities - slip easily through tissues;

• be elastic (sufficient elasticity prevents tissues from being pressed on and necrotized when they subsequently become oedematous);

• be firm at the knots;

• be non-hygroscopic and not swell up;

• be biologically compatible with bodily tissues and not be allergic to the body.

Breakdown of the suture and healing the wound should be simultaneous.

Wound infection rarely occurs when suturing material with antimicrobial activity is used, this is achieved by incorporating into the sutures the antibacterial compounds (e.g. letinal-silk, ftorlonov, acetate and other sutures, containing nitrofuran, antibiotics). Synthetic sutures that contain antiseptics both possess all the qualities of clean materials and cause antibacterial effect.

Sutures can be sterilised with gamma rays by manufacturers. Silk or catgut sutures in ampoules can be kept at room temperature. Metallic suturing materials (wires, clips, braces) are sterilised in the autoclave or can be boiled while cotton sutures, lavsan, kapron may be sterilised in an autoclave. Silk, kapron, lavsan, linen, cotton are sterilised by Kocher's method. Catgut is treated with iodine steam (Sitkov's method), in alcohol solution of Lugole (Gubarev's method) or in water solution of Lugole (Heinac-Claudius method). When catgut is sterilised by the Gubarev's method, it is kept in alcohol solution of Lugole. When Heinac-Claudius method is used, they are kept in 96% ethyl alcohol. Lugole's solution or alcohol should be changed each ten days; bacteriological control each time is obligatory. Silk is kept in 96% ethyl alcohol with a label showing the suture number, dates of preparation and of bacteriological testing. The alcohol should be changed every ten days and bacteriological test done simultaneously.

Preparation of the hands for operation

Scrubbing of the hands is a very important way of preventing infection. Surgeons, operating theatre and dressing nurses should always see to it that their hands are clean, take care of their skin and nails. Taking care of the hands prevents from their cracking and callosity of the skin are prevented. The nails should always be trimmed and short. Whenever very dirty work is to be done manually, gloves should be it is better to worn. Taking good care of the hands should be regarded as a step in the preparation for operation. Whatever method of scrubbing the hands is used, this should start with mechanical cleansing.

Fuerbringer's and Alfred's methods are only of historic value and involve using sterile brush and sterile soap to scrub the hands. Soap is applied to the brush, which is kept in the right hand. After soaping the soap is placed on top of the brush and held at the hand which holds the brush. The brush or napkin should always be moved from outside the fingers to the elbow, fingers should be kept higher than the elbow and the stream of running water from the fingers to the elbows. Scrubbing with the brush is started and ended so that dirty water does not flow back from the elbow to the fingers. Scrubbing starts from the palmar aspect of each finger, then the dorsal aspects are scrubbed, the nail lodges, in between the fingers of the left hand, then the right, the palms and dorsal of the left, further the right hand, and lastly the hands up till the upper third of the forearm towards the elbow joint. The soapy foam is constantly washed away under the running water; the brush is soaped when necessary. Throughout the process of scrubbing it is forbidden to touch the tap, the water flowing; the temperature having been regulated before scrubbing is starts. At the end of scrubbing, the brush and soap are put on a table, the hands rinsed and with the fingers at the level of the chest they are dried with sterile a gauze or napkins, without touching the parts that were not scrubbed. Later on, depending on the method used, the fingers, hands, palms and the lower parts of the forearm are wiped with gauze soaked with alcohol solution and other antiseptics.

- Spasokukotski-Kochergin's method (also uncommon nowadays)

This method involves mechanical cleansing of the hands with 0,5% ammonium. The hands are washed for 3 minutes in each of the two bowls, using a gauze or napkin, and following the steps similar to those in which the brush is used, starting from the fingers of the left hand. In the first bowl, the hands are washed up to the elbow, and in the second one they are washed up as high as the upper third and the middle of the forearm. At the end of scrubbing, the hands are rinsed with ammonium solution and the fingers raised so that the water drains towards the elbow. Since this moment the fingers should constantly kept above the level of the forearm. It is

preferable to dry the hands with a sterile gauze or towel: first dry both hands and discard those napkins, then dry the lower parts of the forearm and then the middle parts.

The hands are disinfected with 96% ethyl alcohol, twice for 2 minutes each, the fingers and hands up till the lower third of the forearm, then the finger tips nail folds; skin creases and folds of the fingers and hands are smeared with 5% alcohol solution of iodine.

Current ways of hand scrubbing involve washing them with running water with soap or liquid washing compounds and subsequent disinfection with chemical antiseptics.

• Pervomur (C-4)

Pervomur is a solution that contains formic acid and hydrogen peroxide. The main solution is prepared initially in the ratio of 81 ml of 85% formic acid and 171 ml of 33% hydrogen peroxide which are mixed in a glass container with a plug and kept in the refrigerator for 2 hours, with periodical shaking. The two compounds react to form a type of the acid with a stronger bactericidal effect. From this amount of the main solution ten litres of 'working solution' of pervomur can be prepared via diluting it with distilled water. The working solution can be used within a day. Preparing the solution, one has to wear gloves to prevent the concentrated solution from burning the hands. Washing with running water and soap for a minute first precedes disinfection of the hands. The hands and forearms up to the middle third are then washed in the bowl with pervomur for another minute and dried with a sterile napkin. As many as five people can use the same bowl of solution.

• Chlorhexidine (0,5% alcohol solution)

The hands (the finger up to the midforearm) are smeared with gauze swabs soaked in the solution of chlorhexidine for about three minutes; prior to this the hands are washed with soap for a minute.

• AHD solution and Eurosept

These solutions contain the antiseptics such as ethanol, chlorhexidine, and polyiolic fatty acid ether. The hands are first washed with soap and running water for a minute. A few millilitres of the solution are then poured onto the hands twice and rubbed for 2-3 minutes each.

Faster ways of washing the hands are used in the outpatient clinics and under extreme conditions (e.g. wartime). Special agents of membrane forming (e.g. «cerigel») with very strong bactericidal effect are used. This compound contains polyvinyl-buterol and 96% ethyl alcohol. Washed with soap, the hands are well dried. 3-4 ml of cerygel are poured into the palm and rubbed on the fingers, hands, up till the lower third of the forearm for 10 seconds. The fingers are half-stretched and spread for 2-3 min, until a membrane of cerygel is formed around the hands. This membrane has bactericidal function, and can easily (with gauze swabs soaked with alcohol) be cleaned off after the operation.

The hands can also be cleansed by rubbing the hands with 96% ethyl alcohol for 10 minutes (Brun's method) or with 2% alcohol solution of iodine for 3 minutes.

Cleaning the operative field

Preparation of the place of the expected incision (operative field or site) starts on the day preceding the operation, which includes hygienic baths and a change of underwear. On the day of operation, the skin of the expected place of incision is dry-shaved and cleaned with alcohol.

Immediately before the operation, on the operating table, the operative field is abundantly smeared with 5% alcohol solution of iodine. The operation site itself is isolated with sterile towels and again smeared with 5% alcohol solution of iodine. Before suturing, the skin is smeared with 5% alcohol solution of iodine and repeated after the suturing. This is known as *Grossich-Filonchikov's method.*

In a patient allergic to iodine the skin can be prepared with brilliant green (Bakkal's method). On the operating table, the operation site can be can be prepared with derivatives of iodine such as iodonate, povidon-iodine, betadin.

In urgent operations, the preparation of the operation site involves shaving of the hair, cleaning the skin with 0,5% ammonium, using one of the methods (Grossich-Filonchikov's or Bakkal's one or application of iodine derivatives).

1.1 ANTISEPSIS

There are four types of antisepsis: mechanical, physical, chemical and biological.

Mechanical and physical antisepsis

Mechanical antisepsis is based on surgical debridement of wounds. This is performed in the surgical theatre and involves excision of the edges, walls and the floor of wounds to remove the non-viable tissue and microorganisms within the wound. It is the major method to treat accidental, infected wounds (see «Wounds»).

Physical antisepsis starts from the law of capillarity, hygroscopicity, diffusion, osmosis, siphoning, ultrasound and laser effects.

These are the principles used:

• to enhance drainage from wounds and pus from abscesses and empyemas,

• to facilitate flow to the outside (into a dressing or a special container with antiseptic solution).

For the treatment of wounds, a gauze pack is used as the drain. Packs of different sizes are made of gauze strips and packed loosely into the wound; owing to their hygroscopic qualities the swab absorbs blood, exudates and pus. Its draining capacity lasts as long as 8 hours. Following this, it turns into a «plug» that blocks the wound and inhibits the flow of exudates outside. To increase the drainage capacity of dressing, the pack is soaked in hypertonic solution (5-10% sodium chloride). This yields a higher osmotic pressure and therefore enhances the flow of liquids from the wound into the dressing.

Apart from the ordinary pack, Mikulin's swab can also be used. A big gauze napkin with a thread sewn into the centre is packed into the wound. The napkin is placed on the floor and walls of the wound to form a packet, which is filled with gauze swabs or packs. When the swabs get soaked with secretions, the former need to be replaced with new ones, the big gauze napkin being left alone. The packs are changed several times until they appear to contain no pus. Following this the main gauze napkin is removed by drawing the thread.

Wounds can also be drained by using plastic, vinylchloride or other tubes of different diameters, which are placed in the wounds, abscess cavity, joints (in purulent arthritis), pleura (in purulent pleuritis), abdominal cavity (in purulent peritonitis). The pus, products of tissue decay, and microorganisms are discharged through one or several drains into the dressing. The drain can be connected by a tube to a container with an antiseptic; thus the secretions empty into the container which prevents pollution of the dressing. Chemical antiseptics, antibiotics, proteolytic enzymes can be inserted through the drainage into the wound or cavity.

To provide a more effective washout of wounds and purulent cavities, apart from the drainage tube, another tube can be placed, through which antibacterial agents can be given and pus, products of tissue decay, blood and fibrin are discharged (fig. 5). Hence a combination of physical and chemical antisepsis results in continuous irrigation drainage. This method is also used in purulent pleuritis and peritonitis. To enhance its efficacy, proteolytic enzymes are used as the washing solution, which promotes lysis of non-viable tissues, pus and fibrin (enzymatic irrigation dialysis method).

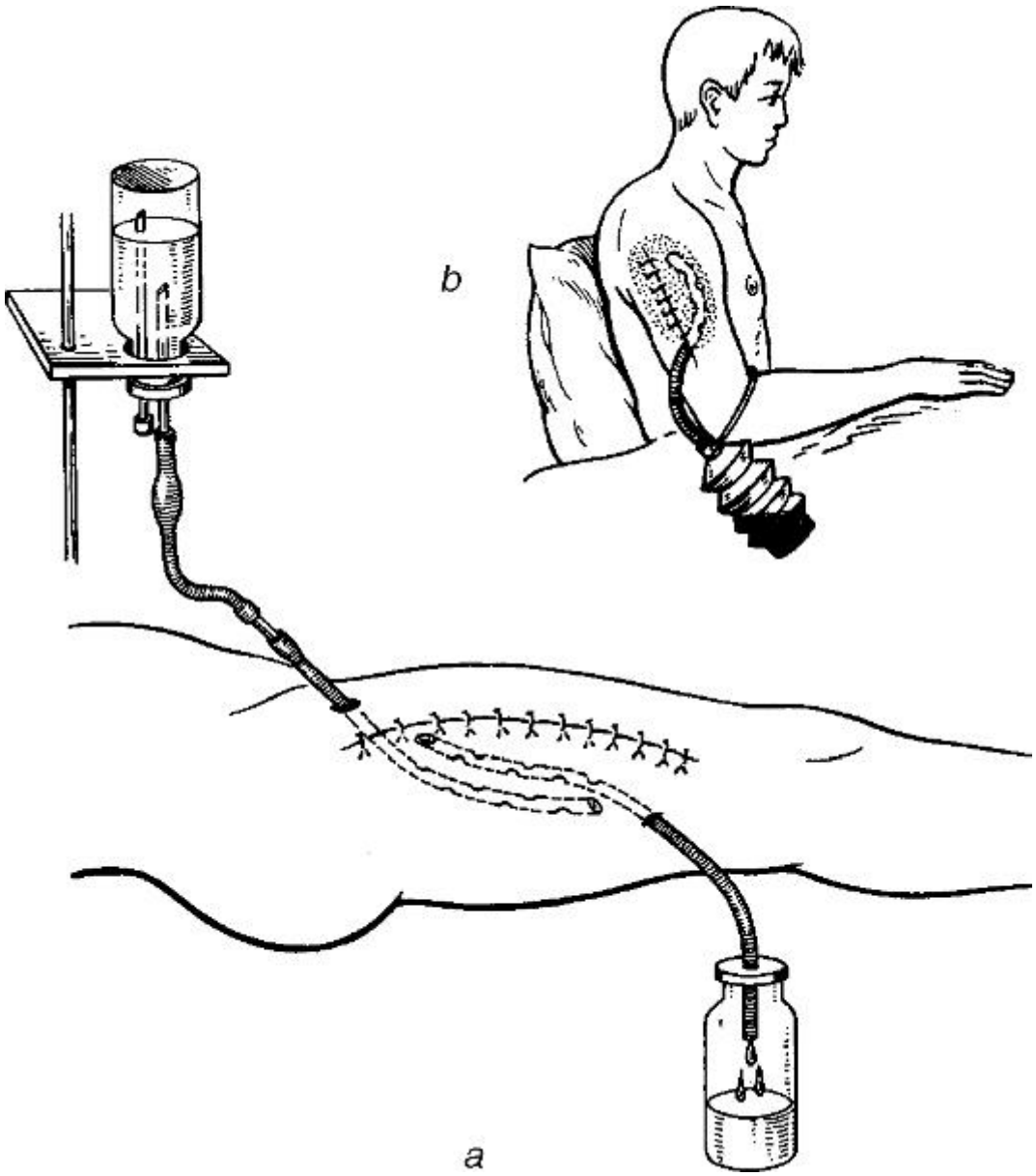

Fig. 5. Through (a) and suction (b) wound drainage.

If the draining cavity is sealed (sutured wound, pleural empyema, purulent arthritis, abscess), active aspiration, or vacuum drainage, can be used. Negative pressure in the system can be reached with Janet's syringe which is used to evacuate air from a sealed bottle connected to a drainage tube, or with the aid of flowing-water suction or a three-bottle system. This is known to be the most effective way of drainage. It also helps reduce the size of the wound cavity and cause fast obliteration and removal of infection, and facilitates expansion of the lung collapsed as a result of the pressure of exudates in pleural empyema.

Chemical antisepsis

Synthetic antibacterial agents are used to combat bacterial infection in the wound or inflammatory foci. These are both effective for therapy and prophylaxis and help achieve antibacterial effect inside the human body.

- Derivatives of nitrofuran. These agents are effective against purulent cocci.

— *Furacilin*

Aqueous solution (1:5,000) is used for washing out purulent wounds during dressing, washing out abscess cavities and empyemas through the drainage tube (e.g. in purulent pleurisy and purulent fistula of osteomyelitis).

— *Soluble Furagin (Furagin K- or Furagin-potassium, Solafur)*

The indications of its 0,1% solution are similar to those of furacilin. It can also be given intravenously in a dose of 300 ml. Orally, furazolidon is taken as 50 mg tablets.

Derivatives of nitrofuran may also be ingredients of the membranous compound lifusol manufactured as an aerosol and used to treat superficial wounds and burns. It forms a defensive membrane that causes antimicrobial effect on the wound's surface. Effect of this membrane lasts for 5-7 days.

• Acid group

For washing wounds, purulent cavities and purulent fistulae, 2-3% aqueous solution of boric acid is used.

• Oxidants

This group involves hydrogen peroxide and potassium permanganate, which, if combined with organic compounds, discharge atoms of oxygen, which cause antimicrobial effect.

— *Hydrogen peroxide* is used for cleaning infected wounds during dressing, purulent fistulae, empyemas and abscesses in the form of 3% aqueous solutions. The thick foam that is formed during the washing facilitates evacuation of pus, fibrin and necrotic tissues. It can also neutralise the offensive odour of the wound.

— *Potassium permanganate* is indicated for purulent wounds (0,1-0,5% solution), washing cavities (0,05-0,1% solution) and burns (2-5% solutions).

• Dyes

— *Brilliant green* is used as a 1-2% alcohol solution for superficial wounds, abrasions and suppurative skin infections.

— *Methylene blue* is used for superficial wounds and abrasions (3% alcohol solution), burns (1-2% alcohol solution) and for washing purulent cavities (0,02% aqueous solution).

• Detergents

— *Chlorhexidine.* The main aqueous solution contains 20% of chlorhexidine bigluconate. For cleaning wounds, a 1:400 solution is available, for washing infected bodily cavities a 1:1,000 may be used. 1 ml of 20% aqueous solution of chlorhexidine bigluconate is diluted in 400-1,000 ml of distilled water. The solution is sterilised in an autoclave at a temperature of 115 °C for 30 minutes.

• 5-Nitro-imidazole derivatives

— Metronidazole; trade names - flagyl, trichopol, clion.

It is effective against non-clostridial anaerobes and can be given intravenously (0,5 g in 100 ml of solvent).

Dioxydin. This is a derivative of oxychinolin. 0,1-1% aqueous solutions are indicated for purulent wounds, for washing the urinary bladder, empyema or abscess cavities, and purulent fistulae. It is available as 10 ml ampoules with 1% solutions of the drug. In severe purulent infections (sepsis, purulent peritonitis), it can be infused intravenously as much as 60-90 ml 2-3 times a day (30 ml of the solution diluted in 500 ml of 5% glucose solution). It should be avoided in patients with impaired renal function.

• Heavy metal salts

— *Silver nitrate* is used as 0,1-0,2% solutions for washing wounds and purulent cavities.

Sulphonamides (streptocide, ethazol, sulfacyl)

Derivatives of sulfacyl with prolonged activity (sulfadimethoxin, sulfalen, sulfapiridazin) are available as tablets.

Topical chemotherapy involves:

a) application of antiseptics to dressing materials for wounds and burns; these may be applied in the form of solutions used to wash the wounds during dressing, soaking the dressing packs as well as in the form of creams and powders;

b) application of antibacterial solutions directly into the wound, closure of the cavity with subsequent aspiration through a drain - washing, leaking drainage (i.e. a combination of physical and chemical types of antisepsis). Examples of combined use of physical and chemical antisepsis are peritoneal dialysis for purulent peritonitis, leaking drainage of pleural cavity in purulent pleuritis;

c) infiltration of foci of inflammation with antibacterial solutions to combat local infection (antibiotics are often used for such purposes).

Systemic chemotherapy includes:

a) oral use of antibacterial agents: tablets of Furagin, Solafur, long-acting and very longacting sulfonamides (sulfadimethoxin, sulfalen) which act topically on gastrointestinal microorganisms; this is part of preoperative workup for patients with impending intestinal surgery. Absorbed into the blood stream, these drugs also act on the body systemically after they have been absorbed into the bloodstream;

b) intravenous use of chemotherapeutic compounds: e.g. soluble furagin, dioxidin

Biological antisepsis

For treatment and prophylaxis of purulent infections biological compounds can also be used. Antibiotics are known to be of greatest importance as far as antibacterial therapy is concerned. Currently, the use of antibiotics has been facing a multitude of problems associated with changes in biology of target microorganisms, i.e. quite a number of drug-resistant strains have emerged. The main causative agents of purulent infections - staphylococci and gram-negative bacteria (e.g. *E. coli, Proteus spp, Pseudomonas aeruginosa)* have become highly resistant to antibiotics as a result of mutations caused by antibiotics. Among the causative agents of purulent infectious diseases, relative pathogenic microorganisms (non-obligatory pathogens) make up a separate group - non-sporiferous (nonclostridial) anaerobes and mainly Bacteroides, which have a natural resistance to most antibiotics.

The major antibiotics used for treatment and prophylaxis of infections are as follows:

- The penicillins

One of the first antibiotics was a natural antibiotic benzylpenicillin still used nowadays in selected cases. The main advantage of bewzylpenicillin is low foxicity.

Semisynthetic penicillins fall into the two groups:

1) stable penicillins (oxacillin, metycillin, dicloxacillin), which are active against gram-positive bacteria. They are indicated for staphylococcal infections of various localization (pneumonia, lung abscess, pleural empyema, osteomyelitis, abscess or phlegmon of soft tissues, wounds),

2) broad-spectrum semisynthetic penicillins (ampicillin; ampiox - a combination of ampicillin and oxacillin; carbenicillin). These are effective in burns, peritonitis, infected wounds caused by*Pseudomonas* and *Proteus spp.*

- Cephalosporins

Firstand second-generation cephalosporins include ceporin (cephaloridin), kefzol (cefazolin), cephalothin, and cephalexin; cephataxime, cefotaxim, ceftriaxon are third-generation cephalosporins, and cephpirom (Quiten) belongs to fourth-generation cephalosporins.

• Aminoglycosides

These include gentamicin, kanamycin, tobramycin and semisynthetic aminoglycoside (amikacin).

• Tetracyclines

These include tetracycline, oxytetracycline and semisynthetic tetracyclines (metacycline or rondomycin), doxycycline (vibramycin).

• Macrolides

These include erythromycin, oleandomycin, azithromycin.

• Fluorquinolones (ofloxacin, pefloxacin, ciprofloxacin, lomefloxacin) are a group of antibacterial agents whose bactericidal effect is based on the block of DNA gyrase of the susceptible bacteria. Their broad spectrum of activity covers numerous gram-negative and gram-positive microorganisms (e.g. *E. coli, Enterobacteriaceae, Klebsiella* and *Staphylococcus spp).*

Other groups of antibiotics used to combat purulent infections are lyncomycin, fusidin.

Broad-spectrum antibiotics that act bactericidal on both gram-negative and -positive strains are semisynthetic penicillins, cephalosporins and aminoglicosides, semisynthetic tetracyclines, fluorquinolones (ofloxacin, ciprofloxacin, levofloxacin). carbopinems (imipenem, pleropenem, tienam (a combination of imipenem + sodium celastatin).

Biologic antiseptic compounds include proteolytic enzymes. They can dissolve (lyse) necrotic tissues, fibrin, pus, prevent oedema and enhance the therapeutic effect of antibiotics. The currently used proteolytic enzymes of animal origin are trypsin, chymotypsin, chymopsin, ribonuclease; those of bacterial origin - terrilitin, streptokinase, collagenase, asperase, ribonuclease, iroxol; plant origin - papain, bromelain.

Proteolytic enzymes can also be used topically for infected wounds or tropical ulcers. After cleaning the wound or ulcer with hydrogen peroxide or furacillin, a piece of gauze soaked with the solution of enzyme is applied on it; if the wound is highly purulent, the powder of the enzyme can be sprinkled on its surface. Some of the enzymes are available in the form of cream (iruxol, asperase), which are also applied to the wound or sore. These are used until the wound is clean of all the necrotic tissues and pus. Their doses may be different and are usually given in their instructions.

Solutions of enzymes can be introduced into various cavities: the pleural cavity in purulent pleurisy, the joint cavity in purulent arthritis or in an abscess cavity. The drug is given through a drainage tube after puncturing the cavity; the contents being then aspirated. In lung abscess that may not be drained through the bronchus, a special method (via a puncture of the chest wall) is used. In osteomyelitis the enzymes are given into the canal of the bone marrow or into the bone cavity by puncturing the bone with a needle or through a drainage tube placed during operation. In purulent fistulas the canals can be washed with the solutions of enzymes. In purulent lung infections proteolytic enzymes can be inhaled or they can be inserted into the bronchi or through a catheter or bronchoscope into the abscess cavity.

In infectious infiltrations, enzymes (trypsin or chemotrypsin) can be given via electrophoresis.

As anti-inflammatory agents proteolytic enzymes (trypsin, chemotrypsin) are given intramuscularly or intravenously in doses of 0,07 mg/kg.

Proteolytic enzymes dissolved in solutions of novocain (procaine) can be used to infiltrate tissues at the initial stages of inflammations or added to the solutions used for novocain

blockage. For example, at the initial stages of mastitis retromammary blockage can be performed (see «Local anaesthesia»): 70-80 ml of 0,25% novocain, 10 mg of chemotrypsin or trypsin and 500,000 units of kanamycin are injected into the retromammary space.

Peculiarities of antibiotic therapy

Indications

Antibiotics should not be prescribed unless they are indicated. Otherwise, they may be even hazardous in such cases as common cold, pharyngitis, furuncle, unexplained fever.

Antibiotics are meant to supplement treatment rather than replace surgical management. Overestimation of the potency of antibiotic therapy can delay the moment of optimum primary or ancillary surgery. The successful therapy of purulent infections depends on the rational management of the patient, awareness of the causative agents of wound infection and their associations.

Contraindications

Underestimating the contraindications for prescribing antibiotic therapy can result in serious complications. Most of these can be prevented if the patient has been meticulously interviewed as to previous episodes of abnormal reactions to antibiotics, allergic reactions, the presence of renal, hepatic diseases, hearing defects or pregnancy.

Renal insufficiency associated with nephritis, urinary infection, or nephrotic syndrome may serve as a contraindication for the intake of aminoglycosides. Anaemia precludes the use of chloramphenicol. In a patient with significant hearing problems, particularly cochlear neuritis, aminoglycosides and polymixin are contraindicated.

Antibiotics should be judiciously prescribed in pregnancy because of their potential toxicity to foetus.

Increased susceptibility to antibiotics, allergic conditions (e.g. bronchial asthma, urticaria) should prompt specific investigations to assess the patient's tolerance of antibiotics.

The choice of antibiotics

Antibiotics are chosen individually according to the causative infectious agent.

The main antibiotics against staphylococci in modern times are currently semi-synthetic penicilinase-resistant penicillins (dicloxacillin, oxacillin, methycillin). If the infection is resistant to the aforementioned agents or the patient is allergic to penicillins, lincomycin, fuzidin, gentamicin combined with cephalosporins can alternatively be used. These antibiotics are also effective against purulent-infection causing *Bacteroides.*

In purulent surgical diseases caused by mixed infections, a combination of semi-synthetic penicillins and aminoglycosides is highly effective. Chloramphenicol is indicated for infections caused by non-sporiferous anaerobic strains.

In *Proteus*-caused infections, a combination of carbenicillin and aminoglycosides may be effective. When purulent infections are caused by non-sporiferous anaerobic strains or a mixture of aerobic and anaerobic strains, treatment is effected with macrolides (erythromycin), lincomycin, chloramphenicol are indicated. The latter is the most effective when combined with aminoglycosides. In non-sporiferous anaerobic strains and *Bacteroides,* chemical antiseptic metronidazole (Trichopol) may be effective.

Antibiotics vary in the mode of action on infection. Aminoglycosides and polymixin act, for example, at the stage of proliferation, while at other stages of microbial life cycle these may appear ineffective. This precludes their use for chronic infections.

Antimicrobial susceptibility to antibiotics The choice of antibiotics should be based on the susceptibility of microorganisms to them. Investigation of microbial cultures obtainer from

wounds, sputum, blood, exudates should be performed each 3-5 days to duly change the antibiotics and thus to prevent development of microbial resistance to the antibiotic administered. When it is not possible to isolate the microorganisms to check their susceptibility, broad-spectrum antibiotics are at first prescribed, and after the susceptibility has been elucidated, the therapy can be changed accordingly.

Combination of antibacterial agents Combination of antibiotics is necessary in cases of microbial associations. In choosing antibiotics the way those drug interact should be considered, as the interaction can be synergistic, antagonistic or indifferent, i.e. do not affect each other's activity. The best choice is the combination of drugs with synergistic effect. In such a case the microorganisms have to be susceptible to each antibiotic combined.

Combination of antibiotics with different spectrum of action is more sound. Antibiotics with similar mode of action should not be combined because of the sum of their side effects (toxic effect). Nephrotoxic and ototoxic effect of aminoglycosides, for example, are enhanced when they are prescribed simultaneously or subsequently. An exception is the penicillins.

Sulphonamides, derivatives of nitrofuran, chinoxydin may serve an example of chemotherapeutic agents mostly often combined with antibiotics. Combined with antibiotics, derivatives of nitrofuran (e.g. furagin, furazolidon) prevent drug resistance of microorganisms.

Side effects are enhanced when such combinations of antibiotics as aminoglycosides + polymixin, chloramphenicol + ristomycin, chloramphenicol + sulphonamides + nitrofuran are administered. When aminoglycosides are given to the patient under general endotracheal anaesthesia, a serious complication (apnoea) can occur after awakening because of reactivation of curare.

Dosing

Antibacterial (bactericidal or bacteriostatic) effect of the agents only occurs if particular concentrations at the focus of infection or in blood for a particular period are being maintained. The *minimum inhibitory concentration* is the least amount of drug necessary to inhibit visible growth after 24 hours (lower amounts of the drug do not cause antibacterial effect and the microorganisms quickly acquire resistance to the antibiotics). If, on the other hand, the concentrations of the drug are too high, in addition to its antibacterial effect it can cause a number of adverse effects. With this in mind, starting doses, intervals and ways of administration should always conform with the instructions of the drug. Assessment of the patient's condition To duly detect complications of antibiotic therapy it is necessary to observe the patient closely. Complete blood count and urinalysis are to be ordered each 4-5 days. The early signs of complications may include leukopenia, eosinophilia, anaemia, and proteinuria, appearance of urinary casts. Skin rash is a sign of allergic reaction. On the contrary, such changes as a fall in white blood cell count and positive changes in the blood smear, a reduction in ESR, body temperature are all signs indicative of successful antibiotic therapy. The latter should always be accompanied with vitamin supplementation, correction of protein deficiency or electrolyte imbalance. Antibiotic therapy may by no means substitute for surgery in purulent infection. The duration of antibiotic therapy The duration of antibiotic therapy depends on the rate of inhibition of inflammation and normalisation of body temperature. The course of treatment in acute infection is about 5-7 days. If the treatment needs to be prolonged, the antibiotic should be changed. Earlier stopping the antibiotic therapy may cause relapse, while unduly prolonging the treatment can lead to complications (e.g. intestinal dysbiosis, toxic effects).

Immune compounds

For *active immunization* anatoxins are used. *Staphylococcal anatoxins* are given subcutaneosly in doses of 0,1 ml at the scapular area, and repeated each 2-3 days, with an increase in the dose by 0,1 ml each time up to a maximum of 1 ml. In emergency, 0,5 ml can be given preoperatively.

Tetanus antitoxin is used for both scheduled and emergent prophylaxis against tetanus. Injection of the drug in emergency is combined with prophylactic doses of antitetanus serum.

For *passive immunization* preparations containing antibodies to causative agents of other surgical infections are used.

Antistaphylococcal hyperimmune plasma is native (liquid or frozen) plasma of donors' blood immunized by adsorbed staphylococcal anatoxins. The titre of antistaphylococcal plasma should be at least 6 IU. The plasma is administered intravenously in the dose of 4-6 ml/kg, in serious infections caused by staphylococci (e.g. sepsis, purulent peritonitis, osteomyelitis). It is given once or can be repeated depending on the condition of the patient. In clinical practice *anti-Pseudomonas hyperimmune plasma*is also used.

Antistaphylococcal gamma globulin is prepared from donors' blood immunized by adsorbed staphylococcal anatoxin. 1 ml of the compound contains 20-50 units of antistaphylococcal immunoglobulin. It is kept in sterile ampoules. One therapeutic dose contains 100 IU of immunoglobulin. Antistaphylococcal gamma globulin is used for treatment and prophylaxis of diseases caused by staphylococci. It is given intramuscularly.

Antitetanus gamma globulin is prepared from donors' blood immunized by adsorbed tetanus anatoxins. It is available in sterile 1 ml ampoules, which is equivalent to 150 IU of antitetanus immunoglobulin. It is used for treatment and prophylaxis of tetanus (see «Tetanus»). The drug is given intramuscularly; immunity is maintained for a month.

Antitetanus serum is immune serum produced from the blood of animals (horse) immunized by tetanus anatoxins. One ampoule of serum contains 1,500-3,000 IU, prophylactic dose of the serum is 3,000 IU. The initial prophylactic dose protects against tetanus for 5 days. Therapeutic doses of the serum are tenfold higher than prophylactic ones. The serum should always be given cautiously because of the risk of anaphylactic reactions.

Antigangrene serum is immune serum of animals (horse) that contains antibodies to the four main causative agents of gas (anaerobic) gangrene - *Cl. perfringes, Cl. oedematiens, Cl. septicum, Cl. histolyticum.* It is used both for prophylaxis and treatment. The drug should be given cautiously, intramuscularly for prophylaxis and intravenously for treatment (see «Specific wound infection»).

Immune stimulators are the agents that improve non-specific immune defense of the body include prodigiozan, lyzozyme and levamisole.

Prodigiozan is bacterial polysaccharide which stimulates leukopoiesis, increases the number of B lymphocytes and stimulates phagocytosis. It is indicated for patients whose leukopoiesis and phagocytosis are inhibited due to a deficit in lymphocytes and monocytes and the immunogramme shows a decrease in the number of B lymphocytes. The drug is given 50 mcg i/m 4 times a day with an interval of 3-4 days.

Levamisole (decaris) stimulates production of T lymphocytes, phagocytosis and enhances synthesis of antibodies. It is indicated for patients who are deficient in T lymphocytes which, in turn, inhibits phagocytosis. The daily dose of 150 mg is given 6 times.

Lyzozyme is a natural non-specific humoral immune factor with bactericidal effect. The drug enhances non-specific immune response hence increases the efficacy of antibiotics.

For prophylaxis and treatment of wound infections and complications, staphylococcal, streptococcal, Proteus and anaerobic bacteriophages are used. Bacteriophages are given in their original forms or in combination with each other. Solutions of bacteriophages can be used to soak the dressing gauze, which is applied to the wound, or to infiltrate the tissue around the wound. In extensive wounds with crushed tissue, a preparation of anaerobic and cocci phages are used for the prophylaxis of anaerobic and pyogenic infections of the wound.

TESTS

Chapter I. ASEPSIS AND ANTISEPSIS

• Asepsis

1. Surgical scrubbing with chlorhexidine bigluconate should last:

A. 1 minute.

B. 3 minutes.

C. 5 minutes.

D. 10 minutes.

Choose the correct answer.

2. Which of the following are «cold» sterilisation methods:

1. Ultraviolet.

2. Ionizing radiation.

3. Ultrasound.

4. Formaldehyde vapour.

5. Autoclaving.

Choose the right combination of answers.

A. 1, 2, 3, 4, 5. B. 2, 3, 4, 5. C. 1, 3, 4, 5. D. 1, 2, 3. 4. E. 1, 2, 3, 5.

3. Sterilisation of instruments in an autoclave under the pressure of two atmospheres takes:

A. 2 hours.

B. 45 minutes.

C. 1 hour.

D. 20 minutes.

E. 1,5 hours.

Choose the correct answer.

4. Which of the following methods help prevent contact infection?

1. Sterilisation of linen.

2. Sterilisation of instruments.

3. Sterilisation of suture materials.

4. Surgical scrubbing.

5. Washing of the operating field.

Choose the right combination of answers:

A. 1, 2, 3, 4. B. 1, 3, 4, 5. C. 1, 2, 3, 5. D. 2, 3, 4, 5. E. 1, 2, 4, 5.

5. The bactericidal effect of ultrasound consists in:

1. Thrombolysis.

2. A change in permeability of capsular microbial cells.

3. Cavitation.

4. Water molecule fission.

5. Mutation of bacterial cells.

Choose the right combination of answers:

A. 1, 3. B. 2, 3. C. 2, 4. D. 1, 4. E. 3, 5.

6. Sterilisation of instruments which were in contact with anaerobic infection, is performed by:

A. Burning.

B. Autoclaving for 1 hour.

C. Boiling in washing soda solution for 30 minutes.

D. Boiling with intervals.

E. With formaldehyde vapour.

Choose the correct answer.

7. Which of the following agents are used for surgical scrubbing?

1. Preparations consisting of diluted mercury peroxide plus formic acid (Pervomur).

2. Novosept.

3. Ceryl gel.

4. Ethyl alcohol.

5. Chloramine.

Choose the right combination of answers:

A. 1, 2, 3, 4. B. 1, 2, 3, 5. C. 2, 3, 4, 5. D. 1, 3, 4, 5. E. 1, 2, 4, 5.

8. Surgical scrubbing using Spasokukotsky-Kochergin's method involves the following stages:

1. Brushing hands.

2. Washing hands with 0,5% ammonia water.

3. Dry wiping hands with a sterile towel or napkin.

4. Scrubbing with 96% ethyl alcohol.

5. Scrubbing with 70% ethyl alcohol.

Choose the right combination of answers:

A. 1, 2, 3. B. 2, 3, 4. C. 1, 3, 4. D. 1, 3, 5. E. 2, 3, 5.

9. What are the basic components of C-4 preparation?

A. Hydrogen peroxides plus ethyl alcohol.

B. Hydrogen peroxide plus formic acid.

C. Hydrogen peroxide plus ammonia water.

D. Hydrogen peroxide plus methyl alcohol.

E. Hydrogen peroxide plus dichloride of mercury.

Choose the correct answer.

10. The sterilisation of the operating linen in autoclave under the pressure of two atmospheres should last for:

A. 2 hours.

B. 1 hour.

C. 45 minutes.

D. 30 minutes.

E. 20 minutes.

Choose the correct answer.

11. Which of the methods of indirect control for sterilization is more reliable?

A. Mikulich's method.

B. Thermometry.

C. Melting of antipyrin.

D. Melting of benzoic acid.

E. Bacteriological control.

Choose the correct answer.

12. Which of the following methods are used for sterilization of cystoscopes, laparoscopes, and thoracoscopes?

1. Burning.

2. Boiling in washing soda solution for 30 minutes.

3. Autoclaving.

4. Sterilization with gas.

5. Sterilization in alcoholic solution of chlorhexi-dine

Choose the right combination of answers:

A. 1, 2, 3. B. 2, 3. C. 2, 4. D. 2, 5. E. 4, 5.

13. Sterilization of catgut using the Gubarev's method is carried out in:

A. Iodine vapour.

B. Alcoholic Lugol's solution.

C. Aqueous Lugol's solution.

D. Ethyl ammonia water.

E. Mercury dichloride solution.

Choose the correct answer.

14. The following regimen of sterilization in drying cabinet is observed:

A. 0,5 hours at 200 °C.

B. 1 hour at 180 °C.

C. 1 hour at 220 °C.

D. 2 hours at 180 °C.

E. 2 hours at 220 °C.

Choose the correct answer.

• Antisepsis

1. Which method is that of mechanical antisepsis?

A. Through drainage.

B. Vacuum drainage with electric motor causing negative pressure in a closed drainage system.

C. Primary surgical debridement.

D. Ultrasonic cavitation of wounds.

E. Through drainage with proteolytic enzymes.

Choose the correct answer.

2. Methods of physical antisepsis are as follows:

1. Drainage of subcutaneous connective tissue.

2. Irrigation of the wound with chlorhexidine solution.

3. Necrectomy.

4. Ultrasonic cavitation.

5. Immunotherapy.

Choose the right combination of answers:

A. 1, 2. B. 2, 3. C. 1, 4. D. 2, 4. E. 3, 5.

3. Agents that work as biological antiseptics are as follows:

1. Vaccines and sera.

2. Sulphonamides.

3. Nitrofurantoins.

4. Antibiotics.

5. Proteolytic enzymes.

Choose the right combination of answers:

A. 1, 2, 3. B. 2, 3, 4. C. 1, 4, 5. D. 1, 2, 5. E. 1, 3, 5.

4. The methods of physical antisepsis are as follows:

1. Ultrasonic cavitation of wounds.

2. Antibiotic and novocain block of the suppurative focus.

3. Through drainage.

4. Cauterizing of superficial wounds with silver nitrate.

5. Vacuum drainage of wounds.

Choose the right combination of answers:

A. 1, 4, 5. B. 1, 2, 3. C. 3, 4, 5. D. 1, 3, 4. E. 1, 3, 5.

5. Oxidizing antiseptics are as follows:

A. Dichloride of mercury.

B. Potassium permanganate.

C. Carbolic acid.

D. Chloramine.

E. Silver nitrate.

Choose the correct answer.

6. Haloid antiseptics are as follows:

A. Potassium permanganate.

B. Dichloride of mercury.

C. Carbolic acid.

D. Chloramine.

E. Silver nitrate.

Choose the correct answer.

7. The following antibiotics exert toxic effect on the auditory nerve:

A. Penicillins.

B. Aminoglycosides.

C. Tetracyclines.

D. Cephalosporines.

E. Macrolides.

Choose the correct answer.

8. The complications of antibacterial therapy are as follows:

1. Intestinal dysbiosis.

2. Hypertension.

3. Deafness.

4. Allergic reactions.

5. Tachycardia.

Choose the right combination of answers.

A. 1, 2, 3. B. 1, 3, 4. C. 2, 3, 4. D. 3, 4, 5. E. 2, 4, 5.

9. Errors of antibacterial therapy are as follows:

A. Combination of antibiotics with nystatin.

B. Combination of antibiotics of the same mechanism of action.

C. Combination of antibiotics and proteolytic enzymes.

D. Combination of several routes of antibiotic administration.

Choose the correct answer.

10. The mechanisms of action of proteolytic enzymes are as follows:

1. Necrotic tissue lysis.

2. Hypercoagulation.

3. Fibrinolysis.

4. Enhancement of antibiotic activity.

5. Oedema counteraction.

Choose the right combination of answers:

A. 1, 2, 3, 4. B. 1, 3, 4, 5. C. 1, 2, 4, 5. D. 1, 2, 3, 5. E. 2, 3, 4, 5.

11. Which agents promote non-specific immune response

1. Anti gas gangrene serum.

2. Anti staphylococcal anatoxin.

3. Prodiogiosane.

4. Levamisole.

5. Antitetanic serum.

6. T-Activine.

Choose the right combination of answers:

A. 1, 3, 5. B. 2, 4, 6. C. 3, 4, 6. D. 3, 4, 5. E. 4, 5, 6.

12. Proteolytic enzymes of animal origin are as follows:

1. Papain.

2. Trypsin.

3. Chymotrypsin.

4. Streptokinase.

5. Terrilytin.

Choose the right combination of answers:

A. 1, 2, 3. B. 1, 5. C. 2, 3. D. 2, 3, 4. E. 1, 4.

13. Active immunization can be performed using the following preparations:

1. Anti staphylococcal anatoxin.

2. Anti staphylococcal globulin g.

3. Bacteriophage.

4. Levamisole.

Choose the right combination of answers: A. 1, 3, 4. B. 1, 2, 4. C. 1, 2, 3. D. 2, 3. E. 1.

14. The preparations which increase patients' non-specific immune protection:

1. Prodiogiosane.

2. Anti staphylococci anatoxin.

3. Lysozyme.

4. Bacteriophage.

5. Levamisole.

Choose the right combination of answers:

A. 1, 2, 3. B. 2, 3, 4. C. 1, 3, 4. D. 1, 3, 5. E. 1, 4, 5.

15. The high-power laser beams exert the following actions:

1. A change in biochemical tissue reactions.

2. An increase in tissue temperature.

3. A destruction of microorganisms.

4. An abrupt increase in intracellular and interstitial pressure.

5. An acceleration in immature cell proliferation.

Choose the right combination of answers:

A. 1, 3. B. 1, 5. C. 1, 3, 4. D. 3, 4, 5. E. 1, 2, 3, 4.

Chapter II. ANAESTHESIA

Local anaesthesia is a reversible loss of sensation in some part of the body induced by a local anaesthetic agent.

The advantages of local anaesthesia involve the following:

- prolonged preoperative preparation is unnecessary;
- it can be used when general anaesthesia (narcosis) is unavailable;
- there is no need for postoperative observation of the patient, as distinct from narcosis.

Outpatient surgeries are often done under local anaesthetics. Similarly, when intubation narcosis is risky, the patient can be operated on under local anaesthetics.

Elderly patients, particularly debilitated ones, as well as those with cardiovascular disease are at increased risk, as far as postoperative mortality rate is concerned. In such cases anaesthesia may outweigh the risk of the operation itself.

Contraindications for local anaesthetics are as follows:

1. The patient's intolerance of local anaesthetics drug (e.g. due to allergies).

2. The patient's age below 10 years.

3. Concurrent psychiatric disease.

4. Scarring or pronounced inflammation of the tissues within the operative field, which may interfere with the infiltration of the anaesthetic.

5. Intractable internal bleeding which requires urgent operation.

6. Thoracic surgery.

Potentiated local anaesthesia can be achieved by combining anaesthetics with neuroleptic drugs (e.g. droperidol) and general analgesics (e.g. phentanyl). In combined anaesthesia, which includes local anaesthesia and neuroleptic analgesia, local anaesthetic effect is enhanced by the positive action of the neuroleptic and the patient's psychic status.

Neuroleptic analgesia and general anaesthesia are used to potentiate different kinds of local anaesthesia (infiltration, trunk block, spinal, epidural). With the aid of neuroleptic analgesia and general anaesthesia the dosage and therefore the toxic effect of local as well as narcotic agents can be reduced.

Complications of local anaesthesia are related to allergic reactions of the anaesthetic drug or its overdose or that of epinephrine. Allergy to a local anaesthetic drug is manifested by skin rash, itching, Quincke's oedema, laryngoand bronchospasm. Antihistamines, glucocorticoids and spasmolytics are used to counteract the allergic reactions.

Overdose of local anaesthetic substances occurs if large amounts of the drug are injected. Symptoms of overdose are anxiety, skin hyperaemic, fast pulse, hypertension, twitching or convulsions. In serious cases of intoxication the patient can develop collapse, respiratory or cardiac arrest or even coma. Mild cases of overdose can be managed with barbiturates, narcotic agents and oxygen therapy. Serious cases may require inotropic and vasopressor agents are given, and transfusion therapy with car-diopulmonary resuscitation may be necessary.

Prevention of the complications includes a thorough interviewing the patient as to drug allergies and meticulous following the protocols of anaesthesia.

The main local anaesthetics and their properties are presented in tab. 1.

Table 1. Local anaesthetic agents

Agent	Effectiveness (in relation to Novocain)	Toxicity (in relation to Novocain)	Concentrations available	Type of anaesthesia
1	2	3	4	5
Novocain (Procaine)			5-10%, 0,25-0,5%, 1-2%, 1-3%	Infiltration, Intravenous, block, spinal,

				peridural, Intraosseous
Lidocain (xylocain, lignocain)	4 times	2 times	1-2-10%, 0,25-0,5%, 0,5-2%	Superficial, infiltration, block, epidural, intravenous.

Tab. 1. Contd.

1	2	3	4	5
Dicaine (tetracain)	15 times	10 times	0,25%, 0,5%, 1-2%, 3%	Superficial
Trimecain (mesocain)	3 times	$1^1/_2$ times	0,25-0,5%, 1%, 2%	Infiltration superbicialblock, peridural spinal
Articain (ultracain)	4 times	2 times	1-2-4%	Infiltration, block, peridural

During preoperative workup the patient is prepared psychologically for local anaesthesia. This derives from the fact that he/she will be conscious during the operation and his/her tactile sensation, as distinct from pain, will be intact. Before the operation preanaesthetic medication (injection of promedol, atropine, droperidol) is given to each patient. It is noteworthy that patients who develop minute psychiatric problems are put on sedatives and anti-anxiety agents for several days preoperatively.

2.1 INFILTRATION ANAESTHESIA

This type of anaesthesia is named after a famous Russian surgeon Alexander Vishnevsky. This way of anaesthesia combines the positive aspects of both infiltration and block anaesthesia. Anatomically, the method is based on the features of fascicular structures. The anaesthetic that is given under pressure into fascicular compartments spreads to engulf and penetrate the nerve and nerve ending. Tense infiltrates of novocain trickle along the fascial covering and converge with each other. Alexander Vishnevsky named his method the tense-creeping infiltrate.

It is the surgeon who is in charge of anaesthesia during the operation - he/she interchanges the injection and the scalpel during incision. Tissue infiltration should precede opening the skin or fascial covering.

Tense infiltration of anaesthetic allows for hydrous dissection of the tissues, in the mist of the infiltration it is easier to identify blood vessels, nerves and thus prevent their damage and enhance ligation of vessels to arrest bleeding. For infiltration anaesthesia to achieve, 0,25% novocain with epinephrine (0,15 mg of epinephrine to 100 ml of novocain) is used. Fascial covering anaesthesia requires a large amount of anaesthetic (as much as 800-1,000 ml), but

because of the low concentration of anaesthetic and the fact that most of the solution pours away through the wound during operation, patients are unlikely to get intoxicated.

Thyroid turgeny may save as an example of that type of anaesthesia.

Two syringes (a 2- and 5- ml or 5- and 10- ml ones are normally used for the injections. To anaesthetise the skin a small needle is used intradermally to form «peau d'orange» along the intended incision line (fig. 6). Each further injection follows the previous one. Novocain is injected also into the subcutaneous fat through the infiltrated skin. Adequate infiltration is achieved when the whole area of incision becomes raised in the form of a fold. After incision of the skin, subcutaneous layer and subcutaneous muscle of the neck, the anaesthetic is injected through the midline, infiltrating the muscles, then under the muscles directing it upwards, downwards and to the sides.

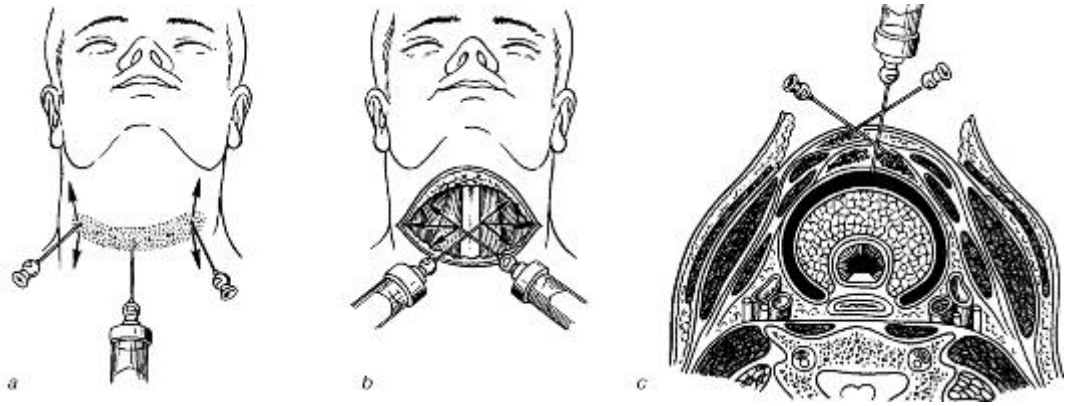

Fig. 6. Infiltration anaesthesia for thyroid surgery.

a - anaesthetising the skin and subcutaneous tissue along the line of incision; *b* - injecting novocain beneath the cervical muscles; *c* - trickling infiltrate surrounding the thyroid gland.

Novocain injected under the muscles spreads beneath the medial cervical fascia to surround the thyroid gland in the form of a case.

After dividing the cervical muscles and delivering the thyroid gland into the incised wound additional infiltration of anaesthetic is given at the upper and lower poles of the gland as well as its posterior aspect.

BLOCK ANAESTHESIA

The following types of block anaesthesia are identified:

- anaesthesia of the neural trunks;
- anaesthesia of the neural plexuses;
- anaesthesia of a group of the nerve ganglia (paravertebral anaesthesia);
- spinal anaesthesia;
- epidural anaesthesia.

Block anaesthesia of the finger by Oberst-Luka-shevich. This method is used to operate on the fingers (for abscess, trauma or tumours). Two or three millilitres of 1-2% novocain are injected into the side of the phalanx as follows (the same amount of novocain is used to anaesthetise the other side of the finger): a plastic tourniquet is applied to the base of the finger, distal to which the skin is anaesthetised, followed by the subcutaneous and further to the bon injections (fig. 7). Novocain is thus injected directly onto the nerves of the finger, which pass along its lateral aspects.

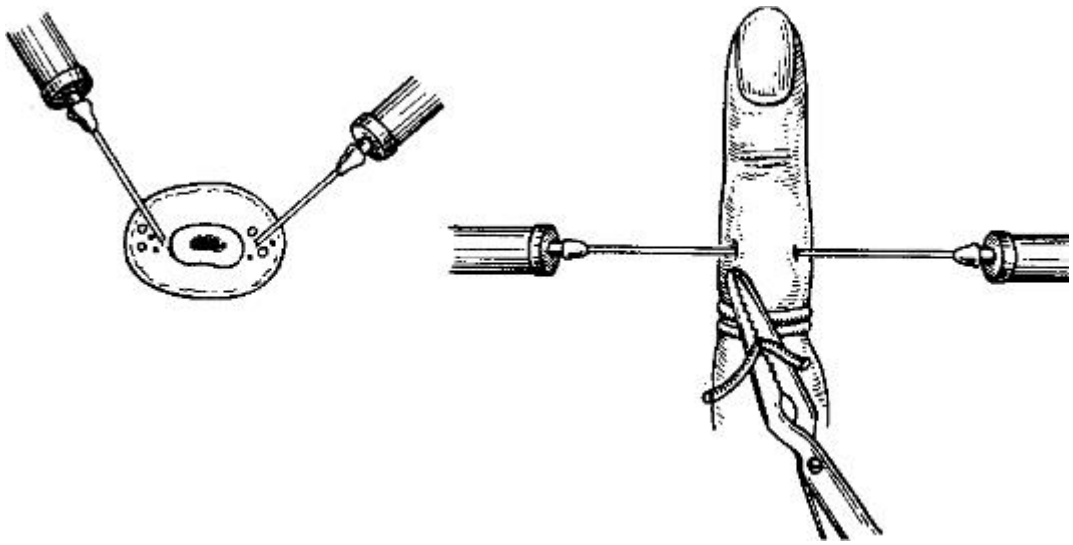

Fig. 7. Conduction anaesthesia (Lukashevich and Oberst's method).

2.2 INTERCOSTAL NERVE BLOCK

This type of anaesthesia is used in rib fractures. A few centimetres away from the fracture site towards the spine, the skin is anaesthetised by intradermal injection of novocain, using a needle and syringe (fig. 8). Novocain is injected through the needle, slowly pusher in the perpendicular direction as long as it luts the fractures. Then the needle is pulled back for about 2-3 mm and is directed to the lower end of the rib along the lower surface and 3-5 ml of 1-2% of Novocain are injected. Passing onto the upper side of the same rib 2-3 ml of 1-2% novocain are injected after which the needle should be removed. In multiple rib fractures the procedure is repeated at the affected sides.

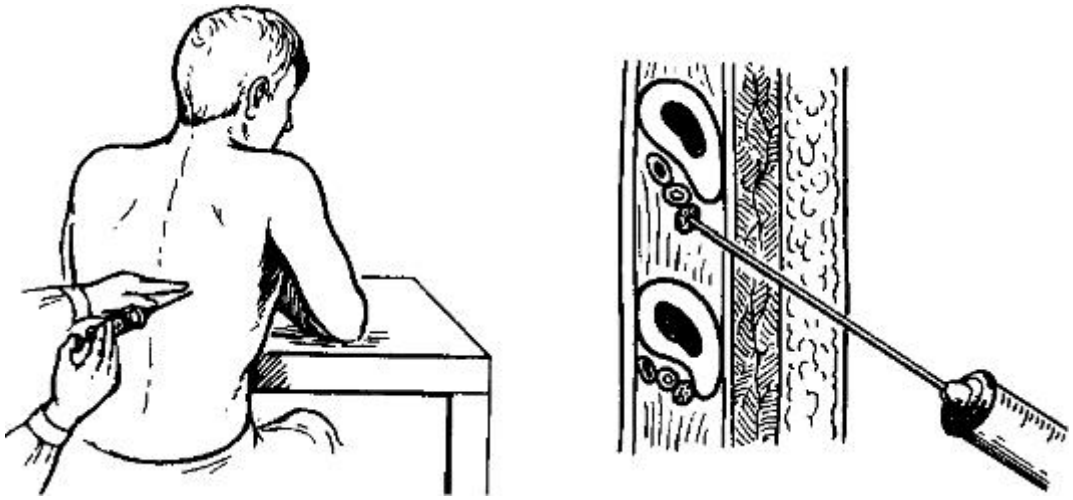

Fig. 8. Intercostal anaesthesia.

2.3 ANAESTHESIA OF THE BRACHIAL PLEXUS AFTER KULENKAMPFF

It is used during operations on the upper limb. With the patient supine and the head turned to the opposite direction the hand is may hang freely. In the supraclavicular depression pulsation of the sub-clavial artery is identified. Following the infiltration of the skin with novocain a long needle without a syringe is pushed laterally from the site of the arterial pulsation and sliding along the upper end of the rib towards the spines of the Th1-2 reaches the plexus (fig. 9). An unpleasant sensation in the hand, numbness or sharp «shooting» pain suggests that the needle has met with some of the branches of the plexus. Appearance of blood in the needle

implies that the needle has entered a blood vessel. Following this the needle is withdrawn a little and its direction is changed. Unless blood is not flowing out of the needle, 30-50 ml of 1% novocain or 30-35 ml of 1 % lidocain are given. Anaesthesia is achieved after 10-15 minutes and is maintained for 2-4 hours or even for 6 hours if lidocain is used.

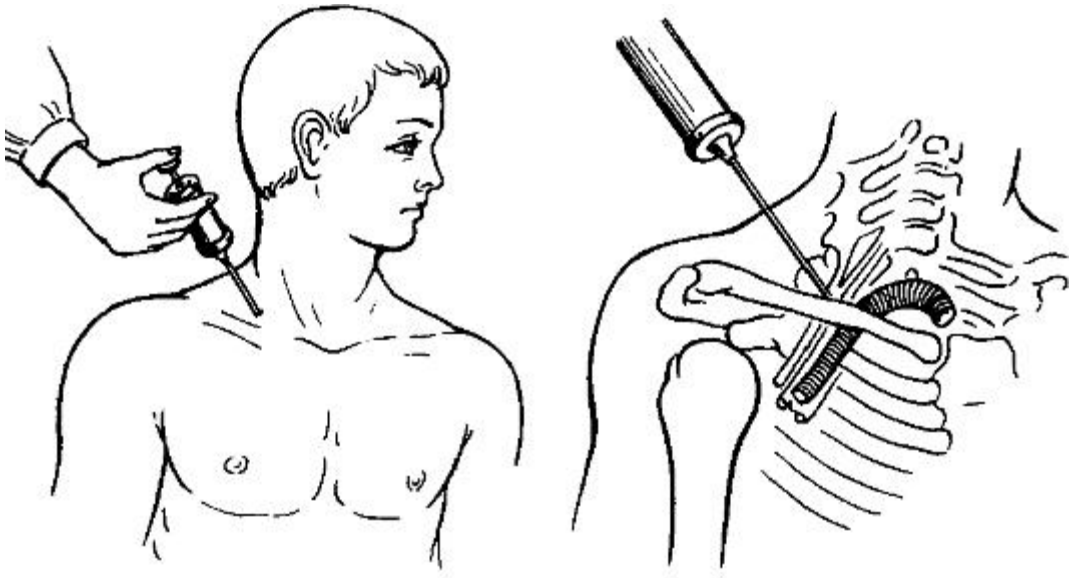

Fig. 9. Humeral plexal anaesthesia (Kulenkampff's method).

2.4 INTRA-ABDOMINAL COELIAC NERVE BLOCK AFTER BROWN

This is used in addition to general anaesthesia during gastric resections. Following laparotomy the left lobe of the liver is lifted up and to the right using a retractor, and the stomach to the left and downwards. In the region of the lesser omentum, the left index finger is used to feel for the pulsation of the aorta above the level of the coeliac trunk and press the vertebra on the right side of the aorta. The finger is thus placed between the aorta and the inferior vena cava. A long needle is used for anaesthesia with a syringe containing 0,5% novocain. The needle is pushed along the finger of the left hand till it hits vertebra Th12, then it is withdrawn a little. Unless there is no blood in the needle, 50-70 ml of 0,5% novocain are injected into the layer fat. The solution spreads into the retroperitoneal space and covers the coeliac plexus. Anaesthesia is achieved after 5-10 minutes and is maintained for $1^1/_2$-2 hours.

2.5 NOVOCAIN BLOCKING

The blocking is used for the prevention and treatment of traumatic shock and as the base for subsequent infiltration anaesthesia.

Blocking of the upper arm

With the arm flexed in the elbow joint and on the anterior surface of the middle third of the upper arm, a thin needle is used to inject novocain intradermally to anaesthetise the skin. Then, using a long needle with 0,25% novocain the skin is pierced followed by the fascia of the arm and the biceps brachii muscle. Pushing the solution of novocain in the needle path, advance the needle to the humerus; slightly drawing back the needle 50-60 ml of 0,25% novocain fill the fascial pouch of the biceps. Similarly, at the same level with the arm extended 50-60 ml of the drug are injected into the fascial pouch of the triceps.

Blocking of the forearm

This is done in the middle third of the forearm. 60-80 ml of 0,25% novocain are injected into the fascial pouches of the flexors and extensors of the forearm.

Blocking of the thigh

On the anterior aspect of the thigh in the middle third, a needle is injected preceded by a stream of novocain; the needle is pushed up to the bone and after withdrawing it slightly 150-180 ml of 0,25% of novocain are given (fig. 10).

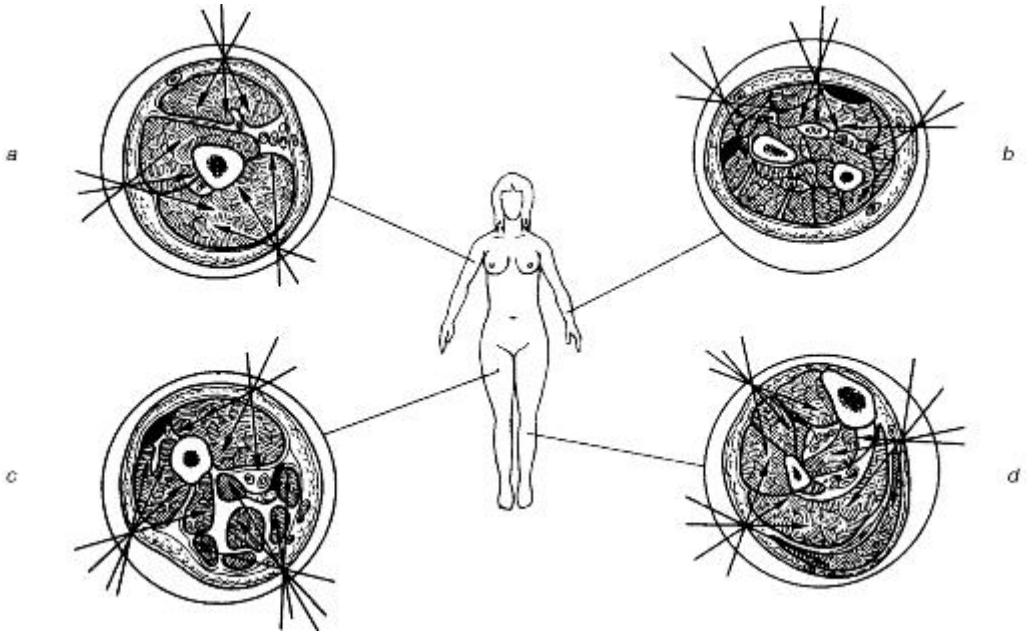

Fig. 10. Circular novocain limb blocks.

Blocking of the leg

Similarly to the previous techniques, novocain is injected into the fascia pouches of the extensor and flexor muscles in the middle third. The injection is placed at the lateral and medial sides of the tibia. 80-100 ml of novocain are injected into each muscular pouch (see fig. 10).

Retromammary block

This method is used to treat the initial stages of mastitis or as a part of local anaesthesia during operations on the breast: sectoral resection, incision and drainage. At the base of the breast in three points (upper, lower and the lateral aspects) 0,5% of novocain is injected intradermally (fig. 11). Then, with a long needle preceded by novocain in the pathway, the drug is injected into the retromammary space. 50 ml of 0,25% novocain are injected through each of the three points. No resistance should be felt during the injection, and after removing the syringe from the needle novocain should not flow out through the open needle. If the block is achieved, the breast looks raised and lying as if on a pillow.

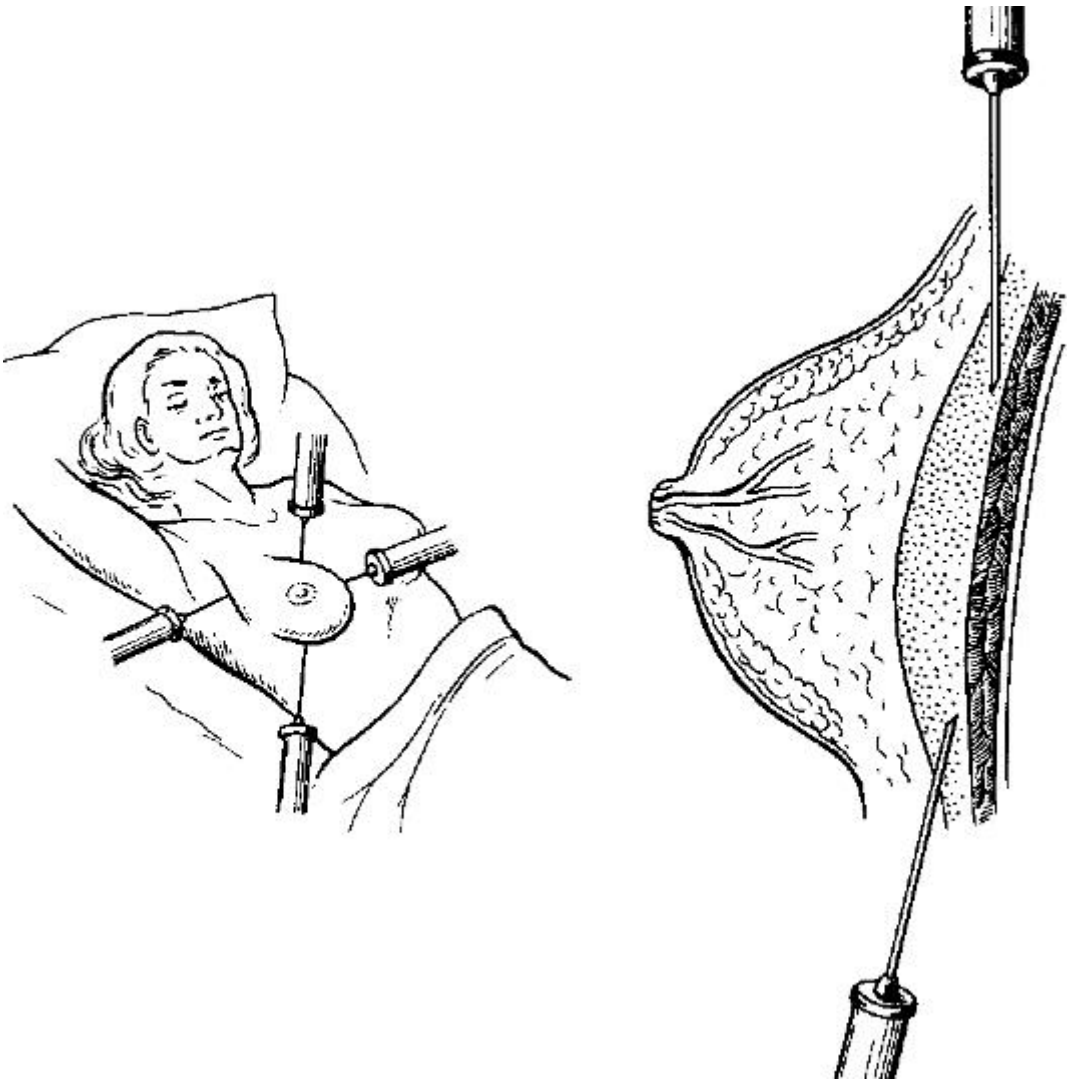

Fig. 11. Retromammary novocain block.

Cervical vago-sympathetic block

It is used to prevent pleurapneumonic shock in cases of injuries to the chest and as the basis for subsequent anaesthesia.

The patient is placed supine with a fold under the neck, the head is turned to the opposite side with the hand on the blocking side drawn downwards. At the posterior side of the sternocleidomastoid muscle, in its mid-portion upper or lower its place of intersection with the jugular vein 0,25% of novocain is injected to anaesthetise the skin. Using the left index finger push the muscle away anteriorly and medially together with the underlying vessels. Novocain (0,25%) in a syringe with a long needle is injected through the skin, with some novocain pushed ahead and the needle advanced up and medially, using the anterior surface of the vertebra as the hallmark. Draw the syringe periodically to be sure you have not entered a blood vessel. 40-50 ml of 0,25% of novocain are injected into each side if bilateral block is required. A successful block is achieved if Horner's sign (dilation of the pupil on the side of the intervention) is positive several minutes later.

Paranephral lumbar block

This method is used in blood transfusion shock, ileus (paralysis of the intestinal muscles), renal or hepatic colic.

The patient is placed on the intact side with a folded sheet under the waist. The leg lying on the top is stretched, while the other one is flexed at the knee joint. The point of injection lies

1-1,5 cm off the angle between the 12th rib and the latissimus dorsi muscle. After anaesthetising the skin insert a long needle perpendicularly to the body surface pushing along 0,25% novocain. On crossing the lumbar fascia, which is felt as the overcoming of resistance, the needle arrives at the paranephric fat (fig. 12). If drawing the piston a little indicates the absence of blood, 60-80 ml of 0,25% novocain are easily injected on each side. No solution trickling out after removing the syringe from the needle implies the needle has been in the right position. If some blood appears in the syringe, it should be withdrawn a little before injecting novocain. The latter spreads into the retroperitoneal fat engulfing the kidney, adrenal glands, solar plexus and coeliac nerves.

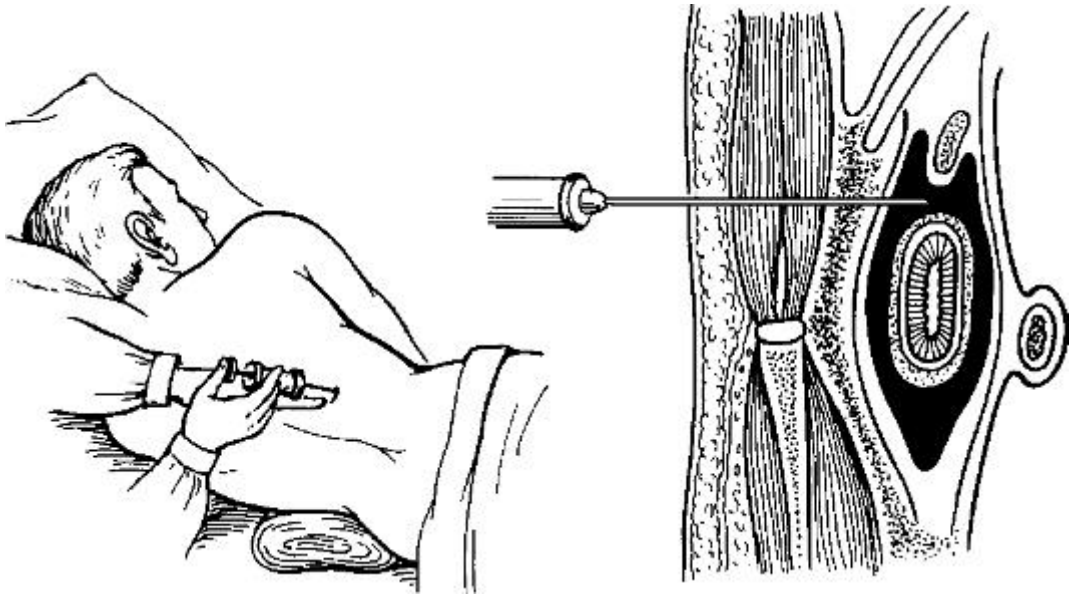

Fig. 12. Lumbar paranephric novocain block.

Intravenous anaesthesia

Intravenous anaesthesia is indicated for operations on the limbs (surgical debridement of wounds, manipulation of dislocations, repositioning of bone fragments, arthrotomy). The method is based on the local effect (by way of diffusion of the anaesthetic given intravenously) of anaesthetics on the nerve endings of the segment of the limb isolated from the main blood circulation by a tourniquet (fig. 13).

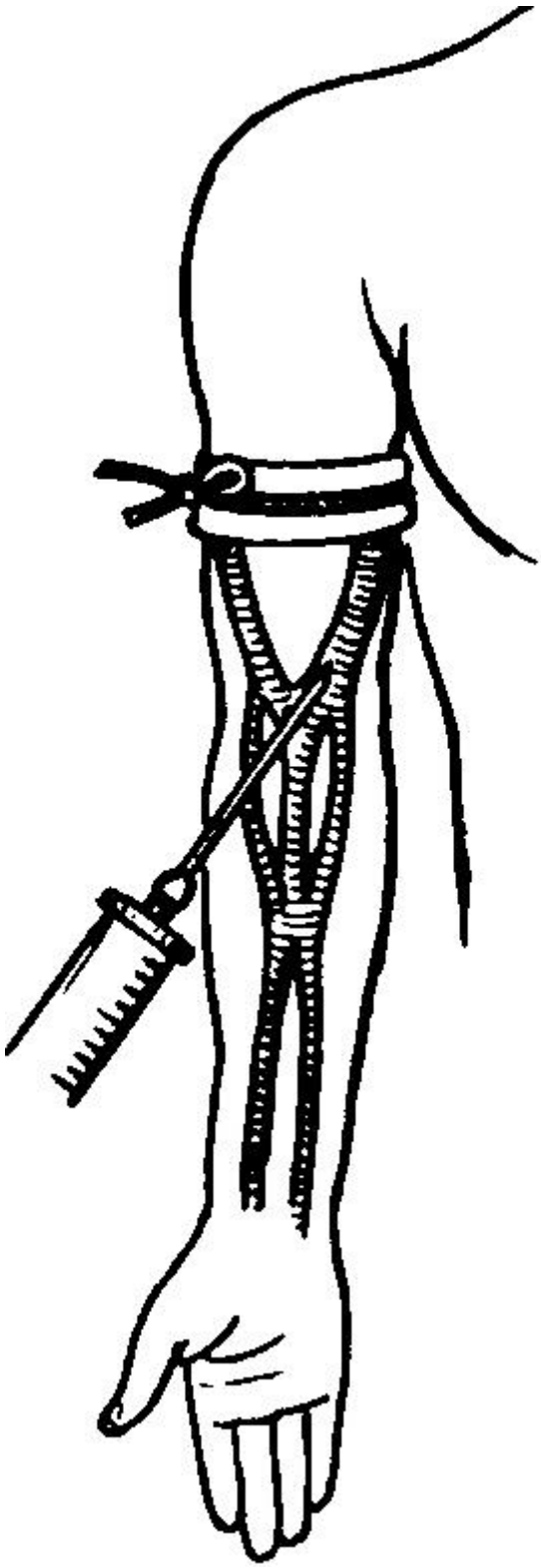

Fig. 13. Intravenous anaesthesia.

Through venepuncture or venesection the anaesthetic is injected into the superficial veins of the forearm or elbow joint, or into the superficial veins of the leg. To enhance the venous blood flow, the limb is raised for 1-2 minutes and to stop arterial blood flow an elastic tourniquet is applied above the expected area of operation. During surgeries on the foot, leg or knee joint the tourniquet is applied on the lower third of the thigh; for operations on the fingers, hands, forearms or elbow joint - on the lower third of the arm. Instead of an elastic bandage for the tourniquet the cuff of a blood pressure apparatus can be used, air is pumped till the arterial blood flow is stopped. 150-200 or 200-250 ml of 0,25% novocain are used for operations on the upper

or lower limb, respectively. At the end of the operation the tourniquet or cuff is removed slowly to prevent the solution of novocain from fast penetration into the systemic circulation.

Intraosseous anaesthesia

This is also a form of intravenous local anaesthesia. The anaesthetic given into the bone enters the venous system of the limb from where it diffuses into the tissues (fig. 14). Intraosseous anaesthesia is used during operations on the limbs. The limb is isolated from the general blood flow by applying a tourniquet or the cuff of a tonometer. The anaesthetic is injected into the humeral condyles, olecranons and fingers, femoral condyles, tarsal bones or malleolae. The tourniquet is usually applied onto the arm, the lower third of the leg, the upper or lower third of the thigh.

Immediately above the site of the puncture the skin and the underlying soft tissues as deeply as the periosteum are anaesthetised with 0,25% novocain. A needle with mandrin used for bone puncture is pushed through the skin fatty layer and in a rolling manner is pushed into the cortical and spongy layers of the bone. 100-150 or 150-200 ml of 0,25% novocain are used for surgeries on the upper and lower limbs or the thighs, respectively. After removal of the tourniquet toxic effect of the anaesthetic's resorption can sometimes occur (weakness, dizziness, hypotension, nausea and vomiting).

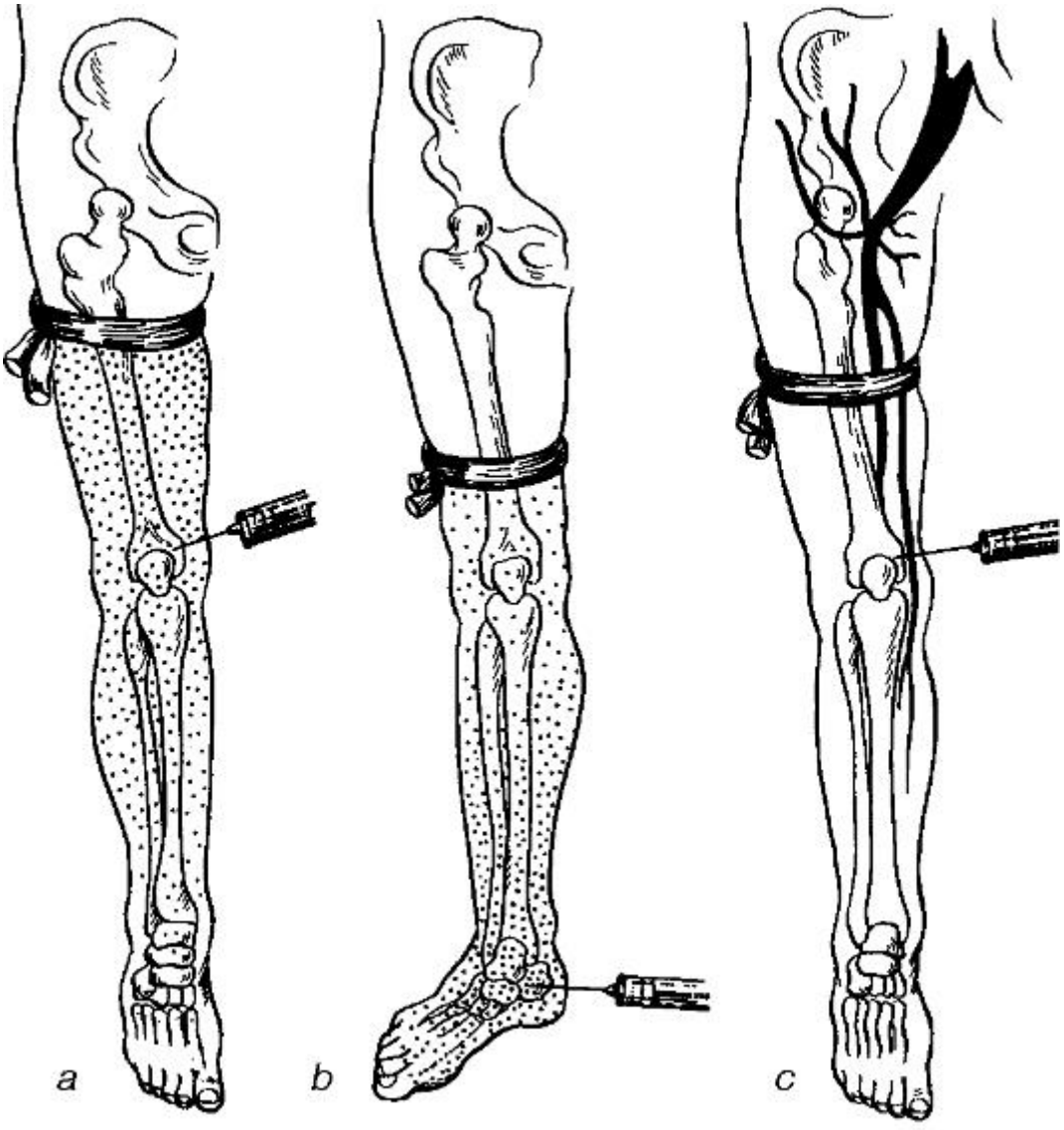

Fig. 14. Distribution of the anaesthetic following intraosseous anaesthesia.

a - injecting the anaesthetic into the humeral condyle; *b* - injecting the anaesthetic into the ankle; *c* - inadequate application of the tourniquet results in the anaesthetic escaping into systemic circulation.

To prevent the toxic effect of novocain, the patient is given 2 ml of caffeine solution subcutaneosly before removing the tourniquet which should be removed slowly.

Potentiated local anaesthesia can be achieved by combining anaesthetics with neuroleptic drugs (e.g. droperidol) and general analgesics (e.g. phentanyl). In combined anaesthesia, which includes local anaesthesia and neuroleptic analgesia, local anaesthetic effect is enhanced by the positive action of the neuroleptic and the patient's psychic status.

Neuroleptic analgesia and general anaesthesia are used to potentiate different kinds of local anaesthesia (infiltration, trunk block, spinal, epidural). With the aid of neuroleptic analgesia and general anaesthesia the dosage and therefore the toxic effect of local as well as narcotic agents can be reduced.

Complications of local anaesthesia are related to allergic reactions of the anaesthetic drug or its overdose or that of epinephrine. Allergy to a local anaesthetic drug is manifested by skin rash, itching, Quincke's oedema, laryngoand bronchospasm. Antihistamines, glucocorticoids and spasmolytics are used to counteract the allergic reactions.

Overdose of local anaesthetic substances occurs if large amounts of the drug are injected. Symptoms of overdose are anxiety, skin hyperaemic, fast pulse, hypertension, twitching or convulsions. In serious cases of intoxication the patient can develop collapse, respiratory or cardiac arrest or even coma. Mild cases of overdose can be managed with barbiturates, narcotic agents and oxygen therapy. Serious cases may require inotropic and vasopressor agents are given, and transfusion therapy with cardiopulmonary resuscitation may be necessary.

Prevention of the complications includes a thorough interviewing the patient as to drug allergies and meticulous following the protocols of anaesthesia.

Spinal and peridural anaesthesia

Spinal anaesthesia is a nerve block-type anaesthesia. It is done by injecting the anaesthetic into the subarachnoid space of the spinal cord and indicated for operations on the organs below the diaphragm (the stomach, intestine, liver and bile ducts, spleen, the pelvic organs) as well as the lower limbs. The anaesthetics block the posterior, or sensory, spinal roots, which leads to the loss of various sorts of sensation, and anterior, or motor, roots that causes muscular relaxation. Preganglionic sympathetic fibres that pass through the anterior roots are also blocked, which results in dilation of the local arterioles. When sympathetic fibres contributing to the coeliac nerves are blocked, the vascular dilation of abdominal and pelvic organs and the lower limbs can lead to the storing of blood into them and hence a fall of blood pressure.

Special spinal needles with well-fixed mandrin, syringes with tenth-millilitre graduations are used. 5% novocain, 1% ultracain, 1% trimecain or 2% lidocain is used. 2 ml of 20% caffeine solution and 1 ml of 5% ephedrine solution are given to the patient 30 minutes prior to the operation. The patient is set on a table, his/her feet put on a step, the knees raised a little and the spine in maximally flexed. The nurse standing in front of the patient presses down on his/her shoulders and helps to keep him/her in the required posture. If the puncture is to be done with the patient lying, he/she is put on a table lying on the side, the back at the edge of the table with the knees raised to the stomach and the chin lowered to touch the chest, the spine being maximally flexed. An assistant stands in front and with his/her one hand on the patient's neck and another on the hip fixes him /her as if trying to fold out his/her spine where the puncture is to be done.

The lumbar puncture is usually performed between L3 and L4 or L2 and L3 vertebrae processes. Lumber spine L4 is used as the hallmark of the line joining the superior posterior

spines of the iliac bones (fig. 15). The operative field is cleansed with ether and alcohol. The skin of the injection site is infiltrated with 0,25% novocain. The needle is placed in the midline in between the bone processes tilted a little (5-10°) downwards. When the needle passes through the intervertebral and yellow ligaments, some resistance, which vanishes after passing through, is felt. Some more resistance is encountered at the point of entry through the spinal dura matter, after this the guidance of the needle is stopped, the mandrin removed and the needle rotationally pushed forward for 2-3 more mm piercing the internal layer of the dura matter. The appearance of colourless fluid suggests successful puncture. If there is no or just a little fluid, the needle is rotated around its axis and advanced for about 1-2 mm. If there is still no fluid or blood appears, the needle is withdrawn and the process repeated through a different intervertebral space.

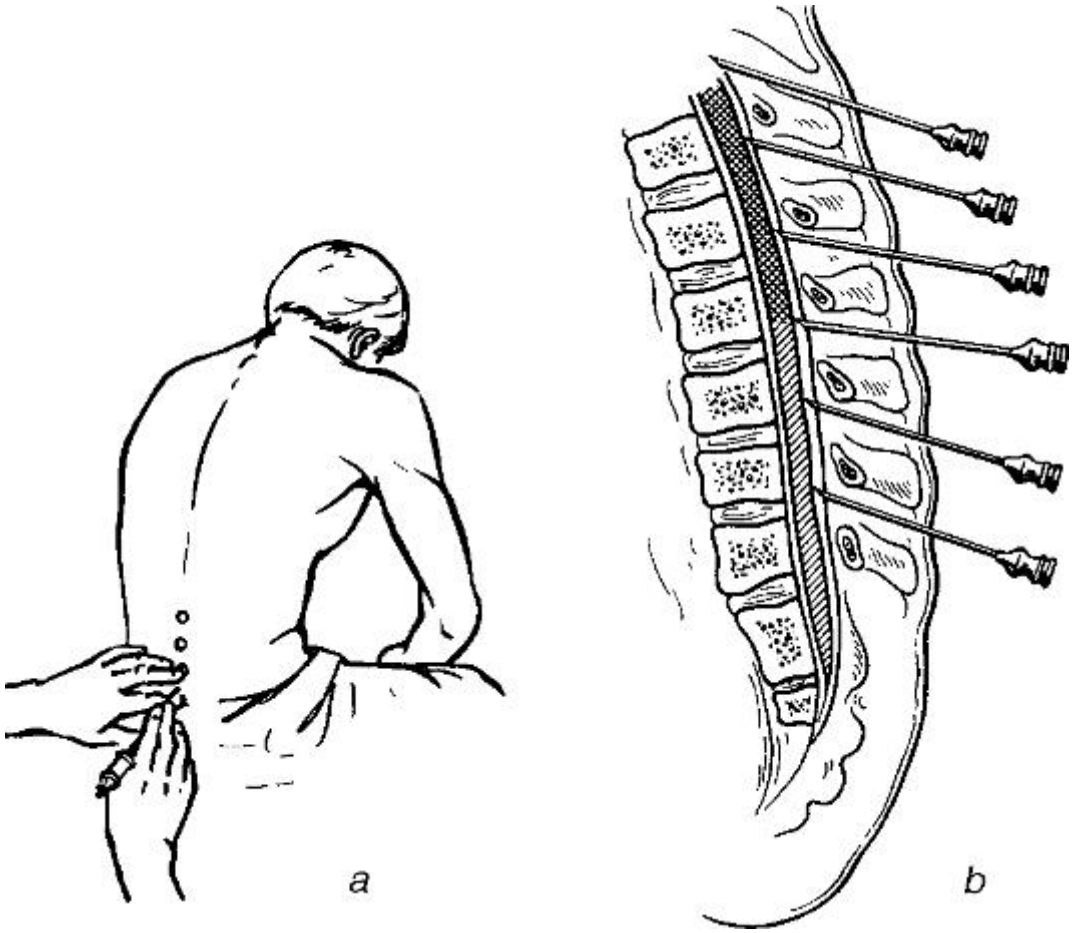

Fig. 15. Lumbar puncture.

a - choosing the optimum puncture site; *b* - directing the needle depending on the vertebral spinal slope.

After successful puncture, 2-3 ml of cerebro-spinal fluid are drawn into the syringe, mixed with 2 ml of 2% lidocaine or 1 ml of 5% novocain and then injected into the cerebrospinal canal. The patient is immediately placed on the operating table with the head end of the table *raised.* With this the anaesthetic is prevented from spreading to upper areas of the spinal cord and to the midbrain.

Contraindications for spinal anaesthesia:

- traumatic shock;
- severe intoxication as a result of peritonitis;
- concurrent hypotension;
- myocarditis;

- cutaneous infections on the spine;
- vertebral column deformity.

Complications

A serious complication of spinal anaesthesia is a fall in blood pressure, which results from block of the sympathetic nerve fibres. This type of complication often occurs when anaesthesia is performed at the level of the lower thoracic or upper lumbar spines; the complication is very rare when the puncture is performed at the lower lumbar spines. To prevent hypotension, vasoconstrictors may be given before or during the procedure, transfusion therapy may also be of use. To centralise blood circulation, the lower limbs are bandaged and raised.

When the anaesthetic spreads upwards along the subarachnoid space, it can block the innervation to the intercostal muscles that control breathing hence affect it or even cause respiratory arrest. Oxygen therapy is used to treat pulmonary insufficiency, and if respiratory arrest is obvious, mechanical ventilation is required.

Headaches, lower limb paresis, suppurative meningitis can occur following spinal anaesthesia.

Because of its serious complications spinal anaesthesia is only rarely used. Recently, peridural anaesthesia has become widely used.

Peridural anaesthesia is a type of nerve block anaesthesia. The anaesthetic, given into the peridural space between the dura matter and the periosteum of the vertebrae, results in the block of the spinal nerve roots (fig. 16). This method of anaesthesia imparts all the advantages of spinal anaesthesia and is void of all its disadvantages.

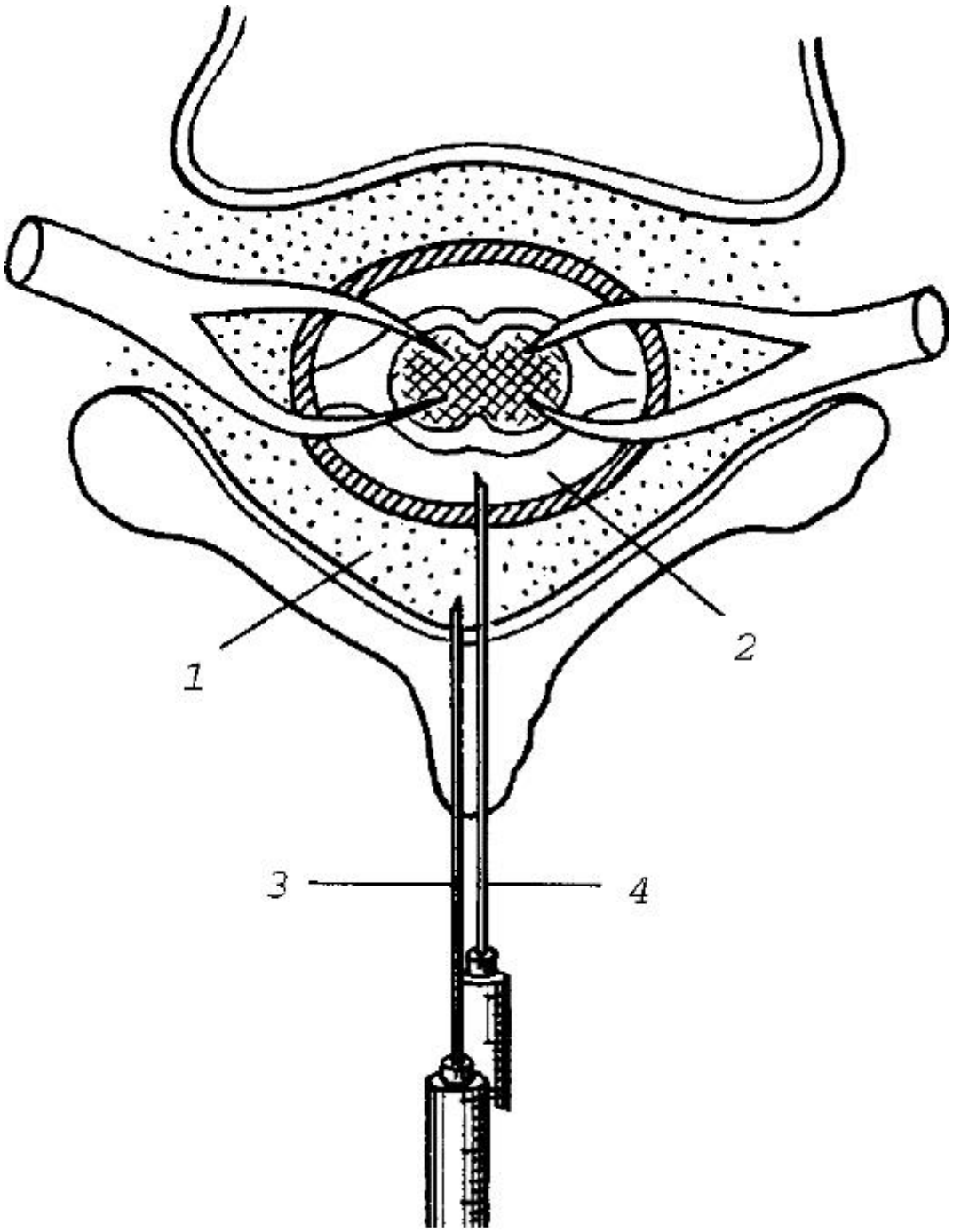

Fig. 16. Epiand subdural puncture.

1 - epidural space; *2* - subdural space; *3* - the needle at the epidural space; *4* - the needle at the subdural space.

Technically, the puncture of the peridural space is similar to that of subdural space. The puncture can be performed at any level of the vertebral column. It is noteworthy that the dura matter can easily be punctured, which will facilitate entering the drug into the subarachnoid space with resultant serious complications. The puncture is done with a needle connected to a syringe that contains normal saline solution. Resistance accompanies movement of the needle on pushing on the syringe until is passes through the intervertebral ligament and enters the peridural space, when no resistance is endured and the liquid is easily injected. Further evidence of the needle being in the correct space is that when the needle is connected to a water manometer, cerebrospinal fluid should not gush out, there should be a negative pressure reading on the manometer. Anaesthetic can be given with a needle or through a catheter which is introduced

through the needle and left for a long period. To lengthen anaesthesia the drug can be given through the catheter in fractions.

Up to 40 ml (fractionaly) of 1-2% lidocain or trimecain are introduced into the peridural space.

Peridural anaesthesia is used during trauma and orthopedic surgeries on the lower limbs, abdominal and pelvic operations. This kind of anaesthesia is used for old and elderly patients, those with serious cardiovascular and respiratory diseases, patients with metabolic disorders (obesity, diabetes mellitus).

Contraindications for peridural anaesthesia are similar to those for spinal anaesthesia.

Complications are very rare. Hypotension and respiratory problems, nausea, vomiting and seizures can occur. Anaesthesia may not be achieved in 5-10% of cases, which is accounted for by the presence of possible adhesions in the peridural space that prevent entry and spread of the anaesthetic drug.

2.6 GENERAL ANAESTHESIA (NARCOSIS)

General anaesthesia is a period of reversible unconsciousness, the absence of pain, reflexes and relaxation of skeletal muscles as a result of the effect of narcotic substances on the central nervous system. Depending on the way the drug is given into the body, the two types of general anaesthesia are identified: inhalation and non-inhalation anaesthesia.

Inhalation anaesthesia

Inhalation anaesthesia is achieved by breathing gaseous or volatile narcotic agents. Ether, halothane, methoxyflurane and trichloroethylene are volatile forms, while gaseous forms include nitrous oxide, cyclopropane.

Narcotic agents work to cause characteristic changes throughout the whole body. During the period of saturation with the substance a certain trend of events (stages) is observed, i.e. in changes in consciousness, breathing and circulation. The period narcosis is hence divided into stages that correspond to the depth of anaesthesia. These stages are mainly obvious when ether is used.

The four stages are as follows: I - analgesia, II - excitement/agitation, III - surgical stage of 4 levels, and IV - awakening.

Analgesia (I). The patient is conscious but confused and answers questions reluctantly. He/she is not sensitive to superficial pain, whereas touch and heat sensitivity are intact. Minor operations (e.g. incision and drainage of abscesses and diagnostic procedures) can be performed during this period. This stage is very short as it persists for 3-4 minutes.

Excitement (agitation) (II). Inhibition of the cortical centres occurs in this stage while the subcortical ones are excited: unconsciousness, increased motor and speech reactions. Patients shout, attempt to get off the operating table. The skin is hyperaemic, pulse accelerated and blood pressure level increased. The pupils are dilated but react to light, tears appear in the eyes. Patients normally cough at this stage, their bronchial secretion is increased and vomit may even occur. Operating on at this stage is prohibited. It is necessary to continue saturating the body with the drug to deepen the narcotic effect. The maintenance period depends on the patient's condition and anaesthetist's qualification. Excitement normally lasts for 7-15 minutes.

Surgical stage (III). With the onset of this period the patient calms down, breathes smoothly, the pulse and blood pressure are near the basal values. Surgical interventions may be performed in this stage. Depending on the depth of anaesthesia, this stage is divided into 4 levels:

• *level 1:* the patient is calm, breathes smoothly, blood pressure and pulse approach the initial values. The pupils begin to constrict, still react to light. The eyeballs are placed

eccentrically and move rolling. Corneal and swallow reflexes are maintained. The muscle tone is maintained, so it is difficult to perform operations on visceral organs;

• *level 2:* the eyeballs stop moving and are located centrally. Pupils start to gradually dilate; reaction of the pupils to light abates. Corneal and swallow reflexes weaken and at the end of the second level are absent. Breathing is quiet and smooth. Blood pressure and pulse rate are normal. Muscle tone starts to decrease, which allows for operations on visceral organs;

• *level 3:* the patient is in deep narcosis. The pupilsare dilated, do not react to light, swallow reflex is absent. The skeletal muscles including the intercostal ones are fully relaxed. Breathing is shallow and diaphragmatic. As a result of relaxation of the muscles of the mandible which can hang, the tongue can fall back to block the entrance of the larynx and cause respiratory arrest. To prevent this complication the mandible should be held forward and kept there. The pulse is fast and weak. Blood pressure falls. It is noteworthy that keeping anaesthesia in this condition may be fatal;

• *level 4:* maximal dilation of the pupils with no reaction to light, the cornea is dry. Breathing is shallow, taking place through the movements of the diaphragm since the intercostal muscles are paralysed. Pulse is faint and fast; blood pressure level is low and can hardly be assessed. To deepen anaesthesia to level 4 may be fatal since respiratory and circulatory arrests can easily set in. Stage of awakening (IV). The moment the supply of the narcotic is stopped, its blood concentration falls, the patient in a reverse way goes through all the stages passed and wakes up.

The following substances are used for inhalation narcosis.

Ether is a colourless liquid with a specific odour and a boiling temperature of 36,5 °C. It dissolves well in fat and alcohol. It should be kept in dark well-cocked bottles since it is oxidized on exposure to light to form a toxic compound. As it is inflammable, it has to be handled with care when used in modern time theatres. Ether is a strong narcotic substance, which causes deep anaesthesia. It is eliminated through the respiratory tract, irritates it and therefore stimulates bronchial secretion. It may also impair hepatic functions.

Halothane (fluothane, narcotan) is a colourless fat-soluble liquid with sweet odour and a boiling temperature of 50,2 °C, which should be kept in dark bottles. It is fire-resistant. Halothane is a potent narcotic: acts fast (within 3-4 minutes), the excitement stage is either very short or does not manifest at all, patients wake up very fast. Transfer from one stage of narcosis to another is very immediate and because of this over dosage can occur. The drug inhibits the cardiovascular system that leads to a reduction in the heartbeat and blood pressure level. The drug is toxic to the liver. It does not irritate the respiratory tract, dilates the bronchi hence can be used for patients with respiratory system diseases. Halothane may increase the sensitivity of cardiac muscles to epinephrine and norepinephrine. Thus, if a patient is under this kind of anaesthesia, such drugs should be avoided.

Methoxyflurane (pentran) is a colourless transparent liquid with a characteristic fruity odour and a boiling temperature of 104 °C. Its narcotic potency is higher than that of ether and chloroform; the narcotic sleep is slow, after 8-10 minutes of its introduction. The excitement stage is more pronounced and awakening is slow. The drug like halothane can reduce blood pressure and increase the sensitivity of the myocardium to the catecholamines (epinephrine and norepinephrine).

Nitrous oxide, or «laughing gas», is a colourless gas without odour, not explosive, but, if combined with ether and oxygen, it can burn. The gas should be kept in grey metallic cylinders in a liquid form under the pressure of 50 atmospheres. Nitrous oxide is an inert gas, in the body it does not affect functions of any organ, it is eliminated via the lungs unchanged. As a narcotic it is only used in combination with oxygen since pure nitrous oxide is toxic. Nitrous oxide and oxygen are used in the ratio of 1:1, 2:1, 3:1 and 4:1. The latter ratio contains 80% nitrous oxide

and 20% oxygen. Decreasing the concentration of oxygen in the compound below 20% is prohibited, otherwise it may cause severe hypoxia. Nitrous oxide causes quick and quiet sleep without the excitement stage. Awakening is immediate, just at the time the anaesthesia is stopped. The disadvantage of nitrous oxide is its low anaesthetic potency: even in its maximum concentration of 80% it gives a slight anaesthetic effect (levels 1-2 of the surgical stage). Muscle relaxation is absent. Nowadays nitrous oxide is used in combination with barbiturates, halothane - in so called «combined anaesthesia».

Cyclopropane is a colourless gas with mild petroleum odour. It is prepared into red cylinders in liquid form under the pressure of 5 atmospheres. It is only used when mixed with oxygen. Its disadvantage is that it is highly inflammable. Cyclopropane is a potent anaesthetic agent: inhalation of only 10-15% of the compound with oxygen causes surgical stage of anaesthesia. Sleep as well as awakening is very fast. It does not irritate the respiratory tract, but its action on the vagus nerve can provoke cardiac arrhythmias. Cyclopropane increases the myocardial sensitivity to epinephrine and norepinephrine, maintains and stabilizes blood pressure and is therefore indicated for bleeding and shock. It does not affect hepatic or renal function.

Preparing the patient for general anaesthesia

The anaesthetist is directly involved in preparing the patient for anaesthesia and operation. The patient should be examined before the operation, history is taken not only of the principal disease that has necessitated the operation, but the details of concurrent conditions as well. If the surgery is scheduled, the patient should be treated of other ailments, and sanitation of the oral cavity should be done. The surgeon has to examine and assess the psychological status of the patient and exclude any possible allergies, previous operations, if any, and the anaesthesia used.

Features of the face, the chest, the type of neck, the nutritive status are evaluated.

All these are essential in making the right choice of anaesthesia and the anaesthetic.

An important measure in preparation of the patient for general anaesthesia is evacuation of the gastrointestinal contents (gastric lavage, cleansing enema).

To suppress the emotional reactions of the patient and depress the functions of the vagus preoperatively, specific preparations (premedication) are used. The patient is given sedatives on the eve of the surgery at night; tranquilizers (seduxen, relanium) are given to patients with neurotic reactions on the day before surgery. 40 minutes prior to the operation a narcotic analgesic is given subcutaneosly or intramuscularly: 1 ml of 1-2% promedol or 1 ml of lexir, 2 ml of fentanyl are given.

To inhibit the vagus and reduce salivation 0,5 ml of 0,1% atropine are given. Patients with allergic conditions are in addition given an antihistamine drug. Immediately before the operation the mouth is inspected and removable teeth prosthesis are taken out.

In emergency, gastric lavage is done and the premedication is given when the patient is on the operating table, the narcotic is given intravenously.

Inhalation general anaesthesia using vapour and gaseous substances is achieved with special apparatus - anaesthetic machine (fig. 17). The main parts of the machine are as follows:

1) cylinder for the gaseous substances (oxygen, nitrous oxide and cyclopropane);

2) vaporiser for steam forming narcotic substances (ether, halothane, pentran);

3) dosimeter;

4) breathing contour.

Oxygen is kept in blue cylinders under the pressure of 150 atmospheres. To reduce the outgoing pressures of nitrous oxide and oxygen, special reducers are used, which bring down the

pressure to as low as 3-4 atmospheres. Kept under a lower pressure, cyclopropane can be given directly into the anaesthetic machine.

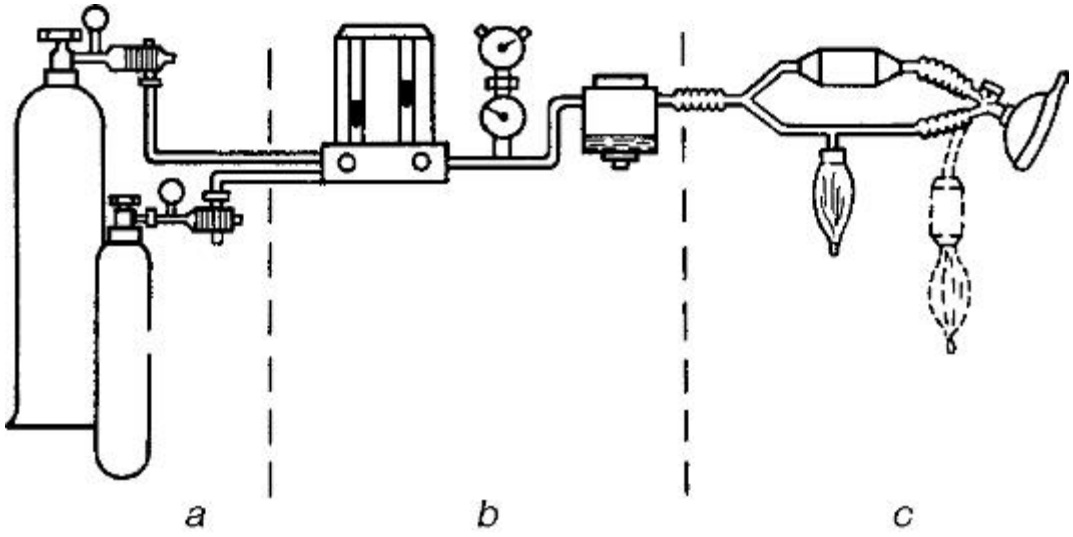

Fig. 17. Anaesthetic machine.

a - gas bags; *b* - dosimeters and evaporators; *c* - ventilators.

Vaporisers are necessary for steam forming narcotic substances. Steams of the narcotic are directed through a valve into the contour of the machine, concentration of the steam varies with the surrounding temperature. Dosage is not precise in arbitrary units, especially that of ether whose boiling temperature is 35,6 °C.

Nowadays, vaporisers with thermic compensators are widely used, which allows for a more precise dosage of the narcotic (in their percentage volumes).

Dosimeters are meant for accurate dosage of gaseous anaesthetic drug and oxygen. Rotational dosimeters are often used - the float type. The stream of gas inside the gas tube directs upwards from below. The float dislocation is equal to the amount of gas used in litres per minute.

Breathing contour comprise a breathing bellows (or mechanical ventilator), bag, hose, valves and absorbers. The anaesthetic substance passes through the breathing contour from the vaporijer and dosimeter to the patient, and then through the air-way out - into the machine. There are 4 types of breathing contours: open, partly open, closed and partly closed. The partly closed type is most often used, here inhalation is received from within the machine and exhalation is done partly into the machine and partly into the atmosphere. Exhaled air enters the machine and is purified of its carbon dioxide when it passes through the chemical absorbent.

Inhalation anaesthesia can be achieved using the mask, endotracheal or endobronchial methods. The anaesthetic machine is first put in working condition as follows:

1) open the regulators of the nitrous oxide and oxygen cylinders;

2) check for the presence of gas in the cylinders by the reading on the manometer;

3) connect cylinders to the machine using the tubes;

4) if the anaesthetic drug is a volatile substance (ether, halothane, methoxyflurane), they are poured into the vaporijer;

5) fill the absorber with the chemical absorbent;

6) earth the machine;

7) make sure the machine is airtight.

To use the mask method for general anaesthesia, the anaesthesist stands beside the patient's head to place the facemask on his/her face. A special belt is passed across the head to

fix the mask on the face. If it is held manually, it should firmly be pressed to the face. The patient breathes in several times through the mask which is then connected to the machine. Oxygen is given to breathe for 1-2 minutes before the anaesthetic substance is allowed to flow. The dosage of the anaesthetic substance is slowly increased. Simultaneously, oxygen is given at the minimum rate of 1liter per minute. The anaesthetist constantly checks the patient's condition and flow of the anaesthetic. The nurse should permanently check the pulse and blood pressure. The anaesthetist examines the position of the eyeballs and the pupils, checks corneal reflex as well as the breathing pattern. When the surgical stage is attained, no more anaesthetic substance is given. Each patient is examined to determine the individual percentage volume dose of the anaesthetic required for at least the first level of the surgical stage of anaesthesia. If anaesthesia has been deepened to the third level of the surgical stage, the lower jaw has to be withdrawn. To do this, the thumbs are used to press on the angles of the lower jaw and pulled forward, until the lower incisors are placed forward to the upper ones. The 3rd, 4th and 5th fingers are then used to hold the lower jaw in that position. To prevent the jaw from falling back, airwaytubes can be used, these are kept to the root of the tongue to prevent it from falling back. It is noteworthy that giving anaesthesia at the third level of the surgical stage is dangerous in terms of overdose. At the end of the operation, after the anaesthetic drug has been put off, the patient continues to receive oxygen for some time before the mask is removed from the face. After the end of work with the machine, all the ventilators of the anaesthetic and cylinders are closed. The remaining volatile substances are poured out of the vaporijer. The tubes and bag of the anaesthetic machine are removed and sterilized in an antiseptic solution.

Intravenous general anaesthesia

Advantages of intravenous general anaesthesia include a quick set-in of anaesthesia without the excitement stage and favourable nature of the patient's sleep. However, the drugs used for intravenous anaesthesia act for a short period and are therefore not suitable for major operations, if used alone.

Derivatives of barbiturate acid (sodium thiopental and hexenal) produce a fast anaesthetic sleep without the excitement stage. Anaesthesia is maintained for 20 minutes, and awakening is fast. The clinical profiles of sodium thiopental and hexenal are identical, hexenal inhibiting the respiratory system at a lesser degree.

Barbiturates are used prepared *ex tempore:* the content of the vial (1 g of the drug) before the anaesthesia is dissolved in 100 ml of normal saline to prepare 1% the drug. The drug is given slowly at a rate of 1 ml per 10-15 seconds. After giving 3-5 ml for a period of 30 seconds the patient is examined for sensitivity to barbiturates, after which the process is continued to induce the surgical stage of anaesthesia. The total dose should not exceed 1,000 mg. During giving the drug the nurse controls the patient's condition (pulse, breathing rate and blood pressure). The anaesthetist checks the state of the pupils, eyeballs and corneal reflexes to assess the depth of anaesthesia.

Suppression of respiration is characteristic of barbiturate anaesthesia, especially that induce by thiopental, which necessitates having a ventilator. With the onset of apnoea artificial respiration is started with the mask of the ventilator. If the drug is given too fast, it can cause hypotension and bradycardia, which requires that the giving of the drug be stopped.

In surgical practice, barbiturate anaesthesia is used for minor operations (10-20 minutes in duration) such as incision and drainage, manipulation of fractures and dislocations and dilatations. Barbiturates are also used to initiate anaesthesia.

Viadryl is used in a dose of 15 mg/kg (average: of 1,000 mg). It induces anaesthesia which is difficult to control and is therefore given only in small doses in combination with nitrous oxide. In high doses the drug can cause hypotension, phlebitis and thrombophlebitis. To

prevent these, it is recommended that the drug be given slowly and into the central vein as 2,5% solution. Viadryl is used to initiate anaesthesia or to perform the short-term procedures.

Propanidide (epontol, sombrevin) is available in 10 ml ampoules of 5% solution. The dosage is 7-10 mg/kg given as an intravenous bolus (500 mg within 30 seconds). Sleep is induced instantly, «at the tip of the needle». Anaesthetic sleep lasts for 5-6 minutes. awakening is fast and quiet. Propanidide causes hyperventilation, which sets in immediately after the loss of consciousness. Occasional apnoea may call for the use of the artificial ventilation machine. The disadvantage of this drug is the risk of hypotension that occurs during its injecting. It is mandatory to control the blood pressure and pulse. The drug is used to initiate anaesthesia, for outpatient surgical manipulations and for momentary surgeries.

Sodium oxybutyrate is given intravenously and slowly, the average dose being 100-150 mg/kg. The drug produces superficial anaesthesia and is therefore often given in combination with other anaesthetics, for example with barbiturates, propanidide. It is often used to initiate anaesthesia.

Ketamine (ketalar) can be injected either intravenously or intramuscularly. The dose is as high as 2-5 mg/kg. It can be used as a monoanaesthetic or as an initiator. Ketamine gives superficial anaesthesia, stimulates cardiovascular function, elevates blood pressure, accelerates pulse rate. Thus hypertension is a contraindication for the use of ketamine. It is widely used in hypotension and shock. Ketamine may produce hallucinations at the end of anaesthesia when the patient is waking up.

Endotracheal anaesthesia

Endotracheal anaesthesia is the type of anaesthesia in which the anaesthetic enters the body through a tube placed in the trachea. Advantages of this method are as follows:

- provides a free passage of the respiratory tract;
- can be used for operations on the neck, face and head;
- lowers the risk of aspirating vomitus or blood;
- reduces the amount of anaesthetic to be used;
- improves gas metabolism by means of a decrease in the «dead» space.

Indicated for major surgeries, endotracheal anaesthesia is used in the form of polyvalent anaesthesia with muscle relaxation *(combined anaesthesia)*. The sum effect of using several anaesthetics in small quantities reduces the toxic effect imposed by each of them separately.

Currently, combined anaesthesia seeks to provide analgesia, unconscious state and relaxation. Analgesia and unconscious state are achieved with one or several anaesthetics (inhalation and non-inhalation). Anaesthesia is maintained at the 1st level of the surgical stage of anaesthesia. Muscle relaxation or relaxation is achieved by fractional injection of muscle relaxants.

There are three stages of anaesthesia:

Stage 1 - *Induction.* To initiate anaesthesia, whichever anaesthetic that can produce adequate narcotic sleep without the excitement stage can be used. Barbiturates, fentanyl combined with sombrevin, or promedol combined with sombrevin, are generally used. Also, sodium thiopental is often used. The drugs are used in the form of 1% solution, given intravenously at a dose of 400-500 mg, maximal one being 1,000 mg. Intubation of the trachea is performed after the muscle relaxant has been given.

Stage 2 - *Maintenance.* For maintenance of general anaesthesia, whichever anaesthetic that can protect the body from the trauma of operation can be used (halothane, cyclopropane, nitrous oxide with oxygen), as well as the neuroleptanalgesics. Anaesthesia is maintained at the 1st and 2ndlevels of the surgical stage of anaesthesia, and to prevent muscle resistance, muscle

relaxants that cause myoplegia of all the skeletal muscles (including the respiratory ones) are given. This accounts for why an artificial ventilation machine is currently used, which provides rhythmic compressing the bag, or bellows.

Nowadays, neuroleptanalgesia is being most widely used: nitrous oxide with oxygen, fentanyl, droperidol and muscle relaxants. Anaesthesia is maintained with nitrous oxide + oxygen in the ratio of 2:1, fractional injection of fentanyl and droperidol 1-2 ml each 15-20 minutes is provided. Tachycardia requires injection of fentanyl, whereas hypertension necessitates administration of droperidol. This type of anaesthesia is the safest for the patient.

Stage 3 - *Conclusion.* At the end of anaesthesia the anaesthetist gradually stops giving the anaesthetic and muscle relaxants. The patient regains consciousness, starts to breathe on his/her own and muscle tonus is reestablished. The indices of P_{O2}, P_{CO2}, and pH are the indicators of the respiratory adequacy. After the main homeostatic indicators have been restored, the patient can be extubated and transported for further observation in the recovery ward.

Management of anaesthesia

During general anaesthesia the main circulatory parameters should be monitored and assessed. Blood pressure and pulse rate are checked each 10-15 minutes. Permanent monitoring of the heart functions is vital for patients with cardiac and vascular problems as well as in thoracic surgeries. Electroencephalogram can be used to assess the depth of anaesthesia. To monitor pulmonary ventilation and metabolic changes during anaesthesia and operation, it is necessary to evaluate the acid-base balance (PO2, PCO2, and pH).

During general anaesthesia, the nurse prepares the patient's anaesthetic chart, which should contain the main homeostatic parameters: pulse rate, blood pressure, the central venous pressure, breathing rate and parameters of the artificial ventilation machine. All the stages of operation and anaesthesia should be recorded. The doses of the anaesthetic substances used and muscle relaxants are also registered. All the drugs given during anaesthesia; the duration of each stage of the operation and the time medications are given should be recorded exactly. At the end of operation the total dose of all the drugs given are noted down in the anaesthetic record. All complications that occurred during anaesthesia and the surgery itself are registered. The anaesthetic record should be kept together with the patient's case history.

TESTS

Chapter II. ANAESTHESIA

1. The types of conduction anaesthesia are as follows:

1. Neural trunk anaesthesia.

2. Neural plexus anaesthesia.

3. Paravertebral anaesthesia.

4. Spinal (intradural) anaesthesia.

5. Epidural (extradural) anaesthesia.

Choose the right combination of answers:

A. 1, 2, 3. B. 1, 2, 3, 4. C. 1, 2, 4, 5. D. 1, 2, 5. E. 1, 2, 3, 4, 5.

2. The concentration of novocain used for infiltration anaesthesia should be as follows:

A. 1%.

B. 0,5%.

C. 0,25%.

D. 10%.

E. 5%.

Choose the correct answer.

3. Contraindications for local anaesthesia are which of the following:

1. Marked inflammatory and/or cicatricose tissue changes.

2. Heavy internal haemorrhage.

3. Heavy haemorrhage from superficial veins.

4. Patient's marked agitation.

5. Patient's age under 10 years.

Choose the right combination of answers:

A. 2, 4, 5. B. 1, 3, 5. C. 1, 2, 4, 5. D. 3, 4, 5. E. 1, 3, 4, 5.

4. The types of anaesthesia used for incision in mastitis or paraproctitis:

1. Local infiltration anaesthesia.

2. Intratratracheal general anaesthesia.

3. Intravenous anaesthesia.

4. Mask anaesthesia.

5. Conduction anaesthesia.

Choose the right combination of answers:

A. 1, 4. B. 4, 5. C. 1, 2, 3. D. 3, 4. E. 1, 2, 3, 4, 5.

5. Name conduction types of anaesthesia:

1. Lukashevich-Oberst.

2. Paravertebral.

3. Epidural.

4. Intraspinal.

5. Intercostal.

6. Retromammary.

Choose the right combination of answers:

A. 1, 2, 4, 5. B. 2, 3, 5, 6. C. 1, 2, 4, 6. D. 1, 2, 5, 6. E. 1, 2, 3, 5.

6. Case block is used in:

1. Injury of extremities.

2. Inflammatory disease.

3. Costal fractures.

4. Snake bites.

5. Infiltration anaesthesia.

Choose the right combination of answers:

A. 1, 2, 3, 4. B. 2, 3, 4, 5. C. 1, 3, 4, 5. D. 1, 2, 4, 5. E. 1, 2, 3, 4, 5.

7. For spinal anaesthesia, which of the following are used:

1. 5% novocain.

2. 2% lidocain.

3. 2,5% trimecain.

4. 10% novocain.

5. 0,5% bupivacain.

Choose the right combination of answers:

A. 1, 2. B. 2, 3. C. 1, 4. D. 1, 2, 3, 5. E. 4, 5.

8. The right position during spinal anaesthesia with the solution of sovcain is which of the following:

A. Lowered upper part of the body.

B. Raised upper part of the body.

C. Horizontal position.

D. On the patient's side.

E. Sitting with the trunk bent forward. Choose he right combination of answer.

9. The late complications of spinal anaesthesia are as follows:

1. Suppurative meningitis.

2. Paresis.

3. Meningism.

4. Headache.

5. Apnoea.

Choose the right combination of answers:

A. 1, 2, 4, 5. B. 2, 3, 4, 5. C. 1, 2, 3, 5. D. 1, 2, 3, 4. E. 1, 2, 3, 4, 5.

10. The aims of premedication are as follows:

1. To prevent vagal effect.

2. To raise sympathetic tone.

3. To depress salivation.

4. To inhibit agitation.

5. To prevent vomiting and gastric regurgutation.

Choose the right combination of answers:

A. 1, 5. B. 1, 4, 5. C. 3, 4. D. 1, 2, 3, 4. E. 1, 2, 3, 4, 5.

11. The general anaesthesia optimal for major abdominal surgeries is one of the following:

A. Ether-oxygen mixture.

B. Halothane-oxygen mixture.

C. Intratracheal general anaesthesia.

D. Neuroleptanalgesia.

E. Fractional ketamine general anaesthesia.

Choose the correct answer.

12. Muscle relaxants are given for which of the following:

1. Enhancement in effect of narcotics.

2. Motor block.

3. Block of autonomous reactions.

4. Stabilization of circulation.

5. Tracheal intubation.

Choose the right combination of answers:

A. 1, 2, 3, 4, 5. B. 1, 3, 4. C. 2, 4, 5. D. 1, 2, 3 E. 2, 5.

13. A 50-year-old man is being operated on for linea alba hernia. He is given halothane-oxygen mixture. His vital signs are as follows: BP 130/60 mm Hg, PR 78 beats/ minute and RR 18/minute. The pupil response and corneal reflex are sluggish.

Indicate the stage of general anaesthesia:

A. I.

B. II.

D. III_3.

Choose the correct answer.

14. Possible complications of intratracheal general anaesthesia are which of the following:

1. Recurarisation.

2. Vomiting.

3. Vocal ligamental oedema.

4. Asphyxia.

5. Muscle pain.

Choose the right combination of answers:

A. 1, 2. B. 3, 4. C. 2, 3, 4. D. 1, 2, 3. E. 1, 2, 3, 4, 5.

15. Contraindications for intravenous general anaesthesia with ketamine are as follows:

1. History of head injury.

2. Hepatic and renal insufficiency.

3. Seizures.

4. Hypovolaemia and marked blood loss.

5. Hypervolaemia and hypertension.

Choose the right combination of answers:

A. 1, 2. B. 2, 3. C. 1, 3, 5. D. 2, 5. E. 1, 2, 3, 4, 5.

16. Contraindications for intravenous general anaesthesia with barbiturate drugs are as follows:

1. History of anaphylactic reactions.

2. Hypertension.

3. Hypotension.

4. Hepatic insufficiency.

5. Hypovolaemia.

Choose the right combination of answers:

A. 1, 2. B. 3, 4. C. 3, 4, 5. D. 1, 3. E. 1, 2, 3, 4, 5.

17. Which intravenous anaesthetic should be preferred for induction in patients with blood loss above 1,000 ml, hypo-volaemia, low BP:

A. Hexenal.

B. Thiopentone sodium.

C. Ketamine.

D. Propanidid.

E. Fentanyl + droperidol.

Choose the correct of answer.

18. Which types of anaesthesia are indicated for reduction of shoulder or femoral dislocation:

1. Intratracheal halothane general anaesthesia.

2. Halothane mask general anaesthesia.

3. Neuroleptanalgesia.

4. Intravenous barbiturate general anaesthesia.

5. Peridural anaesthesia.

Choose the right combination of answers:

A. 1, 2, 4, 5. B. 1, 2. C. 3. D. 2, 4. E. 3, 5.

19. Which types of anaesthesia are preferable in operation for felon:

1. Intravenous general anaesthesia (barbiturate, pronanidid, propofol).

2. Conduction anaesthesia.

3. Ethyl chloride (chlorethyl) anaesthesia.

4. Infiltration anaesthesia.

5. Plexus anaesthesia.

Choose the right combination of answers:

A. 1, 2. B. 3, 4. C. 3, 5. D. 3, 4. E. 1, 2, 3, 4, 5.

20. Prevention of mechanical asphyxia due to sticking the tongue inside in early post-anaesthetic period requires the following measures:

1. Intravenous injection of proserin, a muscle relaxant antagonist, postoperatively.

2. Insertion of an airway tube.

3. Patient monitoring for about two hours after general anaesthesia.

4. Breathing stimulation with analeptics.

5. Insertion of a gastric tube.

Choose the right combination of answers:

A. 1, 2. B. 2, 4. C. 1, 3, 4. D. 4, 5. E. 2, 3.

21. The agents used in conventional premedication include the following:

1. Hexenal (thiopentone sodium).

2. Atropine sulphate (methacine).

3. Promedol (morphine fentanyl).

4. Strophanthin (corglucon).

5. Calcium gluconate (calcium chloride).

Choose the right combination of answers:

A. 1, 2, 4. B. 3, 4, 5. C. 2, 3. D. 4, 5. E. 1, 3, 4, 5.

22. The cause of oxygen kindling and explosion of gas bags with oxygen is which of the following:

A. Work with electrical appliances.

B. Absence of earth of respiration and general anaesthesia appliances.

C. Contamination of the reductor of a gas bag with oil (e.g. Vaseline).

D. Static electricity.

Choose the correct answer.

23. Using an electrical knife should be avoided in which of the following types of general anaesthesia:

A. Halothane.

B. Ether.

C. Nitrous oxide with oxygen.

D. Neuroleptanalgesia.

Choose the correct answer.

Regional anaesthesia

24. The types of regional anaesthesia are as follows:

1. Neural trunk anaesthesia.

2. Neural plexus anaesthesia.

3. Paravertebral anaesthesia.

4. Spinal anaesthesia.

5. Epidural anaesthesia.

Choose the right combination of answers:

A. 1, 2, 3. B. 1, 2, 3, 4. C. 1, 2, 4, 5. D. 1, 2, 5. E. 1, 2, 3, 4, 5.

25. What is the concentration of novocain used during anaesthesia by A.V. Vishnevsky?

A. 1%.

B. 0,5%.

C. 0,25%.

D. 10%.

E. 5%.

Choose the correct answer.

26. Contraindications for regional anaesthesia are as follows:

1. Pronounced local inflammation and scarring tissues.

2. Persistent massive internal bleeding.

3. Intolerance of anaesthetics.

4. The patient's acute excitation.

5. The patient's age under 10 years.

Choose the right combinations of answers:

A.2, 4, 5. B. 1, 3, 5. C. 1, 2, 3, 4, 5. D. 3, 4, 5. E. 1, 3, 4, 5.

27. The appropriate types of anaesthesia in surgery for mastitis are as follows:

1. Local infiltration anaesthesia.

2. Endotracheal anaesthesia.

3. Intravenous anaesthesia (barbiturates, sombrevin, kalipsol).

4. Spinal anaesthesia.

5. Intercostal anaesthesia.

Choose the right combination of answers:

B. 1, 2, 3, 4, 5. B. 2, 3, 5. C. 1, 2, 4. D. 1, 2, 5. E. 1, 2, 3, 5.

28. Fascial block is used for:

1. Limb injury.

2. Treatment of inflammatory disease.

3. Rib fracture.

4. Snake bite.

5. As a basis of infiltration anaesthesia.

Choose the right combination of answers:

C. 1, 2, 3, 4. B. 2, 3, 4, 5 C. 1, 3, 4, 5 D. 1, 2, 4, 5 E. 1, 2, 3, 4, 5.

29. The following types of anaesthesia are used during spinal anaesthesia:

1. Novocain 5%.

2. Lidocain 1-2%.

3. Trimecain 0,5-2%.

4. Novocain 10%.

5. Bupivocain 1%.

Choose the right combination of answers:

A. 1, 2. B. 2, 3. C. 1, 4. D. 1, 5. E. 4, 5.

30. The appropriate patient's position during surgery under spinal anaesthesia is one of the following:

A. Trendelenburg's position.

B. With the upper part of the body raised.

C. Horizontal.

D. Horizontal on one's side.

E. Sitting with the trunk bent forward.

Choose the correct answer.

31. Late complications of spinal anaesthesia are as follows:

1. Purulent meningitis.

2. Motor paresis.

3. Meningism.

4. Headache.

5. Respiratory arrest.

Choose the right combination of answers:

A.1, 2, 4, 5. B. 2, 3, 4, 5. C. 1, 2, 3, 5. D. 1, 2, 3, 4 E. 1, 2, 3, 4, 5.

32. The types of anaesthesia preferable in surgery for felon are as follows:

1. Intravenous anaesthesia (barbiturates and propanidid).

2. Neural trunks anaesthesia (Lukashevich-Oberst's).

3. Chlorethyl.

4. Infiltration anaesthesia.

5. Plexus anaesthesia.

Choose the right combination of answers:

A.1, 2. B. 3, 4. C. 3, 5. D. 1, 2, 3, 4, 5.

Chapter III. CARDIOPULMONARY RESUSCITATION

Resuscitation (Latin *re-*, again + *suscitare,* to revive) is a group of measures to restore life of anyone who is gravely collapsed or apparently dead. The task of resuscitation is to resume and maintain the function of the heart, lungs and metabolism in the patient's body. Resuscitation is most effective in acute cardiac arrest, when the residual compensatory mechanisms are still operable. If, however, cardiac arrest results from a severe incurable disease, in which all the compensatory mechanisms of the body are compromised, CPR is unlikely to be effective.

The three types of terminal conditions are identified: preagonal state, agony and apparent death.

Preagonal state is characterised by confusion, dyspnoea, skin pallor, cyanosis, low or undetectable systolic blood pressure (60-70 mm Hg), weak and rapid heartbeat.

Agony is a further stage of the dying characterised by unconsciousness, a thready or undetectable pulse and blood pressure with shallow, fast, convulsive or very rare breath movements.

Apparent death occurs immediately after breathing and circulation have ceased. It is a transition between life and death, which lasts 3-5 minutes. In apparent death the essential metabolic processes are inhibited and for the lack of oxygen these are mediated by anaerobic glycolysis. After 3 to 5 minutes irreversible changes (primarily in the central nervous system) occur with subsequent somatic, or true biologic death.

Cardiac arrest can either be sudden or gradual in onset or result from a number of chronic diseases. In the latter case a preagonal state and agony precede it.

The causes of sudden cardiac arrest are as follows:

- myocardial infarction;
- upper respiratory tract obstruction by a foreign body;
- injuries to the heart;
- anaphylactic or electric shock;
- drowning;
- severe metabolic disorders (e.g. hyperkalaemia, metabolic acidosis).

The signs of cardiac arrest, i.e. those of the onset of apparent death, include the following:

1) undetectable carotid artery pulse;

2) dilation of the pupils unresponsive to light;

3) respiratory arrest (absent breathing);

4) unconsciousness;

5) pallor, less commonly cyanosis, of the skin;

6) undetectable peripheral artery pulse;

7) undetectable blood pressure;

8) inaudible heart sounds.

Apparent death should be recognised within a short period. *Absolute signs of apparent death, i.e. undetectable pulse on the carotid artery and dilated pupils that do not react to light, require that CPR be started immediately.*

3.1 STEPS OF CARDIOPULMONARY RESUSCITATION (CPR)

CPR comprises the four steps (ABCD):

1) Airway (removal of any loose obstruction in the respiratory tract);

2) Breathing (institution of artificial ventilation);

3) Circulation (closed chest massage);

4) Differential diagnosis, drug therapy, defibrillation.

Lay persons are normally trained to perform the first two steps of CPR. Conversely, specific population categories (e.g. the military; police, especially those of the road traffic units; the fire service; water safety guards) and nurses should be able to provide the third step measures, namely closed heart massage. The first three steps can be taken outside hospital and not necessarily by people with some medical background. In contrast, step four of CPR is to be performed by urgent medicine specialists as well as staff of the intensive care unit.

Step I *(removal of any loose obstruction in the respiratory tract)*. Mucus, sputum, vomitus, blood or foreign bodies usually account for obstruction in the mouth and pharynx. It may also be accompanied by the tongue obstructing the entrance to the trachea due to mandibular muscle relaxation.

The victim is placed supine on a hard surface, with the head turned aside, the 2nd finger crossed over the thumb of the right hand is used to open the mouth and a handkerchief or napkin wrapped around the 2nd and 3rd fingers of the left hand are used to clean the oral cavity (fig. 18). The head is now turned straight and maximally tilted backwards. In doing this one hand is placed behind the neck, the other on the forehead fixing the head in the tilted position. In bending the head backwards the lower jaw is pushed up together with the root of the tongue, which restores the free passage of the airway (fig. 19).

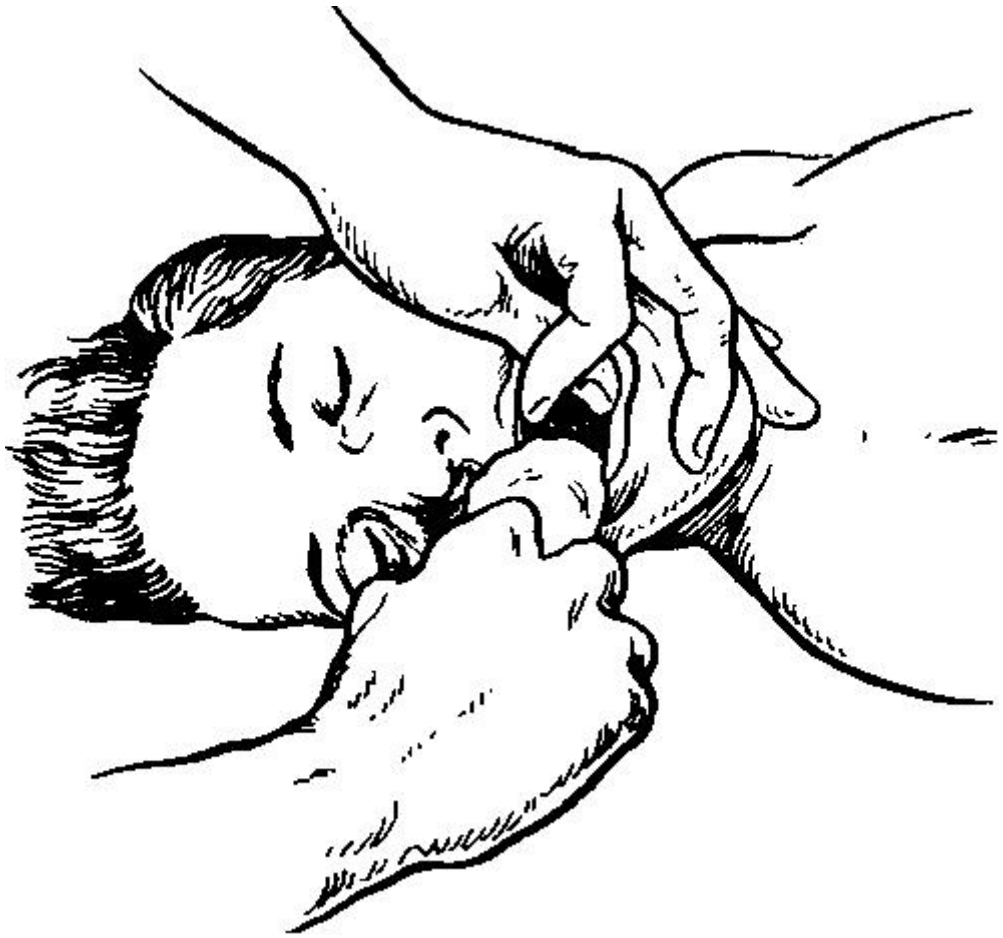

Fig. 18. Cleansing the oral cavity of mucus and foreign bodies.

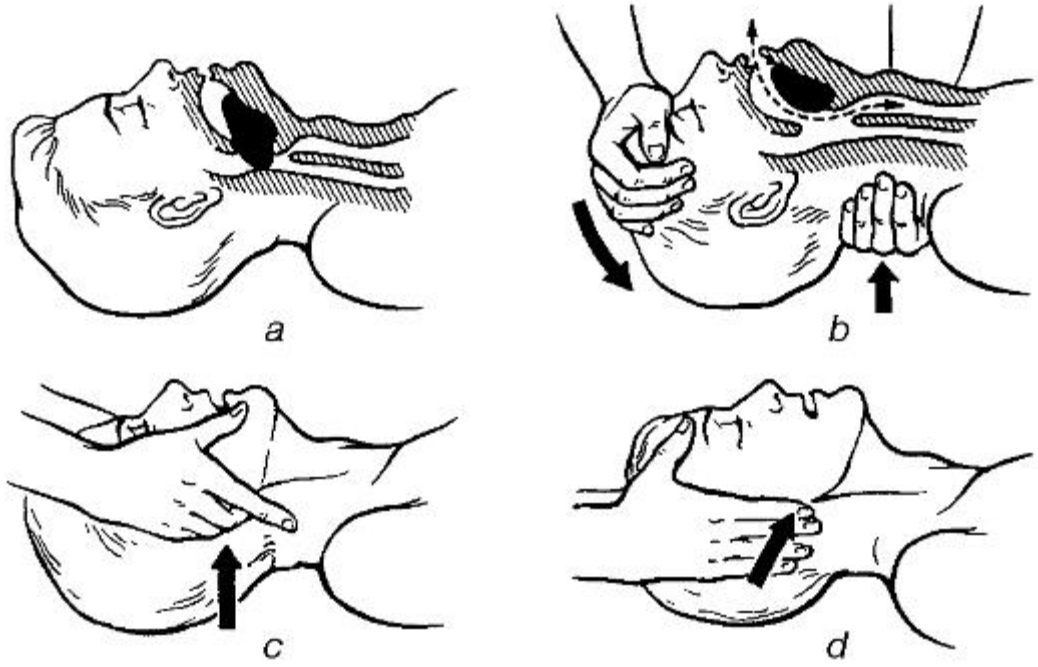

Fig. 19. Prevention of the tongue from falling back: *a* - the tongue has fallen back; *b* - prevention by extending the patient's head back; *c* - prevention by pulling forward the patient's mandible.

Stage II *(institution of artificial ventilation).* This step is achieved through the methods of «mouth to mouth», «mouth to nose», and «mouth to mouth to nose» ventilation (fig. 20). To perform artificial ventilation the one doing it stands by the side of the patient (if the affected

person is lying on the floor he has to kneel down) one hand is placed under the neck, the other on the forehead fixing the head in the maximum tilted position, the 1st and 2nd fingers are used to close tight the patient's nostrils, and with the mouth firmly fixed on the patients mouth he/she strongly breaths out into him. The patient is then left for a moment to allow a passive exhalation. The volume of air that is exhaled into the patient at a time is between 500 to 700 ml, breathing rate being 12 min^{-1}. The effectiveness of artificial ventilation is assessed based on the excursion of the chest wall - rising on inhalation and falling on exhalation.

When there is injury to the lower jaw or when the jaw is hanging too loose, artificial ventilation is done by «mouth to nose». To do this the hand is placed on the forehead, the head is fixed in the tilted position, and the other hand is used to firmly push the lower jaw against the upper, closing the mouth tightly. The patient's nose is grabbed by the lips and breathed forcibly into it. In newly born babies artificial ventilation is done by «mouth to mouth and to nose». The head of the neonate is thrown back. The health care provider uses the mouth to grab both the mouth and nose of the baby and breaths out into them. The respiratory volume of a newly born baby is 30 ml, breathing rate - 25-30 min^{-1}.

The abovementioned method of artificial ventilation should be performed through a gauze or handkerchief to protect the saver from acquiring a respiratory infection. For the same reason artificial ventilation can be performed using an S-shaped tube which is allowed to apply only by medical personnel (fig. 21). The bent tube keeps the root of the tongue from falling back, thus preventing airway obstruction. The S-shaped tube is inserted into the mouth by the bent side with the end upwards, and pushed along the lower edge of the upper jaw. At the level of the root of the tongue it is turned by 180°. The cuff of the tube firmly closes the patient's mouth, and the hand is used to close the nose. Breathing is done into the free lumen of the tube.

Artificial ventilation can also be performed using a facemask or a reservoir bag. The mask is placed on the patient's face covering the nose and mouth.

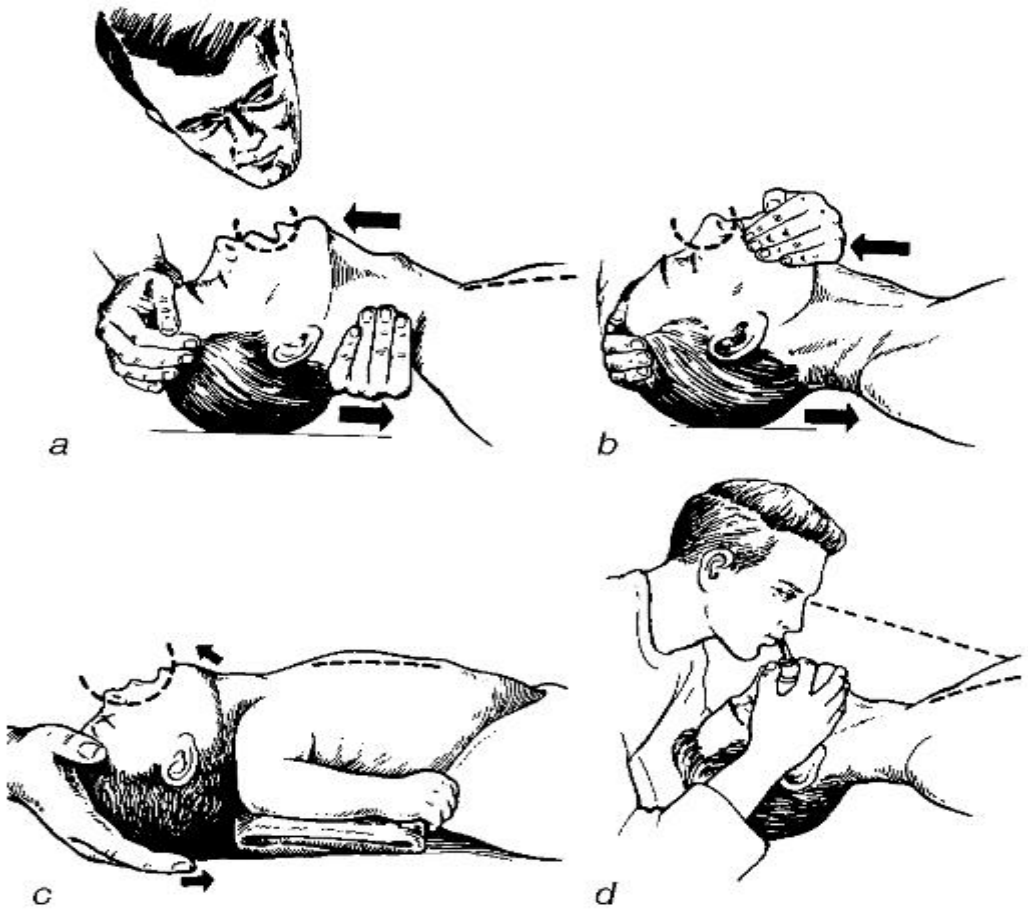

Fig. 20. Mechanical ventilation: a - mouth-to-mouth mode; *b* - mouth-to-nose mode; *c* - mouth-to-mouth and nose mode; *d* - using an airway.

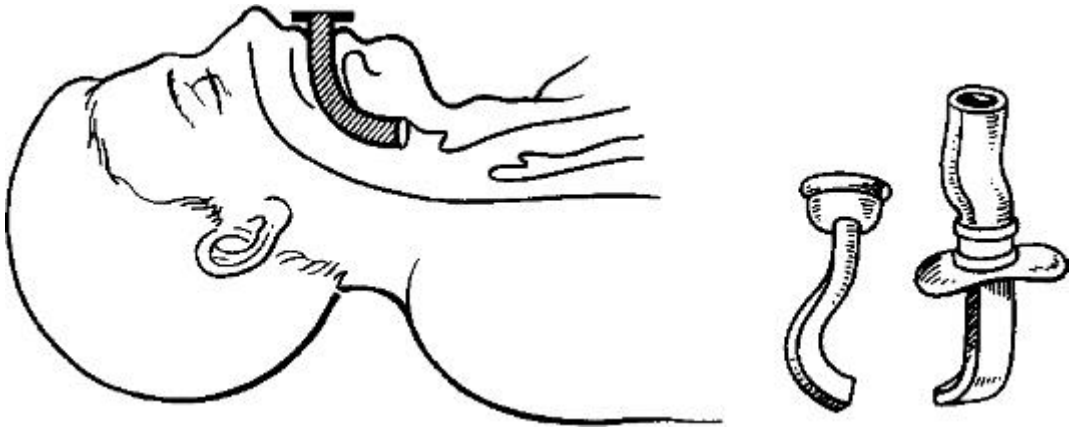

Fig. 21. Prevention of mechanic asphyxia using in airway.

The narrow nasal part of the mask has to be fixed by the thumb, using three fingers (3rd, 4th and 5th), the lower jaw is raised and the 2nd finger is used to fix the lower part of the mask. At the same time the head is fixed in the tilted position backwards. The free hand is used to rhythmically press on the bag to produce an inhalation, passive exhalation occurs through special valves into the atmosphere. Oxygen can also be supplied through the bag.

Stage III *(closed chest massage).* By this procedure one performs heart massage. Cardiac compression creates an artificial heart pump that can maintain the circulation. Blood supply to vital organs (the brain, heart, lungs, liver and kidneys) is thus restored. There are two types of cardiac massage - a closed chest, or an indirect, one and an open chest, or a direct one.

Closed chest (indirect) cardiac massage is normally done before the patient arrives at the hospital; this involves rhythmic compression of the chest between the sternum and the spine. The manipulation is preferably performed with the patient lying on a hard surface. The hands are placed on each other at the right angle on the lower third of the chest, 2 cm off the point where the xyphoid process is fixed to the sternum (fig. 22). As the sternum is being pressed on with a force of about 8-9 kg, it is pushed towards the spine for about 4-5 cm. Cardiac massage is carried out continuously and rhythmically with the sternum being pressed on with the arms straightened at a rate of 60 pressings per minute.

In children under 10 years of age heart massage is done using one hand at a rate of 80 pressings per minute, while in neonates it is performed using two fingers (the 2nd and 3rd ones), placed parallel to the sagittal plane of the sternum, at a rate of 120 pressings per minute.

Open (direct) heart massage is applied in chest surgery, chest injuries or in chest rigidity that precludes adequate external massage. To perform open heart massage, one is to open the thoracic cavity at the 4th left intercostal space. The hand is then introduced into the chest, with four fingers put under the heart and the thumb lying on the top. The heart is massaged by pressing it rhythmically. When the chest is open enough, this can be done using both hands. Moreover, heart tamponade requires that the pericardium be opened.

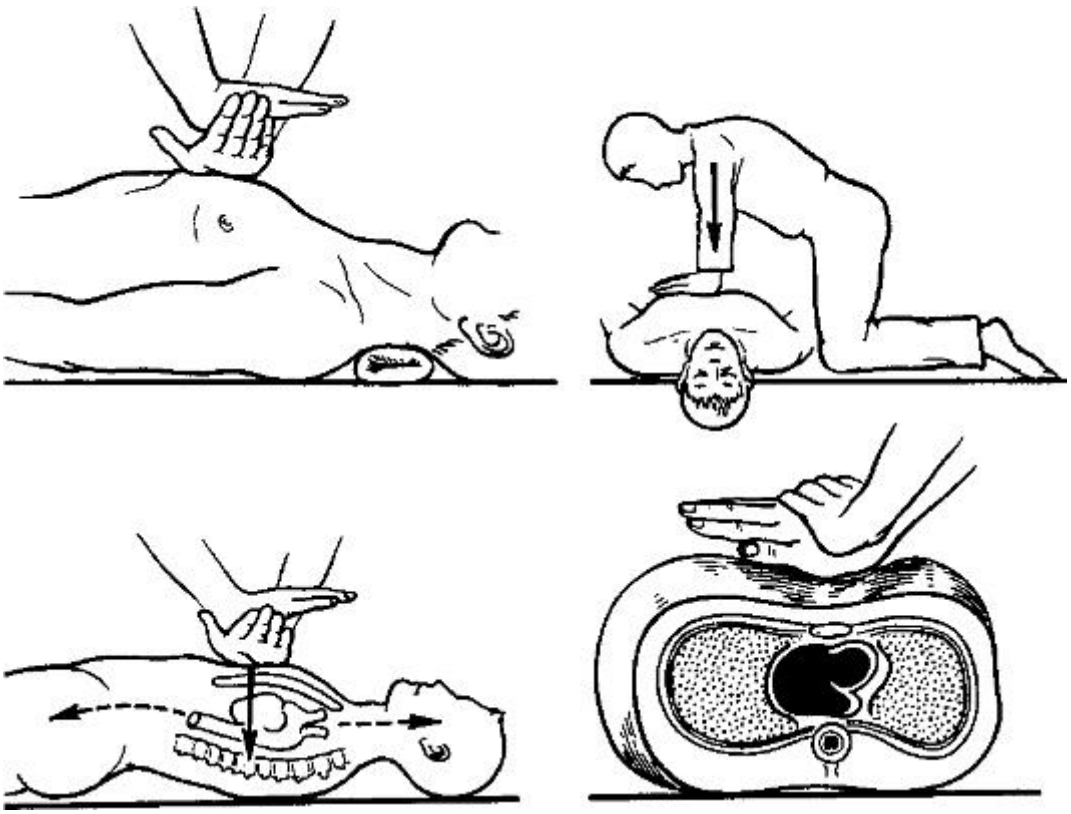

Fig. 22. Position of the hands for an indirect cardiac massage.

Resuscitation can be done by either one or two persons (fig. 23). If resuscitation is performed by a single person, he/she stands beside the patient. After cardiac arrest has been diagnosed and the oral cavity evacuated, four exhalations into the lungs are made using the «mouth to mouth» or «mouth to nose» ventilation. Afterwards, fifteen pressings of the chest alternate with two blows into the lung.

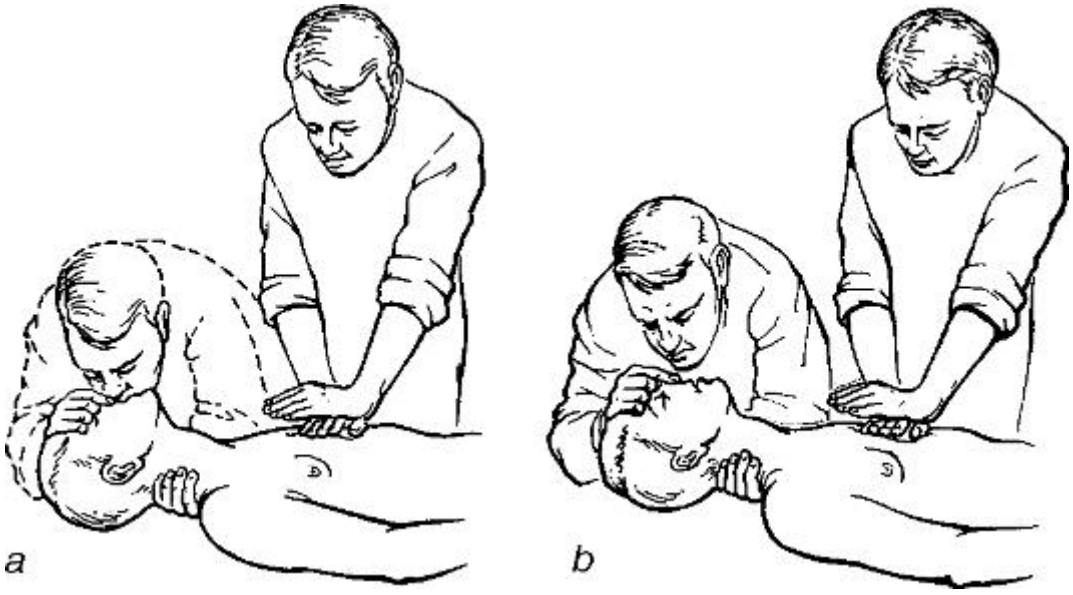

Fig. 23. Cardiopulmonary resuscitation: *a* - using a single hand and *b* - by two persons.

If two persons are involved in the manipulation, they usually stand beside the patient unilaterally. One of them is to be responsible for heart massaging, while the other performs the artificial ventilation. The ratio of artificial ventilation to heart massage is 1:5, i.e. one blow into the lungs is given following each fifth pressing on the sternum. The one involved in artificial ventilation checks for the carotid pulse, sees to it that the massage is being done correctly and

also monitors the pupils. The two people performing the manipulation have to periodically interchange their positions. Resuscitation of the neonate is often done by a single person who periodically makes three blows into the lungs followed by fifteen pressing on the sternum.

The adequacy of resuscitation is ascertained by constriction of the pupils with restoration of their reaction to light and the presence of a corneal reflex, hence the need for continuous monitoring the pupils. Heart massage is suspended every 2-3 minutes to check whether the heart has started beating on its own by feeling the carotid pulse. The moment it does, the massage should be stopped, while the artificial ventilation is continued.

Stage IV *(differential diagnosis, drug therapy, and heart defibrillation).* This is performed by only intensive care physicians and involves such measures as electrocardiography, intracardiac drug injection and heart defibrillation.

3.2 EMERGENCY AID IN ACCIDENTS

Shock is a serious condition that results from exposure to extreme factors, and leads to a rapid progressive reduction in tissue perfusion and therefore failure of all organs. Shock inhibits cardiovascular, respiratory and renal functions and hampers microcirculation and metabolism. Depending on the causative agent shock is classified as *traumatic, hypovolaemic, cardiogenic* and *septic.*

Traumatic shock is the commonest and results from severe injuries. It is often associated with intractable bleeding, severe pain and intoxication due to absorption of products of decay from ischaemic tissues. Bleeding plays an dramatic role in traumatic shock. It is not only the amount of blood lost but also the rate of bleeding which is of significance. In gradual blood loss a 20-30% reduction in circulating blood volume does not lead to a marked fall in blood pressure. On the contrary, in rapid bleeding the decreased circulating blood volume by 30% can be fatal. Thus reduced circulating blood volume (hypovolaemia) and microcirculatory deficiency are the mainstays in pathogenesis of traumatic shock.

Shock evolves two stages: erective and torpid.

Erective phase is very short and follows immediately the exposure to trauma, which causes increased sympathetic nervous activity: pallor of the skin, tachycardia, hypertension, and agitation.

The torpid phase is characterised by semicon-sciousness or even confusion, hypotension and thready pulse. The torpid phase is divided into four degrees.

• *Degree 1.* The patient is conscious and able toanswer the physician's questions but is a bit confused. Systolic blood pressure falls to as low as 90 mm Hg with mild tachycardia. The skin is pale and tremor is sometimes evident. On pressing the nail bed blood flow is restores rather slowly.

• *Degree 2.* The patient is confused. The skin is cool and pale, with diaphoresis. Cyanosis of the nail beds is pronounced, on pressing the nail bed blood flow restores very slowly. Systolic blood pressure falls below 90 mm Hg, pulse is weak and rapid (110-120 beats per minute). Central venous pressure is reduced. Breathing is shallow.

• *Degree 3.* The patient's condition is critical: he/ she is semiconscious, drowsy and can hardly answer the physician's questions, and does not react to pain. The skin is cold and bluish-pale.

Pulse is as fast as 130-140 beats per minute. Breathing is shallow, fast or sometimes rare. Systolic blood pressure is as low as 50-70 mm Hg. Central venous pressure falls to zero or even becomes negative. Urine production ceases.

• *Degree 4.* The patient is in a preagonal state: the skin and mucus membranes are bluish-pale, breathing is shallow and fast, pulse is rapid and very weak, systolic blood pressure falls to as low as 50 mm Hg.

First aid to the patient in shock before admittance to hospital includes the following:

1) bleeding control;

2) clearing the airway and ensuring adequate pulmonary ventilation;

3) pain relief;

4) transfusion therapy;

5) immobilization of fracture sites;

6) appropriate transportation.

Severe traumatic shock usually results in inadequate pulmonary ventilation due to aspiration of vomitus, blood or a foreign body. In such cases the first thing to do is to turn the patient's head aside and clean the mouth. Then the head is tilted backwards and the lower jaw pulled forward. An airway or an S- tube can then be used. External bleeding requires immediate control with a tourniquet, tight bandaging, pressing on the bleeding vessel or the application of the vascular clamps on the bleeding vessel in the wound.

In intractable internal bleeding, the patient must be hospitalised immediately for surgery.

Bleeding control and transfusion therapy should be performed simultaneously. Dextran solutions (polyglucin, reopolyglucin), partially splited gelatine (gelatinol) are usually preferred for nutritional support. Similarly, crystalloids (Ringer's solution, normal saline, lactasol) or 5% glucose can be used. If intravenous fluids that increase the circulating blood volume are unavailable, the patient should be placed in the Trendelenburg's position, i.e. the one with the table tilted head down, the patient being prevented from slipping off by shoulder, or preferably pelvic, supports, and by having the legs hang over the end of the table).

Before transportation analgesia should be provided and splint applied. The analgesics that can be used include morphine, omnopon, promedol, lexyl, and droperidol. It is noteworthy that morphine, omnopon and promedol can suppress respiration, thus they must be used cautiously, especially in patients with chest injuries and the elderly. Lexyl or droperidol is a better choice in such cases. A mask connected to the anaesthetic machine can also be used to provide analgesia. Nitrous oxide and oxygen in the ratio of 1:1 or 2:1 are mostly used.

In traumatic shock non-narcotic analgesics (e.g. 4-5 ml 50% analgin) can also be effective. Equally, such tranquilizers as 1-2 ml 0,5% seduxen (Biazepam) in doses of 1-2 ml of 0,5% solution may also be acceptable. As diminished peripheral circulation impedes absorption of drugs, in shock they should be given intravenously.

Immobilization of injured limbs with splint should be provided as early. Correct transportation of the injured patient is of great importance. Improper transportation augments pain reaction, which, in turn, worsens shock. A conscious patient is put supine on the stretcher to be transported, while an unconscious one should be placed on his/her side carefully monitored to prevent airway obstruction (e.g. the tongue from falling back, vomitus or blood from entering the airway). In nasal or oral cavity injury resulting in bleeding before transportation have the patient lie prone, with his/her head turned aside. When the tongue obstructs trachea, an airway must be used.

3.3 DROWNING AND NEAR-DROWNING

The time for apparent death of a drowning person reduces to 3 minutes. Trying to save himor herself, a drowning person makes a great physical effort and loses a lot of muscular energy, which quickly depletes his/her oxygen reserve, hence the necessity for artificial ventilation as soon as possible. It is started immediately the person is brought out of the water,

while the period he/she is being carried to the shore. In cardiac standstill, external heart massage is started while artificial ventilation of the lungs is continued. Do not waste time trying to evacuate water from his/her lower respiratory tract.

On the shore it is much easier to perform cardiopulmonary resuscitation. The drowning person always has the stomach filled with water, which requires evacuation as soon as possible. The person is put on his/her side and the hand is used to press on the epigastral area, the oral cavity is then cleared of sand, mucus and other particles before resuscitation. In case there are no signs of cardiac standstill in a patient without evidence of breathing, 'mouth to mouth» artificial ventilation is only applicable. In the case of apparent death one or two people have to start cardiopulmonary resuscitation.

When a person drowns in *fresh water* with somewhat lower osmotic pressure than that of blood, water that entered the lower respiratory tract is quickly absorbed. It is therefore required that time not be wasted for evacuating the water from the trachea and bronchi.

In drowning in *salted water* with salt concentration of as much as 3,5-4%, according to osmotic laws, plasma will try to find its way to the upper respiratory tract. The alveoli, trachea and bronchi may be filled with fluid, which can counteract artificial ventilation. Liquid can be partly evacuated by raising the lower part of the body in such a way that the upper part and the head will be hanging. These manipulations must be performed as fast.

When a person drowns in cold water, signs of hypothermia that inhibits metabolism, e.g. oxygenation, of the brain are diminished is observed. For apparent death to occur a longer period is needed and CPR can be a success even though the patient has stayed under water for a long time.

Each patient must be transported to hospital for further treatment and monitoring.

3.4 ELECTRIC SHOCK

Electric shock can cause respiratory arrest with subsequent cardiac standstill. In most cases, this kind of injury results from direct exposure to electricity. Electric energy can also affect distantly, particularly in cases of strong discharge. Lightening that has hit the ground or live electric wires on the ground can also cause electric shock.

The first aid involves evacuating the patient from the source before medical care is provided. In mild cases, place the patient supine and let them have complete rest. In respiratory arrest start artificial ventilation, while cardiac standstill requires closed cardiac massage.

3.5 HEAT INJURY

In heat stroke, the body becomes overheated, and heat regulation is impaired. Heat stroke occurs in people working in stuffy and poorly ventilated rooms with high temperatures as well as people wearing clothes made of synthetic materials.

Sunstroke follows long periods of direct exposure of the head or whole body to sunlight. The signs of heat and sunstroke include red skin discolouration, headache, weakness, nausea, vomiting, tachycardia, fever and fast pulse. Death results from cerebral oedema.

As a first aid measure the undressed patient is transferred to a cool place and given a cold beverage. Measures are taken to cool the body: cold water is poured on the patient; ice packs are applied to the major blood vessels, i.e. those of the neck and groins. In respiratory problems oxygen therapy is provided. In severe cases (e.g. cardiac standstill) CPR is immediately initiated and the patient is subsequently transferred to hospital.

TESTS

Chapter III. CARDIOPULMONARY RESUSCITATION

1. Which of the following are the optimal routes of administration of epinephrine during cardiopulmonary resuscitation:

1. Intramuscular.

2. Subcutaneous.

3. Intravenous.

4. Intramyocardial.

5. ntratracheal.

Choose the right combination of answers:

A. 1, 2, 3. B. 2, 3, 4. C. 3, 4, 5. D. 1, 4. E. 1, 2, 3, 4.

2. The agents used in acute circulatory failure are as follows:

1. Euphylline.

2. Epinephrine.

3. Calcium chloride.

4. Atropine.

5. Strophanthin.

Choose the right combination of answers:

A. 1, 2. B. 2, 3. C. 3, 4, 5. D. 2, 3, 4. E. 1, 2, 3, 4, 5.

3. The signs indicative of successful cardiopulmonary resuscitation are as follows:

1. Miosis.

2. Mydriasis.

3. Amelioration of cyanosis.

4. Recovery of reflexes.

5. Cervical venous engorgement.

Choose the right combination of answers:

A. 1, 5. B. 2, 5. C. 1, 2, 3. D. 1, 3, 4. E. 1, 2, 3, 4.

4. Algover's shock index is which of the following?

A. PR/SBP.

B. SBP/CVP.

C. SBP/ PR.

D. CVP/CBV.

E. CBV/ CVP.

PR = pulse rate. SBP = systolic blood pressure. CVP = central venous pressure. CBV = circulating blood volume.

Choose the correct answer.

5. Infusion therapy of degree III anaphylactic shock consists in which of the following:

1. Administration of epinephrine.

2. Corticosteroids (prednisone, decadron, hydrocortisone).

3. H_2 receptor antagonists (dimedrol, pypolphen, suprastin).

4. Calcium preparation (calcium chloride, calcium gluconate).

5. Narcotic agents (fentanyl, morphine).

Choose the right combination of answers:

A. 1, 2, 3, 4, 5. B. 1, 2, 3, 5. C. 1, 2, 3, 4. D. 2, 3, 4, 5. E. 1, 3, 5.

6. The signs of torpid phase of degree II traumatic shock include the following:

1. Agitation.

2. Adynamia.

3. Hypertension.

4. Hypotension.

5. Tachycardia.

Choose the right combination of answers:

A. 1, 3, 5. B. 2, 4. C. 2, 4, 5. D. 2, 3, 4, 5. E. 1, 4, 5.

7. The parameters that dictate the volume of infusion therapy in hypovolaemic shock are as follows:

1. ECG.

2. BP and pulse rate.

3. CVP.

4. Haematocrit.

5. Complete blood count.

Choose the right combination of answers:

A. 1, 2, 5. B. 1, 2, 3. C. 2, 3, 4. D. 1, 5. E. 1, 2, 3, 4, 5.

8. Treatment of collapse include the following measures:

1. Trendelenburg's position of the patient.

2. Injection of corticosteroids.

3. Inhalation of ammonia water.

4. Injection of analeptics.

5. Infusion of macromolecular dextrans.

Choose the right combination of answers:

A. 1, 2. B. 2, 3. C. 1, 3, 5. D. 1, 3, 4. E. 1, 2, 3, 4, 5.

9. The adverse effects of mask general anaesthesia include the following:

1. High toxicity.

2. An increase in anatomic dead space.

3. An increase in physiologic dead space.

4. A risk of regurgitation and aspiration of the gastric contents.

5. A risk of overdose.

Choose the right combination of answers:

A. 1, 2, 3, 4, 5. B. 1, 4, 5. C. 2, 4. D. 1, 5. E. 4, 3.

10. The advantages of endotracheal general anaesthesia include the following:

1. Reliable prevention of the gastric contents aspiration.

2. A decrease in anatomic dead space.

3. Reliable muscular relaxation.

4. A low risk of overdose of anaesthetics.

5. Reliable prevention of pneumonia.

Choose the right combination of answers:

A. 1, 2, 5. B. 3, 4, 5. C. 1, 2, 3. D. 1, 5. E. 1, 2, 3, 4, 5.

11. The agents used for general anaesthesia that may cause anaphylaxis include the following:

1. Barbiturates.

2. Ether.

3. Halothane.

4. Propanidid.

5. Ketamine.

Choose the correct answer.

12. Sudden cardiac arrest causes irreversible cortical lesions after which of the following periods:

A. 10 minutes.

B. 12 minutes.

C. 4-5 minutes.

D. 1-2 minutes.

Choose the correct answer.

13. The male patient suspected of having ileus is admitted to the surgical department after 3 days of recurrent vomiting, adynamia, and palpitations. The most significant metabolic problems that require correction preoperatively (pre-anaesthetically) are as follows:

1. Hypokalaemia, hypochloraemia.

2. Hyponatraemia, hypocalcaemia.

3. Hypoproteinaemia.

4. Hypovolaemia.

5. Anaemia.

Choose the right combination of answers:

A. 2, 3. B. 1, 2, 3. C. 4, 5. D. 1, 4. E. 1, 2, 3, 4, 5.

14. The signs of hypovolaemia due to pyloric stenosis or ileus include the following:

1. CVP (central venous pressure) < 4 mm H_2O.

2. CVP < 2 cm H_2O.

3. Tachycardia.

4. Hct > 45%.

5. Hct < 45%.

Choose the right combination of answers:

A. 1, 2, 3, 4, 5. B. 1, 3, 4. C. 1, 3, 5. D. 2, 3, 4. E. 2, 3, 5.

15. The measures to promote peripheral circulation include which of the following:

1. Administration of sympathomimetics (ephedrine, mezatone, norepinephrine).

2. Haemodilution to decrease blood viscosity.

3. Infusion of high molecular dextrans (polyglukin).

4. Infusion of low molecular dextrans (rheopolyglukin).

5. Blood transfusion.

Choose the right combination of answers:

A. 1, 2, 3, 4, 5. B. 2, 4. C. 2, 5. D. 1, 2. E. 3, 5.

16. The patient has combined trauma (craniocerebral and femoral fracture), II-III degree traumatic shock (BP 80/ 40 mm Hg, pulse - 120/minute). Intensive care prior to admission to hospital includes the following steps:

1. Blood transfusion.

2. Immobilization.

3. Nutritional support (polyglukin, rheopolyglukin, gelatinol).

4. Anaesthesia with non-narcotic analgesics.

5. Administration of vasopressors to increase BP.

Choose the right combination of answers:

A. 1, 2, 3, 4, 5. B. 1, 2, 4. C. 2, 3, 4. D. 2, 4, 5. E. 1, 4, 5.

Chapter IV. HAEMORRHAGE

Haemorrhage, or bleeding, is the escape of blood from the blood vessels as a result of an injury or defect in the permeability of the vascular walls. Blood loss is a life-threatening condition, which necessitates prompt treatment, as the life of the injured person invariably depends on how fast the doctor can deal with the problem.

In terms of the mechanism, haemorrhage divides into:

• mechanical (disruption or erosion of a vessel);

• neurotrophic (impaired permeability of vessels as a result of vascular wall pathology, which can be secondary to various diseases - scarlet fever, scurvy, haemophilia etc).

The following types of haemorrhage are identified:

1) haemorrhage per rexin (as a result of mechanical damage to the vessel - a tear or rupture);

2) haemorrhage per diabrosin results from erosion of blood vessels (by a tumour, in tissue necrosis and in infections);

3) haemorrhage per diapedesin due to a defect in the permeability of the vascular walls.

Bleeding can also be classified as arterial, arteriovenous, venous and capillary. Parenchymal bleeding is a capillary type of bleeding from an organ like the liver.

Bleeding can also be *external* (when blood oozes outside the body) and *internal* (when blood accumulates in an enclosed space of the body or in the cavity of a hollow organ). Moreover, it can be occult, when diagnosed only by means of specific methods of investigation.

Traumatic bleeding is classified as follows:

• primary (results from an injury to a vessel);

• secondary (occurs if a clot breaks away from the vessel because of a rise in blood pressure or as a result of vascular spasm, in which case it is referred to as *early secondary bleeding)*. On the other hand, *late secondary bleeding* is due to clot dissolution secondary to pyogenic infection or erosion of the vascular wall.

4.1 ACUTE HAEMORRHAGE

Intractable bleeding is life-threatening due to development of shock. Its severity depends on the intensity, duration of bleeding and the volume of blood loss. A fast decrease (i.e. as much as 30%) in blood circulating volume can cause acute anaemia, hypoxia of the brain that can be fatal. When bleeding persists for a long period but in smaller amounts, there are only few circulatory changes, if at all, and the patient can live with as low as 20 g/l of haemoglobin. This is explained as follows. A reduction in blood circulating volume leads to a decrease in venous pressure and the heart ejection force which, in turn, stimulates adrenal secretion of catecholamines and, therefore, vascular spasm and a reduction in vascular volume; all these maintaining appropriate haemodynamics in a safe state.

The four degrees of blood loss are identified:

1) mild - a reduction in blood circulating volume of 10-12%, or 500-700 ml of blood;

2) moderate - a reduction in blood circulating volume of 15-20%, or 1,000-1,400 ml of blood;

3) severe - a reduction in blood circulating volume of 20-30%, or 1,500-2,000 ml of blood;

4) massive - a reduction in blood circulating volume of more than 30%, or more than 2,000 ml of blood.

In severe blood loss the patient develops acidosis with subsequent marked destruction of the microcirculatory system and aggregation of red blood cells in the capillaries. Oliguria (i.e. a reduction in urine volume), which is initially of reflex in character, evolves to anuria (i.e. cessation of urine production) at the stage of decompensation, resulting from the insufficient renal perfusion.

Clinical picture comprises general and local signs. It is noteworthy that the extent of the general signs varies with the degree of haemorrhage. The signs include skin pallor, diaphoresis, facial cyanosis, weak and fast pulse, tachypnoea (periodic breathing, or Cheyne-Stokes phenomenon) in severe cases, as well as a decrease in venous and arterial blood pressure levels. The symptoms involve headache, dryness in the mouth and thirst, nausea, blurred vision and progressive malaise. In contrast, if the blood is being lost slowly, the symptoms and signs may not reflect the amount of the blood lost. It will be noted that the amount of blood loss be evaluated, as this will subsequently, after bleeding arrest, help choose the appropriate therapeutic strategy a reduction in blood circulating volume of 15-20%, or 1,000-1,400 ml of blood.

Laboratory investigations. Checking for levels of the red blood cells, haemoglobin and haematocrit should be done on admission and repeated afterwards. In severe bleeding, the results of the investigations mentioned may not serve as objective indicators of the degree of haemorrhage in the first few hours, since autohaemodilution occurs with time, reaching its maximum within $1^1/_2$-2 days.

It is haematocrit and blood specific gravity which can be relied upon in judging about the interrelationship between the cellular components of blood and plasma.

The blood specific gravity of as much as 1,057-1,054, haemoglobin 65-62 g/l, haematocrit 44-40 suggest blood loss as high as 500 ml, while those of 1,049-1,044, 53-38 g/l, and 30-23, respectively, mean that the amount of the blood lost is above 1,000 ml.

A progressive fall in venous blood pressure suggests that the heart is not receiving enough blood due to a reduction in blood circulating volume. It is measured either in the superior or inferior vena cava. This is performed with a catheter passing through the median cubital or long saphenous vein. The most factual method is whereby the amount of blood loss is checked by calculating the deficit in blood circulating volume and its components (i.e. circulating plasma volume, volume of cellular blood components, etc). The method consists in the introduction of specific indicators (Evans' blue, radioisotopes, etc.) into the vascular system. The concentration of the diluted indicator in the blood helps determine the plasma volume; using the standard table and the haematocrit value allows for the calculation of blood circulating volume and globular volume. The normal values of blood circulating volume and its components are found from the standard table based on the patient's body weight and sex. The difference between the normal and the actual values is used to estimate the deficit in blood circulating volume, circulating plasma volume and the globular volume, i.e. the amount of blood lost.

Special diagnostic methods. If internal bleeding is suspected, diagnostic puncture should be performed (thoracocentesis in haemothorax, laparocentesis in haemoperitoneum, arthrocentesis in haemarthrosis,puncture of the posterior vaginal fornix in ruptured ectopic gestation or ovarian cyst). If indicated, X-ray, ultrasound scanning and computerised tomography can also be used. Endoscopic methods include gastroscopy, rectoscopy, cystoscopy and arthroscopy. It will be noted that clinical symptoms and signs as well as the laboratory findings are used to evaluate the severity of blood loss.

Treatment. The treatment of haemorrhage must be started with maximum swiftness, since a prompt initiation of therapy can prevent the haemorrhagic shock.

The management of severe bleeding has to be started with infusions of blood substitutes before blood grouping and cross-matching. It is important because the human body's tolerance of the plasma loss and hence a reduction in the circulating blood volume is lower than that of the fall in red blood cell count. Albumin, protein and polyglucin are readily held in blood vessels; crystalloids can be used if necessary, but they tend to leave the vascular system rather early. Low-molecular dextran (rheopolyglukin) replenishes the intravascular fluid volume , which improves the microcirculation and rheologic properties of blood. Blood transfusion should be considered whenever haemoglobin and haematocrit levels fall as low as 80 g/l and 30, respectively.

In severe acute bleeding, blood transfusion should be started by the fast flow method through one, two or even three veins, while slow infusion can be justifiable only after the systolic blood pressure has at least risen to as high as 80 mm Hg. Acidosis is corrected by giving sodium bicarbonate, trisamin and lactasol (see Chapter IV). The drugs that increase the vascular tone, or *vasopressors*,should be avoided until the volume of circulating blood has been fully restored, since they are likely to aggravate hypoxia. Alternatively, steroids act to enhance myocardial contractility and counteract peripheral vascular spasm. Oxygen therapy should also be considered; especially effective is hyperbaric oxygenation, which is used after bleeding has stopped.

External bleeding. External bleeding is the major sign of injury. The colour of the escaping blood depends on the type of the vessel affected: it is bright red in arterial bleeding and dark red in venous haemorrhage. It is noteworthy that the lethal bleeding within a few minutes after injury may result not only from a damage to the aorta but also from that to the femoral or axillary arteries or even larger veins. Injury to the major cervical or thoracic vessels can lead to a very serious complication - air embolism. This occurs as a result of air entering the neck veins through the laceration, which subsequently reaches the right cardiac chambers to finally obstruct the branches of the pulmonary artery.

Internal bleeding. This is usually due to traumatic injuries or a pathology of or around the vessel. Making the diagnosis of internal bleeding is more difficult than that of external. The

clinical picture incorporates the *general* signs associated with haemorrhage and *local* ones that vary with the location of the bleeding vessel.

In acute anaemia (e.g. due to a ruptured ectopic pregnancy or ruptured spleen with subcapsular haematoma) the clinical picture is as follows:

- extreme pallor of the skin and visible mucous membranes;
- blurred vision;
- dizziness;
- thirst;
- drowsiness;
- fainting (in severe cases);
- tachycardia (120-140 beats per minute);
- hypotension.

If the bleeding is slow or mild, the signs develop gradually.

When blood escapes into a hollow organ and is discharged via a natural opening outside, the origin of the bleeding (e.g. the blood oozing out of the mouth can be a result of bleeding from the lung, trachea, pharynx, oesophagus, stomach or duodenum) is always difficult to elucidate. The colour and type of blood is, therefore, of great importance:

- foamy bright red blood (in bleeding from the lung);
- ground coffee-like vomitus (in gastric or duodenal haemorrhage);
- *melaena*, or black stools (in bleeding from the upper GIT);
- bright red blood coming from the rectum (in bleeding from the sigmoid or rectum);
- haematuria (in bleeding from the kidney or urinary tract).

To locate the bleeding vessel, specific diagnostic procedures are to be performed: passing a probe into the stomach; digital per rectum examination; endoscopic methods like bronchoscopy in diseases of the lung, oesophagogastroduodeno-, rectosigmoido-, and colonoscopies for gastrointestinal haemorrhages, cystoscopy for diseases of the urinary tract, ultrasound, X-ray are applicable. They are most important for occult bleeding which is not heavy or presents atypically. A radioisotope method can also be used to diagnose internal bleeding. The gist of the method is that a radioactive isotope (normally a colloid solution of gold) injected intravenously accumulates, together with the haemorrhaged blood, in a tissue, cavity or hollow organ. An increase in radioactivity at the area damaged is found during radiometry.

The diagnosis of bleeding into an entrapped body cavity (the cranium, spinal canal, thoracic and abdominal cavities, pericardium and synovial space) tends to be the most complicated. The specific signs of fluid accumulation in a cavity and the general signs of bleeding are indicative of various types of internal bleeding:

Haemoperitoneum, or accumulation of blood in the abdominal cavity, is associated with

- lacerations and blunt injuries to the parenchymal organs (the liver, spleen) or mesenteric vessels;
- rupture of an ectopic pregnancy or an ovarian cyst, loosening of the ligature placed on a bleeding vessel when it loosens or unties post-operatively, etc.

The local signs of the abdominal bleeding may be as follows:

- restricted abdominal breathing;
- abdominal pain;

• slight rigidity of the abdominal wall;

• mild peritoneal tenderness (Blumberg's sign);

• dull tympanitic sound over the areas of blood accumulation (when about 1,000 ml are accumulated);

• bulging the posterior fornix in women on vaginal examination.

The patients suspected of having haemoperitoneum should be closely monitored (particularly in terms of their haemoglobin and haematocrit values) are monitored in dynamics. A progressive fall in these makes the diagnosis of haemoperitoneum most likely. It will be noted, however, that if bleeding is secondary to the rupture or tear of a hollow organ, the signs of haemoperitoneum can be masked by those of the impending peritonitis. To verify the diagnosis, laparocentesis using a «balloon» catheter, peritoneal lavage as well as laparoscopy play a very important role. As soon as the diagnosis is confirmed, the patient must be immediately laparotomised with exploration of the abdominal cavity and stoppage of bleeding.

Haemothorax, or accumulation of blood in the pleural cavity, results from

• injuries to the chest and lung;

• surgical manipulations;

• diseases of the lung and pleura (tuberculosis, tumours, etc.).

Severe bleeding is usually due to injuries to the intercostal and internal thoracic arteries.

Haemothorax divides into mild, moderate and severe (total).

In *mild* cases, blood is accumulated only in the pleural sinuses of the pleural cavity; in *moderate* cases, its level can reach the scapular angles; and in *severe* haemothorax the pleural cavity is completely filled with blood. Owing to the anticoagulant properties the blood that has accumulated in the pleural cavity is not generally inclined to clotting, except for the catastrophic bleeding. The clinical features of haemothorax depend on the intensity of bleeding, pressure on and displacement of the lung and mediastinum.

In severe cases, the clinical picture involves chest pain, restlessness, skin pallor and cyanosis, dyspnoea, cough (occasionally with blood, which is referred to as *haemoptysis),* dull percussion note, an increase in vocal fremitus, mute breath sounds, fast pulse and low blood pressure. The degree of anaemia depends on the amount of the blood loss. The aseptic inflammation of the pleura*(haemopleuritis)* causes an accumulation of serous fluid in the pleural cavity. Bacterial contamination of the site of haemothorax resulting from a damage to the bronchus or lung leads to purulent pleuritis, a very severe complication. To verify the diagnosis of haemothorax X-ray investigation and thoracentesis are used. Therapeutic thoracentesis will suffice for mild or moderate haemothorax, whereas total or massive haemothorax usually requires emergency thoracotomy with ligation of the bleeding vessels or the suturing of the lung rupture.

Haemopericardium, or an accumulation of blood into the pericardial sac, is most commonly caused by rupture of a diseased heart muscle or the ascending aorta and rarely by penetrating (e.g. stab) wounds or myocardial abscess, etc. As much as 200 ml of blood accumulated in the pericardial sac are unlikely to be critical; in contrast, 400-500 ml of blood contained in the pericardium may be life-threatening. Typically, the clinical symptoms and signs include restlessness, chest pains, dyspnoea, tachycardia, weak and fast pulse, low blood pressure, displaced or diminished heartbeat, widened cardiac borders, muffled heart sounds. The progression of the condition may result in cardiac packade, a dramatic complication. Pericardiocentesis is indicated for all cases suspicious of haemopericardium. Small amounts of blood found obviate radical methods of treatment (bed rest and cold compress will suffice), while massive haemopericardium requires an emergency operation to control the bleeding.

Intracranial haemorrhage (i.e. an accumulation of blood within the skull) frequently results from trauma and produces generalised and focal neurologic signs.

Haemarthrosis, or an extravasation of blood into a joint, is caused by an open or closed injury to the joint (fractures, dislocations etc.), in haemophilia, scurvy and some other diseases. Massive haemarthrosis restricts movements, levels its contours and leads to fluctuation, in knee joint involvement it produces patellar ballottement (or floating patella). To verify the diagnosis and rule out a fracture, X-ray films are obtained. In this case arthrocentesis is both of diagnostic and therapeutic value.

An accumulation of blood within tissues causes *haematoma,* a swelling composed of blood, which can be significant clinically (e.g. in femoral shaft fractures the volume of the blood accumulated can be as high as 500 ml). The most dangerous haematomas commonly result from the damage to the major blood vessels. The haematoma connected to an arterial lumen becomes a pulsating one, which subsequently forms a capsule and thus becomes pseudo-aneurysm (a «false» aneurysm). Apart from the general signs of acute anaemia, a pulsating haematoma has two main characteristics: (1) the pulsation over the swelling is synchronous with the pulse rhythm and (2) the presence of a blowing systolic murmur on auscultation. When a major vessel is damaged the affected limb becomes ischaemic, pale and cold on touch, its sensation is impaired, and the distal pulses are not palpable. This serves as an absolute indication for an emergent surgery to restore blood supply to the limb, which may help to save it.

The other type of evtravasation into tissues occurs when the tissue gets soaked or impregnated with small amounts of blood and is termed *apoplexy.*

4.2 HAEMOSTASIS (CONTROL OF HAEMORRHAGE)

In majority of cases of bleeding from the arteries, veins or capillaries, haemostasis occurs spontaneously.

Temporary methods of haemostasis. The most reliable way is the application of a tourniquet; however, it can only be used on the extremities (fig. 24, 25).

In carotid arterial bleeding a tourniquet on the neck using a board or across the contra-lateral axilla is rarely applied. Instead, Cramer's splint is usually placed on the intact side of the neck to serve as a supporting frame. The tourniquet is applied to it and around some gauze pack that has been put on the bleeding vessel on the other side of the neck (fig. 26). If there is no splint at hand, the patient's intact hand is put on his/her head and bandaged.

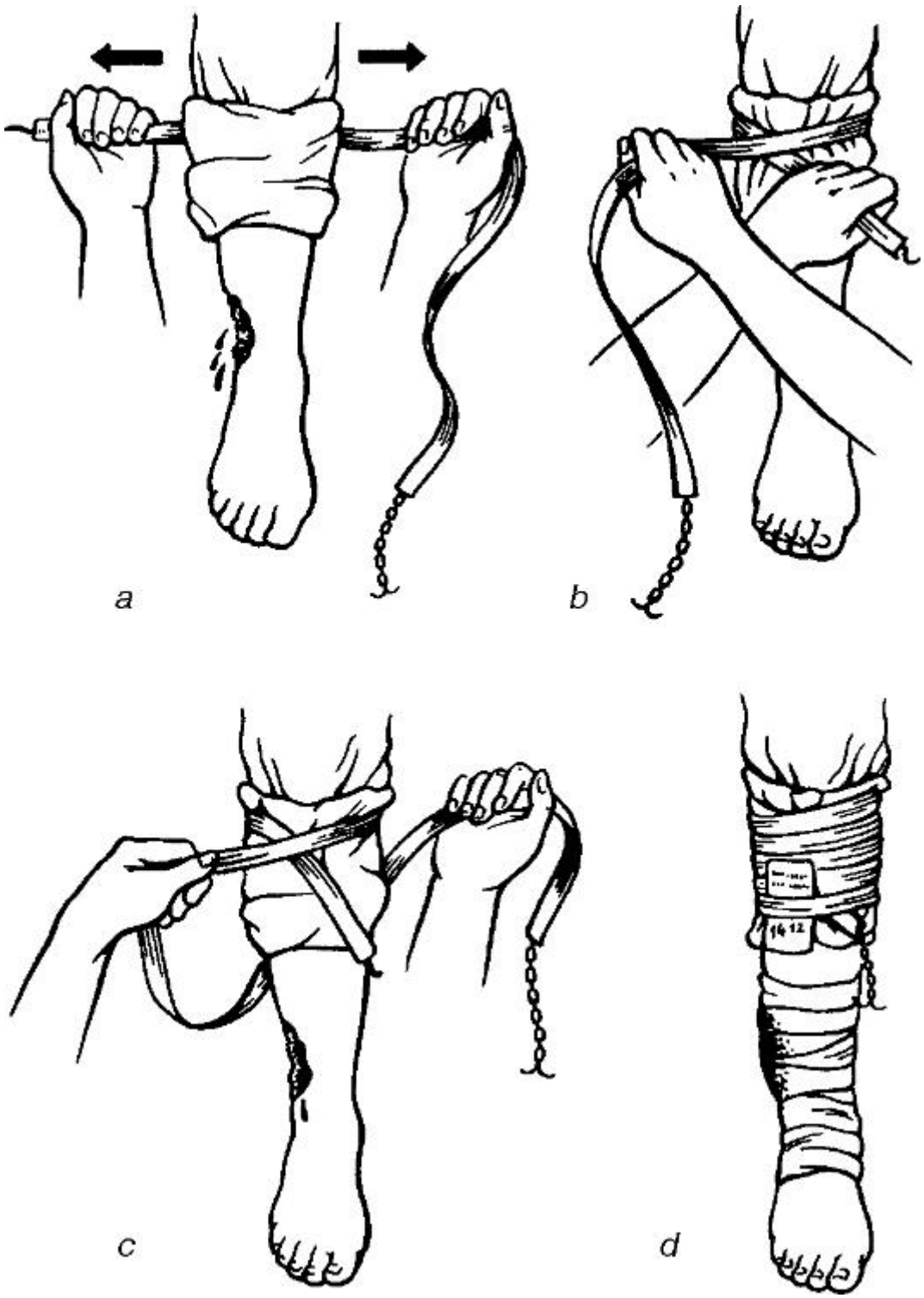

Fig. 24. Application of the limb tourniquet: *a* - preparing the area for application; *b* - the start of the procedure; *c* - fixing the first round; *d* - the view after application.

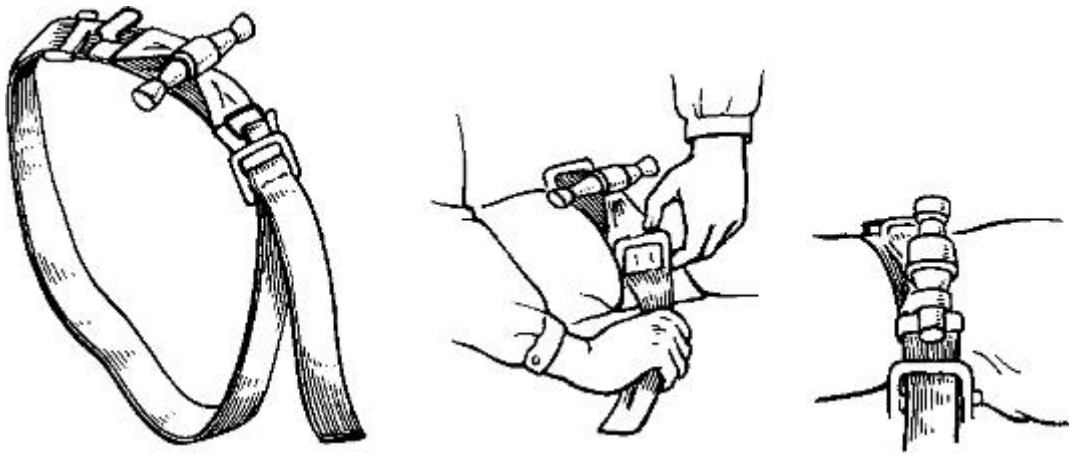

Fig. 25. Application of the cervical «military» tourniquet.

Fig. 26. Application of the facial tourniquet.

Never apply a tourniquet to the abdominal aorta as this can cause damage to the abdominal organs. The tourniquets used to arrest bleeding are broad, flat, rubber bandages applied to the proximal parts of limbs which have been emptied of blood by the application of elastic bandages distoproximally *(Esmarch's tourniquet)* or 1,5 m long tapes with metallic chains on one end and hooks on the other. In arterial bleeding or when massive bleeding is suspected the tourniquet will be applied above the injured site (fig. 27). First put a wet sheet or towel onto the area where the tourniquet is to be fixed, i.e. make a soft pad. The tourniquet should be applied firmly, for 2-3 rounds; the last one will be slightly loosed and fixed to the hooks. *It is a must to write down the time when the tourniquet has been applied* since keeping a tourniquet for more than 2 hours on the lower limb and for above $1^1/_2$ hours on the upper one can result in

ischaemic necrosis. The disappearance of pulse on peripheral arteries, arrest of bleeding and a slightly pale discolouration of the skin below the tourniquet level suggest that it has been applied correctly. If the patient's transportation takes more than $1^1/_2$ hours, the tourniquet should periodically (every 10-15 minutes) be released until the reappearance of the arterial blood flow, before it is reapplied. At this point press on the bleeding vessel with the fingers in the wound or apply some instrument with a plug to the bleeding point. Reapply the tourniquet either somewhat below or above the original place. Subsequently, if necessary, the removal and reapplication of the tourniquet can be repeated (in winter time every 30 minutes, in summer each 50-60 minutes).

Replace the tourniquet by a transportation splint, in cold periods the extremities being covered with warm clothes to prevent freezing. Transport the patient supine with analgesics having been given. Long and crude compression of tissues by a tourniquet can cause paresis and palsy of the limbs resulting both from traumatic damage to the nerves and ischaemic neuritis because of insufficient oxygen supply. Tissue hypoxia favours the proliferation of anaerobic infections, i.e. the species of bacteria able to survive without free oxygen. To prevent complications, stop bleeding by temporary application of an air-filled cuff to the proximal part of the limb. At this site the pressure applied must be higher than the arterial blood pressure.

If the bleeding artery has been pressed on correctly, the haemorrhage can quickly be arrested; it is, however, difficult to keep pressing on a vessel for more than 15-20 minutes. Press on the artery at the sites where it lies superficially and around a bone (fig. 28, 29):

- the carotid artery - the transverse process of the C6 vertebra;

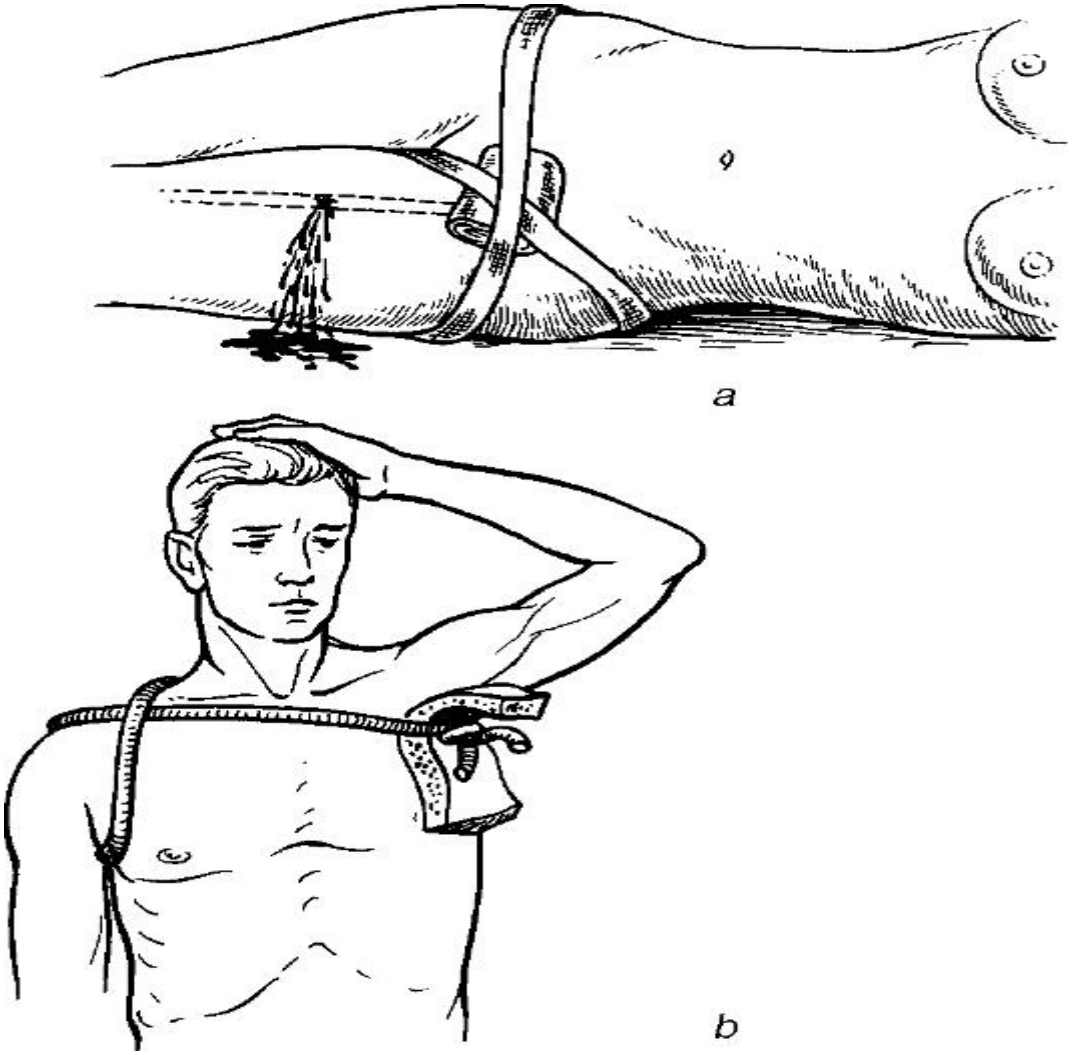

Fig. 27. Application of the tourniquet in a damage to the femoral (a) and axillary (b) arteries.

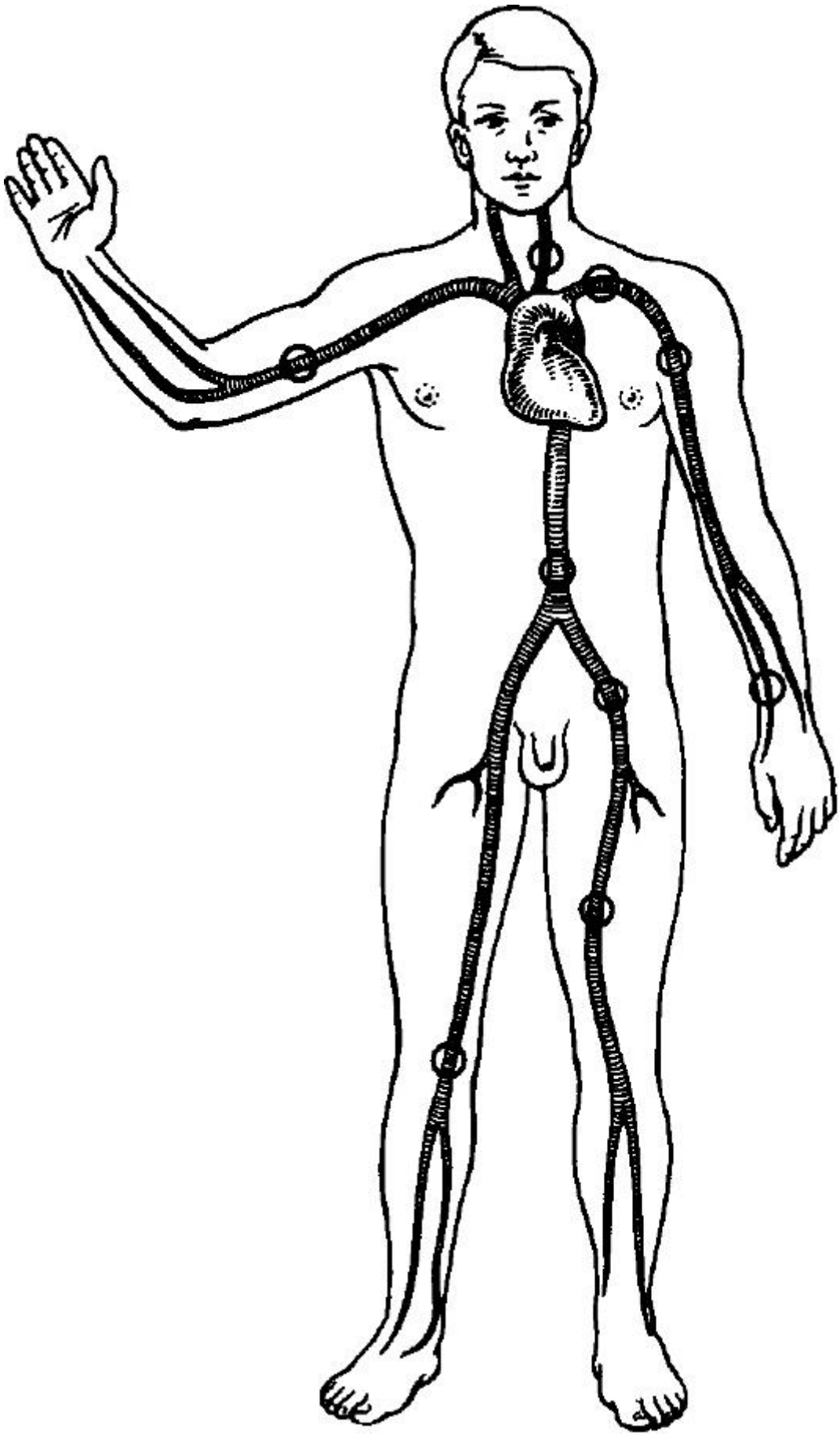

Fig. 28. Topography of the arteries which can be pressed on for temporary bleeding control.

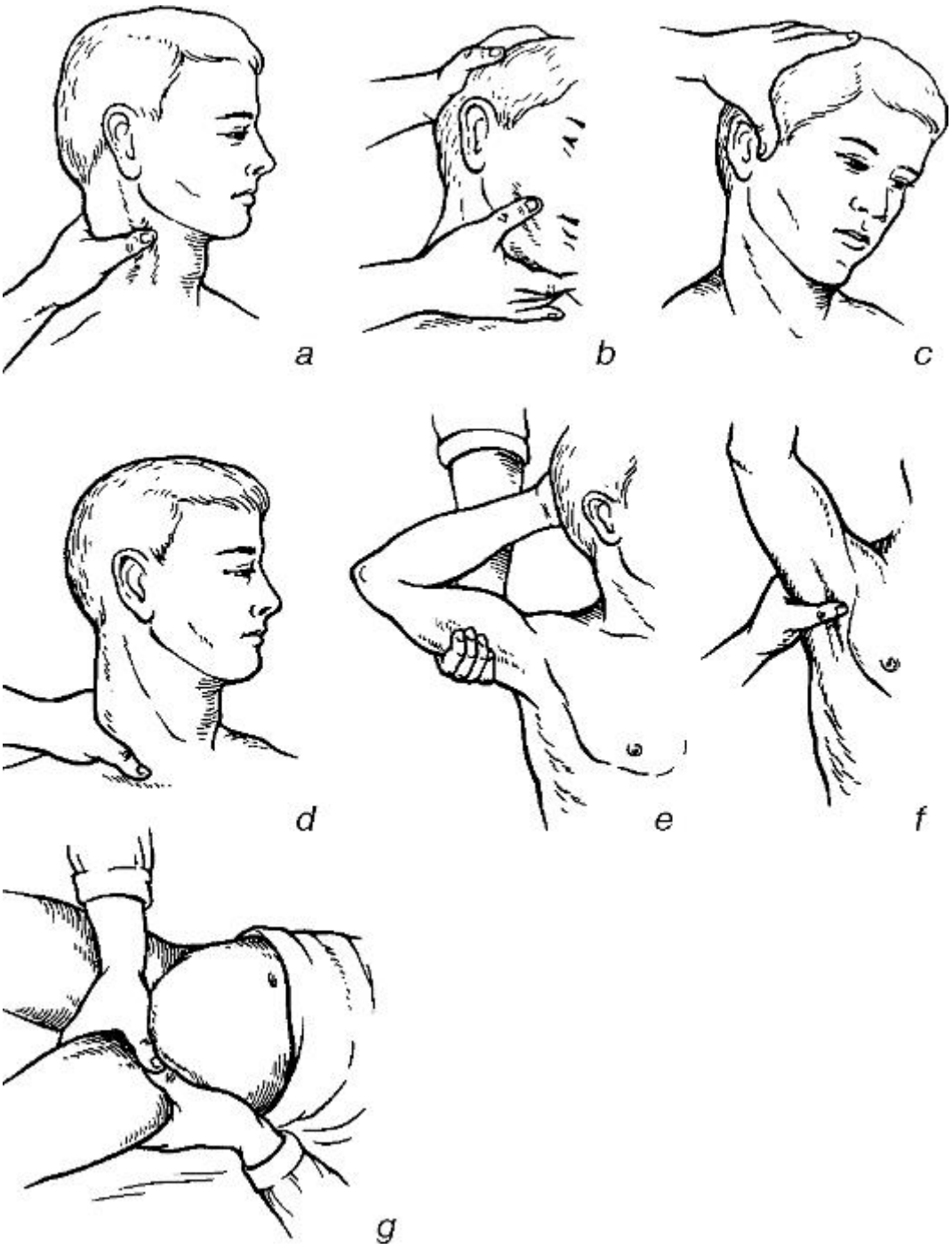

Fig. 29. Digital pressure on an artery to temporarily arrest the bleeding: *a* - the carotid artery; *b* - the sublingual artery; *c* - the temporal artery; *d* - the subclavian artery; *e* - the humeral artery; *f* - the axillary artery; *g* - the femoral artery.

- the subclavian artery - the first rib;
- the brachial artery - the internal surface of the humerus;
- the femoral artery - the pubis.

Unlike the carotid artery, the brachial and femoral ones can be pressed on easily. The subclavian artery is more difficult to press on as it is located behind the clavicle. Consequently, when the bleeding originates from the subclavian or axillary artery, fix the hand in a maximum extended backward position. Then press it on in between the clavicle and first rib. This is most important at the moment of tourniquet application or when changing it or during limb amputations.

Flexion of the limb in a joint.. This method is effective provided that the limb can be flexed fully at the elbow joint and bandaged in that position to stop bleeding from the vessels of the forearm and the hand and at the knee joint to control haemorrhage from the vessels of the leg and foot. If the bleeding site of the femoral artery is too high for a tourniquet to be applied, the thigh can be fixed to the abdomen, with the knee and hip joints maximally bent (fig. 30).

Wound package combined with application of a pressure bandage, immobilisation and raising the extremity is a suitable method of temporary haemostasis if the bleeding originates from veins or small arteries, soft tissues, the scalp, the elbow or knee joint. To achieve a tight package, the gauze should be tightly packed in the wound and pressure bandage applied over it. The tight packing of the knee fossa is contraindicated because this often leads to pedal gangrene. Pressure with load (e.g. a sand bag) or in combination with an ice pack (e.g. a bag with ice) is used for intratissue bleeding and prevention of postoperative haematoma. Digital compression of a vessel in a wound is indicated in emergency, occasionally during operations. For this, the surgeon will quickly put on sterile gloves or clean their hands with alcohol and iodine and press on the vessel or hold it inside the wound. If the bleeding vessel is located deeply inside (e.g. at the base of a limb, in the abdominal cavity, chest) and none of the methods of temporary haemostasis can be applied, the artery forceps or vessel clamps can be used. It is noteworthy that this can cause damage to some vital organs. Hence it is advisable to

- control the bleeding by digital pressure;
- dry the wound of blood;
- apply the clamp on the bleeding vessel.

Temporary bypass of a vessel is required to restore blood circulation in an injury to a major artery. A firm elastic tube is usually applied to both ends of the injured vessel and then fixed by ligatures. The temporary bypass can function for between several hours and several days, before the effective definitive haemostasis has been undertaken.

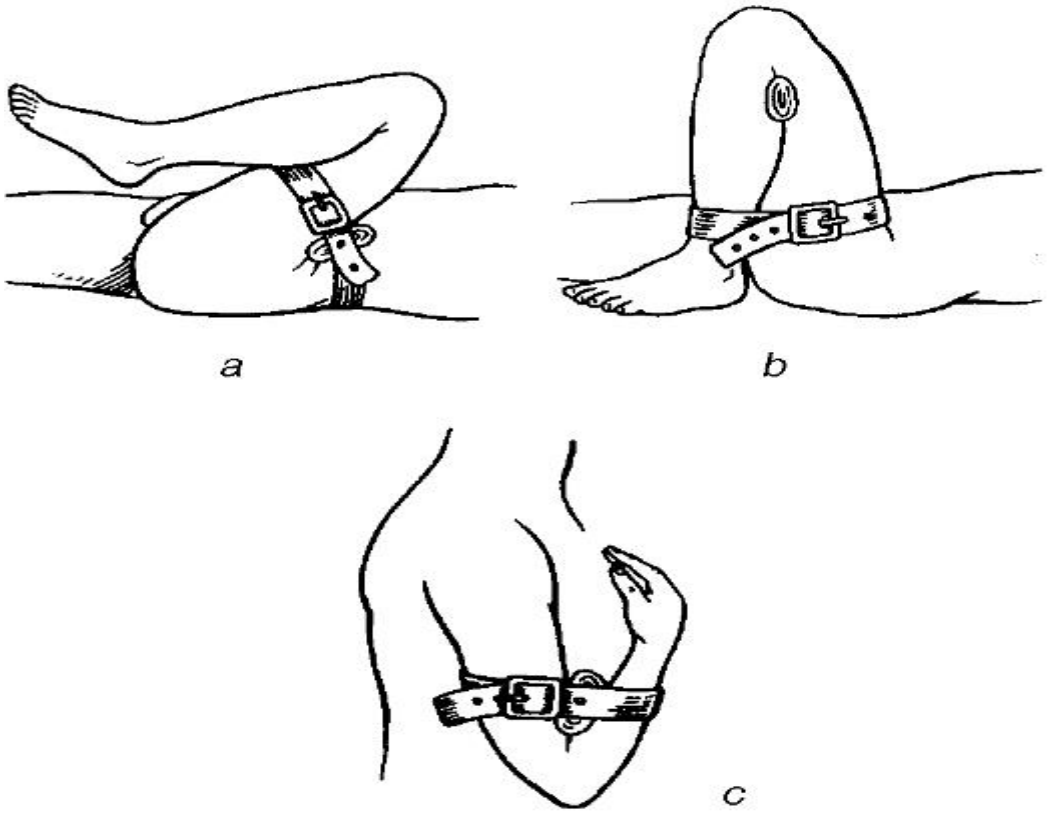

Fig. 30. Temporary control of femoral (a), popliteal (b), humeral and ulnar (c) arterial haemorrhage by means of maximal bending.

4.3 DEFINITIVE HAEMOSTASIS

The methods of definitive haemostasis divide into the four groups:

1) mechanical;

2) physical;

3) chemical and biological;

4) combined.

Mechanical methods involve ligating the bleeding vessel inside the wound or somewhere along it. After the temporary arrest of bleeding has been achieved the definitive care will be provided. This involves surgical wound debridement, revision of the wound, and incision of the soft tissue along the vascular bundle. The vessel's central and peripheral ends are first identified; to pick these up and ligate the vessel artery forceps are used (fig. 31).

Ligation of the vessel along its length is indicated when its ends cannot be identified in the wound. This precludes its ligation in the wound (e.g. injury to the internal and external carotid arteries). This is also the case in secondary bleeding when the eroded vessel is located in the midst of the inflammatory mass. This calls for identification, isolation and ligation of the vessel using the topographic landmarks, which, however, does not ensure the arrest of bleeding from the peripheral ends of the artery or its collaterals. When the surgeon fails to find the ends of the bleeder, they ligate the vessel together with the surrounding soft tissues. If it is not possible to ligate the vessel after its picking up with a clamp or forceps, the clamp can be left in the wound for 8 to 12 days (until the vessel has reliably thrombosed).

Twisting of the bleeding vessel. To stop bleeding from small vessels, these can be picked up with a clamp and rotated.

Wound packade. Bleeding from smaller wounds and injuries to small vessels can be arrested by packade. Dry swabs or those soaked in antiseptic solutions can be used. Anterior and posterior packades used to stop the nasal bleeding can serve as a typical example.

Bleeding from the vessels that are difficult to ligate can be stopped using silver clamps (i.e. *vascular clamping).* For primary arrest of bleeding from the hollow viscus; part of the organ (e.g. stomach resection in bleeding gastric ulcer) or a whole organ (e.g. splenectomy in ruptured spleen) has to be resected. Special sutures may occasionally be applied (e.g. at the edge of the liver affected).

To stop bleeding from the lung, gastrointestinal tract and cerebral vessels a special method of artificial vascular embolism has been recently implemented; this involves the use of lysing (e.g. gelatin, muscle homogenate) or non-lysing (e.g. silicon, polysterol) substances.

Vascular sutures. There exist both manual and mechanical vascular sutures. Suturing a vessel is recommended whenever restoration of the patency of major vessels is necessary.

Circular vascular sutures are placed manually using atraumatic needles (fig. 32). Ideally, an «end-to-end» connection is performed. Vascular sutures should be very compact and airtight and meet the following requirements:

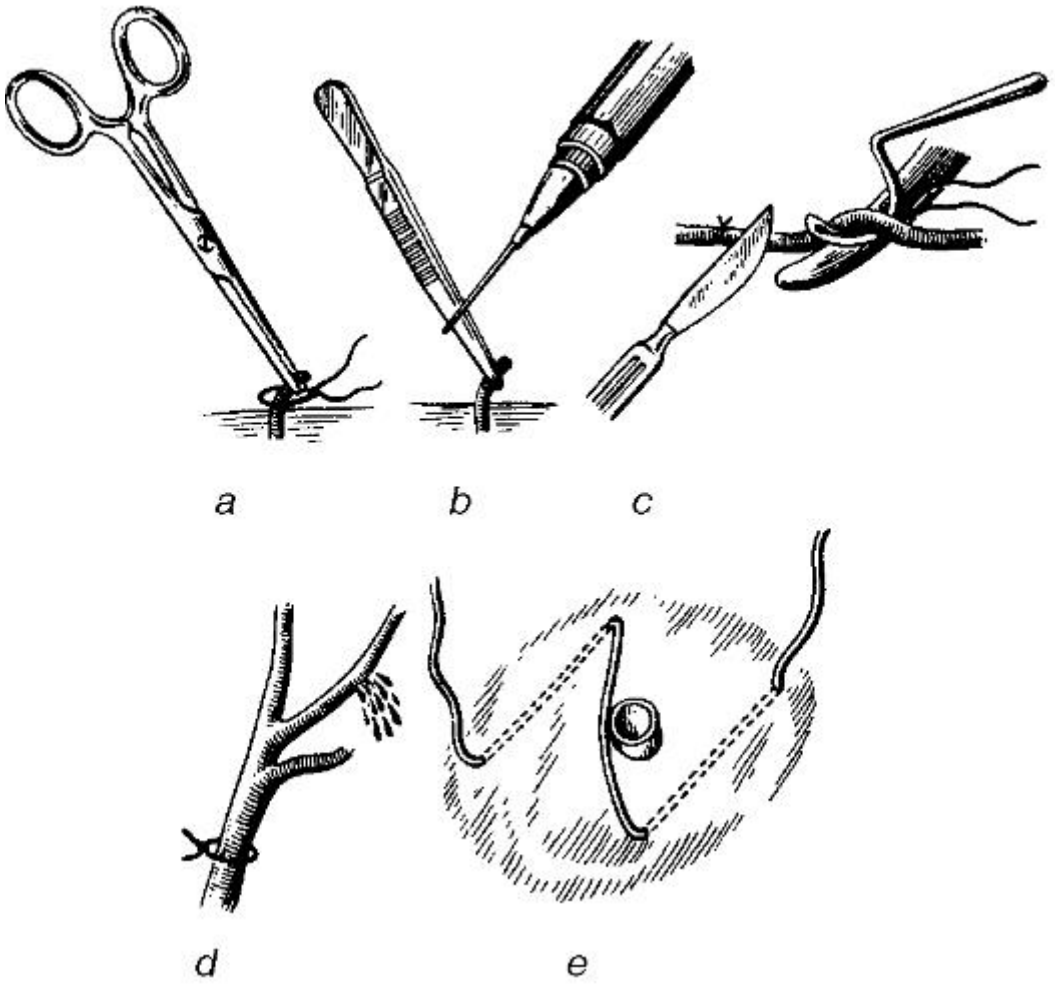

Fig. 31. Definitive methods of haemorrhage arrest. *a* - vascular ligation; *b* - electrocoagulation; *c* - vascular ligation using transection; *d* - vascular ligation in continuity; *e* - mediate ligation.

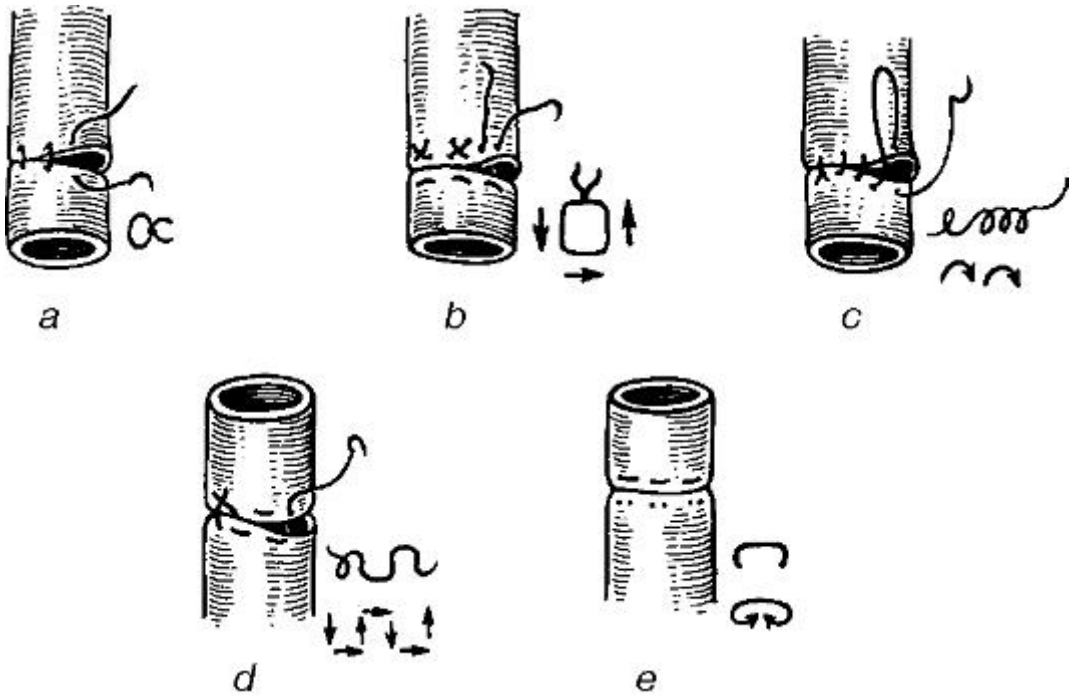

Fig. 32. Vascular sutures.

a - interrupted (Carrel-type); *b* - mattress; *c* - blanket; *d* - continuous mattress; *e* - mechanical.

1) a lack of strictures or bumps (not to impede the blood flow);

2) minimum threads appearing in the lumen. Circular vascular sutures can be made using tantalum staples, Donetski's ring. Mechanical sutures are perfect enough not to obstruct the vascular lumen.

Lateral vascular sutures are placed when the vessels are injured adjacently. On suturing, the vessel can be strengthened with the muscle and fascia.

A large tissue defect resulting from the injury or surgery (e.g. following the excision of a tumour) can be covered with a patch from biological materials (e.g. fasciae, aponeuroses, muscles and venous walls). An «auto-vein» (the superficial veins of the thigh or forearm) is most commonly used.

In vascular surgery autoand allotransplants of arteries and veins are used for grafting (e.g. heterografts or xenotransplants, which are made of synthetic compounds). Performing an «end-to-end» anastomosis or suturing the graft ensures reconstruction.

Physical methods. Thermal means of haemostasis is based on the fact that on exposure to high or cold temperatures proteins coagulate inducing a clot formation cold can cause vascular spasm. This is of great importance for bleeding arrest during operation. In diffuse bleeding from a bone a piece of gauze soaked in hot normal saline is applied. The application of ice packs in cases of subcutaneous haematoma or swallowing of ice cubes in cases of gastric bleeding is widely used in surgery.

Surgical diathermy involves the passage of high frequency electric current by knife or button electrode to generate heat in the tissues for the coagulation of bleeding vessels. It is mainly used to control bleeding from subcutaneous and muscles' vessels as well as from minor vessels of the brain. The surgical diathermy may be applied provided that the wound is dry, and the voltage of the current is not high enough to cause tissue burn since it can itself cause bleeding.

Laser (focused beam of electronic rays) is used in patients with peptic ulcer-associated upper GIT bleeding, haemophiliacs and in oncologic operations.

Cryosurgery is the local application of cold, mostly in tumours of the organs with intense blood supply (e.g. the brain, liver, kidney). Local freezing of tissues is safe to the areas surrounding those exposed to cryonecrosis.

Chemical and biological methods. Haemostatics may be of a resorptive or topical action. Resorption occurs when the substance enters the circulation, while topical effect is visible on the direct application to the bleeding tissue.

Haemostatics with *resorptive action* are widely used for internal bleedings. Direct blood transfusion is the most effective. In addition, transfusion of small amounts (100-150 ml) of freshly frozen blood, plasma, platelet mass, fibrinogen, prothrombin complex, anti-haemophilic globulin, cryoprecipitate is also recommended. These agents are indicated for congenital or acquired deficiency of blood coagulating factors as is the case in pernicious anaemia, leukaemia, haemorrhagic disorders etc.

Currently, inhibitors of fibrinolysis have been widely used to decrease the blood fibrinolytic activity. Bleeding associated with an increase in the blood fibrinolytic activity is encountered during operations on the lung, heart, prostate, in liver cirrhosis, sepsis and following transfusion of large amounts of blood. Biologic anti-fibrinolytic substances include contrycal, trasylol (aprotinin), while aminocapronic acid and ambenum are synthesised.

Dicynone and etamsylate enhance the formation of thromboplastin, normalise vascular permeability and improve microcirculation. *Rutin*, ascorbic acid and *carbazochrome* are used to normalise the permeability of vascular walls.

Vicasol, a synthetic water-soluble analogue of vitamin K, is applicable for haemorrhage associated with a deficit of prothrombin (e.g. acute hepatitis and mechanical jaundice, parenchymal and capillary bleeding following injuries and surgical manipulations, gastrointestinal and nasal bleeding, haemorrhoids).

Conversion of prothrombin to thrombin requires a slight amount of calcium ions that are available in the blood. Therefore, the use of calcium as a haemostatic substance is justified only in massive transfusion of citrated blood, since on reaction with calcium citrate ions tend to lose their anticoagulative properties.

Topical haemostatics. In parenchymal bleeding resulting from a liver rupture specific biologic packs (a muscle or the omentum as a free flap or a peduncular flap, i.e. a flap on a peduncle) are used. Quite effective is the use of fibrin sponge, biological antiseptic pack, haemostatic and gelatin sponges. Haemostatic and gelatin sponges, biological antiseptic packs are used to arrest bleeding from bones, muscles, parenchyma organs, capillaries, as well as for the packade in bleeding from the sinuses of the dura matter.

Thrombin (a substance obtained from the plasma of donor blood) is effective in capillary and parenchymal bleedings as it influences the conversion of fibrinogen into fibrin. Prior to its use it will be dissolved in normal saline to soak sterile gauzes or the haemostatic sponge and then applied to the bleeding surface. The use of thrombin is contrain-dicated in bleeding from major vessels, since it can induce the fatal generalised thrombosis.

4.4 COMBINED METHODS OF BLEEDING CONTROL

Several methods of haemostasis can be combined to increase their efficacy. Of the most commonly used are muscle or glue to wrap around the sutures on the vessel, different types of sutures and biological packs used simultaneously to stop the parenchymal bleeding, etc.

TESTS

Chapter IV. HAEMORRHAGE

1. What are the major causes of death in profuse haemorrhage within the first few hours after its occurrence?

1. Reduced level of haemoglobin.

2. Hepatic ischaemia.

3. Acute circulatory disorder.

4. Respiratory failure.

5. Renal failure.

Choose the right combination of answers:

A. 1, 2. B. 2, 3. C. 3. D. 1, 2, 3, 4. E. 4, 5.

2. The physical methods of bleeding control include which of the following:

1. Local application of cold.

2. Tamponade of the wound.

3. Use of haemostatic sponge.

4. Electric coagulation.

5. Vessel suturing.

Choose the right combination of answers:

A. 1, 2. B. 2, 3, 4. C. 1, 3, 4. D. 1, 4, 5. E. 1, 2, 4.

3. The clinical signs typical of haemorrhage are as follows:

1. Weakness.

2. Thirst.

3. Dizziness.

4. Chest pain.

5. Cyanosis.

Choose the right combination of answers:

A. 1, 2, 3. B. 2, 3, 4. C. 1, 3, 4. D. 1, 4, 5. E. 1, 2, 4.

4. Which methods of temporary bleeding arrest may be used in injury of major arteries?

1. Elevated position of the limbs.

2. Application of a tourniquet.

3. Application of a vessel clamp in the wound.

4. Compression of the artery with fingers.

5. Temporary bypassing of the vessel.

Choose the right combination of answers:

A. 1, 2, 3. B. 1, 2, 3, 4. C. 2, 3, 4, 5. D. 2, 3, 4. E. 2, 4, 5.

5. Which of the following preparations are used for local bleeding arrest?

1. Haemostatic sponge.

2. Gelatin sponge.

3. Thrombin.

4. Fibrin film.

5. Cryoprecipitate.

Choose the right combination of answers:

A. 1, 3. B. 2, 3, 4. C. 2, 3, 4, 5. D. 1, 4, 5. E. 1, 2, 3, 4.

6.Which of the following traumas can result in air embolism?

A. Injury of lower limb veins.

B. Injury of subclavian vein.

C. Penetrating wounds and haemarthrosis of the knee.

D. Injury of the spleen.

E. Injury of a major thigh artery.

Choose the correct answer.

7. The best index of blood loss rate within the first few hours is one of the following:

A. Specific gravity of blood.

B. Haemoglobin levels.

C. Haematocrit readings.

D. Red blood cell count.

E. Changes in blood volume.

Choose the correct answer.

8. The cause of late secondary bleeding is which of the following:

A. Rise in blood pressure.

B. Purulent destruction of the thrombus.

C. Loss of vessel spasm.

D. Erosion of the vessel wall.

E. The injury of vessels, slip of ligature.

Choose the correct answer.

9. The maximal autodilution during acute blood losses occurs within:

A. 12 hours.

B. 12-24 hours.

C. 36-48 hours.

D. 60-72 hours.

E. Over 72 hours.

Choose the correct answer.

10. What are the causes of early secondary haemorrhage?

1. Suppuration of the wound.

2. Injury of vessels.

3. Dislodging of a clot.

4. Slipping of vessel ligature.

5. Increased arterial pressure.

Choose the right combination of answers:

A. 1, 2, 3. B. 2, 3, 5. C. 3, 4, 5. D. 2, 4, 5. E. 4, 5.

11. Melaena is characteristic of bleeding from which of the following organs:

A. Lungs.

B. Upper intestinal tract.

C. Rectum.

D. Kidneys.

E. Spleen.

Choose the correct answer.

12. The agent used for bleeding arrest is one of the following:

1. Aminocaproic acid.

2. Vikasol.

3. Rheoployglukin.

4. Calcium chloride.

5. Heparin.

Choose the right combination of answers: A. 1, 2. B. 2, 3. C. 4, 5. D. 1, 4. E. 2, 5.

13. The haemostatic agents of general resorptive action include which of the following:

1. Aminocaproic acid.

2. Thrombin.

3. Fibrinogen.

4. Trasylol.

5. Epinephrine hydrochloride.

Choose the right combination of answers:

A. 1, 3, 4. B. 2, 3, 4, 5. C. 2, 3, 4. D. 1, 3, 4, 5. E. 1, 4, 5.

14. The types of haemorrhage classified by clinical implication and relation to the environment include which of the following:

1. Latent.

2. External.

3. Secondary.

4. Capillary.

5. Internal.

Choose the right combination of answers:

A. 1, 2, 5. B. 3, 4, 5. C. 2, 4, 5. D. 2, 3, 5. E. 1, 3, 4.

15. Which type of haemorrhage requires ligature in continuity?

A. Gastric haemorrhage.

B. Rectal haemorrhage.

C. Early secondary haemorrhage.

D. Late secondary haemorrhage.

E. Primary haemorrhage.

Choose the correct answer.

16. Biological methods of arresting bleeding are as follows:

1. Wound tamponade with the omentum.

2. Wound tamponade with a muscle.

3. Administration of epinephrine hydrochloride.

4. Intravenous administration of e aminocaproic acid.

5. Intramuscular administration of vikasol.

Choose the right combination of answers:

A. 1, 2. B. 2, 4, 5. C. 1, 2, 3, 4. D. 3, 4, 5. E. 1, 2, 3.

17. Pressure bandage is indicated as a method of temporary arrest of bleeding for:

1. Haemorrhage from the veins of the forearm.

2. Injury of the carotid arteries.

3. Haemorrhage from the soft tissues of the head.

4. Injury of the popliteal fossa.

5. Haemorrhage of the soft tissues of the thoracic wall.

Choose the right combination of answers:

A. 2, 3, 5. B. 1, 3, 4. C. 1, 2, 3, 4, 5. D. 1, 3, 5.

18. Which is the reasonable consequence of steps in transfusion in acute hypovolaemia resulting from bleeding?

1. Aminocrovine.

2. Polyglucin.

3. Blood transfusion.

4. Rheopolyglukin.

5. Haemodes.

Choose the right combination of answers:

A. 1, 2, 3, 4. B. 2, 3, 4. C. 1, 2, 3, 5. D. 1, 2, 4, 5. E. 1, 2, 5.

19. The vital bodily mechanisms involved in the physiologic compensation of blood volume loss and maintenance in acute blood losses are as follows:

1. Vasoconstriction.

2. An increase in central venous pressure.

3. Autodilution.

4. Vasodilation.

5. Centralization of blood flow.

Choose the right combination of answers:

A. 1, 4, 5. B. 1, 3, 5. C. 1, 2, 4. D. 2, 4, 5. E. 2, 3, 4.

Chapter V. BLOOD TRANSFUSION

Transfusiology (Latin *trans*-, across + *fundere*, to pour, Greek logos-,word, thought) is part of clinical medicine which deals with transfusion of blood, its components and substitutes to achieve therapeutic effect through their actions on the composition of blood and fluids of the human body.

5.1 PRODUCTS USED FOR BLOOD TRANSFUSION

In clinical practice, whole blood, its components and products may be used.

Whole blood. Certain precautions are necessary in checking donor and blood for transfusion. No donor should be used who has a haemoglobin value below 12 g/l or who has a history of syphilis, malaria, viral hepatitis, chronic allergy, drug sensitivity or HIV infection. The donor's serologic test for syphilis and the test for antiHBsAg and HIV antibodies should be negative. Do Rh typing on both donor and recipient and check recipient's serum for unusual antigens. Cross-match blood. Blood for transfusion is drawn into containers with ACD (acid-citrate-dextrose), CDP (citrate-dextrose-phosphate), or CDPA-1 (citrate-dextrose-phosphate-adenine) anticoagulant (1:4), which binds calcium ions, prevents blood from coagulating and thus markedly prolongs the viability of red blood cells. Salts of EDTA and heparin may also be used as anticoagulants. Apart from the anticoagulant, the product contains antibiotics and glucose.

The blood must be stored at 4-6 °C. Properly stored blood may be used for transfusion until 21 days (with ACD) or 35 days (with CDPA) after withdrawal from the donor. Blood should not be used after the expire date.

It is noteworthy that not all the functions of the preserved blood are equally maintained. The most vulnerable are the haemostatic factors and immunity, whereas the oxygen-binding ability remains operable for a longer period. Therefore, when bleeding arrest is required, it is recommended that the blood be obtained at least 2-3 days prior to transfusion, and for the purpose of immune correction at least 5-7 days.

Freshly citrated blood. 6% sodium citrate is used as anticoagulant in the ratio of 1:10. Such blood should be used immediately or within some a few hours after withdrawal.

Heparinised blood. It is used to fill in the artificial circulation machine. This requires large amounts of blood that is why citrated blood is dangerous as it may result in citrate intoxication. Heparin, glucose and chloramphenicol are used as the preservative. Heparinised blood can be stored at 4 °C for only 24 hours.

Blood components. Components of blood have been widely used due to the significant incidence of complications associated with the transfusion of whole blood. Moreover, the therapeutic effect of blood component transfusion is higher since it acts directly on specific bodily functions. This type of transfusion is indicated in chronic anaemia and bleeding (packed red blood cells); in leucopenia and particularly in agranulocytosis and immune deficiency (granulocyte concentrates); in thrombocytopenia (platelet concentrates); in hypoor dysproteinaemia, coagulation disorders, deficient blood circulatory volume (liquid, frozen or dried plasma, albumin, protein). In addition, component transfusion is cost-effective, i.e. higher therapeutic effect is achieved with lesser amounts of blood products.

Red blood cell products are obtained from whole blood, which is either left to stand or centrifuged for separation of plasma. They differ from donated blood in the minimal content of plasma and high concentration of red blood cells (haematocrit 0,65-0,8 l/l); they are stored in bottles or plastic bags at 4-6 °C for 21 days.

Packed red cells. Sodium citrate is used as the preservative. These are stored at 4-6 °C for 8 - 15 days and indicated for bleeding, anaemia and other blood diseases, and sepsis.

Washed and frozen red blood cells are the preparations of red cells suspended in saline, produced by for three to five-fold cell separation.

Freezing can be done either gradually (in electro-freezers at -70-80 °C) or rapidly (using liquid nitrogen at -196 °C). *Frozen* red blood cells can be stored for 8-10 years. To thaw the red blood cells, the container is put into water bath heated to as high as 45 °C and is then washed. Red blood cells can be stored at 4 °C for maximum one day after thawing.

The advantage of frozen red blood cells is that they contain minimum, if at all, undesirable antigens (free haemoglobin, leucocytes, platelets), clotting factors, potassium, serotonin. These are, therefore, indicated for allergies, post-transfusion reactions, cardiac or renal insufficiency, thrombosis and embolism. The blood of a universal donor can be used to avoid massive transfusion syndrome. Washed native or frozen red blood cells are used for patients with HLA incompatibility or those sensitised to plasma proteins.

Platelet concentrates are prepared either from whole donated blood by centrifugation or by plateletpheresis of single donors' blood using cell separators. They may be stored at 4-22 °C for up to 7-9 days; it is, however, advisable to use them freshly prepared within 24 hours. The indications include bleeding in patients with thrombocytopenia of different origin (blood disorders, post-radiation conditions, chemotherapy, as well as haemorrhage resulting from massive transfusions for profuse bleeding, disseminated intravascular coagulopathy). Transfusing platelet concentrates one has to take into account the ABO and Rh system compatibility, and to perform the biological testing since the platelet products may contain residuals of donor's red blood cells.

Granulocyte concentrates are preparations comprising mainly leucocytes with traces of red blood cells, platelets and plasma. These are usually collected from HLA-matched donors by cell separation, or leucopheresis, and stored in bottles or plastic bags at 4-6 °C for maximum 24 hours. Again, transfusing white blood cells the physician will take into consideration the ABO, Rh system compatibility. It is a must to perform the biological test for compatibility. The granulocyte concentrates are used for patients with neutropenia, particularly in agranulocytosis

resulting from radiation, chemotherapy, and severe sepsis. Post-transfusion reactions involve dyspnoea, rigors, fever, tachycardia and hypotension.

Blood plasma is obtained by means of separation of blood. It contains protein and other essential components (enzymes, vitamins, hormones, antibodies). Liquid plasma should be used ex tempore, within 2-3 hours after its collection; plasma is collected into 50-250 ml bottles or plastic bags. It may also be used previously *frozen* or *dried* (lyophilised). *Frozen* plasma should be stored for 90 days at -25 °C or for 30 days at 10 °C. Before use it has to be thawed at 37-38 °C. Any suspensions, a change in colour (e.g. greyish-red discolouration), unpleasant smell or evidence of turbidity found before transfusion all preclude its application.

Plasma is indicated for replacement of blood circulating volume (massive whole blood loss, i.e. blood loss exceeding 25% of blood volume, in combination with whole blood and red cell products), bleeding arrest (in haemophilia) and parenteral nutrition (in burns, sepsis). It is contraindicated for severe allergies.

The usual dose is 100-500 ml or even 500-1,000 ml in shock. Group compatibility (ABO) of the donor and recipient is taken into account and biological testing performed.

Dry plasma is available in 100, 250 or 500 ml bottles and stored for 5 years. Prior to its use it will be dissolved in distilled water or normal saline. Indications for use are similar to those of liquid and frozen plasma, except that dry plasma is ineffective if used for bleeding control. Biological test is a prerequisite.

Albumin. It is prepared through separating plasma and subsequent pasteurising and contains 5, 10 or 20 g of protein (97% albumin) in a 100 ml solution. Its 5, 10 and 20% solutions are available in 50, 100, 250 or 500 ml bottles. A high oncotic activity accounts for its ability to keep water within the body and hence increase the circulating blood volume.

It is therefore indicated for shock of whatever origin, burns, hypoproteinaemia in oncological patients, debilitating and chronic infections, as well as plasmopheresis.

Combined with blood transfusion and red blood cell products, albumin works more efficiently in blood loss and post-haemorrhagic anaemia. Transfusion of albumin is indicated for hypoalbuminaemia, with the level of albumin being 25g/l. The dosage of the preparation is as follows: 300-500 ml (5%); 200-300 ml (10%); 100-200 ml (20%) and the like. The usual rate of its infusion is 40-60 drops/minute while in shock it may be given in bolus. Biological testing helps prevent anaphylaxis, which, if severe, is a relative contraindication for transfusion of albumin.

Protein is prepared either from plasma or blood serum. It consists of albumin (75-80%) and a and b globulins (20-25%). The product usually contains 40-50 g/l of protein. Therapeutically, protein is similar to plasma. Pasteurised, i.e. free of hepatitis viruses, protein is available in 250-500 ml bottles. The daily dose for patients with hypoproteinaemia is 250-500 ml of the solution. The preparation is given for several days. For severe shock and massive blood loss the dose is increased to as high as 1,500 - 2,000 ml. It is mandatory to give protein with either donated blood or red cell products. The rate of its infusion depends on the patient's condition: usually infused slowly it is given in bolus for shock and hypotension.

Cryoprecipitate is obtained by allowing the frozen plasma from a single donation to thaw at 4-8 °C and removing supernatant. It is stored at 0 °C in 15 ml vial. Cryoprecipitate contains factor VIII:C, or antihaemophilic globulin, factor XII, or fibrin-stabilizing, or von Willebrand factor (vWF), and fibrinogen. The preparation is indicated for patients with defective blood coagulation secondary to a decrease in VIII factor levels (haemophilia A and Willebrand's disease).

Prothrombin complex is prepared from blood plasma and distinguished by high concentrations of factors II, VII, IX, and X. The preparation is administered to arrest or prevent bleeding in patients with haemophilia B, hypoproteinaemia, and hypoproconvertinaemia.

Fibrinogen is obtained from plasma. Its preparations are indicated for congenital and acquired hypoor afibrinoginaemia, as well as intractable bleeding.

Prepared from plasma, *thrombin* contains thrombin, thromboplastin and calcium chloride, and is stored in vials in powdered form. It is used for capillary and parenchymal bleeding, and extensive wounds. Apart from the above-mentioned preparations, immunologically active preparations are also prepared from the donated blood - g globulin (staphylococcal, tetanus and varicella immune globulins).

Complex immune preparations (e.g. sandobulin) are obtained from plasma donated by people who have had the disease and therefore acquired the immunity, and those vaccinated against the disease. The preparations contain high titres of antibodies. These are stored in vials and given either intramuscularly or intravenously as indicated.

5.2 BLOOD GROUPING

The antigen components of human blood are numerous. To date, about 500 cellular antigens that are the components of blood, as well as above 40 combinations of antigen systems have been identified. In practical transfusiology, the ABO and Rhesus factor (Rh) systems are regarded as the most important.

I. With standard isohaemagglutination serum For the blood grouping the following are required:

- two sets of standard sera I (0), II (A), III (B) of different serial groups;
- an ampoule of serum IV (AB) (Put a dry clean pipette into each ampoule that contains the serum!);
- a vial with normal saline and a pipette;
- a clean dry plate;
- a ground slide;
- sterile spear-like needles for finger pricks;
- sterile swabs;
- alcohol.

The procedure has to be performed in a well-lit room at 15-25 °C.

Each vial of the standard serum has to be labelled with information of the blood group, serial number, titre, expiry date, and the manufacturer. Never use vials without the relevant information provided.

A standard serum ampoule for blood (ABO system) grouping is normally supplied with a specific colour indicator: I (0) - colourless (no stripes on the label), II (A) - blue (two stripes on the label), III (B) - red (three stripes on the label), IV (AB) - yellow (four stripes on the label). The ampoule with serum is kept at 4...10 °C, the sera being clear. The ampoule should be intact.

Never use for transfusion the serum that contains flakes, sediments or turbidity. The typing serum should be potent, with a titre of at least 1:32 and the first signs of agglutination being evident within 30 seconds. Expired serum may never be used.

Procedure. Divide the plate into 4 parts with a colour pencil and label the parts clockwise - I (0), II (A), III (B). Place the serum of the two series of groups I (0), II (A), III (B) on the corresponding areas using their individual pipettes. Cleanse the finger with alcohol and prick it with a sterile needle. Clear away the first blood drop with a swab, while further drops of blood

are to be placed with different edges of the slide and thoroughly mixed with a drop of serum (the drop of blood should be 5-10 times as smaller as that of serum). Shaking the plate facilitates mixing the serum and blood. Check initial results in 3 minutes, then add a few drops of normal saline, and shake the plates again to mix the drops again. Examine finally the mixture for agglutination in 5 minutes (fig. 33, colour inset).

In a positive isohaemagglutination reaction, flakes and granulations of red blood cells that have clung together do not separate on dilution with normal saline or shaking. In a negative reaction, drops of serum on the plate, alternatively, appear transparent, evenly coloured pink, with no granules or flakes visible. The four patterns of the agglutination reaction with standard sera of groups I (0), II (A), III (B) are possible:

1. The agglutination reaction is negative with the three sera in both series. The blood under examination is of *group l (0).*

2. The isohaemaglutination reaction is negative with test serum II (A) in both series and positive with groups I (0) and III (B). The blood under examination is of *group II (A).*

3. The isohaemaglutination reaction is negative with test serum III (B) in both series and positive with I (0) and II (A) groups. The blood under examination is of *group III (B).*

4. All the serum of I (0), II (A), III (B) groups give positive reactions to both series of serum. The blood under examination is of *group IV (AB).*

However, before making the final conclusion another investigation has to be performed with group IV (AB) test serum, following the same procedure as mentioned above. A negative isohaemaglutination reaction following this test attests the blood being of group IV (AB).

If other types of reactions are encountered it means that the procedure was followed improperly.

The information as to the patient's blood group is noted in his/her folder or case history, as well as on the front page of the file with the date and signature of the physician who has conducted the examination.

Mistakes in blood grouping tests are possible when the reaction of agglutination, though having actually occurred, cannot be identified and vice versa.

Agglutination can be overlooked in the following situations:

1) if the strength of the test serum is mild or the red cells are of low agglutinative power;

2) if an excessive amount of blood has been added to the test serum;

3) if the temperature of the room in which the reaction is being performed is too high, a condition which slows down the reaction of agglutination.

To prevent the errors, the test serum to be used should be active in high titres, the ratio of blood to serum being 1:5-1:10. The temperature should not exceed 25 °C and the results should be noted in as late as 5 minutes from the beginning of the test.

Agglutination can be erroneously identified due to drying up the serum drop, the arrangement of the red cells into coin-like piles or «cold» agglutination if the test is performed at room temperature below 15 °C. The addition of normal saline to the blood serum drop and performing the test at a temperature above 15 °C eliminates the possibility of such errors. In general, errors in blood grouping almost always result from not following the instructions have not been followed correctly.

In all dubious cases repeat the test using test serum of different series and or new standard red blood cells.

II. With anti A and anti B monoclonal antibodies, or anti A and anti B celiclones

Anti A and anti B celiclones are used for ABO blood grouping as an alternative to the standard isohaemaglutination serum by way of detecting antigens A and B in the red blood cells by the antibodies contained in celiclones. «Celiclone» is a diluted ascitic fluid of mice carriers of hybridomas that are producing of IgM against antigens A or B. As distinct from the standard ABO-serum, a celiclone provides a quicker and more pronounced reaction of agglutination. The use of celiclone eliminates the risk of transmission of hepatitis B or C viruses or HIV.

The grouping should be performed at 15-25 °C.

Procedure

• Place big drops of anti-A and anti-B celiclones on a labelled plate or a flat plastic surface.

• Put the drops of blood in question (which should be one-tenth as big in size nearby and mix using different sticks or different edges of the ground slide for each group).

• Shake the plate slightly and observe for about 2,5 minutes (the reaction normally occurs within 3-5 seconds to form small red aggregates followed by flakes).

The following patterns of the reaction are possible:

1. *Negative* agglutination with both anti A and anti B celiclones suggests that blood contains neither A- nor B-agglutinogens and thus the patient's blood is of group I (0) (fig. 34, colour inset).

2. *Positive* agglutination with anti A celiclones indicative of A agglutinogens contained in the patient's red blood cells. The blood is therefore of group II (A).

3. *Positive* agglutination with anti B celiclones. The red cells of the blood under examination contain B agglutinogens and are consequently of group III (B).

4. *Positive* agglutination with both anti A and anti B celiclones. The patient's red blood cells contain A and B agglutinogens, which is suggestive of group IV (AB) blood (tab. 2).

Table 2. Agglutination reaction of tested red blood with celiclones anti-A and anti-B

Agglutination reaction		Tested blood group
celiclone anti-A	celiclone anti-B	
-	-	I (0)
+	-	II (A)
-	+	III (B)
+	+	IV (AB)

If the reaction is positive with both anti A and anti B celiclones, i.e. the blood is supposed to be of group IV (AB), a further test should be performed using normal saline, to eliminate the possibility of non-specific agglutination. A big drop (0,1 ml) of normal saline is mixed with a smaller one (0,001 ml) of the test blood. The absence of agglutination supports the conclusion that the blood is of group IV (AB).

Liquid anti A and anti B celiclones are stored in ampoules or vials, labelled red for anti A and blue for anti B celiclones. They are to be kept in the refrigerator at 2-8 °C for two years.

Otherwise, agglutinative grouping is performed by using washed standard red blood cells.

III. With the standard washed red blood cells of the known group

Procedure. Place three to four millilitres of the patient's venous blood into a glass tube and centrifuge it. Put a few drops of the serum on a labelled plate accordingly and add a few drops of the standard red blood cells, one-fifth as big as those of the serum under investigation, mix these using the edges of a slide, and shake the plate for 3 minutes. Then mix one drop of normal saline with each portion and keep shaking the plate for some more time. Observe the reaction after 5 minutes. The four patterns of the reactions are possible:

1. *A negative* reaction with group I (0) red blood cells but a positive one with those of groups II (A) and III (B) imply the patient's blood being of group l (0).

2. *A negative* reaction with group I (0) and II (A) red blood cells but a positive one with those of group III (B) are indicative of the test blood being of group II (A).

3. *A negative* reaction with group I (0) and III (B) red blood cells but a positive one with those of group II (A) suggests that the blood under investigation is of group III (B).

4. *A negative* reaction with group I (0), II (A) and III (B) red blood cells signifies group IV (AB) blood.

Rhesus factor (Rh) typing

Based on conglutination, Rh typing is performed with special antirhesus serum at the laboratory. ABO grouping usually precedes this.

The equipment and prerequisites are as follows:

1. Two different series of the standard anti-Rh serum to match the group of the blood under investigation (you may also use a compatible group of the standard washed Rh positive and Rh negative red blood cells of the same group instead).

2. Petri dish.

3. Water bath.

4. Pipette for serum.

5. Ground slide (or glass rod). *Procedure*

• Put three big drops of the anti-Rh serum of one serial type into the Petri dish;

• add three drops of that of the other series to arrange the drops in two parallel lines;

• place a few small drops of the test blood on the anti Rh drops in the first vertical row of both; series (in the ratio of serum to blood as 10:1 or 5:1);

• put the same small amount of standard Rh positive red blood cells on the serum drops in the second vertical row (to check for its strength);

• add the drops of Rh negative standard red blood cells to the serum drops in the third row (to check for its specificity);

• mix the serum and red blood cells of each row separately, with different glass rods, cover the dish and place it on the water bath at 46-48 °C;

• observe the results in 10 minutes (the room should be well lit).

Results

1. The drop with the standard Rh-positive red blood cells should give a positive reaction of agglutination.

2. The drop with Rh-negative red cells should be negative.

3. The agglutination seen with the drops in both series of the serum with red cells of the blood under examination suggests the presence of Rh factor in the blood is rhesus positive.

4. Otherwise it is Rh-negative.

It will be noted that the addition of normal saline to the serum, as is the case with ABO grouping, must be avoided, since it may counteract agglutination.

The factors that may be responsible for the mistakes in Rh typing are as follows:

- reduced activity of the standard Rh serum;
- wrong serum-blood proportions;
- inappropriate room temperature;
- reduced exposition period (less than 10 minutes);
- addition of normal saline into the serum;
- absence of testing for controls for serum strength and specificity;
- group incompatibility of the standard serum with the blood under investigation and the standard red blood cells.

In emergency, Rh typing can be performed at bedside. An «express» method of Rh typing requires special reagents - anti-Rh serum of group IV (AB) diluted in 20-30% albumin used as the conglutin, i.e. that substance that allows aggregation of red blood cells under room temperature.

Procedure

- Put a drop of the anti-Rh serum of group IV (AB) and nearly a drop of Rh-negative serum of group IV (AB) free of antibodies on a ground slide or a Petri dish;
- add to each drop of serum 2-3 times less than the patient's blood in the amounts half even less as much as those of the serum;
- mix these with a glass rod or by shaking for 3-4 minutes;
- add one drop of normal saline to each mixture;
- Observe the results in 5 minutes.

Results

1. Agglutination of the red blood cells present with the anti Rh serum and absent with the control serum implies Rh-positive blood.

2. The absence of agglutination with the serum is indicative of the patient's blood being Rh-negative.

3. In case of agglutination with both sera the reaction has to be regarded as unclear.

In emergency, transfusion of only Rh-negative blood is possible, and if it is not available and the patient's condition requires blood transfusion, Rh-positive blood may be given following cross-matching the blood for Rh compatibility.

The importance of blood grouping during blood transfusions

The antigens of blood, mainly those of ABO system and Rh, can be responsible for its immunological incompatibility. If the recipient's (i.e. patient's) blood contains antigens against to those of the red blood cells and antibodies in donor's plasma, agglutination of the red blood cells is likely to occur. This type of agglutination can be seen when similar antigens and antibodies A and 6, B and b, as well as Rh antigens and anti Rh antibodies react. For this to take place there should be sufficient amounts of antibodies, or the titre, present in the blood serum. Ottenberg's rule is based on this principle, which says that the donor's red blood cells transfused agglutinates and since the agglutinin of the transfused blood is diluted by the recipient's blood, the concentrations are not as high as to cause agglutination of the recipient's blood. Without cross-matching all recipients may therefore receive only group I (0) blood, as this blood is devoid of any agglutinogens (the holders of group I blood are referred to as *universal donors).* On the other

hand, patients of group IV (AB) blood can receive that from donors of all the other blood groups, since the patient's blood is free of any agglutinins (the holders of group IV blood are called *universal recipients).* However, if large amounts of blood are needed, as is the case in uncontrolled bleeding, agglutinins of the blood transfused can cause agglutination of the patient's red blood cells. Ottenberg's rule is applicable only when the amount of blood to be transfused does not exceed 500 ml.

If Rh-positive blood is transfused for the first time to a Rh-negative patient who has not been sensitised earlier, overt incompatibility reactions are not observed, antibodies, however, being formed. Giving blood to an Rh-negative woman who has been sensitised through pregnancies with a Rh-positive foetus may result in Rh incompatibility. Transfusing Rh-negative blood to a Rh-positive recipient, one should bear in mind that production of antibodies to the weak antigen system of Rh present in the transfused blood cannot be ruled out.

According to the current principles of transfusiology, the blood transfused may be of only the same group (the ABO system and Rh group). In emergency, Ottenberg's rule can be applied.

5.3 METHODS OF BLOOD TRANSFUSION

The following methods of blood transfusion are used:

1) indirect blood transfusion (transfusion of preserved blood);

2) direct blood transfusion;

3) exchange blood transfusion;

4) autologous blood transfusion.

In clinical practice indirect transfusion is the commonest method which involves transfusing preserved blood or blood components.

Direct blood transfusion

Nowadays, transfusing blood directly from a donor to the recipient is rarely done. The indications for direct blood transfusion are as follows:

• intractable bleeding in a patient with haemophilia;

• haemostatic disorders (acute fibrinolysis, thrombocytopenia, and afibrinoginaemia); following massive blood transfusions; blood diseases;

• degree III traumatic shock with concurrent blood loss of at least 25-50% of the circulating blood volume and unresponsiveness to transfusion of preserved blood.

The donor for direct blood transfusion should be examined at a blood transfusion station. The ABO and Rh typing of both the recipient and donor and cross-matching are performed immediately prior to the transfusion, while biological testing should be done at the beginning of transfusion.

The procedure is performed by a physician or nurse. Have the donor lie on a stretcher at the patient's bedside or the operating table. Place the table with instruments covered with sterile materials in between the bed and the stretcher. Put on the table twenty or thirty 20 ml syringes with needles for venipuncture with rubber tubes, sterile gauze packs and sterile clamps (Bilroth's type). Before the transfusion, the patient is given normal saline intravenously. The nurse collects a small amount of blood into a syringe, presses on the rubber tube and hands it over to the physician who will inject it into the patient's vein. Meanwhile, the nurse should fill in another syringe (fig. 35). The manipulation is done synchronically. Put 2 ml of 4% sodium citrate in each of the first three syringes before transfusion to prevent blood clotting, these initial blood transfusions are performed slowly (one syringe for each 2 minutes). This serves as biological testing.

A special apparatus with a roller pump can also be used. The apparatus is used according to the instructions attached. Biological test is done by rapid transfusion of 20-25 ml of blood with a three-fold reduction after each portion transfused. The apparatus provides the rate of transfusion as high as 50-75 ml/minute.

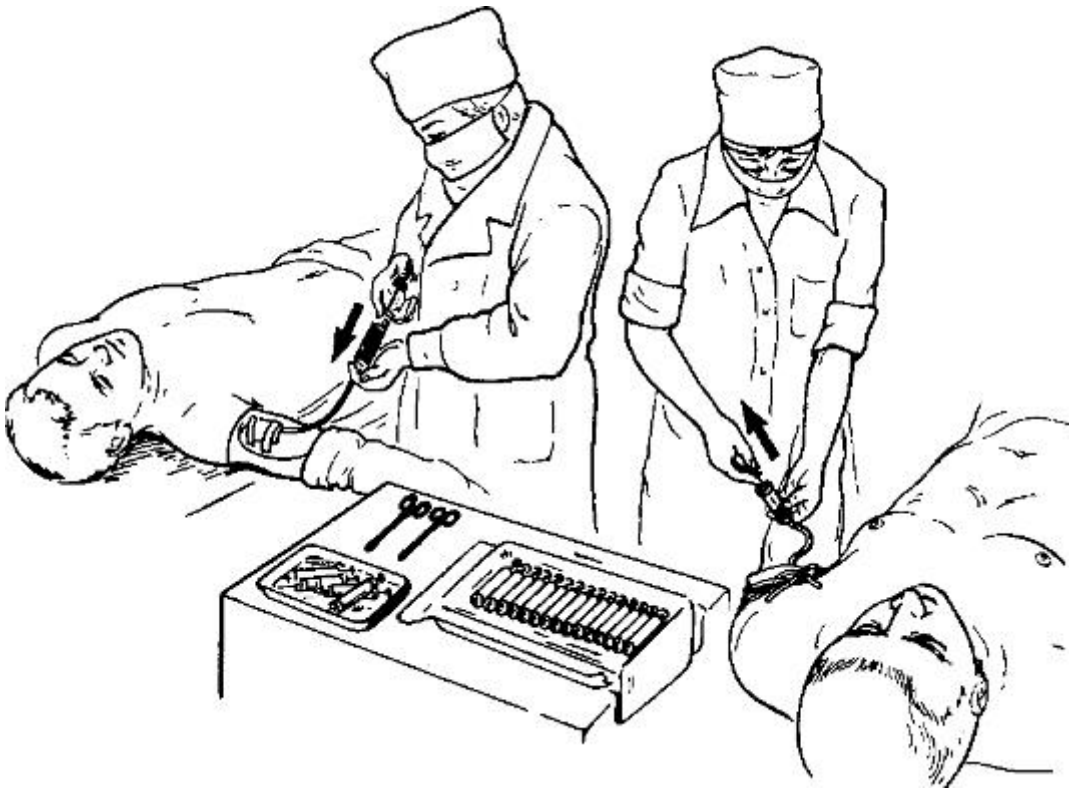

Fig. 35. Direct blood transfusion using syringes.

Exchange blood transfusion

This method involves a partial or full drainage of the patient's blood and its replacement with the equivalent volume. Exchange blood transfusion is indicated for poisoning, haemolytic disease of the newborn, immediate haemolytic transfusion reaction, and acute renal failure. Blood contaminated with toxic compounds is removed and infusion is aimed at replacing the blood volume.

In exchange blood transfusion it is important to use either freshly prepared blood or that has not been stored for too long for. Blood infusion is done into any of the superficial veins while exfusion (draining out) is performed through a major vein or artery to prevent clotting. Both drainage of the patient's blood and infusion of donor's blood are to be done simultaneously at a rate of 1 l per 15-20 minutes. To complete blood exchange 10-15 l of donor's blood are needed.

Autologous blood transfusion

This involves transfusion of the patient's own blood that has been obtained either long before surgery, immediately before or during surgery. Autologous blood transfusion is void of all disadvantages that transfusion of donor's blood may have, such as immunisation of the recipient, development of homological blood syndrome, and, apart from these, it eliminates the problem of finding individual donors for patients with antibodies to red blood cell antigens that are not included in the ABO and Rh systems.

The *indications* for autologous blood transfusion are as follows:

1) rare blood group of the patient;

2) inability to find a donor;

3) increased risk of a post-transfusion reaction;

4) impending operation associated with a massive blood loss.

Autologous transfusion is *contraindicated* in

1) infections;

2) severe liver or kidney diseases;

3) debilitating malady (e.g. full-blown tumours).

The widely known method is *blood salvage*, or retransfusion of the blood lost and collected during or after surgery. It is applied in such abdominal conditions as ectopic gestation, rupture of the spleen, liver or mesenteric vessels; in closed damage to the chest organs - injuries to the intrathoracic vessels and the lung. Reinfusion is effectively used for blood replacement during operations when the patient's blood from the wound is collected and reinfused. Blood collected into a bottle with anticoagulant is filtered through 8-layer gauze and emptied into the transfusion system equipped with a standard micro-filter for onward blood transfusion. Blood salvage is contraindicated if there is a damage to any hollow organ of the chest (the major bronchi, oesophagus) and the abdominal cavity (the stomach, intestine, gallbladder, extra-hepatic bile ducts, and urinary bladder) as well as in malignant tumours. Also, retransfusion of the blood that has stayed in the abdominal cavity for more than 24 hours should be avoided. Reinfusion is contraindicated when the accumulated blood is contaminated with pus, stomach and intestinal contents, bleeding from a ruptured uterus and malignant tumours.

To preserve the blood, preservative solutions in their ratio to blood of 1:4, or most often heparin solution is used - 10 mg of heparin in 50 mL of normal saline is mixed with 500 ml of blood. The accumulated blood is collected by scooping dry with a small metallic cup and immediately filtered through an 8-layer gauze. Collecting blood by a suction machine with a pressure of at least 0,2 atmospheres is more effective. Blood collected into a bottle with anticoagulant is filtered through 8-layer gauze and emptied into the transfusion system equipped with a standard filter for onward blood transfusion.

Autotransfusion, using previously preserved blood, is done by draining the patient about 4-6 days before scheduled surgery and storing the blood for later use. Four to six days is enough for the patient to regain their lost blood, the stored blood being intact with all the valuable components. The process of recovery after the donation is facilitated by not only the transfer of interstitial fluid into the blood stream (like is the case in any blood loss), but also by the stimulatory effect of blood drainage on haemopoiesis. Preparing blood through that way yields a volume of as great as 500 ml. When blood is collected in steps within a long-term preoperative period, as much as 1,000 ml can be preserved within 15 days or even 1,500 ml within 25 days. If this method is to be used, the blood volume of 300-400 ml first is drained, it is then reinfused every 4-5 days and 200-250 ml more than what has been given are drained. Such method provides a large amount of good quality blood that can be stored for maximum 4-5 days.

Blood is collected into bottles with preservatives and stored at 4 °C. To be able to keep blood for a long time it has to be frozen at -196 °C.

Haemodilution is another method of autologous blood transfusion. Urgent preoperative haemodilution is done immediately prior to the surgery and is aimed at reducing bleeding during the intervention. As a result, the patient loses the diluted blood (with limited amounts of blood cells and plasma factors); and replacement of blood loss by auto-blood follows. Immediately prior to operation the patient's blood is drawn into a bottle containing some preservative and at the same time the haemodilution solution consisting of rheopolyglukin, 20% albumin and Ringer-Lock's solution is given. In mild haemodilution (i.e. a reduction in haematocrit by a fourth) the volume of blood drained should approximate 800 ml, the volume of infusion given - 1,100-1,200 ml (rheopolyglukin - 400 ml, Ringer's solution - 500 ml, 20% albumin - 100 ml).

Significant haemodilution (i.e. a reduction in haematocrit by one-third) involves drainage of about 1,200 ml, infusion of about 1600 ml (rheopolyglukin - 700 ml, Ringer's solution - 750 ml, 20% albumin - 150 ml).

Haemodilution aimed at reducing the amount of blood lost at operation does not necessarily involve drainage the patient's blood. This can be achieved by infusing solutions with high colloid properties, that can increase the circulating blood volume (e.g. albumin, polyglukin, gelatinol) in combination with blood replacement solutions (Ringer's solution).

Plasma autologous transfusion

Replacement of lost blood can be done with the patient's own plasma to provide an ideal blood substitute and prevent homological blood syndrome. Plasma autologous transfusion can be used to replace lost blood when collecting the blood for subsequent autologous transfusion. Thus plasma is obtained through plasmopheresis and then preserved; 500 ml of plasma are considered the safe dose that can be drawn at a time. Drainage can be repeated in 5-7 days. Glucose-citrate solution is used as the preservative. To replace the blood lost at surgery, autol-ogous plasma is used as a blood substitute or as the main blood component. The combination of autologous plasma and washed red blood cells prevents homological blood syndrome. To achieve this, about 1,000 ml of autologous plasma are required.

5.4 METHODS OF BLOOD TRANSFUSION

Intravenous blood transfusion is the main method of blood transfusion. Most often, puncturing the cubital or subclavian veins is used. A venesection is only rarely used. To puncture the cubital vein, a tourniquet is applied to the lower third of the upper arm, the puncture site is cleansed with alcohol or iodine and isolated with a sterile material. The tourniquet should compress only the veins leaving the arteries patent. With several fist clenching and contracting the forearm muscles the veins engorge and can be easily identified.

Using a wide lumen needle (with or without a syringe) the skin is punctured, through the subcutaneous tissue, the needle is inserted further (about 1 cm) over the subcutaneous vein and then the anterior wall of the vein is punctured. The needle is then inserted into the vein. The appearance of blood from the needle or in the syringe suggests successful venipuncture. Three to five millilitres of blood are taken from the vein for group and Rh typing and compatibility test. Further, the tourniquet is removed and a blood giving or infusion set is attached to an infusion solution (e.g. normal saline) to prevent blood from clotting in the needle. The needle is fixed to the skin with some adhesive plaster. Subsequently, the blood giving set is attached and transfusion started.

In case the superficial veins cannot be punctured (e.g. collapsed veins in shock, marked obesity) transfusion is done through a venesection. The puncture site is cleansed with alcohol or iodine and isolated with a sterile material. The site of incision is infiltrated with 0,25% novocain. A tourniquet is applied to compress only the veins leaving the arteries patent. The skin and subcutaneous tissues are incised and a forceps is used to expose the vein. Two ligatures are passed beneath the vein, the peripheral one serving as the retractor. Pulling the vein by the retractor, it is punctured directing towards the centre, a pair of scissors can also be used to slit open the anterior wall and the needle or vein catheter is inserted through. The central ligature is used to fix the needle. The blood giving set is then attached to the needle and the skin is closed with two or three sutures.

At the end of transfusion, when about 20 ml of blood is left in the system, it is closed and the needle removed. The place of puncture or venesection is cleaned with iodine tincture and pressing bandage applied.

In cases when long-term (i.e. for several days) infusion of solutions, blood and its components is anticipated, venipuncture of either the subclavian or external jugular is preferred,

a special catheter, which can stay for long periods (up to a month) is placed in the vein and blood or infusion sets can be attached for transfusion, when needed.

Intra-arterial blood transfusion is indicated for:

- clinical death (respiratory and cardiac arrests) caused by massive blood loss
- severe traumatic shock with persistently low systolic arterial blood pressure of less than 60 mm Hg
- ineffective intravenous blood transfusion.

Therapeutic effects of intra-arterial transfusion are assessed based on the reflective stimulation of cardiovascular functions and restoration of coronary blood circulation. To achieve this, blood has to be given at a rate of 200-250 ml for $1^1/_2$-2 minutes and under the pressure of 200 mm Hg; on restoration of cardiac functions the pressure is reduced to 120 mm Hg. When the pulse is clearly felt, intravenous infusion is started; when the systolic pressure is stabilised at 90-100 mm Hg, the needle is removed from the artery.

The system for intra-arterial blood transfusion (fig. 36) is similar to the intravenous one, with the exception being that the long needle in the bottle is attached to Richardson's tube used to pump in air, which, in turn, is connected to a manometer. The artery is punctured through the skin or arteriosection is done.

The femoral and brachial arteries are used for transfusion. Arteriosection is often necessary, using the radial and posterior tibial arteries. The manipulation is done using local infiltration anaesthesia.

Pumping blood under pressure can be associated with a great risk of air embolism. It is therefore recommended that the blood flow in the system be monitored to be able to promptly close it, if necessary.

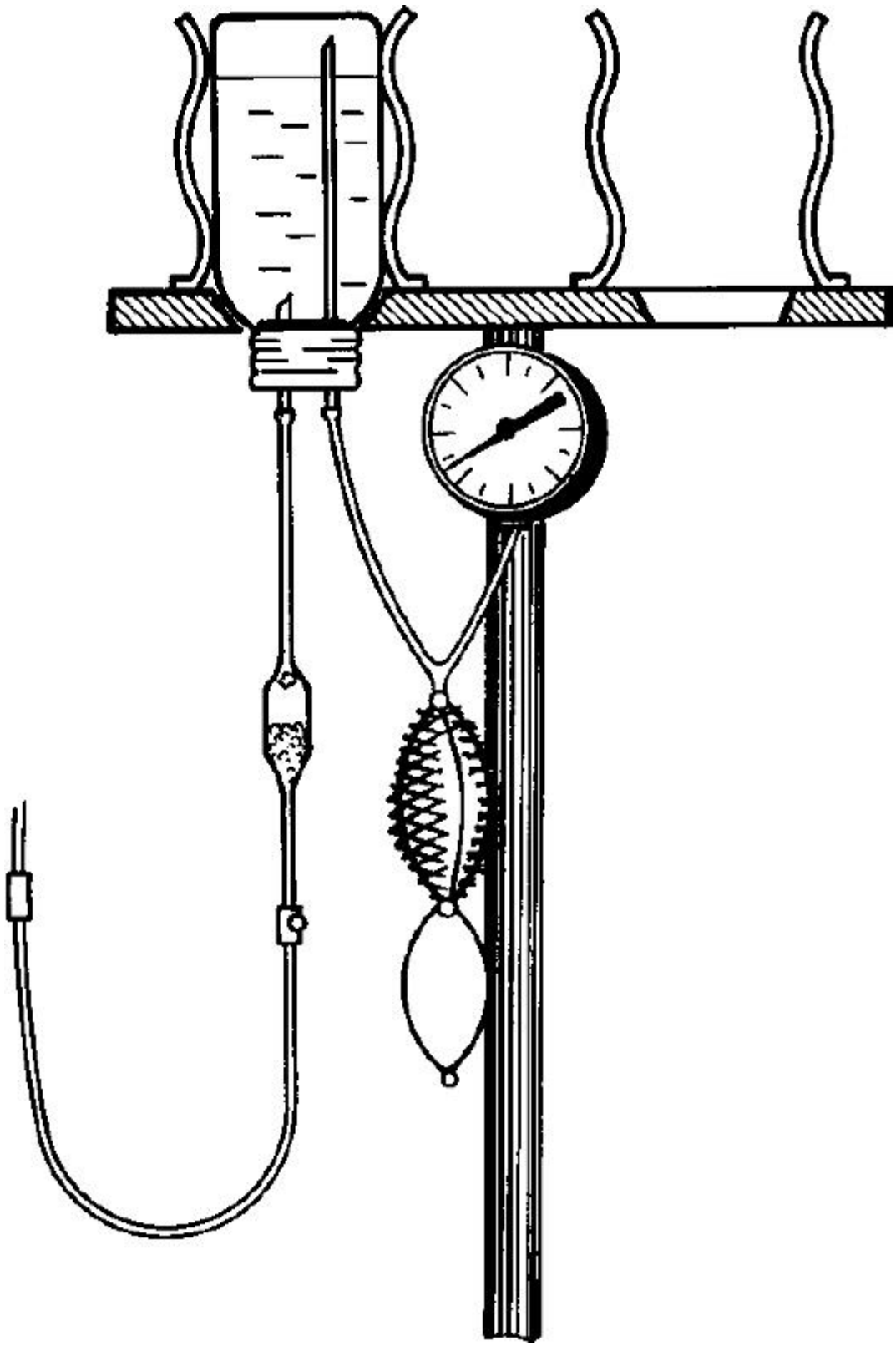

Fig. 36. The system for intra-arterial blood transfusion.

Intra-aortal blood transfusion

It is used in sudden clinical death, massive bleeding resulting from thoracic surgeries. Intra-aortal blood transfusion can be done with the help of a catheter inserted into the aorta through one of the peripheral arteries (often the femoral, rarely brachial) by means of a puncture or section. In the case of intra-arterial transfusion this is done under pressure and with the use of the same type of systems.

Intra-osseous transfusion

This method is only used when it is not possible to transfuse blood through other means (e.g. in severe widespread burns). Blood is transfused into the sternum, the iliac crest and the heel bone.

Puncture of the sternum is done with the patient lying supine. It is punctured under local anaesthesia into the shaft or body of the sternum. It is Kassirsky's needle that is used for this puncture. The operation site is cleansed. Injection is strictly made in the midline, passing through the skin, subcutaneous tissues; the initial resistance is at the bony lamella of the sternum, which is overcome with some effort. A specific feeling of the needle indicates that it has reached the bone marrow. The mandrin is removed and a syringe is used to aspirate the bone marrow. The appearance of the latter in the syringe indicates that the needle is positioned correctly, 3-5 ml of 1-2% novocain (procaine) are then injected into the bone marrow and the transfusion system is attached.

The iliac crest is punctured in the centre of the posterior third since in this area the spongy layer of bone has a loose structure that makes it easier to transfuse.

Flow of blood should be as slow as 5-30 drops/ minute, the transfusion of 250 ml of blood, therefore, takes 2-3 hours. To accelerate the flow, raise the bottle or increase the pressure in the bottle by injecting air under pressure up to 220 mm Hg.

5.5 THE PROCEDURE OF BLOOD TRANSFUSION

Blood transfusion is a serious operation which consists in transplantation of human living tissues. This method of treatment is widespread in clinical practice. Health care professionals of different specialities perform blood transfusion: surgeons, obstetrician and gynaecologists, traumatologists, internists, etc. Up-to-date scientific advancements, especially those in transfusiology, help prevent the complications associated with blood transfusion, which can sometimes even lead to death. These complications occur because of the errors that are committed in the process, which result from inadequate knowledge of the essentials of transfusion or violation of whichever step of the procedure. These include the inappropriate decisions as to the indications or contraindications for blood transfusion, errors in blood group and Rh typing, misinterpretation of the results of compatibility tests, etc. Observing the rules and regulations and following the steps of the procedure are bound to lead to successful blood transfusion.

Indications for blood transfusion. As blood transfusion is a serious intervention for each patient, it must always be justified. If it is possible to avoid the procedure or the benefits expected from blood transfusion are unlikely, the procedure should always be avoided. The indications for blood transfusion depend on the effect it is supposed to achieve: replacement of deficient blood volume or its components; improvement of the clotting properties of blood in case of bleeding disorders. Blood transfusion is absolutely indicated for acute blood loss, shock, bleeding, severe anaemia, major traumatic operations, including those with heartlung bypass. Diseases of blood, pyogenic infections and severe intoxication are all indications for transfusing blood or its components.

Contraindications for blood transfusion

1. Decompensated cardiac disease.

2. Septic endocarditis.

3. Advanced hypertension (i.e. with numerous complications).

4. Cerebral vascular thromboembolism.

5. Pulmonary oedema.

6. Acute nephritis.

7. Severe hepatic failure.

8. Generalised amyloidosis.

9. Hypersensitivity.

10. Bronchial asthma.

An important role in the evaluation of contraindications to blood transfusion play the patient's transfusion and allergic histories, i.e. the information on previous blood transfusions and their outcome as well as the presence of an allergic condition.

Risk group patients should be identified. These are the patients who had blood transfusions more than 3 weeks ago, accompanied by complications; women with the history of miscarriages, pathological pregnancies and births due to neonate haemolytic disease and jaundice; patients with decay of a malignant tumour, diseases of the blood with chronic purulent infections. The cases with complicated blood transfusions and unfavourable obstetric history are to be suspected of having been sensitised to Rh. In such a case blood transfusion has to be postponed before the presence of antibodies to Rh or any other antigens have been excluded. Compatibility tests of the patients must be done in the laboratory using indirect Coomb's test.

In life-threatening situations (e.g. shock, acute or intractable haemorrhage, severe anaemia, major traumatic operations) blood transfusion may has to be performed in spite of the contraindications. In such a case it is advisable to choose certain blood components or its preparations and take the necessary prophylactic measures. For instance, when blood transfusion is urgently needed in a patient with hypersensitivity or bronchial asthma, desensitising agents (e.g. calcium chloride, antihistamines, corticosteroids) are given before the procedure, and the blood components with minimal amounts of antigen (e.g. washed and frozen red blood cells) are used. It is better to combine blood with blood substitutes that have specific properties, and during operations, if possible, transfuse autologous blood.

Preparing for blood transfusion. Each patient admitted to the surgical unit must be investigated for blood grouping and Rh. Cardiovascular and respiratory systems, the kidneys and urinary tract should be examined to rule out contraindications for blood transfusion. Routine blood tests are performed 1-2 days prior to blood transfusion. Immediately before the procedure the patient has to urinate and defecate, if possible. The transfusion should preferably be performed in a fasting patient or after a light breakfast.

Methods and types of products for transfusion

In anaemia, leucopenia, thrombocytopenia and clotting disorders when particular blood components are deficient, transfusion of whole blood is not justified. The whole blood therapeutic effects in such cases are therefore low whilst the waste of blood is unreasonably high. Instead, concentrated blood components (e.g. red blood cell or leucocyte mass, plasma, albumin) are to be used. Patients with haemophilia, for example, will only need transfusion of factor VIII. Again, instead of giving litres of whole blood, the therapeutic effect can be achieved by giving only a few millilitres of antihaemophilic globulin. In hypoand afibrinoginaemia, up to 10 l of whole blood may be needed to compensate for the deficit in fibrinogen, whereas only 10-12 g of the blood product of fibrinogen may suffice. Besides, transfusion of whole blood can lead to sensitisation of the patient, the formation of antibodies to blood cells (leucocytes, platelets) or plasma proteins, which can cause serious complications during subsequent blood transfusions or pregnancies. Transfusion of whole blood is indicated in acute haemorrhage with a dramatic decrease in the circulating blood volume, in exchange blood transfusions, in heart-lung bypass during open heart surgeries.

It is recommended that the product for transfusion contain the components of blood that the patient needs most of all (tab. 3).

Examination of preserved blood and its components before transfusion. The blood to be transfused has to be examined for viability (fig. 37, colour inset): the wholeness of the package, expiring date and possible violations of storage (frozen or otherwise overheated). The best blood to transfuse is the one that has not been stored for more than 5-7 days, since a longer storage period may result in biochemical and morphological changes which reduce the positive properties of blood. Macroscopically, blood should have three layers. The red layer of red blood cells is located at the base followed by a thin layer of leucocytes and the top transparent yellowish layer of plasma. Signs which show that blood is not fit for transfusion are as follows: red or pink discoloration of plasma (haemolysis), the presence of flakes, cloudiness, the presence of a film on the surface (signs of contamination), the presence of clots (clotted blood). In emergency blood transfusions some of the blood is put in a glass tube and centrifuged. Pink discoloration of plasma indicates haemolysis. To transfuse frozen blood components the package is quickly warmed to 38 °C, the cryostabiliser (glycerin for red blood cells and dimethyl sulphoxide for leucocytes and platelets) is then washed off red blood cells.

Cross-matching (i.e. checking) the blood groups of the donor and recipient's blood. Although the data from the patient's case history may coincide with those on the the labels on the blood bag, it is necessary to repeat typing the patient's blood group of the patient that of the blood to be transfused immediately before the procedure. It is the physician who will perform transfusion is responsible for checking. In emergency transfusion, apart from checking the blood group by the ABO system, Rh is checked using the express method. The grouping is done according to the stipulated rules and regulations and the results are observed not only by the doctor performing the transfusion but also by other doctors.

Testing for compatibility. To check for individual compatibility 3-5 ml of blood is taken from the patient's vein, this is centrifuged or allowed to stand. One big drop of the serum is then put on a plate or flat surface. A drop of donor blood is placed nearby at the ratio of 5:1 - 10:1, mixed together by a glass rod or the slide edge and observed for 5 minutes, after which a drop of normal saline is added and the result determined by the presence or absence of agglutination. The absence of agglutination indicates that the blood groups of the patient and the donor are compatible, and the presence of it means incompatibility (fig. 38, colour inset). This checking for compatibility is to be performed on each bag of blood that is to be transfused. Checking for compatibility of the Rh is done in the case of unfavourable transfusion history (previous post-transfusion reactions, Rh conflict pregnancies, miscarriages), in critical conditions when it is not possible to recheck the patients Rh, and in a case when the patient with unknown Rh has to receive Rh positive blood. Blood is taken from the vein like in checking individual compatibility for grouping, centrifuged, a drop is put into the Petri dish and a smaller drop (3-5 times smaller) of the donor blood is added, mixed together, covered and allowed to float on a water bath at 42-45 °C for 10 minutes.

Table 3. Indications of transfusion solutions

Indication	Blood and blood products									
	whole blood	RBC	WBC	3latelets	plasma	albumin	cryoprecipitate	fibrinogen, thrombin	immunoglobulin	blood substitutes
Acute haemorrhage:										
10-15%										+

CBV										
15-30% CBV		+				+				+
30% + CBV	+					+				+
Shock		+				+				+
Anaemia		+								+
Thrombocytopenia				+						
Leucopenia			+				+	+		+
Haemophilia							+	+		
Bleeding	+				+					+
Hypo-, disproteinemia					+	+				+
Pyogenic infections					+	+			+	+

The checking is better done in light using a magnifying glass. The absence of agglutination allows for the transfusion of blood in that package. The presence of agglutination indicates that the patient's blood is Rh negative, and contains anti-rhesus antibodies (fig. 39, colour inset). Such a patient can only be transfused with Rh negative blood. Compatibility test for the Rh has to be done on each donor pack that is to be transfused. If true agglutination is encountered in the process of the ABO system and Rh tests, the specific donors have to be searched for the particular patient through the blood bank. Assuming the patient's condition is critical and urgent blood transfusion is needed, a search is done through the available stock without waiting for an answer from the blood bank. Blood is chosen from the same group and Rh. Blood from each pack is tested with the serum of the patient according to the ABO system and the Rh for compatibility. If agglutination does not occur, that blood can be transfused starting with the biological test. In case the tests from all the existing blood in stock with the same groupand Rh give positive reactions of agglutination, none of them can be transfused and the patient will have to wait for an individual donor to be found through the blood bank.

If such blood is received through the blood bank, it still has to be grouped and cross-matched again for the ABO system and Rh as well as for individual compatibility. It is only when the patient's blood is of the same group and Rh with the donor blood and there is no sign of agglutination in the compatibility tests for the ABO system and Rh that the blood can be transfused always starting with the biological test.

Preparation for transfusion. Blood is transfused through a disposable plastic system with nylon filter preventing blood clots from entering the blood stream (fig. 40). The system consists of a short tube with a needle and filter for allowing air into the bottle, a long tube for the infusion of blood with a needle at each end - one to put into the bottle and the other to puncture the patient's vein. The system is fitted with a dropper, nylon filter and a plastic clamp to regulate the rate of infusion. They are produced in sterile forms packed into polyethylene bag which should be opened only immediately before use.

Transfusion sets that can be used for several times are not advisable since they are not equipped with micro filters. However, when needed, a non-pyrogenic tube has to be used, a glass dropper that controls the rate of flow is mounted onto it, and a glass tube attached towards the outlet controls the complete exit of air out of the tube while filling with blood. To attach the system to the bottle, two special needles - a long and short ones which are inserted through the rubber cork of the bottle. The longer needle is inserted as deep as the bottom of the bottle, and it is through it that air escapes during the time of transfusion, the shorter needle is attached to the plastic tube for transfusion, onto which the plastic clamp is fitted; the bottle is turned upside down and hung on the drip stand. The system is subsequently filled with blood after all the air has been expelled from it.

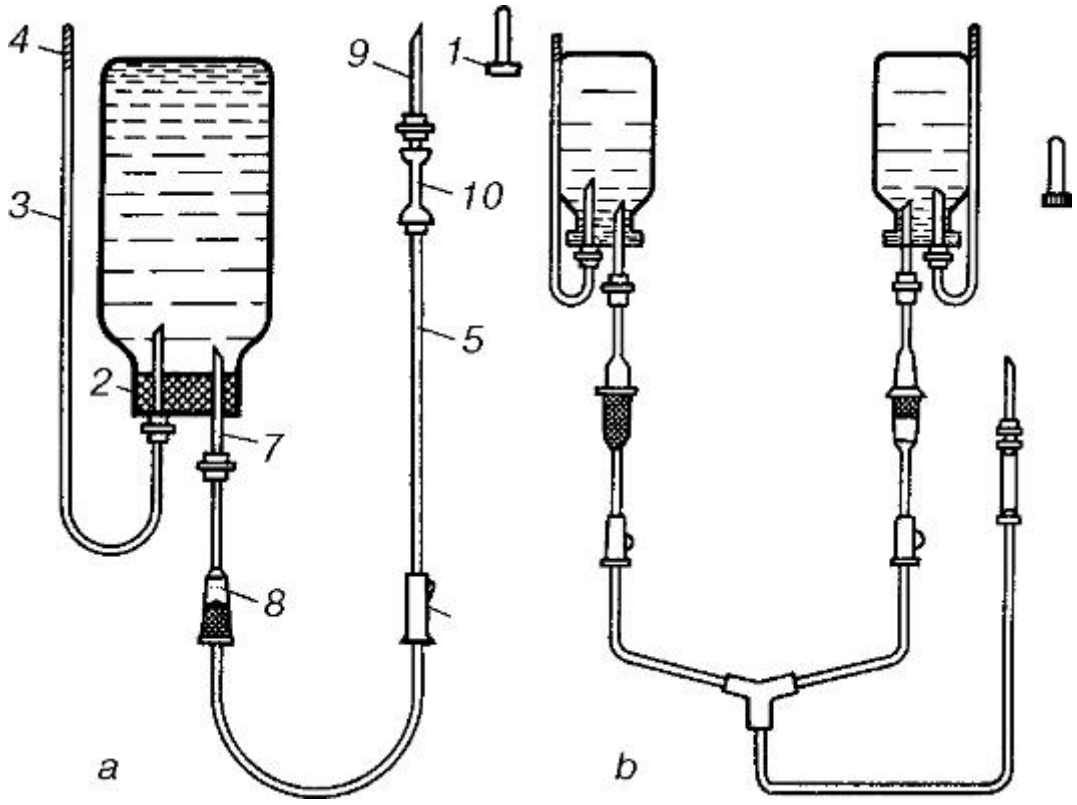

Fig. 40. The blood and fluid infusion system.

(a) the mounted system: *1* - needle cover; *2* - bottle filled with blood; *3* - air-way tube; *4* - air-filter;*5* - transfusion tube; *6* - clamp for regulating the blood flow rate; *7* - needle for blood flow from the bottle; *8* - dropper filter; *9* - needle for venepuncture; *10* - joining tube; (b) multi-bottle blood and fluid infusion system.

Mounting the system for transfusion one should abide by the following regulation: *transfuse blood from the bottle in which it has been prepared and stored.*

When transfused from a plastic bag, blood is first mixed by shaking the bag, a clamp is put on the central outlet tube, alcohol or 10% iodine is used to cleanse the tube which is cut at about 1-1,5 cm below the clamp. The safety cap of the system is removed and attached to the system by way of attaching the tube end of the bag to the cannula of the system. The bag of blood is hung upside down onto the drip stand, the system with the dropper is raised and turned so that the filter in the dropper is situated on the upper part. The clamp is removed from the tube; the dropper is half filled with blood before the clamp is reapplied. The system is put back to its original position with the filter downwards and must be filled with blood. The clamp is removed and that part below the filter is filled with blood until all the air in it is evacuated and blood drops start coming out of the needle. A few drops of blood are let onto the plate for onward control determination of the grouping, Rh of the donor blood and compatibility. The system is checked through observation to make sure there are no air bubbles inside. The system is now

ready for use. The rate of infusion is regulated with the clamp. When it is necessary to change an empty bag with a new one, the system is closed with the clamp, a few forceps are used to clamp the tube, the old bag is removed and a new one attached.

Blood transfusion using the standard bottle. The top of aluminium cap is removed, the adjacent rubber cork is then cleansed with alcohol or iodine tincture and punctured with two needles. A short tube is attached to one of the needles for air passage, the end of which placed above the bottom of the bottle, and to the other needle is attached the disposable system with the bottle hung upside down on the drip stand. The system is filled with blood as mentioned above.

After mounting the system and determination of the grouping and Rh as well as the compatibility tests blood transfusion can be started. The system is attached to a needle that has previously been inserted into the vein with some solution for infusion already running.

The test for biological compatibility. Transfusion of blood or its components (red blood cell mass, red blood cell suspension, plasma) has to be preceded by the biological test for compatibility. To perform this test, the first 15-20 ml of blood are allowed to flow fast; the infusion is stopped and the patient's response and condition are observed (behaviour, skin colour, pulse and breath rates). Tachycardia, dyspnoea, facial hyperaemia and hypotension all suggest incompatibility of the donor's blood with that of the recipient. In the absence of signs of incompatibility the test is repeated twice, and if there are still no reactions the blood transfusion is continued. During the triple biological test the needle can be thrombosed when the infusion is halted. To prevent this when infusion is supposed to have been halted, it can be allowed to drop at a very slow rate or if blood substitutes are to be given with the blood, they can be given in those intervals.

Supervision of blood transfusion. The rate of flow is regulated with a special clamp. Blood is to be given in drops at a rate of 50-60 drops/minute. If fast flow of blood is needed, the clamp is fully opened, or a Richardson's cylinder can be attached to pump in air into the bottle (transfusion under pressure).

The patient has to be closely observed throughout the whole period of transfusion, so that in case there are any complications or reactions they can be noticed, and transfusion stopped early enough to start therapeutic measures.

If the lumen of needle is blocked by a thrombus, it is not advisable to use any solutions or the mandrin as it may push the thrombus further into the patient's vein. In such a case it is advisable to clamp the system, disconnect it from the needle, remove the thrombus from the vein and apply a pressure bandage; a new needle is then used to puncture a new vein to continue with the transfusion.

It is allowed to mix sterile intact blood substitutes that are in standard packages with the blood in the process of blood transfusion.

Transfusion is stopped when about 20 ml of blood are left in the bottle, ampoule or plastic bag. The needle is removed and a sterile dressing is bandaged on the puncture site. The blood left in the bottle is stored under sterile conditions in the refrigerator at 4 °C for 48 hours. In case the patient develops a reaction later this left over blood can then be used to investigate the cause of the complication (checking for bacterial contamination, blood group and Rh cross-matching, retesting for compatibility of the donor blood with the patient's blood).

Recording blood transfusion. Every blood transfusion must be recorded into a special book meant for this purpose as well as into the patient's case history. Such information as the amount of blood given, the data written on the given blood pack, the result of the compatibility test and reactions or complications, if any, are to be noted.

Monitoring the patient after blood transfusion.

The patient who has undergone blood transfusion should stay in bed for at least 3-4 hours. They have to be followed for 24 hours by the doctor and nurse. The patient's symptoms and signs (e.g. retrosternal or lumbar pain, cutaneous changes like pallor or cyanosis fever, tachycardia or hypotension) are assessed and precisely registered. An hourly check of pulse and temperature is done for the first four hours. A routine blood and urinalysis should be performed the following day. Post-transfusion reactions require that urgent therapeutic measures be taken. Normal body temperature for the first four hours suggests that no reaction occurred after transfusion.

5.5 COMPLICATIONS OF BLOOD TRANSFUSION

Blood transfusion is considered to be a safe method of treatment if all the rules and regulations are carefully followed. Violation of the regulations, underestimation of contraindications, and technical errors can lead to serious post-transfusion reactions and complications.

Blood transfusion reactions. Unlike complications, these do not result in serious bodily dysfunctions and are therefore usually not life-threatening. They may be either pyrogenic or anaphylactic and occur promptly after transfusion. Their manifestations are as follows: fever, malaise and adynamia, rigors, headache, itching, Quincke's oedema.

Half of all the reactions and complications are due to pyrogenic reactions which may be mild, moderate or severe. In a mild reaction, the body temperature increases by 1 °C and the patient complains of headache and muscle pain. A moderate reaction involves rigors, a body temperature increase by 1,5-2 °C, tachycardia and dyspnoea. Severe reactions are characterised by rigors, a body temperature rise by more than 2 °C to as high as 40 °C, severe headaches, pains in the muscles and bones, tachycardia, labial cyanosis and dyspnoea.

The pyrogenic reactions are mediated by the products of plasma protein decay, leucocytes of the donor's blood, products of microbial activity, breakdown of plasma and blood particles left over from previous transfusions.

In a pyrogenic reaction, the patient should be covered with warm clothing and hot water bottles applied to the feet, he/she should be given hot drinks as well as paracetamol. If it is a mild or moderate reaction, these measures may suffice. In severe reactions, apart from the above-mentioned measures, the patient is given promedol, analgin in injections, 5-10 ml of 10% calcium chloride and solutions of glucose are given intravenously. To prevent pyrogenic reactions in patients with severe anaemia, washed and frozen red blood cells should be transfused.

Allergic reactions because of the recipient's body being sensitive to immunoglobulins occur mostly in repeated transfusions. Clinical manifestations of anaphylaxis include rigors, fever, malaise, urticaria, dyspnoea, suffocation, nausea, vomiting. Antihistamines and desensitising agents (dimedrol, suprastin, calcium chloride, corticosteroids) are used, in case of vascular insufficiency vasopressors are administered.

Complications of blood transfusion. If blood incompatible mainly by the ABO group and Rh systems is transfused, the patient develops blood transfusion shock resulting from rapid intravascular haemolysis of the transfused blood. The main reasons of incompatibility of blood are technical errors.

The three degrees of shock are identified: degee 1 - a fall in systolic blood pressure to 90 mm Hg, degee 2 - a fall in systolic blood pressure to 80-70 mm Hg, degee 3 - a fall in systolic blood pressure below than 70 mm Hg.

The following periods are identified in the course of blood transfusion shock:

1) blood transfusion shock per se;

2) oliguria and anuria;

3) restoration of diuresis;

4) recovery.

Clinical symptoms and signs of shock can occur at the beginning of the procedure following transfusion of only 10-30 ml of blood, at the end of transfusion or immediately after transfusion. These usually involve restlessness, pain and a sensation of retrosternal uneasiness, lumbar or muscle pain, and sometimes rigors; the patient is dyspnoeic, tachycardic and hypotensive, his/her face being hyperaemic, sometimes pale or cyanotic. The may also experience nausea, vomiting, enuresis or even encopresis. Fulminant development of these manifestations may be fatal.

If incompatible, blood is transfused to a surgical patient under general anaesthesia during operation these signs of shock may manifest mildly, if at all. In such cases incompatibility is identified by the increase or decrease in blood pressure, cyanosis of the skin and visible mucus layer, an increase sometimes very pronounced bleeding tendencies of tissues in the operation wound. When the patient recovers consciousness, they may have tachycardia, hypotension, and acute respiratory arrest.

Clinical manifestations of blood transfusion shock after transfusing Rh incompatible blood occur after 30-40 minutes, and occasionally several hours after transfusion.

During recovery from blood transfusion shock, they can develop acute renal failure. Oliguria, hyposthenuria and progressing uraemia may be evident in the first few days. Progression of acute renal failure can lead to a cessation of urine production, or *anuria*. The levels of products of protein degradation, urea and bilirubin start to increase in the blood. In severe cases the period can last for 8-30 days. In favourable situations, the signs of renal failure subside, diuresis is gradually restored and the patient enters the recovery period. If uraemia sets in, death usually occurs within 3-15 days.

With the early signs of blood transfusion shock, transfusion must be stopped and intensive therapy started.

1. Cardiovascular agents like strophanthin, corglucon (in cardiovascular failure), norepinephrine (in hypotension), dimedrol, suprastin or diprazin are used as antihistamines, corticosteroids (50-150 mg of prednisolone or 250 mg of hydrocortisone) are given to stimulate vascular tone and inhibit the antigen - antibody reaction.

2. To accelerate the restoration of circulation rheopolyglukin and saline solutions are given.

3. To remove the products of haemolysis hydrocarbonate and sodium lactate are given.

4. To support diuresis haemodes, lasix and mannitol are given.

5. To reduce spasm of the renal vessels an emergency bilateral paranephric novocain (procaine) blockage is done.

6. Oxygen therapy is given and in respiratory failure artificial ventilation of the lung is provided.

7. Ineffective drug therapy of acute renal failure and progressing uraemia is an indication for haemodialysis or haemabsorption.

Bacterial - toxic shock only rarely occurs. It is caused by contamination of the blood during its preparation or storage. Complications occur either during transfusion or within 30-60 minutes. Rigors occur suddenly, fever, anxiety, semi-consciousness, fast and thready pulse, marked hypotension, enuresis and encopresis.

Bacteriological investigation of the blood left after transfusion plays a major role in confirmation of the diagnosis.

Treatment is by means of immediate antishock transfusion, detoxication and antibacterial substances, analgesic and vasoconstrictors (norepinephrine), solutions with rheologic and desintoxicating properties (rheopolyglukin, haemodes), electrolyte solutions, anticoagulants, broad-spectrum antibiotics (aminoglycosides, cephalosporins).

Most effective is the complex therapy with exchange blood transfusion.

Air embolism. This may be due to defective of transfusion techniques, namely incorrect filling of the blood giving system which results in air having been left in the tubes, when transfusion under pressure is not duly stopped. In such situations air can enter the patient's vein, reach the right cardiac chambers and obstruct the pulmonary artery and its branches. Air embolism may result from an instant entry of as much as 2-3 cm^3 to the vein. Clinical signs of air embolism of the pulmonary artery are severe chest pain, dyspnoea, cough, cyanosis of the upper trunk, fast weak pulse and hypotension. The outcome is often unfavourable. With the early signs of embolism, transfusion must be stopped and resuscitation started: artificial ventilation, cardiovascular drug therapy.

Thromboembolism secondary to blood transfusion results from migration of a vein thrombus. The clinical features of this complication are similar to those of air embolism. Small thrombi obstruct smaller branches of the pulmonary artery causing lung infarction, whose clinical signs being as follows: chest pain, cough (progressing from being dry to that with bloody sputum), fever. Chest x-rays show signs of focal pneumonia.

With the early signs of thromboembolism transfusion must be stopped and cardiovascular drugs, oxygen, fibrinolysin, streptokinase and heparin given.

Transfusing an amount of donor's blood above 40-50% of the circulating blood volume (i.e. about 2-3 l) within a short period (up to 24 hours) is referred to as *massive blood transfusion.* In transfusing such an amount of blood (especially after long storage) from different donors there is a risk of*massive blood transfusion syndrome*. The factors that contribute to its development are as follows:

- exposure of blood to cold (refrigerator);
- administration of excessive amounts of sodium citrate and products of blood decay (e.g. potassium, ammonia), which accumulate in plasma during its storage;
- administration of excessive amounts of fluid that enters the blood stream and overloads the cardiovascular system.

Acute cardiac dilation of the heart results from large amounts of preserved blood being infused rapidly or under pressure. The clinical picture includes dyspnoea, cyanosis, right hypochondriac pain , fast weak arrhythmic pulse, arterial hypotension with venous hypertension. When there are signs of cardiac overload, transfusion should be stopped, cardiac drugs (strophanthin, corglucon) as well as vasoconstrictors and 10 ml of 10% calcium chloride is given. Massive transfusion may cause *citrate intoxication.* The toxic dose of sodium citrate is considered to be as much as 0,3 g/kg. Sodium citrate interacts with calcium ions in the recipient's blood and causes hypocalcaemia, which, combined with accumulation of citrate in the blood, leads to severe intoxication. The signs of the latter are as follows: tremor, twitching, fast pulse, hypotension, arrhythmia. In severe cases dilation of the pupils, cerebral and pulmonary oedema can be evident. To prevent citrate intoxication, it is required that following transfusion of each 500 ml of preserved blood 5 ml of 10% calcium chloride be given. To neutralise sodium, citrate solutions of calcium gluconate and calcium chloride are administered.

The transfusion of blood that has been stored for a long period (more than 10 days) can be followed by severe potassium intoxication that leads to ventricular fibrillations and further to

cardiac arrest. Clinically, hyperkalaemia involves bradycardia, arrhythmia, myocardial atony. Prevention of potassium intoxication consists in transfusion of blood that has been stored for a short time (maximum 3-5 days) or the use of washed and frozen red blood cells. As a therapeutic measure, 10% calcium chloride, normal saline, 40% glucose with insulin as well as cardiac preparations are given. In massive blood transfusions when compatible blood of the same group and Rh, obtained from different donors is transfused, individual incompatibility of plasma proteins can cause the development of a serious complication known as *homological blood syndrome*. Clinical signs of the syndrome include skin pallor with bluish discoloration, dyspnoea, anxiety, cool skin on touch, fast and weak pulse, arterial hypotension with venous hypertension. Multiple rhonchi are audible on auscultation of the lungs. Haematocrit falls and the circulating blood volume dramatically decreases, although sufficient blood has already been transfused; the blood clotting time slows down. A microcirculatory defect, red cell stasis, microthrombosis and deposition of blood all contribute to the pathogenesis of this syndrome.

Prevention of the syndrome of homological blood involves replacement of blood loss depending on the circulating blood volume and its components. It is important to combine donor's blood with anti-shock solutions (polyglukin, rheopolyglukin) that improve the rheologic properties of blood (fluidity) because of dilution of blood, reduction of its viscosity and acceleration of microcirculation. In massive transfusion it is not necessary to fully replace the concentration of haemoglobin. To maintain the transport function of blood haemoglobin blood levels of at least 75-80 g/l will suffice. To replace the deficit in the circulating blood volume, solutions must be used. Of great importance in prevention of the syndrome of homological blood is autotransfusion of blood and plasma, i.e. the transfusion of absolutely compatible transfusion solutions as well as washed and frozen red blood cells.

Infectious complications. These include acute infections (e.g. influenza, measles, typhoid, brucellosis, toxoplasmosis) and diseases that are transmitted through serum (e.g. hepatitis B, C, HIV, cytomegalovirus infection, malaria). Prevention of such complications involves thorough choice of donors, education of donors, proper management of the blood banks' and blood stations' work.

TESTS

Chapter V. BLOOD TRANSFUSION

1. Which blood component contains agglutinin?

A. Serum.

B. White blood cells.

C. Red blood cells.

D. Platelets.

E. Monocytes.

Choose the correct answer.

2. Agglutinogens are contained in one of the following blood components:

A. Plasma.

B. Serum.

C. White blood cells.

D. Red blood cells.

E. Platelets.

Choose the correct answer.

3. During blood grouping, the reaction of agglutination appeared positive with standard sera of groups 0 and B and negative with the one of A group. The blood examined is therefore of which of the following groups:

A. 0.

B. A.

C. B.

D. AB.

Choose the correct answer.

4. During blood grouping, the reaction of agglutination appeared positive with standard sera of groups 0 and A and negative with the one of B group. The blood examined is therefore of which of the following groups:

A. 0.

B. A.

C. B.

D. AB.

Choose the correct answer.

5. During blood grouping, the reaction of agglutination appeared positive with standard sera of groups A and B and negative with those of 0 and AB groups. The blood examined is therefore of which of the following groups:

A. 0.

B. A.

C. B.

D. AB.

E. Inadequate standard sera.

Choose the correct answer.

6. During blood grouping with cyliclones, the reaction of agglutination is negative with anti A- and B- cyliclones. The blood under examination is therefore of group:

A. 0.

B. A.

C. B.

D. AB.

Choose the correct answer.

7. Agglutination is positive with anti A- cyliclones and negative with anti B- ones. The blood under examined is therefore of group:

A. 0.

B. A.

C. B.

D. AB.

Choose the correct answer.

8. Agglutination is observed with anti A- and anti B- cyli-clones. The blood under examination is therefore of group:

A. 0.

B. A.

C. B.

D. AB.

Choose the correct answer.

9. Agglutination has occurred with anti B-cyliclones. The blood under examination is therefore of group:

A. 0.

B. A.

C. B.

D. AB.

Choose the correct answer.

10. During blood grouping with cyliclones, monitoring the reaction of agglutination should last for:

A. 3-5 seconds.

B. 20-30 seconds.

C. 1 minute.

D. 2 minutes.

E. 2,5 minutes.

Choose the correct answer.

11. Testing for individual blood compatibility requires:

A. The patient's plasma or serum and donor blood.

B. Donor plasma and the patient's blood.

C. The patient's blood components and donor blood.

D. Donor blood components and the patient's blood.

E. Donor blood and the patient's blood.

Choose the correct answer.

12. In which of the following conditions is blood transfusion indicated:

1. The patient's allergic condition.

2. Shock.

3. Hepatic or renal insufficiency.

4. Blood loss.

5. Vitamin deficiency.

Choose the right combination of answers:

A. 1, 2. B. 1, 3. C. 2, 3. D. 2, 4. E. 4, 5.

13. The signs of transfusion of inappropriate blood are as follows:

1. An increase in the packed cell volume or haematocrit.

2. Rigors.

3. Fever.

4. Lumbar pain.

5. Tachycardia.

Choose the right combination of answers:

A. 1, 2, 3, 4. B. 2, 3, 4. C. 1, 3, 4, 5. D. 2, 4, 5. E. 2, 3, 4, 5.

14. The sites of intraosseous blood transfusion are as follows:

1. The iliac crest.

2. The femoral diaphyses.

3. The calcaneus.

4. The sternum.

5. The tibial metaphyses.

Choose the right combination of answers:

A. 1, 2, 3. B. 2, 3, 4. C. 1, 3, 4. D. 1, 3, 5. E. 1, 2, 5.

15. The indications for blood transfusion are as follows:

1. Acute blood loss.

2. Suppurative intoxication.

3. Acute thrombophlebitis.

4. Acute tuberculosis.

5. Shock.

Choose the right combination of answers:

A. 1, 2, 5. B. 2, 3, 5. C. 3, 4, 5. D. 2, 4, 5. E. 1, 3, 5.

16. The optimal temperature of blood storage is one of the following:

A. 0 +1 °C.

B. +4-+6 °C.

C. +8-+10 °C.

D. -1 °C.

E. -2 °C.

Choose the correct answer.

17. The blood lost in which of the following conditions is suitable for reinfusion?

1. Tubal pregnancy.

2. Rupture of the intestine.

3. Rupture of the spleen.

4. Rupture of aortic aneurysm.

5. Rupture of the gall bladder.

Choose the right combination of answers:

A. 1, 2, 3. B. 2, 3, 5. C. 3, 4, 5. D. 1, 3, 4. E. 1, 5.

18. The indications for intra-arterial blood transfusion include which of the following:

1. Sever shock.

2. Preagonal condition as a result of acute blood loss.

3. Clinical death.

4. Preoperative assessment.

5. Surgical operation.

Choose the right combination of answers:

A. 1, 2, 3, 4. B. 1, 3, 4. C. 1, 2, 4. D. 1, 2, 3. E. 1, 2, 3, 4, 5.

19. The patient with trauma (brain injury plus hip fracture) has degree III traumatic shock (BP-70/40 mm Hg, pulse - 120/min). The intensive therapy before hospitalization includes:

1. Blood transfusion.

2. Immobilization of the lower limb.

3. Nutritional support (polyglucin, rhepolyglukin, gelatinol).

4. Anaesthesia with non-narcotic anaesthetics.

5. Administration of vasoconstrictors to raise blood pressure.

Choose the right combination of answers:

A. 1, 2, 3, 4, 5. B. 1, 2, 4. C. 2, 3, 4, 5. D. 2, 4, 5. E. 1, 4, 5.

20. The clinical manifestations of blood transfusion shock are as follows:

1. Abdominal pain.

2. Tachycardia.

3. Bradycardia.

4. Hypotension.

5. Lumbar pain.

Choose the right combination of answers:

A. 1, 2, 3. B. 2, 4. C. 3, 4, 5. D. 2, 4, 5. E. 1, 3, 4, 5.

21. To prevent citrate intoxication during stored blood transfusion, it is necessary to administer:

A. 500 ml of stored blood.

B. Potassium chloride.

C. Antihistamine agent.

D. Calcium chloride.

E. Sodium bicarbonate.

Choose the correct answer.

22. The sources of blood and blood products are as follows:

1. Donor blood.

2. Autologous blood.

3. Animal blood.

4. Cadaver blood.

5. Placental blood.

Choose the right combination of answers:

A. 1, 2, 3. B. 2, 4, 5. C. 2, 3, 5. D. 1, 2, 4, 5. E. 1,

2, 3, 4, 5.

23. Blood transfusion shock requires the following steps to take:

1. To increase the rate of blood transfusion and quickly complete the transfusion.

2. To begin administration of polyglucin.

3. To provide oxygen inhalation.

4. To perform paranephric block by A. V. Vishnevsky.

5. To quit blood transfusion.

Choose the right combination of answers:

A. 1, 2, 3. B. 2, 3, 4, 5. C. 1, 2, 3, 4. D. 1, 2, 4. E. 1, 3, 4.

24. The reaction most common in patients under anaesthesia during blood transfusion is one of the following:

A. Blood transfusion shock.

B. Increased tissue bleeding.

C. Quincke's disease.

D. Acute hepatic failure.

E. Rigors.

Choose the correct answer.

25. The contraindications for blood reinfusion are as follows:

1. Haemothorax with injury of the major bronchi.

2. Haemoperitoneum with injury of the stomach and intestine.

3. Haemoperitoneum due to a malignant tumour.

4. Blood having been in the abdominal cavity more than 24 hours.

5. Ruptured ectopic pregnancy.

Choose the right combination of answers:

A. 1, 2, 3, 4. B. 2, 3, 4, 5. C. 2, 4, 5. D. 1, 2, 4, 5.

26. The complications due to rhesus incompatibility may occur under the following conditions:

1. Repeated transfusion of Rh positive blood to a Rh negative recipient.

2. Pregnancy of a Rh negative woman with a Rh positive foetus.

3. Transfusion of Rh negative blood to a Rh positive recipient.

4. Pregnancy of a Rh positive women with a Rh negative foetus.

5. Transfusion of a Rh positive donor's plasma to Rh a negative recipient.

Choose the right combination of answers:

A. 1, 3, 4, 5. B. 1, 2. C. 2, 3, 5. D. 2, 4, 5. E. 2, 3, 4, 5.

27. Haemodilution is one of the following:

A. Direct blood transfusion.

B. Blood dilution.

C. Autologous plasma transfusion.

D. Autologous blood transfusion.

E. Exchanging blood transfusion.

Choose the correct answer.

Chapter VI. BLOOD COMPONENTS, BLOOD PRODUCTS AND NUTRITIONAL SUPPORT

Most blood collected from donors is processed as follows:

• Blood components (e.g. red blood cell and platelet concentrates; fresh frozen plasma [FFP]; cryoprecipitate) are prepared from a *single* donation of blood by simple separation methods such as centrifugation and are transfused without processing

• Blood products (e. g. coagulation factor concentrates; albumin and immunoglobulin solutions) are produced by complex processes using the plasma from *many* donors as the starting material.

In most circumstances it is preferable to transfuse only the blood component or product required by the patient *(component therapy)* rather than use whole blood. This is the most effective way of applying donor blood, which is a scarce resource. Besides, it reduces the risk of complications from transfusion of unnecessary components of the blood. *Packed red blood cells (red blood cell suspension)*Under absolutely sterile conditions some 200-250 ml of plasma are removed from whole blood to be frozen as FFP or to be further processed (preferably packed by centrifuging). Packed red cells obtained in this way must be used promptly. Devoid of white blood cells («leuco-poor») these are associated with reduced incidence of febrile reactions following transfusion

Red blood cell concentrates Virtually all the plasma is removed and replaced by approximately 100 ml of an *optimal additive solution*, such as SAG-M which contains sodium chloride, adenine, glucose and mannitol. The packed cell volume (PCV) is about 0,65 l/l, but the viscosity is low as there are no plasma proteins in the additive solution which allows fast administration whenever necessary. *Buffy coat-depleted red cell concentrates* These are prepared by removal of the buffy coat, which contains most of the leucocytes and platelets. They are useful in preventing febrile reactions in patients with a previous history of reactions and in those likely to receive multiple transfusions (e.g. patients with haematological diseases). *Leucocyte-depleted red cell concentrates* These are usually produced by filtration and indicated for prevention of alloimmunization to leucocyte antigens (e.g. in aplastic anaemia patients who are potential recipients of allogenic bone marrow transplants).

The source of human whole blood and its components is not unlimited. Due to more and more operations being performed these days and using devices as heart-lung bypass or an artificial kidney that require large amounts of blood, the issue becomes as ever vital. Neither blood obtained from dead people (cadaver's blood) nor blood products have been able to fully meet the needs of transfusiology.

The advances of chemistry, particularly those of enzymology, allow the production of heteroproteins, polysaccharides and synthetic products from raw materials available.

Solutions for parenteral infusion. These are physically homogenous transfusion solutions that have specific properties and act on the body to make up for specific functions of blood. A formulation of different blood products or their use in specific succession can give a complex effect on the body.

Solutions for parenteral infusion must comply with the following requirements:

1. Have physical and chemical properties similar to those of blood plasma.

2. Be able to be fully excreted from the body or fully metabolised by the bodily enzymes.

3. Be unable to sensitise the patient's body on repeated transfusions.

4. Be non-toxic.

5. Be able to withstand the exposure to high temperatures on sterilisation and maintain their physical, chemical, and biological properties for a long period.

Liquid supplements for nutritional support may be classified under the following types:

1) colloid solutions:

• dextran (polyglucin, reopolyglucin);

• gelatin products (poliglucan, gelatinol);

• solutions of polyvinylpirolidon;

2) saline solutions:

• isotonic saline (0,9%);

• Ringer's solution;

• lactasol;

3) buffer solutions:

• sodium bicarbonate;

• trisamine;

4) solutions of sugar and polyvalent alcohols (glucose, sorbitol, fructose);

5) protein products (protein hydrolysate, amino acid solutions);

6) fatty products - fat emulsions (lipofundin, intralipid).

The solutions for parenteral infusion are indicated for shock, intoxication, parenteral nutrition and acid-base and electrolyte disorders (see *Classification).*

Classification of solutions for transfusion (based on indications)

I. Anti-shock solutions:

• low molecular dextrans - rheopolyglucin, rheogluman, lomodex;

• moderate molecular dextrans - polyglucin, polypher, macrodex;

• products of gelatin - gelatinol;

• products based on hidroxyethye starch - plasmosteryl, oxyamal, volecam.

II. Detoxicating solutions:

1. Low molecular polyvinylpirobidon - haemodes.

2. Low molecular polyvinic acid - polides.

III. Parenteral nutrition solutions:

1. Amino acid solutions - polyamine, maryamine, friamine.

2. Protein hydrolysates - hydrolysates of casein, amino peptide, aminocrovine, aminosol, hydrolysin.

3. Fatty emulsions - intralipid, lipofundin.

4. Sugars and polyvalent alcohols - glucose, sorbitol, fructose.

IV. Regulators of acid-base balance

1. Saline solutions - normal saline, ringer's solution, lactasol, sodium bicarbonate solutions, trisamine solutions.

V. Oxygen transferring solutions

6.1 ANTISHOCK SOLUTIONS

High molecular solutions are able to increase the circulating blood volume and therefore restore normal blood pressure. They can also stay in the blood stream over a long period and draw fluid from the intercellular space. These properties are important in shock. Low molecular blood products enhance capillary perfusion, have a shorter $T_{1/2}$, and are eliminated from the body by the kidneys. These properties are used in the management of capillary perfusion insufficiency, dehydration, and detoxication, in which case toxins are rapidly eliminated through the kidneys.

Polyglucin. This is a colloid solution of the fractions of dextran *(polyanhydroglucose)*, - a glucose polymer, produced by the action of certain bacteria on polysaccharides, of moderate molecular weight (MW - 6,0000±1,0000). This makes it similar to plasma albumin which maintains normal osmotic pressure in human blood. The product contains dextran 6% in normal saline, with pH being within the range of 4,5-6,5. It is stored in sterile 400 ml bottles at -10° ...+ 20 °C for 5 years. After thawing therapeutic effects of the product are restored.

Polyglucin elevates and maintains circulating blood volume by attracting fluid from the intercellular space into the bloodstream through its colloid properties. Following infusion of polyglucan an increase in blood plasma volume exceeds the volume of the solution infused. The product circulates in the blood for 3-4 days ($T_1/_2$ 24 hours).

Circulatory characteristics of polyglucin surpass those of other products. Owing to its osmotic properties polyglucin restores arterial and venous blood pressures and improves blood circulation. Polyglucin contains up to 20% of low molecular fractions of dextran, which is able to stimulate diuresis and thus contributes to elimination of toxic products from the body. Indications for the use of polyglucin are as follows:

1. Shock (traumatic, surgical in severe burns).

2. Acute haemorrhage.

3. Acute circulatory failure resulting from severe intoxication (e.g. peritonitis, sepsis, intestinal obstruction).

4. Circulatory failure (for exchange blood transfusion).

This product is contraindicated for head injury, increased intracranial pressure or intractable internal bleeding.

Stat dose (given once) of the product usually ranges from 400-1,200 ml; it can, however, if necessary, be increased to as much as 2,000 ml. Polyglucan is given intravenously (IV) in drops or as a bolus depending on the patient's condition. In emergency, it is initially given as a bolus, and subsequently, i.e. after the blood pressure has increased, the infusion is continued in drops at a rate of 60-70 drops/minute.

Rheopolyglucin. This is 10% low molecular (MW-35,000) dextran in normal saline. Rheopolyglucin is able to raise the blood circulating volume, each 20 ml of the solution bind an extra 10-15 ml of water from the interstitial fluid. Counteracting aggregation of red blood cells (RBCs) the product inhibits stasis, reduces blood viscosity and increases blood flow. It therefore improves rheologic properties of blood and microcirculation. Thanks to its diuretic potency rheopolyglucan is preferably used in intoxication. The product is eliminated from the body within 2-3 days, but it is mostly excreted through the urine within the first 24 hours. Indications for use are similar to those of other circulatory blood solutions. However, rheopolyglucan can also be used for prevention and treatment of thrombosis, post-transfusion complications as well as prevention of acute renal failure. The average dose of the product is 500-750 ml. It is contraindicated in chronic renal failure.

Gelatinol 8%. This is partially hydrolysed gelatin in normal saline. MW of the product is 20,000. Owing to its osmotic properties gelatinol increases blood circulating volume. Due to its

rheologic effects it improves blood viscosity hence microcirculation. The product lacks nutritional value and is eliminated within a day via the kidneys, and only 20% of gelatinol may be found in the blood in 2 hours after the infusion. It may be given IV, intra-arterially, in drops or as a bolus. Gelatinol is used for artificial blood circulation. The total dose is 2,000 ml. Acute or chronic nephritis is a relative contraindication for the use of the product .

Emergent transfusion therapy (e.g. in shock, acute haemorrhage, acute circulatory insufficiency) is to be initiated with the solutions that can rapidly restore circulating blood volume. The use of donor blood implies the delay in transfusion as it takes about 20-30 minutes to perform blood typing (ABO grouping and Rh typing, compatibility testing). In its ability to restore circulating blood volume donor blood is not superior to colloid plasma products. Moreover, in shock and severe deficit in circulating blood volume, donor's blood transfusion may contribute to impairment of microcirculation that results from blood hyperviscosity, sloughing blood cells and microthrombosis. Thus in shock and haemorrhage, transfusion therapy should be started with infusion of antishock products - polyglucin or rheopolyglucin.

Chemically, plasmosteryl, volex (as well as Russian made products - volecam, oxyamal) are related to glycogen. These are solutions of hydroxyethye starch, which is broken down by amylase in the blood. They have osmotic properties and potent circulatory effect.

6.2 BLOOD PRODUCTS WITH DETOXICATING PROPERTIES

Haemodes 6%. This is low molecular polyvinyl piroeidon in a balanced solution of electrolytes. It is available in 100, 200 or 400 ml bottles and is stored at 0 - +20 °C for 5 years. Haemodes exhibits good absorbing properties: upon binding to toxins circulating in blood, including those of bacteria, it partially deactivates them with subsequent fast renal elimination: up to 80% of the product is excreted within 4-6 hours. Also, haemodes may clear up capillary RBC stasis, which is not uncommon in intoxication. Improved capillary perfusion helps eliminate toxins from tissues. Average stat dose of haemodes is 400 ml with infusion rate of 40-50 drops per minute. The product is indicated for severe pyogenic infections accompanied by fever, purulent peritonitis, intestinal obstruction, sepsis, burns, post-operative and post-traumatic conditions.

Polydes 3%. This is polyvinic low - molecular alcohol in normal saline. It is stored in 100, 200 or 400 ml bottles at i +10 °C. Its mechanism of action and indications are similar to those of haemodes. The dose is usually 250 ml. The product is given twice at the intervals of several hours, infusion rate being 20-40 drops per minute. Both haemodes and polydes are contraindicated for thrombosis and thrombophlebitis due to the risk of embolism.

6.3 PRODUCTS FOR PARENTERAL NUTRITION

A. Protein blood products are used restoration of the nutritional properties of blood. The products are solutions of protein hydrolysates containing essential and non-essential amino acids and low molecular peptides. The latter are fully disintegrated in the liver during transfusion. Casein hydrolysates are obtained from technical casein, while hydrolysin and aminopeptide are extracted from cattle plasma protein. *Aminocrovinum* is prepared from whole donor blood, RBC masses or blood clots, which are the remnants of blood products, as well as placental blood. As whole protein molecules cannot degrade in the liver, whole blood, plasma or serum may not be considered as liquid supplements for nutritional support. Whole blood or its components which contain whole protein molecules can only be used to make up for deficient blood components. If the amino acid complex to be transfused lacks at least a single non-essential amino acid, the synthesis of protein is very unlikely to occur.

Hydrolysate of casein contains 43-59 g of amino acid and simple peptides, 5,5 g of sodium chloride, 0,4 g of potassium chloride, 0,4 g of calcium chloride, 0,005 g of magnesium chloride in 1,000 mL of non-pyrogenic water. It is available in 200 and 400 mL bottles at -10....+ 23 °C for 7 years. The product is easily assimilated by the body (nitrogen utilisation approximates to 80-93%) and does not cause anaphylactic reactions. Small particles of suspension visible during storage normally disappear upon shaking the bottle.

Hydrolysin. The solution contains 43-53 g of amino acids and simple peptides, 20 g of glucose in 1,000 ml of non-pyrogenic water. It is available in 400 ml bottles at 4-20 °C for 5 years. The product does not cause anaphylactic reactions, nor does it sensitise the body, even when used repeatedly.

Aminopeptide 5% contains protein as amino acids and simple peptides. Of the 0,6-0,9% of general nitrogen content, amine nitrogen amounts to 50%. It is available in 200-400 ml and stored at room temperature for 3 years. Prolonged storage may result in formation of flaky sediments, which, however, can dissolve on heating in water at the temperature of 85-100 °C. If the sediments fail to dissolve on heating or if they reoccur on cooling to the room temperature, the product may not be used for parenteral nutrition.

Aminocrovinum comprises both essential and non-essential amino acids and simple peptides, the quantitative contents of which are similar to those in other hydrolysates. In addition, it contains glucose 5%. It is available in 400 ml bottles and stored at 4...20 °C for 3 years. A small amount of sediment that may appear during storage and disappears upon shaking the bottle is permissible. Persisting sedimentation and turbid appearance suggest that the product may not be used.

B. Amino acid formulation consists of a balanced formulation of crystalloid clear amino acids in proportion optimum for nutrition. The product contains all essential amino acids and especially valuable non-essential ones. The products of amino acid formulations are used as follows: polyamine (Russia), frialin (USA), aminofrusin Germany), moriamine (Japan), vamine (Sweden).

Polyamine contains crystals of L-amino acid 8% and D-sorbitol 5% in 100 ml of non-pyrogenic water. It is available in 200-400 ml bottles and is stored at -10...+20 °C for 2 years.

In total parenteral nutrition, the doses of protein blood products are estimated based on the daily protein allowances for each individual (1,0-1,5 g/kg ideal body weight/day), which is equivalent to 1,500-2,000 ml of protein hydrolysates, to 800-1200 ml of an amino acid formulation. In partial parenteral nutrition, the doses range from 700-1,000 and 400-600 ml, respectively (i.e. half as much as that of the full parenteral nutrition). It will be noted that combination of protein products, amino acid solutions, and blood products (e.g. plasma, albumin) should be given based on the patient's total daily allowances for protein and protein contents of transfusion solutions.

Indications

Protein hydrolysates are used as one of the steps of preoperative workup. Various types of diseases (e.g. cancer, pyogenic infections, conditions associated with defective enteral nutrition, such as peptic ulcers, oesophageal or pyloric stenosis) may lead to hypo-/disproteinaemia. Because severe malnutrition increases the postoperative complications as a consequence of infection and poor wound healing, it is essential that patients who require perioperative nutritional support be identified early so that enteral or parenteral nutrition can be instituted. The application of protein hydrolysates and amino acid formulations allows correction of protein malnutrition. Prescription of protein blood products in the postoperative period, particularly after GIT surgeries, helps maintain nitrogen balance which, in turn, yields a more favourable postoperative outcome.

Protein hydrolysates are indicated for pyogenic infections (e.g. peritonitis, pleural empyema, lung abscess, huge phlegmon, osteomyelitis) and in intestinal obstruction, which invariably causes a dramatic decrease in blood protein levels and its loss exudates (e.g. pus) and faeces.

Protein solutions are of great importance in burns as they help compensate for protein loss owing to trauma itself, subsequent loss of plasma, and purulent infections that ensue thereafter.

Usually, protein hydrolysates and amino acid formulations are given intravenously, while occasionally they are administered subcutaneously or through a tube placed into the small intestine during operations on the oesophagus or stomach.

Contraindications involve the following conditions:

1) acute circulatory failure (haemorrhage, shock);

2) acute or subacute renal failures;

3) thrombosis, thrombophlebitis, thromboembolism.

C. Fatty emulsions

Intralipid 10% and 20%. These emulsions of soy oil consist of fatty particles (of 0,1-0,5 mm size). Their caloric concentrations are as high as 1,000 and 2,000 kcal/l.

Lipofundin 20% is a soy oil emulsion that comprises fatty particles (less than 1 mm in size) and caloric concentration of 2,100 kcal/l. Fatty emulsions are primarily indicated for prolonged (3-4 weeks) parenteral nutrition, and also when large amounts of calories in a limited quantity of fluid are required. Fatty emulsions are contraindicated for patients with shock and in early postoperative period, severe liver diseases, fat embolism, thrombophlebitis, thromboembolism, pronounced arteriosclerosis, poorly controlled diabetes mellitus and hyperlipidaemia.

D. Carbohydrate solutions

To make up for the patient's caloric requirements, glucose, fructose and sorbitol are used. Glucose plays a key role in energetic turnover and is available in 5, 10, 20 and 40% solutions. As the kidneys can rapidly eliminate excessive glucose, it is only seldom used alone. It is often given as an energy additive to other products, particularly protein hydrolysates. Alternatively, in glucose metabolic disorders (e.g. diabetes mellitus, stress, shock) fructose and sorbitol are used instead.

Fructose is almost fully metabolised in the liver; the process being independent of insulin. It is available in 10 and 20% solutions.

Sorbitol is a polyvalent alcohol which is utilized after its hepatic breakdown. Its metabolism is independent of insulin, which makes it possible to use it for parenteral nutrition of diabetic patients. It is available in a 5% solution.

The parenteral administration of carbohydrates promotes accumulation of proteins in the body. Their daily allowance is as high as 250 g.

6.4 ELECTROLYTE SOLUTIONS

Balanced parenteral therapy involves infusion of electrolytes to restore and maintain the osmotic pressure in the interstitial space. Electrolyte solutions improve rheologic properties of blood and therefore restore microcirculation. In shock, haemorrhage, severe intoxication, and dehydration water moves from the interstitial space into the vessels, which leads to fluid deficit in the interstitial spaces. Saline solutions with low molecular masses can easily enter the interstitial space, through the capillary walls, to restore the fluid volume. As all saline solutions

escape from circulation, they should be combined with osmotic solutions, which will prolong their half-life in circulation.

Isotonic solution of sodium chloride (normal saline 0,9%). Commercial solution is available in bottles or can be prepared in the pharmacy. In severe fluid loss accompanied by extracellular dehydration at least 2 l of the solution can be given in 24 hours. Normal saline is known to quickly leave circulation; hence its efficacy in shock and haemorrhage is limited. It is used in combination with blood transfusion and antishock products.

Ringer's solution. This product contains sodium chloride (9 g), sodium bicarbonate (0,2 g), calcium chloride (0,2 g), potassium chloride (0,2 g), glucose (1 g), bi-distilled water up to 1,000 ml. The solution has better therapeutic properties than normal saline. It is indicated for shock and haemorrhage and is usually combined with transfusion of blood, plasma, and blood products with circulatory properties.

Lactasol. This product contains sodium chloride (6,2 g), sodium bicarbonate (0,2 g), calcium chloride (0,16 g), potassium chloride (0,3 g), magnesium chloride (0,1 g), sodium lactate (3,36 g), distilled water up to 1,000 mL. Sodium lactate of the solution is converted into sodium bicarbonate in the body. The product, as well as 5-7% sodium bicarbonate and 3% trisamine, helps restore acid-base balance and improve circulation.

6.5 OXYGEN TRANSFERRING AGENTS (OXYGEN CARRIERS)

Products of this group are the derivatives of carbon perfluoride (perfluoric, perfucol) and of soluble haemoglobin. They are called «artificial blood». As yet, their clinical efficacy still remains to be investigated as they possess numerous toxic effects, and their pharmacokinetics, including elimination, has not been elucidated.

6.6 PRINCIPLES OF PARENTERAL NUTRITION

In shock, haemorrhage, surgery and conditions precluding enteral nutrition, transfusion therapy may be necessary. Apart from restoration of circulating blood volume and fluid and electrolyte balance, it meets requirements in energy and nutrients of the patient in stress. Especially is it necessary for postoperative patients when the deficit of nutrients inhibits wound healing and recovery. Caloric deficiency of energetic materials promotes tissue protein breakdown that may be prevented by infusion of hydrolysates and amino acids. All these account for the balanced parenteral nutrition being provided. The baseline requirements are as follows:

- caloric - 25 kcal/kg ideal body weight/d;
- protein - 1-1,5 g/kg ideal body weight/d;
- fat - 1-2 g/kg ideal body weight/d.

The caloric concentrations of materials for parenteral nutrition are as follows:

- 20% Glucose - 800 kcal/l (1 g glucose provides 4 kcal);
- 20% Intralipid - 1,000 kcal/500 ml (1 g lipids yields 9 kcal).

Alcohol can also be used as the source of calories: 1 g of alcohol produces 7 kcal, not more than 50-100 ml of 5-7% ethanol may be given in 24 hours together with other transfusion solutions. Appropriate parenteral nutrition includes infusion of crystalloid solutions, sodium bicarbonate (trisamine), dextran and vitamins in amounts based on the fluid, electrolyte, and acid-base balance of the body. The protein contents of hydrolysates is about 5%, while in blood plasma and serum it is about 7,5-9%.

Lipid emulsions are used to meet caloric requirements of the body. Glucose in normal saline used as a source of energy in parenteral nutrition needs the application of large volumes of the solution, which in high concentrations may cause hyperosmolar coma. Similarly, lipid emulsions as the only source of energy may bring about excessive formation of ketones. This requires that fat emulsions be combined with carbohydrates.

Native protein as that of whole blood, plasma, protein or albumin need not be used for parenteral nutrition since the half-life of proteins is as long as 14-30 days. Protein of blood components is indicated for acute deficit in plasma volume, the proteins contained in solutions for transfusion, those in blood products and those already existing in the blood supply must perform the corresponding functions.

In parenteral nutrition, the total daily volume of liquid supplemented is as high as 2,500-3,000 ml (1,500 ml/m^2 of body surface area + 500 ml for each 1 °C of body temperature above normal), the average caloric concentration of the solutions must be consistent with the liquid volume (ml). The sample regimens of parenteral nutrition with allowance made for daily energy and nutrient requirements can be as follows:

1. 500 ml glucose 20% +50 ml ethyl alcohol 70%+500 ml protein hydrolysates (or amino acid solutions), 500 ml Ringer's solution, and vitamins C, B_1, B_2. The formulation should be infused within 4-5 hours before PM. Whenever necessary, sodium bicarbonate, trisamine and potassium chloride can be added;

2. 500 ml glucose 20% + 500 ml Intralipid 20% + 500 ml protein hydrolysates (or amino acid solutions) + 50-100 ml albumin, protein or blood plasma 20%. The formulation should be infused within 4-5 hours at PM. Whenever necessary, electrolytes or other components can be added.

6.7 NUTRITIONAL THERAPY

Indications for transfusion

Assessment of the patient's status provides the clue for the indications for transfusing *circulatory*solutions and rheopolyglucan, which, apart from its antishock properties, improves defective microcirculation resulting from thrombophlebitis, thromboembolism, and vascular surgery.

Products with *detoxicating properties* are administered for sepsis and intoxication associated with trauma. *Parenteral nutrition* is used when enteral nutrition is a challenge or in hypoproteinaemia (e.g. purulent infections, burns).

During anaesthesia, electrolyte and acid-base imbalances, transfusion of electrolytes (e.g. sodium bicarbonate) and trisamine is indicated.

Contraindications for transfusion

Prior to transfusion, acute liver disease, cardiac failure, thrombosis and embolism have to be ruled out. The transfusion and allergic histories, i.e. data on previous transfusions and their outcome, and on the presence of any allergy, are of vital importance. Protein products are contraindicated in cases with liver failure, acute nephritis, allergies, or active tuberculosis.

Methods of nutritional support

Parenteral feeding mainly calls for intravenous route of administration of nutritional solutions, while in exceptional cases these can be given subcutaneously. Protein hydrolysates can also be given through tubes that are passed intranasally into the intestines following oesophageal or gastric surgeries. The following equipment is necessary for parenteral nutrition:

1) infusion set with a dropper;

2) needle for venipuncture;

3) sterile tray;

4) rubber tourniquet;

5) alcohol for cleansing the injection site as well as the cork of the bottle;

6) sterile gauze swabs;

7) drip stand and ampoules;

8) clamp for regulating the rate of infusion;

9) bilroth's forceps;

10) plaster.

The system for transfusing nutritional solutions should be mounted the same way as the one for blood transfusions or a disposable system can be used. The system is filled with the solution in such a way that all air bubbles are evacuated and the drops can be counted. The infusion technique is similar to that of blood transfusion.

Combination of blood products

This depends on the indications for transfusion therapy such as traumatic shock; sepsis; thermal shock; acute haemorrhage; prolonged starvation in postoperative patients; hypoproteinaemia; fluid, electrolyte, and acid-base disorders; preoperative workup of malnourished patients.

Viability of products

The shelf-life of the product, inappropriate storage (overheating or freezing) and intactness of the bottle all have to be considered. Any change in transparency of the product, turbid appearance and the presence of flakes or sediments all preclude its use for transfusion. Only the presence of small particles in amino-peptides or casein hydrolysates can be neglected.

Technique of transfusion

The system for transfusing nutritional solutions should be mounted the same way as the one for blood transfusions. After cleansing the injection site and venipuncture inject 20-25 ml of 0,5% Novocain using a syringe, then connect the infusion set to the needle and start transfusion in drops. The stat dose for subcutaneous infusions should not exceed 500 ml. The subcutaneous infusion is used very rarely, since it is hardly ever efficacious: the absorption of protein is very low, and in shock it fails to duly replete the circulating blood volume.

The biologic testing

This is a prerequisite when using protein hydrolysates, fatty emulsions and Polyglucin. Biological testing involves infusion of 5, 10, 15 ml of the product at 3 minute intervals and if no reactions (e.g. agitation, tachycardia, difficulty in breathing, skin itching, facial hyperaemia, skin rash, hypotension) are visible, the transfusion can then be continued.

When transfusing fat emulsions a prolonged biological test is done: the product is given at the rate of 10-20 drops/minute in the first 10 minute, in the absence of reactions the transfusion is continued at a rate of 20-30 drops/minute.

Infusing Polyglucin after giving the first 10 and the next 30 drops transfusion is suspended for 3 minutes and if no reactions occur it is then resumed.

The rate of administration

In emergency, antishock products are initially given rapidly with a subsequent shift to a rate of 60-70 drops/minute.

Conversely, detoxicating products and electrolytes are given at a rate of 40-50 drops/minute.

Twenty drops of protein products/minute is the rate which provides 85 per cent hepatic assimilation of amine nitrogen, septic or toxic reactions being not encountered. In contrast, when protein products are administered at a rate of 40-60 drops/minute, the liver is only able to assimilate 73% of nitrogen, and in most instances the complications occur. At a rate of100 drops/minute 22% of nitrogen is absorbed, and the complications are almost inevitable. The

preferred rate of infusion of protein hydrolysates and amino acid solutions is therefore 20-40 drops/minute.

Monitoring the patient

Parenteral feeding requires close clinical monitoring the patient (general condition, his/her sensations, behaviour, skin colour, pulse and breathing rates). At the first suspicion of any serious transfusion reaction (e.g. restlessness, headache, facial hyperaemia, skin rash, tachycardia and dispnoea), the transfusion should always be stopped, and if the reaction fails to resolve spontaneously, the appropriate drug therapy must be started.

Records of transfusion

Once the transfusion has ended, it has to be registered in the patient's case history or a folder as well as in a special book assigned for that purpose. The recording should include the volume and the type of product given, reactions or complications, if any.

Post-transfusion side effects are rarely encountered. Transfusion of protein hydrolysates and fat emulsions results in 1 - 1,5% rate of side effects, whereas administration of Polyglucin is complicated in 0,1% of cases.

They are classed as allergic, infectious and toxic reactions.

Following transfusion of protein hydrolysates allergic reactions can occur in patients with severe pyogenic infections, burns as a result of auto-sensitization of such patients with allergic conditions. Clinically, these involve cyanosis, suffocation, tachycardia, palpebral oedema, Quincke's oedema, skin rash and itching.

Infectious reactions manifest themselves as fever and rigors, either before or after the end of the transfusion. To prevent such a reaction, use only disposable kits for transfusion and change the system if it is to be used for a long period (more than a day) and always pay attention to the expiring dates on the bottle.

Toxic reactions include headaches, tachycardia, hepatomegaly, waist pains and urinary changes. This reaction is caused by the presence of rotten substances in the protein hydrolysates. It is forbidden to transfuse overdue or non-viable products.

Once the transfusion has been stopped, 10 mL of 10% calcium chloride, antihistamines (dimedrol, suprastin), 20 ml of 40% glucose, 1 ml of 0,2% platiphylline, 1 ml of 1% promedol are given. In hypotensive patients vasoconstrictors and inotropic drugs are given as are crystalloids and corticosteroids.

To prevent complications, follow the rules of transfusion, take the transfusion and allergic histories meticulously, do not exceed the stat and daily doses or the rate of infusion of protein hydrolysates (20-40 drops/minute), perform the biologic test when administering protein products, Polyglucin and fat emulsions. If a reaction is expected, give diprazin, suprastin or dimedrol and calcium chloride within 10-15 minutes prior transfusion.

TESTS

Chapter VI. BLOOD COMPONENTS, BLOOD PRODUCTS AND NUTRITIONAL SUPPORT

1. What preparations may serve as solutions:

1. Isotonic solution of sodium chloride.

2. Hypertonic solution of sodium chloride.

3. Gelatinol.

4. Polyglucin.

5. Lipomyse.

Choose the right combination of answers:

A. 3, 4. B. 2, 5. C. 3, 5. D. 2, 4. E. 1, 3, 4

2. The properties of ideal antishock solutions are as follows:

1. Rapid flow of the fluid from the blood stream.

2. Rapid metabolism.

3. Prolonged retention of fluid in the blood stream.

4. Rapid increase in blood circulatory volume.

5. Changes in chemical characteristics of blood.

Choose the right combination of answers:

A. 1, 2, 4. B. 3, 4. C. 3, 4, 5. D. 1, 2. E. 1, 3, 4, 5.

3. The rheologic effects of rheopolyglucin are as follows:

1. Stimulation of haemopoiesis.

2. Increase in blood coagulation.

3. Restoration of blood circulatory volume.

4. Improvement in rheological properties of blood.

5. Improvement in microcirculation.

Choose the right combination of answers:

A. 1, 2, 4. B. 2, 3, 1. C. 2, 3, 4. D. 3, 4, 5. E. 2, 3, 5

4. The major properties of detoxifiers are as follows:

1. Haemodilution.

2. Change of physical and chemical properties of blood.

3. High absorptive capacity.

4. Acceleration in glomerular filtration rate.

5. Acceleration in hepatic detoxication.

Choose the right combination of answers:

A. 1, 3, 4. B. 2, 3, 4. C. 3, 4. D. 3, 4, 5. E. 3, 5.

5. The solutions used for dehydration are as follows:

1. Lipofundin.

2. 4% solution of sodium bicarbonate.

3. Polyglucin.

4. Mannitol.

5. Protein solutions.

Choose the right combination of answers:

A.1, 3, 4. B. 2, 3, 4. C. 3, 4. D. 3, 4, 5. E. 3, 5.

6. The total volume of transfusion in parenteral nutrition is one of the following:

A. 500-1,000 ml.

B. 1,500-2,000 ml.

C. 2,500-3,000 ml.

D. 3,500 ml.

E. More than 3,500 ml.

Choose the correct answer.

7. Transfusion of protein solutions is contraindicated in patients with:

1. Suppurative and inflammatory conditions.

2. Thrombophlebitis.

3. Acute blood loss.

4. Renal failure.

5. Tumours.

Choose the right combination of answers:

A. 1, 2, 5. B. 2, 4. C. 3, 4. D. 2, 3, 4. E. 2, 4, 5.

8. Preparations for parenteral nutrition are combined with glucose:

A. To dilute the main solution.

B. To decrease the risk of anaphylaxis.

C. To boost the energy value of the main solution.

D. To decrease the risk of hypercoagulation.

E. To accelerate assimilation of amino acids.

Choose the correct answer.

9. What is the optimum rate for infusion of detoxifiers:

A. 20 drops/min.

B. 30 drops/min.

C. 40-50 drops/min.

D. 60 drops/min.

Choose the correct answer.

10. What is the optimum rate for infusion of protein blood solutions?

A. 20 drops/min.

B. 20-40 drops/min.

C. 50-60 drops/min.

D. 70-80 drops/min.

E. At least 100 drops/min.

Choose the correct answer.

11. The signs of excessive volume of transfusion are as follows:

1. Shortness of breath.

2. Engorgement of the cervical veins due to raised JVP.

3. Prominent P_2 on cardiac auscultation.

4. «Moist» bronchi.

5. Right abdominal pain.

Choose the right combination of answers:

A. 1, 2, 4. B. 1, 2, 3. C. 2, 4, 5. D. 1, 3, 4, 5. E. 1, 2, 3, 4, 5.

Chapter VII. PREOPERATIVE PERIOD

The *preoperative period* encompasses the time between the patient's admission to the hospital and start of the operation.

The duration of the period may vary with a number of factors, such as

- type of disease;
- severity of the patient's condition;
- nature of the surgery.

The main purposes of the preoperative period are as follows:

1) to define the problem (i.e. to make the diagnosis);

2) to identify other conditions that may influence anaesthesia or surgery (i.e. to determine the indications and contra-indications, urgency and type of operation to be performed);

3) to prepare the patient for the operation (to minimise the risk associated with the surgery and that of postoperative complications):

- to evaluate the functions of all body systems (including the operative site) and thus to prevent their deterioration;
- to identify and, whenever necessary, eradicate endogenous infection;
- to prepare the patient psychologically;
- to choose and provide the patient with appropriate anaesthesia.

Depending on the urgency operations are classified as:

1. Emergency operations should be performed either immediately or within several hours after the patient's admission to the surgical unit.

2. Urgent operations are to be undertaken within a few days after admission.

3. Elective operations are those that have been previously scheduled.

DETERMINING THE URGENCY OF SURGERY

The time within which an operation has to be performed varies with indications that fall into the three categories: life-saving, absolute and relative.

Life-saving indications imply that the least delay in performing the operation would result in the patient's death. The following may serve as examples:

1. Sustained bleeding due to

- rupture of internal organs (e.g. the liver, spleen, kidney, uterine tubes in an ectopic pregnancy);
- injury to major vessels;
- gastric and duodenal ulcers.

2. Acute abdominal infections (e.g. acute appendicitis), strangulated hernias, acute intestinal obstruction or thromboembolism (as they can result in pyogenic peritonitis or gangrene in the case of thromboembolism)

3. Pyogenic, or suppurative, infections such as abscess, phlegmon, pyogenic mastitis, acute osteomyelitis, etc. (as they increase the risk of generalised infection, or sepsis).

Absolute indications emerge when the absence or delay of surgery can be lifethreatening. Such operations are performed within a few days or weeks after admission. Among the conditions are malignant tumours, pyloric stenosis, mechanical jaundice, chronic lung abscesses,

etc. Unjustifiable delay in operating can lead to tumour metastases, cachexia, liver failure as well as other complications.

Relative indications such as hernias, superficial varicose veins of the lower extremities, benign tumours usually require scheduled surgeries rather than emergency ones.

When assessing the indications for surgery, possible contra-indications are to be sought: respiratory, cardiac or vascular insufficiency (shock), cardiac infarctions, strokes (cerebrovascular accidents), hepatic failure, thromboembolism, severe metabolic disorders (unstable diabetes mellitus, diabetic ketoacidosis or coma), severe anaemia, marked cachexia. These changes must be evaluated in terms of the extent and risk of the forthcoming surgery.

To accomplish this, a comprehensive evaluation of the patient should be performed. For instance, if the patient has an underlying or concurrent disease, a relevant specialist (internist, neurologist, etc.) should also assess their condition.

In the case of *relative* indications associated with a concurrent condition that increases the hazard of surgery, it is usually delayed to restore the function affected, whereas the preoperative workup in the case of *absolute* indications consists in compensating for the functions involved.

If a life-saving operation is to be performed (i.e. the preoperative period is confined to several hours), the preparation will be completed by a team of specialiststhe surgeon, anaesthesiologist and internist. The joint decision should be made on the extent of operation, method of anaesthesia, drug and infusion therapy to use.

In a critically-ill patient, the *extent of surgery* should be minimal and directed at saving the patient's life (e.g. cholecystostomy rather than cholecystectomy in acute cholecystitis; colostomy in acute intestinal obstruction due to a large bowel tumour, etc).

Similarly, the anaesthetic method is to be chosen on an individual basis, neuroleptanalgesia being commonly preferred. In patients with a respiratory disease, for instance (e.g. bronchial asthma) Halothane is recommended, while in those with cardiac problems it would be more appropriate to apply local anaesthesia with potentiation.

Additional preoperative workup

1. Reviewing data of anamnesis and symptoms helps to find out the clues for further management of the patient. For example, thirst, the amount of fluid and/or blood loss as a result of vomiting and/ or external bleeding should be taken into consideration.

Likewise, of crucial importance are allergic and drug anamnesis (particularly the tolerance of previous intravenous fluids) as well as concurrent hepatic or renal insufficiency (including the character of micturition and urinary volume).

2. Examination of the skin and visible mucous layers aids to reveal cutaneous dryness and collapse of the superficial veins, suggestive of dehydration and circulating blood volume depletion. Besides, acrocyanosis and marble discoloration of the skin are the signs of microcirculatory deficiency and respiratory failure.

3. It is a must to check for the pulse rate and character, arterial blood pressure and central venous pressure in critically-ill patients (which is normally between 50-150 mm of water level); electrocardiography should also be obtained. Moreover, the depth and rate of breathing, dyspnoea are to be assessed, murmurs and abnormal breath sounds being noted on cardiac and pulmonary auscultation, respectively.

To evaluate renal function, daily diuresis (normal, 30-40 ml per hour) and the urinary specific gravity are to be measured.

The assessment of homeostasis requires serial checks of haemoglobin and haematocrit values, as well as acid-base equilibrium, the levels of major ions (K^+, Ca^{2+}, Mg^{2+}, Cl^-),

circulating blood volume and its components. The homeostatic changes occur in different types of surgical conditions (trauma, haemorrhage, surgical infections) and are therefore nonspecific.

In emergency, laboratory investigations should be minimal so as not to delay the operation. After the diagnosis has been made, the routine blood and urine analyses help determine the severity of infections, if any, and the degree of blood loss (based on haemoglobin and haematocrit values), the urinanalysis being also used to assess renal function. If possible, the blood electrolyte levels and circulating blood volume are to be evaluated, as these dictate anticipated intravenous fluid therapy either to detoxicate patients with pyogenic infections or replace blood volume in those with haemorrhage.

Assessment of surgical and anaesthetic risks

As both surgery and anaesthesia pose potential risks to the patient, their objective assessment is very important. It helps determine the indications for surgery and choose the appropriate surgical and anaesthetic techniques, which, in turn, reduces the perioperative risks. To do this, the scoring system is frequently used. When assessing the anaesthetic risk, the *three* aspects should be considered, namely the patient's general condition, the extent and type of the surgery, the anaesthetic technique.

1. The patient's general condition:

a) satisfactory: the otherwise healthy patient- 0,5 points;

b) fair: the patient with a mild systemic disease - 1 point;

c) severe: the patient with severe disease that limits activity but is not incapacitating - 2 points;

d) critical: the patient with an incapacitating disease that is life-threatening - 4 points;

e) terminal: moribund patient not expected to survive 24 hours with or without surgery - 6 points.

2. The extent and type of the surgery:

a) superficial operations and those for mild infections - 0,5 points;

b) more complex superficial operations and the ones on the viscera, spine and peripheral nerves, and vessels - 1 point;

c) prolonged and invasive surgeries on the viscera in traumatology, urology, oncology, and neurosurgery - 1,5 points;

d) cardiac and major vascular surgeries, major operations in oncology, repeated and reconstructive surgeries - 2 points;

e) complex cardiac surgeries using extracorporeal circulation technique (coronary artery bypass, cardiac transplantation) - 2,5 points.

3. The anaesthetic technique:

a) local potentiated anaesthesia - 0,5 points;

b) regional spinal, epidural, intravenous anaesthesia, inhalation mask anaesthesia with spontaneous breathing - 1 point;

c) standard combined endotracheal anaesthesia - 1,5 points;

d) endotracheal anaesthesia combined with artificial hypothermia, controlled hypotension, massive infusion therapy, electric cardiac stimulation - 2 points;

e) endotracheal anaesthesia combined with extracorporeal circulation using a heart-lung machine (e.g. coronary artery bypass), hyperbaric oxygenation, intensive care and resuscitation - 2,5 points.

Further, the risk is assessed based on the sum of points:

- degree 1 (minimal risk) - 1,5 points;
- degree 2 (moderate risk) - from 2 to 3 points;
- degree 3 (high risk) - from 3,5 to 5 points;
- degree 4 (extremely high risk) - from 8,5 to 11 points.

In emergency, the preoperative period is very short (e.g. heart injuries, massive internal bleeding) with the patient being immediately admitted to the operating theatre. Preparation of the patient for elective surgery is started before he/she arrives at the surgical unit.The outpatient surgeon or physician is to promptly determine the preliminary indications for surgery, order the pertinent additional investigations to establish the diagnosis, and psychologically prepare the patient for the impending surgery.

Whatever vital function disorders (e.g. haemorrhage) require that the surgeon start emergent management - control of bleeding and giving vasopressor and/or vasodilator agents. These will be continued during the patient's transportation to the surgical unit and are considered the preoperative care.

Contraindications. The laboratory findings help assess the patient's general condition, reveal concurrent diseases and thus determine the contraindications, if any, for the operation.

The *absolute* contraindications include the following:

- shock (other than that resulting from sustained bleeding);
- acute myocardial infarction;
- stroke.

The *relative* contraindications involve as follows:

- congestive heart failure;
- cardiac arrhythmia;
- ischaemic heart disease;
- respiratory failure;
- bronchial asthma;
- chronic renal failure;
- hepatitis;
- anaemia;
- leukaemia;
- diabetes mellitus.

Assessing the contraindications for the operation the surgeon should take both the indications and the risk degree into consideration. Currently, each situation with absolute indications for surgery can virtually always be resolved.

Psychological preparation for surgery

The surgeon should provide a clear explanation of the planned course of therapy. The patient must be informed of the risks of the proposed treatment, the risks of the underlying disease, and plausible therapeutic methods.

The psychological preparation is mainly aimed at clarifying the necessity and instilling hope for a successful outcome of the surgery. Especially is this necessary when a patient refuses the operation as a result of their incomprehension of the severity of their condition (e.g. acute appendicitis, strangulated hernia, perforated peptic ulcer, intra-abdominal bleeding due to a

rupture of ectopic gestation, or the spleen or liver, penetrating injuries to the abdomen, chest) in which case a delay in surgery can lead to severe peritonitis or pleuritis, blood loss and irreversible consequences.

Physiologic preparation for surgery

Even though an urgent surgery is needed, the existing organ failures should always be corrected prior to, during or following the surgery, otherwise the favourable outcome of the treatment is unlikely.

The preoperative workup should be as short and efficient, in emergency being primarily aimed at reducing hypovolaemia and tissue dehydration. In patients with hypovolaemia, electrolyte and acid-base imbalances, infusion therapy including intravenous solutions of polyglucin, albumin, protein (and sodium bicarbonate in those with acidosis) with cardiovascular agents is immediately to be provided. To correct metabolic acidosis resulting from diabetes mellitus concentrated solutions of glucose with insulin are given.

In acute haemorrhage (and after the bleeding has been controlled) intravenous administration of polyglucin, albumin, and plasma is indicated. In sustained massive bleeding intravenous fluid therapy will be started with cannulas placed at least in two peripheral veins simultaneously while the patient is being transferred to the operating room where he/she is operated on to stop the bleeding. Intravenous fluid therapy is to be continued throughout surgery.

Emergency management of shock (traumatic, toxic or haemorrhagic with the bleeding already controlled) is aimed at:

a) eliminating the shock factor (pain control in traumatic shock; bleeding control in haemorrhage; detoxication therapy in toxic shock);

b) restoration of the circulating blood volume by way of intravenous fluid therapy;

c) restoring vascular tone with vasoconstrictors.

In most cases, surgery can be started with systolic blood pressure of at least 90 mm Hg. In the cases of haemorrhagic shock and sustained internal bleeding the surgery may be started before the patient's circulatory parameters have been corrected as the causative factor of the shock - bleeding - can definitively be controlled only by operating on the patient.

The physiologic preparation for the surgery must include the following:

1. Estimation of the surgical risk associated with the underlying circulatory disorders, diagnosis and management of the preoperative cardiovascular problems (e.g. preparations that improve microcirculation (rheopolyglucin).

2. Prevention and treatment of respiratory distress (oxygen therapy, improvement of pulmonary circulation, and mechanical ventilation in severe cases).

3. Detoxication therapy - fluid infusion, blood substitutes with detoxicating properties, forced diuresis with specific techniques - hemabsorption, lymph absorption, plasmapheresis and oxygen therapy.

4. Correction of fluid, electrolyte, and acid-base disorders.

Intravenous fluid therapy is aimed at restoring the circulating blood volume, eliminating dehydration, and normalising fluid, acid-base and electrolyte balances. Therefore, in hypovolaemia, electrolyte, and acid-base imbalances the abovementioned therapy is a matter of urgency (see Chapter VI).

Also, the preoperative period may require that a number of manipulations be performed. If, for instance, the patient ate the previous day or shows the signs of intestinal obstruction, the stomach is to be lavaged before the operation to prevent vomiting or regurgitation during general anaesthesia.

Stomach lavage. To perform gastric washout the following equipment is needed: a nasogastric tube, funnel, bowl, plastic apron, pair of gloves, a cup and jug with boiled water. The patient's condition permitting, he/she is made to lie (or sometimes sit on a chair); the end of the tube will be lubricated with vaseline and inserted into the patient's throat (they should try to swallow the tube while the physician passes it into the oesophagus). On reaching the first mark on the tube (50 cm) the end appears at the cardiac portion of the stomach. If the stomach is full, the contents start gushing out immediately and are thus to be directed into the bowl. When the spontaneous flow stops, a glass funnel will be attached to the outer end with subsequent aspiration of the gastric contents. To do this, the funnel is raised 20-25 cm above the mouth level and 0,5-1 l of water that passes into the stomach is poured into the funnel. To prevent air from entering the stomach, the water must flow continuously. When all the water in the funnel has been emptied into the stomach, the tube with the funnel still attached is then lowered into the bowl (below the knee and bed levels for the patient sitting and lying, respectively) with the funnel cup in an upward position. After the funnel has been filled up with the gastric contents it is emptied into the bowl or bucket. If the amount of fluid emptied is less than that given, the position of the tube is changed - it can be pushed a little further or pulled back, the funnel being either gently pushed down or pulled out. Thereafter, the contents usually starts to flow out, the procedure being repeated after the gastric contents have stopped flowing. The stomach should be washed until clear water starts flowing out.

When the flow stops, irrigating syringe has to be used - pour with force and aspirate the water, the procedure being repeated several times. As a matter of fact, pieces of food particles that cause obstruction are evacuated in this process; alternatively, the tube can be removed and reinserted.

Finally, the tube is to be removed gently into a napkin placed at the patient's mouth.

Insertion of urethral catheter. The procedure is applied preoperatively to empty the bladder in urinary retention, monitor the urine output during operation and prevent bladder injury during pelvic surgery or laparoscopy.

The equipment required includes a sterile rubber catheter, two sterile forceps, sterile vaseline oil, gauze swabs, furacilin solution 1:5000 or 2% boric acid. All these are to be placed on a sterile tray. The hands are washed with running water and soap, and cleansed with alcohol for 3 minutes.

The *male* patient is put supine with his legs bent in the hip and knee joints and opened apart. The tray or pot for the collection of urine is placed in between the patient's legs. The urethral meatus and the surrounding areas are cleansed thoroughly with gauze swabs dipped into antiseptic. Using the forceps the catheter is picked 2-3 cm from the end and dipped into the sterile vaseline oil. The left hand (between fingers 3 and 4) is used to fix the penis while fingers 1 and 2 to open the outer end of the urethra. Using the forceps, the catheter is inserted into the urethra and subsequently into the bladder. Passing through the isthmus of the urethra the catheter can encounter resistance. Once the catheter is in the bladder, urine should flow freely into the disposable basin provided. The volume, colour and turbidity of the urine are noted. The catheter is removed after the bladder has been completely emptied.

When the bladder cannot be emptied with the soft catheter, a metallic one should be used, which, however, requires much experience for the danger of injuring the urethra.

Passing the catheter in a *female* patient is technically easier since the female urethra is shorter, wider and straighter. It is performed with the woman supine and her legs apart. The patient lies on the bad-pan. Running water is used to wash the perineum, the smaller lips being opened with the left hand fingers. Cotton swabs soaked in antiseptic are used to cleanse the external urethral meatus. With the right hand and forceps the catheter is passed into the urethra. A metallic catheter for women can be used, which is held in such a way that the beak points

upwards. The catheter is easily inserted until urine appears. On emptying the bladder the catheter is removed.

Enema. To perform a cleansing (purgative) enema the following items are necessary: Esmarch's cup with a rubber tube, a tap or clamp, and a glass or plastic tip (end-piece). 1-1,5 l of water are poured into the cup and fills the tube to evacuate all the air, the tube is then closed with the tap or clamped at its end. The tip (end piece) is to be lubricated with vaseline or oil. The patient will be placed on the left side (on the side of the sigmoid colon) to insert the tip into the rectum 10-15 cm deep. The clamp is then removed or the tap opened and the cup gradually raised. After the water has started flowing slowly into the rectum, the end piece is removed and the patient turned to lie supine on a bed pan or receiver (they are made, if possible, to sit on the closet). It is recommended that the water be allowed to stay as long as possible in the rectum before evacuation.

Cleansing («siphon») enema. This type of enema is indicated when ordinary enemas are ineffective in evacuating faeces (intestinal obstruction, faecal impaction). The equipment used for the cleansing enema includes a rubber or plastic tube fitted onto a large glass funnel. The patient should be placed on their left side at the edge of the bed or couch. The funnel will be filled with water, the clamp opened to drive away the air and then closed again to fill up. The tip of the rubber tube is inserted into the rectum 10-12 cm deep, the clamp being removed and the funnel raised to allow the water to flow into the large intestine. 2-3 l of water are usually passed at a time, with constant pouring it into the funnel so as to avoid a break in the flow of water and to prevent air from entering the intestine. When the patient expresses the urge to defaecate the funnel is lowered below the bed level and the water flows out together with the faeces and air. When filled up, the funnel is emptied. Filling with water and evacuating the intestinal contents are repeated several times, using totally 10-15 l of water. Such signs as massive evacuation of the faeces and gases, a relief of pain and reduction in abdominal distension in patients with intestinal obstruction are favourable.

Prevention of endogenous infection. All chronic infections (e.g. tooth decay, tonsillitis, pharyngitis and pyogenic dermatitis) should be sought and treated preoperatively. When the impending surgery has a relative indication, the patient can be discharged to eradicate the infection before admission back to the surgery.

The surgery for a lung abscess involves bronchoscopy to remove, at least initially, inspissated purulent debris. For the patients to be operated on for a large intestinal condition a soft diet, cleansing enema and oral broad-spectrum antibiotics for a few days preoperatively are ordered.

In addition, the patient will be examined by the anaesthetist who prescribes the appropriate anaesthetic technique (see Chapter II).

Preliminary preparation of the operative field. On the day preceding that of the operation a cleansing enema is performed, the patient takes a hygienic bath and changes into clean fresh underwear; immediately before transfer of the patient to the operating theatre the exposure area will be dry-shaved.

The operative field should be prepared differently in case of an ulcer or wound: the dressing is removed and the wound is covered with a sterile dressing, the skin around the wound being cleansed with benzene or ether and the hair dry-shaved. All movements - cleansing the skin or shaving the hair - must be directed outward from the wound so as to reduce the risk of contaminating the wound. On shaving, the dressing should be removed and the surrounding skin cleansed with 5% alcohol solution of iodine, with the wound being covered with sterile dressing. In the theatre the wound is again scrubbed widely with alcohol solution of iodine and isolated with sterile operating sheets.

Anaesthetic technique. Before the patient is taken to the operating theatre he/she is given specific drugs to reduce the risk of adverse effects of anaesthesia and surgery itself, as well as to avoid negative events intra-operatively.

Transferring the patient to the operating theatre.

A patient is usually transferred to the operating theatre on a stretcher. In emergency, providing endotracheal anaesthesia via intubation is continued if the patient has been previously intubated, with simultaneous mechanical pulmonary ventilation.

If the tourniquet has been applied for external bleeding, the patient is taken to the theatre with it, the tourniquet being removed immediately before or during the operation. Similarly, the patients with open fractures are admitted to the operating theatre with the dressing originally placed on the wound as well as the transportation splint intact. The cases with acute intestinal obstruction will be admitted to the theatre with a nasogastric tube.

A surgical patient is gently transferred from the stretcher to the operating table together with the intravenous infusion system, tourniquet or transportation splint, and is positioned as required.

TESTS

Chapter VII. PREOPERATIVE PERIOD

1. Which of the following are specific types of surgery:

1. Microsurgery.

2. Endoscopy.

3. Simultaneous.

4. Diagnostic.

5. Endovascular.

Choose the right combination of answers:

A. 1, 2, 5. B. 1, 2, 3. C. 1, 3, 4, 5. D. 4, 5.

2. Which of the following conditions require urgent surgery?

1. Gastric carcinoma.

2. Perforated gastric ulcer.

3. Acute appendicitis.

4. Malignant pulmonary tumour.

5. Incarcerated inguinal hernia.

6. Lipoma of the shoulder.

Choose the right combination of answers:

A. 2, 3, 5. B. 1, 3, 5. C. 2, 4, 6. D. 2, 3. E. 1, 4.

3. A surgical operation includes the following stages:

1. Surgical approach.

2. Laying the patient down on the operating table.

3. Surgical technique.

4. Arrest of bleeding.

5. Suturing of the wound.

Choose the right combination of answers:

A. 1, 2, 3, 4, 5. B. 1, 2, 3. C. 1, 3, 5. D. 1, 3, 4, 5.

4. Which of the operations should be first on the schedule?

A. Phlebectomy.

B. Pulmonectomy.

C. Resection of the transverse colon.

D. Resection of the small bowel.

E. Application of the secondary sutures.

Choose the correct answer.

5. The male patient is admitted to the surgical department, supposedly with ileus, after 3 days of recurrent vomiting, adynamia, and palpitations. The most significant metabolic and haematological problems that require correction preoperatively are as follows:

1. Hypokalaemia, hypochloraemia.

2. Hyponatraemia, hypocalcaemia.

3. Hypoproteinaemia.

4. Hypovolaemia.

5. Anaemia.

Choose the right combination of answers:

A. 2, 3. B. 1, 2, 5. C. 4, 5. D. 1, 4. E. 1, 2, 3, 4, 5.

6. The aims of the preoperative period include which of the following:

1. Making the definitive diagnosis.

2. Determination of the indications for the surgery.

3. Preparing the patient for the surgery.

4. Determination of the urgency and character of the surgery.

5. Determination of the extent and duration of the surgery.

Choose the right combination of answers:

A. 1, 2, 3. B. 1, 3, 4, 5. C. 2, 3, 4, 5. D. 1, 2, 3, 4. E. 1, 2, 3, 4, 5.

7. The preoperative period begins:

A. At the onset of the disease.

B. The moment the diagnosis has been established.

C. On admission to the surgical department.

D. Once the indications for surgery have been determined.

Choose the correct answer.

8. The major factors of duration of the preoperative period are which of the following:

1. Nature of the disease.

2. Extent of the surgery to be performed.

3. The condition of the patient.

4. The method of anaesthesia used.

5. Urgency of the surgery.

Choose the right combination of answers:

A. 1, 2, 3. B. 2, 3, 4. C. 1, 3, 5. D. 2, 4, 5. E. 2, 3, 5.

9. The aims of the direct preoperative workup include which of the following:

1. To make the definitive diagnosis.

2. To recognise concurrent conditions, if any.

3. To determine the indications for the surgery.

4. To combat endogenous infection, if any.

5. To eliminate hypovolaemia and hypoproteinaemia.

Choose the right combination of answers:

A. 1, 2, 3. B. 2, 3, 4. C. 3, 4, 5. D. 3, 4. E. 4, 5.

10. What immediately precedes the surgery?

1. Standard hygiene of the oral cavity.

2. Shaving of the area to be operated on.

3. Premedication.

4. Blood transfusion.

5. Gastric lavage.

Choose the right combination of answers:

A. 1, 2, 3. B. 2, 3. C. 3, 4. D. 2, 3, 5. E. 1, 3.

11. Which types of enema are used to prepare the patient for intestinal surgery?

A. Hypertonic.

B. Siphon.

C. Cleansing.

Choose the correct answer.

12. In the preoperative period, the prevention of endogenous infection consists in which of the following:

1. Sanation of the oral cavity.

2. Taking a hygienic bath.

3. Scrubbing of the operating field.

4. Change of linen.

5. Treatment of pyoderma.

Choose the right combination of answers:

A. 1, 2, 3, 4. B. 2, 3, 4, 5. C.1, 2, 4, 5. D. 1, 4, 5. E. 1, 2, 3, 4, 5.

13. Which of the following solutions are to be transfused to patients with hypoproteinaemia during the preoperative period?

1. Haemodes.

2. Gelatinol.

3. Hydrolysin.

4. Aminocrovine.

5. Amino acid solution.

Choose the right combination of answers:

A. 1, 2. B. 1, 3. C. 3, 4. D. 2, 4, 5. E. 3, 5.

14. Which of the instrumental methods of investigation yield a more accurate diagnosis in a patient with abdominal problems?

1. GI endoscopy.

2. Laparoscopy.

3. Abdominal X-ray.

4. Abdominal ultrasonography.

5. Abdominal angiography.

6. Colonoscopy.

Choose the right combination of answers:

A. 1, 2, 3, 4. B. 1, 2, 4, 5. C. 1, 2, 3, 5. D. 3, 6. E. 1, 2, 6.

Chapter VIII. POSTOPERATIVE PERIOD

An operation, or a surgery, is a specific mechanic intervention upon a part of the body for diagnosis or treatment.

Surgeries are commonly classified depending on their urgency and the chance of curing the patient.

Depending on the urgency , there are the following types of operations.

1. Urgent, i.e. the ones to be performed immediately or within a few hours following the patient's admission.

2. Emergency, i.e. the ones that should be done within several days after the patient's admission.

3. Scheduled, i.e. the ones performed according to schedule (the date of the operation is not fixed).

Each operation may be either radical or palliative:

1. Radical, i.e. the one intended to extirpate the disease, usually malignant, completely.

2. Palliative, i.e. the one intended to relieve symptoms without hope of cure.

An operation can also be a one-stage or multistage surgery. Each step of a one-stage operation follows the previous one in succession, while a multi-stage operation consists of a series of surgeries performed on different days.

Current methods of anaesthesia and intensive care allow for two or more operations be done simultaneously in the same patient.

Microsurgery requires that the object to operate on be magnified at least 3- to 40-fold, which is achieved with special glasses or a microscope and that special microsurgical instruments and the thinnest sutural strips be used.

Endoscopic (e.g. laparoscopic, thoracoscopic) operations are performed with special devices.

Endovascular operations are closed intravascular interventions done under the X-ray control, e.g. widening a narrowed vessel with a special catheter; removing artificial occlusion of the vessel, or embolization; elimination of intravascular atheromata, etc.

The surgical operation consists of following main steps:

— operative access;

— primary step (operation itself);

— finishing the operation, suture of wound.

All the events associated with the operation itself, including the operation stress and effect of anaesthesia, are referred to as the postoperative period, while the consequences of surgery are called as the postoperative condition, or *«postoperative disease».*

The operation stress caused by the surgery results from various factors such as fear, excitement, pain, the effect of anaesthetics, trauma, wound formation, abstinence from food, being bed-ridden, etc.

The development of a stressful state is promoted by the following factors:

1. The patient's general status before and during the surgery, which depends on the type of disease.

2. The traumatic nature and duration of the surgical manipulation.

3. Inadequate anaesthesia.

In terms of its duration, the postoperative period encompasses the period from the end of the operation up to the patient's complete recovery or his/ her recognition being disabled.

The following stages of the postoperative period are identified:

• *early* postoperative period (from the end of surgery to the time the patient is discharged from hospital);

• *late* postoperative period (from the time the patient is discharged till the time he/she recovered fully or is found disabled).

Both surgery and anaesthesia bring about particular pathological changes in the body, which are the manifestations of the body's response to the surgical trauma. This induces defensive mechanisms to eliminate the consequences of the trauma and therefore restore homeostasis. The surgery affects the balance in the rate of metabolic (anabolic and catabolic) reactions rather than launches new metabolic events. The postoperative state divides into the three phases:

• catabolic phase;

• resolution phase;

• anabolic phase.

The catabolic phase lasts three to seven days. The period tends to be more acute when the serious changes in the body are caused by the severity of the principal condition or the extent and hazards of the surgery itself. The catabolic stage may also be prolonged and worsened if postoperative complications develop. These include the following:

• bleeding;

• pyogenic infections;

• hypovolaemia;

• fluid, electrolyte, and acid-base disorders.

The improper management (e.g. inadequate analgesia or nutritional support, parenteral nutritional support, pulmonary hypoventilation) is known to contribute to prolonged catabolic phase as well.

The catabolic phase is a defensive body reaction aimed at enhancing the resistance of the body by way of prompt transfer of the energetic and plastic materials to the vital organs. It is characterised by specific neuroendocrine reactions: activating the sympathetic nervous system and adrenals, hypothalamus and pituitary, intensive synthesis with subsequent release of

catecholamines, glucocorticoids, aldosterone and ACTH into the blood. This results in an increase in the amount of glycogen in the circulation, accompanied by a fall in insulin blood levels. Furthermore, intensive synthesis of angiotensin and renin occurs. The neurohumoral disturbances alter the vascular tone to cause vascular spasm and defects in microcirculation and tissue perfusion, which, in turn, leads to hypoxia, metabolic acidosis, electrolyte imbalance, fluid redistribution, an increase in blood viscosity and blood cellular stasis. This further affects the extent of disturbance in the tissue redox processes that take place in the acceleration of anaerobic glycolysis as a result of tissue hypoxia. The myocardium, liver and kidneys are therefore the first to be affected.

The catabolic phase also involves accelerated protein breakdown which is manifested by the decrease in muscle and connective tissue protein, and, which is even more important, by the depletion in enzymes. The proteolysis in the liver and digestive tract is the fastest to occur, while that in the striated muscles takes significantly longer to complete. A 24-hour hunger, for example, decreases the amount of liver enzymes by 50%. The total loss of body protein during the postoperative period tends to be considerable. During ten days following uncomplicated stomach resection without parenteral nutritional support, for example, the patient loses 250 to 400 g of protein, which is twice as much as the amount of plasma protein and corresponds to the loss of 1,700 to 2,000 g of muscle weight. The loss of protein appears even greater if bleeding or postoperative purulent complications develop. This inflicts a particular hazard on those patients who have been hypoproteinaemic preoperatively.

The clinical specificities of the catabolic phase in the postoperative period

1. Nervous system.

• As a result of the residual action of the narcotic and sedative substances during the first few days postoperatively, the patient is most likely to be somnolent and indifferent to his/her surroundings.

• From the second day the effect of most anaesthetics begins to cease and pain reactions evolve into unstable psychotic states that can manifest as disorderly behaviour, anxiety or, alternatively, depression. These are mostly due to postoperative complications (e.g. progressive hypoxia and fluid and electrolyte disorders).

2. Cardiovascular system.

The common cardiologic complications are as follows:

• skin pallor;

• 20 to 30% increase in the pulse rate;

• moderate increase in blood pressure;

• muffled heart sounds.

3. Respiratory system.

• Fast shallow breathing with a reduction in vital capacity by 30-50%.

Shallow breathing can result from the pain at the site of operation, an elevation of the diaphragm or limitations in its movement after abdominal surgery or development of paresis of the gastrointestinal tract.

4. Liver and kidneys.

• Progressive dysproteinaemia;

• decrease in the synthesis of enzymes;

• decrease in urinary output as a result of a fall in renal perfusion and a rise in blood aldoster-one and antidiuretic hormone (ADH) levels.

The resolution phase

The resolution phase commonly lasts 4 to 6 days and is a gradual transition from the catabolic phase to anabolic one. This period is characterised by the reduction in the overactivity of the sympathetic nervous system and adrenals, and slowing down catabolism which becomes evident as a decrease in nitrogen urinary excretion to as low as 5-8 g/24 hours (as compared with 15-20 g/24 hours in the catabolic phase). The positive nitrogen balance (the amount of nitrogen excreted is less than the amount given) suggests improvement in protein metabolism. In this period, potassium urinary excretion decreases as the electrolyte starts accumulating to take part in the synthesis of protein and glycogen. The fluid and electrolyte balance is restoring. As far as the autonomous nervous and endocrine systems are concerned, the parasympathetic activity predominates and blood growth hormone (GH) level is rising, as are those of insulin and androgen.

During the resolution phase, the increased waste of energy and plastic materials (protein, fat, carbohydrates) is still, though at a somewhat reduced rate, under way. When this eventually fades away, the active synthesis of protein and glycogen starts with subsequent production of fat, which rises as the intensity of catabolism falls. The persistent predominance of anabolism over catabolism is a sign of the transfer of the postoperative period to the anabolic phase.

The resolution phase occurs 3 to 7 days after the surgery if the postoperative period is uneventful (i.e. without complications). The signs suggestive of the beginning of the resolution stage are generally as follows:

- absence of pain;
- normalisation of body temperature;
- resumption of appetite.

In addition, patients become active, and their body functions restore (the skin colour returns to normal; breathing becomes deep and its rate reduces; the heart rate returns to the preoperative one; peristaltic bowel sounds and flatus passage resume).

The anabolic phase

The anabolic phase is characterised by an increase in the synthesis of protein, glycogen, and fat, which have been depleted during the operation and the postoperative catabolic period. Furthermore, the parasympathetic nervous system tends to be overactive. Similarly, the secretion of anabolic hormones (GH and androgens) increases to allow for the protein synthesis. GH, for instance, is responsible for the transport of amino acids from the intercellular space to the cells, while androgens promote the synthesis of proteins in the liver, kidneys, and myocardium directly. The specific hormonal responses increase the amounts of protein in the blood, organs as well as in the wound site, which accounts for the reparative processes and proliferation and maturation of the connective tissue. During the postoperative anabolic phase the replenishment of the hepatic and muscular glycogen stores occurs, which is mediated by the counter-insulin action of GH.

Clinically, the anabolic phase is, in fact, the period of recovery, restoration of the impaired functions of the cardiac, respiratory, excretory, digestive and nervous systems. In this phase, the patient's general condition improves, appetite increases, the heart beat and rate return to normal as do the blood pressure levels, the digestive functions (food passage, intestinal absorption and spontaneous bowel movements) are restored.

The anabolic phase usually lasts 2-5 weeks, which is dependent on the extent of the surgery, the patient's state preoperatively as well as the severity and duration of the catabolic phase.

This phase of the postoperative period ends with an increase in weight, which occurs after 3-4 weeks and continues till full recovery, which sometimes can take several months. The

restoration of the body weight depends on a number of factors like the extent of weight loss preoperatively (depending on the nature of the condition), the extent of the surgery, postoperative complications, the course and duration of the postoperative catabolic phase. It usually takes 3 to 6 months for the reparative process (i.e. maturation of the connective tissue and formation of the scar) to complete.

Immediately after the operation the patient is transferred either to the ward or intensive care unit which are arranged to monitor the patients and, if needed, to provide them with emergency and intensive care. These units are equipped with gadgets and appliances that constantly record the pulse rate and rhythm, ECG, EEG. The emergency laboratory ensures a prompt monitoring of blood haemoglobin, haematocrit, electrolyte and protein levels, as well as circulating blood volume and acid-base balance. The intensive care unit is also equipped with all that is necessary to provide the emergency aid: medications and transfusion fluids, a mechanical ventilation apparatus, sterile sets for venous injections or infusions and tracheostomy, defibrillator, sterile catheters, tubes, a set for change of dressing.

In the postoperative period, the patient is to be examined thoroughly using the general physical methods (inspection, palpation, percussion, auscultation) and, whenever necessary, laboratory investigations (e.g. ECG, X-ray, EEG). Each patient should be constantly monitored both for psychotic signs (consciousness, behaviour changes such as excitement, depression, delirium, hallucination) and skin condition (pallor, cyanosis, jaundice, dryness and perspiration).

Examining the cardiovascular system, the physician will pay attention to the pulse rate, character and rhythm, as well as blood pressure levels and, if pertinent, those of the central venous pressure; the character of the heart sounds and the presence or absence of murmurs.

The respiratory system is assessed by way of percussion and auscultation: the rate, depth and rhythm of breathing are taken into consideration.

The evaluation of the gastrointestinal tract involves inspection of the tongue (dryness, fur), inspection and palpation of the abdomen (distension, involvement in breathing, signs of peritoneal irritation like the symptom of defence of the abdominal wall muscles or rebound tenderness, the presence of bowel sounds), the liver is palpated for its enlargement and tenderness. The patient is to be asked of the passage of flatus and stools as well.

The examination of the urinary system includes the determination of diurnal urine volume and urine output through the permanent catheter.

The clinical and laboratory findings (haemoglobin level, haematocrit, metabolic indicators, circulating blood volume, blood electrolytes, etc.) should be meticulously scrutinised as this helps determine the type and amount of transfusion fluid as well as prescribe the appropriate drugs.

The patient should be examined on a regular basis as this enables the physician to reveal the early signs of deterioration and therefore duly adjust the current therapy.

All the clinical and laboratory findings are liable to be recorded in a special chart of observation at the intensive care unit, and also in the patient's case history.

When monitoring the patient, the physician uses specific criteria to determine the cause of the vital organs' deterioration:

1. The cardiovascular system:

- pulse rate above 120 beats per minute;
- fall (J80 mm Hg) and rise (i200 mm Hg) in systolic blood pressure;
- cardiac arrhythmia;
- reduction (<50 mm of H_2O) and elevation (>110 mm H_2O) in the central venous pressure.

2. The respiratory system:

- respiratory rate above 28 per minute;
- extremely dull percussion notes, all over the lung;
- the absence of breath sounds over the dull areas.

3. The skin and visible mucous membranes:

- extreme pallor;
- acrocyanosis;
- cold sticky sweat.

4. The urinary system:

- decrease in urine production (<10 ml per hour);
- anuria.

5. The gastrointestinal tract:

- defencive rigidity of muscles of the anterior abdominal wall;
- black stools, occult blood in the stools;
- vivid rebound tenderness;
- abdominal distention;
- absence of flatus and bowel sounds for more than 3 days.

6. The central nervous system:

- loss of consciousness, delirium, hallucinations;
- excessive talking, speech and motion excitement;
- depression.

7. The state of the operation wound:

- profuse blood staining of the wound dressing;
- gapping of the wound edges;
- evisceration (eventration) of the abdominal organs into the wound;
- profuse soaking of the dressing with pus or intestinal contents.

The treatment consists in compensation of metabolic disorders, restoration of the body functions, normalisation of the redox reactions in the tissues - oxygen transfer, elimination of the products of incomplete metabolism and carbon dioxide and replenishment of the increased energy waste. Parenteral and, whenever possible, enteral nutritional support is a very important method to improve and maintain of the protein and electrolyte balance. It is advisable to give fluids and nutrients by the natural way and try to implement this as early as possible.

The following are important hints on intensive therapy of the postoperative patient:

1. Relief of pain with analgesics, electro-analgesia, peridural anaesthesia, etc.

2. Restoration of the cardiovascular functions, correction of the deficient microcirculation (cardiovascular drugs and rheopolyglucan).

3. Prevention and treatment of respiratory insufficiency (oxygen therapy, breathing gymnastics, controlled breathing).

4. Detoxication therapy (see Chapter VI).

5. Correction of the metabolic imbalance (fluid, electrolyte balance, acid-base balance, protein synthesis; see "Blood components").

6. Balanced parenteral nutritional support (see "Blood components").

7. Restoration of the urinary system functions.

8. Restoration of the body functions affected by the surgery (intestinal paresis in abdominal interventions, pulmonary hypoventilation or atelectasis in respiratory operations, etc.).

Complications may develop in the early postoperative period (before the patient has been discharged from the surgical unit).

During the first two days postoperatively the following complications can be encountered:

- bleeding (internal or external);
- acute circulatory failure (shock);
- cardiac arrest;
- asphyxia, respiratory failure;
- complications of anaesthesia;
- fluid and electrolyte disorders;
- failure of the urinary system (oliguria, anuria);
- gastric or intestinal paresis.

On the subsequent days (days 3-8) there is a high risk of congestive heart failure, pneumonia, thrombophlebitis, thromboembolism, acute liver failure and wound infection.

After the patient has been discharged from the hospital (late postoperative period) complications can arise from the organs which have been operated on (e. g. as a result of gastric resection, postcholecystectomy, abdominal adhesions). Some other complications are not infrequent: ligature fistula (stitch abscess), postoperative hernia, keloid cicatrix.

TESTS

Chapter VIII. POSTOPERATIVE PERIOD

1. The catabolic stage of the postoperative period is characterised by:

1. Activation of the sympathetic nervous system and adrenals.

2. Hyperglycaemia.

3. Increase in protein degradation.

4. Increase in pulmonary vital capacity.

5. Decrease in urinary output.

Choose the right combination of answers:

A. 1, 2, 3. B. 2, 3, 4, 5. C. 1, 3, 5. D. 1, 2, 3, 5. E. 1, 2, 3, 4, 5.

2. The reverse stage of the postoperative period without complications is characterised by:

1. Duration of 2 to 3 days.

2. Duration of 4 to 6 days.

3. Positive nitrogen balance.

4. Decreased activity of the sympathetic nervous system and adrenals.

5. Restoration of GI tract activity.

Choose the right combination of answers:

A. 1, 3, 5. B. 2, 3, 5. C. 2, 5. D. 1, 4, 5. E. 2, 3, 4, 5.

3. Which of the following clinical findings suggest grave deterioration of the patient:

1. Pulse rate above 120/minute.

2. Fall in blood pressure to as low as 80 mm Hg.

3. Respiratory rate 20/minute.

4. Perspiration.

5. Gaseous abdominal distension with absence of flatus for 24 hours.

Choose the right combination of answers:

A. 1, 2, 3. B. 2, 3, 4. C. 1, 3, 4. D. 1, 3, 5. E. 1, 2, 4.

4. A weight to press on the wound after the operation is applied to:

A. Prevent wound dehiscence.

B. Relieve pain.

C. Prevent infection.

D. Prevent thrombosis and embolism.

E. Prevent bleeding.

Choose the correct answer.

5. Non-specific prevention of postoperative thromboem-bolism includes which of the following measures:

1. Strict bed rest.

2. Application of elastic bandage on the lower limbs.

3. Active patient's motion in bed.

4. Short bed-ridden period.

5. Use of anticoagulants.

Choose the right combination of answers:

A. 1, 2, 3. B. 2, 3, 4, 5. C. 2, 3, 4. D. 3, 4, 5. E. 1, 2, 5.

6. Therapeutic measures in postoperative urinary retention are as follows:

1. Warming the bladder area.

2. Hypertonic enema.

3. 10 ml urotropin 40%.

4. Diuretics.

5. Bladder catheterization.

Choose the right combination of answers:

A. 1, 2, 3. B. 1, 2, 3, 4. C. 1, 2, 3, 5. D. 1, 3, 5. E. 1, 2, 3, 4, 5.

7. To prevent postoperative pneumonia, the following should be used:

1. Respiratory gymnastics.

2. Anaesthetics.

3. Vigorous hydration.

4. Proserine.

5. Cupping glass and mustard plaster on the chest.

Choose the right combination of answers:

A. 1, 2, 3. B. 1, 2, 4. C. 1, 2, 5. D. 1, 3, 5. E. 2, 3, 4.

8. The most common complication of prolonged and traumatic abdominal surgery is which of the following:

A. GI paresis.

B. Peritonitis.

C. Pneumonia.

D. Anuria.

E. Thromboembolism.

Choose the correct answer.

9. The following measures are all applicable in GI paresis, except:

A. Paranephric block.

B. Hypertonic sodium chloride IV.

C. Proserine.

D. Hypertonic enema.

E. Vigorous antibacterial therapy.

Choose the correct answer.

10. On day 3 postoperatively, a male patient operated on for perforation of gastric ulcer complains of a sudden worsening of abdominal pain. He denies having nausea or vomiting. On examination: pale skin, dry tongue, pulse 120/min, BP 120/80 mm Hg, abdominal distension, total rebound tenderness on abdominal palpation. Blumberg's sign is positive. Bowel peristaltic sounds are inaudible, acid (according to pH measuring) serous and purulent secretion through the abdominal wall is evident. Identify the complication.

A. Dehiscence of gastric sutures.

B. Endogenous bleeding.

C. Early adhesive intestinal obstruction.

D.Thromboembolism of the upper mesenteric artery.

E. Eventration.

Choose the correct answer.

11. The major postoperative therapeutic measures in diffuse peritonitis are which of the following:

1. Correction of fluid and electrolyte balance.

2. Antibacterial therapy.

3. Haemodilution.

4. Restoration of intestinal motor function.

5. Correction of dysproteinaemia.

Choose the right combination of answers:

A. 1, 2, 3, 5. B. 2, 3, 4. C. 1, 2, 4, 5. D. 2, 3, 5. E. 2, 4, 5.

12. The early local postoperative complications are as follows:

1. Pain in the wound.

2. Haematoma.

3. Bleeding.

4. Wound infiltration.

5. Suppuration of wound.

6. Ligature fistula.

Choose the right combination of answers:

A. 1, 2, 3, 4, 5. B. 2, 3, 4, 5, 6. C. 2, 3, 5, 6. D. 2, 3, 4. E. 1, 2, 3, 4, 5, 6.

13. The early postoperative period ends after:

A. Resolution of early postoperative complications.

B. Removal of suture from the operation wound.

C. Healing of the operation wound.

D.The patient's discharge from the hospital.

E. Recovery of the patient.

Choose the correct answer.

Chapter IX. GUIDELINES FOR PREOPERATIVE CARE

A comprehensive and thorough examination of a surgical patient is a prerequisite for making the definitive diagnosis. The purposes of the preoperative diagnostic workup are therefore as follows:

1) to define the organ affected;

2) to find out the aetiology and pathogenesis of the disease;

3) to identify the complications, if any, of the condition.

It is noteworthy that the results of each of the three stages do influence the therapeutic plan.

All the pertinent findings, both positive and negative, of physical examination and laboratory investigations are to be recorded in *the patient's medical record.* This is a document with medical, research and legal purposes; thus it should be written clearly, accurately and be free of non-conventional abbreviations.

A standard outline for history-taking and physical examination in surgery, alongside with specific patterns, whenever necessary, follows.

The chief complaints in detail, history of the present illness, as well as results of the comprehensive physical examination with an emphasis on the organ(s) affected (Latin *status localis)* are the mainstays of the patient's medical record.

Taking the medical history. Trying to find out the patient's life events associated with the problem that has made them seek out the medical aid, the physician will interview the patient in a standardised sequence. Putting questions in simple nontechnical words is a prerequisite as this ensures that the patient understands what he/she is meant to talk about. The chief purpose of the history to furnish clues for diagnosis, which implies that only relevant data are to be considered seriously. The value of interrogation can be sometimes undermined when the patient is not able to present the complaints well and explain the chief complaints despite the fact that the question has been put correctly.

It is sometimes hard to establish contact with the patient if, for instance, they are in severe pain during the interrogation. This makes the surgeon arm himor herself with patience and

be considerate so as to be able to obtain the information required for the diagnosis to be made. Occasionally, patients deliberately exaggerate their complaints (which is referred to as *aggravation)* or present non-existent symptoms (the phenomenon known as *simulation).* At the same time,*dissimulation,* or concealing the symptoms because of the fear of surgery or for some other reason, has also to be born in mind.

When it is impossible to take the history from the patient him-/herself, other informants (e.g. next of kin) will be involved in the interrogation.

The history of symptoms starts with the *chief complaints,* abbreviated CC. Each complaint must both be clarified and quantified. If, for example, the patient complains of pain, its localisation and irradiation have to be specified, and so do the time of its onset, persistence, intensity and the character, its recurrence, the relation of the pain to physical activity, trauma, physiological functions, its association with dizziness, loss of consciousness or temperature changes.

Or, if the patient complains of vomiting, it is important to ascertain the nature of vomitus, frequency of vomiting and specify other complaints that accompany it, if any. Further, it has to be found out whether the patient feels better after vomiting or not.

As was mentioned above, in taking the *history of the present illness* (PI; Latin *anamnesis morbi)* it is necessary to clarify the time of onset of the symptoms and their progression. Also, the type and results of previous hospitalisations and therapy (surgical, conservative or sanatorium) have to be ascertained. The relevant medical documents have to be scrutinised as well, such as referral notes, discharge summaries, and the results of laboratory and X-ray investigations; all these are subject to registration in the patient's medical record.

Past medical history (Latin *anmnesis vitae)* is a short biographical narrative of the patient that comprises the information on the following:

1) hospitalisation(s) (date, duration, and diagnosis);

2) operations;

3) childhood illnesses;

4) injuries;

5) illnesses requiring physician's attention;

6) family history with specific mentioning the data on parents (age and health status) and any disease in which congenital factors may play a role (e.g. TB, hypertension, coronary heart disease, anaemia, diabetes, blood dyscrasia, cancer, migraine);

7) social history (residences and education; all jobs and posts held and military service with a description of occupational hazards; tobacco, alcohol, and other drugs);

8) allergies, particularly those to antibiotics and previous blood transfusions or blood substitutes in female patients, gynaecologic conditions.

The next step in making the diagnosis is the physical examination of the patient, which implies utilisation of the following methods: inspection, thermometry, palpation, percussion and auscultation.

Inspection. Of the several methods of examination, inspection yields the most of clinical signs in surgery, and not infrequently it provides a valuable clue to the diagnosis.

Focusing observation on a single anatomic region it is required that the former be well exposed. Position patient so that the part under examination is sufficiently lighted. During inspection, compare the symmetrical sites and structures of the body (e.g. the affected part with the intact one on inspection of an injured knee). The position, form, size, mobility, changes in

skin colour, folds and normal lines, the change in the axis of an organ, and its transparency should also be noted.

From the position of an organ one can infer not only the type of disease but also its duration and severity. For example, a stiff vertebral column, especially in the patient supporting the trunk or head with their hands, suggests spondylitis. On the other hand, the unusual positioning of an organ can result from skeletal changes, muscle contractions and palsy, acquired and congenital diseases and other deformities. It is necessary that a would-be surgeon make it a rule to examine each patient both supine and standing, with the exception of critically ill patients. This is particularly pertinent to conditions of the lower extremities, spine or genitals (e.g. in congenital hydrocele of the testes and spermatic cord, when fluid can flow from the abdominal cavity into the scrotum or the inguinal region on standing and go back into the abdomen in the patient being supine).

Bone deformities may occur either rapidly, as is the case in bone fractures, dislocations and ligamental straining or gradually, resulting from osseous or articular infections.

When inspecting a limb consider the possibility of axial deformities that occur in fractures, dislocations or joint or diaphysis deformity. The axis of the *upper* limb is a line passing through the centre of the humeral head and the heads of the radius and ulna, while that of the *lower* limb is the line connecting the anterior superior spine of the iliac bone, the centre of the patella and the space between the first and second toes.

A change in the shape of the part under examination is the first to attract the surgeon's attention. In this case the commonest conditions identified are swelling and tumours (the terms which are frequently confused). *A swelling* can be due to inflammation, oedema or neoplasm, while *a tumour* is an overgrowth of the new tissue which is visualised by its location, form and partly its mobility (e.g. the movement of a thyroid tumour on swallowing). A tumour can be spherical, eggor pear-shaped, oblong, cylindrical, irregular etc. It will be noted that spherical, or round-shaped, tumours are typically cysts, atheromas, etc. A tumour on a stalk is mostly benign (e.g. polyposis); alternatively, malignant tumours have commonly wide bases and often an almost invisible stalk with changes in the overlying skin.

The size of a tumour is usually assessed by comparing it to a well-known object (e.g. a tumour of a size of a nut, bean, orange, hen or goose egg). Tumour can occasionally be as huge as a child's or even adult's head. To obtain the size more accurately (in cm) the tumour has to be measured with a tape.

Skin changes can offer diagnostic clues as well. The colour helps both assess the patient's general condition and gain the information about the local process. The skin can be pinkish or pale, and the patients with debilitating disease may have sallow complexion.

Generalised straw-yellow skin discolouration of a patient with a malignant tumour suggests an advanced stage of the condition resulting in severe intoxication and cachexia. In contrast, localized skin discolouration depends on the extent of circulatory disorder or disturbance in pigmentation.

Local skin pallor may serve as evidence of severe defect in arterial blood circulation, cyanosis - insufficient oxygen saturation of arterial blood or venous stasis. The skin changes such as peeling, wasting or alopecia (i.e. hair loss) are commonly found in chronic circulatory insufficiency of the affected area. Cutaneous hyperaemia may be caused by inflammation, pathological dilation or an increase in the amount of blood vessels (e.g. teleangioctasic, varicose veins). Pigmentation disorders occur as a result of excessive accumulation of the pigment (e.g. venous dilation, melanosis) or its insufficient production (leucodermia in syphilis or vitiligo in white leprosy). Skin rash can also be encountered: macules (spots), papules, nodules or nodes, vesicles or bullae filled with pus or fluid, blisters, erythaema, crusts, fissures, ulcers, erosions.

Scarring can result from vaccinations, chicken pox, lupus erythematosus, trophic ulcers (on the leg), tuberculous lymphadenitis (on the neck), syphilis or surgery. The size, location, mobility (i.e. the degree of attachment to the underlying tissue, bone) and the colour (pigmented or depigmented) of the scar have to be noted. *Transparency* is one of the characteristics of tumour-like structures that consist of the sac containing fluid (e.g. scrotal hydrocele). Transparent fluid suggests the serous nature of the fluid.

Thermometry. Increased body temperature, or *fever*, is a characteristic sign of an inflammation; pyogenic infections, for example, produce fever of the alternating pattern. On the other hand, a fall in body temperature previously raised and its normalisation may be well suggestive of a favourable outcome of the condition. Further, fever accompanied by chills is a sign of purulent infection that may result in septicaemia. Of the important aspects of fever is the relationship between a rise in body temperature and the pulse rate: tachycardia with a fall in temperature tends to imply worsening the patient's condition and, therefore, be a prognostically unfavourable sign.

To check the local skin temperature the physician places the dorsum of the hand on the site examined. If, for example, the local temperature is found to be higher compared with that in the symmetrical site, an inflammation may probably be found either in the skin or the underlying tissues (phlegmon, osteomyelitis, arthritis, etc.), as may a malignancy (benign tumours are very unlikely to increase the local skin temperature). In contrast, gangrene, occlusion of arterial branches and spasm of small arteries commonly cause a reduction in the local temperature.

Measurement of organs or parts of the body. Measurement of an organ or tumour-like structure yields valuable clues that help make the diagnosis. The circumference of the abdomen should be measured if an intra-abdominal condition (e.g. ascitis, tumour) is suspected; the measurement of the extremities aids to recognise a reduction in their size in muscular atrophy or an increase in their oedema. Equally, an increase in the size of a limb can be a sign of venous or lymphatic stasis. Measurement of the circumference and length of a limb is to be performed both on the affected and intact sides, the results obtained being compared. A tape measure is applied to measure the circumference and length of the limb in cm.

To perform the procedure, place the patient comfortably: the pelvis should not be distorted, the line joining the two anterior iliac spines must be perpendicular to the mid-sagittal plane of the pelvis. The length of the upper arm is regarded as the distance from the acromion to the olecranon or the lateral humeral epicondyle, while the length of the forearm is the distance from the olecranon to ulnar styloid process of the. The length of the lower limb is measured from the superior anterior iliac spine to the medial malleolus; the length of the thigh - the distance between the major trochanters and the knee joint space; the length of the shin (i.e. the distance between the knee joint space and the lateral malleolus). The shortening or lengthening of the limb may result from a number of causes.

Abnormal joint movements can be identified by inspection. These are usually classified into active, or voluntary, and passive, or involuntary (i.e. performed by the examiner). Absolute or almost absolute limitation of both active and passive movements is encountered in ankylosis of the joints. Conversely, excessive movements in the joints are characteristic of «the dangling joint», as is the case in a ligament tear. Suppleness along the length of a long bone suggests a fracture. The absence of activity and the ability to passive movements of a limb may serve as evidence of palsy.

The amplitude of motion in a joint is evaluated with an angle gauge whose sides are placed in the direction opposite to the segments that form the joint. The angles are measured from the initial position of the limb (i.e. the one of the joint when the trunk and limbs are in the vertical position).

When examining the limbs, their *muscle power* (i.e. the counteractive motion of the patient in various directions) is also assessed. The reverse effect on the examiner is compared to the power in the symmetrical muscles. The application of dynamometer provides more precise information about the muscle power.

Palpation. Palpation is preferably performed with warm hands and the patient made to take various positions. Start palpating from the areas far-off from the pain-causing site, moving gradually and carefully towards it. Careful superficial palpation evolving into a deeper one is advisable.

Palpation adds to the information obtained through inspection, namely, that about the position, shape and size of a tumour or swelling. Further, the consistency of the organ or swelling under examination is determined. Some conditions can cause the accumulation of dense products identified by the change in consistency. The accumulation of fluid in tissues can either account for infiltration or cavity full of fluid. The consistency can be either woody-or stone-hard; it can also be soft, for example, jellylike (i.e. the finger embedded on pressing leaves a dimple) or elastic (e.g. like a plastic ball).

The accumulation of fluid (pus in an abscess, serous fluid in a cyst or blood in haematoma) in a cavity or sac-like tumour is characterised by fluctuation, and occasionally a tense elasticity is identified. Fluctuation is accounted for by the transfer of waves of liquid vibration caused by a special type of pressure applied to the cavity wall. It is performed the following way: one or two fingers of one hand are placed on one side of the swelling, and the fingers of the other hand are used to perform a short and fast tappings on the opposite side; the first hand receives the jolts being transmitted. This manipulation has to be repeated several times to obtain more precise and clear information. This method is used to estimate the volume of fluid accumulated in suppurative focus, the abdominal cavity or elsewhere in the body. In huge cysts, a modified form of the method is used, in which the palm of one hand is placed on the side of the swelling and the other hand is used to tap from the opposite side. The resultant vibrations are felt by the first hand. It is noteworthy that pseudo fluctuations can be encountered and should not be confused with authentic ones. Pseudo fluctuations can be found in lipomas, myxomas or fungating masses of joints and tendons. On the other hand, fluctuation may be overlooked if the accumulation of fluid is deep-sited (e.g. beneath the greater muscles) or the cavity containing the fluid is formed by rigid tissues, in which case the consistency resembles that of a blown balloon.

The lymph nodes are to be palpated in a careful circular manner using fingers 2-4, the size, consistency, and mobility of the nodes being examined. Their relationship with each other and the surrounding tissues (lying free, being grouped in packets), tenderness should also be specified.

The point of maximum tenderness on palpation indicates the site of the disease which is liable to scrutiny (e.g. in felon or phlegmon). The place of maximum tenderness identified with a probe may help localise the site of accumulation of pus, while the place of maximum tenderness found with the finger passing along a bone in case of trauma points to the fractured site). Similarly, identification of abdominal tenderness points facilitates the diagnosis, for example, of acute appendicitis.

Palpation is also practical in evaluating changes in the size of a swelling (e.g. hernias) and tumour (e.g. angiomata, or in vascular tumours). Pressing on angiomata, or varices often yields their emptying of the blood which flows into the vessels. Equally, the contents of a reducible hernia (abdominal or cerebral) move back either to the abdominal cavity or skull when pressure is applied.

The mobility of a tumour is also assessed by way of palpation which helps identify the origin of the tumour (the skin, muscle or bone). In fact, malignant tumours tend to be fixed, while benign masses are commonly mobile and therefore can be displaced in relation to the

surrounding tissues. Technically, holding it at its base and moving upwards, downwards and laterally checks the mobility of the tumour.

Pulsation is known to be typical of vascular tumours and aneurysms. Arteriovenous aneurysms produce specific vibration - a hum murmur, while a vibration synchronous with the heartbeat is characteristic of pulsating haematomas.

The pulse rate should be evaluated at specific sites as follows:

• the radial artery - on the palmar aspect of the outer border of the forearm, about 2-3 cm above the wrist joint;

• the humeral artery - on the medial aspect of the biceps brachii muscle;

• the femoral artery - below the Pourpart's ligament, about 1,5-2 cm medial from its midpoint;

• the popliteal fossa - with the patient lying on the abdomen and their knee joint bent at the angle of 120°;

• the posterior tibial artery - between the posterior inferior aspect of the medial malleolus and the Achilles tendon;

• the dorsalis pedis artery - along the line drawn between toes 1 and 2 towards the ankle joint;

• the temporal artery -about 1 cm anterior to the auricle.

Palpation can also be used to identify crackles, snap, and crepitations, which may serve as a sign of accumulation of air (e.g. subcutaneous emphysema) or gas (e.g. anaerobic infections). Crepitations are recognised by a slight tap or pressure on the skin. Accumulation of blood mixed with blood clots produces a mild crackle felt by the fingers, which resembles that of snow. On the other hand, fibrin deposits in the tendon sheets of the fingers may cause specific snap audible with the fingers bent in the joints. In fractures of long bones clear crepitation sounds are elicited as a result of the friction of the bone fragments against each other. Parchment crackles are typical of central bone cysts, myelogenic sarcoma and fibrous ostitis if the thin plate of the cortical bone substance is pressed upon.

Palpation of the abdomen is indispensable in examining abdominal organs, especially in the presence of inflammation. The abdomen must be fully relaxed during this procedure. For this, the patient should be placed on a firm couch without a pillow, their legs bent in the knee joint. The patient will be asked to breathe evenly but not very deeply, since during the forceful deep breathing the abdomen is rather drawn in, which impedes the overcoming of the resistance of abdominal muscles.

The examiner has to use their both hands, placing the palms on the abdominal wall in a way that the fingers are slightly bent, and gradually pressing deep. The hands are then moved in a sliding manner, perpendicular to the axis of the organ being examined. The location of the organ or tumour, its size and form and mobility with breathing are thus noted. Abdominal tenderness is assessed during palpation as well as by reflective resistance of the abdominal muscles. Palpation is used to reveal specific pain signs (Blumberg's, Rovsing's, Obraztsov's etc.). The findings obtained by palpation of the abdomen are usually supplemented by auscultation.

Percussion. In physical diagnosis, percussion is the method of examination in which the surface of the body is struck to emit sounds that vary in quality according to the density of the underlying tissues. It is very informative in the examination of many diseases of the viscera. Percussion is employed to determine the borders of the heart and lungs, as well as the presence of fluid (e.g. pus) in the pleural cavity or pericardial sac. The pleural fluid, for instance, is detected by the presence of an oblique line (Damoiseau's line) whose apical point is situated on the posterior axillary line. The fluid level can sometimes be horizontal, as is the case in

pyopneumothorax when, apart from the fluid, the pleural cavity contains air. Besides, percussion helps locate the heart: cardiac displacement resulting from accumulation of fluid and gas in the pleural cavity.

Percussion of the abdomen allows verifying a decrease or even absence of hepatic dullness, the presence of fluid in the abdominal cavity, and the extent of abdominal distension as well. Also, it helps elicit local tenderness. Fluid accumulation is known to be typical of peritonitis in which case the dull percussion sound is heard over the areas of fluid accumulation in the abdominal cavity; this changes with a change in the patient's position. To elicit the clinical sign, abdominal percussion will be started with the patient lying on the back; then without changing the location of the physician's hands placed on the patient's abdomen they are asked to turn aside, after which percussion is continued. Fluid accumulation, along with dullness of the percussion sound, is revealed on the side the patient is lying on. The sound on the opposite side that has initially been dull on percussion evolves into a tympanic one.

Percussion can also be used to determine intestinal distension resulting from peritonitis and other abdominal inflammatory conditions.

Auscultation is the method of listening to and interpreting the meaning of sounds produced within the body:

1) heart sounds (clear/dull/accentuated, etc.) and murmurs (systolic/diastolic, etc.);

2) breath sounds (vesicular/bronchovesicular/ bronchial,etc.) and crackles (rales, crepitations, moist sounds);

3) bowel sounds.

• the absence of bowel sounds on abdominal auscultation may be well suggestive of severe peritonitis in which peristaltic intestinal movements are unlikely to be audible;

• sound of «falling drops» (is abscence of peristatic ones peristalsis) is often found in intestinal obstruction etc.

Auscultation of *the skeleton* is generally of limited value. In some cases, however, local auscultation can be helpful (e.g. intra-articular injuries; aneurysms; long bone fractures in which crepitations can be heard, etc.) In fractures there is no sound conduction through a bone.

Arterial auscultation is to be performed in each patient with arteriosclerosis. In health, a characteristic conductivity tone is heard from the pulsating waves of major arteries during auscultation, while in vascular pathologies various auscultation signs may be found:

• systolic murmur in constricted or dilated arteries;

• systolic-diastolic murmur when blood is being pumped from an artery into the vein.

Based on the physical findings an initial impression, or *the preliminary diagnosis,* is made; this includes the main disease and its complications, and concurrent conditions. The preliminary diagnosis dictates further workup. The diagnostic algorithm implies that more sophisticated and invasive investigations should follow simpler and non-invasive ones if only the latter appeared inconclusive.

The results obtained through the physical examination and additional investigations are used to make *the final, or definitive, diagnosis.* This should comprise the confirmed major disease and, if any, its complications and all the concurrent conditions.

Specific laboratory techniques can occasionally be associated with complications. The invasive methods such as diagnostic punctures, laparoscopy, thoracoscopy, biopsy, etc. may result in bleeding, damage to the internal organs or infections. Thus, in prescribing any of the special investigations one should bear in mind the following principles.

• The investigation must never be more dangerous than the disease itself.

- Contraindications to the investigation must always be considered.
- Safer but as effective techniques must be preferred.

Making the diagnosis the physician inevitably assesses the severity of the patient's condition. This is more objective if the scoring system is applied.

The Glasgow Coma Scale is widely used (tab. 4).

Table 4. Glasgow Coma Scale

Condition	Score	Maximum Value
Eye opening (E)		
Spontaneous	4	
To speech	3	
To pain	2	
No response	1	4
Verbal response (V)		
Orientated	5	
Confused conversation	4	
Inappropriate words	3	
Incomprehensible sounds	2	
No response	1	5
Motor response (M)		
Obeys	6	
Localizes pain stimulus	5	
Withdraws extremities as a reaction to pain	4	
Flexion pathological	3	
Extension pathological	2	
No response	1	
Glasgow Coma Scale = E + V + M		
GCS minimum	3	
GCS maximum	15	

The Glasgow scale is used to assess the functional state of the central nervous system in disturbed consciousness, particularly in head injury, cerebrovascular disease, poisoning and endogenous intoxication. Patients with scores above 9 are likely to recover. The Glasgow score has been incorporated into the Simplified Acute Physiology Score (SAPS) as part of evaluation

of the patient's general condition and estimation of the overall prognosis by adding up the points. The SAPS is based on the deviation from the norm of each of its fourteen parameters (tab. 5).

Table 5. Simplified Acute Physiology Score (SAPS)

Clinical signs	Scores								
and laboratory fidings	+ 4	+ 3	+ 2	+1	0	+1	+2	+3	+4
1	2	3	4	5	6	7	8	9	10
Age, yrs					<45	46-55	56-65	66-75	>75
Pulse rate, min^{-1}	>180	140-179	110-139		70-109		55-69	40-54	<40
Systolic BP, mm Hg	>190		150-189		80-149		55-79		<55
T,°C	>41	39,040,9		38,538,9	36,038,0	34,035,9	32,033,9	30,031,9	<30
Respiratory rate, min^{-1}	>50	35-49		25-34	12-24	10-11	6-9		<6
Mechanical ventilation	-	-	-	-	-	-	-		-
Urea, mmol/l	>55,0	36,054,9	29,035,9	7,528,9	3,5-7,4	<3,5			
Haematocrit (PCV) %	>60,0		50,059,9	46,049,9	30,045,9		20,029,9		<20,0
WBC, $x10^9/l$	>40,0		20,039,9	15,019,9	3,014,9		1,0-2,9		<1,0
Glucose, mmol/l	>44,5	27,844,4		1427,7	3,913,9		2,8-3,8	1,6-2,7	<1,6

Tab. 5. Contd.

1	2	3	4	5	6	7	8	9	10
Potassium, meq/l (mmol/l)	>7,0	6,0-6,9		5,5-5,9	3,5-5,4	3,0-3,4	2,5-2,9	2,0-2,4	<2,0

Sodium, meq/l (mmol/l)	>180 ,0	161179	156160	151155	130150		120129	110119	<110
Bicarbonate, meq/l (mmol/l)		>40,0		30,039 ,9	20,029 ,9	10,019 ,9		5,0-9,9	<5,0
Glasgow Coma Scale (score)	13-15	10-12	7-9	4-6	3				

Table 6. The prognostic probability of a lethal outcome using the SAPS system of scores

Score	Lethal prognosis (%)
4	-
5-6	10,7
7-8	13,3
9-10	19,4
11-12	24,5
13-14	30,0
15-16	32,1
17-18	44,2
19-20	50,0
20	81,1

9.1 GENERAL PRINCIPLES OF DIAGNOSIS AND TREATMENT

Clinical Examination of Traumatic Patients

Special considerations

Diagnosis of injuries is made using conventional clinical methods. To verify the diagnosis special investigations are used.

History. Delineating the cause of the trauma facilitates diagnosis and prevention of the trauma. The mechanism of the trauma can be deduced from the patient's history, which coupled with the initial impression may help outline the workup (e.g. falling with one's arm outstretched results in a radial fracture in a typical site or a fracture of the humeral head; falling from a height and landing on the buttocks leads to a compression fracture of the lumbar spine, etc.).

Inspection. Inspection of the patient and the injured area even without special equipment can be of diagnostic value. It is a must to compare the injured side of the limb with the intact one. In examining the affected organ the three main positions are to be considered: passive, active or forced.

Passive position of the whole body suggests a serious injury and is characteristic of an unconscious patient (e.g. in head or spinal injuries with possible palsy). A passively placed limb is typical of fractures (e.g. in femoral neck fractures, the fractured leg is found rotated outside; when a major nerve is injured there can be passive positioning of the limb without active movements etc.).

Forced position of the limb occurs in displacements and in the acute phase of fractures or in inappropriately healed fractures and development of ankylosis.

On inspection, the skin pallor and hyperaemia are to be noted, as well as skin hydration (dry hot skin/cold sticky sweat), the presence of abrasions, bruises, their localisation, size or colour etc.

Chapter X. TRAUMA

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Forced position of the limb occurs in displacements and in the acute phase of fractures or in inappropriately healed fractures and development of ankylosis.

On inspection, the skin pallor and hyperaemia are to be noted, as well as skin hydration (dry hot skin/cold sticky sweat), the presence of abrasions, bruises, their localisation, size or colour etc.

It is important to ascertain any changes in the positioning of limbs in relation to their axes. Normally, the axis of the lower limb corresponds to a direct line joining the superior anterior iliac spine, the medial aspect of the patella and the first toe.

The injured limb can be rotated internally or externally, forming an angle at the knee joint that opens inor outwards. Thus, the two types of deformity are identified: *valgus* deformity, i.e. the angle opens outwards, and *varus* deformity, i.e. the angle opens inwards.

The normal axis of the upper limb corresponds to a direct line joining the centre of the humeral head, the radial and ulnar heads. A rotation of the forearm from the upper limb axis leads to formation of an angle with the apex at the elbow joint; correspondingly, when this angle is opened outwards or inwards, a valgus or varus deformity is observed.

The axes of the upper and lower limbs change in fractures, displacements, ankylosis or inappropriate fracture healing. The axial changes can also be found in patients with congenital deformities or acquired conditions such as rickets.

Inspection helps to elicit changes in the affected organ - levelling of the folds (contours) of a joint in haemarthrosis; swelling in soft tissue haematomas; deformation of the limb in fractures etc.

Palpation. On palpation the injured sites, pain, swelling or induration may be noted. In fracture of jaws palpation is performed via the oral cavity, while in that of the coccyx bone it is carried on through the rectum. The presence of fluid in a joint can be identified by palpation (e.g. the ballottement of patella sign that occurs in haemarthrosis, synovitis).

Palpation can help to determine «gap» tissue defects that may be the case in a muscle or ligament tear. Rupture of the biceps muscle is characterised by a gap in the muscle bulk with its defiguration during contraction, while clavicle fracture produces deformation during palpation; in the Achilles' tendon tear contraction of the calf muscle brings about a gap in that area etc.

Auscultation. This technique plays a vital role in the examination of chest and abdominal organs and helps to elicit changes resulting from the injury (e.g. an absence of peristalsis in posttraumatic peritonitis; a decrease in or absence of breath movements in pulmonary injuries complicated by pneumo- and/ or haemothorax; a characteristic murmur in post-traumatic aneurysm).

Determination of joint motion starts with assessment of the extent of active joint motion that can be performed by the patient themselves. The surgeon is to evaluate the extent of passive motion, which helps establish the absence of active or passive motion or any limitations due to tenderness on motion. An angular is used to measure the degree of motion; its sides being connected to hinges. The movement of the siteers along the conveyer helps to measure (in degrees) the extent of joint motion. The one at the injured site is compared to that at the intact side and also to average values for a normal person of the same age and sex.

The original position of the shoulder joint is regarded as the free fall of the limb along the trunk, while that of the elbow, wrist, and finger joints is the state of full extension in the joints at 180°. For the hip and knee joints the normal angle of position is 180° when the body is in the vertical position, the ankle joint - 90° to the axis of the leg.

To measure the motion in the shoulder and hip joints, one side of the angular is placed along the body axis with the other being put along the moving limb following the flexion and extension of the limb. In measuring the motion in other joints one side of the angular is placed along the proximal aspect of the limb above the joint (along the thigh, upper arm, leg and forearm), while the other along the distal end below the joint. The hinge of the angular is positioned at the level of the joint involved. The displacement of the angular's side connected to the distal end of the limb is used to determine the degree of motion in the joint. Special types of angulars (protractors) are used to determine other types of motion in the joints (e.g.rotation).

Changes in the degree of joint motion can vary from *ankylosis,* or stiffness, to *contracture,* or limited motion.

Ankylosis can be due to the bones forming the joint fused together or as a result of the formation of fibrous fusion of joint spaces (fibrous ankylosis). Joint stiffness can be due to sclerosis and calcification of the soft tissues around the joint (extra-articular ankylosis).

Contracture can result from one of the following: degeneration of the muscles of the limb, impaired innervation, displacement resulting from distortion of anatomical relation between the joint surfaces of the bone and the spastic contractions of the muscles. Joint contracture caused by progressive changes in the neighbouring soft tissues and joint capsule can lead to extra-articular ankylosis.

Measurement of the extremity length is of vital importance in the examination of patients with trauma. The length of an extremity can be estimated visually by comparing the two symmetrical limbs on different segments and the levels of position of symmetrical bone projections. To do this, have the patient lie supine on a firm surface placing the two lower extremities in a symmetrical position, the bone projections on the legs being thus compared - the anterior superior iliac spines, major trochanters, patellas, malleoli in relation to each other. Mismatch of these suggests a shortening of the limb and its extent of either the thigh or leg can then be measured based on the differences in the levels of the major trochanters, patellas, malleoli. The length of the upper limbs can be compared by the position in relation to their symmetrical bone projections, the patient "standing to attention".

A more exact measurement is obtained by using a tape measure. The length of the lower limb is assessed from the anterior superior iliac spines, to the lateral malleolus; the thigh's length - from the major trochanter to the knee joint space, the length of the leg from the knee joint space to the lateral ankle bone malleolus; the upper limb from the acromial end of the clavicle to the end of the third phalanx; the upper arm (humerus) from the acromial end of the clavicle to the olecranon; the forearm - from the olecranon to styloid process of the radius. The length of the limb changes in fractures and displacements.

The circumference of a limb is measured at the symmetrical levels of the two limbs. The difference in the circumference of the injured limb suggests the presence of oedema, haematoma, and bleeding as well as the displacement of bone fragments.

The *X-ray methods* play a major role in diagnosis of trauma. X-ray films are to be obtained in at least two projections - sagittal and lateral. In fractures and displacements X-ray pictures help to determine the type of displacement of fracture fragments and joint ends in displacements. Serial X-rays facilitate evaluation of the adequacy of the bracing of the fracture fragments together and relocation of the displaced joint as well as the assessment of the therapeutic results.

In traumatology, radio-opaque methods (e.g. *arthrography,* or investigation ofjoints, *angiography,* or investigation of vessels) are also used.

Tomography yields X-ray images of bones and other organs at different levels, which provide a more detailed impression of the type of injury and help exclude the presence of foreign bodies etc.

Functional methods of investigations *(e.g. rheovasography, oscillometry)* provide the data as to the regional circulation. Electromyography enables the physician to evaluate muscular contractility.

Dressings

Dressings is a surgical area that deals with bandaging. The indications for bandaging usually involve protection of wound or damaged fissues from external exposures.

The main types of bandages are given below (tab. 7).

Table 7. Types of Bandage and Their Indications

	Type of bandage	Indication
1.	Protective	Prevention of bacterial contamination of wounds
2.	Pressure / Compression	Bleeding arrest
3.	Therapeutic (drug)	Topical drug therapy

4.	Immovable	Fixation of the injured organ (mostly extremities) in a certain position
5.	Correctional	Correction of the organ's deformity
6.	Occlusive	Open pneumothorax

Bandages are divided into soft and immobilisation (immovable) ones.

Immobilisation bandages (fastened and correction bandages) and those with traction are generally used for the treatment of patients with injuries and diseases of the locomotive system. These include the plaster of Paris bandage, splint and apparatus.

Soft bandages comprise the dressing material that is placed directly on the wound and a means of fixation. They are divided into simple soft (protective and therapeutic), pressure (haemostatic) and occlusive bandages.

Fixation of the dressing material is done with gauze, knitted tube bandages, netknitted medical bandage «retilast», cotton scarf, glue, collodion, adhesion plaster. A bandage has two ends: the rolled side, or *the head,* and the free end, or the beginning.

The rules and regulations of bandaging are as follows:

1. The patient should be placed in a comfortable position, with maximum relaxation of the muscles. There should be a free access to the part of the body to be bandaged. The part to be bandaged is to be placed in the position it is supposed to occupy after the bandage has been applied and must stay immobile during the process of bandaging.

2. The person applying the bandage should stand facing the patient in order to be able to see by the patient's facial expression whether the procedure is causing him/her pain.

3. Bandaging is started from the periphery towards the trunk stretching the bandage with equal force. The direction of the rounds should be from left to right in relation to the one bandaging (with the exception of bandaging the left eye, Desault's bandage on the right hand etc.). The right hand is used to unwrap the head of the bandage and the left one is used to hold and straighten out the bandage. The bandage is unrolled while being put around the part of body that is bandaged, each round covering the previous one by either a half or two thirds of its width. The end of the bandage is fastened with a safety pin or adhesion plaster to the bandage either along the free end or around the bandaged area fastening it to the intact side.

A well-applied bandage should fasten the dressing material, adequately cover the injured part, and be comfortable for the patient, light and nice looking.

The main types of bandage dressing. *Circular,* or round, *bandage* is the initial step in any soft bandage dressing and is used alone for the closure of small wounds on the forehead, neck, wrist or ankle joint etc. In this kind of bandaging, each round completely covers the previous one. The first round is placed a bit slanting and tighter than the following ones, leaving the tip of the bandage uncovered to fold over the second round and to fasten it by the third one. A drawback of this type of bandage is that it can rotate and in so doing displace the dressing material.

Spiral bandage is used to cover big wounds on the trunk and extremities (fig. 41, c). It is started with a circular bandage above or below the injured site and the rounds directed spirally covering the previous round by 2/3. Simple spiral bandage is applied to cylindrical parts of the body (chest wall, upper arm, and the thigh). Spiral bandage with a bend is applied to cone-shaped parts of the body (shin and forearm). The bend is done as follows: each next round is done in a more slanting manner than the previous spiral rounds; the thumb of the left hand is used to keep the lower edge, the head of the bandage is unfolded a little and pulled so that the upper edge becomes the lower and vice versa; then the next round is applied and so on. In this

way the bending has to be done along the same line and outwards from the injury site. This bandage dressing is simple and quick, but it can easily slip down when the patient is walking or running. To keep it firm in place, the last round can be fastened to the skin with glue (fig. 42).

Serpiginous bandage is the preliminary stage of a spiral or any other type of bandage. It is used to fasten large piles of dressing (normally on the limbs) (see fig. 41, fig. 43). It is started with a circular bandage around the wrist or ankle joint, then goes spirally, each round not touching the preceding one. In this way free spaces, the size of about the width of the bandage, are left in between the bandage rounds.

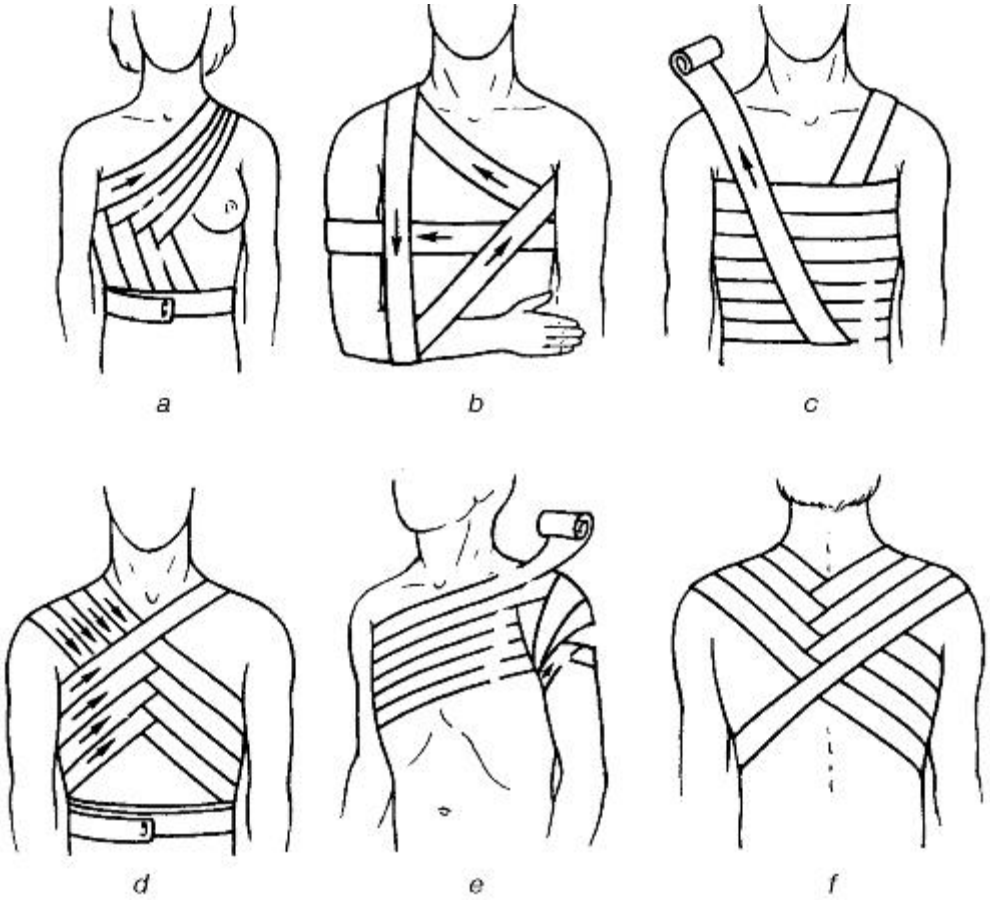


Fig. 41. Bandaging the thorax and the shoulder: *a* - mammary bandage; *b* - Desault's bandage; *c* -spiral bandage; *d* - and *f* - figure-of-eight bandage; *e* - spica bandage.

Cross, or «a figure of eight», bandage is very convenient in bandaging parts of the body with uneven surfaces (the back of the neck, occipital area, the upper chest and the perineum). It is started with the circular bandaging which is followed by cross over rounds, intermittent with circular rounds that are placed distal or proximal to the first circular rounds.

At the back of the neck, and occipital a cross or figure eight bandage is applied in the following way: the bandage is fastened around the head in a circular manner, then above and posterior to the left ear it is lowered to the right side of the neck up to the right ear, passing in front of the neck and rising along its posterior aspect up to the right ear. Passing in front of the head the bandage is placed above the left ear slanting down, repeating the preceding rounds. The bandage is fastened around the head.

In bandaging the chest the bandage is passed around the shoulder in a figure of eight with the crossing rounds located in relation to the injury site either in front or at the back of the chest.

Spica bandage is a type of a figure of eight one and differs in that at the crossing site the preceding round is not fully covered, but covers on only one side lying above or below. In this way the crossing site appears like a an ear of grain. A well-placed bandage looks nice and does

not fall when the limb is moved. Such bandage is applied to the hip and shoulder joints, above the shoulder and other difficult areas where their uneven nature makes it difficult to keep dressing materials on the wound by means of other methods (see fig. 41).

«Tortoise» bandage is applied on the elbow and knee joints. This kind of bandage has two variants - diverging and converging bandages. Diverging bandage on the knee joint is started with circular rounds placed directly around the joint; then similarly above and below the preceding rounds. The rounds are crossed over in the popliteal fossa, and in front of the joint they diverge on both sides of the first bands, covering in that way most areas of the joint. The bandage is fastened around the thigh.

Converging bandage is started with a circular one above and below the joint, crossing in the popliteal fossa. The subsequent rounds are placed closer and closer to each other and to the most prominent area of the joint until all the area has been covered completely.

Returning bandage is applied on the head, foot or hand and on the stump after amputations. It is started with circular rounds on the limb. It is then bent on the anterior aspect of the stump with a vertical round across the proximal part of the stump to the posterior aspect. A circular round is additionally added to fasten each returning band. Vertical rounds are successively moving to the lateral and medial aspects of the stump. Additional fixation of these rounds is achieved with spiral rounds.

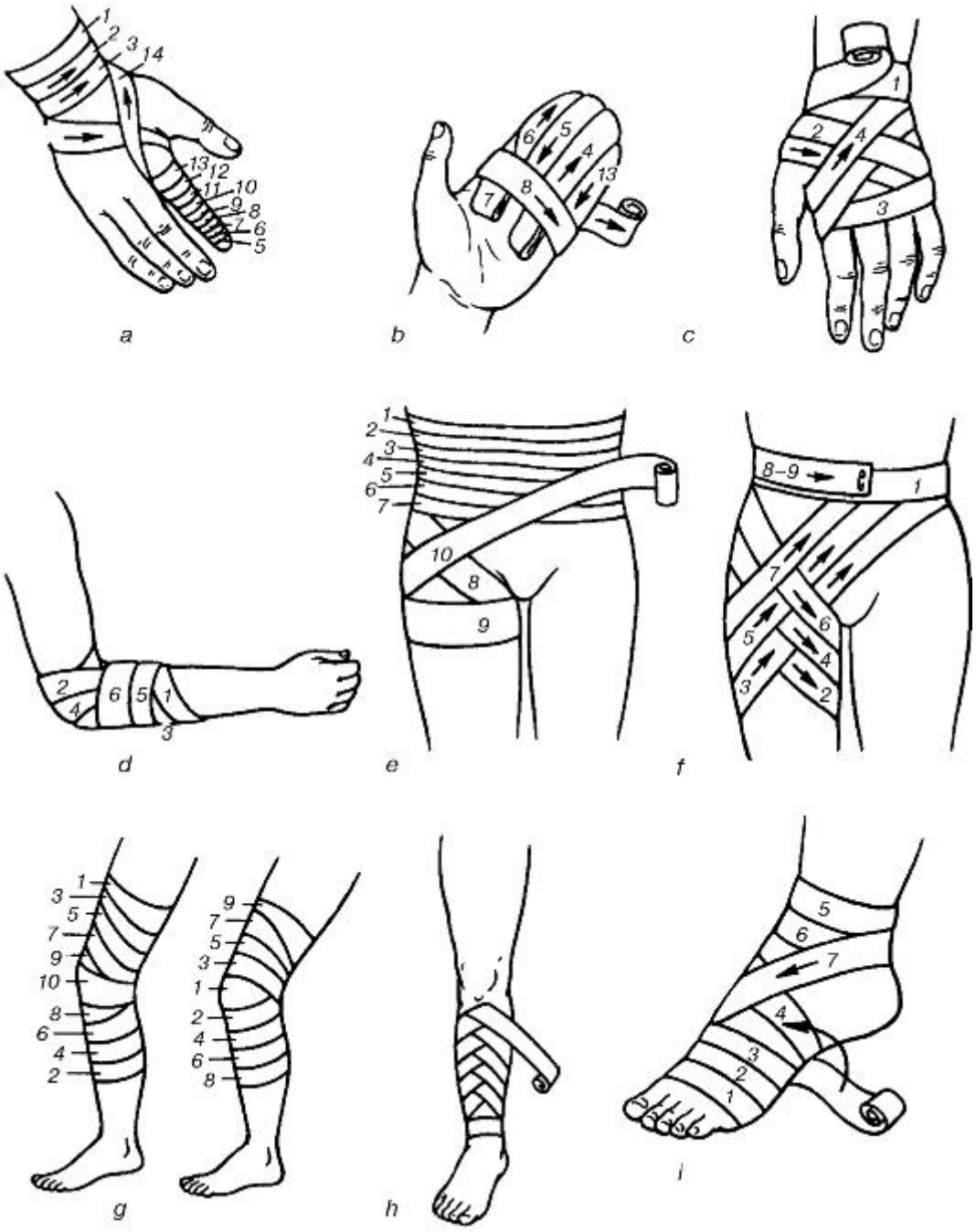


Fig. 42. Bandaging the upper and lower limbs: *a* - digital spiral bandage; *b* - hand bandage; *c* - hand cross bandage; *d* - converging elbow bandage; *e* - abdominal and hip bandage; *f* - inguinal bandage;*g* - «tortoise»-type knee bandage, converging (left), diverging (right); *h* - bent spiral bandage; *i* - foot and ankle bandage. Figures match the rounds.

Triangular bandage (fig. 44, 45). This is a triangle-shaped piece of cloth or scarf folded into an angle. The longer side is termed the base, the opposite angle being the apex and the other two sides - the base angles. If one-meter square of material is cut along its diagonal into two, two big triangular scarves are made, while division of these into two parts yields four small triangular scarves. Triangles are more convenient for giving the first aid. It is commonly used to support the arm in fractures of the forearm or in impacted humeral rod fractures.

Types of bandages applied depending on parts of the body

Head and neck bandages (see fig. 43). Circular bandages on the head are applied for minor injuries on the forehead, temporal and occipital regions. Returning bandages on the head

are used for widespread injuries involving the hairy parts. Their characteristic feature is that all the returning rounds are first applied and then fastened with ordinary circular rounds.

Galen's bandage is one of the simplest and most convenient forms of head bandage. It is started with the placement of a single piece of string of about one metre long: the middle of the string is placed over the temporal region, whilst the ends are left hanging anterior to the auricles. The patient is made to hold and slightly pull on the string, the first circular round is made around the head and then on reaching the string the bandage is wrapped around it and sent in a slanting manner across the occipital area. On the other side the bandage is again wrapped around the string and sent across the fronto-parietal region in a slanting manner partly covering the previously placed round. The subsequent ones are applied similarly, constantly heading upward towards the parietal region until the head is fully covered. The final round of the bandage is placed either circular around the head or fastened to the vertical string. The ends are fastened below the chin.

Hippocrates' cap is applied using a double-head bandage or two separate bandages. One of the bandages always goes circularly around across the forehead and occiput, fastening rounds of the second bandage covering the head from midline to the right and left. The ends are knotted at the occiput.

Bandage on the right eye. Circular horizontal rounds are applied around the forehead, thus fastening the bandage, and then it should go downwards to the occiput, below the right ear and across the lateral aspect of the neck and across the cheek bone upwards covering the sick eye. Oblique rounds are fastened with circular ones. The upward oblique rounds are later alternated with circular rounds.

Bandage on the left eye is applied in an atypical manner. The beginning of the bandage is held in the right hand and the head in the left hand. The next stages of bandaging follow the pattern described above but in the opposite direction.

Bandage on both eyes is started typically with the one on the right eye. A circular round of bandage is then done atypically from the right temporal region down over the left eye, followed by circular fastening rounds and subsequent alternating rounds covering the right and left eyes.

To cover the back of the neck and occipital regions a figure of eight bandage is used. A true circular bandage is rarely applied to the neck. This kind of bandage is commonly used in combination with either the figure of 8 tied on the forehead or with a cross bandage over the upper posterior chest wall.

Four-tailed bandage is a strip of material or a piece of gauze both ends of which have been slit open lengthwise. It is used to cover wounds on the chin, nose and occipital region.

Bandaging of the chest and shoulder girdle. Apart from the above-described circular, spiral, figure 8 and the spica bandages, special types of bandages are also applied to these areas (see fig. 41).

Bandaging of the breasts. When bandaging the right breast, the direction of the rounds is from left to right. The fastening round is passed around the chest beneath the breasts and on approaching the right breast the bandage grabs the lateral and lower parts of it. Then the round is sent to the sick armpit and across the back to the intact shoulder. Then it descends obliquely, lifting the medial part of the inflicted breast torwards the initial circular round on the chest. Further, these steps are repeated. When the left breast is bandaged, the direction is the opposite.

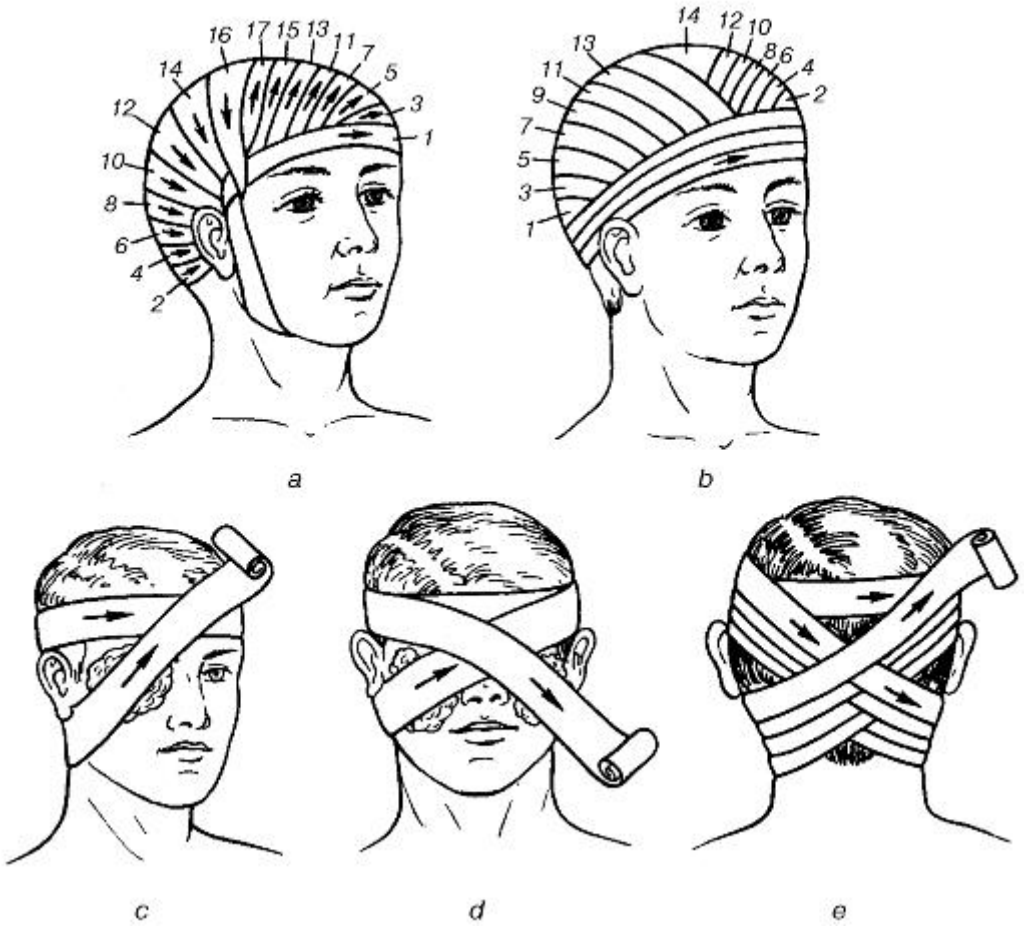


Fig. 43. Bandaging the head: *a* - head gear; *b* - Hippocratic cap; *c* - one eye bandage; *d* - both eyes bandage; *e* - occipital bandage. Figures match the rounds.

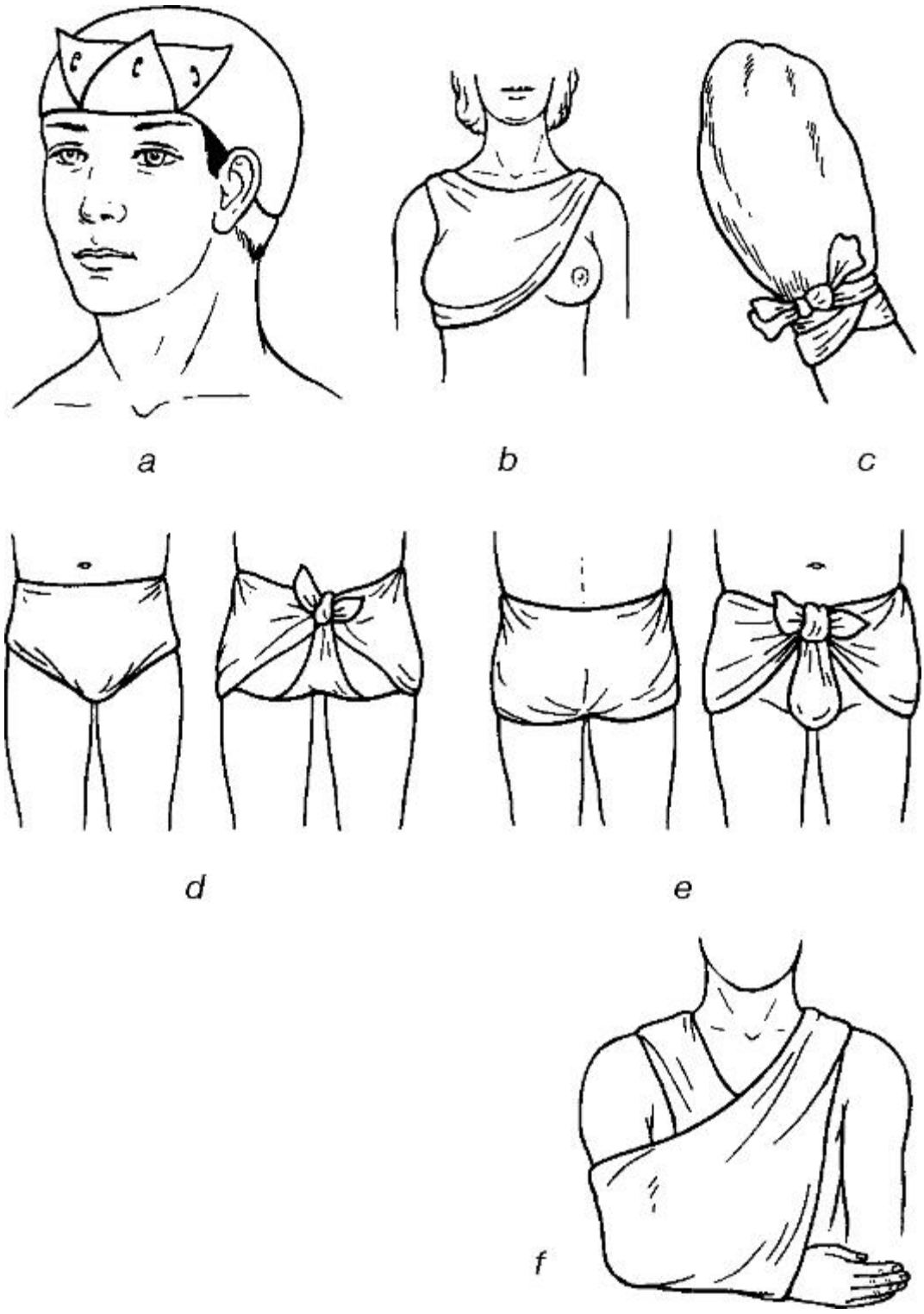


Fig. 44. Head (a), mammary (b), hand (c), perineal *(c, d)* and upper limb triangular bandages.

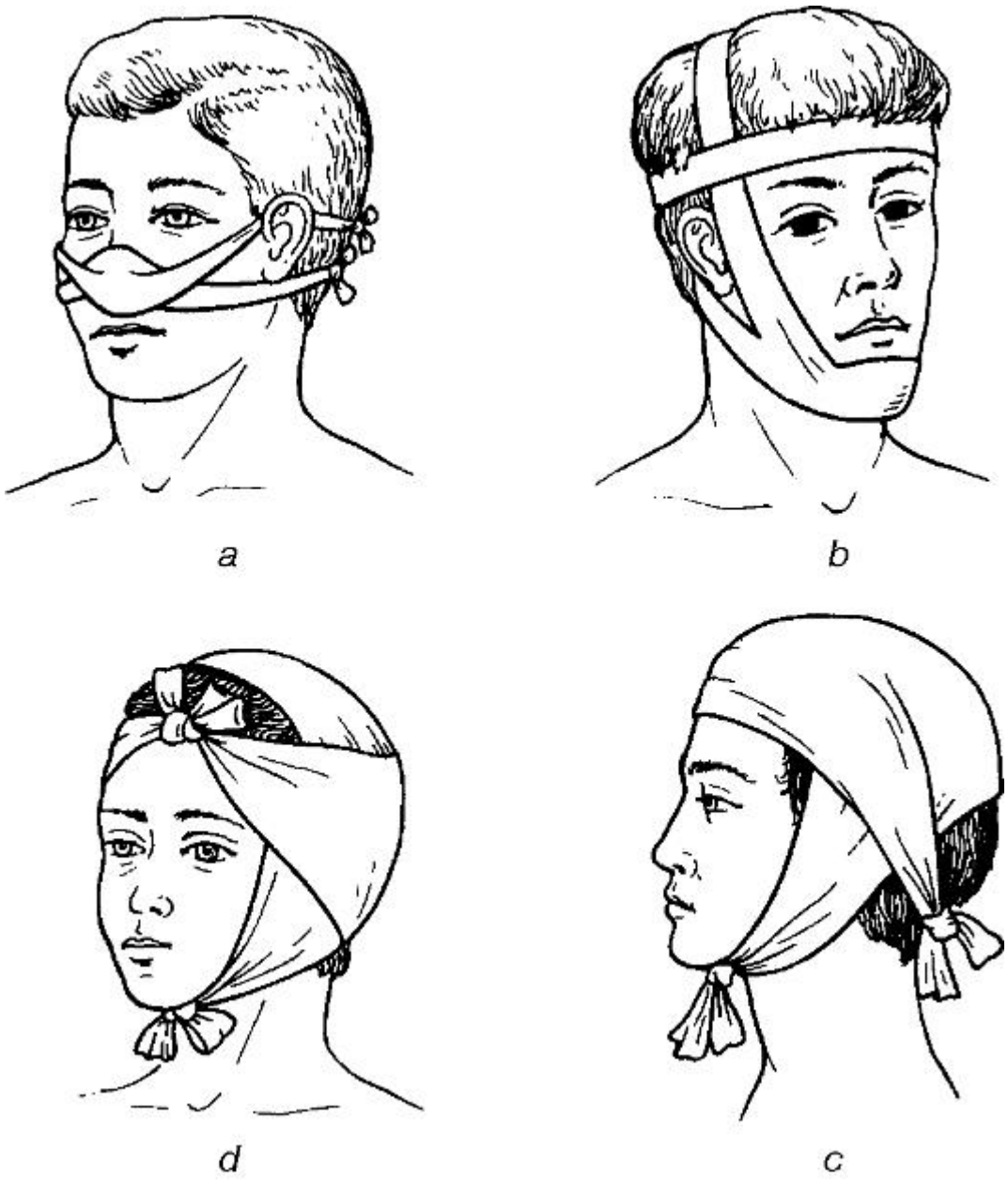


Fig. 45. Nasal (a), chin (b), occipital (c) and parietal (d) four-tailed bandages.

Velpeau's bandage is applied for fractures of the clavicle and after repositioning of a dislocated shoulder. In this process the arm on the injured side is placed on the intact shoulder and bandaged to the trunk. Bandaging is started from the injured side. The first round starts from the mid portion of the back, goes horizontally grabbing the chest and arm, under the armpit of the intact side, then the second round is passed across the back obliquely upwards to the injured upper shoulder and bending around it drops vertically down (third round), grabbing the elbow from below and is sent to the armpit of the intact side. All the three rounds are repeated making sure that the horizontal rounds are placed beneath the preceding ones, and vertical rounds placed medial to the previous one ones.

Bandaging of the abdomen and hip. To prevent slipping down, which is commonly the case, the spiral bandage is fastened with a spica bandage over the upper third of the thigh. Hip bandage is a variant of the spica bandage. A fastening circular round is initially applied across the abdomen above the umbilicus. From the lateral aspect of the abdominal wall, a downward course is then taken along the internal aspect of the thigh, bent around it from behind and rises on the lateral surface of the thigh to the anterior on the abdomen. The next round repeats the

previous one course but lies beneath. The bandage is fastened with a circular round across the abdomen.

Depending on the area of crossing, these bandages are applied to the inguinal region, upper third of the thigh, perineum, the gluteus region or on both sides.

Bandaging the upper and lower limbs. All the various types of bandages can be applied to these parts of the body (see fig. 42).

Spiral bandage of the finger. Using circular courses the bandage is fastened on the wrist and then sent obliquely along the dorsum of the fingers to the fingertips. Spiral bandaging is applied on the finger up to the base and along the dorsal aspect of the fingers it is returned to the wrist where it is fastened by circular rounds. When it is necessary to bandage all the fingers in the form of gloves, the courses are repeated as described for each finger.

To fasten a bandage, knitted tubes and elastic netting bandages can be used (e.g. *retylast,* or elastic netting material in the form of a stocking of different sizes available in rolls). To fasten the dressing on a wound, a one-layer elastic tube is put on. Over the finger - sizes 1 and 2 on the limbs - sizes 3 and 4; over the head sizes 5 and 6; on the trunk - sizes 6 and 7 are applied. Individual dressing packs are used for extensive injuries. The pack consists of two cotton-wool cushions of about 15x15 cm and a 9-cm wide bandage. One of the cushions is fastened stationary on the bandage, while the other one can be moved alongwise. The dressing materials are packed into a paper bag and into an airtight plastic bag which can be used for occlusion bandage in a penetrating chest injury.

When using a dressing packet, the plastic bag is torn or cut open to remove the paper envelope, which is drawn out by its safety pin and torn open to remove the bandage with cotton-wool swabs. The head of the bandage is held with the right hand and the bandage is unfolded without touching on the cushion surfaces. The mobile swab is moved to the required distance and placed on the wound or one on each side of the wound (the entry and exit sites) and fastened by circular bandaging. The end of the bandage is fastened with a safety pin.

Wound dressing

Dressing is applied to provide favourable healing conditions for a pathological process. It is used in cases when there is a defect in the skin covering (wounds, ulcers, burns, frostbites, necrosis, external fistulae etc.).

Change of dressing is performed for both therapeutic and diagnostic purposes, i.e. to determine the type, extent and course of the disease process, to determine complications, to probe fistula tracts, to perform fistulography etc. It is done in dressing rooms, or on dressing tables using surgical instruments.

The rules and regulations of asepsis must be abided by without infringement to avoid contamination of aseptic wounds, secondary infections of purulent (septic) wounds and burns. The dressing room nurse prepares for the manipulation as she does for the operation. She cleans her hands by means of one of the methods of scrubbing and wears sterile gloves, covers the dressing table with a sterile material (sheet) and arranges the required sterile instruments taking into consideration the workload to be performed. In case there are only a few dressings to be done, the nurse after laying the table can either help the doctor do some of the dressing or performs some of the minor dressing under the doctor's supervision. In a heavy scheduled set-up there should two nurses in the dressing room: one to give out the instruments and dressing materials and the other to assist the doctor in the procedure. The physician has also to scrub the hands and wear sterile gloves. In certain instances dressing is done by using instruments alone.

The main steps to change wound dressing are as follows: analgesia - anaesthesia, removal of the previous dressing, initial inspection of the wound, wound toileting and treatment of surrounding skin with solutions of iodine, iodonate, betadine, removal of wound discharge

(blood clots, necrotic tissue, foreign body etc.), repeated wound inspection, therapeutic or diagnostic manipulations, other procedures (instrumental investigations, wound washout, taking materials for wound culture etc.), repeated wound toileting if during the manipulation some pus is identified, removal of antiseptic solutions that need to be evacuated, cleaning the surrounding skin with iodine and lastly, application of the sterile dressing materials.

Change of wound dressing should cause minimal pain to a patient, which is of importance when certain therapeutic or diagnostic manipulations associated with pain are required (wound toileting, removal of necrotic tissue, instrumental examination of the wound, placement of a drainage tube or tamponade into the wound etc).

When changing the dressing anaesthetic and narcotic substances are used: injections of analgin, promedol, morphine, fentanyl solutions and occasionally short-acting inhalation (pentran, nitrous oxide, halotan + ether) or non-inhalation (hexenal, ketamin) anaesthesia (see "General Anaesthesia") are used.

In traumatic injuries (e.g. wounds, burns) the first dressing is normally applied by the patient, relatives or witnesses or by the medical personnel at the place of an accident. Such dressing is mostly aimed at arresting the bleeding and prevention of wound contamination.

When the bandage is soaked with pus or wound discharge or if the wound is contaminated by intestinal contents, urine and exudates, the change of dressing is indicated to prevent anaerobic infection. In case the secondary bleeding is suspected (the bandage is heavily soaked with blood) emergency change of dressing is also indicated to perform wound revision and control bleeding.

When removing a wound dressing one should aim at minimal tissue trauma. Otherwise, the procedure is not only painful but may also destroy the granulation tissue and cause bleeding. Scissors should be used to cut the dressing alongwise. Before removing the dressing dried to the wound it must be first soaked with antiseptic solutions (hydrogen peroxides, furacilin, solafur, potassium permanganate), or isotonic solutions of sodium chloride, or novocain. If the wound is on the limb, the whole limb can be put in a bucket or bowl containing the antiseptic solution to soak up the dressing. In some minutes, after the dressing has been well soaked, it is removed using some forceps and along the wound length.

After removing the dressing the wound is inspected, the type of wound, its character, the presence of bleeding, wound discharge, inflammation as well as the state of the regeneration process are all assessed.

The surrounding skin is then cleaned with one of the antiseptic solutions that are used to clean operative fields. If it is the first dressing of a freshly contaminated wound in a surgical setting up the indications for primary wound debridement are considered.

The first change of dressing after an aseptic operation is performed the following day after surgery. If the wound is dry with no signs of inflammation the dressing may be kept till the removal of stitches. Indications for the change of dressing are the onset of bleeding, signs of local or generalised infections (rise in body temperature, tachycardia, leucocytosis, wound discharge and pus)

Having removed the dressing from the wound with either primary or secondary sutures, the wound is inspected for signs of local infections (hyperaemia, oedema, redness of skin etc.); the condition of the sutures is also assessed (eruption, cutting through etc.). In normal suture conditions without any signs of inflammation 5% alcohol solution of iodine, or 1% alcohol solution of brilliant green, or 3-5% potassium permanganate is used to clean along the suture line, after this a sterile gauze dressing is applied and fastened with either glue, a tube or ordinary bandage.

Removal of sutures. If necessary, before sutures are removed the surrounding skin is cleaned from residual glue with a mixture of camphor spirit and ether, or 0,5% liquid ammonium or turpentine. To clean the wound along the suture line, alcohol or solutions of iodine or potassium permanganate are used. Forceps are used to pick the thread by the knot and moved slightly away from the skin until the stitch shows out from the stitch canal. The thread is held in that position and cut at the site that came out of the canal using scissors, then the thread is drawn out. When done in this way the possibility of infecting the stitch tract at the time of stitch removal is minimised. After removal of the sutures, 5% alcohol solution of iodine, or 1% alcohol solution of brilliant green, or 3-5% potassium permanganate is used to clean along the suture line and the wound. A sterile dressing is then applied.

Skin care during wound dressing is of great importance, especially in such cases as constant contamination by intestinal contents, pancreatic juice, bile, urine, in the presence of fistulae from different organs, as well as pus in extensive purulent infections, purulent fistulae, e.g. in osteomyelitis, chronic paraproctitis etc. When wound discharge constantly contaminates the skin it leads to its maceration, inflammation and ulceration. Macerated skin serves as an entry site for secondary infections.

To reduce the rate of contamination of the surrounding skin several forms of dressing materials are used - pelotas, intestinal prosthesis, obturating dressing etc. To reduce the irritating action of digestive enzymes, mainly that of trypsin, chemotrypsin, and pepsin which may cause skin maceration, agents that inactivate these enzymes are used when dressing the patient. For this purpose, decimolar solutions of hydrochloric acid, minced meat, meat stock, etc. are used. These are used to soak the dressing or irrigate the wound (through a microirrigator). 5-10% tannin, 3-5% potassium permanganate or 1% alcohol solution of methylene blue can be applied on the macerated skin. To reduce the skin irritation caused by the discharge from a fistula the surrounding skin can be smeared with Lassar cream, or zinc ointment during dressing. It can also be powdered with modified plaster of Paris, chalk, talcum powder. Cerygel or BF-6 (a sort of glue) can be applied to form a protective film on the skin. In severe skin conditions when the dressing does not provide appropriate skin protection, «open» wound treatment (i.e. without dressing materials) is recommended.

When dressing a septic wound, attention is paid to the type of wound discharge. In the presence of wound discharge (blood, pus, serous fluid, intestinal contents, bile, urine etc.), cleaning is done by using gauze swabs, tamponade, or napkins. The wound is washed with an antiseptic solution (3% hydrogen peroxide is preferable) using a syringe. Alternatively, the solution is just poured over the wound and dried with gauze swabs by way of blotting. Using forceps or by washing out bone sequestra, any as well as detached necrotic tissues are removed from the wound. In case the necrotic tissues are fastened necrectomy is done (see Chapter XIII).

To ensure the free flow of pus, wound discharge and exudates from wounds and cavities as well as the arrest of bleeding methods of drainage and tamponade (packing) are used. It is commonly performed during surgery. The necessity to drain or pack a wound while changing the dressing occurs when there is retention of pus or discharge in the wound and when there are signs of secondary haemorrhage. The functional status of the drainage and tamponade (position, patency and quality of the tampon) is checked when changing the dressing and if there is still the need to drain the wound, they are changed. When they are no longer needed the drainage and tamponade are removed.

The draining ability of gauze pack is limited to only a few hours. For the purpose of long-term drainage rubber or chlorvinyl tubes or other tubes with extra opening are used.

After wound toileting and cleaning the surrounding skin the drain is put and fastened with plaster strips in a position that will facilitate the outflow of contents.

The change of dressing is completed by bandaging on the wound or ulcer.

Transportation immobilisation

Providing immobility and rest for an organ, part of or the whole body during transportation of the patient to a surgical centre is termed *transportation immobilisation.* The aim of the transportation immobilisation is to prevent extra tissue and organ damage, development of shock during moving the patient and transportation.

Indications for the use of transportation immobilisation are bone fractures, injuries to the joints, major vessels, nerve trunks, extensive wounds, crushed extremities as well as infections of the limbs (acute osteomyelitis, acute thrombophlebitis).

The following are the main rules and regulations of transportation immobilisation:

• Immobilisation has to be done at the accident site, moving the injured person without first immobilising is not allowed.

• The patient has to be given analgesia (promedol, morphine) before immobilisation is started.

• Bleeding has to be stopped first by applying a tourniquet or some pressure dressing; an aseptic dressing is put on the wound.

• The splint is applied right to the clothing, if, however, the splint has to be applied to the bare skin, some cotton wool or napkin or the patient's clothes should be placed on the skin before the splint is applied.

• Two joints adjacent to the injured one are to be immobilised in extremity injury; if it involves the thigh, all the three lower limb joints are to be immobilised.

• In closed fractures, the extremity is slightly pulled along its axis during splint application, holding on to the distal part of the arm or leg and fastened in that position.

• In open fractures pulling is not allowed; the limb is fastened in the position in which it is found.

• If a tourniquet has been applied to the extremity before the splint, it must be seen to it that the splint bandage does not cover the tourniquet.

• In moving the injured person after immobilisation the assistant has to support the injured part.

In inappropriate immobilisation, the displacement of bone fragments during transportation and movement of the patient can turn a closed fracture into an open one. Also, mobile fragments can cause damage to the vital organs - major vessels, nerves, brain and spinal cord, thoracic, abdominal and pelvic organs. Extra injuries to the adjacent tissues can lead to shock.

For transportation immobilisation, standard splints (Kramer's, Dieterich's, pneumatic splints), vacuum immobilisation stretchers as well as plastic splints are used.

Kramer's ladder splint is universal. This kind of splint can be transformed to acquire whatever desired configuration desired. More variants are made by joining several Kramer's splints together. They are used to immobilise the upper and lower limbs and the head.

Dieterich's splint consists of movable outer and inner plates, plywood bases with metal brackets. This type of splint is used for fractures of the femur, pelvis and the knee joint. The advantage of this splint is that it serves to combine immobilisation with traction.

Inflatable splints comprise a double layer of airtight soft case with a closing zip. The soft case is put on the limb, the zip closed and air pumped into it through a tube, to make it firm. To remove the splint the air in it is allowed to escape and the zip opened up. This type of splint is simple and convenient, and transparent for X-rays. The splint is used for immobilisation of fractures of the hand, forearm, elbow joint, the foot, shin and the knee joint.

In the absence of commercial splints, they are made of available materials ex tempore: a board, ski, stick, or a door (for the transportation of patients with spinal injuries).

The standard Yelansky's plywood splint is used to immobilise patients with injuries to the head and the cervical spine (fig. 46). The splint folds are opened, cotton wool layers are placed over the side with the semicircular oilcloth bolster cloth to support the head. The splint is applied beneath the head and the upper part of the chest and fastened with belts to the trunk. The head is placed on a special hollow for the occipital region and is bandaged to the splint.

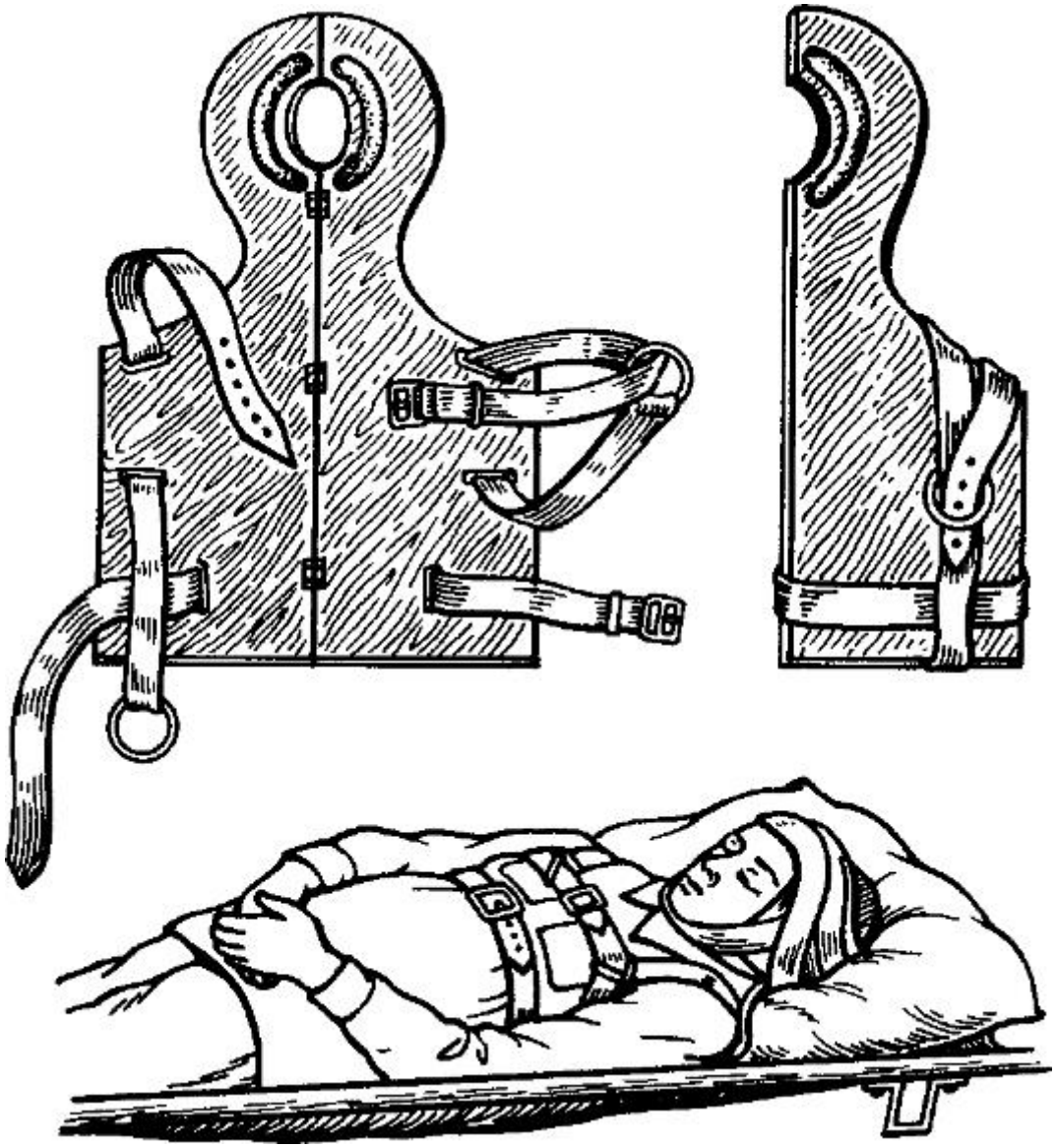


Fig. 46. Transportation immobilisation of the head and cervical spine using the Yelansky's splint.

To immobilise the head, a cotton wool, or gauze ring can be used. The injured person is put on the stretcher, the head placed on the cotton wool ring in such a way that the occiput is fitted in the hollow of the ring. The patient is then tied to the stretcher to prevent him/her from moving during transportation.

Cotton wool and gauze collars of the Shants type are used to immobilise patients with neck injuries like the if the patient is neither vomiting nor has difficulty breathing. Three to four layers of cotton wool are bandaged around the neck to form the collar, its upper part supporting the occiput and the mastoid processes, and the lower ones resting on the chest (fig. 47).

Immobilisation of the head and neck can be achieved by the application of the Kramer's splints that have been preliminary bent to fit the shape of the head. One splint is placed under the head and neck, the other one is folded into a semicircle, the ends of which press against the shoulders. The splint is then fastened with a bandage.

In case of a fracture of the clavicle, the fragments are immobilised with Desault's bandage, or a triangular bandage with a bolster placed in the armpit or with a figure of 8 bandage (see «Dressings»).

Fractures of the humerus and injuries to the shoulder and elbow joints can be immobilised by the application of a large ladder Kramer's splint that has been preliminary moulded on the physician (fig. 48). The limb is positioned as shown in the Figure with a bolster placed in the armpit. The splint fastens all the three joints of the upper limb. The upper and lower ends of the splint are secured with a tape of bandage, one end of which has been passed in front and the other under the armpit on the intact side. The lower end of the splint is hung on the neck using a belt or scarf.

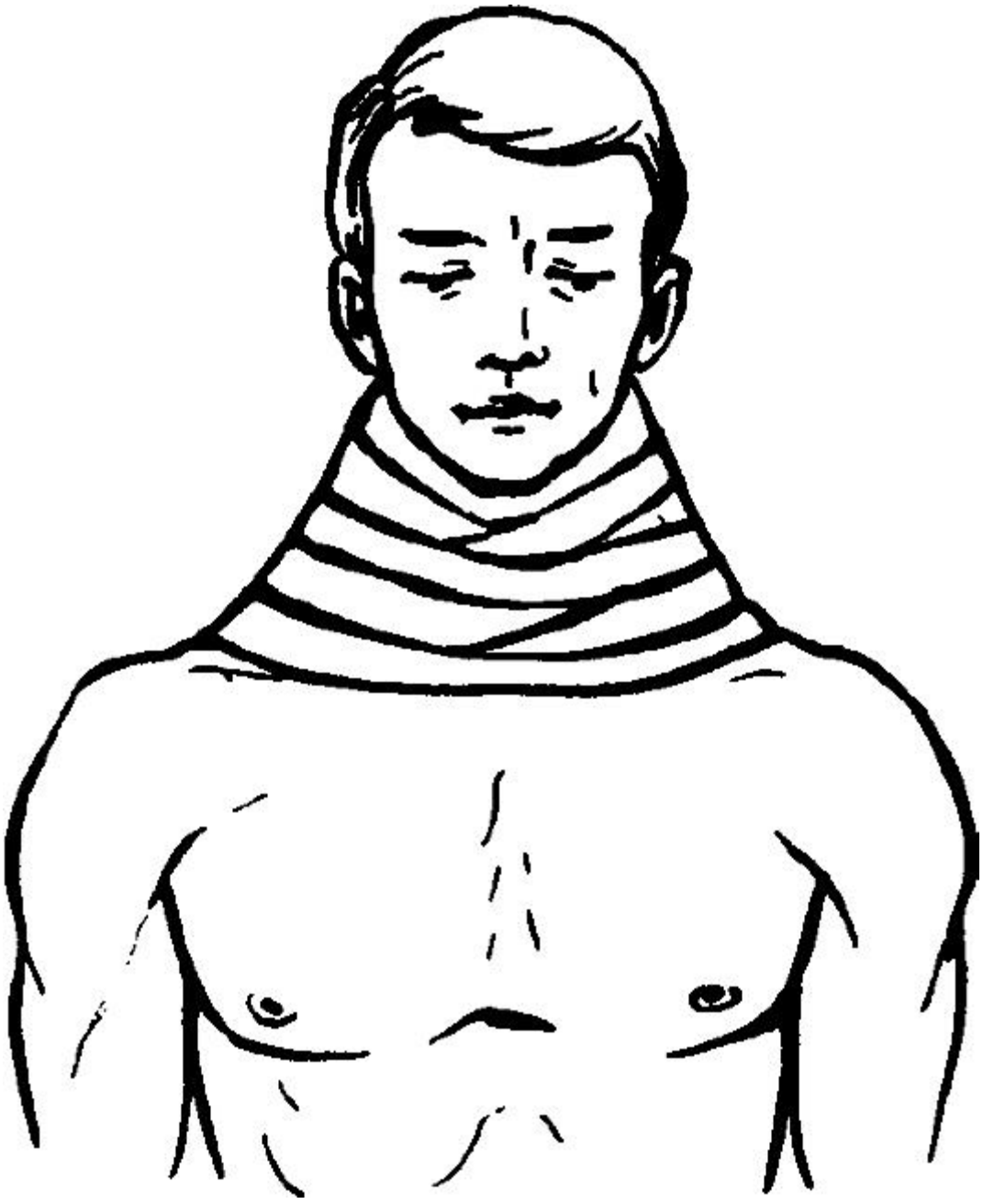


Fig. 47. Cotton-and-gauze collar for transportation of the patients with cervical damage.

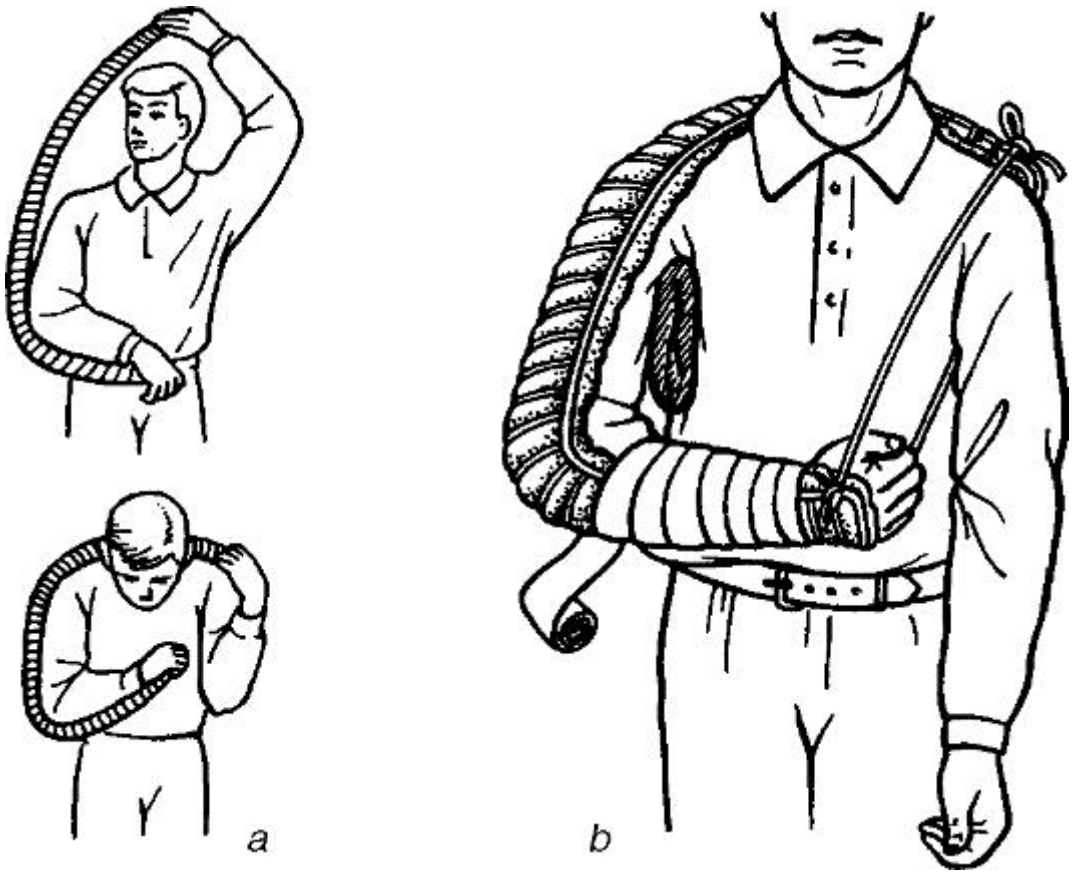


Fig. 48. Immobilisation of the upper limb using a ladder splint: *a* - modelling Cramer's splint; *b* - view after application of Cramer's splint.

In the absence of standard splints, fractures of the shoulder or humerus in the upper third can be immobilised to make up a triangular bandage. A small cotton wool-gauze bolster is put in the axilla and bandaged to the chest through the intact shoulder. The arm, which is bent in the elbow joint at 60^0, is hung on the triangular bandage, the arm is then bandaged to the body.

For the immobilisation of the hand and forearm a small ladder splint is used, onto which the hand and forearm are bandaged fastening the wrist and elbow joints. The arm is bent in the elbow joint and the hand after the application of the splint is hung on the scarf. In the absence of special splints the forearm can be hung on a scarf or immobilised with a board, carton, plywood with fixation of two joints as a must.

In femoral rod fractures, and those of the hip and knee joints, the Dieterich's splint is applied. The foot end of the splint is bandaged to the sole of the patient's shoe using a figure of 8 bandage. The external and internal plates of the splint are adjusted to the injured person's height by shifting the bracelets and fastening them by pins. The external plate is pushed to support against the armpit, and the internal plank in the inguinal region, the lower ends should appear beneath the sole for about 10-12 cm. The plate is passed through the cramp of the sole plate and stuck together with a collar. A string is passed through the hole in the sole and tied together on the screw stick. Several cotton wool-gauze pads are put on the ankle joints and on the plate of the clutches. The splint is fastened to the body with bandages and the planks are fastened to each other. The leg is pulled beyond the sole plates (fig. 49) and the screw board is screwed. The splint is bandaged to the leg and body. On the posterior aspects of the leg the Cramer's splint is placed and bandaged to prevent the leg form falling backwards.

For immobilisation of the injured, thigh Cramer's splints (fig. 50), which have been fastened to each other can be used, they are placed on the lateral, medial and posterior aspects. It is a must to immobilise the three joints.

Fractures of legs are immobilised with the Cramer's splint. Fixation is achieved by using three splints; making in that way the knee and ankle joints immobile.

The shin and knee joints are immobilised with the inflatable splint (fig. 51).

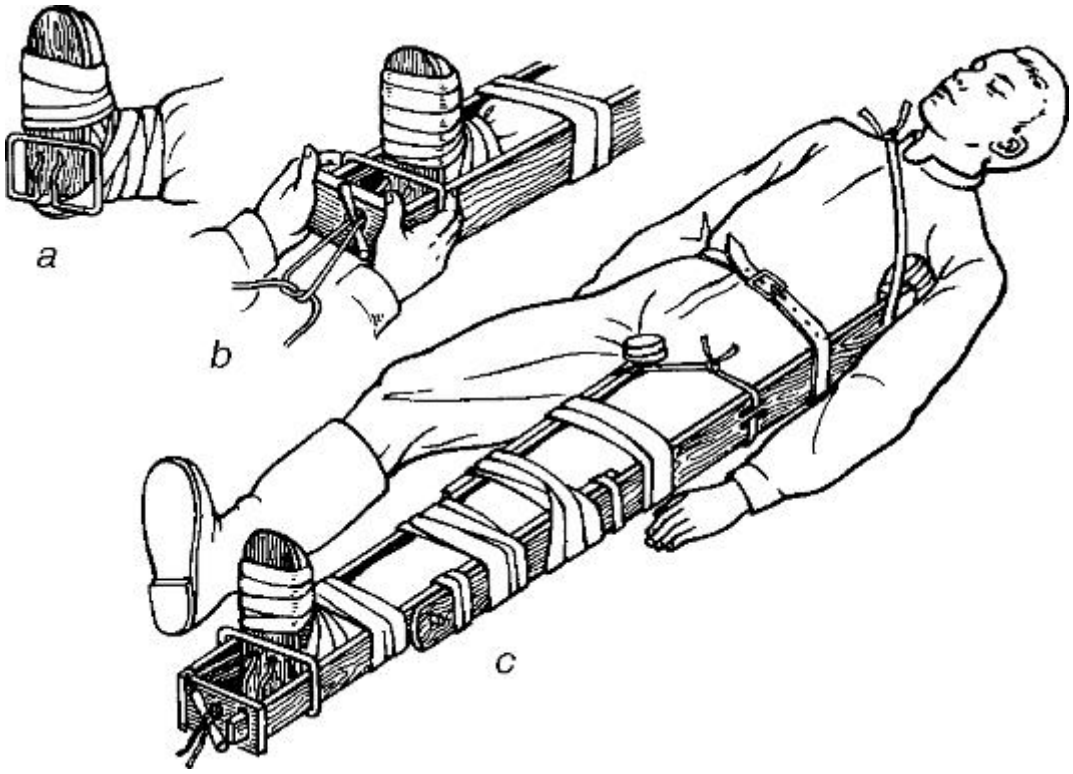


Fig. 49. Application of the Dieterichs' splint: *a* - plantar fixation; *b* - limb traction in the splint; *c* - the view of the splint applied.

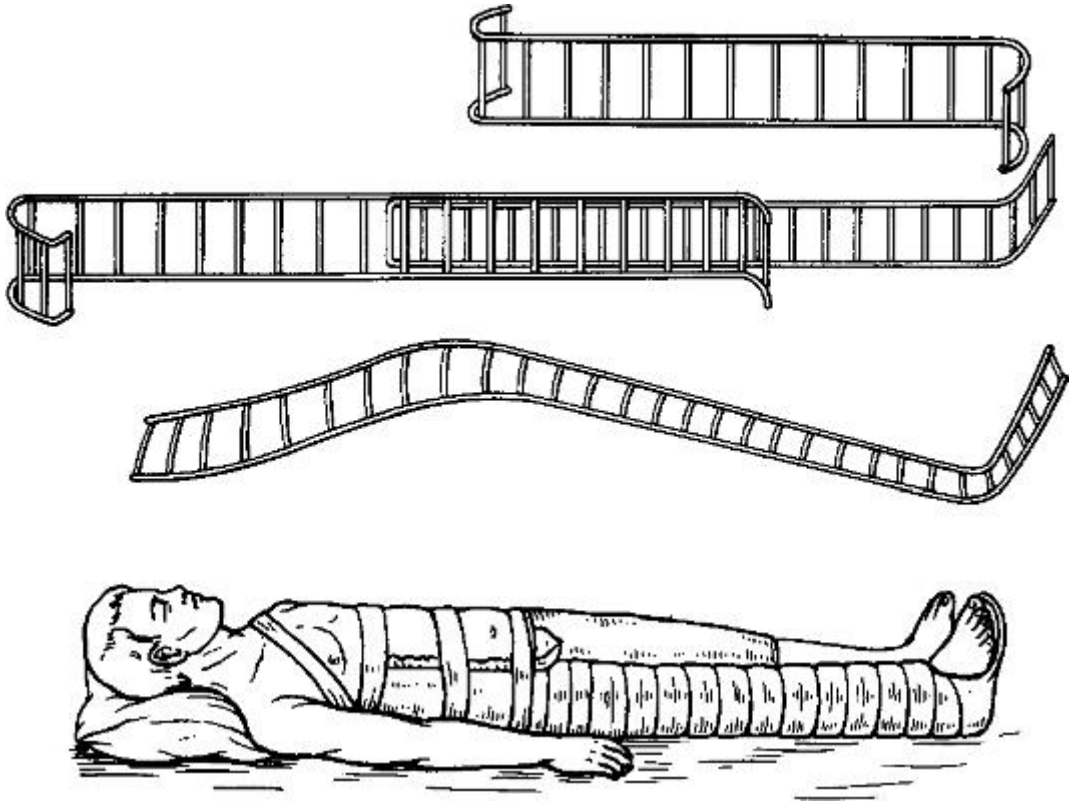


Fig. 50. Transportation immobilisation of the lower limbs using the ladder (Cramer's) splint.

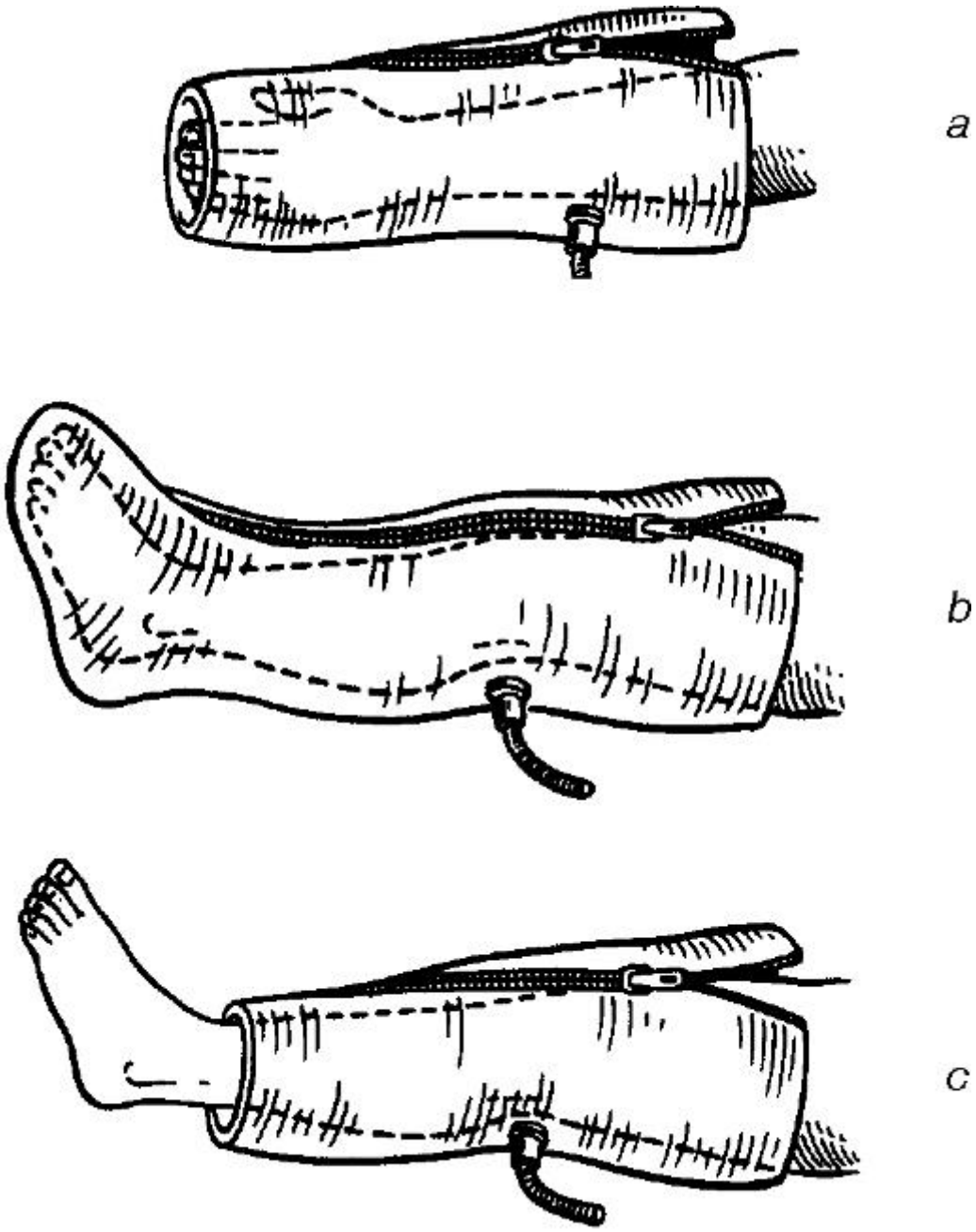


Fig. 51. Medical pneumatic splints: *a* - for the hand and forearm; *b* - for the foot and shin; *c* - for the knee joint.

In fractures of the pelvic bones the injured person is transported on a stretcher, a wooden board or plywood plate has to be put under it. The legs should be flexed in the hip joints, with some pads of cloth or pillow placed under the knees (fig. 52). The injured person is then tied up to the stretcher.

In fractures of the spine in the thoracic and lumbar regions, the injured person is transported on a stretcher with a board. The patient is placed supine with pads of cloth or pillow placed under the knees. The injured person is then tied up to the stretcher. In case the patient has to be transported on a soft stretcher he/she is made to lie on the stomach with some pad under the chest. In trauma to the neck and upper thoracic spines, the injured person is transported lying supine on a stretcher with a pad under the neck.

In severe injuries to the spine, pelvis, and severe multiple injuries, transportation immobilisation is done with vacuum immobilisation stretchers (VIS). The injured person is placed on a double airtight case on which and the mattress laced up. Vacuum of 500 mm Hg is

created in the case using a vacuum absorber. It takes about 8 minutes for the mattress to get firm due to cohesion of polyester foam granules contained in it, which constitute 2/3 of the volume. The patient is placed to assume the position required for transportation (e.g. half sitting position) during filling with vacuum (fig. 53).

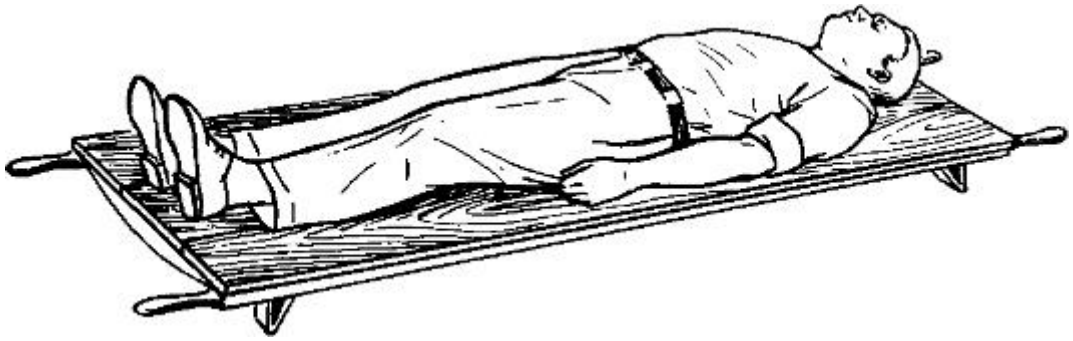


Fig. 52. Transportation of the injured with the spinal fracture using the board.

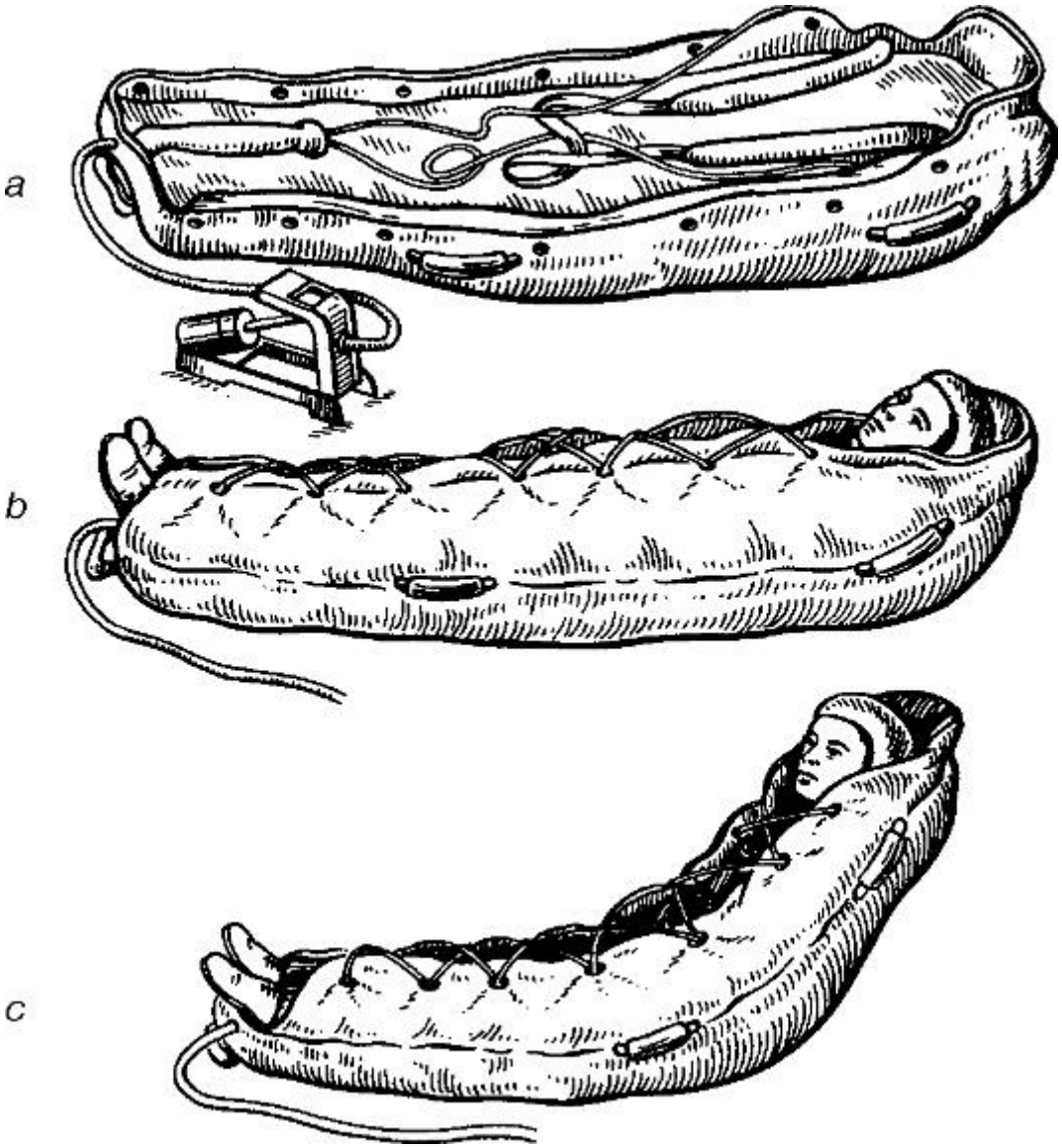


Fig. 53. Vacuum immobilisation stretcher: *a* - general view; *b* - stretcher with the patient lying inside;*c* - stretcher with the patient in a half-sitting position.

Closed soft tissue injuries

Closed injuries are mechanical injuries to the soft tissues (contusions, crushes, strains and ruptures) without defects in the skin covering.

Contusion. Contusion is a closed mechanical injury to the soft tissues and organs without apparent damage to their anatomical structures, in contrast to subcutaneous ruptures.

Contusions occur as a result of a fall or a blow from a blunt object with minimum kinetic energy (e.g. stones, parts of an object, instrument). Soft tissue contusions can be encountered alone or in combination with bone fractures resulting from severe blows, contused wounds. Most common are external (superficial) contusions of the limbs and head; they can also accompany contusions and other injuries (concussion, rupture) of internal chest, abdominal, cerebral organs. Clinical signs of contusion are signs, swelling, haemorrhage and functional disorder.

Pain is the first symptom of contusion, it appears immediately at the moment of injury and can be rather severe. Pain is especially intensive in contusion to the periosteum. Later the pain may reduce in intensity, and in 1-3 hours after injury reappears or even intensifies. The change in pain character, an increase in its intensity result from the traumatic oedema, haemorrhage (infiltration of tissues with blood) or from growing haematoma.

In limb contusions, movements in the joints are initially intact; progression of oedema and bleeding, however, make movements impossible, especially in haemarthrosis. It is the functional disorder that differentiates contusion from fractures and displacements when immediately after the injury both active and passive movements become impossible.

Swelling at the site of contusion appears fast. On inspection it appears as a painful induration without sharp borders with the intact tissues. Pain is more intensive on palpation when there is contusion of the periosteum, with subperiosteal haematoma. Swelling as a rule increases in the first hours or days after injury, which is as a result of the development of posttraumatic oedema and inflammatory changes.

Contusion is normally associated with bruises, which result from bleeding into (impregnation of) the skin and subcutaneous tissues. The time of appearance of bruises depends on how deep the damaged vessels are situated. In skin and subcutaneous contusions they appear within the immediate minutes or hours. In contusions of the muscle and periosteum, they appear within the 2-3 days and occasionally far from the contused area. The appearance of late bruises that are situated far away from the contused sites is a serious sign that requires extra investigations (e.g. X-ray to rule out bone fractures and cracks). An example is the sign of «spectacles» - bruises around the eyes, which occur in several hours or even two days after contusion of the head. This sign is strongly suggestive of a severe head injury, i.e. skull base fracture.

The colour of bruises changes as a result of disintegration of haemoglobin. Fresh bruise is of red colour, after 5-6 days it turns green, and then yellow. The colour of the bruise can be used to determine the duration of trauma.

When giving the first aid at the accident site a pressure bandage is applied on the contused site. During the first few days, ice packs are applied to the contused site to reduce bleeding into tissues. A break in the application of icepacks is done every 2 hours for 30-40 minutes. In contusion of the extremities with formation of haemarthrosis, the limb has to be put to rest in a raised position, with a pressure bandage applied to the joint. Starting from day 2-3 following trauma, to enhance the resolution of small haematomas, heat is applied (e.g. hot water bottles). In contrast, large haematomas are punctured after 5-7 days, blood is evacuated and pressure dressing applied.

In examining a patient with soft tissue contusion of the extremities, pulsation of the peripheral arteries must be checked; skin temperature on both limbs should be compared, peripheral nerve sensations should also be checked since contusions can be accompanied by nerve damage or the compression of nerve bundles by haematoma. If damage to the bone (e.g. fracture, crack) is suspected, an X-ray film should be obtained.

Crush syndrome. Crush syndrome (traumatic toxicosis; the syndrome of prolonged compression) is a condition typically caused by prolonged compression of the soft tissues of the limb, resulting in ischaemic necrosis of muscles, intoxication with the products of necrotic disintegration with subsequent hepatic and renal failures. The condition occurs after the limb has been freed from the compression. The following are the major factors of crush syndrome.

- Pain irritation.
- Traumatic toxaemia resulting from absorption of tissue disintegration products.
- Plasma and blood loss.

Clinically, the three periods of traumatic toxicosis are distinguished:

1. Oedema and vascular insufficiency (days 1-3).

2. Acute renal failure (days 3-12).

3. Recovery.

In the first period immediately after freeing the limb from compression, there is severe pain in the leg, which cannot be moved by the patient, weakness, and nausea. The limb is found to be pale, with multiple abrasions and bruises. The general condition of the patient can be satisfactory, skin colour is pale, slight tachycardia is observed and blood pressure is within normal limits. However, within a few hours the affected leg gets rapidly swollen. The limb size increases, the skin assumes an uneven bluish-purple colour with haemorrhages, blisters with serous or serosanguinous contents form. The pulse rate rises, blood pressure falls, body temperature increases, skin becomes very pale and the patient gets weaker, i.e. develops the clinical picture of shock.

On palpation, the limb is of wood-hard consistency, and pressing with the finger does not leave a mark. Movement in the affected limb joint is not possible, and an attempt at this causes extreme pain. Peripheral arterial pulse of the peripheral arteries in their distal parts is absent, all types of sensation are lost. Urine production quickly reduces (occasionally immediately after injury) up to 50-70 ml per day. Urine colour changes to varnish-red and later to dark brown with a high protein content (600-1,200 ml/l). Urinary sediment shows copious red cells, and casts consisting of myoglobin. Blood viscosity rises with an increase in haemoglobin level and red blood cell count, haematocrit and progressive uraemia.

The restoration of blood circulation and worsening signs of renal failure indicate transmission of the disease into the period of acute renal failure. Pain in the limb reduces, blood pressure returns to normal, moderate tachycardia persists, pulse matches the temperature of 37,5-38,5 °C. Despite the improvement of blood circulation, renal insufficiency worsens, oliguria progresses turning into anuria; the levels of blood urea nitrogen and creatinine are very high. Extensive tissue damage treatment may be ineffective and in such cases fatal uraemia may develop on days 5-7.

Favourable course, coupled with effective treatment, results in recovery. The patient's general condition improves, azotaemia reduces, the urine volume increases, and the casts and red blood cells disappear from the urine. With improvement in the general condition, pain in the limb that can be occasionally very intensive and burning sensation recurs, oedema resolves and sensation restores. Examination of the limb reveals a wide area of skin necrosis. Dull grey necrotised muscles that can be seen in the wound, disintegrate. The muscles progressively atrophy and movement of the limb becomes limited.

Treatment. As soon as the limb is rescued, the patient is given an injection of promedol or morphine; the injured limb is bandaged tight with either elastic or an ordinary bandage after which a transportation splint is applied. Signs of cardiovascular insufficiency evident before transportation require that the patient be first given ephedrine, norepinephrine, and an antishock blood substitute (e.g. polyglucin). On admission to hospital, adequate (to the disease's stage)

treatment is given. Antishock and detoxication therapy is started immediately. Antishock blood substitutes, solutions of albumin, sodium bicarbonate and plasma are given intravenously. 3,000-4,000 ml of fluid have to be given within 24 hours taking into consideration the patient's diuresis.

A circular novocain block of the limb is done on admission, after which icepacks are applied. The application of icepacks is continued for 2-3 days, after each 3-5 hours the ice is removed for $1_{1/2}$- 2 hours. Broad-spectrum antibiotics are given. The patient is closely monitored (measurement of blood pressure, pulse and the hourly diuresis).

In progressive oliguria, wide incisions of the damaged area are done. In the second period of the disease, when the patient is out of the shock, haemodialysis can be used to treat renal failure.

In the third period, treatment of the purulent wound, necrosis and gangrene is provided.

In life-threatening cases, amputation of the damaged limb is indicated.

Sprains and ruptures. *Sprain* is a joint injury in which some of the fibres of a supporting ligament are ruptured, the continuity of the former, however, remaining intact. If the elastic threshold is overcome, *rupture* occurs.

Sprain of the ankle joint most commonly occurs, mainly resulting from a twist of the foot, while the knee joint is only rarely affected. The clinical manifestations of sprain are similar to those of soft tissue contusion: local tenderness, tissue oedema and painful joint movements.

Treatment involves rest for the limb, pressure bandage, icepacks during the first few days followed by heat therapy to promote haematoma resolution.

Muscle rupture occurs in excessive muscle stress. Most commonly affected are as follows: the biceps brachii, quadriceps femoris, and gastrocnemius muscles. The clinical presentation is quiet clear: severe pain at the moment of the tear (as if struck by an electric shock), abrupt muscular paresis, local haematoma formation.

In partial muscle tear, the limb is immobilized with a plaster of Paris (POP) splint, the muscle being placed in a completely relaxed position. In biceps rupture, the upper limb is immobilized by bending it in the elbow joint at right angles. Rupture of the quadriceps requires that POP be applied with the lower limb in a straightened position; in gastrocnemius muscle rupture, the leg is bent in the knee joint. Immobilisation should last for 2-3 weeks, followed by physical therapy (massage and exercise).

In complete muscle rupture, the only treatment is by surgery, i.e. suturing the ruptured muscle with subsequent immobilisation of the limb for 2-3 weeks.

Tendon tear is accompanied by pain and joint dysfunction (inability to flex or extend depending upon the tendon affected). Most commonly it is the tendons of the fingers, hands, Achilles tendon and the tendon of the long biceps head that get affected. Examination reveals local tenderness and oedema.

Suturing the tendon is a usual therapy.

Fractures. Fracture is a break or interruption in the continuity of a bone, which is caused by mechanical exposure (trauma) or pathology (tumour or inflammation).

Classification of fractures

I. Based on the origin of fractures:

- congenital (intrauterine);
- acquired.

Congenital fractures, mostly multiple, are due to changes in the foetal bones or maternal abdominal trauma during pregnancy.

Acquired fractures are subdivided further into *traumatic* and *pathological* ones. The latter are caused by bone tumours, osteomyelitis, tuberculosis, echinococcosis and syphilis. *Obstetric* fractures that occur during delivery (passage through the birth canal) are also identified.

II. Based on the extent of organ or tissue damage:

- complicated;
- non-complicated.

Complicated (open) fractures are those with local damage to the skin and subcutaneous fat, which allows microorganisms to enter the wound and cause inflammation. Fractures accompanied by the damage to the major vessels, neural trunks, and viscera (e.g. the lungs, pelvic organs, the brain and spinal cord, joints) are all examples of complicated ones. It is noteworthy that closed fractures lack skin defects.

III. Based on the location of fractures, i.e. the position of the fracture line:

- diaphyseal;
- epiphyseal;
- metaphyseal.

IV. Based on the relation of the fracture line to the longitudinal axis of the bone:

- transverse;
- oblique;
- spiral.

Fig. 54 shows bone fractures depending on their mechanisms.

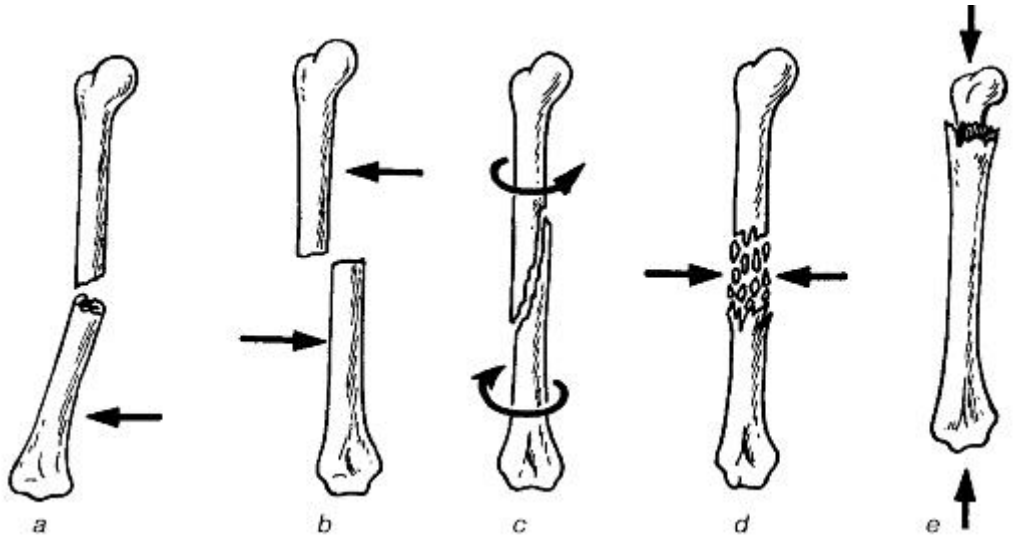


Fig. 54. Bone fractures depending on their mechanisms: a - due to flexion; *b* - due to a direct blow;*c* - due to twisting; *d* - due to comminuting; *e* - due to longitudinal compression. The arrows show the direction of the causative factor.

Physical examination

1. Complaints (pain and limb dysfunction are commonly the major complaints).

2. History.

Meticulous history taking helps elicidate the mechanism of trauma, the location and type of fracture. For example one's head hitting when diving can result in a fracture of the cervical spine; direct hitting against the bumper can lead to a pelvic fracture or fracture of the lower limbs; being run over by a car may cause fractures of the pelvis, thigh and leg bones; falling

from height on the buttocks or heels can lead to a compression fracture of the spine or fractures of the ischium bones; twisting the foot medially or laterally results in ankle fractures.

Both limbs have to be examined comparatively. All manipulations have to be performed carefully and gently.

Probable signs of fractures are as follows: pain and tenderness, swelling, deformity and dysfunction, while *absolute* ones involve pathological mobility of the limb at unusual sites and crepitation of bone fragments.

Pain is an indispensable symptom localized, as a rule, at the fracture site; it progresses on an attempt to move the limb. Firm but careful palpation with one finger away from the expected fracture site helps find out *tenderness.* Tenderness localised at one site is an important sign. It can also be established by making light knocks along the axis of the limb e.g. upon slight hitting on the heel, tenderness is elicited at the site of fracture on the thigh.

Swelling may be due to bleeding, haematoma, blood or lymph circulatory defect. The circumference of the affected limb may reach $1^1/_2$ as much as that of the intact side.

Deformation of the limb is elucidated on examination and depends on the angular displacements of the bone fragments. The limb can either be distorted or shortened. The distal end of the limb can be turned to either side (rotational displacement).

The longitudinal axis of the upper limb corresponds to the line joining the three sites of: heads of the humerus, radius and ulna with the fingers in supination. The axis of the lower limb also joins the three sites: anterior superior iliac spine, mid patella and the middle portion of the anterior surface of the ankle joint.

Inspection. Measurement and palpation of the limb help determine the location or displacement of the bone fragments. The rotation of the distal end of a limb without a change in its length is indicative of a rotational displacement of fragments; lengthening or shortening of the limb may be found in displacement along its length; change in the axis of the limb, i.e. an angular twist at the fracture site at an angle is indicative of an axial (angular) displacement and finally an increase in the limb's size the limb suggests a transverse displacement (fig. 55).

The exact type of the fracture and location of bone fragments of a fracture are established with X-ray pictures that are taken in two views.

Dysfunction is established by the extent of active movement in the limb. As a rule, the patient is not able to move the limb or part of it immediately after the trauma because of severe pain. The lying patient is asked to move the foot, fingers or bend the extremity in the joint (elbow, knee or shoulder). Even the attempt to move can occasionally cause severe pain.

Pathological movements are a reliable sign of a fracture. They must be assessed very carefully and gently so as not to cause further damage to the adjacent tissues and organs by the bone fragments. The peripheral part of an extremity is gently moved, whilst the mobility in the fracture site is observed. Swinging motions in the thigh, upper arm, forearm, shin indicate a fracture.

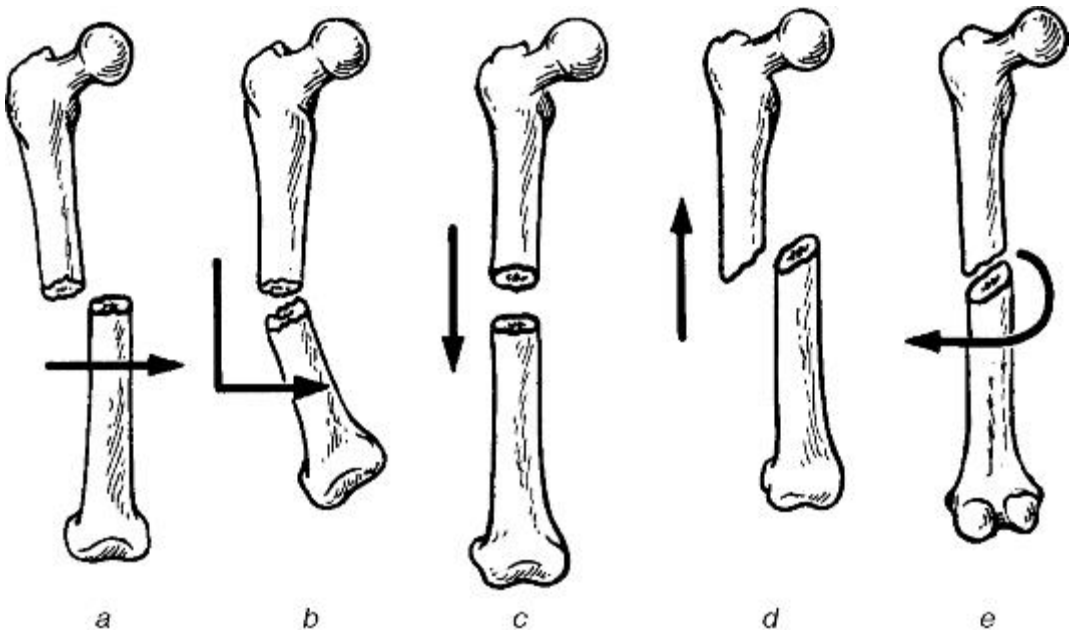


Fig. 55. Bone fragment displacements due to fractures: *a* - lateral; *b* - axial (angular); *c* - with prolongation of the bone; *d* - with shortening of the bone; *e* - rotational.

Crepitation of bone fragments is established by the hands. The limb is fastened above and below the suspected fracture site and moved in both directions. The appearance of friction sounds of bone fragments moving over each other is an absolute sign of a fracture. Because these two methods can cause further the damage to tissues, they are used only in extreme situations.

Clinical examination of the patient with fracture involves the measurement of limb length, determination of peripheral vascular pulsation, skin sensitivity, active movements in the fingers and toes to identify any vascular or neural damage.

Conservative treatment of fractures. Conservative methods are commonly used to treat fractures. In both conservative and surgical treatment of fractures the three main principles have to be followed.

1. Reposition of bone fragments;

2. Immobilisation of repositioned bone fragments:

3. Use of agents and physical methods that promote formation of new bone callus and bone consolidation.

The successful repositioning of bone fragments is achieved with adequate analgesia, which removes the reflective muscle contraction. Muscle contraction is the cause of the secondary displacement of fragments.

Anaesthesia in fracture cases is achieved by injecting solutions of novocain, lidocaine, or trimecain into the haematoma at the fracture site. To do this, the skin at the fracture site is cleaned with iodine solution. It is then infiltrated with novocain using a 10 ml syringe. After this a long needle is moved to the fracture site (fig. 56), 3-5 ml are injected, periodically checking for the presence of blood. The appearance of blood in the syringe is an indicative of the needle located in the haematoma at the fracture site. The injection of 20 ml of of any of the abovementioned 1-2% anaesthetic solutions provides for adequate anaesthesia at the fracture site for $1^1/_2$-2 hours. If the needle fails to get into the fracture site haematoma, it is removed, the site of fracture is determined once again and the procedure is repeated. If the anaesthetic solution is given not into the haematoma, anaesthesia is not achieved.

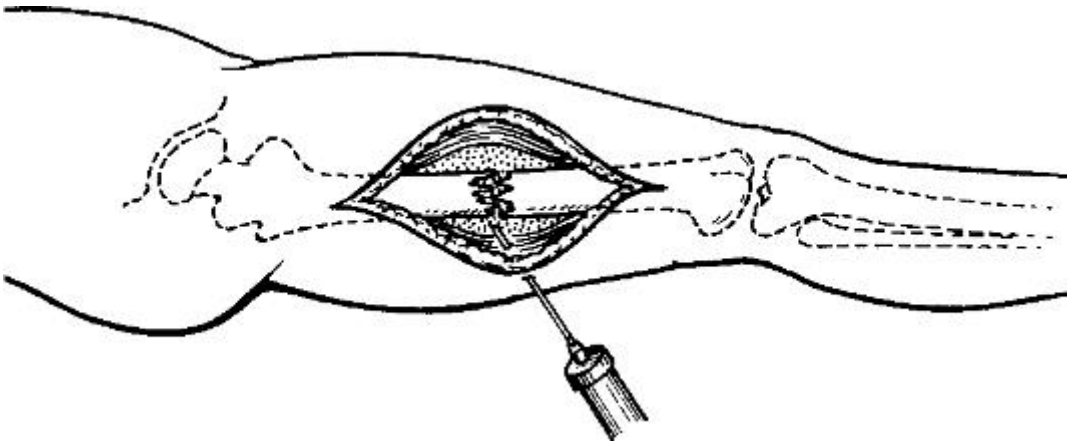


Fig. 56. Anaesthesia in femoral fracture.

In case it is impossible to give the anaesthesia to the fracture site, block anaesthesia above the site of fracture, or the conduction anaesthesia can be used. When local anaesthesia is inefficient the patient is given general anaesthesia.

Repositioning of displaced bone splinters involves their accurate resetting of the bone fragments along the fracture line to provide for further consolidation. The outcome of treatment will be restoration of limb function, which mainly depends on the accuracy of repositioning. To manage rotational displacement, the peripheral fragment has to be placed in its correct position in relation to the longitudinal axis of the limb, which is achieved by rotating the peripheral part of the limb in the opposite direction, i.e. by placing the limb along its exact axis. It is only in fracture of the middle and lower thirds of the forearm that the arm is placed in the midsite between supination and pronation.

Resetting an angular displacement of fragments is rather easy. One of the assistants holds on to the central fragment, fastening the hands on the central part of the limb. The surgeon pulls the distal part (below the fracture level) to restore the longitudinal axis of the limb (fig. 57). Replacing the fragments longitudinally occasionally requires enough strength, to be able to overcome the reflex muscle contraction that is most commonly seen in femoral fractures. The manipulation is done by traction along the limb's length and countertraction by its central part. In femoral and humeral fractures, the limb should be put in the median physiologic position: for the lower limb, flexed in the hip and knee joints at 140°; for the upper limb, drawn a little laterally at 60° and forward at 30°; in bending the hand at the elbow at 90° the forearm should be positioned between supination and pronation. To verify the restoration of its length, the limb is to be measured.

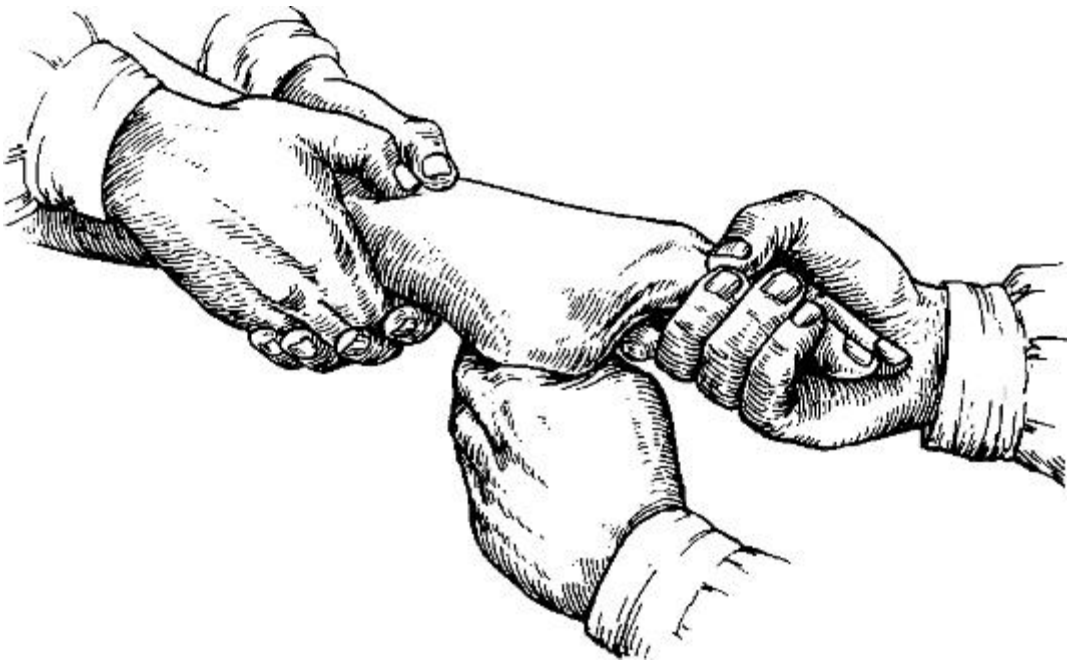


Fig. 57. Manual reposition in radial fracture.

To correct the displacement of fragments along the limbs is more difficult. The same manipulations of traction and contratraction are used in the median physiologic position of the limb. Interposition of tissues is commonly observed in transverse diaphyseal femoral and humerus fractures with displacement of splinters along the limbs. Repositioning is hampered by bone chips and projections along the fracture line. These types of fractures are a relative indication for surgical intervention, i.e. open reposition of bone splinters.

The reposition of bone fragments is occasionally done with a loop, cuff, and weight (fig. 58) or by a special apparatus (fig. 59), but it is commonly done by manual reposition or constant traction. The latter provides gradual repositioning of bone fragments, which is often the case in spinal fractures (fig. 60).

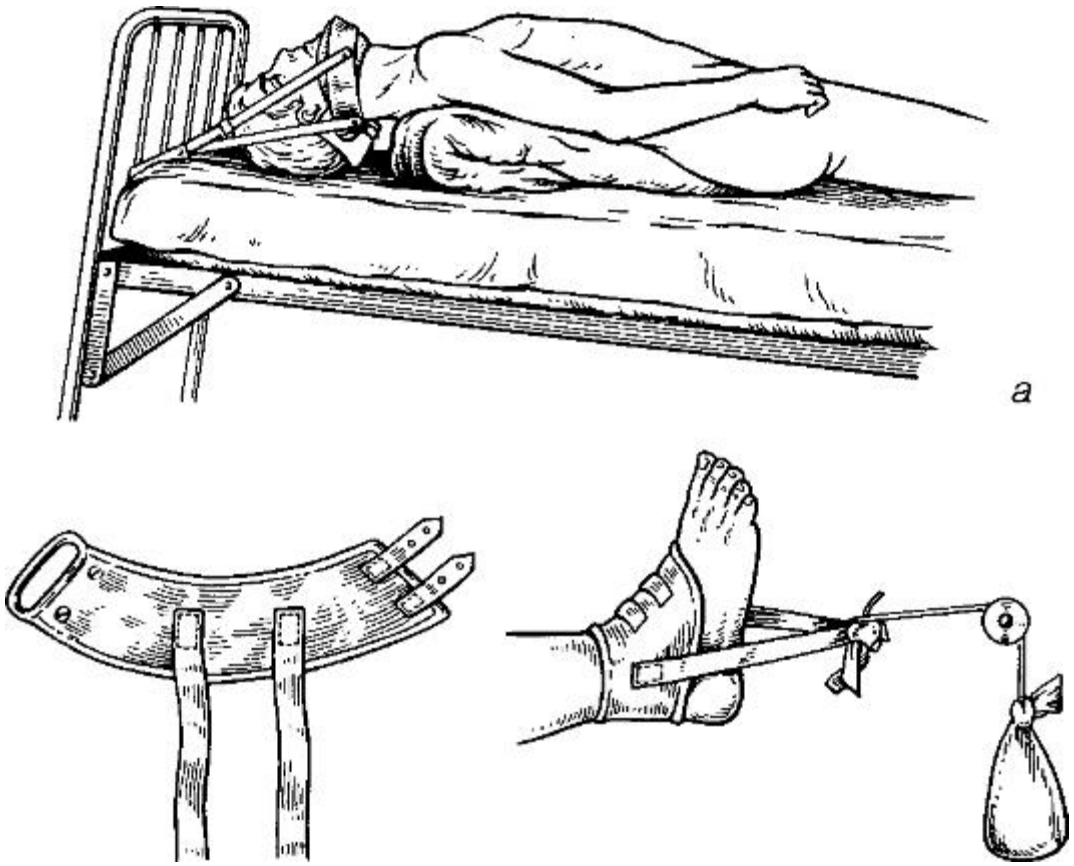


Fig. 58. «Soft» traction: *a* - using Glisson's sling for cervical spine fractures; *b* - using a gaiter.

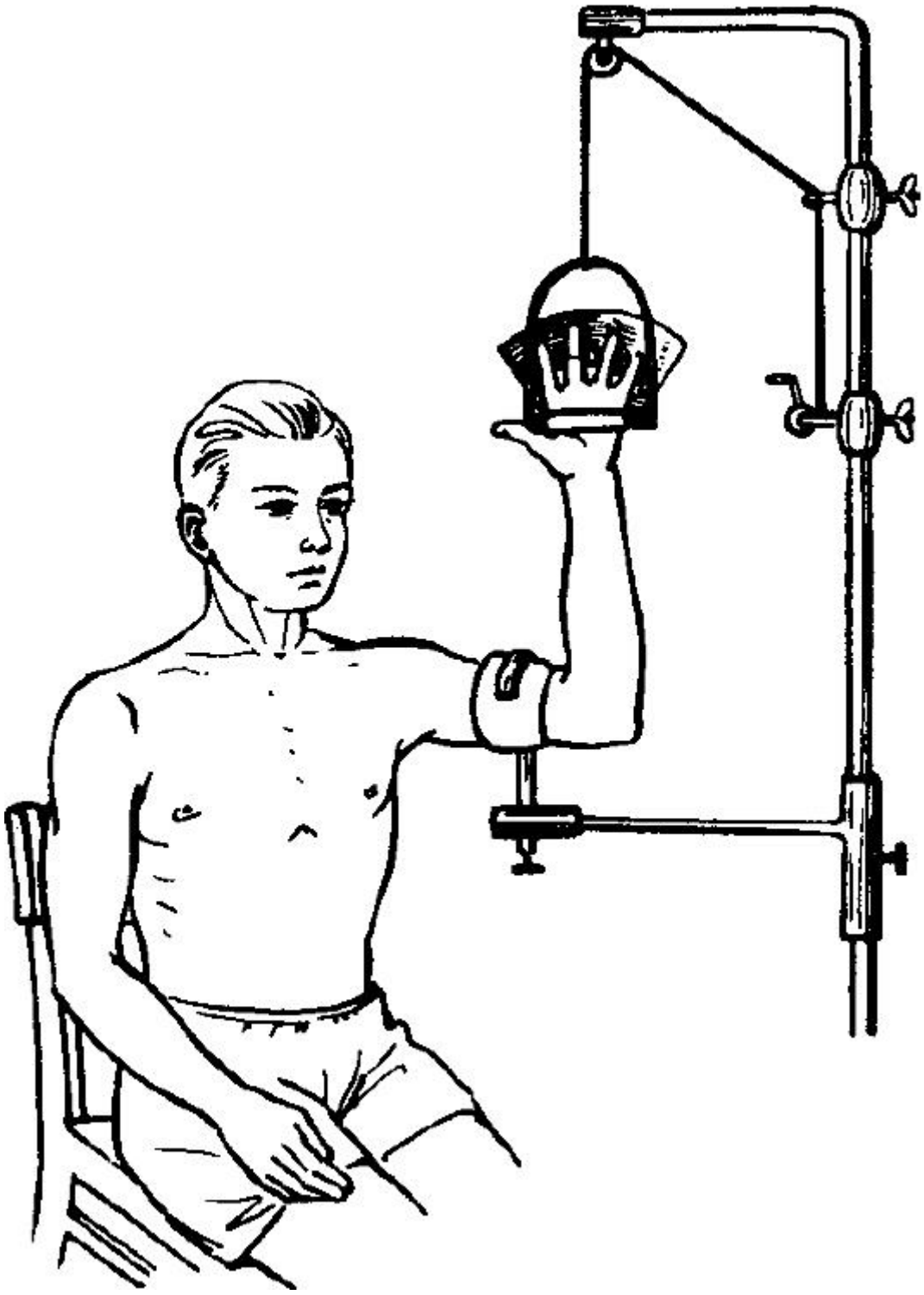


Fig. 59. Reposition in forearm fracture using Sokolovsky's apparatus.

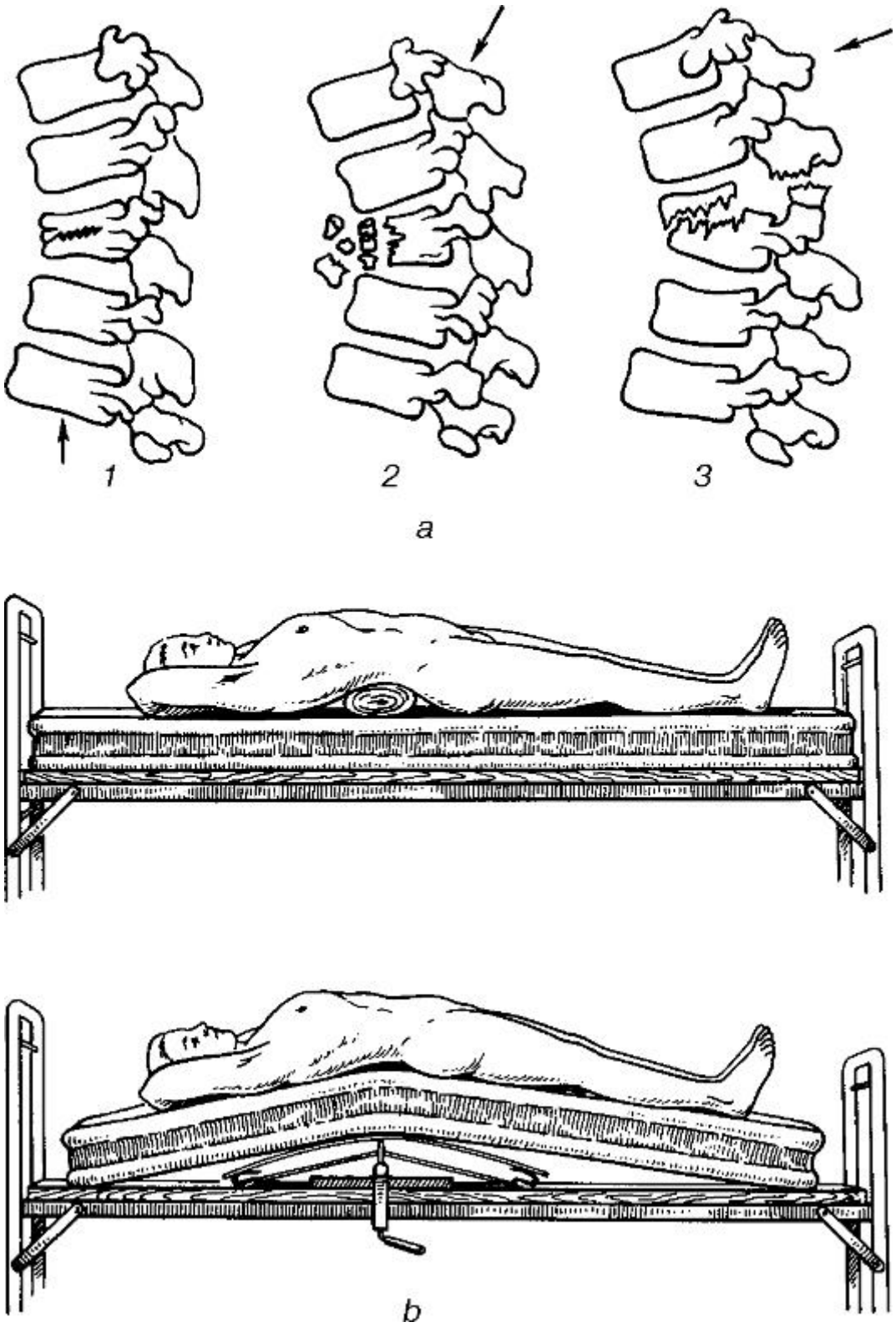


Fig. 60. Reposition in compression spinal fracture: *a* - types of flexion fractures of vertebral bodies depending on the direction of the causative factor (shown by the arrows); *1* - wedge-shaped fracture due to vertical compression; *2* - comminuted fracture due to sudden flexion; *3* - dislocation fracture due to flexion using horizontal anteposition; *b* - reclination.

The patient is placed supine on a special table with a steep slope and kept in this position for several days. The reposition of spinal fragments is thus achieved.

Immobilisation with plaster of Paris (POP). In the conservative treatment of fractures, the POP is widely used; it is the best material for external fixation of fracture fragments and limb

immobilisation. The POP is widely used both as a separate method of treating fractures and also to provide additional immobilisation in metal osteosynthesis and to prolong immobilisation following the removal of traction.

The POP (calcium sulphate) consists of tiny powder, which on mixing with water forms some porridge-like mass that hardens within several minutes. To do the dressing, bandages of the POP made with white gauze are used. Standard gauze bandage is 2,5-3 m long and is impregnated with the POP powder. Such POP gauze bandages are available in already prepared forms, packed into polyethylene bags, but they can also be prepared ex tempore. Before use, the POP has to be tested for its viability since it can loose its quality during storage. The viable POP is of a smooth consistency and void of lumps and grains. After squeezing it in the hand it should not form a lump with the finger marks but should easily scatter. The formation of lumps is an indication of an increase in humidity. The smell of rotten egg on mixing the POP with water suggests that it may not be used. An important property of the POP is the ability to harden quickly, which is tested by mixing equal amounts of the POP and water, the mass that is obtained, is moulded into a plate that should harden within 6-7 min and when broken, it should not crumble. To remove the lumps and grains the POP powder can be sieved. If the powder is very humid or hardens slowly, it can be heated in an oven at 120 °C to render it viable.

When the POP bandage is to be prepared manually, a gauze bandage is unrolled onto a table covered with a plastic cloth; the POP powder is spread onto it and rubbed into the gauze using the palms so that it covers the gauze like a thin film. The gauze impregnated with the powder, it is carefully folded into a loose roll, and packed flat into a box to keep the POP on the bandage and stored in a dry place.

When applying the POP, specific regulations are to be followed:

• the limb must be placed in a functional position;

• the bone fragments must be repositioned properly, the limb which being held firm during application of the POP until it hardens;

• the POP bandage must be applied to cover the two neighbouring joints;

• finger or toe tips must be left uncovered;

• cotton wool pads (non-hygroscopic type, which is more elastic and does not get soaked with sweat) must be placed under bone projections;

• the POP must be well moulded and put evenly but it should not compress any underlying part of the body;

• after application a POP bandage must be marked: the date of fracture, the date of application and the supposed date of its removal are noted down on the POP bandage.

The POP bandage on the thigh and hip joint and the POP «bed» are applied on special orthopaedic tables whose construction ensures immobilization of repositioned fragments both using countertraction and manual traction (fig. 61, 62). In the absence of such a table, this type of the POP bandage can be applied on a dressing table using special supporting stands.

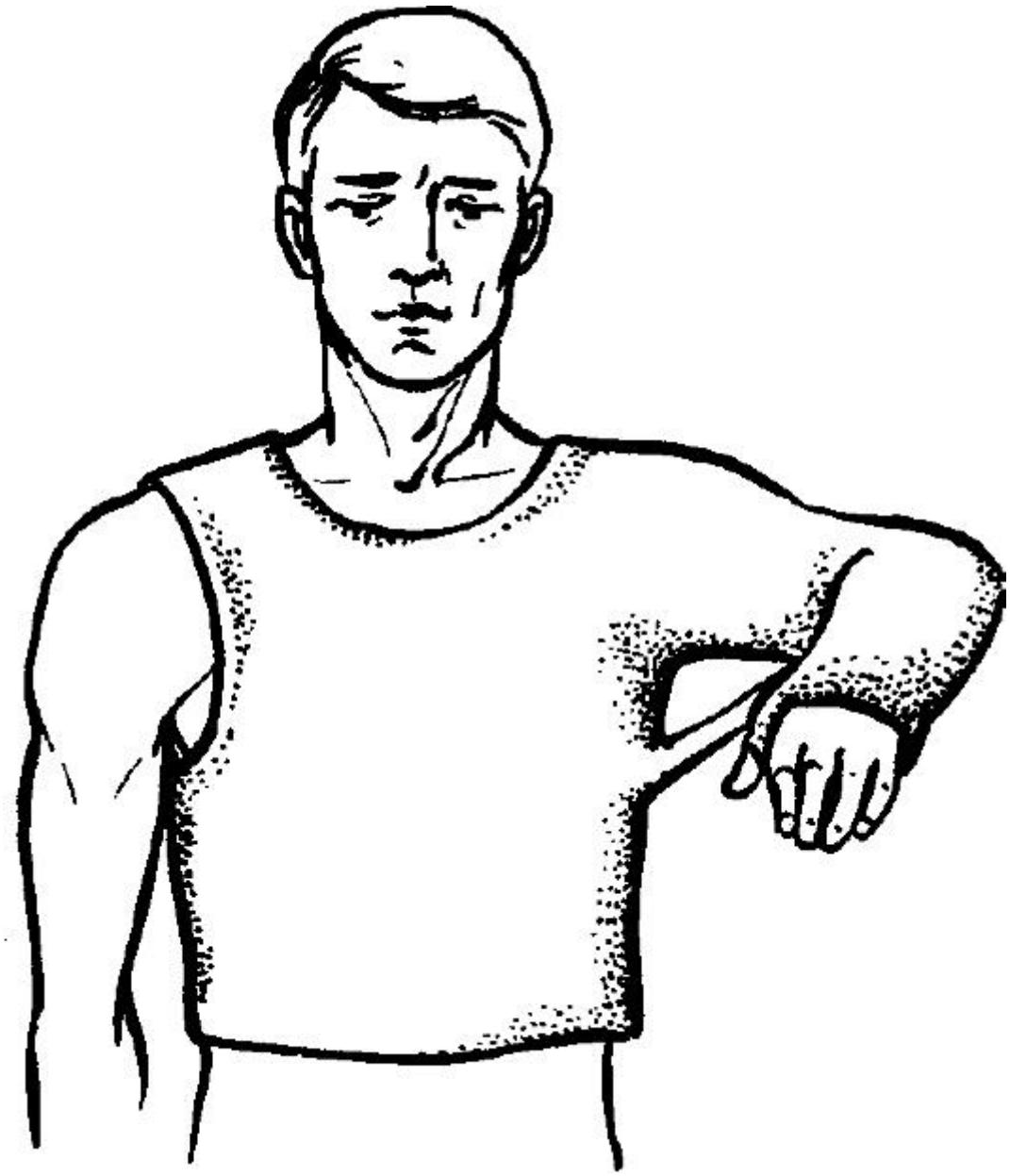


Fig. 61. Plaster bandage in humeral fracture.

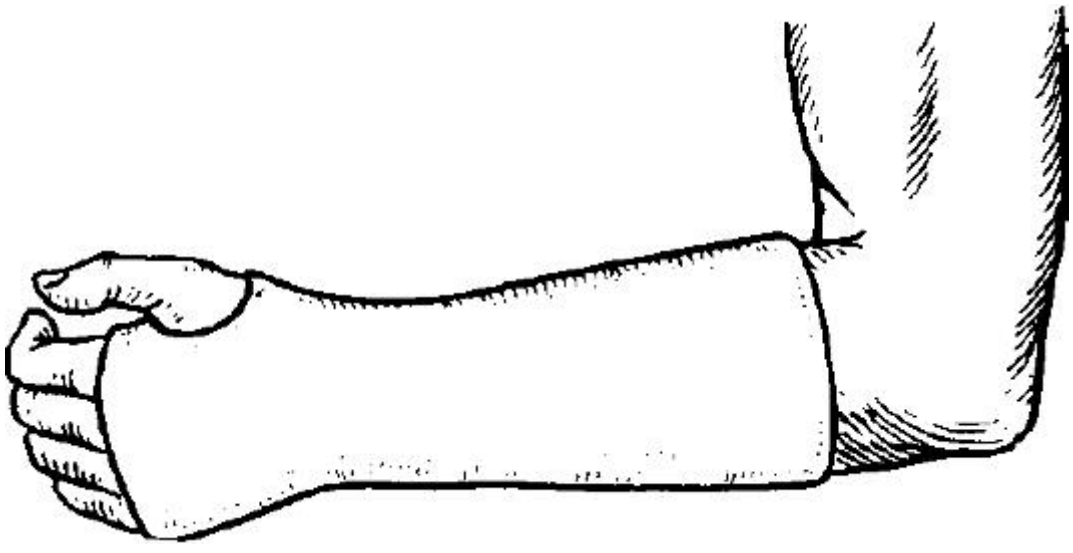


Fig. 62. Plaster bandage in radial (Colle's) fracture.

The following types of POP bandages are identified: plaster bar, circular, plaster bar circular. Best of all is the combined plaster bar circular type which does not require cotton wool padding on the whole length but only on bone projections to prevent pressure sores. In purulent fistulas or a wound on the limb, a window is left in the POP bandage for observation and change of dressing and pus removing. Such type is known as fenestrated plaster bandage. Occasionally, the POP bandage consists of two parts joined together by one, two or more bridges (the bridged type).

A bowl containing water at the temperature of about 20 °C is used to wet the POP bandage. To prevent the POP powder from falling off the bandage has to be handled and put carefully into the water. While in the water the POP bandage should not be folded or squeezed roughly. It takes about 1,5 - 2 minutes for the POP bandage to get fully soaked with water. It is taken out of water by the ends using both hands and slightly twisted to remove the excess of water, it is then straightened for use.

To apply a plaster bar or plaster bar circular bandage, the plaster bar of the required length is made, having initially measured the length of the injured leg with a piece of a gauze bandage. The measure is placed on a casting table and the soaked bandages of the same length are unrolled, straightening each layer with the hands, and laid one over another. Not allowing the POP to harden the plaster is placed on the patient's injured limb, moulded and fastened with a soft roller gauze bandage. When applying the circular plaster bar bandage, the plaster bar is fastened with spiral turns of plaster bandage. Bandaging should be neither tight nor loose, no folds or bents are allowed; each new turn is smoothed out with the palm. Plaster bars can be made into different thickness: thin (3-4 layered) - for the upper limbs and thick (6 -8 layered) - for the lower limb. To apply and fix a circular plaster bar bandage on the upper limb 2-3 layers of plaster bandage are needed, on the shin - 5-6, on the thigh - 6-8 layers. The plaster bar has to be constantly held by the assistant. Occasionally two assistants are needed: one holding the limb, to prevent displacement of the fragments, the other holds the plaster bar and helps in the application. The assistant holding the plaster bar should do it with the hands and not only the fingers to keep it smooth and thus prevent pressure sores. While the plaster bandage is hardening, it is thoroughly moulded at the fracture site and on the bone projections. The bandage applied of POP, the limb is placed on an oil-cloth pillow.

Transportation of the patient is not allowed until 25-30 minutes after the procedure, which is enough for the plaster to harden and thus avoid bandage deformation and another displacement of bone fragments.

The application of a circular plaster bar bandage to the fractured shin (the tibia and fibula) may serve as an example. A back plaster bar is prepared from the end of the toes to the mid-third of the thigh using a 5-6 layered POP bandage. One of the assistants holds the straightened leg, the foot being held at right angles. The plaster bar is put on the back of the leg to cover it from the upper end is at the mid-tlurd of the fligh to the lower end of the bar going about 2-3 cm further beyond the tips of the toes. Holding the bar in that position it is fixed with 4-5 circular turns of the POP bandage. The bandage is thoroughly moulded around the ankles, Achilles tendon and at the knee. The patient is placed in the bed with a wooden board put under the mattress to prevent deformation of the plaster bandage. It takes 1-3 days for the plaster bandage to get dry at room temperature (depending on its thickness). To make it quicker, dry air (fan) or an ordinary electric lamps can be applied.

After the application of a POP bandage the patient's condition must be monitored, including the condition of the limb. The allerting picture commonly involves complaints of pain in the leg and local pressing sensation, tachycardia, fever, and a change in the condition of open fingers as well as other areas free from the bandage. These are serious symptoms and signs and may require immediate measures to be taken. Oedema, cyanosis, cooling, sensory disorders and the disturbance of active movement of the fingers or toes of the limb indicate that the plaster

bandage is too tight, which brigs about venous stasis. In such a case, the POP bandage has to be either cut through partially or in full length and the edges turned back to both sides. In case of a fast increase of oedema, the bandage has to be cut along its length rapidly. If the fingers or toes return to normal colour, the POP bandage is fastened by several turns of the plaster bandage.

Localised pain is indicative of pressure sores. In such a case, the bandage has to be cut at that place and the edges turned back to the sides. The severe sensation of pressure in the limb, local pain, rigors, fever, tachycardia, regional lymphadenitis, oedema of the areas above the bandage and signs of severe intoxication are all manifestations of anaerobic infection. The POP bandage must be removed immediately, the wound inspected and emergency measures taken to treat the gas gangrene (see «Wounds»).

Localised pulsating pain, fever, tender and enlarged regional lymph nodes and leucocytosis are signs of local purulent infection.

After the fracture has united, the POP bandage is removed. A special type of scissors or a plaster saw is used to cut the POP bandage in its length, its edges are opened wide and the limb is taken out carefully so as not to damage the soft bone callus that has formed at the fracture site. The limb is washed with water and soap and abrasions treated with iodine solution.

The method of constant traction. This method ensures both reposition and maintenance of the repositioned fragments. Its variants are skin (fig. 63) and skeletal traction. The latter is most effective. Using the method of constant traction, the following has to be taken into consideration:

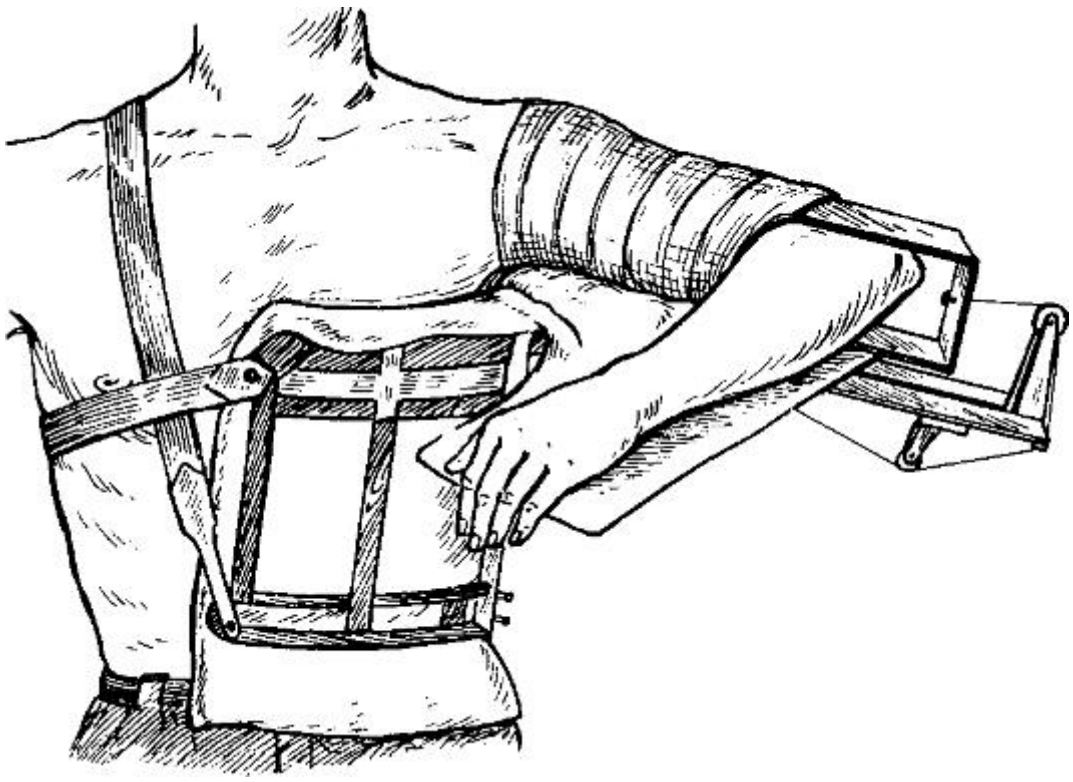


Fig. 63. Skin (plaster) traction using CITO splint in humeral fracture.

• traction has to be done with the limb in the median physiologic position, i.e. there should be the equilibrium between antagonistic muscles. This is achieved by placing the semi-flexed limbs on a Bahler's or Bogdanov's splint (fig. 64);

• resetting has to be done along the axis of the central bone fragment, i.e. the peripheral fragment has to be placed along the axis of the central one;

• the weight for traction has to be added gradually, which provides a painless traction on the muscles and reposition of the fragments;

• it is necessary to establish a countertraction, which is achieved for example by raising the foot end of the bed treating lower limb fractures. In such a position, the weight of the patient establishes countertraction.

To perform *skeletal traction* (fig. 65), the following set of sterile instruments is required: Kirschner's wires or extension wires for skeletal traction, a special hand or electric drill for passing a wire. The wires are passed in the operating theatre. After anaesthetising the fracture site the patient's limb is placed on a therapeutic Border's splint. The operative field is cleansed according to the generally accepted principles and the site locally anaesthetised: the skin is infiltrated with 0,5% novocain, then the subcutaneous, periosteum: first at the entry site and later at the site of exit of the wire in that same order. In femoral rod fracture the wire is passed through the area just above the projections of the condyles, which corresponds to the upper edge of the patella or behind the tuberoses of the tibia bone - at 1,5-2 cm backwards from the most prominent part of the tuberoses. The wire is passed from external towards the medial. In fractures of shin bones, the wire is passed through the calcaneum - 3-4 cm posterior and below the ankle. In fracture of the humerus, the wire is passed through the olecranon through a site located at 2-3 cm distally from its apex of the process and 1-1,5 cm deeper from its surface.

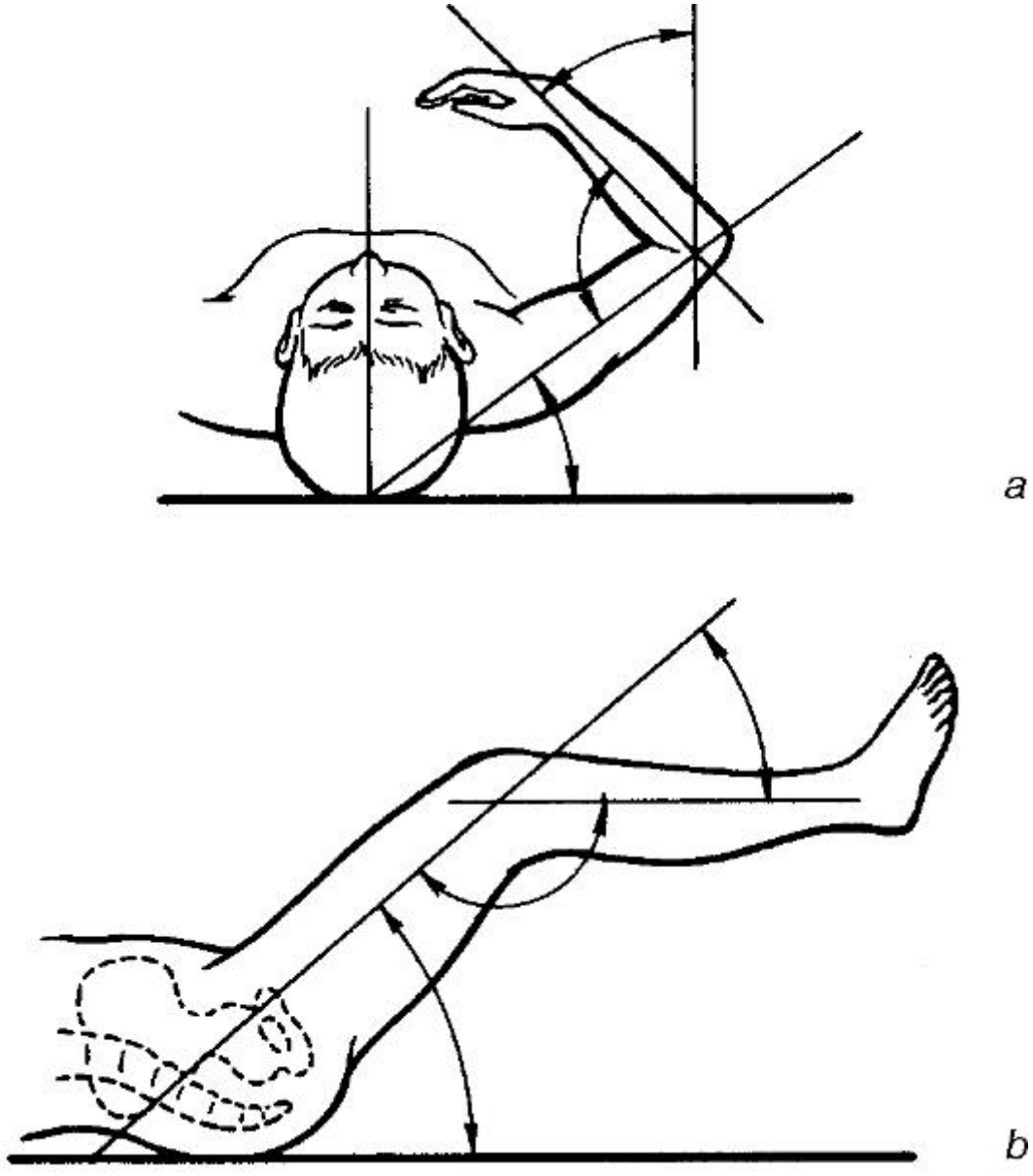
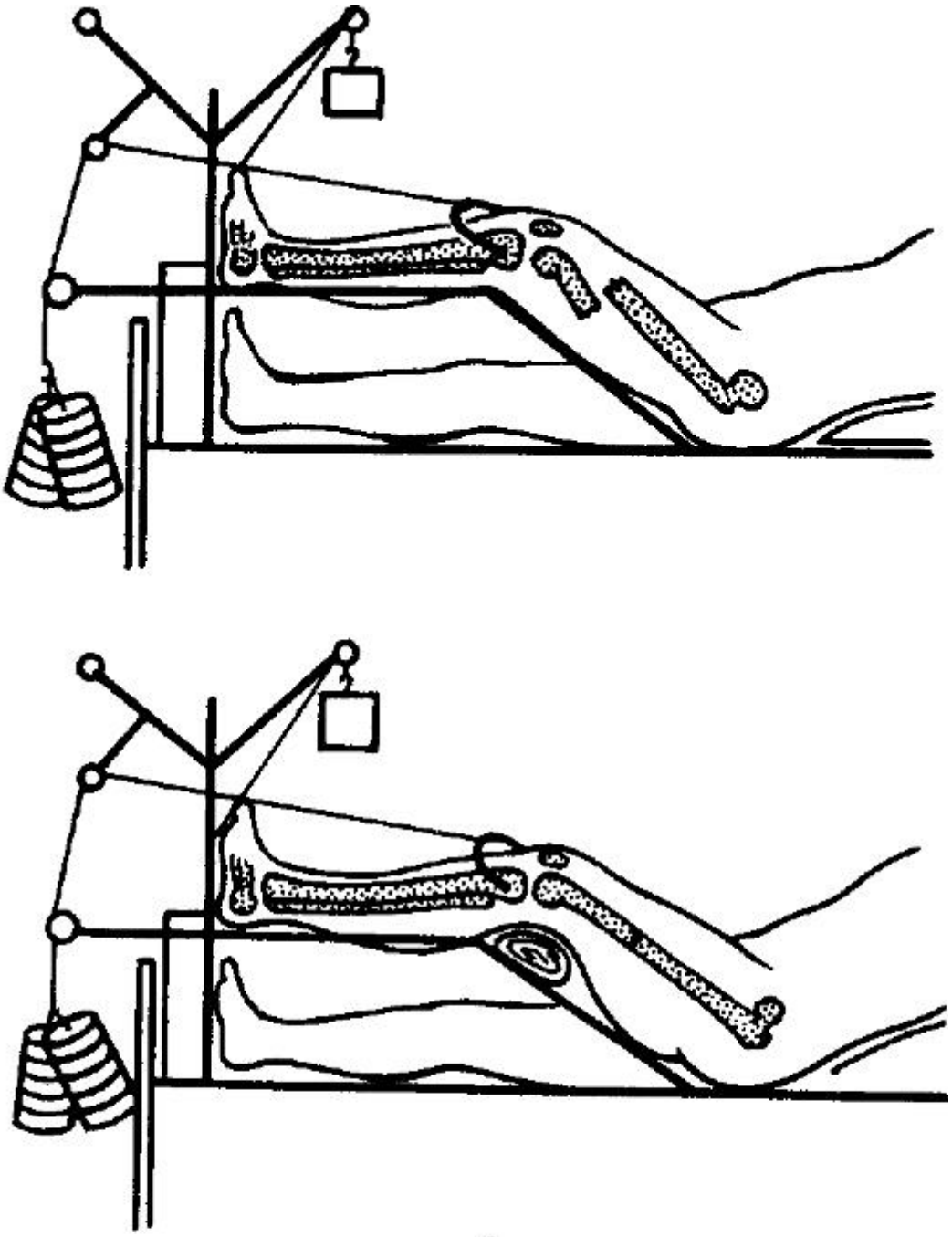


Fig. 64. Physiologic position of the upper (a) and lower *(b)* limbs.



a

Fig. 65. Skeletal traction in femoral (a) and shin (b) fractures.

The wire is pushed through the skin and its sharp end strictly perpendicular to the longitudinal axis of the bone is passed using a drill. As soon as the wire comes out of the bone and is felt in the subcutaneous layer at the opposite side, the power is off, the skin is pierced by the wire (to prevent the skin from winding around and causing additional more damage) and the power started again, and the wire is advanced further until equal lengths of appear on each side. Iodine solution is used to clean the wire exit sites and gauze balls are fixed to the wire and to the skin to prevent displacement of the wire.

A stirrup is attached to the wire with screws and a wrench to press and tighten the wire and thus to prevent its cutting through the bone during traction.

Not removing the leg from the splint, the patient is then transported to the ward and placed on the bed with a wooden board under the mattress. A string is attached to the stirrup and passed over the pulleys of the system of traction along the splint axis, which is placed along the axis of the central bone fragment and the weight is then attached. A piece of bandage is fixed or clayed to the sole, passed over the pulley and a small weight is attached to it. This helps to keep the foot at right angles and in that way prevents the formation of a «foot drop».

Skeletal traction provides for constant monitoring of the limb, and allows for movements in the joints keeping the fracture site immobilized. This improves blood circulation in the limb and facilitates consolidation of bone fragments. This method of treatment is known as *functional.*

The traction weight depends on the extent of displacement of the bone fragments, muscle development and the patient's body weight. The approximate weight to use for lower limb fractures is 15% of the body weight in femoral fractures and 10% of the body weight for shin fractures; or it is equal to the first figure of the body weight in fractures of the shin and the first figure of the body weight plus half its value in femoral fracture. The countertraction in constant traction is provided by the patient's weight due to raising the foot end of the patient's bed. To ensure adequate countertraction the bed is raised to different levels depending on the weight being used for the traction: for the weight of 6-10 kg it is 30 cm, the weight of 11 - 15 kg - 70 cm.

Reposition of fragments lasts for 1-3 days, then during the period of reparation bone callus forms, which takes about 4-6 weeks depending on the location and the type of fracture.

To achieve an increasing traction during reposition more weight is added gradually, within 24 hours, starting from 4-5 kg and adding 1-2 kg every 2 hours. After reposition has been achieved, the weight is reduced to 4-5 kg, to prevent over-extension of the muscles and displacement of the fragments.

The favourable conditions for fracture consolidation imply a balanced diet rich in proteins, vitamins, minerals, and primarily phosphorus and calcium. Measures to improve blood circulation at the fracture site include physiotherapy (e.g. exercise, massage, mechanical stimulation).

Skeletal traction is maintained for a long time, occasionally for up to 2 months. At the end of traction the weight is first removed, the stirrup and wire are then removed. To do this both the wire and the surrounding skin are treated thoroughly with iodine, a sterile wire cutter is used to cut the wire right at the entry site to the canal, it is then pulled out of the canal from the opposite side. The skin wounds remaining are cleaned and covered by sterile gauze. An indication for an urgent removal of the wire to stop skeletal traction is inflammation accompanied by pain at the site of entry of the wire or the surrounding skin. In such a case the wire is cut off at the opposite side, and drawn out from the side where the infection is more pronounced.

Constant traction can also be achieved with a loop, a strap and a cuff. The principles of treatment are similar to those for skeletal traction. For reposition of fractures of the cervical and upper thoracic spine traction is achieved with Glisson's loop (see fig. 29). The loop is fastened to the head end of the bed, which is raised as high as 50-60 cm. After reposition, the bed is lowered by 25-30 cm.

Open reposition of fractures *(surgical treatment of fractures)*. There are absolute and relative indications for surgical treatment of fractures.

The *absolute* indications are as follows.

1. Open fractures.

2. Bone fragments damaging vital organs (the brain, spinal cord, organs of the chest and abdominal cavities, major vessels and nerves of the limb).

3. Interposition of soft tissues (e.g. muscles, tendons, fasciae - are trapped in between the bone fragments); this makes reposition and consolidation of bones impossible.

4. Pseudoarthrosis.

5. Purulent complications of bone fractures.

6. Imperfectly united fracture with severe organ dysfunction.

The *relative* indications include the following ones.

1. Failure to reset bone fragments despite several attempts.

2. Delayed bone consolidation.

3. Transverse fractures of long bone rods when it is not possible to reduce the fragments and maintain the achieved reposition.

4. Imperfectly united fracture with moderate organ dysfunction.

Bone fragments can be joined and kept using different methods by metal constructions (pins, nails, plates, rods, screws, bolts, wires etc).

Metal rods are passed into a bone (intramedullar osteosynthesis) (fig. 66) or metal plates are placed on the fragments and fastened with screws (extramedullar osteosynthesis) (fig. 67, 68). Bone fragments can also be fastened with bolts, metal wires. All these types of bone fragment fixation are performed directly at the fracture site during focal osteosynthesis. The fracture focus is exposed surgically, open reposition is performed, one of the fixation variants is then performed.

Disadvantages of this method are as follows:

- additional trauma to the tissues at the fracture site;
- traumatic character of the intervention;
- destruction of the bone marrow along the limbs (intramedullar osteosynthesis);
- the need for another operation to remove the metal after fracture consolidation.

The use of compression apparatus helps to avoid the abovementioned problems. The major advantage of the technique is that the fixing wires are not passed through the fracture site (extramedullar osteosynthesis). The apparatus of Ilizarov, Gudushauri, Volkov-Oganesian provide for reposition of bone fragments without operation at the fracture site. They have been constructed not only to keep bones in the united position, but also to establish compression, tight pressing the fragments to each other with special bolts and rods (fig. 69).

The method of extramedullar compression osteosynthesis is used for treating not only fresh fractures but also pseudoarthrosis, slowly uniting fractures, osteomyelitis of bone ends.

This method helps prevent pyogenic infections, since there are no any foreign bodies (e.g. metal rods) in the fracture site and the adjacent tissues.

The complications are slow consolidation and development of a false joint. During this period, the bone marrow canal is closed up. Consolidation is considered slow if it does not occur within twice the average time required for the union of such a fracture, which depends on the location and type of fracture. The main characteristic of false joint is the closure of the bone warrow canal. It takes about nine to ten months after the fracture for a false joint to form.

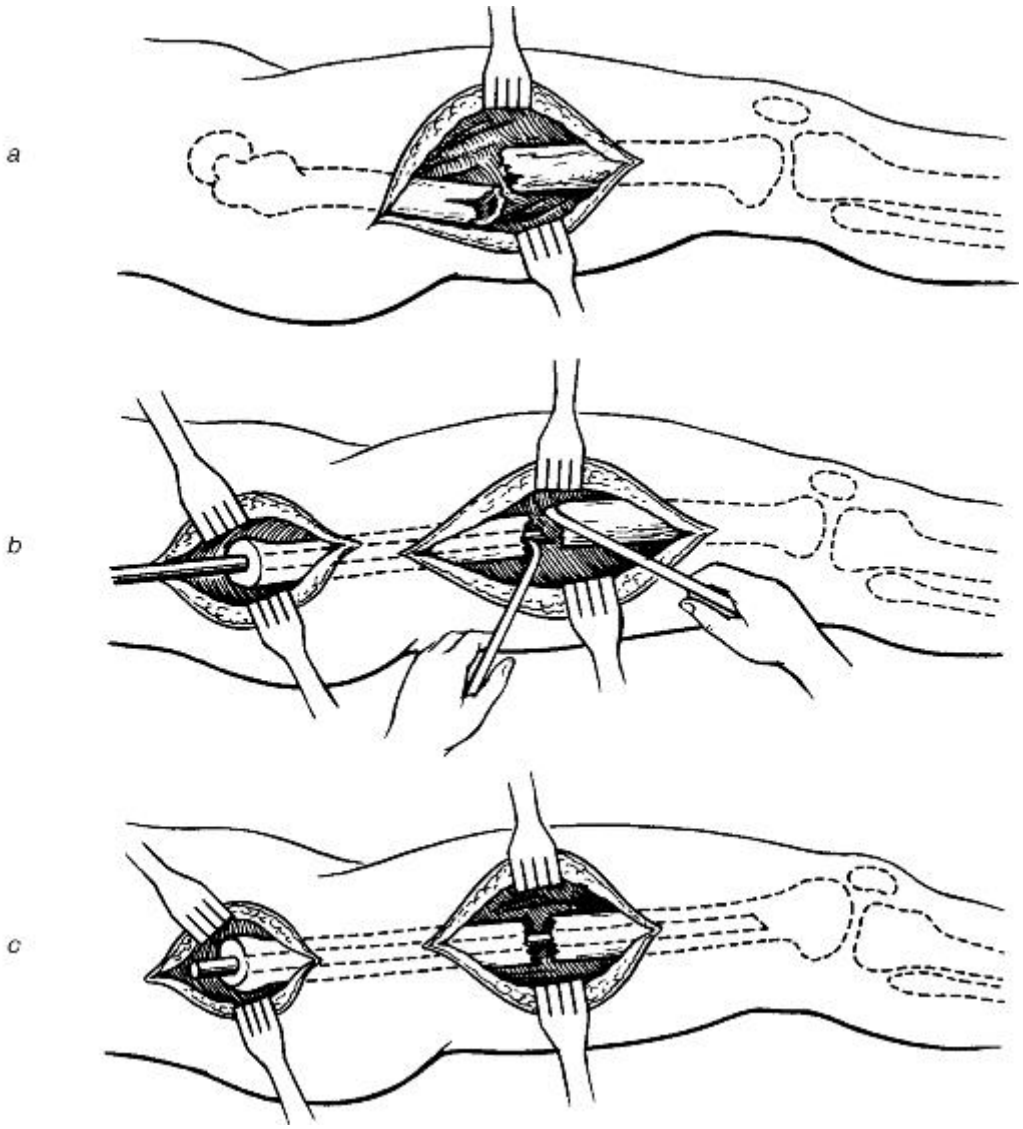


Fig. 66. Intramedullary osteosynthesis in femoral fracture: *a* - displacement of the femoral bone fragment; *b* - insertion of the metal rod in the proximal fragment; *c* - the metal rod inserted in the proximal and distal fragments of the thighbone.

The causes of slow consolidation can be of local (most commonly) and general character. The *local*factors are as follows.

1. Improper reposition of the fragments.

2. Inadequate immobilisation (mobile fragments, overextension during constant traction).

3. Partial or complete interposition of soft tissues, the latter invariably resulting in a false joint.

4. Bone defects formed as a result of bone fragment removal or bone resection.

5. Osteomyelitis of the bone fragments at the fracture site.

6. Dystrophy due to injuries to the vessels or nerves of the limb or because of severe soft tissue damage at the fracture site.

General factors include debilitating conditions, inadequate nutrition, infections, and metabolic diseases (e.g. diabetes mellitus), old age.

The signs of slow consolidation are as follows: pathologic mobility at the fracture site, skin hyperaemia, tissue swelling, muscle atrophy, tenderness on axial pressure. To differentiate slow consolidation from a false joint an X-ray has to be taken, which may show sclerotic ends of the bone fragments or their disjunction. A false joint is identified by the obliteration of the bone marrow canal.

Conservative treatment of slow consolidation requires thorough immobilisation throughout the whole period of consolidation of a fresh fracture. Immobilisation is usually achieved with POP bandage or the apparatus for compression osteosynthesis. In case the reposition of fragments is unsatisfactory, scar tissues between the fragments is to be removed and the bone fragments are to be reset. To enhance regeneration of bone tissue, massage, electrophoresis of chloridium, exercise, anabolic hormones are administered as well as a balanced diet.

Treatment of false joints is only by surgery. During the operation, the scar tissue around the bone fragments is excised, their edges are exposed, and the fragments repositioned thoroughly. Bone fragments are fastened using compression apparatus or bone auto-transplant or an operation of the of «Russian lock♠ type. Good results are achieved by the combination of bone plastic operations and compression osteosynthesis.

Dislocations

Dislocation is a complete displacement of the joint ends of bones in relation to each other; it will be noted that *partial dislocation* may also occur.

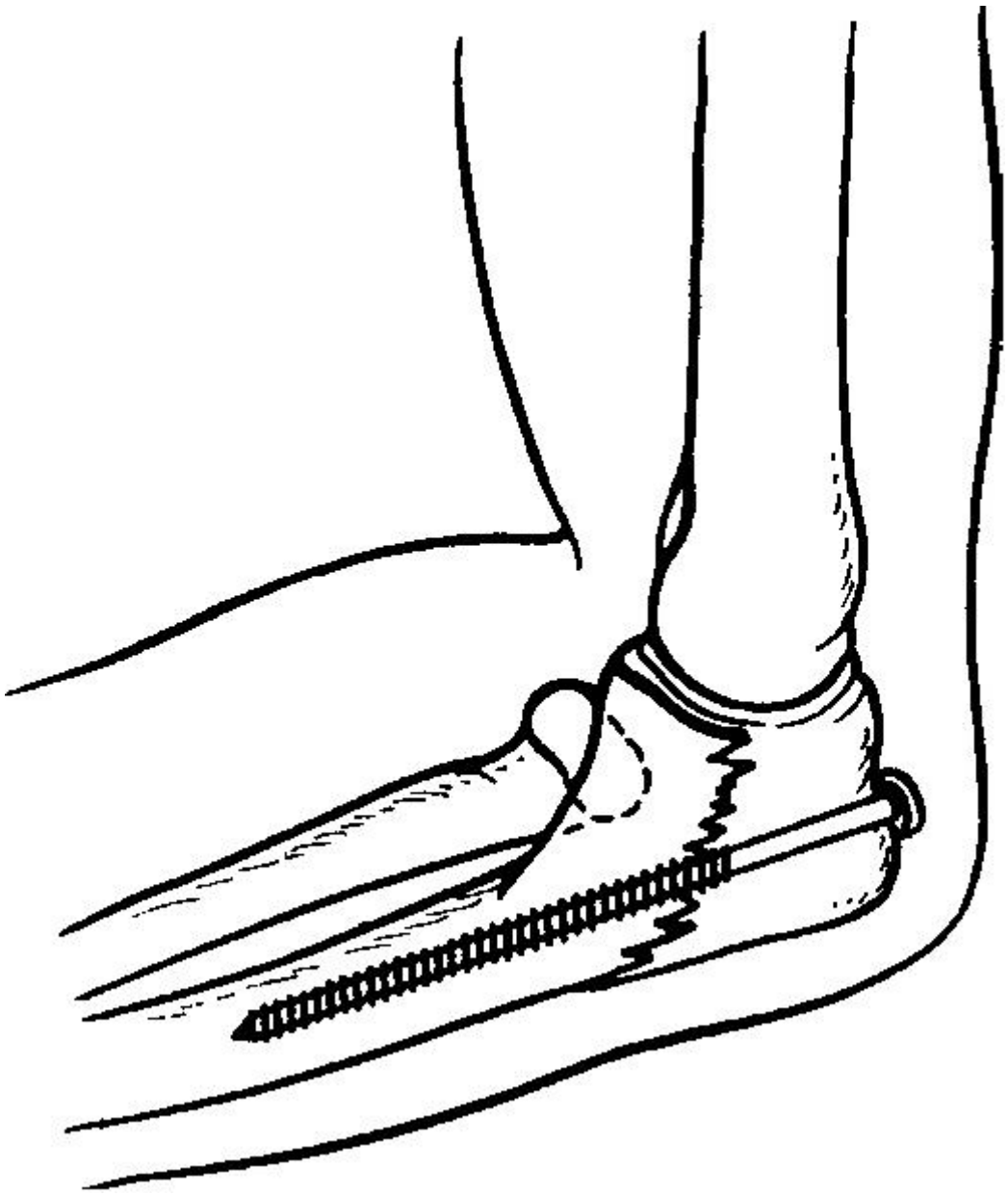


Fig. 67. Extramedullary osteosynthesis (e.g. fixation of the olecranon using a screw).

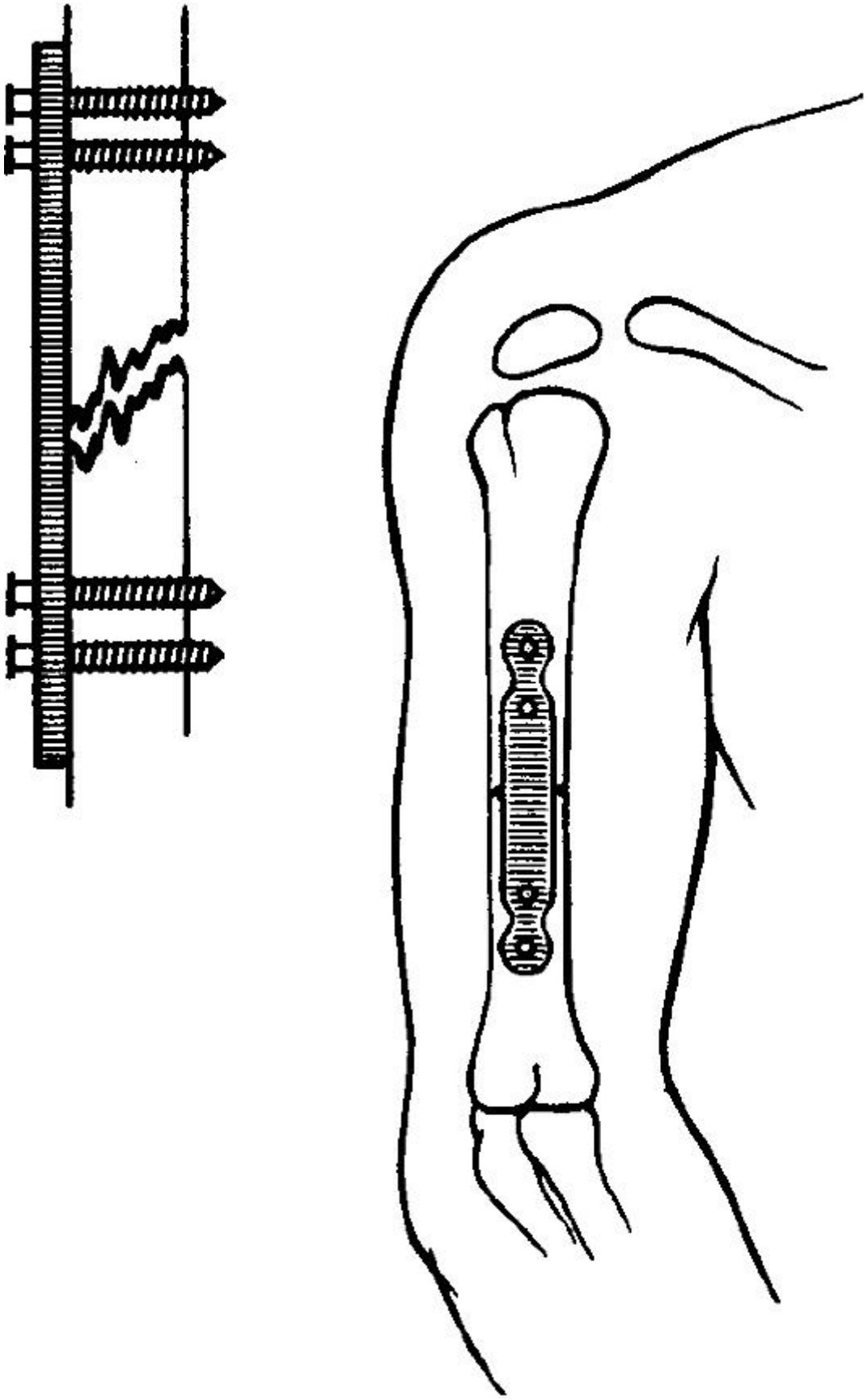


Fig. 68. Extramedullary osteosynthesis (e.g. fixation of the humeral fragments using a plate and screws).

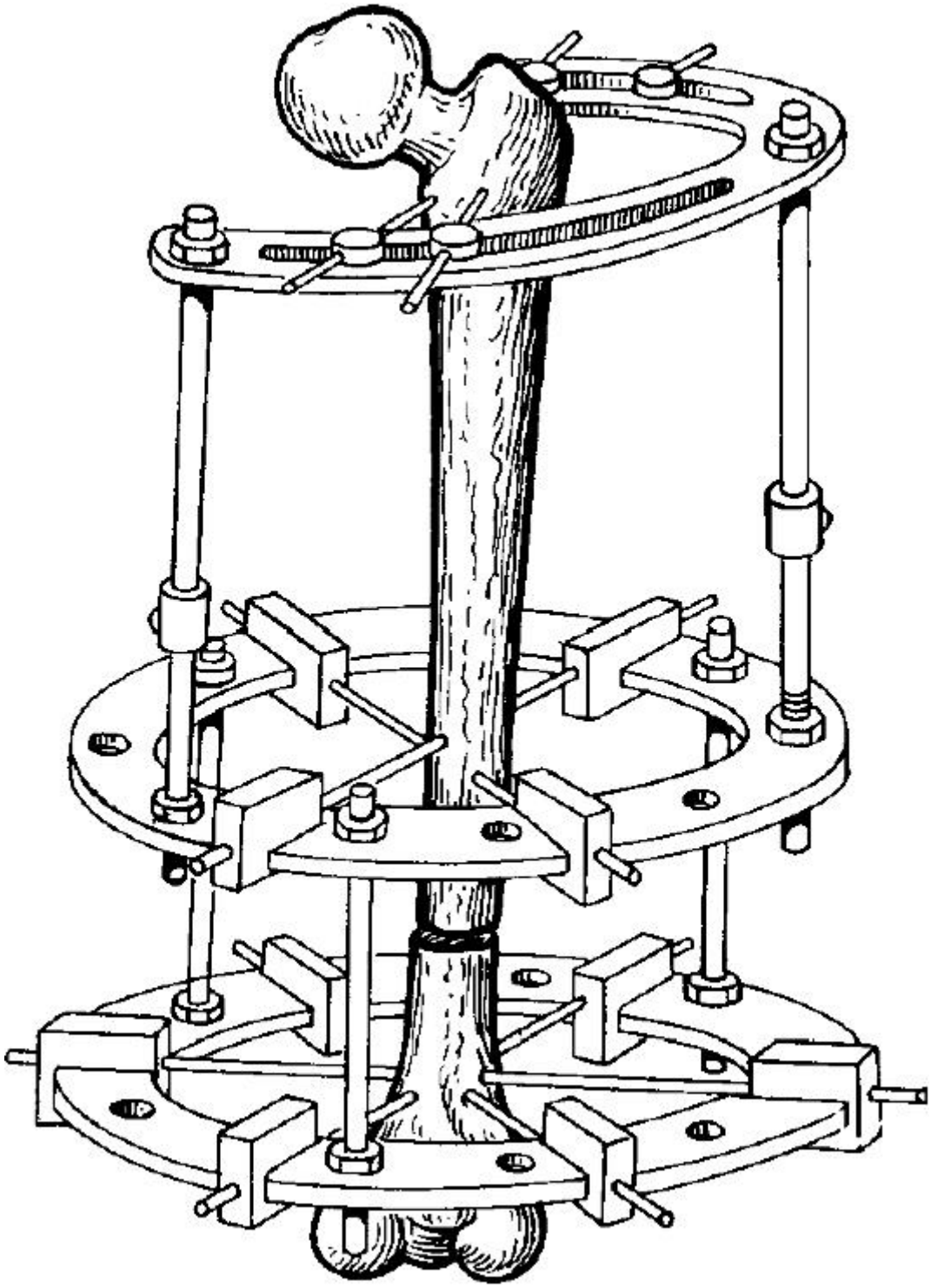


Fig. 69. Extraosseous osteosynthesis using Ilizarov's apparatus.

Classification of dislocations. Dislocations are divided into congenital and acquired. Acquired dislocations are, on the other hand, subdivided into traumatic and pathologic; complicated and non-complicated; open and closed. Habitual (repeated dislocations in one particular joint) are also identified.

Management of dislocations. Patients usually complain of severe pain in the affected joint and are unable to make any active or passive movements as an attempt causes extreme pain. History taking yields the mechanism of injury: a fall on the limb (e.g. on an outstretched "barm); overextension in the joint, a direct blow on the joint etc.

On inspection, there is deformation at the joint region and atypical, forced positioning of the joint (fig. 70-72). Active movement is impossible, there is shortening (rarely lengthening) of the limb and a change in the limb axis.

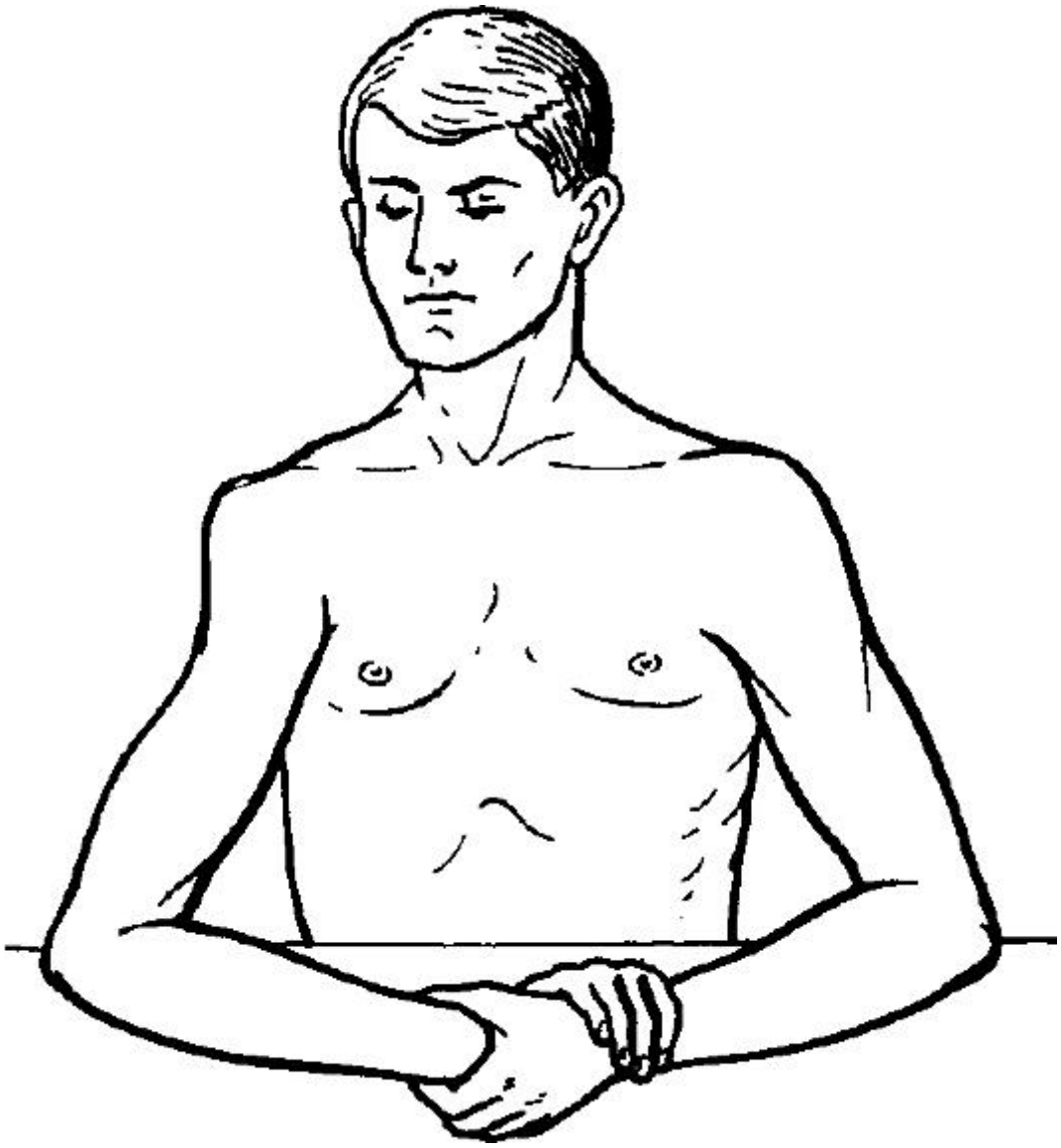


Fig. 70. Humeral dislocation.

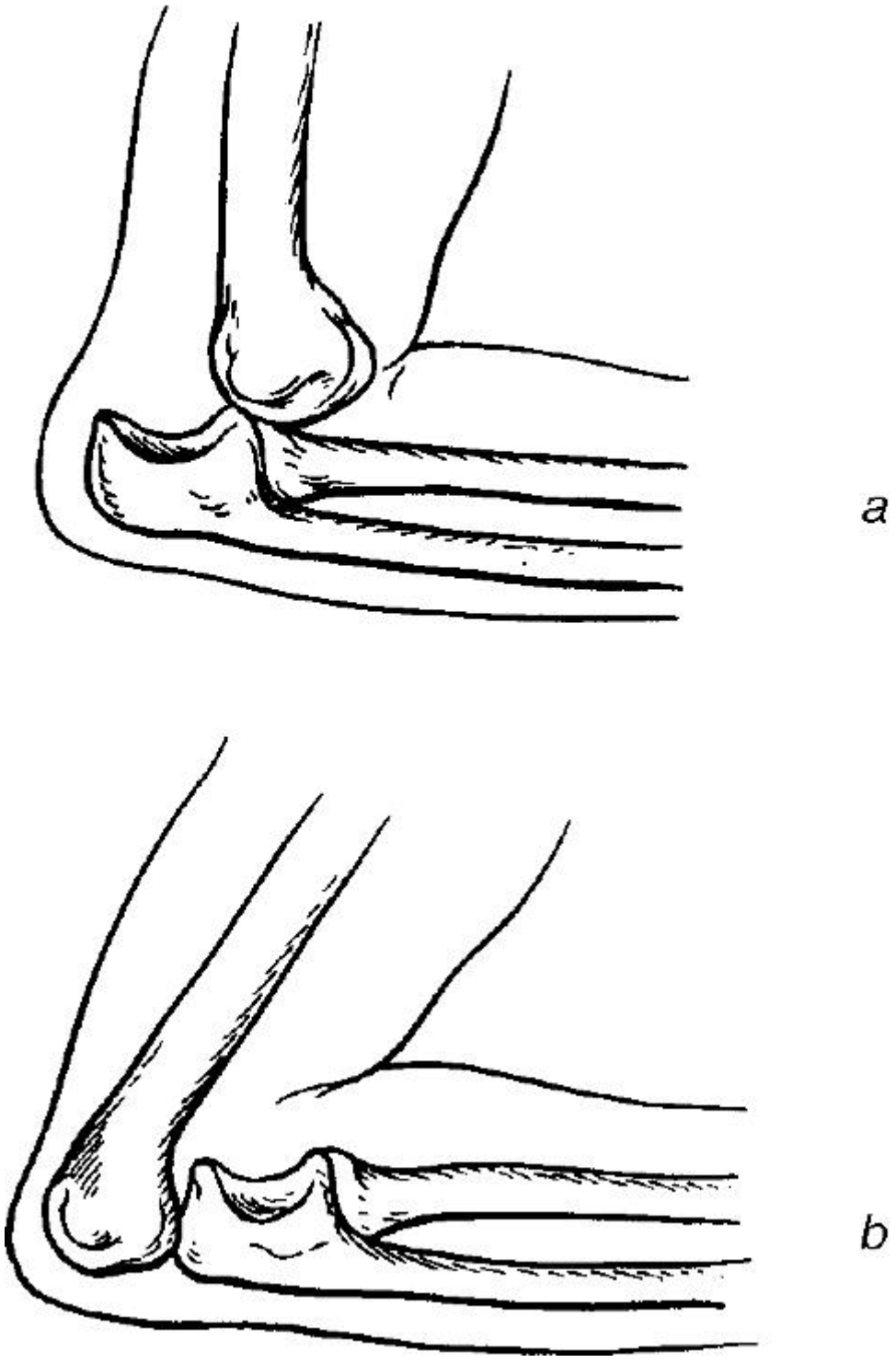


Fig. 71. Forearm dislocation.

On palpation, there is tenderness at the joint, occasionally the joint end can even be palpated in an abnormal position only. In dislocation of the humerus, instead of its head, for instance, a hollow is palpated and the joint is felt to be «empty».

Passive motion is very limited and painful. When attempting to change the atypical position of the joint, springy resistance in it is felt, the extremity returns to its original position if not held (the springy resistance sign). In dislocation of the acromial end of the clavicle, pressing on the protruding end returns the joint to its normal position; but as soon as the pressure is released it goes back to the forced position (the «key sign»).

Examination of the patient with dislocation should include feeling peripheral arterial pulses, sensitivity and the extent of active movement in the fingers or toes, for there can be damage to the vascular nerve bundles.

X-ray is used to confirm the diagnosis of dislocation and helps to determine the exact position of the joint surfaces as well as possible fractures of the bone joint ends.

Dislocations are divided into *fresh* (up to 3 days from the trauma), *not fresh* (from 3 days to 3 weeks from the trauma) and *long-standing*, or *chronic* (since the trauma occurred 2-3 weeks ago). The older the process, the more pronounced the changes that occur on the joint surfaces and the adjacent tissues. Initially, oedema of the adjacent tissues increasingly develops followed by rapid development of muscle retraction and haematoma formation. Later on, the gradual scar of the joint capsule and adjacent tissue occurs filling in the joint cavity. Chronic dislocations can be reduced only through surgery (open method). The dislocations are therefore to be reduced as soon as possible.

The treatment of traumatic dislocations involves the three stages.

- Reduction.
- Immobilisation of the limb.
- Restoration of functions.

Of utmost importance are adequate anaesthesia and complete relaxation of the muscles during the reduction. Reducing a dislocated joint without analgesics is prohibited, since the resultant pain can lead to more muscular resistance and more damage to the joint capsule causing severe capsular rupture and subsequent development of scar tissue and, later on, of habitual dislocations.

Analgesia can be achieved by injecting 1 ml of 1% promedol or morphine subcutaneously and 20 ml of 1-2% novocain intra-artcularly (e.g. in shoulder, forearm or foot dislocations). Hip dislocations are reduced under general anaesthesia. The use of muscle relaxants in difficult cases of hip dislocations makes the reduction much easier, the type of manipulation playing no particular role.

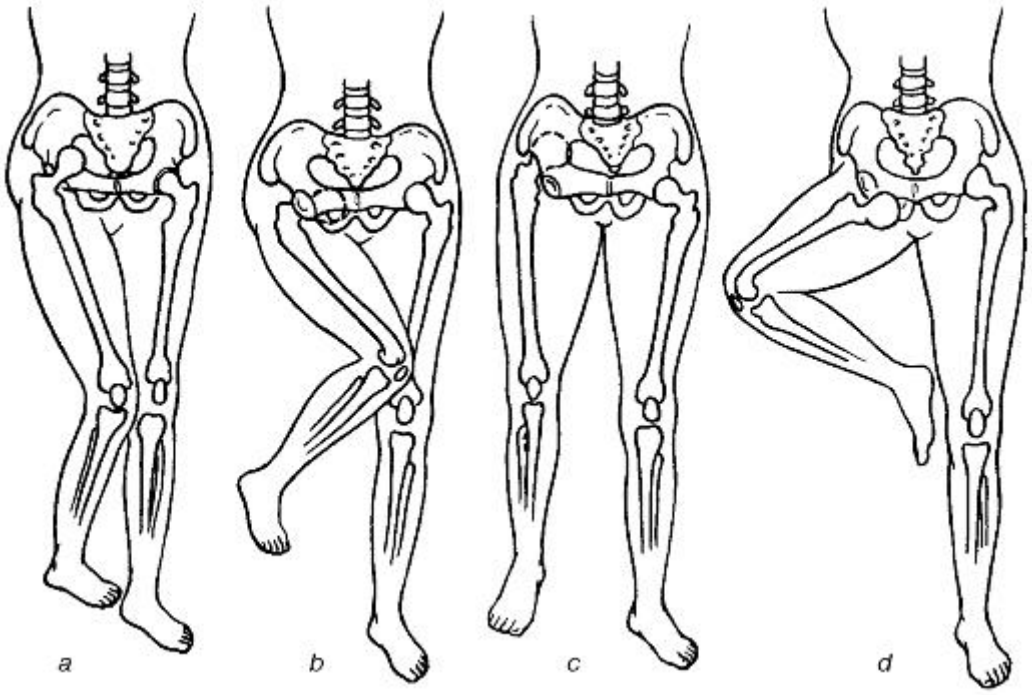


Fig. 72. Femoral dislocation: *a* - iliac; *b* - ischiaic; *c* - suprapubic; *d* - obturator.

Shoulder dislocation is one of the commonest types (50-60% of all dislocations). The shoulder joint is deformed (see fig. 70), the humeral head is absent in its normal position and can be palpated either in the armpit or beneath the coracoid process. The humeral head should preferably be palpated when the arm is flexed at the right angle in the elbow joint. To reduce shoulder dislocation a number of methods [e.g. that of Kocher (fig. 73), Djanelidze (fig. 74), Motais (fig. 75) or Hippocrates] can be used.

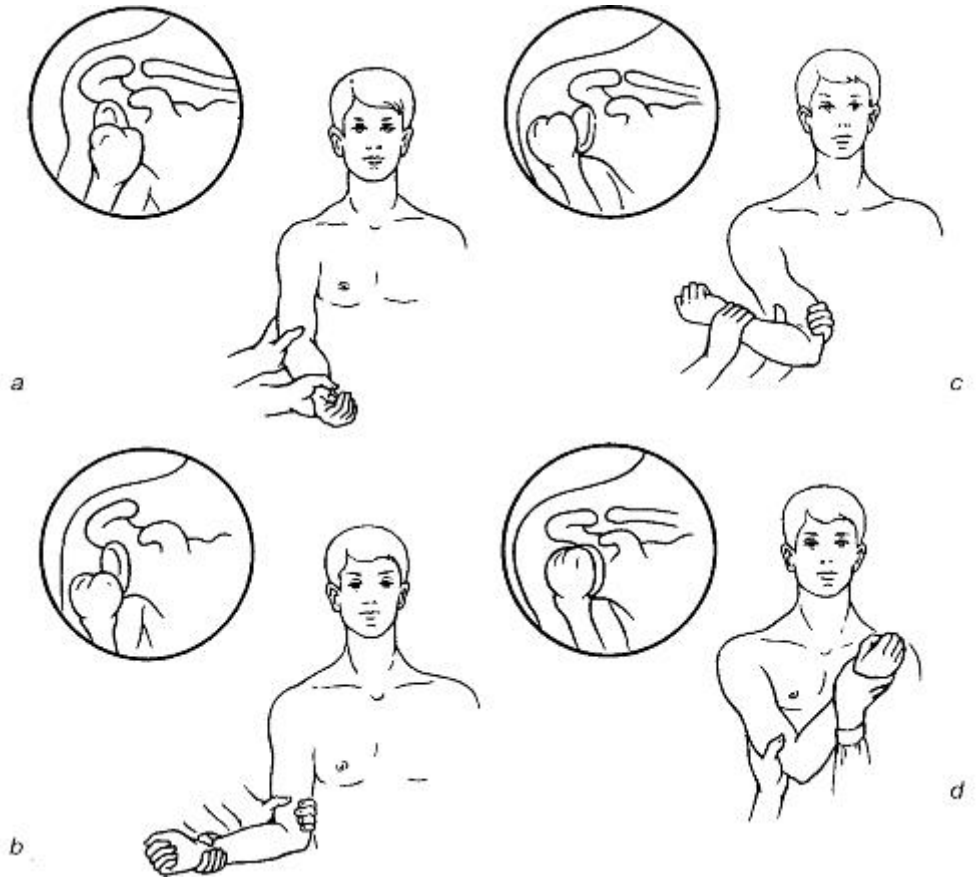


Fig. 73. Reducing humeral dislocation (Kocher's method): a - axial humeral traction followed by adduction of the arm; *b* - external humeral rotation; *c* - humeral displacement to the anterior thoracic surface; *d* - internal humeral rotation.

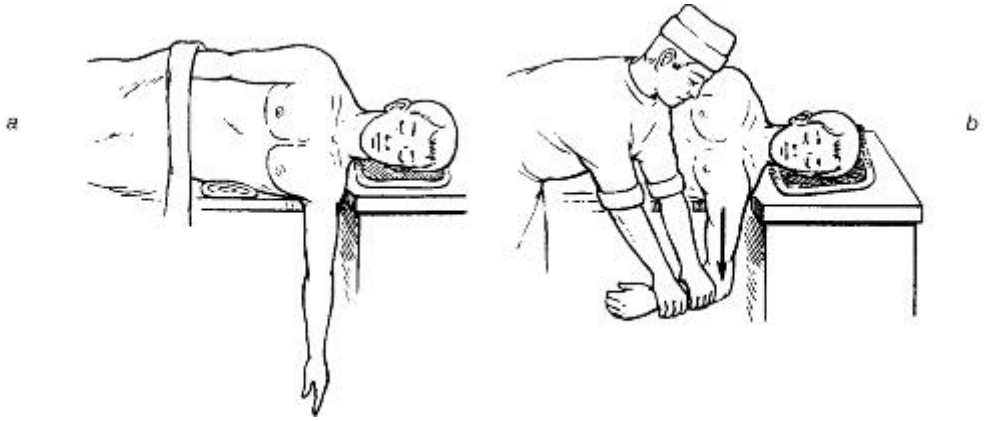


Fig. 74. Reducing humeral dislocation (Dzhanelidze's method): *a* - the patient's position before reducing; *b* - reducing the dislocation.

When reducing the dislocation by Motais (fig. 75), the trunk is fastened with some bed sheet passed under the axilla and the injured limb traction is pulled. The click sound and restoration of the joint's function both indicate successful reduction.

The reduction by Hippocrates is performed by putting the patient in the supine position and the doctor sets the heel against the patient's armpit, and pulls the affected arm holding it onto the hand and forearm.

After the reduction the limb is fastened either with a plaster bar or Desault's bandage or with a triangular bandage for 2-3 weeks. It is necessary to perform a control X-ray investigation after the reduction.

Dislocation of the elbow joint. A characteristic sign is the projection of the olecranon (posterior dislocation; see fig. 71) or the block of the humerus (anterior dislocation). Posterior dislocation is reduced under general anaesthesia. To reduce a posterior dislocation, the assistant pulls on the forearm flexed at right angles, and the doctor presses on the olecranon using the fingers. In anterior dislocation, a big towel is applied and pulled along the axis of the humerus, trying to pull the olecranon over the humeral block. A click sound indicates a successful reduction. After the reduction and an X-ray control, a back plaster bar is applied for 5-7 days until the pain is over.

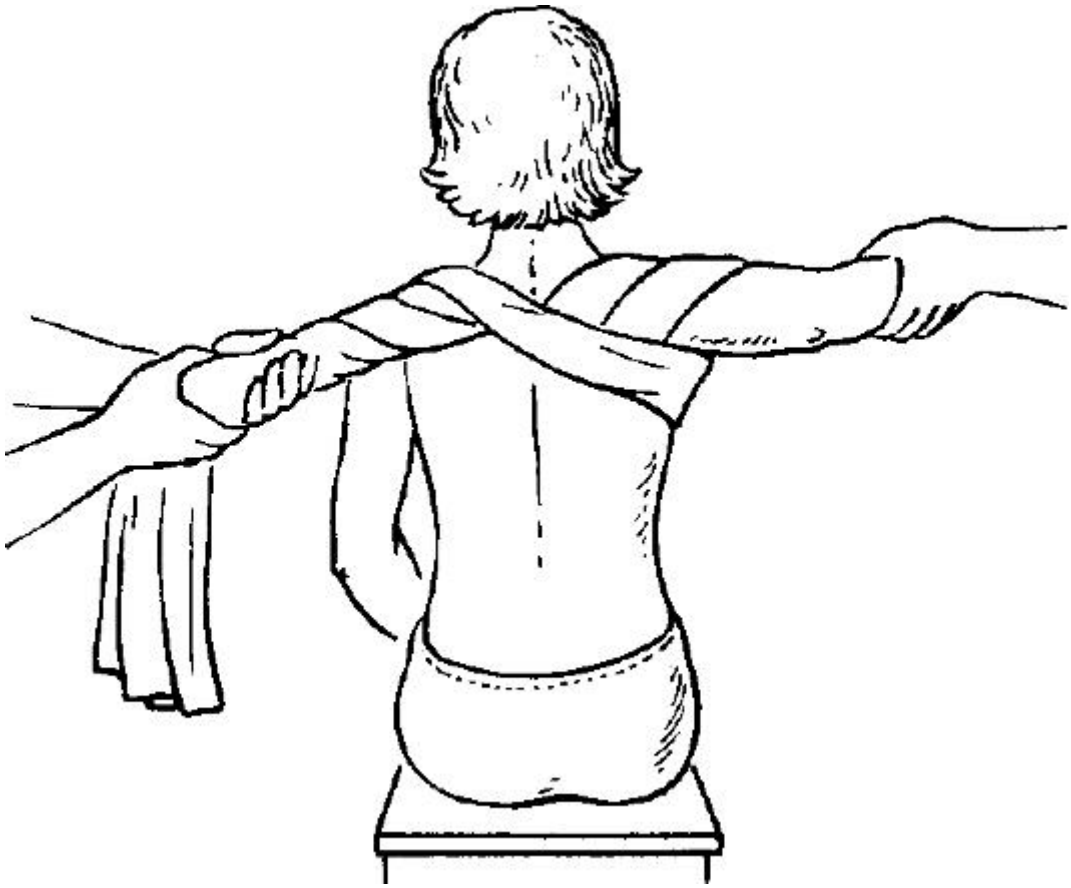


Fig. 75. Reducing humeral dislocation (Motta's method).

Hip dislocation (see fig. 72). This is characterised by the general clinical symptoms of joint dislocation with the typical positioning of the limb. Reduction is achieved by using the Kocher's method under general anaesthesia. The assistant fastens the patient's pelvis with both hands, pressing it against the table. The doctor holds the shin flexed in the knee joint at right angles, and strongly pulls the thigh upwards rotating it laterally at the same time. The appearance of active and passive movements in the hip joint is an indication of a successful reduction. X-ray control is done and a complete bed rest is prescribed for a period of 3-4 weeks, after which the patient is allowed to walk with crutches for another 4 weeks.

Dislocation of the shin is accompanied by damage to the ligaments of the joint and characterised by a typical positioning of the shin. Reduction of this type of dislocation is done under general anaesthesia by pulling on the limb along its length. After reduction, the POP

bandage is applied to cover the limb from the ankle to the mid-third of the thigh. If it is not possible to reduce this type of dislocation in such a way, it means there is interposition of soft tissues or bone fragments in the joint, which is an indication for emergency surgery, i.e. open reduction of the dislocation.

Wounds

Wound is an injury caused by physical means, with disruption of the normal continuity of the skin and underlying tissues.

Classification of wounds

I. Depending on *the cause:*

— surgical, or aseptic, i.e. resulting from aseptic surgery;

— accidental, or casual (these are always infected!);

— battle (wartime) wounds.

II. According to *the character:*

— incised;

— stab;

— chopped;

— contused;

— crushed;

— lacerated;

— bite;

— gunshot;

— poisoned;

— combined.

III. Depending on *the presence of microorganisms in the wound:*

— aseptic, or surgical;

— infected, or accidental;

— purulent, i.e. resulting from contamination with pyogenic flora.

IV. *In relation to the bodily cavities:*

— penetrating, i.e. penetrate into the chest, abdominal cavity, the skull or joint cavities etc.;

— non-penetrating, i.e. when the injury is confined to the cavity wall without penetrating into it.

V. Depending on *the presence of complications:*

— non-complicated, i.e. involving only mechanical tissue injury;

— complicated, i.e. in addition to mechanical damage, accompanied by other factors: poison, radioactivity, infection, burns and frostbite.

Examination and management of wounded patients Examination of the patient with a wound has to be done thoroughly. The place, the circumstances under which the injury was inflicted, the patient's condition at the moment he/she got injured should always be taken into account.

The patient's general condition is assessed: consciousness, skin colour (pallor), rate and volume of pulse, depth and rate of breathing. The information about first aid is obtained: by whom and what kind of aid was provided (self help, lay man's help or by a medical personnel), as well as how the injured was transported to the hospital. The history should contain information on the injuring agent and possible blood loss.

The main *clinical signs* and symptoms of wounds are pain, bleeding and gaping.

Pain is due to injury to the nerve endings and depends on the location of a wound; most painful are wounds of the organs with large amounts of nerve endings (e.g. finger tips, the periosteum or peritoneum). The type of an agent of injury also plays a role - contused, lacerated and crushed wounds are more painful. The patient's condition also plays a role as pain threshold is decreased in shock, drunkenness and in massive blood loss.

Bleeding always accompanies wounds but the extent and rate differ, depending on the calibre and type of the injured vessel (artery, vein, minute vessels), location (bleeding is more marked if the wound is located on the face, scalp or), bleeding from an incised wound is more pronounced than from lacerated and contused ones. Defective blood clotting system (e.g. haemophilia) can produce profuse haemorrhage.

Gaping of wound edges results from contraction of elastic skin fibres, deep lying muscles and tissue defect because of the trauma.

On inspection, the size and type of wound, the difference in the affected part of the body as compared to the intact one, the presence of deformation, mobility in the joints, the presence of active and passive movements, the state of superficial and deep sensitivity, the presence and type of pulse on the peripheral arteries of the limbs are all taken note of. In chest wounds, lung percussion and auscultation have to be done. In abdominal wounds, percussion, auscultation and palpation are to be performed. These examinations done prior to examination of the wound itself help in the assessment of possible injuries to the nerves, arteries or organs of the abdominal and chest cavities.

The next step is the examination of the wound itself. The use of probes and other instruments is not recommended at this stage. The wound is inspected to determine its size and character and the extent of tissue damage, contamination and possible complications.

Incised (slashed) wounds tend to have smooth edges and, as a rule, be confined to soft tissues. When the incision is transverse to the elastic fibres of the skin compared to longitudinal incisions the wound gapes, bleeds more.

Stab wounds caused by knives, awl, bayonets as well as other sharp piercing objects have smaller entry sites and are commonly accompanied by minimum damage to the adjacent tissues. It is imperative to thoroughly examine the patient with a stab wound since there is always the danger of damage to the internal organs, e.g. the stab can be penetrating into the chest or abdominal cavity (see below). If it is on the limb there can be damage to the major vessels, with haematoma formation or bleeding into the deeper layers, that increases the limb size and causes tissue induration.

Chopped wounds have even edges and are characterised by soft tissue damage and haemorrhage around the wound. Bleeding is usually profuse and there can be bone involvement.

Contused wounds have an irregular shape. The adjacent tissue is crushed, there are marked haemorrhages with haematomas. The crushed adjacent tissues are normally not viable and are necrotised later on.

Lacerated wound can result from contact with a fast moving object (e.g. a saw, shell-splinter). Tissue damage (the skin, muscle, tendon) in such injuries is marked. The wound has an irregular shape, edges are jagged and there are massive haemorrhages into the skin, subcutaneous tissues and muscles. The wound cavity can also be filled with blood clots, bleeding mildly.

Bite wounds occur from animal or human bites. They are similar to the lacerated and contused ones.

Gunshot wounds result from the injuries by projectiles, firearms and grenades (e.g. missiles, bullets, pellets, bomb, mines etc.). These types of wounds are typically with extensive tissue damage because of the high speed of the wound infecting and the resultant injury by bone fragments. The three areas from a gunshot wound of damage are identified: the wound canal, the areas of primary traumatic necrosis and the area of concussion.

The wound canal contains shell-splinters, tissue and clothing fragments and other foreign bodies, and blood clots.

The area of primary traumatic necrosis consists of necrotised tissues adjacent to the wound canal.

The area of molecular concussion is characterised by haemorrhages, impaired capillary blood flow (i.e. stasis of blood cells and capillary ruptures)

Modern gunshot wounds that are inflicted by high tech missiles with unstable flight directions are characterised by large wound canals. Gunshot wounds are accompanied by extensive traumatic tissue necrosis, the tissues surrounding the wound canal form wide nonviable areas with multiple haemorrhages. Wounds caused by the exit sites of such wounds are wider than their inlet sites.

Wounds caused by shell-splinters are commonly blind and the damage at ther entry site is always greater. Large areas of dead tissue, pronounced bacterial contamination, progressing tissue necrosis at the area of molecular concussion as well as the concurrent damage to the vessels and nerves, bones, joints; blood loss and shock are characteristic features of gunshot wounds. Such wounds are not infrequently complicated with infection (purulent, putrid, anaerobic).

In chest injuries apart from the type of injury (stab, gunshot, incised), the patient has to be examined for signs of penetration. The presence of penetration into the chest cavity is identified by the noisy outflow of foamy blood from the wound, «breathing» in the air into the pleural cavity accompanied by whistling breath sounds, the air bubbles coming out of from the wound and subcutaneous emphysema. The entry of air into the pleural cavity leads to an open pneumothorax. In open pneumothorax, air enters through the wound on inspiration and escapes on expiration with whistling sounds. Tension (valvular) pneumothorax can also develop when the air breathed into the pleural cavity but is not able to escape on expiration because the valves formed by tissues of the chest wall close up. The condition of the patient with tension pneumothorax is always critical and deteriorates progressively because of the increased compression of the lung and displacement of the mediastinal organs to the intact side. In patients with this condition severe dyspnoea, acrocyanosis, fast and weak pulse are observed. Intercostal spaces on the affected side widen up, half of the chest swells up, the percussion note on this side is tympanitic, and breath sounds are absent.

Signs of penetrating abdominal wounds are intraperitoneal haemorrhage and posttraumatic peritonitis. Patients complain of abdominal pains, thirst and malaise. Skin pallor, tachycardia, fast and weak pulse may be noted. The abdomen is tender and tense, Blumberg's sign is positive; percussion note is highly tympanic and the liver dullness is diminished, because the air having entered the abdominal cavity. If the penetrating injury is accompanied by intraperitoneal bleeding, dull percussion notes characterise the areas where blood has accumulated. Diagnosis of penetrating abdominal injury is confirmed in cases when loops of intestine, omentum, intestinal contents, urine or bile are found in the wound.

First aid and management of wounds. First aid prior to hospitalization should include bleeding arrest, application of bandages and, when necessary, transport immobilisation. In case of profuse arterial and venous bleeding tourniquet has to be applied (see Chapter IV).

The surrounding skin is cleaned with solutions of iodine, iodonate betadine, and free lying foreign bodies are removed from the wound. It is not allowed to use instruments (probes) and the fingers to examine the wound as it may cause additional damage to the vessels and nerves as well as transfer infections from the surface deep into the wound. The wound is covered with sterile tissue or cotton wool - gauze pads (see «Dressings») and then bandaged. To stop venous and capillary bleeding the pressure bandage is applied. In case of open fractures, damage to major vessels and nerves, extensive soft tissue damage (lacerated and contused wounds) the standard transportation immobilisation or improvised splints are applied. The patient is then transported to a surgical unit.

In giving first aid to a patient with penetrating chest wound that is complicated with an open pneumothorax it is advisable to try to as early as possible block the contact of the pleural cavity with the surround by applying an occlusive bandage. An individual dressing pack is ideal for this purpose.

The wound edges are cleaned with an antiseptic solution. The individual pack's cover is cut open and its internal surface applied on the wound, the cotton wool pads are placed on top and bandaged firmly to the chest (fig. 76). In the absence of a plastic pack, any available material that does not allow air to pass through can be used - polyethylene bag, oilcloth and in extreme cases cotton wool heavily covered with sterile Vaseline or some other harmless cream to the wound. Strips of adhesive plaster can also be used to make the wound airtight. The wound edges are brought together with some plaster strips and then the imbricated bandage is applied, each new strip covering half of the previous one.

In penetrating abdominal injuries, the first aid is to apply aseptic dressing on the wound. If there is external bleeding, pressure haemostatic bandaging is done. In eventration of the internal organs (e.g. the loop of intestine, omentum) they are not to be reduced back into the abdomen but rather sterile gauze tissue is placed on them and a circular bandage around the abdomen is applied.

Primary surgical wound debridement. At the basis of treating infected wounds is primary debridement. The aim is to remove nonviable tissues together with the microorganisms and in that way prevent the further development of wound infections (fig. 77; fig. 78, colour inset).

Primary wound debridement is divided into: *early*, which is done within the first day of injury;*delayed* - within the second day after injury and *late* - more than 48 hours after injury. The earlier the primary debridement is done, the better are chances of preventing the wound from being infected.

Surgical debridement is not done for non-penetrating stab wounds without damage to major vessels, for piercing wounds with small entry and exit sites without signs of injury to the vital organs, vessels, and for incised wounds that do not go beyond the subcutaneous fat.

Fig. 76. Occlusive dressing in open pneumothorax.

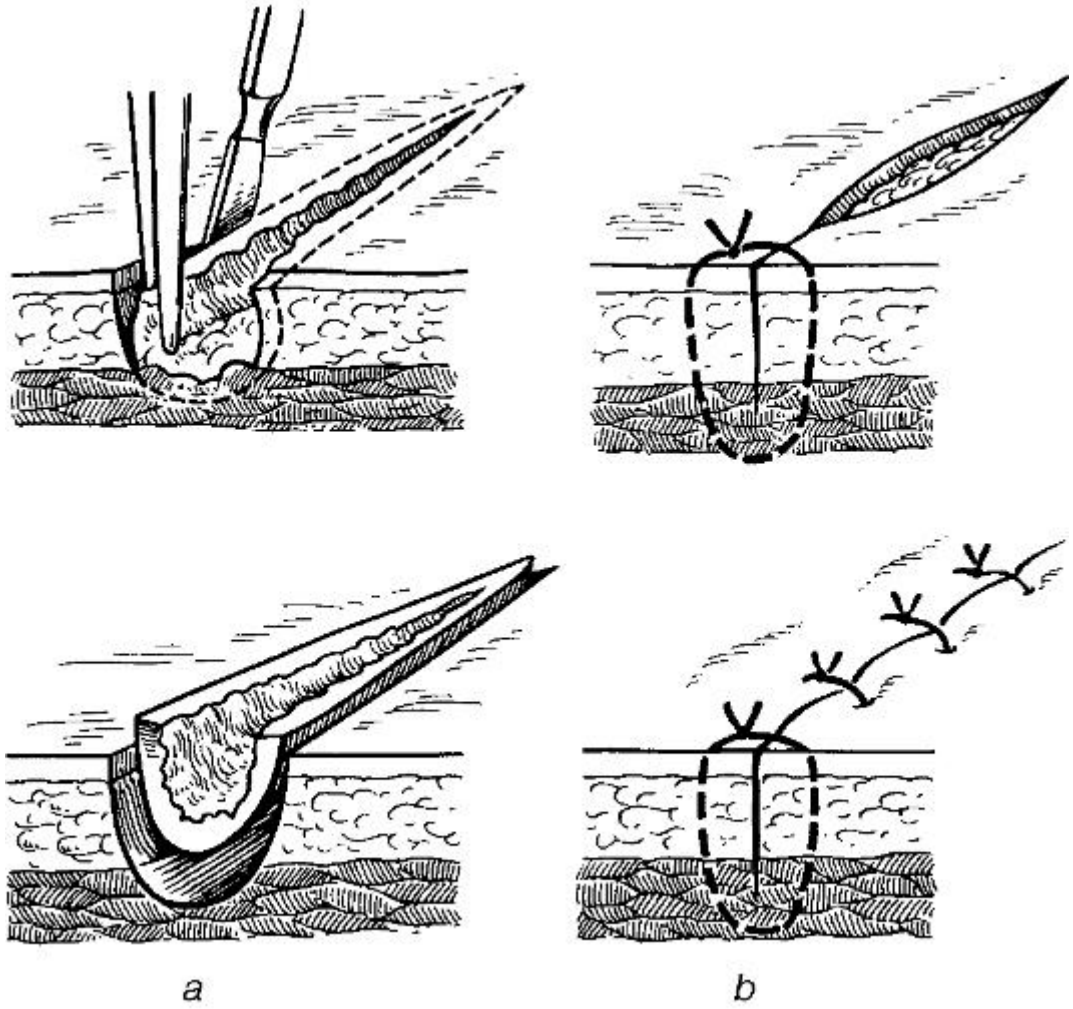


Fig. 77. Primary surgical debridement of a wound: *a* - edge, wall and base excision; *b* - primary suturing.

Primary surgical wound debridement should be done in one stage and should remove all nonviable tissue. The first to be operated on are the injured with haemostatic tourniquet and those with extensive shell-splinter injuries with soil contamination and thus being at high risk of anaerobic infections.

Primary surgical wound debridement involves excision of wound edges, bases and walls up to the intact tissues with restoration of anatomical structure.

The manipulation is started with incision of the wound: 0,5 - 1 cm of the skin and subcutaneous tissue around the wound is excised. In an extremity injury, after that the incision is performed along the limb axis, along the vascular - nerve bundle making it long enough to inspect the wound including its pockets and to excise all the nonviable tissues. Then the fascia and aponeurosis are incised in a Z-shaped or a semilunar incision. This ensures adequate inspection of the wound and prevents muscle compression due to oedema, which is of special importance in gunshot wounds.

After the wound has been incised, pieces of clothing, clots of blood, free lying foreign bodies are removed before the excision of crushed and contaminated tissues is started.

Muscles are excised up to intact tissue. Nonviable muscles are dark-red and dull, do not bleed on cutting and do not contract on touch with the forceps.

Intact major vessels, nerves and tendons have to be preserved; contaminated tissue is carefully removed from their surface. Free lying small bone fragments that are found in the wound should be removed, and bone edges having no periosteum should be cut off with a bone cutter. In injuries to the vessels, nerves, tendons, they have to be repaired. Meticulous homeostasis has to be done during wound debridement. After the wound has been thoroughly cleaned of all the dead tissues and foreign bodies it is sutured (primary suturing).

Late surgical wound debridement is performed following the same principles as for the early one, but if there are signs of pyogenic infection, it is done by removing foreign bodies, cleaning the wound of dirt, removal of necrotic tissue, opening up of pus collected into pockets, haematomas, abscesses to provide for a free flow of tissue secretions. Wide excision of the wound as a rule is not done for fear of generalising the infection.

The application of primary sutures is the last step in the primary surgical wound debridement. Primary suturing restores the continuity of tissues. It is aimed at preventing secondary infections of the wound and provides the conditions for wound healing by primary intention.

Primary suturing is done within the first day after the injury. Aseptic operations are also most commonly completed with the application of primary sutures. Primary sutures may be applied after incision and drainage of subcutaneous abscesses, phlegmon, and the excision of necrotic tissue which provides for better drainage and long term wound washouts with solutions of antiseptics and proteolytic enzymes (see Chapter XI).

Primary - delayed sutures are applied during 5-7 days after the primary surgical wound debridement, before the formation of granulation tissue if the wound did not get infected.

Inflammation in the primarily sutured wound is usually mild and healing by primary intention results.

The widespread use of primary suturing even when the wounds are debrided at late periods (12-24 hours) has become possible because of the effective antibacterial therapy and the systematic observation of the patient.

At first signs of infection, some or all of the sutures have to be removed. Experience from the Second World War and subsequent other local wars has shown that application of primary sutures to gunshot wounds is not justified not only because of their extent but also because of the

impossibility to monitor such wounds under war conditions and during the period of medical evacuation.

The concluding and delayed stage of the primary wound debridement is the application of the secondary suture. It is placed on granulating wound provided there are no signs of purulence. Secondary suture can be applied within several days to several months. It is used to enhance wound healing.

Early secondary suturing is done on a granulating wound between days 8-15. The wound edges are usually mobile and there is no need to excise them.

Late secondary suturing is done in later periods (in about 2 weeks) when scar has already set in at the wound edges and walls. Bringing the wound edges together is impossible unless the edges are mobilised and the scar tissues excised. In large tissue defects skin grafting has to be done.

Indications for the use of secondary sutures are as follows: body temperature and the blood picture having returned to normal, patient's satisfactory general condition, as well as the following wound characteristics: - no oedema and surrounding skin hyperaemia, clean wound devoid of pus and necrotic tissue, healthy, bright and sappy granulation.

Different types of sutures can be used but independent of the type the following general principles have to be abided by: there should not be empty spaces and pockets left within the wound, adaptation of wound edges and walls must be maximum. Removable sutures should be used and no ligatures (either absorbable or catgut) should be left in the sutured wound cavity, since the presence of these foreign bodies, can lead to wound suppuration. In early secondary suturing the granulation tissue should be left intact, which makes the operation technique easier and preserves granulation's barrier function, thus preventing the spread of infection to the adjacent tissues.

Healing of the wound treated with secondary suturing without infection is referred to as healing by the type of primary intention as opposed to the true primary intention, since even though in the former the wound heals with a linear scar, it was preceded by the maturing and scar of granulation tissue.

Surgical infection

Wound suppuration. Clinical signs of local wound infection are usually evident within 2-3 days following the injury. The risk of purulent infections is high by extensive tissue damage, incomplete excision of nonviable tissues during wound debridement, and the presence of pathogenic microorganisms in the wound. Fulminant suppuration, severe intoxication, intense pain in the sutured wound, fever with moderate tissue necrosis in the wound are characteristic of staphylococcal infection. Sluggish suppuration with extensive tissue necrosis is typical of infections caused by *E. coli, Proteus* and *Pseudomonas spp;* in such cases infection in these cases will spread extensively. Streptococcal infection is characterised by formation of marked inflammatory infiltrates with distinct hyperaemia of the skin.

Pyogenic infection in the wound that occurs within the first 3-5 days is referred to as *primary infection*, while that developing later as *secondary infection*, which is caused by new necrotic foci in the wound or by secondary infection with nosocomial strains of microorganisms.

Following contamination, pain in the wound intensifies, its edges become oedematous, tissue colour changes, clots of blood and fibrin appear as dirty grey, wound secretion accelerates, serous and/or haemorrhagic exudates evolve to serous and/or purulent or then to purulent. The neighbouring tissues are hyperaemic on inspection and firm on palpation. The regional lymph nodes are commonly enlarged, firm and tender. Lymphadenitis is common.

As the infection begins to subside, oedema of the adjacent tissues reduces as does skin hyperaemia; necrotic tissue falling off and wound granulation start, which indicates the transfer to *the reparative phase* (the stage of wound healing, or dehydration).

In unfavourable course, the patient's condition may deteriorate - intoxication (fever as high as 39-40 °C, rigors, tachycardia) sets in, neighbouring tissues become oedematous and the skin becomes hyperaemic, tissue necrosis worsens and the purulent secretions from the wound increases. In severe cases the patient progressively becomes weaker, loses appetite and complains of headache. The blood film may show leucocytosis with a left shift and rise in ESR.

The colour, odour and consistency of the exudate depend on the type of infection. Ichorous offensive smell and dirty grey colour of pus are characteristic of ichorous bacteria, bluish-green colour of exudates is found in cases of *Pseudomonas spp.*

Recurrent rigors in a patient without pain in the wound are an early sign of suppurative wound tissue decay, of which specific odour of rotten tissue is typical. The odour depends on the type of the causative agent: the odour of rotten meat is characteristic of *Cl. sporogene,* that of ammonia is encountered in infecting by *B. coli communis* or *Proteus vulgaris;* the odour of mould rotten stuff is produced by fungal or spirochaetal infection.

In ichorous infections the wound appears dry, granulation is absent and tissue necrosis progresses, muscles become grey and dull. Wound discharge is dirty grey, or dark brown or greenish in colour with specific smell. The skin and subcutaneous tissues are usually covered with dirty-green patches as they get soaked with the products of haemolysis. The regional lymph nodes are commonly enlarged and tender.

The signs anaerobic infections other than *Clostridium* spp include offensive smell of the exudate, excessively necrotised wound tissues, dirty-grey purulent contents with droplets of fat. Furthermore, severe intoxication is evident: subicteric or icteric sclerae and skin, anaemia, tachycardia etc. Unlike anaerobic clostridial (gas) gangrene, this type of infection produces less prominent local signs, and there is no specific muscle change, i.e. no «boiled meat» appearance or bronze discolouration of the skin, accumulation of gas in the tissues is very rare (crepitation is not revealed).

Treatment involves antibacterial, detoxicating, anti-inflammatory and supportive measures and depends on the phase of the condition.

• Phase 1 includes evacuation of pus, necrotic tissue, dehydration and antibacterial therapy. Round change of wound dressing is of great importance. To evacuate pus, products of necrolysis and exudates drainage as well as hypertonic solutions are used (see «Mechanical and physical antiseptics»). Proteolytic enzymes are used to stimulate necrolysis (see "Biological antiseptics"). Moreover, the wounds are washed with solutions of antiseptics (see «Chemical antiseptics). To remove necrotic tissues, laser beams and ultrasound cavitation are applied. In extensive necrosis, necrectomy is indicated, either as a one-stage procedure or a serial one.

Such wounds require daily change of dressing, in severe infection the procedure may need to be performed twice a day.

• Phase 2 (reparative regeneration) precludes the use of physical antiseptics or proteolytic enzymes since such substances hamper regeneration of tissues. The rate of dressing should be reduced. Ointments that enhance tissue regeneration are prescribed for topical wound dressing (e.g. methyluracyl). Stripes of adhesive plaster can be used to approximate the wound edges. When the infection has subsided completely, the wound can be managed by early or late secondary suturing and in extensive tissue defect, autodermoplasty may be an option.

Specific wound infections

Anaerobic (gas) gangrene. When the wound is infected by anaerobic clostridial microorganisms, it is characterised by fast progressive tissue necrosis with oedema, gas

formation, and severe intoxication (fig. 79, colour inset). Anaerobic infections are caused by sporeforming anaerobic microorganisms such as *Cl. perfringes, Cl. oedematiens, Cl. septicum,* and *Cl. histolyticum.*

Classification of gas gangrene

1. Localisation:

• Clostridial myositis.

• Clostridial cellulitis.

2. Clinical course:

• Fulminant.

• Fast progressive.

• Slow progressive.

The incubation period for gas gangrene lasts 1-3 days; in fulminant forms, however, it can only take a few hours. The earlier the infection sets in, the more severe it is.

Factors that predispose to gas gangrene are as follows:

• injuries to the lower limb with concurrent massive tissue damage, tissue contusion and marked contamination of the wound with soil, clothing etc.;

• blood circulatory disorders due to the injury;

• ligation of major blood vessels;

• vascular occlusion by the applied tourniquet;

• tight bandaging;

• lowered general body resistance due to shock, anaemia, frostbite, long starvation periods, vitamin deficiencies, and secondary trauma resulting from inadequate transportation and immobilisation).

Early signs of anaerobic infections include the following:

— the patient's inadequate behaviour (e.g. restlessness, agitation or adynamia);

— fever;

— tachycardia;

— pain in the wound, pains and tenderness along the vascular-nerve bundles of the affected limb, a sensation of tightness at the bandage.

Examination of the wound can show a change in the wound discharge, eventration of muscles into the wound, oedematous wound edges, and the appearance of blisters on the skin. Specially placed tight control bandage leaves a mark on the skin after removal and the sutures seem to be «cutting through» the skin. Deep pressing with fingers does not leave fingerprints on the oedematous tissues. The presence of oedema is confirmed by the clearly distinct deepening of hair roots on the skin. Oedema spreads to a particular limb segment or the whole limb.

The presence of gas (a «crepitation» sign) on palpation of the tissues confirms the diagnosis. Shaving of the skin around the wound gives a typical high metal sound (a «shave» sign). The formation of gas usually starts from the deeper tissues, which affects its elicitation at early stages. In such cases X-ray investigations can show the presence of gas. Serial examinations can confirm the increasing oedema. X-ray shows radioluscent areas around the bones, and in between the muscle bundles because of accumulation of gas in those areas.

Such signs as pain, fever, and an increase in the limb's size require that the urgent wound revision be done.

Slow progression of anaerobic infections is characteristic of a localized injury signs. The infection develops gradually, the pain is mild and intoxication is moderate, gas accumulates around the wound, wound discharge is serous and purulent with an offensive odour. This kind of localised anaerobic infection is known as *clostridial cellulitis.*

In fast developing fulminant forms of gas gangrene, the incubation period lasts from a few hours up to 2 days. Then oedema of the limb develops rapidly, the skin gets stretched and skin folds disappear. The skin of the affected limb becomes pale and icteric with bronze-greenish-blue patches. The epidermis exfoliates in blisters with transparent or turbid contents. Gas accumulates in the subcutaneous tissues and muscles. Grey muscles can be seen in the wound. Intoxication worsens fast. This type of anaerobic infection is termed as *clostridial necrotising myositis.* The causes of fulminant development of the infection are not fully understood. Clostridial necrotising myositis is not so common as clostridial cellulitis and not infrequently leads to amputation of the affected limb.

Inspection of the wound reveals swollen muscles that are first «waxy» and then appear as boiled meat. Dirty grey film may cover the wound. On pressing on the wound edges, gas bubbles appear. The granulation is absent and the wound discharge of light yellow to dirty brown colour is scanty and is occasionally jelly-like. When putrid infection develops in addition to gangrene, a smell of rotten tissue can be noted.

Qualitative and quantitative changes of the exudate and dryness of tissues imply poor prognosis. An increased serous secretion suggests the subsiding of the process. The appearance of thick pus discharge implies the presence of a secondary purulent infection. Oedematous wound edges with hyperaemic surrounding skin are typical of severe secondary purulent infection.

Gram stain of the wound smears can confirm the diagnosis if large gram-positive bacilli are revealed. Cultural studies, however, are of limited value in the acute period of infection but their results can be very helpful for the subsequent adjustment of antibiotic therapy.

Complex *prevention* of anaerobic infection includes early first aid to injured persons, prevention and treatment of shock, anaemia as well as early primary surgical wound debridement.

Primary surgical wound debridement should be preceded by complete excision of necrotised tissue, opening of pockets of pus. Gunshot and crushed wounds are not to be sutured. Thorough immobilisation of the limb, both transportation and therapeutic is important. In extensive injuries or severe contamination, polyvalent antigangrene serum is given to prevent infection. The average prophylactic dose of serum is 30,000 IU (10,000 IU for each of the three main causative agents - *Cl. perfringes, Cl. oedematiens, Cl. septicum).*

Treatment should be started as early as possible. The patient should be isolated into special cubicles. Emergency operation is indicated which includes incision of the wound and removal of necrotic tissues, especially muscles. In severe advanced cases, the limb has to be amputated (without using a tourniquet or suturing). In critical cases, amputation with extensive tissue excision and fasciotomy of the stump is done without suturing the wound.

Following surgery, wounds need to be treated with antiseptics such as oxidants (e.g. hydrogen peroxide, potassium permanganate).

The indications for limb amputations are as follows.

- Gangrene of a whole segment of limb.
- Progression of the process despite previous primary wound debridement (primary surgical debridement, stripe incisions) and provision of complex therapeutic measures.
- Severe gunshot injury leading to extensive damage to the bones and joint of the limb.

• Ischaemia of the limb following irreversible damage to the major vessels.

Fractured limb must be immobilised by using skeletal traction, plaster bars (the application of circular POP bandages is contraindicated in these cases).

Specific treatment should be started immediately. During the operation, intravenous infusion of serum at a rate of one ml/minute is given under general anaesthesia: 50,000 IU up to 150,000 IU against the three main causative agents: *Cl. perfring-es*, *Cl. oedematiens*, *Cl. septicum*. Serum is diluted with 300-400 ml of normal saline. Five prophylactic doses of serum are given intramuscularly. After the causative agent has been isolated, the appropriate serum is given. Prior to this, tests for the patient's tolerance of foreign protein: are done 0,1 ml of serum are injected intradermally from a test ampoule in the concentration of 1:100. If the size of the resulting blister exceeds 10 mm (with surrounding hyperaemia), the test is regarded as positive. If the test is negative, 0,1 ml of serum are given again subcutaneosly (if in 30 minutes no reaction is seen, the preparation is injected either intramuscularly or intravenously).

Detoxicating transfusion therapy is of vital importance - at least 4 l of fluid have to be given in 24 hours (polyion solutions; detoxicating solutions - haemodes (neocompensan); those that facilitate microcirculation - rheopolyglucin; glucose and protein solutions).

The patient needs complete bed rest, balanced diet and supportive treatment.

Antibacterial therapy involves the following drugs:

1. Antibiotics:

• carbopenems;

• vancomycin.

2. Chemical antiseptics:

• metronidazole;

• dioxydine (see «Biological antiseptics»).

Hyperbaric oxygenation plays an important role in the complex therapeutic measures. This involves treatment in the chamber under the pressure of 2,5-3 atmospheres. The method helps to reduce the extent of surgery required and to prevent a delay in the need for early amputation of the limb.

Tetanus. Tetanus is a severe wound infection. The incubation period ranges from 4 to 14 days. Its early recognition is of critical importance. The classical triad of signs (trismus, facies tetanica and opisthotonos) can be observed in the late stages of the disease. It can be suspected when new local and general signs appear: shooting or twitching pain in the wound with irradiation along the nerve fibres, burning or tingling in the wound area, increased and localised sweating, and in some instances paraesthesia associated with muscular hypertonicity, and a change in the positioning of the limb.

The early general signs include perspiration, weakness and difficulty in swallowing and require that the patient be immediately examined to exclude hyperreflexia and rigidity of muscles. During dressing, the wound has to be thoroughly examined, twitching of the muscles in the wound may be observed and when the wound is touched with forceps or a piece of gauze, a muscle twitch can occur. Remember to examine the muscle tonus, including that of the chewing muscles (rapping the chin with the patient's mouth open causes a sharp closure of the mouth as a result of spasm of the chewing muscles), occipital muscle rigidity (by way of bending the neck), muscles of the pharynx (by the act of swallowing).

In advanced cases of tetanus, the patient will complain of fear and insomnia and will demonstrate agitation and wincing, fever and perspiration.

The major signs of tetanus are muscular hypertonicity, rigidity, and tonic and clonic spasms. The «descending» form of tetanus starts with rigidity of the chewing and other facial muscles, while the 'ascending' one is characterised by initial rigidity of muscles around the wound. Spasms that are initially local develop with: trismus (lockjaw), dysphagia (spasm of the swallowing muscles), rigidity of the occipital muscles, spasm of the facial muscles (risus sardonicus) (fig. 80, colour inset).

Progression of the disease leads to spread of the spasms over all other muscles of the trunk, spine, abdomen, with resultant opisthotonos - overextension of the body due to convulsive contraction of the long muscles of the back.

Spasms need only minimum external stimuli to occur - light, noise or just a small push. The duration of convulsing ranges from a few seconds to a few minutes. The patient is conscious and has marked muscular pain. During general convulsive attacks, respiration arrest ensues, lasting the whole period of convulsions, and may even be fatal due to asphyxia.

Convulsions usually develop parallel to general signs of infection: fever, tachycardia, and sweating.

Treatment. The patient should be kept in a separate quiet and dark environment to be monitored for 24 hours; this helps notice the signs of impending seizures and provide the appropriate aid (control of spasms and respiratory arrest). Treatment must be started as early and involve anticonvulsive measures, airway management, detoxication, specific antibacterial and antitoxic therapy.

In localised spasms sedative agents (diazepam, seduxen etc) are used, barbiturates, aminazin, droperidol etc.

In severe generalised convulsions muscular relaxants together with barbiturates or diazepam may be used. Muscular relaxants have to be used with artificial lung respiration through tracheostomy for about 7-10 days, or in severe cases up to 30 days and longer, i.e. until spasms cease. Muscular relaxants and mechanical ventilation are indicated for short lasting initial stage of tetanus, fast progression of spasms, ineffectiveness of neuroplegic agents and barbiturates, in respiratory defect and aspiration pneumonia. Hyperbaric oxygenation is part of therapy.

Specific therapy must be started as soon when the toxin is still circulating in the blood (after 2-3 days the toxin enters the neurons which renders antitoxins ineffective)

The daily dose of the antitetanus serum is 100,000-150,000 IU, the total dose being up to 200,000-300,000 IU. Half of the daily dose is diluted with normal saline in the ratio of 1:10 and infused slowly intravenously, while the rest is given intramuscularly (as a single dose). Antitetanus gamma globulin is administered intramuscularly (the total dose is as high as 20,000-50,000 IU, initially 10,000 IU and then 5,000 IU daily). In children, the total dose is 3,000-6,000 IU.

Tetanus toxoids are given intramuscularly at 0,5 ml three times each 5 days.

Detoxication involves giving detoxicating solutions, those of electrolytes and glucose. Acidosis requires administration of solutions of sodium bicarbonate and trisamine.

When the patient cannot eat, parenteral nutrition is provided (see Chapter IV) - 2,000-2,500 kcal/ day.

Broad-spectrum antibiotics are also used for both prevention and therapy of suppurative complications (wound infections, pyogenic tracheobronchitis, pneumonia etc.).

As an emergency measure, the wound (which is expected to be the entry site for the infection) should be inspected; the sutures are to be removed, the edges retracted and the wound washed with hydrogen peroxide. In extensive necrosis and foreign bodies in the wound

secondary surgical debridement is done, collections of pus abscesses in the wound are incised and evacuated by draining.

If at the time tetanus occurs the wound has already healed, the scar tissue should invariably be excised within the intact tissue, minute foreign bodies removed. Subsequently, the wound is left open without suturing.

Specific tetanus prophylaxis is done both as a scheduled and emergency measure. To achieve active immunity to tetanus absorbed toxoids are given. Scheduled immunisation is indicated for the following subpopulations: the military, machine-operators, builders etc.: 0,5 ml of toxoid are given twice once a month. Revaccination is done after one year - 0,5 ml of toxoid are given, and repeated revaccination is done only after 5 years. Children below 12 years of age are vaccinated with the complex vaccine of DPT (diphtheria - pertussis - tetanus). The mode of emergent prophylaxis depends on the immune status of the patient (previously immunised vs. non-immunised). Those immunised are given 0,5 ml of toxoid as a single dose. The non-immunised are given 1 ml of toxoid and 1,500-3,000 IU of antitetanus serum or 450-600 IU of antitetanus gamma globulin, 0,5 ml of toxoid are given again after 1 month and to reliably provide immunity 0,5 ml of the toxoid are given after 1 year.

Burns. *Burns* are the damage to tissues caused by their exposure to thermal, chemical, electrical, or radiation energy.

Classification

A) Causes

1. Thermal.

2. Chemical.

3. Electrical.

4. Radiation.

B) Depth of damage

Degree 1 - damage to only the epidermis.

Degree 2 - damage to the epithelium up to the basal layer.

Degree 3 - damage to the dermis.

3a - epithelial necrosis with partial involvement of the basal layer; hair follicles, sweat and sebaceous glands are intact.

3b - complete necroses of the dermis, basal layer and part of the subcutaneous layer.

Degree 4 - complete necrosis of the skin and underlying tissues.

The severity of burns depends on the area and depth of damage.

Assessment of the area of burns facilitates adequacy of the therapy. The methods currently used to calculate the area involved the are as follows:

1. The «rule of nine». According to this rule, the body surface regions are divided into areas that are multiples of 9%. Each of the following body regions comprises 9% of total surface burn area: head and neck - 9%, upper limb - 9%; anterior part of the trunk - 18%, the back - 18%, lower limb - 18% (thigh - 9%, leg and foot - 9%), the external genitals - 1%.

2. The «rule of palm». If the areas damaged are not so extensive and scattered on different parts of the body, the rule of palm is applied to determine the areas of deep burns in the basis of superficial ones. The size of an adult palm is about 1% of the body surface area.

The «rule of nine» and the «rule of palm» (fig. 81) give an estimation of the area involved. More precise information can be obtained based on a direct measurement of the area (sterile transparent marked paper or film is placed on the burn surface, the contours of which are

traced onto the paper; the sheet of paper is then cut along the contour line and placed on a marked net with known graduations (e.g. on a graph sheet). This method yields the absolute figures. Special tables with graduations made according to the body surface areas (cm^2) can also be used (the face 500 cm^2, or 3,1%; scalp - the hairy part of the head - 480 cm^2, or 3,0%; chest and abdomen - 2990 cm^2, or 18,0%; the hand - 360 cm^2, or 2,25%; the back - 2560 cm^2, or 16,0%, etc.).

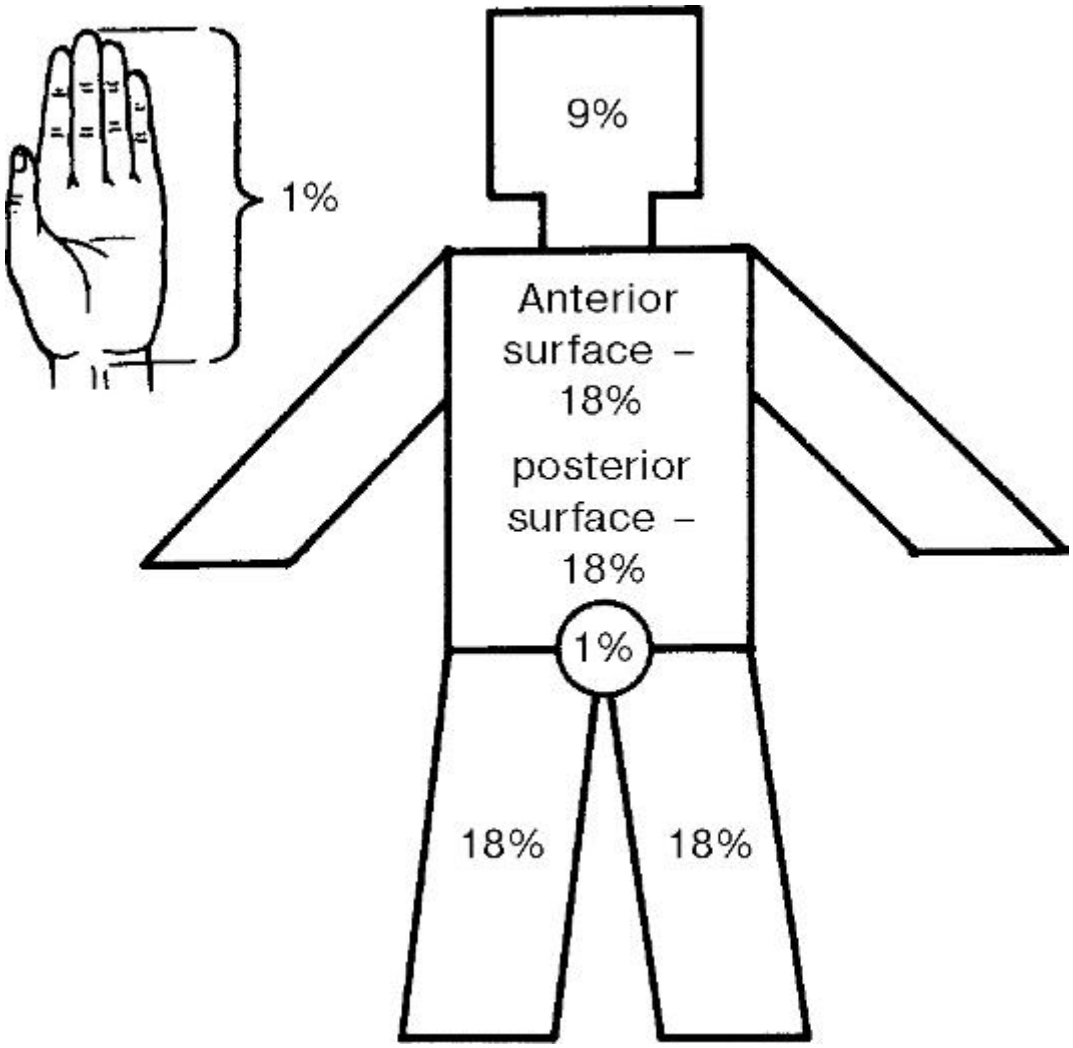


Fig. 81. Assessment of the burn area: the «rule of nines», the «rule of the palm».

Assessment of the depth of burns. The classification of burns into superficial (degrees 1, 2, 3a) and deep (degrees 3b, 4) is primarily based on the skin's capability of regenerating through epithelization in superficial burns (fig. 82).

Within the first few hours or even days following injury, it is difficult to assess the depth of burns. The evaluation of skin sensation is used. In *superficial* burns, pain sensation at the affected areas is intact or somewhat reduced, while in deep burns it is lost. In *deep* burns of a limb, unaffected areas below the affected ones become oedematous. The method of infrared thermography can also be used to determine the depth of burns (the areas with deep burns emit heat at a lesser degree than normal ones). The depth of burns can be established on days 7-14 following the injury.

Evaluation of severity of burns. In adults, the rule of 100 can be used (age in years + general burns area in %: J60 - good prognosis; 61-80 - relatively good prognosis; 81 - 100 - doubtful prognosis; i101 - poor prognosis).

Frank's index is known to be more specific and involves determination of both the area and depth of damage. It is based on the assumption that deep burns worsen the patient's status

three times as much as superficial burns. Thus, if 1% of a superficial burn equals one point, a deep burn equals three points. The total sum is referred to as Frank's index. The prognosis is good if the index is below 30 sites, relatively good - 30-60 sites, doubtful - 61-90 and poor - above 90 sites.

Burn disease. Burn disease is a constellation of clinical signs that result from superficial burns (degrees 2-3a) with a burn area of above 15% body surface and in deep burns of more than 10% body surface.

The four periods of the disease are identified.

1. Burn shock.

2. Acute burn toxaemia.

3. Septicaemia.

4. Recovery.

Burn shock. Being the major pathogenic mechanism of burn shock (erectile phase), loss of blood plasma results in local accumulation of vasoactive substances (e.g. histamine, serotonin) and an increase in blood viscosity, which consequently impairs microcirculation.

The manifestations of burn shock, which may last 2-72 hours, depend on its duration and severity of circulatory defects (see «Shock»). Stabilisation of the latter may imply evolution to the further period of burn shock.

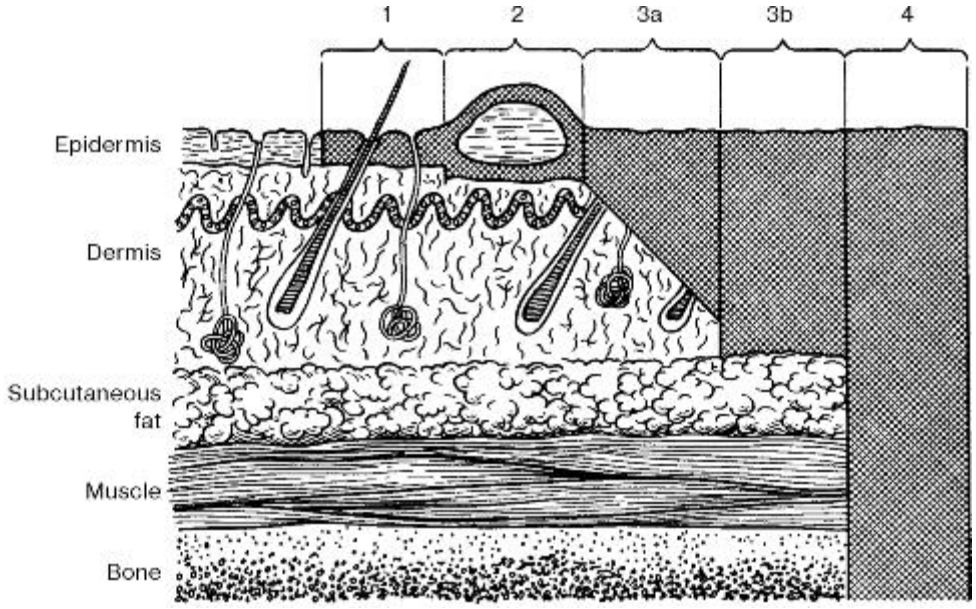


Fig. 82. Determination of burn depth.

Acute burn toxaemia. Once toxic products enter the blood stream, circulating blood volume returns to the basal levels; on the other hand, this leads to severe intoxication. Burn toxaemia manifests by fever, pronounced tachycardia, dullness of heart sounds, anaemia, hypoand dysproteinaemia, abnormal hepatic and renal functions. Acute burn toxaemia continues for 7-8 days.

Septicaemia. Septicaemia starts approximately on day 10 and is characterised by severe infection.*Staphylococcus, Pseudomonas and Proteus spp* and *E. coli* are common causative agents. In deep and extensive burns, suppuration of the burn wound may occur during toxaemia. During this period, patients with deep and extensive burns show signs of general deterioration, which in severe cases may present as weight loss, skin dryness and pallor, pronounced muscular atrophy, bed sores and contractures of joints. The separation of the necrotic eschar starts on days 7-10, the period being characterised by proliferation of microbes and development of varied

septic conditions (e.g. pneumonia, pressure sores, and sepsis). Complete skin regeneration is indicative of the end of the septicaemic period.

Recovery. Recovery is characterised by restoration of bodily functions, which have been affected previously, i.e. during the earlier three periods of the disease. As the functional organ changes (e.g. those of the heart, liver, kidneys) can persist for as long as 2-4 years after the trauma, the patients with a history of burn disease should be followed up regularly.

First aid in burns should aim at terminating the burning process and cooling the burnt area.

Cooling is achieved with cold water, ice packs, and snow and is to be continued for at least 10-15 minutes. After the pain has subsided, aseptic dressing should applied locally, and analgesics and non-steroidal inflammatory drugs, warm tea and mineral water are given to the patient. During this period, topical treatment (i.e. therapeutic bandages) should be avoided.

Apart from analgesics, the patient is given neuroleptics and antihistamines prior to transportation that should be as long as an hour. If the patient is to be transported for a long distance, he/she has to be given intravenous infusion of plasma substitutes and solutions of electrolytes, oxygen therapy and general anaesthesia (nitrous oxide), large amounts of alkaline drinks and cardiovascular agents.

Local treatment. The two topical (closed and open) methods are used for burns.

First, primary wound toileting is done. The skin around the burnt areas is cleansed with swabs soaked in 0,25% ammonium, 3-4% boric acid, benzene or warm soapy water, with subsequent application of alcohol. Pieces of clothing, foreign bodies, peeling epidermis are removed from the wound; large blisters are opened to drain their contents, minor ones being left alone. Fibrin deposits are usually left intact since it is under these where regeneration takes place. Excessively dirty burnt areas are cleansed with 3% hydrogen peroxide. Sterile gauze or tissues are used to dry the burnt surface.

As a rule, the primary wound toileting is done after 1-2 ml of promedol or omnopon have been injected subcutaneously.

The *closed* method (bandaging or covering with dressing material) is the most commonly used and has a number of advantages as follows:

- isolation of the wound;
- provision of optimum conditions for the application of topical agents;
- the possibility of active movement of patients with extensive burns during transportation.

Its pitfalls are the following:

- labour intensiveness;
- the expenditure of large amounts of dressing material;
- painful change of dressing.

The *open method* is void of these disadvantages. In addition, it promotes formation of the thick eschar on the burnt surface, which is aided by free flow of air over the area, ultraviolet rays or the use of agents that dry it and coagulate protein. It is difficult, however, to implement this method when dealing with patients with deep and wide areas of burns as it requires the use of special equipment (e.g. chambers, cage with electric lamps). Moreover, there is always a high risk of wound infection (e.g. nosocomial).

When treated by the open method, superficial (degrees 2-3a) burns tend to spontaneously heal. The open method is indicated for facial, genital or perineal burns. The open method requires the use of ointments containing antibiotics (5 and 10% synthomycin emulsions) and

antiseptics (0,5% furacilin, 10% sulphacyl) three to four times a day. Suppurated wounds should be dressed. If granulation is found in the areas of deep burns treated with the open method, the closed method should be added.

Each of these methods has its specific indications. At the same time, they can be combined, whenever necessary.

Mafenid (5% aqueous solution or 10% ointment) is successfully used, especially when the microorganisms in the wound are resistant to other antibiotics. Silver-containing sulphonamides on hydrophilic base (ointment *Sulfaraginum)* are also widely used. These possess potent antibacterial properties and thus promote epithelization.

In degree 2, burns it takes 7-12 days for the epithelium to form, while in 3a degree 3 to 4 weeks.

In deep burns, eschar, either as wet or dry necrosis, forms for 3-7 days. In the former variant a spread of necrosis, severe suppuration with intoxication may commonly be found. The separation of dry eschar starts on days 7 to 10 and leads to formation of granulation mounds (spots), which completes by weeks 4 to 5. The eschar is step-wise separated from the underlying tissues and removed. In deep burns, the primary task within the first 7 to 10 days is to promote dry eschar formation by means of special lamps, ultrasound or treatment with 1-5% solutions of potassium permanganate. To fasten the separation of eschar, chemical necrectomy, proteolytic enzymes, 40-50% salicylic and benzoic acids are used.

Surgical treatment involves several operations: early necrectomy, autodermaplasty, limb amputation and reconstructive operations.

Circular burns of chest and limbs have to be treated by necrectomy. The operation helps reduce the pressure exerted on the underlying tissues. If possible, necrectomy should be performed in the first three days after trauma when shock has resolved.

Indications for early necrectomy are as follows:

1. Deep burns involving 10-20% of the body surface, especially if simultaneous autodermaplasty may be possible to perform.

2. Burns involving fingers; in such cases it is necessary to prevent excessive scar (webbed fingers) that can affect digital functions.

3. In elderly burn patients, to prevent wound infection and to facilitate early mobilisation.

Extensive necrectomy is to be done within the first seven days since at a later period the risk of septicaemia is rather high. Necrectomy performed at a time should by no means exceed 25-35% of the body surface area.

Autodermaplasty is the only method applied for deep burns (degrees 3b and 4). For this operation split thickness skin flaps (dermatome plastic), full thickness flaps on vascular peduncles, as well as migrating (Filatov's) stalks are used. The skin graft (0,2-0,4 mm thick) is harvested from the intact skin, preferably taken from symmetrical areas with a dermatome. The operation can be performed either under local or general anaesthesia.

To cover the burnt surface in deep burns cultured autofibroblasts or foetal fibroblasts can be used. This stimulates skin regeneration, which is especially effective if the skin growth layers have not been destroyed (degree 3b). The transplantation of the cultured fibroblasts is done in combination with that of split thickness net skin flaps.

Principles of treatment and resuscitation. Resuscitation of the patient in the state of shock should be started at the stage of first aid and continued in hospital. Before admittance to hospital.

1. Give rest and apply dressing to the wound.

2. Give analgesics and antihistamines; during transportation in case of extensive burns - give phentanyl and droperidol, inhalation of nitrous oxyde in combination with oxygen.

3. Keep the patient (warm drinks, hot water bottles).

4. Compensate for plasma loss by giving alkaline solutions and parenteral infusion of fluids.

When hospitalised, the patient is admitted into the antishock ward. The major task is to restore circulation and replace circulating blood volume by means of the following measures.

— Administration of analgesics (fentanyl + droperidol), antihistamines.

— Improving cardiac function by giving digitalis derivatives.

— Improving microcirculation with euphyllin, intravenous droperidol and 0,25% novocain).

— Injection of hydrocortisone (125-250 mg) or prednisolone (60-90 mg) after circulating blood volume has been restored.

— Oxygen therapy.

— Restoration of renal function (mannitol, lasix in mild cases, intravenous infusion of 20% sorbitol solution in severe cases).

— Early administration of bacteriophages, staphylococcal toxoid.

— Transfusion of plasma solutions (native and dry plasma, albumin, protein, fibrin), whole blood, solutions that improve circulation, detoxication solutions, saline solutions (10% glucose, acesol, disol, trisol, lactosol).

Burns involving above 10% of the body surface can lead to burn shock. Before burn shock develops, it is necessary to take preventive measures and give therapy (analgesia, replacement of plasma loss etc).

It has to be taken into consideration that most plasma is usually lost within the first 8 to 12 hours and continues for about 2 days. In extensive burns, plasma loss can reach at least 6-8 l/day, the daily loss of protein being at least 70-80 g.

There are several methods to calculate the fluid requirement, the principles of which can be as follows:

1. The volume of fluid given should not exceed 10% of the patient's body weight.

2. Within the first 8 hours after injury 1/2 or 2/3 of the daily amount of fluid required should be given.

3. On days 2 and 3, the amount of fluid given should not exceed 5% of the body weight.

Of practical importance is the Brock's formula: [2 ml × body weight × the surface area burnt (unless the burn is of degree 1) + 2000 ml of 5% glucose solution.

The effectiveness of treatment is assessed based on clinical features, haemoglobin and haematocrit values; of great importance are the serial central venous pressure values and those of hourly diuresis.

Chemical burns. These are caused by concentrated solutions of acids and alkali (base), which leads to necrosis of the skin and mucosal membranes that may extend to deeper lays.

Acids cause *dry,* or coagulation, *necrosis,* while alkali cause *wet,* or colliquative, *necrosis.* The common culprits are sulphuric, hydrochloric acid, and sodium hydroxide. Chemical burns are most commonly localised. Examination of the patient reveals burnt areas with clear borders. Strips of bands can be seen leading from the damaged areas, which form as a result of the trickling of the acid or base, or separate areas of necrotic spots are encountered when the chemical substance was sprinkled.

Acids cause tissue dehydration, eschars form that are located deeper than the intact skin. When the burn is caused by sulphuric acid, the eschar formed is grey, dark brown or black, nitric acid - yellow, hydrochloric - grey yellow, acetic - greenish.

Wet necrosis caused by alkali burns appears as a thick jelly mass of grey colour. The necrotic skin is on the same level with the intact skin or occasionally a bit swollen up. Chemical burns of the first and second degrees are considered *superficial,* third and fourth degree burns are regarded as *deep*burns.

In first degree burns patients complain of pains, and burning sensation. Examination of the burnt area reveals an outlined area of hyperaemia with minimal swelling of the skin, which is more pronounced in alkaline burns. All types of sensory functions are intact, pain sensation is exaggerated.

In second-degree burns dry (in acid burns) or jelly-like/soapy (in alkaline burns) superficial skin eschars are found. The eschar is very thin and easily creased.

In deep (third and fourth degree) chemical burns, thick firm skin eschar is found, which cannot be creased. The eschar is immobile and appears as wet necrosis in alkaline burns and dry necrosis in acid burns. All types of sensation are lost. It is not possible to differentiate between third and fourth degree chemical burn at the first examination.

In third degree of burns, all skin layers are necrotised, in the fourth degree, necrosis develops as deep as to the bone. It is only at the third - fourth week after injury when the eschar begins to separate and the depth of damage can be established: if only necrotised skin peels off then it is a third degree burn, in case deeper lying tissues separate, it is a fourth degree burn.

First aid for chemical burns involves the removal of the chemical agent from the skin as early as possible (the first few seconds or minutes). It is more effective to wash the area under running tap water for 10-15 min, and if the washing was started late then it should be continued for 30-40 min; in fluoric acid burns washing is continued for 2-3 hours. Washing of the burnt surface should be continued until the smell of the chemical disappears or until the colour of the litmus paper placed on the area has changed. In burns caused by lime, washing is not allowed because the resulting chemical reaction produces more heat to lead to thermal burns in addition. When slaking lime pours on the skin, it has to be removed mechanically. After the chemical agent has been removed from the skin sterile dressing is applied and the patient is transported to the hospital.

Electric burns. High-voltage electric current can cause electric burns at the entry and exit sites of the current. These kinds of burns are always deep, and here the underlying tissues are damaged than the skin itself. All the tissues on the way of the current get necrotic, the major vessels get thrombosed in addition. In view of these the extent of burn is not established by the skin damage, which is limited to about 2-3 cm in diameter, but by the damage caused to the deep lying tissues that come into contact with the current. When major vessels are damaged there can be tissue necrosis, gangrene of an organ e.g. a limb.

On the sites of entry and exit of the current «current signs» form - burn wounds. The type of «sign» differs: circular, oval, with normally a diameter of 2-3 cm with the centre drawn in; in lightning treelike type. «Current signs» consist of grey or dark brown coloured eschars with depressed centres and oedema of the adjacent tissue. Skin sensitivity is decreased. The «figures» of lightning consist of dark greyish brown tree like forms.

First aid to the person with electric shock should primarily be aimed at removing the patient from the current and starting resuscitation measures, if necessary (see Chapter X), and the places of burns should be covered with sterile dressing.

When rescuing the patient from the current, it has to be remembered that touching the patient's body can also lead to injury of the one trying to help. Putting off the electricity

connection to the source or cutting off the wire using a wooden handled axe or instrument with dry wood handle can rescue the patient. The wire is then pushed away with a stick, or board and the injured is pulled away to the side by his/her clothing.

After the cardiac and respiration functions have been restored, dry sterile dressing is applied to the burnt areas. All persons after rescue from an electric shock must be sent to the hospital.

In thermal burns as a result of breathing in hot air or gaseous substances or smoke there can be burns to the respiratory tract.

Breaking of the voice (hoarseness), hyperaemia of the mucus layers of the throat and mouth with white patches and traces of soot are all signs of burns to the respiratory tract.

Frost bite (freezing). This involves local damage to the skin and deep lying tissues because of extreme cold resulting to blood circulatory failures.

Classification of frostbite

1. Depth of damage:

degree 1 - blood circulatory disorders and the development of reactive inflammations;

degree 2 - damage to the epithelia up till the germinal layer which is intact (fig. 83, a, colour inset);

degree 3 - complete skin necrosis and partial necrosis of the subcutaneous layer (see fig. 83, b, colour inset);

degree 4 - skin necrosis and necrosis of deep lying tissues.

2. According to the disease period (period of frostbite):

- latent (pre-reactive) period;
- reactive period.

Under the influence of very cold temperatures there can be local frost bite and general frostbite.

Local damage by extreme cold to the skin and deep lying tissues occurs due to disorders of blood circulation rather than as a result of the direct cold: spasm, and in the reactive period, vascular (capillary and minor arterial) paresis, the decrease in blood flow, stasis of blood cells and thrombus formation. Later morphological changes in the vascular walls are usually as follows: swelling of the endothelium, plasmatic infiltration of endothelial structures, formation of necrosis followed by connective tissue formation and vascular obliteration.

Thus, tissue necrosis in frostbite has the secondary character and continues into the reactive phase of frostbite. The changes that occur in the vascular walls after frostbite provide favourable conditions for the development of obliterating vascular diseases and the development of trophic disorders.

Most commonly (in 95% of cases) it is the extremities that get frostbitten since blood circulation in the limbs is rather vulnerable.

The *latent period,* or hypothermia, continues from several hours to a day up to the beginning of the period of warming and restoration of blood circulation.

The *reactive period* starts from warming the affected organ and restoration of blood circulation. It is divided into early and late reactive periods. Early reactive period lasts for 12 hours from the beginning of warming and is characterised by the disorders in blood circulation, changes in the vascular walls, hypercoagulation and clotting. The late reactive period follows the early one and is characterised by necrotic changes and infectious complications. It is normally associated with intoxication, anaemia and hypoproteinaemia.

Degrees 1 and 2 are superficial, while degrees 3 and 4 are deep.

In first degree frostbite there is blood circulation disorders without necrotic changes in the tissues. Full recovery is usually evident on days 5-7. In second degree burns the superficial layers of skin are damaged, the germinal layer is intact. Skin damage is fully healed within 1-2 weeks.

In the third degree frostbite, skin regeneration is impossible, and after the eschar has fallen off a skin defect forms, which is covered by granulation tissue and unless skin grafting is done to cover the defect, the wound heals with the formation of a scar.

In fourth degree frostbite, a dry or wet gangrene of the affected organ, usually of the limb, occurs.

Evaluation should include complaints and history. It is required that the patient be questioned as to the circumstances under which the frostbite occurred (air temperature, humidity, wind, long periods in the cold, the character and contents of the first aid given).

It is worthwhile to reveal all the factors that may reduce the body's general resistance to cold (e.g. cachexia, fatigue, blood loss, shock, vitamin deficiency and drunkenness), as well as local tissue resistance (obliterating vascular conditions, disorders of innervation, trophic skin and tissue disorders and previous one episodes of frostbite)

During the latent (pre-reactive) phase, the patient may experience paraesthesia in the frozen areas, which is later joined by a feeling of numbness. Pain is not always present. Skin in those areas is pale, rarely cyanosed, cold to touch, sensory function is reduced or absent. It is not possible to determine the extent of frostbite in this period; it can only be estimated that the absence of sensation indicates severe frostbite.

During warming the limb, as the blood circulation improves, frostbite moves into the reactive period. Tingling, burning sensations, itching and pain (in deep frostbite pains do not increase) occur in the frozen area and the limb warms up. Examination reveals reddened skin, and in deep frostbite -cyanotic with marble coloration or very hyperaemic. As the patient warms up tissue oedema, which is more pronounced in cases of deep freezing sets in.

It may be possible to ascertain the spread and depth of damage only after all the signs have manifested themselves, i.e. after several days.

Patients with first-degree frostbite complain of pain occasionally burning and unbearable during the warming period. As the patient warms, skin pallor turns into hyperaemia and becomes warm to touch, tissue oedema is minimal, limited to the damaged areas and do not progress. All types of sensation and movement in the hand and foot joints are intact.

Patients with second degree frostbite complain of itching, burning sensation, tension in the tissues, which persist for several days. Blister formation, which commonly appears in the first days, occasionally on the second day, and rarely on the third-fifth day, is a characteristic sign. Blisters are filled with transparent contents, when there are opened a red or pink papilla layer of the skin that is occasionally covered with fibrin shows. When the bare layer at the base of the blister is touched the patient experiences severe pain. Skin oedema spreads beyond the damaged area.

In third degree frostbite, pain is more severe and long lasting; there is a history of staying in the cold for long. The skin in the reactive period is violet bluish and cold to touch. If blisters form (which is rarely the case), they are usually filled with haemorrhagic contents. During the first days or even hours, pronounced oedema that extends beyond the affected skin areas occurs. All types of sensation are lost. When the blisters are opened violet-bluish surface of the blister base that is not sensitive to skin prick or irritation by gauze swabs soaked with alcohol is found. Subsequently dry or wet skin necrosis sets in; and when they peel off granulation tissue forms.

During the first few hours or even days, the fourth degree frostbite is unlikely to be distinguished from that of the third degree. The damaged skin looks pale or bluish. All types of sensation are lost; the limb is cold to touch. Blisters can appear in the first hours and are friable, filled with haemorrhagic dark contents. Limb oedema develops very fast - 12 or a few hours after warming. Oedema occupies much larger areas than the necrotic area: hence, in frozen fingers the whole forearm becomes oedematous, the foot - the whole leg. Subsequently dry or wet gangrene develops. After a week, oedema subsides and the demarcation line appears - a line that separates the intact side from the necrotic areas.

Because of long repeated frostbite (interchanging with warming) at 0 ... + 10 °C and high humidity a particular type of localised frost bite «trench foot» develops. Frostbite commonly persists for several days after which dull pains and burning sensations as well as a wooden type of limb is felt.

Examination reveals a pale, oedematous foot, which is cold to touch. All types of sensation are lost. Blisters with haemorrhagic content are then formed, their bases being part of the necrotic papilla layer. Intoxication is pronounced: high body temperature, tachycardia and general malaise. Sepsis commonly sets in.

First aid. Fast warming of the affected area is the main element of treatment since that leads to a quick restoration of the blood circulation. Warming can be done through any means but best results are achieved when heating is fast.

The injured has to be taken to a room. Since it is normally the limbs that are frozen they are put in warm baths with the temperature of water at 18-20 °C and within a period of 20-30 min the temperature is raised to 39-40 °C while at the same time massaging the limb carefully from the periphery to the centre, manually or with soaped sponge. After 30-40 minutes of massage and heating, the skin gets warm and pink. The limb is taken out of the water, dried with a clean towel and treated with 70% alcohol after which an aseptic dressing is applied; a thick layer of cotton wool is used to cover the first dressing and bandaged. The patient is placed in bed keeping the limbs raised, hot drinks and a little alcohol is given.

When the external ear, nose and cheeks are frozen, they can be rubbed with warm hands or some soft material until they become red. They are then treated with 70% alcohol and sterile Vaseline oil. They should never be rubbed with snow, since that can freeze the skin more and the snow crystals can cause mechanical damage to the skin creating the conditions for infection and the development of erysipelas inflammations.

When it is impossible to actively heat the affected part, heat insulation dressing that prevents heat loss and further cooling is used. Sterile dressing is put on the affected part on top of which only cotton wool is placed and bandaged. Woollen blankets and fur materials can be used for the heat insulation purpose. Using heat insulation materials to warm the affected part takes 5-6 hours whilst active warming takes just 40-60 min.

Heating under field conditions is done with such heat sources as burning fire, or hot water bottles. The affected limb can be placed in the armpit, on the stomach, in between the thighs of either the injured or the one giving the first aid. In all instances it has to be made sure that the rate of heat production is greater and the rate of heat loss is reduced by covering the injured with warm clothing, hot tea and injections of spasmolytics.

When the adequate first aid is given in the latent period the development of primary tissue necrosis is avoided.

Treatment. This is primarily directed to restoration of blood circulation, treatment of local damage, prevention and treatment of infectious complications. Treatment is either conservative or surgical.

Infusion therapy is the most important measure in the conservative therapy. The choice of the solution for transfusion varies with the period of injury.

In the pre-reactive period, when vascular spasm, increased blood viscosity and aggregation of blood cells persist, preparations that improve metabolism are given either intra-arterially or intravenously: rheopolyglucin, rheogluman (10% dextran and 5% mannit in 0,9% normal saline); spasmolytics: 2% solution of papaverin - 2 ml mixed with 1% nicotinic acid - 2 ml in of the mixture with 10 ml of 0,25% novocain (intra-arterially). Prevention of thrombosis is achieved by giving 20,000-30,000 IU of heparin. This therapy is continued in the early reactive period in the first 12 hours after the limb has been heated.

At the early stages of intoxication blood substitutes with detoxication properties (haemodes), crystalloids are added to the drug infused. Apart from intravenous and intra-arterial modes of administration, heparin can also be given subcutaneosly every 6 hours at the dose of 5,000 IU.

In the late reactive period in view of infections, intoxication and necrosis that develop, the following preparations are commonly used: detoxication drugs, blood components, immune stimulators, and preparations for parenteral nutrition. Antibacterial therapy is achieved with antibiotics, bacteriophages, and chemical antiseptics.

Surgical treatment for frostbite is aimed at excising the necrotic tissue and closure of tissue defect by autodermaplasty. These can be achieved by the following methods: *necrotomy* - incision of necrotic tissue within the first 3 days; *necrectomy* - early (i.e. within the first day) in gangrene and impending sepsis and delayed, 15-30 days after trauma; *limb amputation* - amputation of the damaged segment proximal from the demarcation line; plastic and reconstruction surgeries - skin transplant on the granulated wound, modification of stump and improvement of stump functions, restoration of cosmetic defects.

Local treatment of frostbite starts from primary wound toileting. The wound is opened, surrounding skin cleaned with alcohol solution and some ointment with antiseptic property (e.g. synthomycin emulsion) is used for the dressing.

In first and second degree frostbites, treatment is conservative, which involves the change of dressing every 2-3 days. Blisters that form in second-degree frostbite can be opened slightly at the base, and when they are infected, the contents have to be evacuated with the dead epidermis. After the blisters have been opened, they have to be dressed with antiseptic bandage.

In third degree frostbite, treatment is conservative and includes of the change of dressing and using antiseptic dressing, and proteolytic enzymes. After the wound has been cleaned of all the necrotic tissue in case of minor wounds, ointments that enhance wound healing can be used for the dressing. Extensive wounds need skin grafting.

In fourth degree frostbite, conservative treatment (the use of antiseptics for the prevention of wound infection) is a means of preoperative preparation.

Local treatment of fourth degree frostbite is step-wise: necrotomy - necrectomy - amputation. Necrotomy is done towards the end of the first week: necrotic tissues are incised up to the bone. Anaesthesia is not necessary, since there is normally no sensation in this part of the body. The resulting wound is treated according to the general principles of treating septic wounds: using antiseptics and proteolytic enzymes. After necrotomy the patient's condition normally improves - intoxication, adjacent tissue oedema and skin hyperaemia reduce, the demarcation line becomes more distinct. Necrectomy is done 7-10 days after necrotomy and involves excision of the necrotic tissue until intact tissue up to 1-2 cm distal from the demarcation line. Amputation is accomplished 2-3 weeks after the necrectomy and it is done taking into account the most functionally advantageous position of the involved limb.

General hypothermia. This is a serious condition, in which the body temperature drops to below 34 °C, and rectal temperature is below 35 °C. It is blood circulatory and metabolic disorders, hypoxia and the like that underlie the changes within the body.

Three degrees or forms of general hypothermia are as follows: mild (adynamic form) when the body temperature reduces to 35-34 °C; average (stupor form) when the body temperature reduces to 33-29 °C; and severe (convulsive form) when the body temperature falls to below 29 °C. A fall in the body temperature to as low as 25-22 °C leads to death.

The mild form of hypothermia (adynamic) is characterised by general fatigue, malaise and somnolence. Movement is stiff, speech is distorted, pulse is slow - 60-66 beats per min and the blood pressure is moderately increased (up to 140/100 mm Hg). The patient complains of thirst and rigors . Skin is pale or cyanotic with marble colour (alternating pale and cyanotic spots), «goose pimples» appear all over the skin, and rectal temperature is within 35-33 °C.

In moderate hypothermia, or stupor, the patient is stuporous (semiconscious), joints movements are very stiff, rare and shallow breath movements (8-12 per minute), bradycardia (34-56 beats per minute), weak pulse, blood pressure is moderately reduced. Skin is pale, cyanotic and cold to touch.

The patient with the severe form of frostbite (convulsive type) is unconscious, pupils are constricted, reaction to light is very weak or absent. Tonic spasms of the limbs are difficult to cope with. The chewing muscles and those of the abdominal press are contracted and stiff. Skin is pale, cyanotic and cold to touch. Breath movements are rare (4-6 per minute), shallow and intermittent, weak and rare pulse (34-30 beats per minute), blood pressure markedly falls.

First aid is aimed at warming the affected person as fast as possible. He/she is placed in a bath with the water temperature of 36 °C, and is increased to 38-40 °C within 15-20 minutes. Warming is continued for about $1^1/_2$-2 hours until the body temperature has increased to as low as 35 °C. The patient is simultaneously given hot drinks: tea, coffee; 50-70 ml of 40% glucose solution, 5-10 ml of 10% calcium chloride, 200 ml of 5% sodium bicarbonate are given intravenously, cardiac preparations, vascular drug (corglucon, caffeine), antihistamine agents and analgesics are also given.

After warming in the reactive period, prevention of possible complications or treatment of pre-existing ones (bronchitis, pneumonia, pulmonary oedema, cerebral oedema, neuritis, paresis, paralysis etc.) should be started.

TESTS

Chapter X. TRAUMA

Injury of the soft tissues. Traumatic toxicosis

1. The clinical features of the soft tissue contusion are as follows:

1. Pain.

2. Ecchymosis.

3. Cutaneous hyperaemia with distinct borders.

4. Swelling.

5. Organ dysfunction.

Choose the right combination of answers:

A. 1, 2, 3, 4. B. 2, 3, 4, 5. C. 1, 4, 5. D. 1, 2, 4, 5. E. 1, 2, 3, 4, 5.

2. The clinical signs of traumatic toxaemia usually develop:

A. Immediately after the limb has been compressed.

B. After the limb has been released from a compression.

C. In 4-8 hours after the limb has been released from a compression.

D. Within 24-48 hours after the limb has been released.

E. In 48-96 hours after the limb has been released.

Choose the correct answer.

3. The major causative factors of traumatic toxaemia are as follows:

1. Exposure to pain.

2. Fatty embolus.

3. Blood and plasma loss.

4. Defective blood coagulation.

5. Traumatic toxaemia.

Choose the right combination of answers:

A. 1, 2, 3. B. 1, 3, 4. C. 1, 4, 5. D. 1, 3, 5. E. 2, 3, 4.

4. The major periods of clinical course of traumatic toxicosis are as follows:

1. Reactive period.

2. Oedema and vascular insufficiency.

3. Toxicosis.

4. Acute renal failure.

5. Recovery.

Choose the right combination of answers:

A. 1, 2, 3. B. 1, 3, 4. C. 2, 4, 5. D. 1, 3, 5. E. 1, 4, 5.

5. The following muscles are most often ruptured:

1. Biceps brachii muscle.

2. Latissimus dorsi muscle.

3. Rectus abdominis muscle.

4. Quadriceps femoris muscle.

5. Gastrocnemius muscle.

Choose the right combination of answers:

A. 1, 2, 3. B. 1, 4, 5. C. 1, 3, 5. D. 1, 3, 4.

6. Clinically, brain concussion is characterised by:

1. Loss of consciousness at the moment of trauma.

2. Retrograde amnesia.

3. Focal cerebral deficits.

4. Impaired sensitivity and/or hemiparesis.

5. Dizziness.

Choose the right combination of answers:

A. 1, 2. B. 1, 3, 4. C. 1, 2, 4. D. 1, 4. E. 1, 2, 5.

7. As to the major sites of cerebral haematoma, the following types are identified:

1. Epidural.

2. Subdural.

3. Intraventricular.

4. Intracerebral.

Choose the right combination of answers:

A. 1, 2, 3, 4. B. 2, 3, 4. C. 1, 3, 4. D. 2, 4. E. 1, 2, 3, 4.

8. The common complications of the closed lung trauma are as follows:

1. Closed pneumothorax.

2. Open (penetrating) pneumothorax.

3. Valve (tension) pneumothorax.

4. Soft tissue emphysema.

5. The «moist» lung.

Choose the right combination of answers:

A. 1, 2, 3, 4. B. 1, 4, 5. C. 1, 3, 4, 5. D. 2, 3, 4. E. 1, 2, 3, 5.

9. The common complications of a hollow organ rupture due to closed abdominal trauma are as follows:

1. Peritonitis.

2. Haematuria.

3. Free gas accumulation in the pelvis.

4. Free gas accumulation under the diaphragm.

Choose the right combination of answers:

A. 1, 2. B. 1, 3. C. 1, 4. D. 1, 2, 4.

10. The most effective instrumental methods used to recognise closed abdominal traumas are as follows:

1. Scintigraphy.

2. Oesophagael, gastric and duodenal endoscopy.

3. Thermography.

4. Laparoscopy.

5. X-ray.

Choose the right combination of answers:

A. 2, 4, 5. B. 1, 2, 4, 5. C. 3, 4, 5. D. 4, 5. E. 1, 4, 5.

Fractures and dislocations

1. The major local signs of fractures are as follows:

1. Pain and swelling.

2. Limb defiguration.

3. Lacerated wound with crushed tissues.

4. Pathological mobility of the limb.

5. Limb shortening.

Choose the right combination of answers:

A. 2, 3, 4. B. 2, 4, 5. C. 3, 4, 5. D. 1, 2, 3. E. 1, 3, 5.

2. The following types of bone fragment displacement are identified:

1. Combined.
2. Angulated.
3. Epiphysial.
4. Longitudinal.
5. Lateral.

Choose the right combination of answers:

A. 2, 4, 5. B. 1, 2, 4. C. 1, 3, 5. D. 3, 4, 5. E. 2, 3, 4.

3. As to localization, the following types of the fractures are identified:

1. Epiphysial.
2. Suberiosteal.
3. Diaphyseal.
4. Metaphyseal.
5. Epiphyseolysis.

Choose the right combination of answers:

A. 1, 2, 3, 4. B. 1, 2, 3. C. 2, 3, 4. D. 1, 3, 4. E. 1, 2, 3, 4, 5.

4. The methods of stable bone fragment fixation are as follows:

1. With Dietrichs splint.
2. With Cramer's splint.
3. With plaster bandage.
4. With intramedullary osteosynthesis.
5. With extramedullary osteosynthesis.
6. With compression and distractional osteosynthesis.

Choose the right combination of answers:

A. 1, 2, 4, 5. B. 3, 4, 5. C. 3, 4, 5, 6. D. 1, 4, 5, 6. E. 4, 5. 6.

5. The callus consists of the following layers:

1. Periosteal.
2. Endosteal.
3. Basal.
4. Intermediate.
5. Paraossal.

Choose the right combination of answers:

A. 1, 2, 3. B. 1, 2, 4, 5. C. 1, 2, 3, 5. D. 1, 2, 4. E. 1, 2, 3, 4, 5.

6. The histologic sequence of bone callus formation and maturation is as follows:

1. Primary bone callus formation.
2. Fibrous callus formation.
3. Osteoclasia.
4. Periosteal productive reaction.
5. Secondary bone corn formation.

Choose the right combination of answers:

A. 1, 2, 3. B. 2, 3, 4. C. 1, 3, 4. D. 1, 2, 4. E. 1, 2, 3, 4, 5.

7. The major principles of fracture treatment are as follows:

1. Repositioning.

2. Correct bone fragment fixation.

3. Elimination of haematoma by its aspiration from the fractured zone.

4. Stimulation of bone consolidation and organ function restoration.

Choose the right combination of answers:

A. 1, 2, 3. B. 2, 3. C. 1, 3, 4. D. 1, 2, 4. E. 1, 2, 3, 4.

8. The sites of spoke insertion to provide skeletal traction are as follows:

1. The olecranon.

2. The anterior superior iliac spine.

3. The greater trochanter.

4. The lateral/medial condyle of femur.

5. The tubercle of tibia.

6. Over the ankle.

7. The ankle.

8. The calcaneum.

Choose the right combination of answers:

A. 1, 2, 3, 5, 8. B. 1, 3, 4, 5, 8. C. 1, 3, 4, 5, 6, 8. D. 1, 4, 5, 8. E. 1, 2, 3, 4, 5.

9. Put the following steps in the right sequence required in shin fracture:

1. Local anaesthesia.

2. Passing the pin through the calcaneous bone.

3. Anaesthesia of the pin introduction site.

4. Fixing the weight and stirrup.

Choose the right combination of answers:

A. 1, 2, 3, 4. B. 3, 1, 2, 4. C. 3, 2, 1, 4. D. 2, 3, 1, 4. E. 1, 3, 2, 4.

10. The indications for surgical treatment of fractures are which of the following:

1. Non-union and malunion of fractures.

2. Fresh medial fractures of the femoral neck.

3. Transverse fractures.

4. Muscle and fascia interposition.

5. Impacted fracture.

Choose the right combination of answers:

A. 2, 3, 4, 5. B. 1, 3, 5. C. 3, 4, 5. D. 1, 2, 4. E. 1, 2, 3, 4.

11. Which of the following types of the bone fragment fixation is non-surgical:

A. Silk sutures.

B. Connecting by metal plates.

C. Skeletal traction.

D. Insertion of the pin into the intramedullary canal.

E. Compression and distraction.

Choose the correct answers.

12. The local causes of delayed fracture union are as follows:

1. Soft tissue interposition.

2. Vitamin deficiency.

3. Bone fragment displacement resulting from repositioning failure.

4. Mineral metabolic disorder.

5. Poor blood supply of bone fragments.

Choose the right combination of answers:

A. 1, 2, 3. B. 2, 3, 4. C. 1, 3, 4. D. 3, 4, 5. E. 1, 3, 5.

13. The late complications of trauma are as follows:

1. Chromic osteomyelitis with fistulas.

2. Varicose (trophic) ulcers.

3. Damage to the vital organs.

4. Organ dysfunction caused by scarring.

5. Contractures.

6. Post-traumatic seizures.

Choose the right combination of answers:

A. 1, 3, 4. B. 4. C. 1, 2, 4, 6. D. 1, 2, 3. E. 1, 2, 3, 4, 5.

14. It is postulated that the bone which is more likely to be dislocated has the joint surface situated more distal to the other bones of the joint, with the exception of:

A. Shoulder dislocation.

B. Elbow dislocation.

C. Finger phalanx dislocation.

D. Thigh dislocation.

E. Vertebral dislocation.

Choose the correct answer.

15. The sequence of steps in shoulder dislocation replacement by Kocher is which of the following:

1. Flexion of the forearm in the elbow joint.

2. Anterior elbow adduction with simultaneous shoulder inward rotation.

3. Adduction of the shoulder to the trunk.

4. Forward and upward arm raising.

5. Simultaneous shoulder downtraction and outward rotation.

Choose the right combination of answer:

A. 2, 1, 4, 3. B. 1, 5, 4, 3. C. 4, 3, 2, 5. D. 1, 3, 5, 2. E. 3, 5, 1, 2.

Burns, frostbite, electric burns

1. Superficial burns are categorized as:

1. First degree burns.

2. Second degree burns.

3. Third degree burns.

4. Fourth degree burns.

Choose the right combination of answers:

A. 1. B. 1, 2. C. 1, 2, 3. D. 1, 2, 3, 4.

2. Put the following local clinical manifestations of radiation burns in correct sequence of stages:

1. Primary response.

2. Latent stage.

3. Cutaneous erythaema and oedema.

4. Blister formation.

5. Necrosis.

Choose the right combination of answer:

A. 1, 2, 3, 5. B. 2, 3, 4, 5. C. 1, 2, 3, 4. D. 1, 3, 4, 5. E. 1, 2, 3, 4, 5.

3. The early signs (i.e. found within the first hours of the injury) indicative of deep burns are as follows:

1. Preserved pain sensation.

2. Loss of pain sensation.

3. Oedema of the underlying tissues of the limbs.

4. Absence of oedema.

5. Low heat reflection of the burnt area found by means of thermography.

Choose the right combination of answers:

A. 1, 2, 5. B. 1, 3, 5. C. 2, 3, 5. D. 2, 4, 5. E. 2, 5.

4. Burn disease develops:

1. In superficial burns of less than 10% of the total body surface area.

2. In superficial burns of more than 15% of the total body surface area.

3. In superficial burns of more than 20% of the total body surface area.

4. In deep burns of 5% to 10% of the total body surface area.

5. In deep burns of more than 10% of the total body surface area.

Choose the right combination of answers:

A. 1, 4. B. 2, 5. C. 2, 4. D. 1, 5. E. 3, 5.

5. In deep burns, an eschar forms:

A. Within 1-2 days.

B. Within 3-7 days.

C. Within 8-10 days.

D. Within 11-15 days.

E. After 15 days.

Choose the right combination of answers:

A. 1, 2. B. 2, 5. C. 2, 4. D. 1, 5. E. 3, 5.

6. A relatively favourable prognosis in burns may be expected in which of the following cases:

A. According to the «rule of nines» - 45%.

B. According to the «rule of 100» - 81-100.

C. According to the «rule of 100» - 40-60.

D. Superficial burn - 20%.

E. According to Frank's index - 30-60 units.

Choose the correct answers.

7. Put the stages of burn disease in a correct sequence:

1. Acute burn toxaemia.

2. Dehydration.

3. Burn shock.

4. Septicaemia.

5. Hydration.

6. Healing.

Choose the right combination of answers:

A. 1, 2, 3, 4. B. 1, 3, 5, 6. C. 1, 3, 4, 6. D. 1, 2, 3, 6. E. 1, 3, 4, 6.

8. The characteristic features of burn shock are as follows:

1. Excitement within the first few hours of the burn.

2. Torpid phase of the shock immediately after burn.

3. Hypovolaemia.

4. Hypercapnia.

5. Oliguria.

Choose the right combination of answer:

A. 2, 4, 5. B. 1, 3, 4. C. 2, 3, 5. D. 1, 3, 5. E. 1, 4, 5.

9. Acute burn toxaemia lasts for:

A. 2-72 hours.

B. 7-8 days.

C. 10-15 days.

D. 15-20 days.

E. Above 20 days.

Choose the correct answer.

10. The clinical manifestations of moderate burn shock are as follows:

A. Skin cyanosis.

B. Skin pallor.

C. Oliguria.

D. Increased urinary output.

E. Normal blood pressure.

Choose the right combination of answers:

A. 1, 3, 5. B. 1, 4, 5. C. 2, 3, 5. D. 2, 4, 5. E. 2, 3.

11. The appropriate surgery on day 5 following a mild (i.e. less than 10 percent of the body surface area) burn injury due to exposure to burning hot metal is one of the following:

A. Exposure therapy.

B. Necrectomy.

C. Treatment in a controlled sterile environment.

D. Occlusive dressing.

E. Plastics.

Choose the correct answer.

12. The local signs typical of electric burns are as follows:

1. Coagulation necrosis.

2. Colliquative necrosis.

3. Tenderness.

4. Progredient necrosis.

5. Formation of «current signs».

6. Formation of bullae.

Choose the right combination of answers:

A. 2, 3, 4, 5. B. 1, 4, 5, 6. C. 1, 3, 4, 5. D. 2, 4, 5, 6. E. 2, 3, 4, 6.

Contaminated wounds. Suppurative wounds

1. Therapeutic modalities that help remove suppurative contents from the wound are as follows:

1. Drainage.

2. Proteolytic enzymes.

3. Hypertonic solution of sodium chloride.

4. Irrigation with solution of antibiotics.

5. Alhypor.

Choose the right combination of answers:

A. 1, 2, 3, 4. B. 2, 3, 4, 5. C. 1, 3, 4, 5. D. 1, 2, 3, 5. E. 1, 2, 3, 4, 5.

2. The methods of local treatment of suppurative wounds in inflammation stage are as follows:

1. Ointment bandage.

2. Proteolytic enzymes.

3. Bandage with hypertonic solution.

4. Irrigation with antiseptics.

5. Immunization.

Choose the right combination of answers:

A. 1, 2. B. 1, 2, 3. C. 2, 3, 4. D. 1, 5. E. 1, 4, 5.

3. The signs characteristic of wound inflammation stage are as follows:

1. Defective vessel wall permeability.

2. Inflammatory oedema.

3. Tissue granulation.

4. White cell infiltration of tissues.

5. Tissue acidosis.

Choose the right combination of answers:

A. 1, 2, 3, 4. B. 2, 3, 4, 5. C. 1, 2, 5. D. 1, 2, 4, 5. E. 1, 2, 3, 4, 5.

4. The factor that promotes primary wound healing is which of the following:

A. Blood clots in the wound.

B. Tight closure of the wound.

C. Local administration of antibiotics.

D. Drainage in the wound.

E. Infection.

Choose the correct answer.

5. The wound that is more likely to be complicated is which of the following:

A. Inflicted with an axe.

B. Missile wound.

C. Gunshot wound.

D. Inflicted with sharp cutting objects.

E. Inflicted with a blunt object.

Choose the correct answer.

6. The contraindication for primary surgical debridement of forearm wounds is which of the following:

A. Wound contamination.

B. Wound crushing.

C. Crushed wound edges of open fracture of the radius.

D. Degree 3 shock.

E. Injury of tendons.

Choose the correct answer.

7. In patients with severe shock, the primary surgical de-bridement should be performed:

A. Immediately on arrival.

B. Immediately after recovering from shock.

C. Within two hours after admission.

D. The next day.

E. Following blood transfusion.

Choose the correct answer.

8. The primary surgical debridement involves which of the following manipulations:

1. Excision of wound edges.

2. Bleeding control.

3. Removal of foreign bodies from the wound.

4. Irrigation of the wound with antibiotics.

5. Suturing or drainage of the wound.

Choose the right combination of answers:

A. 1, 3, 4, 5. B. 1, 2, 3, 5. C. 2, 3, 4, 5. D. 1, 2, 4, 5. E. 1, 2, 3, 4, 5.

9. The appropriate treatment of the wound with major vessels at the bottom is which of the following:

A. Conservative treatment without primary surgical debridement.

B. Excision of the wound edges, walls and bottom including the vascular bundle with subsequent closure of the wound.

C. Conservative treatment with subsequent secondary suturing.

D. Excision of the wound edges and walls with the vascular bundle left intact, removal of the foreign bodies and necrotic tissues, administration of antibiotics.

E. Excision and drainage of the wound without suturing.

Choose the correct answer.

10. The early primary surgical debridement of the wound is performed within:

A. 24 hours.

B. 36 hours.

C. 48 hours.

D. 72 hours.

E. After 72 hours of antibacterial therapy.

Choose the correct answer.

11. The suture for closing the wound placed in within 14 days after injury is called:

A. Primary.

B. Primary delayed.

C. Early secondary.

D. Late secondary.

E. Provisional (untied).

Choose the correct answer.

12. Factors that make it possible to perform secondary suturing are which of the following:

1. Maximal adjustment of the edges and walls of the wound.

2. Removability of the suture.

3. Non-removability of the suture.

4. Persistence of granulation.

5. Excision of granulation.

Choose the right combination of answers:

A. 1, 2. B. 1, 2, 4. C. 1, 3, 5. D. 1, 2, 5. E. 1, 3, 4.

13. The signs characteristic of staphylococcal infection in wound suppuration are as follows:

1. Rapid progression of inflammation.

2. Slow progression of inflammation.

3. Severe pain in the closed wound.

4. Absence of pain in the wound.

5. Pronounced intoxication.

Choose the right combination of answers:

A. 1, 3, 5. B. 2, 4, 5. C. 2, 3, 5. D. 1, 4, 5. E. 3, 5.

14. The signs of putrid wound infection are as follows:

1. Ichorous smell.

2. Absence of granulation.

3. Grey exudate.

4. Rigors without pain.

5. Pronounced pain without rigors.

Choose the right combination of answers:

A. 1, 2, 3, 5. B. 2, 3, 4. C. 1, 2, 3, 4. D. 1, 2, 5. E. 1, 3, 5.

15. The signs of clostridial panniculitis is which of the following:

1. Rapid progression of disease.

2. Slow progression of disease.

3. Rapid progression of intoxication.

4. Serous and putrid wound exudate with offensive smell.

5. Grey muscles bulging from the wound.

Choose the right combination of answers:

A. 1, 3, 4. B. 1, 5. C. 1, 2. D. 2, 4. E. 2, 5.

16. The early signs of anaerobic infection are as follows:

1. Fever.

2. The patient's inadequate behaviour.

3. Local pain.

4. Increased limb size.

5. Frequent and weak pulse.

Choose the right combination of answers:

A. 1, 2, 3. B. 2, 3, 4, 5. C. 1, 2, 3, 4. D. 1, 3, 4, 5. E. 1, 2, 3, 4, 5.

17. The signs of non-clostridial anaerobic infections are as follows:

1. Bronze skin.

2. Offensive smell.

3. Abundant necrotic tissues in the wound.

4. Pronounced hyperaemia.

5. Grey pus with fatty droplets.

Choose the right combination of answers:

A. 1, 2, 3. B. 2, 4, 5. C. 3, 4, 5. D. 2, 3, 5. E. 1, 2, 3, 4, 5.

18. The appropriate surgical manipulations in progression of clostridial infection are which of the following:

1. Abscess excision and drainage.

2. Extensive wound incision.

3. Incision of the fasciae.

4. Amputation with incision of the stump.

5. Amputation without application of a tourniquet and then suturing the stump.

Choose the right combination of answers:

A. 1, 3, 5. B. 1, 2, 5. C. 2, 3, 5. D. 2, 3, 4. E. 1, 2, 3, 5.

19. Identify the first signs of tetanus:

1. Local tingling pain.

2. Trismus.

3. Local perspiration.

4. Local muscle contraction.

5. Sardonic smile.

Choose the right combination of answers:

A. 1, 3, 5. B. 2, 3, 5. C. 1, 4, 5. D. 1, 3, 4. E. 1, 2, 3, 4.

20. The clinical forms of tetanus are as follows:

1. Mitigated.

2. Subacute.

3. Acute.

4. Chronic.

5. Relapsing.

Choose the right combination of answers:

A. 1, 2, 4. B. 2, 3, 4. C. 3, 4, 5. D. 1, 2, 3. E. 1, 3, 4.

21. The daily dose of antitetanus serum is as follows:

A. 3,000-5,000 IU.

B. 10,000-20,000 IU.

C. 50,000 IU.

D.100,000-150,000 IU.

E. 200,000 IU.

Choose the correct answer.

Chapter XI. SUPPURATIVE INFLAMMATORY DISEASES

11.1 CLINICAL MANIFESTATIONS AND PATIENT EXAMINATION AND MANAGEMENT

The clinical manifestations of suppurative-inflammatory diseases are comprised of local and general symptoms. The local features of inflammation reflect the stage of development, the character and localization of the inflammatory process. Hence foci of superficial inflammation (suppurative inflammatory skin diseases, subcutaneous fat, the breasts, muscles etc.) or foci located deep but with the involvement of skin in the inflammatory process are characterized by the classical signs of inflammation - *redness (rubor),* caused by peristatic hyperemia, edema, *swelling (tumor),* pain (dolor), increase in local *temperature (calor)* and *organ function disorder (functio laesa).The* spread and manifestation of the inflammatory process determine the extent of the local clinical presentation. The inflammatory process of the internal organs has their own specific local clinical signs that differ from organ to organ, for example in purulent pleurisy, peritonitis.

During the process of clinical examination of patients with suppurative-inflammatory disease the stage of the disease process can be identified: when a firm tender mass is palpated in the presence of other signs of inflammation, it is an indication of some inflammatory process in the soft tissue and glandular organ, skin and subcutaneous layer, breast or in the abdominal cavity that is still in its infiltrative phase. Palpation of a soft infiltrate, positive fluctuation sign indicate that the infiltrative phase has moved into the suppurative (purulent) phase. The local clinical signs of progressive suppuration are: zones or stripes of redness in the skin (lymphangitis), firm tender strings of induration along the superficial veins (thrombophlebitis), the appearance of firm tender indurations at the sites of the regional lymph nodes (lymphadenitis). There is always a correlation between the extent of the local presentation and the intensity of general clinical signs of intoxication: a progression of the inflammatory process is accompanied by the progress of both local and general signs of inflammation and intoxication.

The body's response to the inflammatory process is shown clinically as follows: a rise in body temperature, chills, agitation or alternatively weakness, and in extreme cases mental confusion, sometimes unconsciousness, headaches, general malaise, fatigue, a rapid pulse, extreme deviations in the blood picture, signs of liver and kidney function disorder, a reduction in the blood pressure and congestion in the pulmonary blood circulation. The above symptoms can either be pronounced or latent depending on the character, type, extent, location and spread of the inflammation as well as the organism's response to it.

In surgical infections the body temperature can rise to 40 °C and over, there occur recurrent chills and headache, the level of hemoglobin tends to decrease sharply as do the erythrocytes, leucocytes increase - in severe cases up to 25,0-30,0x10^9/l. Plasma globulins increase while albumins decrease, there is loss of appetite and intestinal disorders, constipation, protein and cylinders appear in the urine. Intoxication that results leads to a distortion of the hemopoesis as a result of which the patient becomes anemic accompanied by marked changes in the white blood components: immature blood cells appear in the peripheral circulation, a shift of the leukocyte formula to the left is observed (a decrease in the mature and stab forms of neutrophils). A sharp increase in the erythrocyte sedimentation rate (ESR) occurs during the inflammatory process. It is notable that once it appeared at the onset of inflammation it tends to persist for a long time even after the inflammation is over. Sometimes the spleen and liver can enlarge, with yellowish sclera.

In hyperergic (excessive) reactions of the individual to the surgical infection, all the above-mentioned manifestations are further enhanced; in average or minimum reactions these signs can be either moderate or even latent. Yet any local inflammatory process is associated with general manifestations, which in the case of suppurative infections have features that are similar to sepsis and some other infectious diseases (typhoid, brucellosis, paratyphoid,

tuberculosis etc.). Such patients therefore need to be thoroughly investigated, one of the most important aims being to establish the primary focus of infection, and the point of entry for the pyogenic microorganisms. When the general condition of a patient with a local infection is severe, one should bear in mind not only the possibility of an infectious disease but also try to establish by repeated blood cultures the presence or absence of bacteremia. The detection of bacteria in the blood in the absence of clinical improvement after surgical treatment of the focus of infection argues the presence of sepsis and not just the body's general response to the local suppurative process.

The main difference between sepsis and the organism's general reaction to the suppurative process is that in the case of the body's reaction all the symptoms sharply decline or disappear following incision of the locus of infection and proper drainage of its contents; whereas in the case of sepsis the symptoms change almost not at all. Determination of the extent of the patient's reaction to the local suppurative infection is essential for the correct assessment of the patient's general condition, the character of the inflammatory process and the prognosis of possible complications.

The clinical signs of endogenic intoxication are a function of its severity: the more pronounced the extent of intoxication, the more vividly it manifests itself. In mild intoxications the skin is pale, and in severe cases the skin is sallow; there is acrocyanosis, and the face is hyperemic. Pulse rate is fast -up to 100-110 beats per min, in severe conditions more than 130 per minute, blood pressure falls. The patient becomes dyspnoeic - breathing rate reaches 25-30 per min, and in severe intoxication more than 30 in a min. A change in the functions of the CNS is a vital feature of intoxication; from light euphoria at the beginning to depression or psychosis in the case of toxemia, in extreme cases of intoxication the patient can develop intoxication delirium. Assessment of diuresis plays a vital role in determining the severity of intoxication: there is a reduced output of urine in severe intoxications and in extreme cases acute renal failure can occur with associated oliguria and sometimes anuria.

The most important laboratory tests , which provide a clue to intoxication, are those that permit to assess the following: the increase of blood urea, necrotic, polypeptides, circulatory immune complexes, proteolytic activity of blood serum. Severe intoxication is also associated with anemia, a shift of the leukocyte formula to the left, the appearance of toxic granules in the blood cells and the development of hypoand disproteinemia.

Special methods of investigations are used to confirm the diagnosis of suppurative-inflammatory disease - puncture, roentgenography, endoscopic methods, clinical laboratory and biochemical analysis of blood, urine and exudates.

Microbiological analysis has the potential not only to isolate the causative agent, its pathogenic properties but also to determine the microorganism's sensitivity to the antibacterial preparations. An important role in the comprehensive treatment of suppurative-inflammatory disease is assigned to the assessment of the patient's immune status, in order to select the appropriate and tailored immune therapy.

The adequate and timely surgical treatment of trauma and acute surgical disease in combination with rational antibiotic therapy have contributed to reduced incidence of suppurative infections and led to a change in the classical outcome of suppurative infections.

These days when antibiotic therapy is widely used before the patient is admitted to the hospital, sometimes not even prescribed by a doctor, surgeons often have to deal with patients with advanced and critical forms of suppurative processes (purulent appendicitis, gall bladder empyema, peritonitis, purulent pleurisy, mastitis, phlegmon etc.) who present without high body temperature, with moderate leucocytosis, minimal changes in ESR and minimal intoxications.

The foregoing changes in the clinical pattern of suppurative processes especially in cases of hidden locus of infection in the abdominal cavity can make an accurate diagnosis more

difficult. It is only through complex examination of patients with suppurative-inflammatory conditions that a correct diagnosis of the disease can be made and its nature and extent ascertained.

Acute suppurative diseases of soft tissues (soft tissue infections)

Abscess *(boil). This is a localized accumulation of pus in different tissues or organs resulting from suppurative tissue disintegration and cavity formation* unlike an empyema, which involves the accumulation of pus into natural body cavities and cavities of hollow organs.

The agents of infection are normally staphylococci in the form of a monoculture or in association with other microbes - *E. Coli, proteus, streptococcus, bacterioides* etc.

The infectious agents normally enter the organism from outside (exogenic infections), but can also invade the body from within (endogenic) - as for instance, when the organisms enter from neighboring or distant organs, metastatic abscesses in cases of sepsis. Abscesses can result from the injection into tissues of concentrated solutions of drugs - 25% solutions of magnesium sulphate, 24% solutions of cordiamin, 50% solutions of analgin etc. The development of suppurative inflammation leads to tissue disintegration and sometimes necrosis with rejection of the dead tissues - sequestration. Sequestra can subsequently dissolve when acted upon by enzymes. The form of the abscess cavity can be a simple one or complex with several pockets. The abscess wall is initially covered with purulent fibrinous deposits and fragments of necrotic tissues. Then an inflammation zone develops at the periphery leading to the formation of the pyogenic membrane made up of connective tissue.

An abscess that has resulted from a suppurative or aseptic inflammation can have different outcomes: spontaneous opening (burst) outside (abscess of the subcutaneous fatty layer, abscess of the muscles, mastitis, paraproctitis etc.), burst opening of an abscess into a closed cavity (abdominal, pleura, in a joint space etc.). An abscess can also open into a hollow cavity that has a connection to the outside (the intestinal lumen, the urinary bladder etc.). Under favourable conditions an abscess cavity decreases in size after the pus has evacuated, collapses and heals up by scarring; when evacuation is not complete the process can develop into a chronic one with formation of a fistula at the site where it burst.

Superficially located abscesses are marked by redness, swelling, pain, local rise in temperature, functional disorders and sometimes fluctuations can be elicited. The sites of infection may vary in size. The characteristics of the pus contained in an abscess cavity (consistency, colour and odour) depend on the type of causative agent involved: foul-smelling odour, dirty grey colour of pus is characteristic of ichorous strains; thick yellowish green pus - for staphylococcus; a bluish-green colour and sweetish smell - *pseudomonas bacilli* etc.

General clinical features of an abscess are: a rise in body temperature from subfebrile to high, general malaise, weakness, loss of appetite and headache. The peripheral blood picture shows leucocytosis with neutrophilia and a shift of the leukocyte count to the left. ESR is raised.

Signs of intoxication that occur in cases of serious abscesses can result from the absorption of toxic products from the focus of infection (suppurative resorptive fever), as well as from the development of sepsis (see «Sepsis»).

An abscess has to be differentiated from haematoma, cysts and tumor degenerations. Diagnostic puncture can play a very important role here: when pus is obtained in this procedure it not only helps to establish the diagnosis in unclear cases but also can be sent for bacteriologic analysis - to isolate the agent and to determine its sensitivity to antibiotics.

The presence of gas - producing bacterial strains lead to the accumulation of gas in the abscess cavity, so-called gaseous abscess. Percussion over such an abscess gives a tympanic sound; X-ray films show the presence of gas bubbles with horizontal fluid levels beneath them (it is often observed in abscesses caused by agents of ichorous infections).

Treatment of an abscess is by incision, evacuation and drainage of the abscess cavity. Cold tuberculous abscesses are not to be incised since there is always the danger of causing superinfections by suppurative strains. Small abscesses with well-formed capsules have to be removed in whole without first opening them.

An abscess has to be incised using the shortest surgical approach based on the anatomic and topographic peculiarities of the organ. Not infrequently an abscess is opened along a needle: the abscess is initially punctured with a needle, then the incision is made along the needle into the abscess cavity. The incision has to be made as much as possible towards the lower poles in order to create better conditions for drainage.

In order to reduce contamination of the surrounding tissues during the process of incision, the surgical field is well isolated by gauze or napkins and after a small incision into the cavity an electric suction machine is used to evacuate the pus. After the pus has been suctioned, the incision is increased, the cavity is explored by using the finger, breaking in the process the lacunae, and tissue sequestra are removed. All manipulations should be done carefully, so as not to destroy the pyogenic membrane. The abscess cavity is washed with an antiseptic solution, and then drained with one or several plastic or PVC tubes, or gauze swabs soaked with some proteolytic enzymes and antiseptics are packed into the cavity for drainage purposes. If drainage through the main incision is not adequate, another one is made on the opposite side - counter-aperture. Treatment of abscesses after incision and drainage is identical to that for treating infected wounds.

General therapeutic measures include body fortifying therapies, blood and plasma transfusions, and prescription of antibiotics taking into consideration the sensitivity results of the microbiologic analysis, specific therapeutic modalities (immunization with staphylococcal anatoxin, specific anatoxin etc.).

Phlegmon. *This is an acute diffuse suppurative inflammation of the subcutaneous fatty tissue without localization.* Depending on the locality, phlegmon is divided into subcutaneous, intra muscular and retroperitoneal. Phlegmons of certain locations have specific names: suppurative (purulent) mediastinitis, paraproctitis, paranephritis, paraarticular phlegmon etc. Phlegmon that develops from the spread of a suppurative infection from the lymph nodes is known as an adenophlegmon. Phlegmons tend to spread through the subcutaneous space, vascular beds and along the fascia lodge.

Phlegmon starts with the development of serous infiltration of the fatty layer. The exudate quickly assumes a suppurative nature, areas of necrosis are formed, which later join together. Necrosis and the fatty dissolution lead to the formation of a phlegmonic abscess.

Signs of phlegmon are similar to the general symptoms of suppurative-inflammatory processes (a rise in the body temperature, weakness, malaise, and headache). These determine the patient's complaints, there is also pain and swelling at the site of infection, tenderness in movement as well as when changing position of the body.

Subcutaneous phlegmon locally presents with the classical signs of inflammation (fig. 84, colour inset). Swelling normally increases at the beginning, the overlying skin is red and shiny and then gradually gets pale and later turns to normal. A painful induration is palpated without clear boundaries, immobile and hot to touch. When an abscess forms, the infiltrate becomes soft and fluctuation sign can be positive. Regional lymph nodes are enlarged and painful. In certain instances red stripes or bands (net or tubular lymphadenitis) can be found around the infiltration.

Active and passive limb movements, turning of the head, and a change in bodily posture cause extreme pain in the area of phlegmon.

In deep-seated (intermuscular) phlegmon of the limb, the limb size increases compared to the other healthy limb. A measuring tape can be used to gauge the exact increase in limb size. Sometimes the tissues in the area of the phlegmon get enlarged. A deep extremely painful

infiltrate is palpated. An attempt to move the limb may cause severe pain, a defensive (tender) muscle contracture can be encountered in the form of a forced positioning of the limb in a less painful position. Regional lymph nodes are enlarged and painful. When pus is aspirated during puncture it confirms the diagnosis of intermuscular phlegmon.

In the neck region suppurative inflammation with mild general clinical symptoms of infection can appear in the form of a wood-hard infiltration - *woody phlegmon.* The infiltration is not very painful, fixed to the skin, fascia and aponeurosis and absolutely immobile, increase in size is very slow. Suppuration of the infiltrate occurs rarely. The disease process is very slow, with subfebrile temperature and a very mild form of intoxication.

Treatment of phlegmon is surgical. It is only at the initial stage when the process is still assumed to be a serous inflammation that conservative therapy can be allowed: this includes bed rest, rest of the affected limb, antibiotic therapy, ultraviolet irradiation therapy as well as electrophoresis with chemotrypsin. Novocain block of fascial case with antibiotics by the Vishnevsky method is usually effective. The improvement of the patient's general condition, diminishing local signs of inflammation are indicative of the process being localized or regressing. In the absence of positive effect within 12-24 hours or in the case of deterioration of symptoms the patient must be operated upon.

Patients admitted to hospital in the advanced stage of the disease, those with severe intoxications, progressive symptoms and those with purulent infections are operated upon as emergency. The phlegmon is incised under general anesthesia; pus and necrotic tissues are evacuated. Purulent tracts and pockets are opened; the wound is thoroughly washed with antiseptic solutions and drained. To ensure adequate drainage extra incisions (contra-apertures) are sometimes made. Treatment after surgery is similar to that for treating infected wounds.

Furuncle *(pimple). This is an acute suppurative-necrotic inflammation of the hair follicle of the sebaceous gland and the surrounding subcutaneous fatty layer.* Furuncles are mostly found at the back of the neck, forearm, the dorsal aspect of the hand and fingers, the face and the thigh. The appearance of two or more furuncles suggests furunculosis. In the development of a furuncle, micro trauma e.g. scratching of the skin during diseases that are accompanied by itching plays an important role. The hair bed initially gets inflamed, as does the sebaceous gland, which later on together with surrounding tissues get necrotic to form a necrotic core around which the inflammation infiltrate is centered.

In the early stage of the inflammatory process patients complain of the development of a painful pustule or tender induration in the thick of skin. With a progression of the disease general malaise sets in, the body temperature rises and the pain in the area of growing induration also increases. Furuncles that occur in areas such as the scalp, occipitus, external ears and the dorsal aspects of the fingers, where the skin is closely fixed to the underlying tissues, are the most painful.

Examination at the onset of the disease reveals a small pustule with surrounding skin hyperemia. Rarely an induration deep in the skin is found with the overlying skin hyperemic, pus at this stage is absent. As the process continues, there appears above the surrounding skin a cone - shaped infiltrate 0,5-1,5 cm in diameter, which has no clear boundaries. The overlying skin is of purple - red colour. In the center of infiltration there appears a soft area covered by a scab, with small amounts of pus oozing out beneath the scab. After evacuation of the pus some greenish coloured area of tissue is noticeable - apex of the necrotic core. With the development of the necrotic core the quantity of pus increases, and the core is evacuated with the pus and blood. After the core has been cleared, a fairly deep wound with a mild bleeding tendency is found in the center; this is quickly filled with granulation and heals over after 2-3 days with the formation of a depressed scar.

Sometimes a round, soft swelling with minimum pus is found during examination at the site of the furuncle. This is a furuncle with an abscess formation as a result of complete dissolution of the necrotic core without a point of escape for the pus.

When red stripes are found to be going out from the furuncle, it suggests the presence of lymphangitis, while the enlargement and tenderness of lymph nodes on palpation points to development of lymphadenitis.

Patients with furuncles on the face (upper lips, eyelids, forehead) sometimes complain of severe headaches, and high temperature (fig. 85, color inset), which are signs of the furuncle being complicated by suppurative thrombophlebitis of the facial veins. The latter is associated with purulent meningitis as a result of the infection spreading to the veins of the cavernous sinus.

When such symptoms as remittent fever, intense chills, profuse sweating, delirium, confusion and skin pallor are encountered, it means the patient has developed sepsis, and the appearance of suppuration in other organs (metastatic abscess) confirms the diagnosis of septicemia (septicopyemia).

Furuncles are *treated conservatively*. Patients are to be informed of the possibility of developing serious complications should they attempt to pick the lesions or cut them with a blade or even apply a hot compress. In the early stage of the process a 70% solution of alcohol is used to clean the skin, 2% alcohol solution of salicylate, and ultraviolet radiation therapy is applied. After they have opened up, dressings are put on with proteolytic enzymes, hypertonic solutions of sodium chloride and ultraviolet irradiation is applied. When the core is evacuated, dressings with synthomycin ointments, or methyluracyl are applied. When the furuncle is associated with such complications as lymphangitis and lymphadenitis, antibiotic therapy is indicated.

Patients with furuncles of the upper lip and above it have to be hospitalized as emergency in the surgical unit for general and topical therapy including antibiotic therapy. The condition is treated by bed rest and a diet of mashed foods.

If the furuncle turns into an abscess it has to be removed through incision and drainage.

The patient with recurrent furuncle at the same place has to be examined specially to rule out any metabolic disorders (diabetes mellitus, vitamin deficiency). To boost the body's resistance to staphylococcal infections, immunization is done with staphylococcal anatoxin.

Carbuncle. *This is an acute diffuse suppurative-necrotic inflammation of several hair follicles and sebaceous glands accompanied by the development of a common infiltration and necrosis of the skin and the surrounding subcutaneous fatty tissue as a result of vascular thrombosis.*

Patients complain of severe pain, the presence of a tender infiltration, a rise in body temperature, chills, malaise, weakness, fatigue, loss of appetite and headaches. There is normally a history of diabetes mellitus, vitamin deficiencies and malnutrition (fig. 86).

Apart from the general symptoms of suppurative inflammations (rise in body temperature, rapid pulse, etc.), examination of the patients reveals the presence of violet - blue swelling at the back of the neck, back, the lumbar region, the face and rarely the extremities. Several infiltrations can be found at the onset of the disease, which later on join together to form a marked swelling rising above the skin level. The skin over the infiltration is tense and shiny with the violet-blue colouration more intensive in the center, which gradually becomes pale at the periphery. Several suppurative-necrotic pustules appear on the surface of the infiltration, which join together in the center to form an extensive area of skin necrosis (see fig. 86). The thin areas of necrotic skin open up at several places to form an opening through which the pus escapes. The infiltration is firm in consistency, very tender with pronounced edema around. Regional lymph nodes are enlarged and painful (lymphadenitis), lymphangitis is rare.

If the infiltration bursts on its own with the release of necrotic tissues, a big hole is left in the center covered with grayish-green necrotic tissue with profuse pus.

If during monitoring of a patient it is found that the edema is increasing, necrosis is rapidly progressing and the symptoms of general intoxication (tachycardia, headache, weakness) are getting worse, as evidenced by extreme chills, profuse sweating, lymphangitis, lymphadenitis, and thrombophlebitis, then this should be considered as an adverse progression of carbuncle with the development of phlegmon and sepsis.

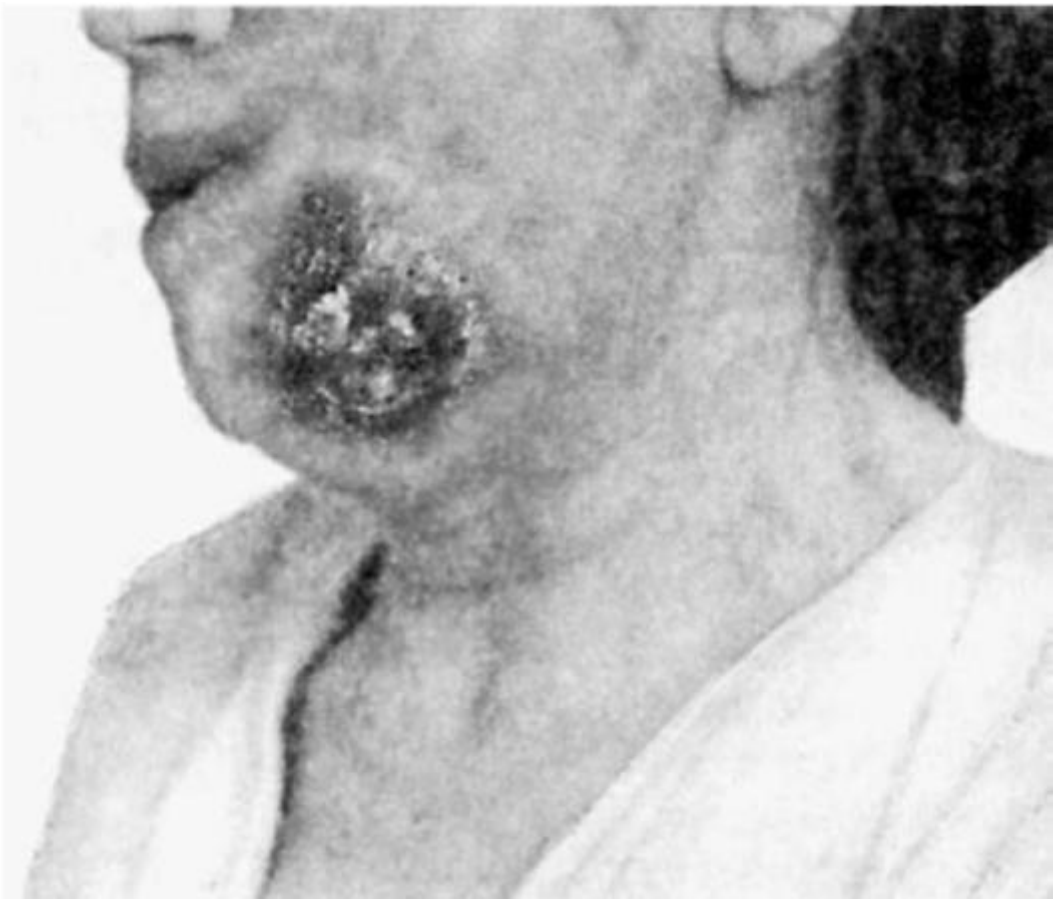


Fig. 86. Facial carbuncle.

Carbuncle of the face should be taken seriously, because of the possibility of infection spreading through the facial veins, through the superior orbital veins into the brain sinuses and the development of suppurative thrombophlebitis as well as purulent meningitis.

Carbuncle has to be differentiated from *Siberian ulcer carbuncle,* which is characterized by the presence of hemorrhagic blisters, the absence of purulent discharge, a painless infiltration, extreme tissue edema; the necrotic tissue that results is black in colour and surrounded by tiny blisters with hemorrhagic contents. The blisters are found to contain the Siberian ulcer bacilli.

Treatment of a carbuncle at the initial stages is conservative. It involves rest for the affected organ. If it is on the face the patient should be put on bed rest. Patients are not allowed to talk, and are given liquid food. After treating the carbuncle with 70% ethyl spirit, aseptic dressing is applied, and ultraviolet radiation therapy is prescribed. Antibiotics are administered parenterally and long-acting sulphanilamides - orally.

Ineffective conservative therapy for 2-3 days with spreading necrosis, suppurative intoxication are indications for surgical treatment, which is done under general anesthesia. A crosswise incision is made over the infiltration up to the fascia and the necrotic tissues are excised throughout, separating them from the fascia and skin, the whole area being cleaned of necrosis and pus (fig. 87). The postoperative period is managed according to the principles of

treating infected wounds; proteolytic enzymes can be applied for complete cleansing of the necrotic tissues.

Hydradenitis *is a suppurative inflammation of the apocrine sweat glands.* Examination of the patient reveals a painful swelling often in the axilla, and rarely in the inguinal and perianal regions - the areas where the apocrine sweat glands are located. The personal history reveals the presence of some predisposing factors: increased sweating, poor hygiene, the use of depilator and the shaving of the axillary region.

The disease is marked by sudden onset with the appearance of a small painful nodule, which increases in size up to 1-2 cm in diameter and sharply protrudes above the surrounding skin level (fig. 88, colour inset).

Examination reveals a violet-red swelling. When several sweat glands are involved, they coalesce to form a firm infiltration, which can occupy the whole axillary fossa. Single nodules are superficial and fixed to the skin. After 10-15 days the center of the swelling softens up, fluctuation is noticeable, and some thick milky pus starts to discharge from the burst area. Once the pus is evacuated, healing starts with the formation of a scar. The disease tends to recur.

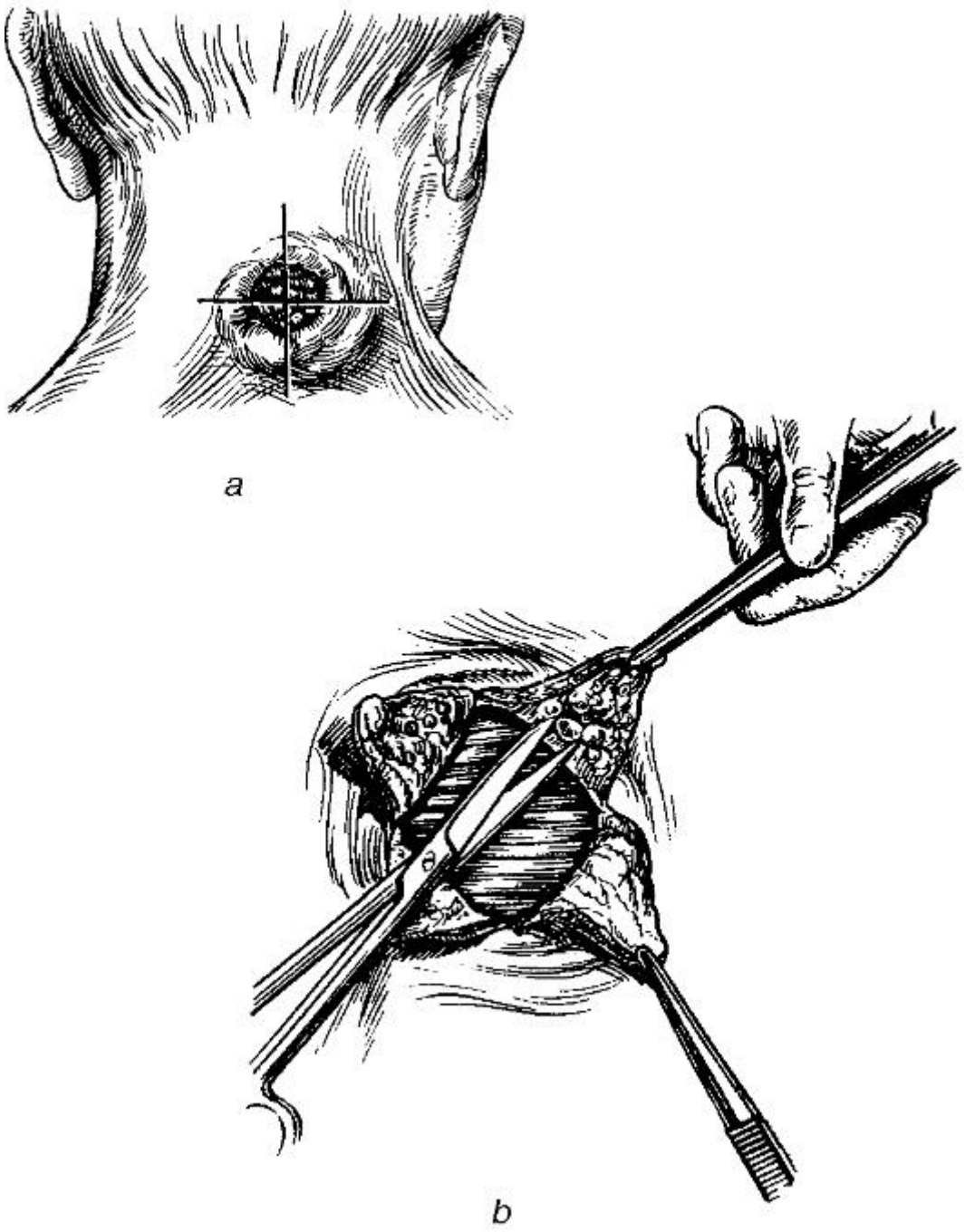


Fig. 87. Dissection of carbuncle *(a*) and debridement *(b).*

When the surrounding subcutaneous fatty layer gets involved in the process, a phlegmon develops, and when the lymph nodes are involved - lymphadenitis.

Unlike furuncle, the infiltration is devoid of follicular pustules or necrotic centers. Axillary hydradenitis is characterized by deep-seated infiltrations, enlarged lymph nodes, and the skin over the lesion is not firmly attached to it.

Hydradenitis is *treated* with antibiotics, and long-acting sulphanylamides. Immunization with staphylococcal anatoxin is prescribed. The hair in the axilla is shaved, the skin is cleaned with spirit, and smeared with a 3% solution of brilliant green. Ultrasound and ultraviolet irradiation are used as physical therapeutic measures.

In the case of an abscess formation, surgery has to be performed - incision and drainage. If long-term treatment of hydradenitis proves unsuccessful and there is fear of ensuing sepsis, the whole subcutaneous fatty layer of the axillary fossa is excised such as with a carbuncle.

Erysipelas is a progressive acute inflammation of skin or, rarely, of mucous membranes caused by diverse *Streptococcus* spp.

Erythaematous erysipelas results from serous inflammation at the site of invasion of the bacteria, which, in turn, leads to epidermal desquamation and detachment by inflammatory exudate with subsequent formation of blisters, or *bullous* erysipelas. Further, pustulous infiltration of the skin results in *phlegmonous* erysipelas. In addition, vascular thrombosis may cause cutaneous necrosis, or*necrotic* erysipelas.

The condition is characterised by acute onset (rigors, severe headache, tachycardia, tachypnoea, fever as high as 40-41 °C and typical signs of intoxication, i.e. insomnia, oliguria, proteinuria, haematuria, leukocyturia and hyaline and granular casts present in the urine).

Marked hyperaemia (flame-like) is the major local sign of erythaematous erysipelas, which is usually accompanied by burning sensation and fever. The signs of bullous erysipelas are all those of erythaematous erysipelas accompanied by serous, purulent or haemorrhagic blisters of various size.

In phlegmonous erysipelas, the local signs, i.e. hyperaemia, pain, itching, are moderate, while general ones (rigors, fever, tachycardia) may be pronounced.

Necrotic erysipelas presents as black solid painless lesions of the skin at the sites of former hyperaemia, blisters or oedema.

For treatment, the patient must be hospitalised. Antibacterial therapy with penicillins coupled with ultraviolet is applied as long as hyperaemia begins to subside and body temperature becomes normal.

It should be noted that wet bandages, compresses or baths are absolutely contra-indicated. After cleansing with ethanol, blisters should be opened and covered by dressing with synthomycin emulsion, streptocid suspension or tetracycline ointment. Phlegmonous and necrotic erysipelas both require opening of purulent blisters, their drainage and removal of necrosis. Autodermoplasty is used to close granulating wounds.

11.2 INFLAMMATION OF THE LYMPHATIC VESSELS AND LYMPH NODES

Lymphangitis *is an inflammation of the lymphatic vessels that accompanies different inflammatory diseases:*infected wounds and abrasions, furuncles, carbuncles, abscesses, phlegmons, panaritia etc. Lymphangitis occurs most commomly on the limbs.

The appearance of lymphangitis in the course of any suppurative inflammation is an indication of progression of the main disease and a factor contributing to its aggravation. As a rule the body temperature rises to 39-40 °C, with chills, headache, increased sweating, weakness and high leucocytosis. In reticular lymphangitis, there is extreme skin hyperemia, similar to that of erysipelas but without distinct boundaries; sometime a web-like pattern is observed in the zone of marked hyperemia (fig. 88, colour inset). In trunk lymphangitis, hyperemia has the appearanace of separate bands leading from the inflamed site towards the regional lymph nodes - towards the axillary fossa or the inguinal region, the skin is edematous. Palpation reveals stripes of tender indurations in the form of strings or streaks along the lymph vessels. Regional lymph nodes are enlarged, firm, and tender to palpation. When the process affects deep lymph vessels, skin hyperemia is absent, there is pain in the limb, edema, tenderness on deep palpation and the early appearance of lymphadenitis.

In the case of perilymphangitis areas of induration are found along the lymphatic vessels.

Treatment is aimed primarily at eliminating the primary focus of infection and includes incision and drainage of abscess, phlegmon, pyodermia, and the rational drainage of purulent lesions. Antibiotic therapy is prescribed according to the type of microbes and their resistance to drug therapy. Rest is important, and the limb has to be elevated; for this purpose it can be immobilized.

Prophylaxis of lymphangitis involves a timely and thorough primary surgical wound debridement, immobilization of the limb, and proper incision and drainage of suppurative foci as well as the rational use of antibiotics.

Lymphadenitis *is an inflammation of the lymph nodes resulting from a complication of different inflammatory diseases* (infected wounds, furuncles, carbuncles, panaritium, erysipelas infection, osteomyelitis, thrombophlebitis, trophic ulcers etc.) and from specific infections such as tuberculosis, plague and actinomycosis (fig. 89, colour inset).

The inflammation starts with a serous edema (simple, catarrhal lymphadenitis), which may evolve into suppurative and when the surrounding tissues are involved adenophlegmon develops.

Acute lymphadenitis starts with the development of a tender enlarged lymph node, headaches, weakness, general ill feeling (malaise) and a rise in body temperature. The disease is not infrequently associated with lymphangitis. In catarrhal (serous) lymphadenitis the patients' general condition is only slightly affected. They complain of pains in the area of the regional lymph nodes, which are enlarged in size, firm and tender on palpation and not firmly attached to the surrounding tissues; the skin over a node is unaffected.

In suppurative lymphadenitis pain is severe. Skin over the nodes is hyperemic, and the nodes are very tender on palpation. Lymph nodes, which could previously be palpated, clearly fuse together and with the surrounding tissues and become immobile. In the case of adenophlegmon there is a widespread skin hyperemia, firm infiltration without distinct borders with patches of soft areas. The body temperature rises to a high level, accompanied by chills, tachycardia, headache and pronounced weakness. In ichorous phlegmon crepitations are detected during palpation of the lesion. Suppurative lymphadenitis can lead to a spread of the infection to the subcutaneous spaces (retroperitoneal, mediasternum etc.) and sepsis.

Treatment of the initial stages of lymphadenitis is conservative. It involves resting the affected organ, ultraviolet irradiation, active treatment of the primary focus of infection (timely incision and drainage of abscesses, phlegmon, proper drainage of purulent processes), and antibiotic therapy. Suppurative lymphadenitis is treated by surgery which includes incision of abscess, adenophlegmon, evacuation of pus and drainage. Postoperative therapy follows the methods of treatment for infected wounds.

11.3 ACUTE MASTITIS

Mastitis is an inflammation of the parenchyma and interstitial tissues of the breast. Classification of mastitis.

1. Edematous form.
2. Infiltrative form.
3. Suppurative-destructive forms:
   a) breast abscess;
   b) phlegmonous mastitis;
   c) gangrenous mastitis.

Acute mastitis is generally encountered in breastfeeding women, during the first two weeks after childbirth (lactating mastitis). Primiparas (those delivering for the first time) suffer more than women who have had several deliveries and this is due to the narrow breast ducts, slightly mobile nipples, the friable nipple skin that is easily exposed to minute injuries.

Acute mastitis is divided according to the period of the inflammatory process into serous (initial), acute infiltrative and destructive: abscess, phlegmonous and gangrenous mastitis. Early diagnosis of initial forms of mastitis and the earlier initiated treatment lead to a complete resolution of the process and prevent it from going to the purulent and destructive stage.

Acute inflammatory processes in the breast are to be differentiated from acute milk stasis (congestion). Milk congestion occurs twice as often in primiparas. Patients complain of breast engorgement, heaviness and tension in the breasts, which gradually increase in intensity. Presenting masses conform to the contours of the breast lobules, and are quiet mobile, with distinct borders, the surface is not smooth and not painful. When they are pressed milk flows out easily and milking is not painful. After the milk is released the patient immediately feels relieved. The general condition is relatively not affected, the body temperature, blood test results are all within the normal values. Acute breast congestion is often bilateral and occurs at the time of profuse milk secretion (on the 2^{nd}-5^{th} day after delivery).

It is not always easy to differentiate congestion from an initial stage of mastitis, so any breast engorgement accompanied by an increase of body temperature should be considered as the serous stage of mastitis. Such an approach helps to start treatment in good time and thus prevent the process from moving into the suppurative phase of inflammation.

If pyogenic microorganisms enter the breast with congestion, then after 2-4 days the breast becomes inflamed which sets the stage for the serous phase of mastitis. The condition is of sudden onset with a rise in body temperature, sweating, weakness, fatigue, and severe pain in the breast. The breast is found to be enlarged, tender on palpation, and the area of infiltration is not distinct. Milking is painful and does not bring any relief. Blood leucocytosis is up to 10-12x10", ESR up to 20-30 mm/hr. If treatment is delayed, the process can progress after 3-6 days to the infiltrative phase with pronounced clinical features of inflammation, and deterioration of the general condition. Temperature of the body may rise to 38-40 °C. The mass that is palpated assumes a more distinct form. The inflammatory process in the breast changes the milk acidity by increasing the pH of milk, which is due to the increase of the activity of alkaline phosphatase. Microscopic analysis of the cellular content of secretions from the breast shows large amounts of leucocytes.

The transition of early forms of mastitis into purulent phase (fig. 90, colour inset) is characterized by an increase in intensity of both the local and general symptoms of inflammation. Body temperature is constantly high or hectic. Infiltration in the breast increases, as does the skin hyperemia, fluctuation appears in one of the breast segments. An abscess can be localized either superficially or deeper with a spread to the retromammary space (fig. 91).

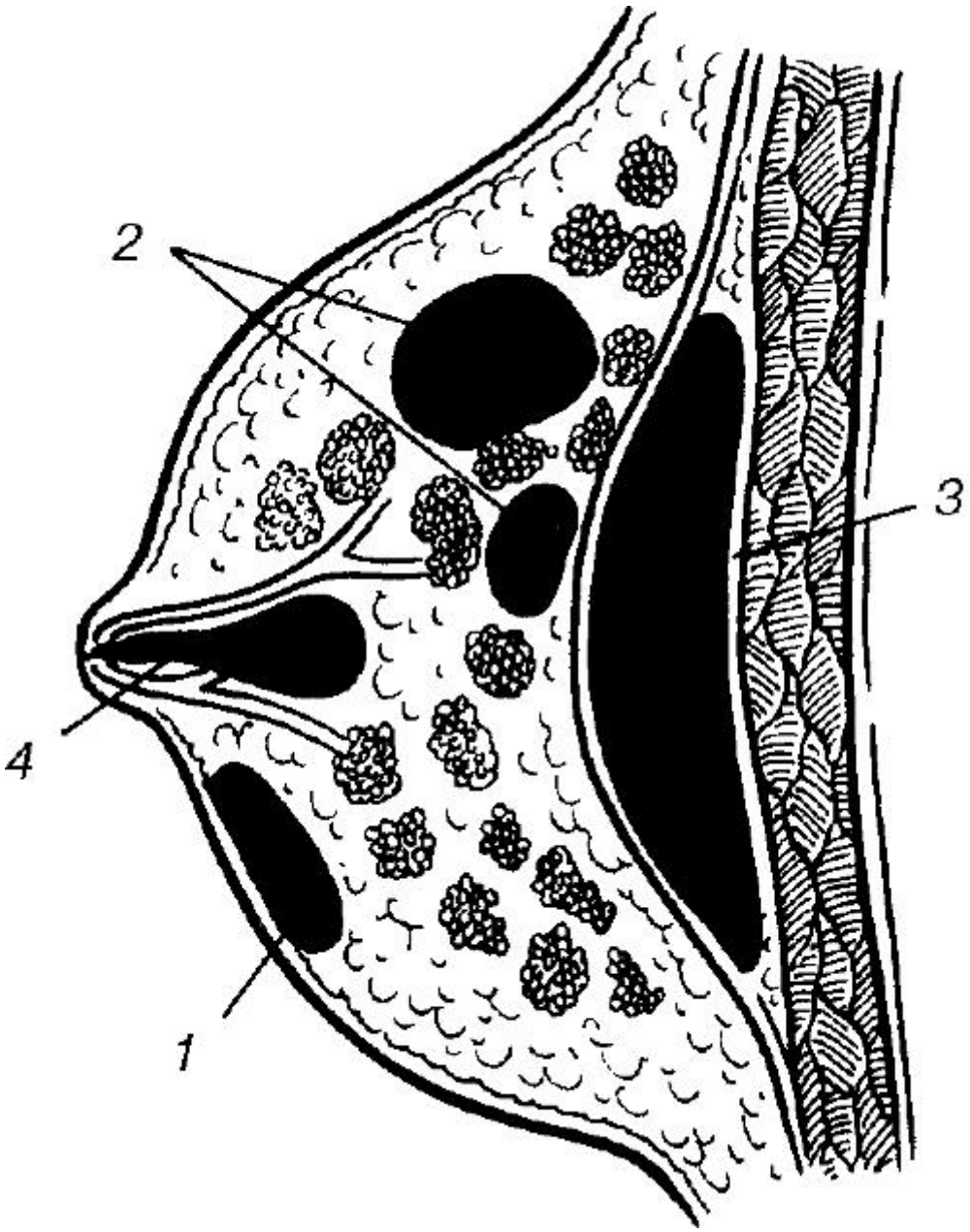


Fig. 91. Topography of abscesses in mastitis: *1* - subcutaneous; *2* - intramammary; *3* - retromammary;*4* - galactophoritis.

Patients with gangrenous mastitis are found to be critically sick: Body temperature is very high - up to 40-41 °C, pulse up to 120-130 beats per min, the breast is very swollen, skin is edematous with blisters containing hemorrhagic fluids and areas of necrosis. The edema spreads to the surrounding areas. High blood leucocytosis is noted with a shift to the left and toxic granular leucocytosis, protein is found in the urine.

Mastitis can be complicated with the development of lymphangitis, lymphadenitis and rarely sepsis. After the abscess has burst, especially if it occurs spontaneously, a breast fistula that can close spontaneously after a long time may result.

Treatment. Treatment of the initial stages of mastitis is conservative, and of the purulent forms - surgical. As soon as signs of breast congestion are noticed, the breasts should be supported in a raised position with either an immobilization bandage or brassiere that do not squeeze or press on the breasts but rather support them. Using a breast pump the breasts are evacuated of the milk; breastfeeding should be continued, fluid intake is limited, oxytoxin and nospani are given. Antibiotics are used in the case of serous and infiltrative mastitis

(semisynthetic penicillins, aminoglycosides, cephalosporins, and macrolides), sulfanilamides (in combination with antibiotics), infusion therapy, including plasma substitutes, hemodes, protein preparations, saline solutions; substances that improve the body's resistance (gamma globulins, etc.) are also used. The breasts must be milked constantly to prevent congestion. A regression of the process can be enhanced by retromammal novocain block using antibiotics and proteolytic enzymes: 70-80 ml of 0,5% solution of novocain, 500000 units of kanamycin and 10 mg of trypsin or chemotrypsin. To enhance a regression of the serous and infiltrative processes, ultraviolet irradiation, high-frequency-current therapy , ultrasonic therapy are used. All manipulations should be done after the breast has been emptied. In severe cases of mastitis it is recommended to suppress lactation by a combination of estrogen and androgen preparations.

Purulent mastitis is an indication for surgery, which is done under general anesthesia; it is only in the case of superficially located small abscesses that surgery can be done under local anesthesia with retromammal novocain block. Wide and fairly deep incisions are made on the breast; all the pus and necrotic tissues are evacuated (fig. 92). Intramammary lesions are opened through radial incisions. After the pus has been evacuated, the cavity is examined using a finger, opening at the same time the various lacunae, hydrogen peroxide solution is used to wash or irrigate the cavity and the latter is dried. Then under adequate lighting the cavity is examined visually with the wound edges held open by retractors, while pressing on the breast. If it is found that some pus is entering the wound from a deeper area, then that opening is widened up to join the main cavity. All necrotic tissue lying loose in the abscess cavity is excised and removed. With several abscesses on the same breast, they are opened with separate incisions.

Retromammal and deeplyseated intramammal abscesses are drained through semilunar incisions made through the lower inframammary fold. (fig. 93) In this way the breast is separated from the pectoralis major muscle. Intramammal abscesses are drained from their back, the cavity is drained and the resulting wound is sutured leaving the drainage site with the tubes. This method of incision and drainage prevents damage to the intralobular milk ducts while providing a good drainage of pus and necrotic tissues and at the same time giving a good cosmetic result. In localized forms of acute mastitis and especially in cases of chronic mastitis, the focus of infection can be excised within healthy tissue and firm sutures applied with a small drain inserted for the instillation of antibiotics.

Treatment of the wound after incision and drainage is done taking into consideration the stage of the wound process. The use of secondary sutures cuts the healing time and improves the cosmetic results of the operation.

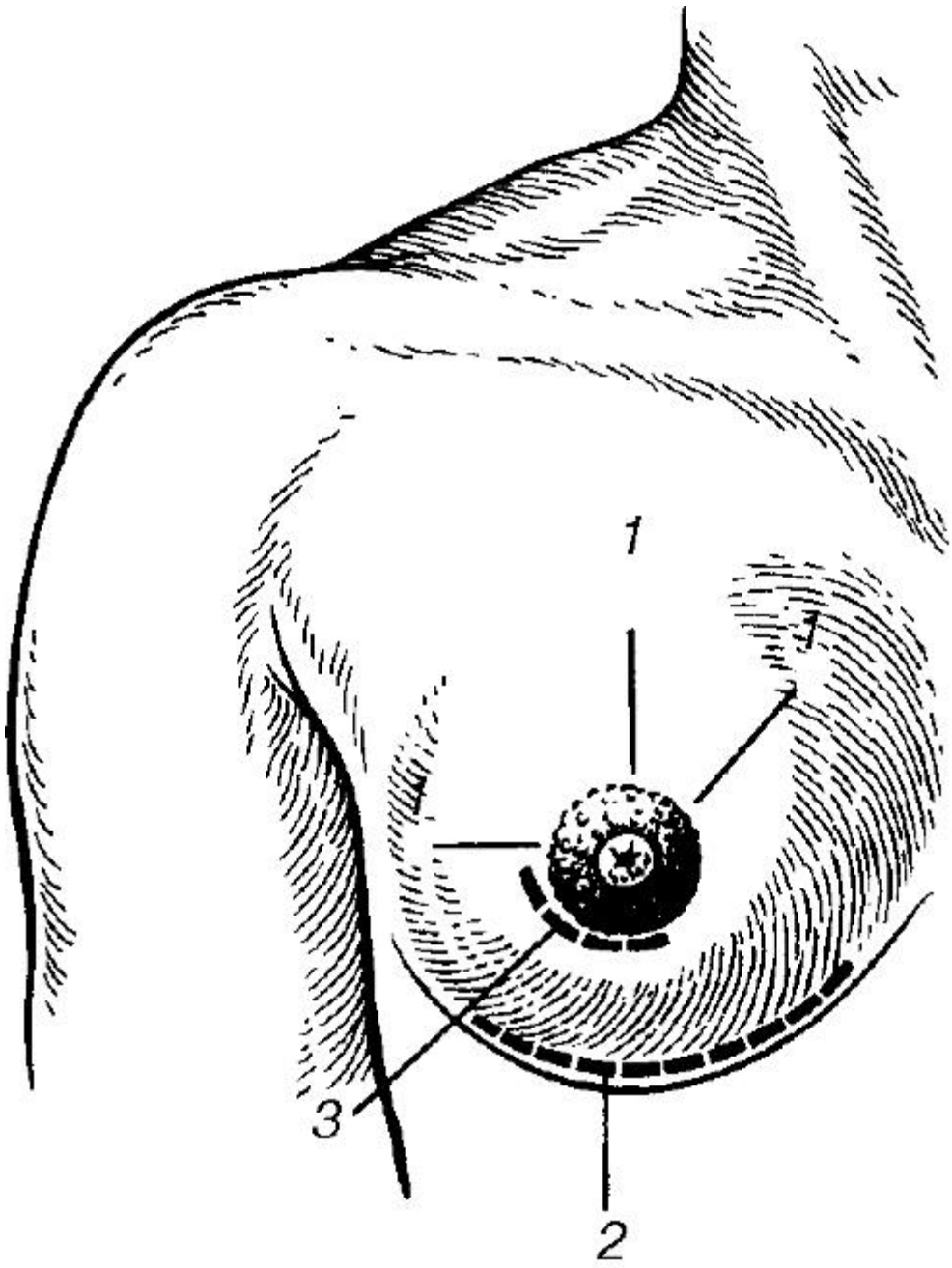


Fig. 92. Incisions made in suppurative mastitis: *1* - radial; *2* - Bardenheur's (incision); *3* - para-areolar.

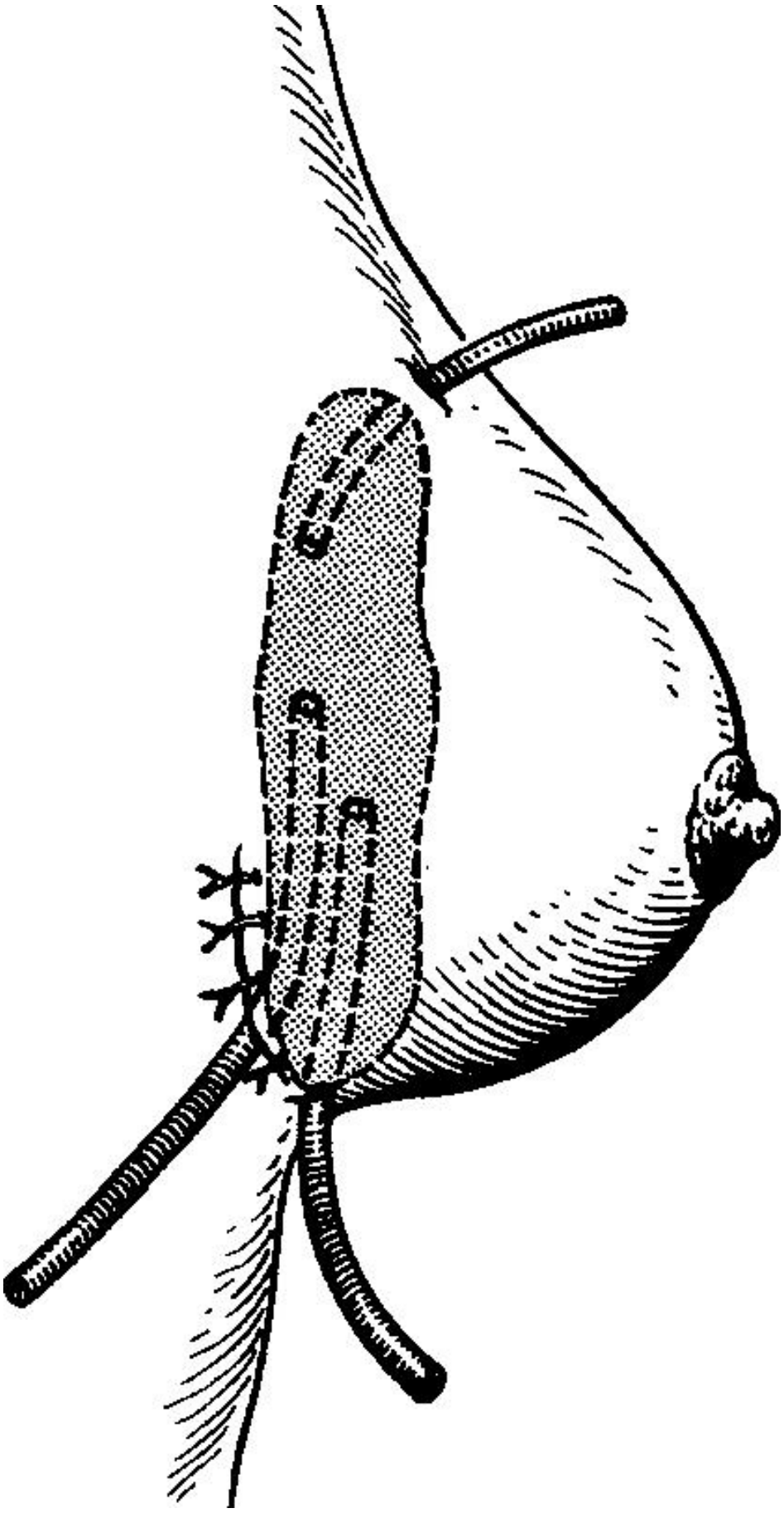


Fig. 93. Through and suction drainage in retromammary abscess.

11.4 SUPPURATIVE DISEASES OF THE HANDS AND FINGERS

Suppurative lesions of the fingers include felon (panaritium), pyogenic infections of the thumb, little finger, thecal whitlow; infections of the dorsal aspects of the hand (phlegmon).

Classification: Panaritium

1. Superficial forms: cutaneous, subcutaneous, paronychial, hyponychial.

2. Deeper forms: tendinous, osteal, articular and pandactilitis.

Suppurative hand infections

1. Suppurative diseases of the *skin and subcutaneous* tissues: cutaneous abscess; corn abscess; interphalangeal (commissural) phlegmon; supraaponeurotic phlegmon of the palm.

2. Suppurative diseases of the *fascial and interstitial spaces:* phlegmon of the mid palmar space; thenar phlegmon; hypothenar phlegmon.

3. Suppurative diseases of the *dorsal aspect (dorsum) of the hand:* subcutaneous phlegmon.

Suppurative diseases of the hands and fingers are among the commonest diseases in ambulatory surgical practice. The development of these acute pyogenic infections is preceded by minor skin injuries: stab wounds, contusions and abrasions.

With the aim choosing a rational therapy the period of infection is divided into the initial (serousinfiltrating) and suppurative (purulent-necrotic) stages of the inflammation.

The clinical picture of the suppurative hand infection exhibits both general and local features: oedema, hyperemia, pain (fig. 94), increase in body temperature and functional disorders. However, infections of the subcutaneous fatty tissues of the palm are only associated with tenderness on palpation and some amount of smoothening of the palmar folds. Other signs of inflammation (hyperemia, pronounced oedema) are more prominent at the dorsum.

Cutaneous felon. In cutaneous panaritium the exudate is located beneath the epidermis and divides it by forming blisters (fig. 95) whose contents can be serous, purulent or hemorrhagic. Cutaneous panaritium can sometimes be associated with high body temperature, regional lymphadenitis and lymphangitis, which is accounted for by the presence of very virulent infections.

Subcutaneous felon. This is one of the most commonly encountered hand infections (see fig. 95). It is most often reported at the purulent stage since patients rarely seek medical advice in the early stages of disease. The hallmark of the condition is tenderness at the focus of inflammation. Pain increases gradually, and is of throbbing and pulsating character. Patients normally go about their daily business during the first hours and sometimes even the first days of the disease. Pain, however, increases in intensity and the victims may become uncomfortable and unable to sleep.

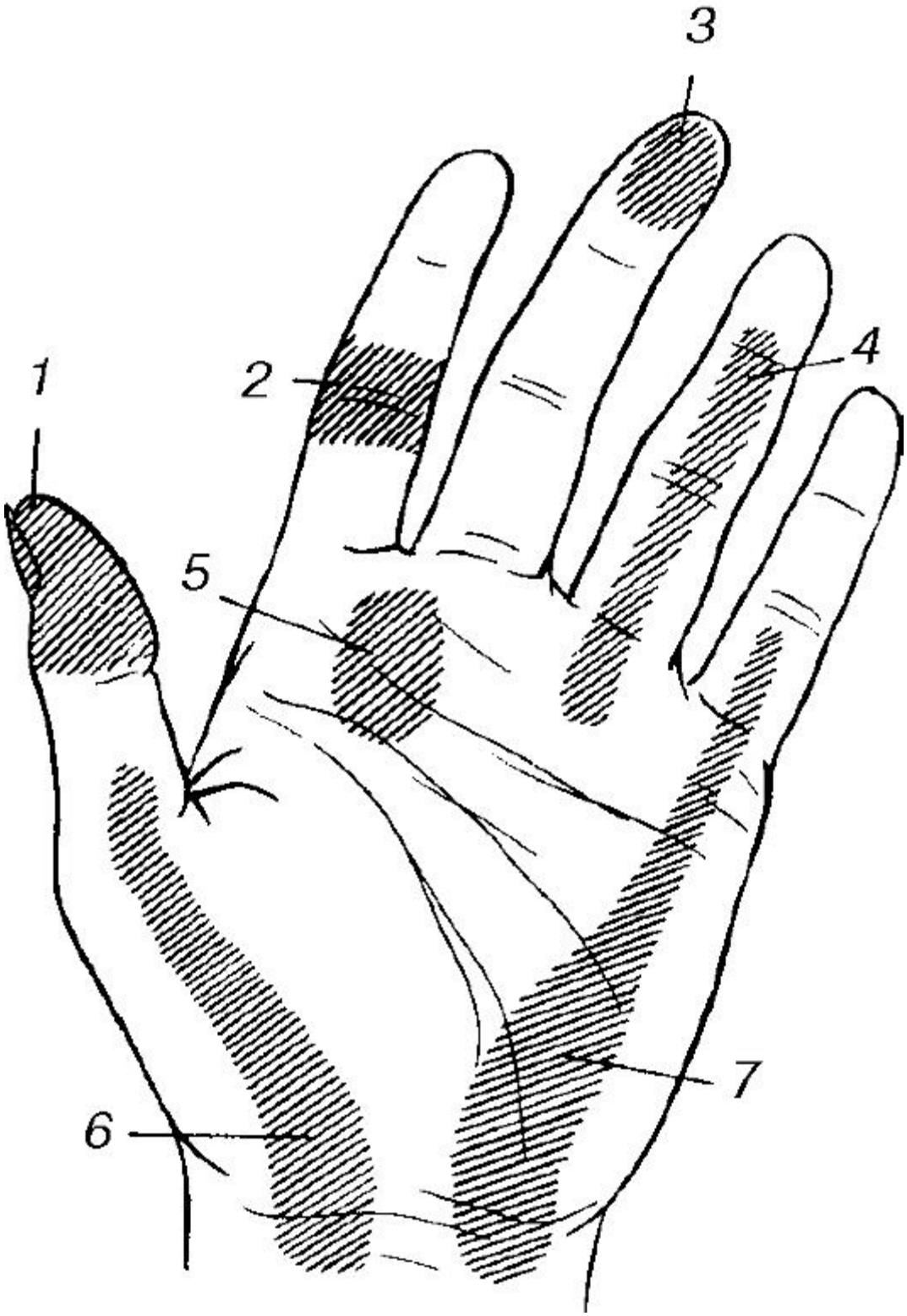


Fig. 94. Zones of tenderness in suppurative hand infections: *1* - osteal felon; *2* - articular felon; *3* - subcutaneous whitflow; *4* - thecal whitflow; *5* - corn palmar abscess; *6* - 1st digital and radial tenobursitis; *7* - 5th digital and ulnar tenobursitis.

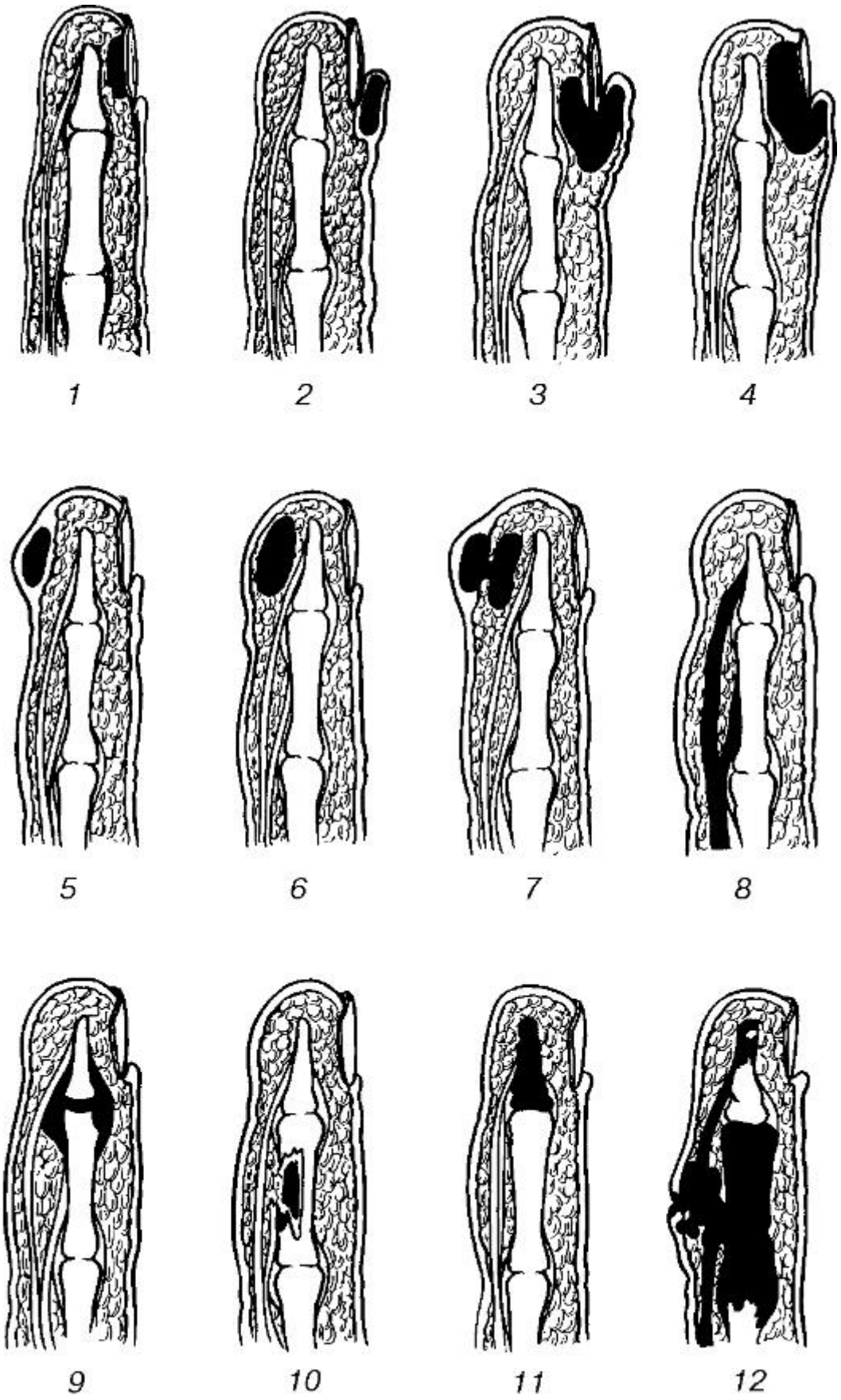


Fig. 95. Topography of abscesses in hand infections: *1* - subungual felon; *2* - paronychia; *3, 4* - subungual paronychia; *5* - cutaneous whitflow; *6* - subcutaneous whitflow; *7* - «cuff-link»-type subcutaneous whitflow; *8* -thecal whitflow; *9* - articular felon; *10* - osteal felon; *11* -infection of the distal phalanx; *12* - pandactylitis.

Examination of the finger reveals tension in the tissues with the finger folds at the interphalangeal joints leveled out around the focus of infection. Skin hyperemia is not so distinct. Using a blunt probe for methodical and systematic palpation, the most painful area, which corresponds to the location of the pus, can be easily identified.

The patient's general condition is bad because of the persistent pain. The connective tissue bands in the subcutaneous layer, which connect the skin to the periosteum, prevent the pus from spreading to the periphery. The tension in these tissue bands causes intensive pain in the finger. The pus in subcutaneous panaritium tends to spread to the deep-lying tissues.

Paronychia. This is an inflammation of the areas around the nail fold, associated with tender swellings of the nail fold and hyperemia of the surrounding tissue. Examination reveals the affected nail fold floating over the nail plate (fig. 96, colour inset). Palpation of the edematous area around the affected nail phalanx is tender. The fast rate of spread of the infectious process quickly renders the affected person incapacitated.

In certain instances of paronychia the pus can spread to beneath the nail plate dividing it from the lateral or proximal sides. In this way the purulent exudate shows through the divided nail end.

Hyponychial felon. This is characterized by the accumulation of pus beneath the nail plate, dividing the latter from the nail bed either along its entire length or at some particular areas. Its presence is noted with the loosening of the nail plate, its fixation to the bed is lost and the nail is only fixed firmly at the proximal ends at the matrixes. The accumulation of pus is visible beneath the nail plate either along its entire length, or in small areas of proximal, lateral or distal portions of the nail bed.

Oedema and skin hyperemia are minimal in hyponychial panaritium. The main symptoms are pulsating throbbing pain at the nail phalanx. There is tenderness on palpation or percussion of the nail plate.

Articular felon. This type of infection often occurs after injuries to the dorsum, interphalangeal or carpophalangeal aspects where the joints are covered by only a thin layer of soft tissue. Pain during the serous phase of infection is quiet intensive, making the patient feel very uncomfortable and reducing considerably his work input. The inflamed joint assumes a fusiform appearance. Dorsal interphalangeal folds smoothen up. An attempt to bend the finger in the affected joint causes extreme pain. There is a local increase in temperature. Oedema and hyperemia are more pronounced at the dorsal aspects. Puncture of the joint space yields some minimal turbid fluid. If the condition is not treated early and the infection spreads to the connective, cartilage and bony apparatus of the finger, then a pathological motility, and a sensation of crepitus of the cartilaginous articular surfaces of the bones may be evident.

Osteal felon. This condition as a rule develops as a secondary process, when the process spreads from the soft tissues of the fingers to the bone, mainly in the case of subcutaneous panaritium. In such cases after the pus has been drained from a subcutaneous panaritium, followed by a brief period of seeming improvement in health, reduction of oedema and pain, recovery does not occur. Pain in the hand becomes dull and nagging, minimal purulent discharge from the wound persists and sometimes even with small particles of bony sequestra. The finger gets clubbed and puffy and tender on palpation.

Signs of bone destruction on the X-rays are apparent only towards the end of the 2nd - the beginning of the 3rd week. Surgery should be performed based on the clinical presentation without having to wait for clear-cut X-ray features of bone destruction.

Tendinous felon. In some cases subcutaneous felon may trigger tendovaginitis as a result of spread of the infection to the tendons and the tendon sheaths of the flexor digitorium muscles. The patient's general condition deteriorates, a shooting and throbbing pain spreads to the whole finger, evenly spread oedema with smoothening of the skin folds at the interphalangeal joints is

present. The finger appears to be sausage-like and is slightly bent in this position, with the result that the tension on the tendons is relieved and the pain reduced. Attempt to extend the finger causes extreme pain. Palpation with a probe along the tendon sheath is very painful. The above signs as well as the clinical presentations help to establish the diagnosis of tendon panaritium (tendovaginitis).

Delay in the surgical treatment of tendovaginitis is very dangerous, because once the blood supply to the tendon is cut due to the pressure of the exudates on the mesotendon vessels, the tendon is rapidly necrotized .

Pandactilitis. This is a suppurative inflammation of all the finger tissues. Pandactilitis is a serious infection associated with severe intoxication (headache, elevated body temperature), regional lymphangitis; cubital and axillary lymphadenitis. Peripheral blood picture shows the changes typical for acute suppurative inflammations. Pandactilitis develops gradually. It is caused by the virulent infectious contamination through a hand injury. It can also result from a simple panaritium, especially the subcutaneous one.

As pandactilitis develops, pain gradually increases in intensity, and the sick person experiences an intense, excruciating and distending pain. The oedematous finger is of a bluish-violet colour. The infection can be either of a dry or wet necrosis. The discharge from the suppurative fistula or the postoperative wound is scanty pus; granulation is grey and dead (see fig. 96, colour inset). Palpation is tender all over the involved area and an attempt to move the finger may cause extreme pain. The patient's condition deteriorates, the temperature of the body increases, oedema and hyperemia of tissues increase and extend in the proximal direction. It is only an immediate surgical intervention that can stop the progression of the suppurative inflammatory process.

Hand phlegmon (fig. 97). The local signs of hand phlegmon are: tissue oedema and hyperemia, hand dysfunction, increase in the local temperature and tenderness on palpation.

Phlegmon of the ball of thumb (thenar eminence). This is accompanied by an extreme oedema of the thenar and the radial end of the dorsum of the hand. Severe pain on palpation, tense tissues, limitations in the mobility of the oedematous thenar tissues, smoothening of the palmar folds are all characteristic symptoms of thenar phlegmon. The purulent exudates can sometimes also spread along the first interosteal muscles on the dorsum. In other cases the connective tissue barriers that divide the thenar from the mid palmar space disintegrate as a result of the suppurative process causing phlegmon of the mid palmar cavity.

Phlegmon of the hypothenar is often accompanied by mild intoxication. Minimal oedema, hyperemia and tension in the tissues, tenderness on palpation over the hypothenar and an increase in pain upon moving the little finger are the characteristic features.

Commissural phlegmon is localized at the distal part of the palm. The entry points of infection are usually deep skin fissures and skin callosity over the area of the 2^{nd}-4^{th} carpophalangeal joints of the palm. This phlegmon is also known as corn abscess. Phlegmons are associated with extreme pain, oedema on both sides of the hand. Fingers adjacent to the area of infection are somewhat spread apart and bent in their interphalangeal joints; extension is painful as a result of the tension on the inflamed palmar aponeurosis. It is possible for the pus to spread directly through the oval fissure of the aponeurosis to the dorsal surface of the hand, involving in the process the tendons of the deep flexors, which are situated very closely. The spread of infection can also occur in the proximal direction along the canals of the vermiform muscles, involving in the inflammation process the mid palmar space (fig. 98).

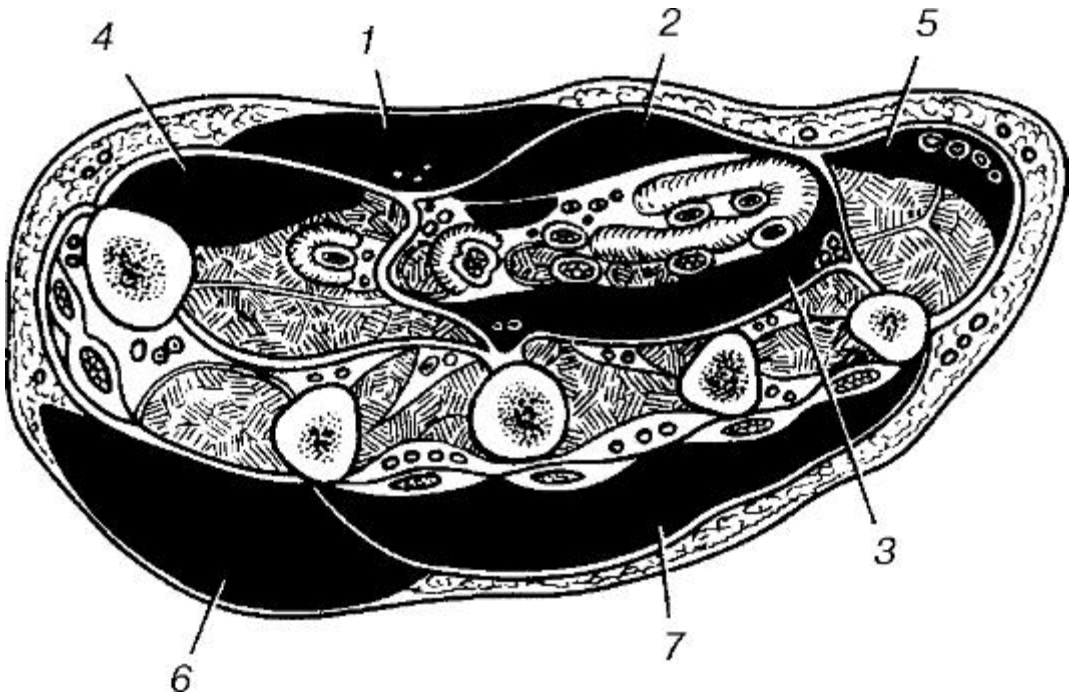


Fig. 97. Topography of phlegmon in palmar and dorsal hand infections: *1* - subcutaneous; *2* - palmar supratendinous; *3* - subtendinous; *4* - thenar; *5* - hypothenar; *6* - dorsal subcutaneous; *7* - dorsal subfascial.

Phlegmons of the mid palmar space are associated with the accumulation of pus in between the palmar aponeurosis and the thin fascial sheath covering tendons of the flexor digitorium or between the fascia covering the palmar sides of the interosteal muscles and the posterior surface of the tendons of the long flexor digitorium. The disease is accompanied by pronounced intoxication, high body temperature, headache, as well as changes in the peripheral blood picture.

Examination of the hand reveals a swelling in the central palmar area, the skin is tense, skin folds are smooth and fluctuation is not possible to elicit. Palpation over the inflamed region may cause extreme pain. The dorsum of the hand is very oedematous. The 2^{nd}-5^{th} fingers are slightly bent in the interphalangeal joints, attempts at passive or active movement cause extreme stretching of the inflamed palmar aponeurosis, which results in pain increase. Delayed or irrational treatment of mid palmar space phlegmon may entail a complication with the abscess bursting into the thenar fissure and the pus spreading along the canals of the vermiform muscles on the dorsum.

Crossed or U-form phlegmon is the most severe form of suppurative hand inflammation. The disease results from a purulent tendovaginitis of the 1^{st} or 5^{th} finger with a spread of the purulent exudates to radial and ulna synovial sacs.

U - form phlegmon is accompanied by pronounced intoxication, high body temperature, headache, as well as body weakness. The hand is oedematous, bluish-violet in colour and palpation is extremely tender. The fingers are bent towards the palm, active movement is absent. Attempts at passive movement may cause extreme pain. By means of palpation the area of extreme tenderness is found to be around the projections of the 1^{st} and 5^{th} tendons and in the proximal parts of the hand, that is, at the site of the blunt ends of the radius and ulna synovial sacs. When the pus bursts into Pirogoff's space, diffuse tenderness and oedema of the distal parts of the forearm may result. The suppurative inflammatory process can spread to the mid palmar space, fissures of the thenar or hypothenar in the case of tenobursitis of the 1^{st} and 5^{th} fingers. Subsequently the pus spreads through the canals of the vermiform muscles to the dorsum of the hand to form an extensive purulent-necrotic area.

Even with favourable resolution of U-type phlegmon the distant postoperative period is associated with limitations in the functions of the hand. Hence, it is very important to have a timely diagnosis and surgical treatment of this condition.

In *subcutaneous phlegmon of the dorsum of the hand* tissue oedema and hyperemia are of diffuse nature, and it is difficult to determine the demarcation line of the infection. Thorough palpation can help to assess the area of tissue softening.

Subaponeurotic phlegmon of the dorsum of the hand occurs as a result of infection penetrating deep under the aponeurosis in the case of stab wounds.

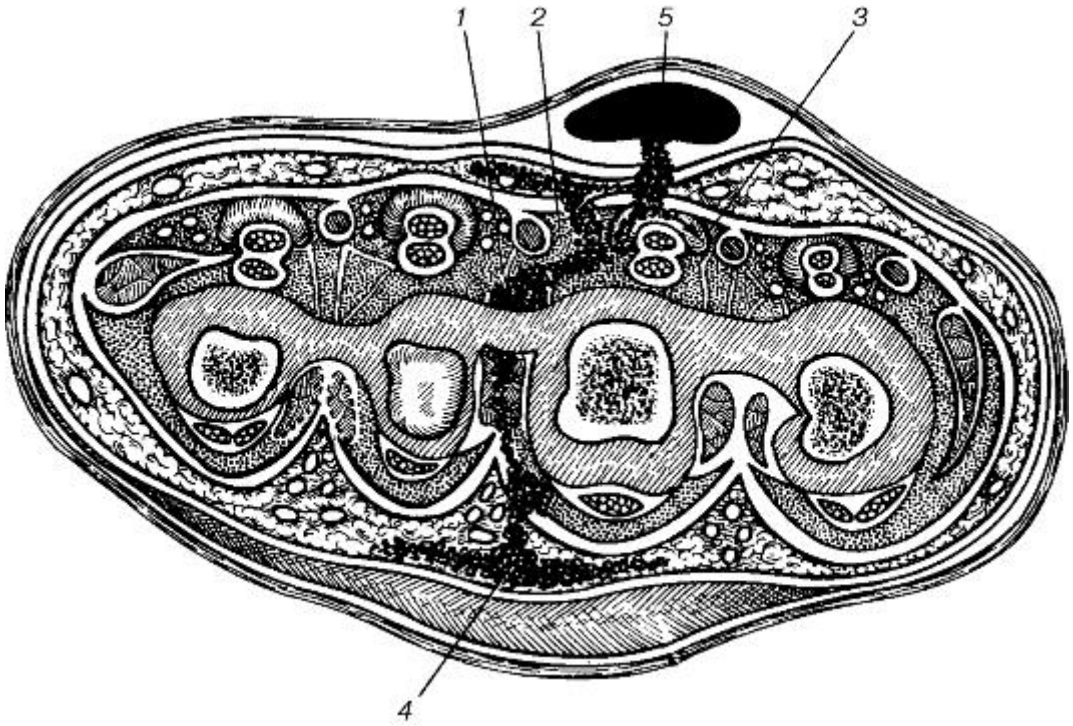


Fig. 98. Topography of suppuration in corn abscesses (frontal view): *1* - interosseous fissure; *2* - mid-palmar space; *3* - tendon sheaths; *4* - dorsal hand fat; *5* - corn abscess.

In this kind of phlegmon a firm induration is observed which is associated with oedema and hyperemia of the dorsum. Subcutaneous phlegmon also occurs, as a rule, secondary to damage to the skin covering of the dorsum of the hand. In suppurative affection of the palm there can be transmission of the infection to the dorsum through the lymphatic vessels or through the canals of the vermiform muscles. In such situations oedema of the dorsum that is normally present in palmar lesions is accompanied by skin hyperemia, and the appearance of a diffusely tender area on palpation.

Furuncles and carbuncles of the hand. Oedema, hyperemia and extreme tenderness on palpating the dorsal aspects of the finger or hand, and the presence of a necrotic core are the symptoms of furuncles. In the case of carbuncles these symptoms are more acute, there being several necrotic cores; the patient's general condition deteriorates and the features of intoxication are more pronounced (headache, weakness, rise in body temperature), regional lymphadenitis and lymphangitis.

Treatment. During the serousinfiltration stage of the inflammation alcohol compress, baths, electrophoresis with trypsin, chemotrypsin, antibiotic therapy including the regional intravenous infusions of antibiotics and ultraviolet irradiation therapy are used. The first sleepless night as well as severe tenderness on pressing the affected area, the appearance of a firm swelling in the soft areas of the palm, oedema of the surrounding tissues are indications for surgery.

In subcutaneous panaritium of the distal and middle phalanx, hyponychial panaritium (subungual) and paronychia, surgery can be performed without pain by using the block anesthesia method of Oberst-Lukashevich. A tourniquet applied at the base of the finger helps to perform the operation without bleeding, which allows for a good orientation in the wound and cleansing it of all the necrotic tissues.

In severe forms of panaritium (tendinous, pandactilitis), phlegmon of the hand surgery is performed under conduction local anesthesia. In very severe phlegmon of the hand and phlegmon of Pirogoff's space, surgery is performed under intravenous general anesthesia.

Operations on the hand should be done using ophthalmology instruments (scalpels and sharpedged scissors). These instruments allow for adequate incisions, easy manipulations in the wound, gentle handling of the viable tissues and can effectively remove all the necrotic tissues in the wound.

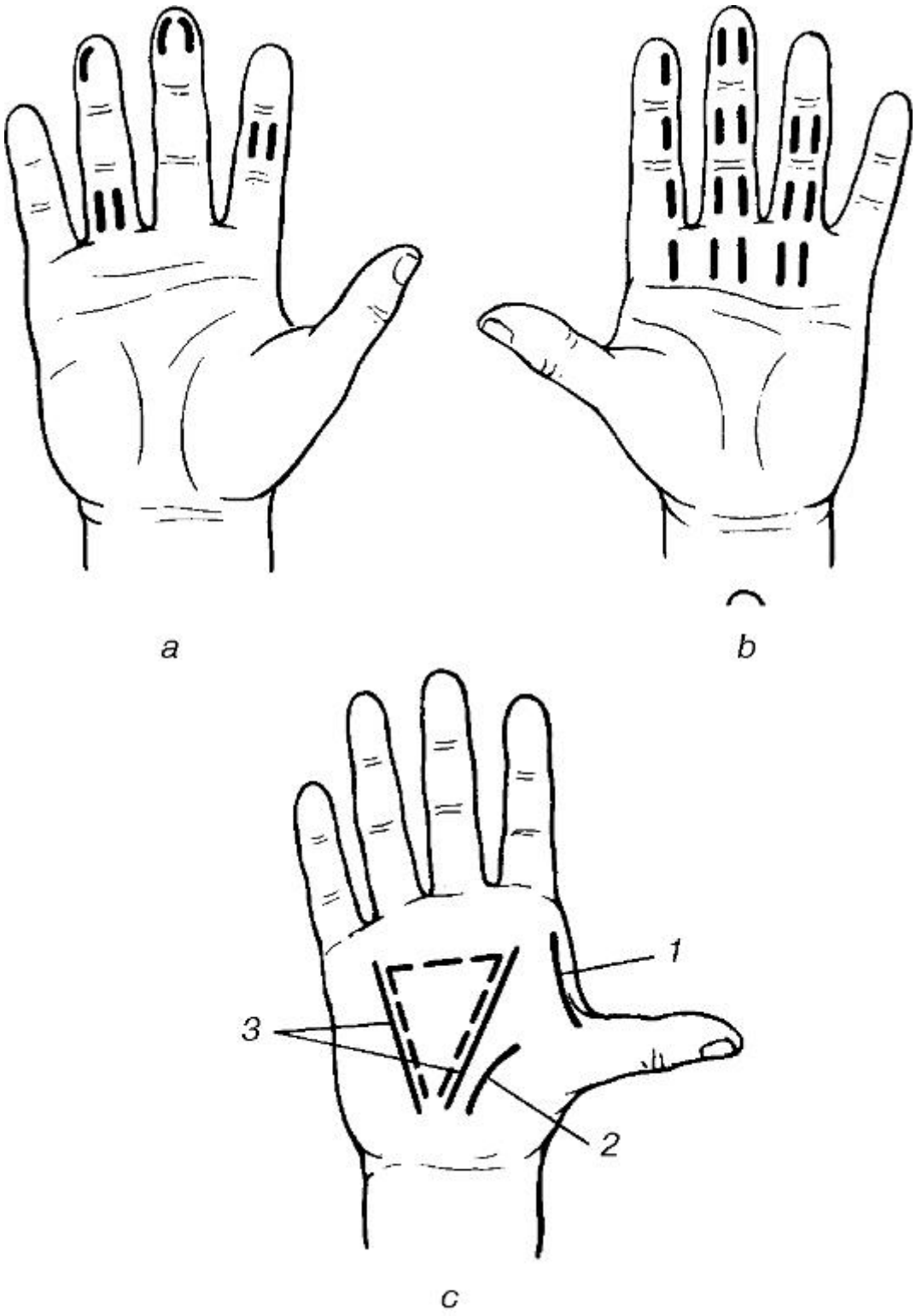


Fig. 99. Lateral linear incisions: digital in subcutaneous (a) and subtendineous (b) whitflow; palmar in phlegmon (c); *1, 2* - dissection of thenar phlegmon; *3* - dissection of the palmar space. The projection of the palmar space is dotted.

Depending on the extent of the purulent process single or double linear incisions are made on the sides of the finger (fig. 99). With the exception of cutaneous, hyponychial and cutaneous abscesses of the palm, all operations are completed by wound drainage. For this purpose use is made of rubber fenestrated drainage tubes are used, which allows for periodic or constant irrigation of the wounds with solutions of antiseptics or proteolytic enzymes and this in

turn facilitates quick removal of the pus, reduces pain, enhances the shedding of necrotic tissues and a faster healing process (fig. 100).

In cutaneous and hyponychial panaritium only the split (disintegrated) part of the epidermis, or the nail plate is incised, the wound is washed with a 3% solution of hydrogen peroxide and the surrounding skin is cleaned with alcohol solution (fig. 101).

Incision and drainage of tendon sheaths is done by single (one sided) or parallel (on both sides) lateral linear incisions on the middle and proximal phalanges. Drainage of the tendon sheaths is done by the rubber fenestrated drainage tubes, placed perpendicularly above the tendons so as not to damage the mesotendon.

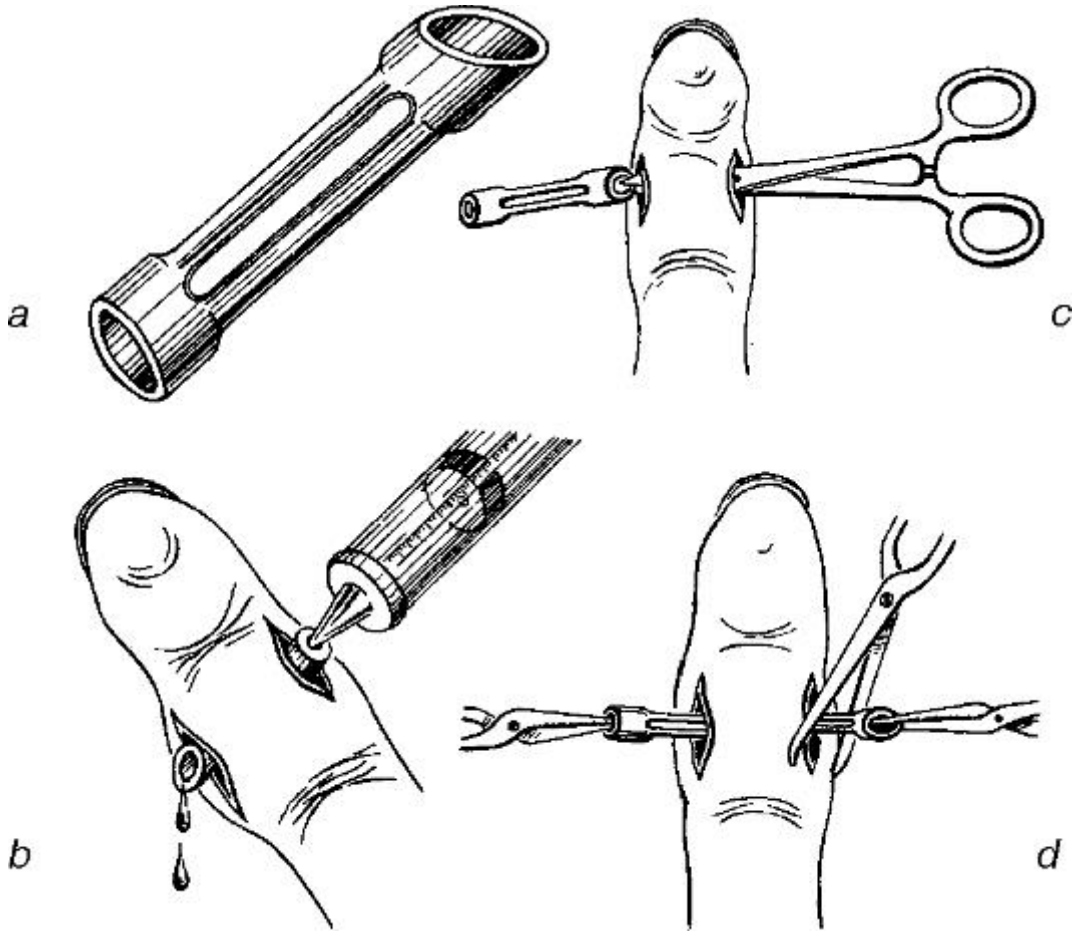
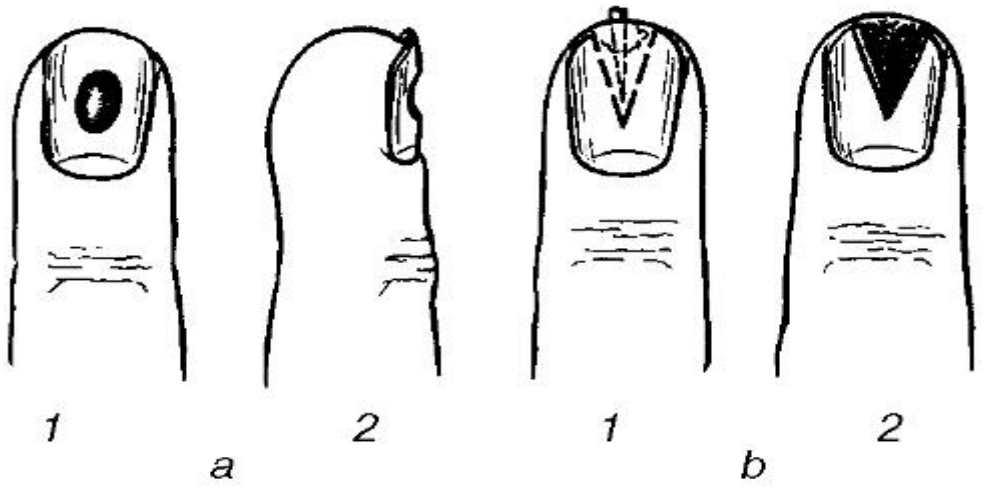


Fig. 100. Fenestrated drainage: *a* - general view; *b* - insertion of the drain; *c* - drainage of the wound with a tube; *d* - extraction of the drain.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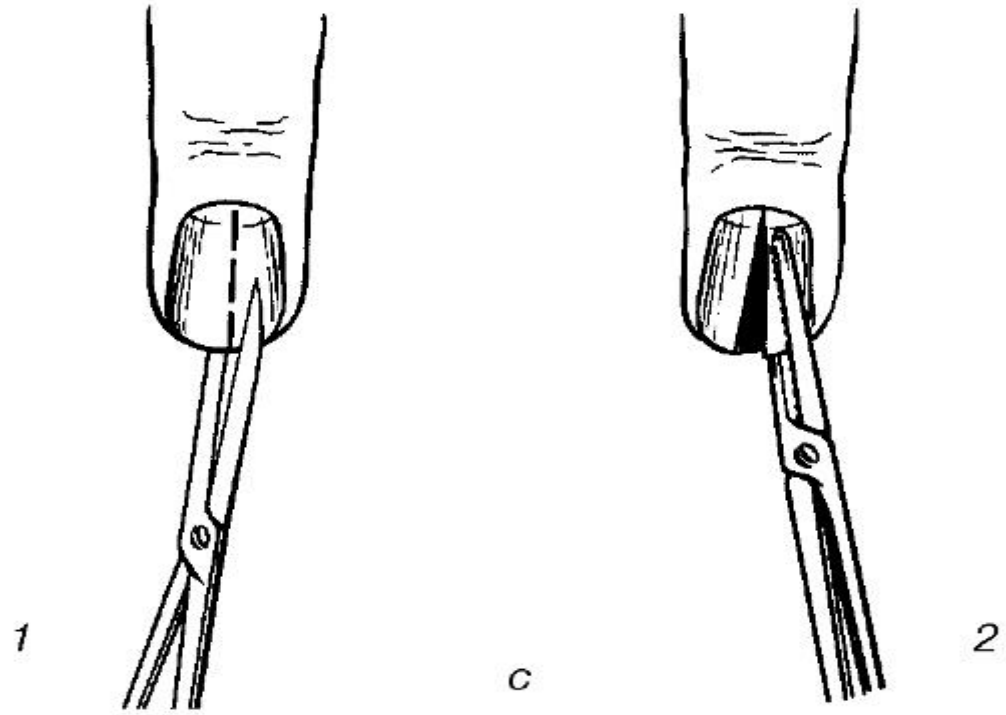
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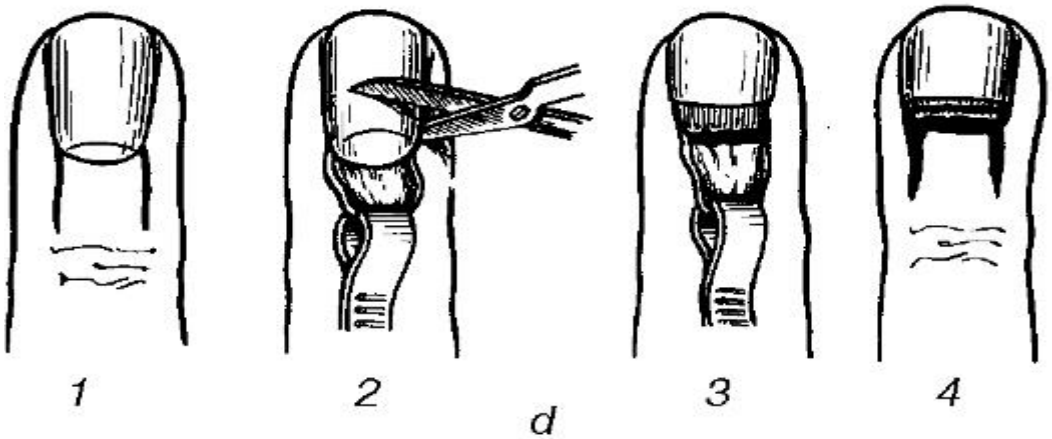
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Fig. 101. Surgeries for nail plate involvement: *a* - trephination of the nail plate (1, 2); *b* - wedge-shaped incision of the nail plate followed by removal of a foreign body (1, 2); *c* - removal of the nail plate (1, 2); *d* - surgery for nail wall and base involvement: *1* - cutaneous incision; *2, 3* -nail wall and base incision; *4* - the nail post surgery.

In case of panaritium involving the bones and joints, double lateral linear incisions are made, the purulent necrotic cavities are opened and cleansed. Necrotic tissues and sequestra are evacuated, the affected bones are resected and the wound drained with fenestrated drainage tubes.

To prevent generalized infection and to eliminate the purulent foci during pandactilitis of the 1^{st}-5^{th}fingers when other forms of treatment have failed, exarticulation of the finger is done as an ultimate measure. In the case of pandactilitis of the 1st finger (the thumb) the surgeon should always hesitate to perform this type of operation since even if the thumb loses its extensor-flexor qualities it still maintains the function of opposition without which the patient becomes disabled.

In performing operations in the case of palmar phlegmon one has to consider the fact that there is always oedema at the dorsum. Even in the presence of pronounced oedema at the dorsum one should never make an incision over this area before the presence of suppuration in the fingers and palm has been confirmed. However, if after an incision and drainage of a palmar or finger abscess the dorsum continues to swell, becomes more hyperemic and firmer, then there is good reason to think that the contralateral oedema has become suppurative.

11.5 OSTEOMYELITIS AND ACUTE SUPPURATIVE ARTHRITIS

Osteomyelitis is an infectious disease characterized by the inflammation of bone tissue in which the pathological process involves not only the bone marrow but also the compact bony part, periosteum and often the surrounding soft tissues.

Classification

1. According to their etiological factors:

1) nonspecific osteomyelitis;

2) specific osteomyelitis.

2. According to the mode of infection (transmission):

1) haematogenic;

2) non-haematogenic:

a) traumatic;

b) gunshot;

c) contact.

3. According to the clinical manifestation:

1) haematogenic:

a) acute (toxic form, septicopyemia, localizedform);

b) primary chronic;

c) secondary chronic;

2) non-haematogenic:

a) acute;

b) chronic.

Two types of osteomyelitis are identified depending on the mode of penetration of the infection:*haematogenic* when an endogenic suppurative infection gains access to bone via the bloodstream, and *Non-haematogenic* when the infection reaches the bone from the outside (exogenic) (fig. 102). Non-haematogenic osteomyelitis occurs after open fractures, gunshots, internal fixation of bone (osteosynthesis) during healing of a fracture, in orthopedic operations, from the transfer of infection from the tissues surrounding the bone.

Acute haematogenic osteomyelitis. Depending on the severity of the disease, the rate of development of the pathological process, the spread of infection, and other clinical factors three forms of acute haematogenic osteomyelitis are identified: toxic form, septicopyemia, localized form.

Toxic form, which is often termed fulminant, is characterized by the development of extreme septic intoxication that starts in the early stage of the disease, the disease progresses rapidly and death ensues within the first few days. In this form the local pathological signs in the bone and its surrounding tissues do not have the time to develop.

Septicophyaemic form, which is said to be severe, is characterized by the development of several suppurative-destructive foci in several bones simultaneously from the very onset of disease. Not infrequently abscesses are encountered in several parenchymatous organs such as the lungs, liver, and kidney.

All this adversely affects the disease process leading to death in most instances. Bacteremia which is often encountered in this case contributes to the development of new osteomyelitis foci.

Localized form of acute haematogenic osteomyelitis manifests itself as a mild form of infection compared to the two previous ones: symptoms of suppurative intoxication are mild and often associated with a single suppurative-destructive focus in the bone. Local signs of infection are more common than the general signs and intoxication. This type of osteomyelitis often develops into a chronic form.

The toxic (fulminant) type is rare, the localized form of haematogenic osteomyelitis is the one commonly encountered.

In the localized form the following local events occur as the process develops further: purulent exudate spreads along these two channels: through the bone marrow canal to the diaphysis of the bone and through the osteon canal *(Haversian canal)* - to the surface of bones. The periosteum becomes inflamed and most often pus is accumulated beneath it causing it to separate. Suppurative inflammation spreads to the surrounding tissues forming phlegmon, which later opens outside to form a fistula. Sometimes the surrounding tissue (paraosseal) phlegmon is accompanied by extensive and deep purulent accumulations that can open up as fistulas at sites far away from the affected bone. This is especially common for osteomyelitis of the pelvic bone, the vertebrae and the femur.

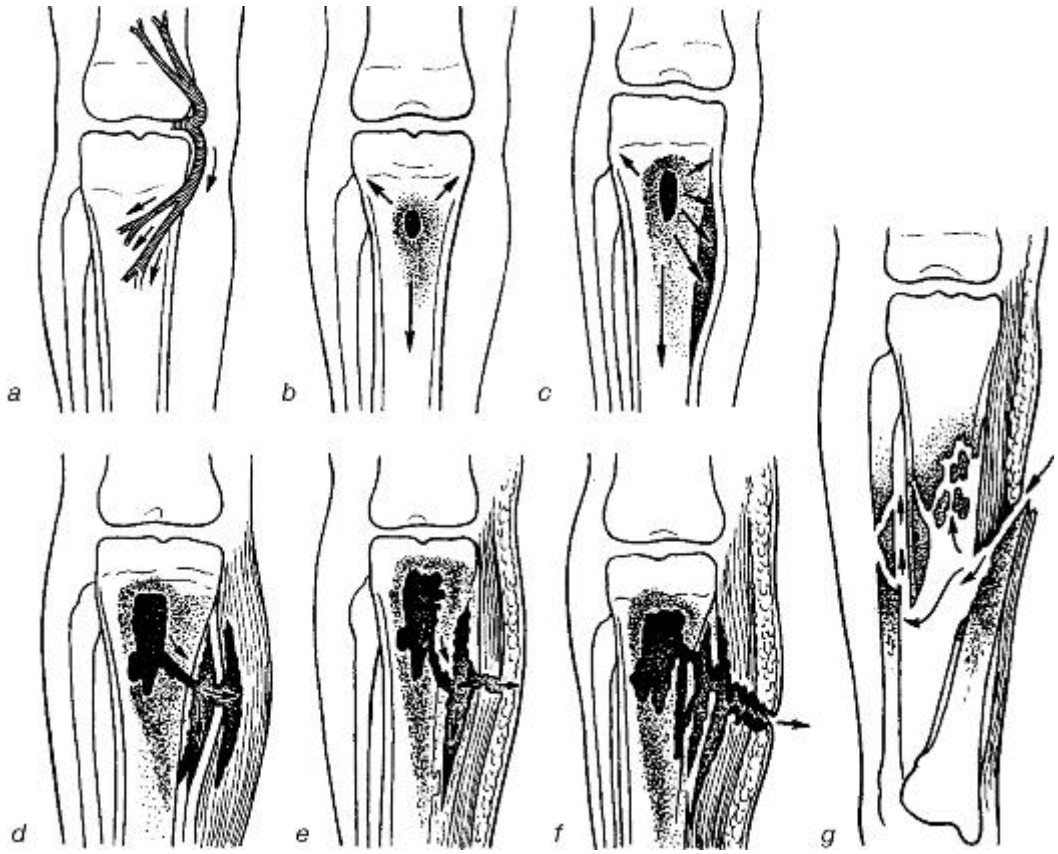


Fig. 102. The stages of osteomyelitis: a - haematogenous spread of infection; *b* - the primary focus; *c*- subperiosteal abscess; *d* - intercondylar phlegmon; *e* - subcutaneous abscess; *f* - osteomyelitic cavity with fistula; g - posttraumatic osteomyelitis.

Because of the suppurative inflammation of the bone marrow, the periosteum and the involvement of the compact bone layers, blood supply to the bone is impaired and this leads to bone necrosis and the formation of sequestra. The extent of intoxication depends on the size of the primary focus of osteomyelitis, the amount of soft tissue involved in the process, the rate at which the purulent fistula opens up or the rate of surgical incision and drainage of the paraosseal phlegmon.

Acute haematogenic osteomyelitis mostly affects children and young adults, and occurs 3-5 times more often in boys than in girls. The disease is of sudden onset but can sometimes be preceded by a feeling of general malaise 1-2 days before the onset.

The patients with acute haematogenic osteomyelitis mostly complain of sudden onset of severe pain in the bone, often at the site of one of the major joints. The pain is felt as intense and throbbing. It is so agonizing that the patients cry, cannot sleep and the least movement in the affected bone may trigger intensive pain. They complain of malaise, headache, rise in body temperature, chills and loss of appetite.

From the case history it is possible to establish the predisposing factors that could lead to the development of the disease such as limb contusion the past history of angina (acute tonsillitis), suppurative pharyngitis, the presence of tooth decay, pyogenic infections (furuncle, panaritium, infected wounds and abrasions etc.). All this can be the source of infection in the case of haematogenic osteomyelitis.

During examination of the patient, signs of general intoxication are noted: weakness, adynamia, depression, sticky sweat, skin pallor, rapid breathing, tachycardia up to 110-120 beats per min. Heart sounds are dull with systolic murmurs. The spleen and liver are often enlarged; there is vomiting, paresis of the intestines, and renal pain with a positive sign of Pasternatsky.

Examination of the patient in the first few days reveals a patient lying in a forced position with the affected limb in a bent position. Both active and passive movements in the adjacent to the affected area joints are strictly limited because of the extreme pain.

To establish the focus of osteomyelitis gentle taps are done along the bone. Hitting on the heel may cause pain along the bone axis. The appearance of extreme pain in one of the meta-epiphysis is an indication of an acute suppurative inflammation in the bone. In later stages the skin over the affected bone becomes tense, indurated and then hyperemic. Palpation shows induration of the soft tissues, tenderness and local hyperthermia. Using a tape measure to measure the affected limb in comparison with the other healthy symmetric limb shows an increase in size of the affected limb due to the increasing oedema.

In advanced stages of untreated acute haematogenic osteomyelitis local signs of phlegmon are elicited: swelling, skin hyperemia and fluctuation. Sometimes patients are admitted after the phlegmon has burst spontaneously on its own with the formation of fistula. In severe cases of osteomyelitis within 3-4 weeks after the onset of disease symptoms of pathological movements can be elicited in the affected limb, which is an indication of a pathological fracture occurring as a result of osteonecrosis.

When the primary focus of osteomyelitis is located in the metaepiphyseal zone the adjacent joint is often involved in the inflammatory process. This is associated with typical signs of purulent arthritis: smoothening of the joint folds, fluctuation signs, limitations in the extent of movement, tenderness and the presence of purulent aspirate on diagnostic taps. These local symptoms are often sufficient to establish a diagnosis of acute haematogenic osteomyelitis. Difficulty in establishing the diagnosis occurs when the patient is admitted in the early stage of disease when the infection of the soft tissues has not yet developed. In such a situation, a diagnostic tap of the bone (osteoperforation) is indicated using a special needle in the corresponding metaphysis. The aspiration of a turbid liquid, pus or fluffy sanguineous content confirms the diagnosis of osteomyelitis. If unchanged blood is aspirated, the diagnosis of osteomyelitis has to be excluded but observation of the patient is continued. When the bone marrow canal is punctured, the patients with osteomyelitis , moreover, exhibit elevated bone marrow pressure of up to 300-400 mm of water level (normal values - 50 mm of H_2O).

Acute haematogenic osteomyelitis is associated with leucocytosis of up to $20x10^9$/l with an increase in the number of neutrophils; ESR is always high. Hemoglobin is slightly low. Disproteinemia - low albumin levels and high levels of α_1 and α_2 globulins in the blood plasma - occurs at the same time. Urine changes are detected: traces of protein, leucocytes and cylinders. In the septicopyemic form of osteomyelitis bacteriuria is often disgnosed.

Plausible X-ray signs of osteomyelitis appear not earlier than 10-14 days from the onset of the disease. From this time on it becomes possible to establish the thickening of periosteum, «erosion» of the bony architecture with the subsequent formation of cavity in the bone. The earliest but not constant sign of acute osteomyelitis on the X-ray is the increase in the soft tissue markings (shadows) adjacent to the damaged part of bone.

Radionuclide and IR imaging techniques can be used to diagnose early forms of acute osteomyelitis. During the scintiscanning, hyperfixation of the pharmacological preparation to the affected bone segment can be identified on the 2^{nd}-3^{rd} day from the onset of disease. Data obtained by thermal infra-red imaging technique can also be used to establish the presence of infection in the bone and surrounding soft tissue within the first few days.

Acute haematogenic osteomyelitis on many occasions has to be differentiated from rheumatism, the aftereffects of trauma, tuberculosis of the bone, bone destruction in the case of typhoid etc. To rule out traumatic injuries, the case history, the presence of general signs of inflammation and intoxication, X-ray data, laboratory findings etc. may be helpful. Rheumatism is associated with several days of prodromal period and the involvement of several minor joints

whereas osteomyelitis affects as a matter of fact one joint. The effusion in rheumatism is serous and rather than purulent. In osteomyelitis the inflammation spreads to the metaphysis whereas in osteomyelitis it is limited around the epiphysis.

Tuberculosis is associated with atrophy of the limb muscles and osteoporosis, radiographs show the features of a «melting sugar», whereas in osteomyelitis areas of osteoporosis are seen alternating with areas of osteosclerosis with the presence of cavities and in later stages - sequestra.

Treatment. Therapy of acute haematogenic osteomyelitis is complex, a combination of surgical and conservative methods of treatment. In the presence of paraosseal phlegmon the latter has to be opened with the incision of the periosteum along the whole length of lesion and a trepanation of the bone. The operation is completed by wound drainage. It is important to properly immobilize the limb.

The optimal surgical treatment is the early decompress drainage of the bone by way of drilling several holes in the area of osteomyelitis after incising the soft tissues. Drainage tubes are passed through the perforated holes into the purulent focus and active irrigation is effected in this way. Vacuum or long-term drainage with solutions of antiseptics (chlorhexidine, dioxidin, sodium hypochloride) conducted for at least 7-10 days and discontinued only when the suppuration has been eliminated and the patient's condition has improved is often used for this purpose. Extensive trepanation of the bone in acute haematogenic osteomyelitis is not recommended, since it creates the hazard of generalized infection - the development of septicopyemic metastasis in distant areas.

Conservative therapeutic measures include antibiotic therapy, immune therapy, detoxication measures, the correction of metabolic disorders etc. It is good practice to use osteotropic substances (lincomycin, morphocycline, fusidin, gentamycin etc.) for the antibiotic therapy. The most effective administration of drugs is by intraosseous and regional (intraarterial, and intravenous) routes. Immunotherapy includes in the first place treatment by preparations for passive immunization (hyperimmune antistaphylococcal plasma, staphylococcal immunoglobulin), which is combined with staphylococcal anatoxin, bacteriophages, nonspecific immune therapy (prodigiozan, lizosim, methyluracyl etc) as well as desensitization preparations.

Long-term fluid management depending on the indication includes: hemodes, reopolyglucan, protein blood substitutes, blood transfusion, albumin, protein, plasma etc.

The successful treatment of acute haematogenic osteomyelitis depends to a large extent on how early the decompressive drainage of the bone marrow canal is done with the active aspiration by drainage of the focus of osteomyelitis.

Chronic osteomyelitis. The condition is normally preceded by an acute form of disease. An exception is the rare case of primary chronic osteomyelitis of the following types: Garre's osteomyelitis, Ollier's osteomyelitis and Brodie's abscess.

Osteomyelitis is divided into chronic, haematogenic and posttraumatic (gunshot, after nailing osteosynthesis etc.).

The transition of osteomyelitis into the chronic form is due to several factors, most important of which are the late start of treatment, inadequate surgical procedures and wrong antibiotic therapy. The inadequate drainage of purulent foci favours the transition of the acute process into a chronic form. This often happens when the periosteum is not excised fully along its length and the openings made by drilling do not correspond to the spread of the process of osteomyelitis. The main fault of antibiotic therapy is using antibiotics without regard for the changing pattern of sensitivity of the pathogenic strains as well as the early termination of the antibiotic therapy for no apparent reason. The transfer of acute into chronic osteomyelitis is also determined by specific pathomorphological changes, complete expulsion of sequestra or the formation of osteomyelitic cavity at the site of osteolysis.

The *clinical* presentation of chronic osteomyelitis comprises two phases: *relapse and remission.* Given active pathogenic strains and a body weakened by disease, exposure to radiation, injury and other factors, reactivation of the chronic process of osteomyelitis occurs - relapse of the disease. Under the effect of antimicrobial therapy or as a result of spontaneous healing of the active process, the whole condition may resolve and the phase of remission sets in. This kind of interchange of phases can be repeated several times.

The following main triad of signs characterizes chronic osteomyelitis: *relapsing trend, the formation of sequestra (or osteomyelitic cavity), purulent fistula.*

Relapse of chronic osteomyelitis presents as deterioration in the patient's general condition. The patient complains of general malaise, weakness, headache, rise in body temperature, sweating, chills. There is pain in the limb, and a purulent fistula opens up. In some instances the skin over the focus of osteomyelitis becomes hyperemic, intensive pain and induration of the soft tissue occur followed by the fluctuation sign and the old fistula that had closed early on opens up again, or a spontaneous opening of the phlegmon at a new site occurs. After the pus has been evacuated the patient's condition improves, intoxication reduces, temperature falls to subfebrile, local inflammation is gradually eliminated, the purulent fistula continues to function or also gradually closes up. The process enters into the remission phase, which can at any time change into relapse.

The clinical presentations of the different kinds of chronic osteomyelitis are principally identical - there is an interchange of disease phases. In post-traumatic cases (including gunshot osteomyelitis), however, the area of bone infection is normally limited to the fracture site from whence the purulent fistulas emanate. Chronic haematogenic osteomyelitis is characterized by the presence of extensive areas of osteomyelitis along the metaepiphysis and diaphysis with the purulent fistulas, sometimes several of them, situated at different sites. Accordingly, the patient shows pronounced signs of chronic suppurative intoxication, changes in the blood picture (leucocytosis, increased ESR, disproteinemia), renal disorders, etc.

When taking a history it is easy to elicit the previous episodes of an acute haematogenic osteomyelitis or a fracture of the bone that was complicated by suppurative process. The number of relapses should be ascertained , the duration of remission as well as the possible expulsion of minute bone sequestra from the fistula. The number of previous operations, their nature and the type of plastic that was applied to the bone cavity as well as the immediate postoperative outcome should be noted. Assessment of the patient's complaints should focus on whether the pains radiate to the joints, the presence of pain sensation along the vascular-nerve bundles, which can point to the development of new suppurative foci. The general symptoms of a relapse of chronic osteomyelitis are similar to those of any suppurative surgical disease, hence the body temperature is checked as well as the necessary blood tests and urinalysis are taken.

In the presence of local signs the extent of skin hyperemia, soft tissue induration and the presence of signs of fluctuation are taken note of. It is important to assess the functional status of the fistula; a blunt probe is used to do the assessment, which in certain cases helps to establish the location of the focus of osteomyelitis. When an ulcer is found in the area of a long - standing purulent fistula, the edges and surface of the wound have to be thoroughly examined and if malignancy is suspected a biopsy is performed. To establish the extent of spread of the inflammatory process to the adjacent joint, the extent of movement, the presence of tenderness or effusion in it are assessed.

X-ray methods help find out bone changes in acute osteomyelitis (periostitis or subperiosteal abscess) or chronic osteomyelitis (osteosclerosis, bone sequester or sequester box). Mild pathology may be detected by means of CT scan. Radiography is one of the most important diagnostic tools whereby the presence of sequestra, cavities, chronic periostitis is established and the extent of damage to the bone determined (fig. 103, colour inset). Fistulography is a very valuable method of investigation, it gives evidence of the direction of the fistula tract, its

connection with the bone cavity, which is necessary in planning surgery, notably to determine the surgical approach (fig. 104).

It is a must to investigate the type of pathogens and their sensitivity to antibiotics as well as the indications of specific and nonspecific immunobiological reactions of the body. Most often staphylococcal and gram negative strains either in monoculture or in association are identified and these are often resistant to a lot of antibiotics. Patients with chronic osteomyelitis are often found to have slightly lowered titers of staphylococcal antitoxin and indices of immunobiological reactions: complement titers, phagocyte activity, leucocytes, T-lymphocytes etc.

Initially, primary chronic haematogenous osteomyelitis develops without marked inflammation. The following types of the disease are distinguished:

1. Brodie's abscess, or intraosseous abscess, i.e. a circumscribed necrosis of the bone sponge with its subsequent lysis and cavity formation.

2. Garre's disease, or severe sclerosing osteitis with areas of rarefaction in the bone and a spindle-shaped thickening of bone diaphyses.

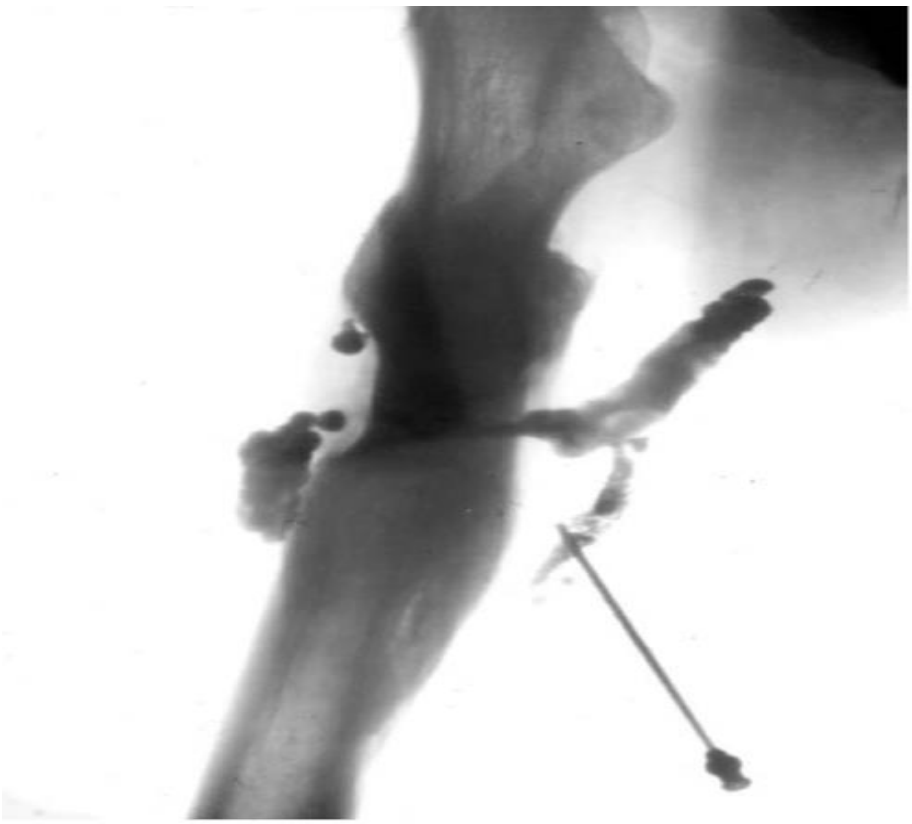
3. Ollier's osteomyelitis, or albuminous osteomyelitis, i.e. slow accumulation of serous fluid rich in protein in the bone rather than of pus, which is occasionally followed by sequestration. Posttraumatic osteomyelitis results from traumatic bone fracture with subsequent local infection.

Treatment. Surgical treatment for chronic osteomyelitis is indicated when there are sequestra, purulent fistula, osteomyelitic cavity in the bone, osteomyelitic ulcers, malignancy, in pseudoarthrosis, in cases of frequent relapse with severe pain, intoxication and dysfunction of the locomotive system as well as in the case of functional and morphological changes in the internal organs caused by the chronic suppurative infection.

Contraindications to the performance of radical surgery - necrectomy - are severe renal failure associated with amyloidosis, decompensated cardiovascular and respiratory systems, etc.

The main component in the complex treatment of chronic osteomyelitis (fig. 105, colour inset) is radical surgery - necrectomy, which is often referred to as sequestrectomy. The aim of the operation is elimination of the chronic focus of infection in the bone and its surrounding soft tissues. In radical necrectomy the sequestrum is removed, all osteomyelitic cavities are incised and liquidated together with their internal wall granulations and detritus; all purulent fistulas are excised. The next important step in the radical surgery is the sanitation and plasty of the bone cavity. More recently the plasty of bone cavity is achieved by using muscle pedicle flaps, bone plates (using autogenous or conserved bone tissue), chondroplasty (using conserved cartilage), and rarely, cutaneous flaps are used (fig. 106). Different biopolymer materials are used: collagen sponge impregnated with antibiotics, glue compositions with different ingredients and biopolymer plombes containing antiseptics. All these materials contain substances that enhance or activate bone tissue regeneration as well. Sanitation of the bone cavity after necrectomy is done by long - term methods of washing and drainage as well as vacuum drainage (fig. 107). These methods are sometimes used simultaneously: washing of the cavity is done through an afferent drainage tube with the efferent tube connected to a suction apparatus. In the case of washing drainage that is continued for 7-15 days different antiseptic solutions are used: antibiotics, dioxidin, soluble furagin, sodium hypochloride etc. The effectiveness of cavity sanitation is assessed and controlled by microbiological investigations.

After necrectomy, treatment is aimed mainly at the suppression of the remaining microorganisms in the area of surgical manipulation, which yields a good immediate postoperative result.



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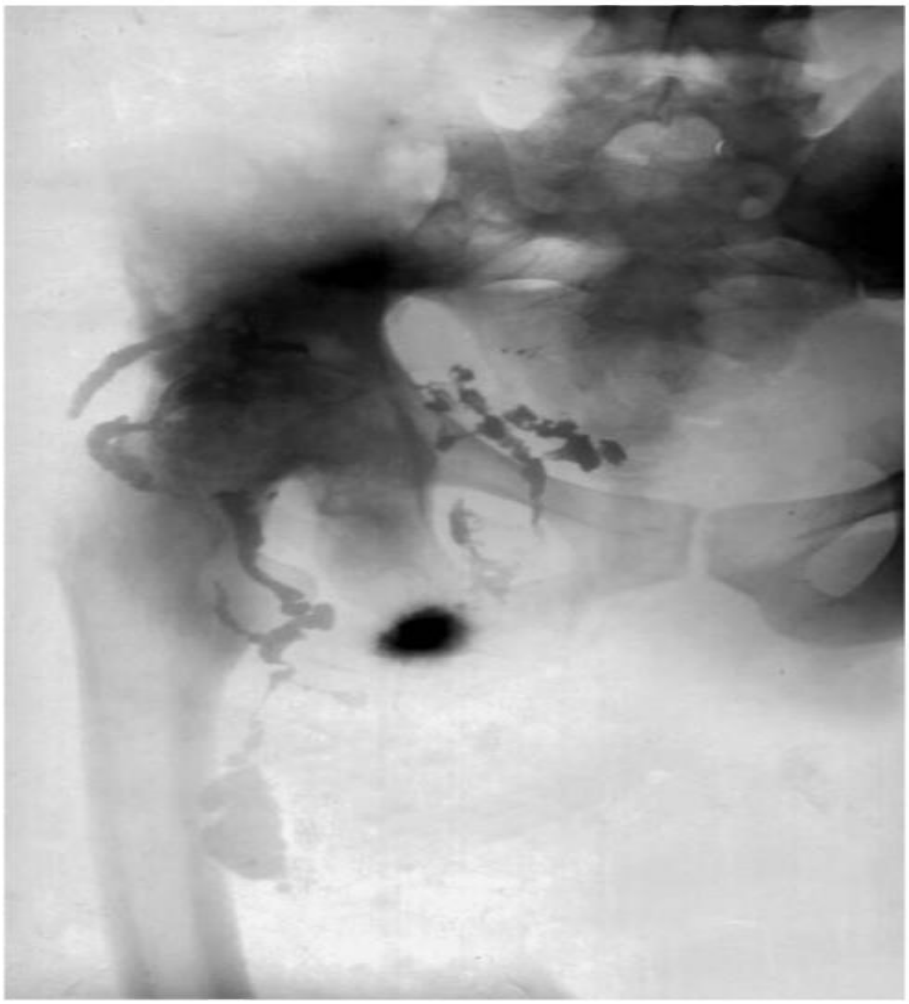


b

Fig. 104. Osteomyelitis: femoral (a) and iliac (b); fistular X-rays.

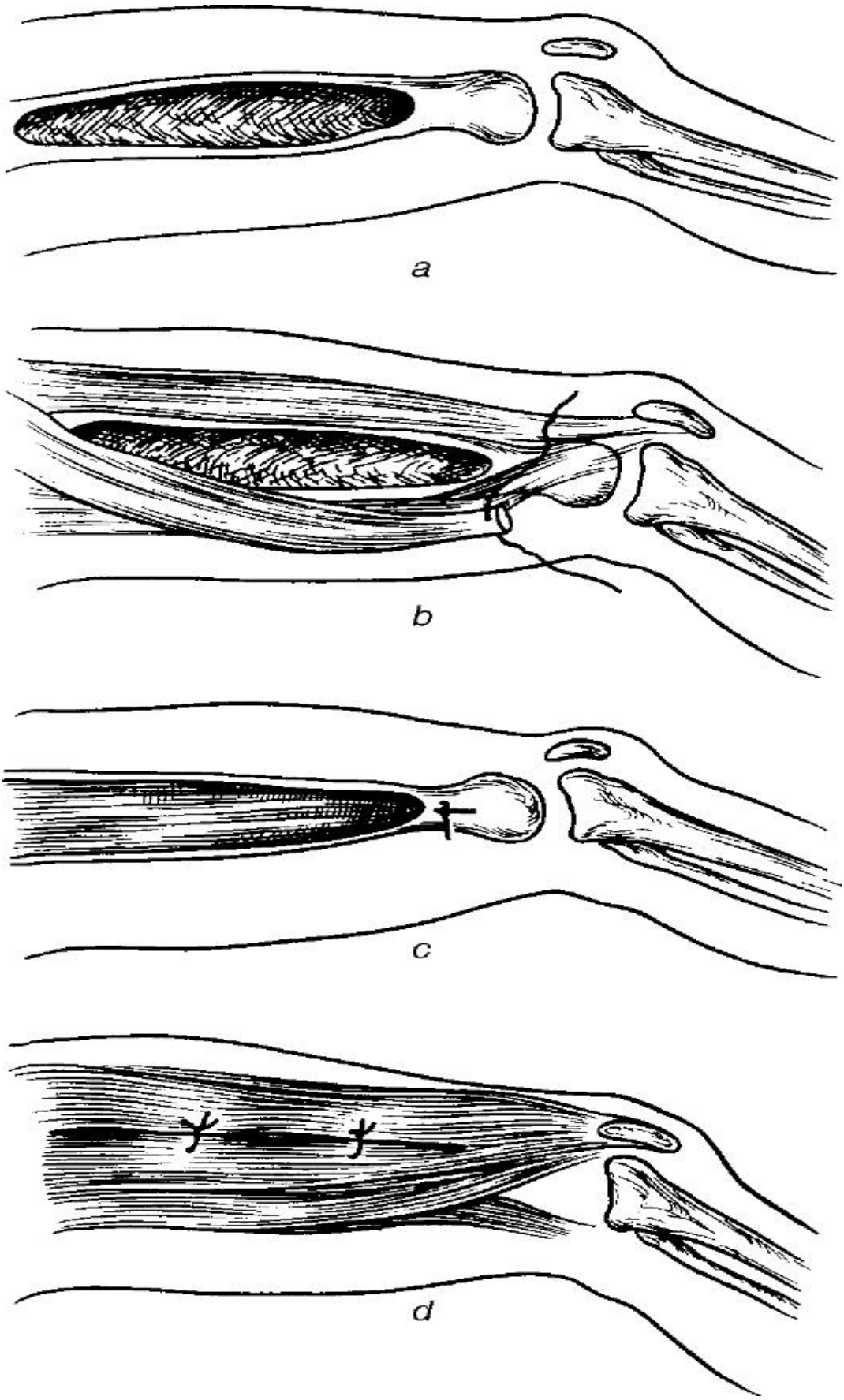


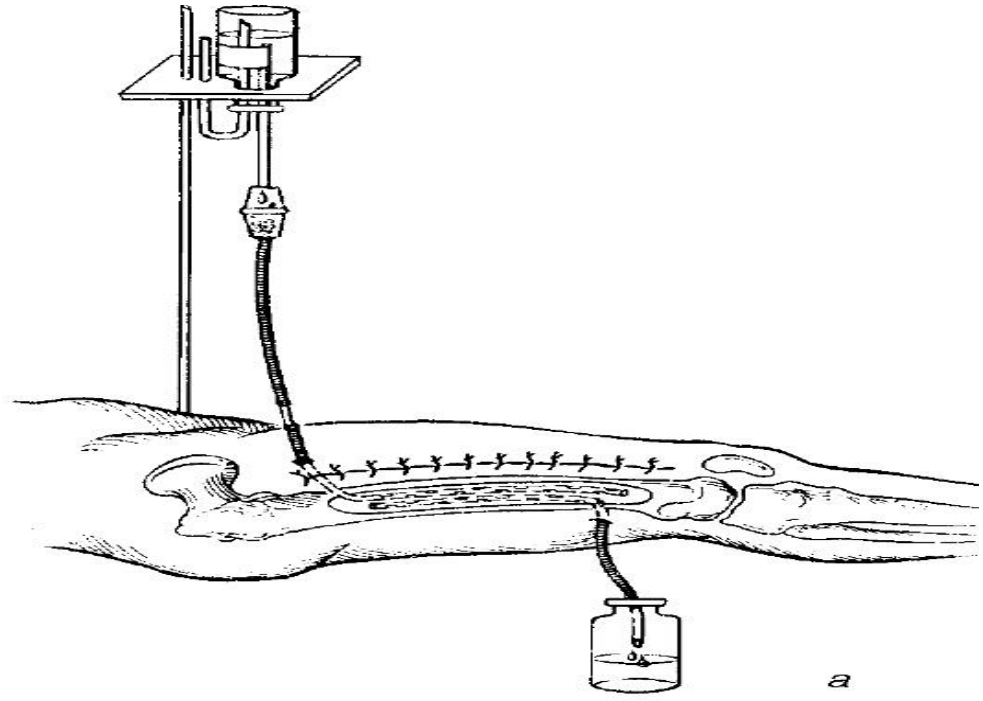
Fig. 106. Muscular plastics of the bone cavity for chronic haematogenous hip osteomyelitis: *a* - the bone cavity prepared for muscular plastics; *b* - the muscular flap on a proximal pedicle; *c* - the flap inserted in the bone cavity and sutured with the bone; *d* - periosteal and muscular suturing above the muscular flap.

This aim is achieved by the following therapeutic measures: 1) antibiotic therapy, 2) immunotherapy, 3) local physiotherapeutic measures: ultrasound therapy, electrophoresis with drug preparations. Fluid management is initiated during the postoperative period: blood transfusions, protein blood substitutes, electrolyte solutions; correction of metabolic disorders; immobilization of the limb followed by exercise therapy to improve the functions of the locomotive system.

Acute suppurative arthritis. *This is an acute inflammation process of the joint caused by pyogenic microorganisms.* Acute suppurative arthritis can either be primary or secondary. Primary contamination of the joint occurs with injuries to the joint; secondary infections occur when pathogenic pyogenic microorganisms gain entry to the joint by haematogenous spread from distant pyogenic foci or from purulent infected tissues surrounding the joint.

Acute suppurative arthritis is often caused by staphylococcus. The changes that occur in the joint depend on the type of inflammation (serous, purulent, fibrinous or ichorous). The extent of spread of the process also plays an important role. The transition of the inflammation onto the joint cartilage and spongy tissue of the bone epiphysis suggests osteoarthritis and the inflammation of the surrounding soft tissue results in paraarticular phlegmon (fig. 108, 109).

The *clinical presentations* of acute suppurative arthritis are: sudden onset, severe pain and limitations in the joint movement, tension, induration and hyperemia of the integument as well as a change in the joint size and shape. In complicated cases local signs of phlegmon are encountered. General clinical symptoms include the presence of suppurative intoxication: high body temperature, weakness, malaise, chills, sweating, depression, progressive anemia etc.



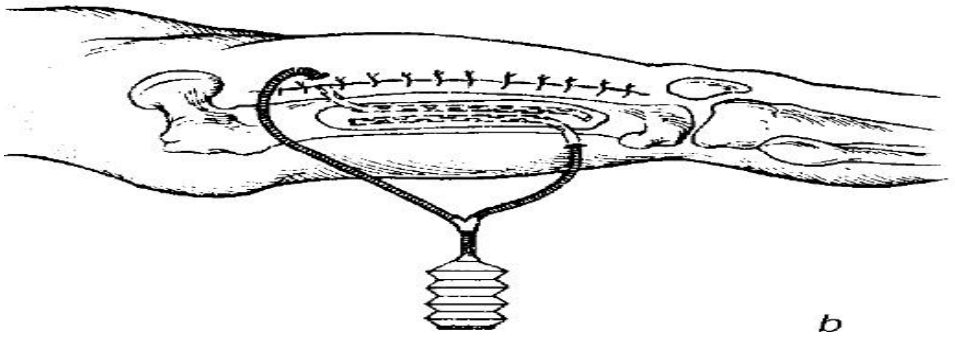


Fig. 107. Post surgery bone cavity drainage in chronic femoral osteomyelitis: *a* - through; *b* - suction.

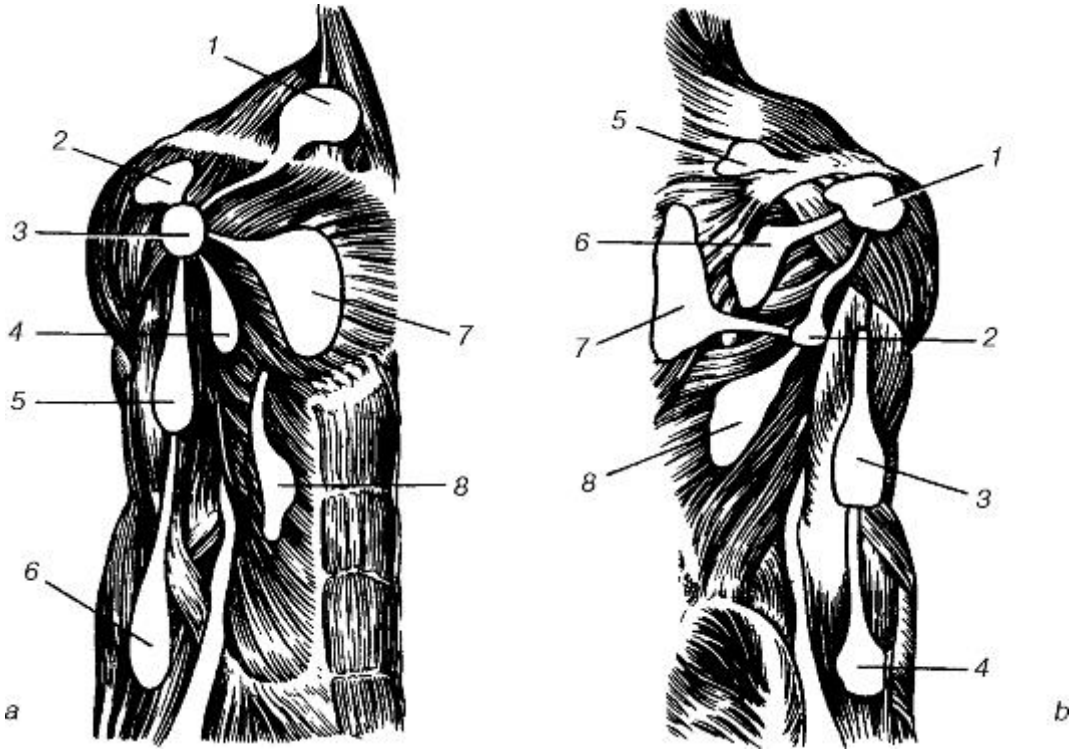


Fig. 108. Topography of humeral suppurative arthritis: *a* - anterior surface: *1* - supraclavicular; *2* - subdeltoid; *3* -arthral; *4* - axillary; *5* - anterior humeral; *6* - anterior forearm; *7* - subpectoral; *8* - abdominal wall; *b* - posterior surface: *1* - subdeltoid; *2* - axillary; *3* - posterior humeral; *4* - posterior forearm; *5* - supraosteal; 6 - subspinal; *7* -subtrapezoid; *8* - sublatissimus dorsi.

Examination of the patient with acute suppurative arthritis has its peculiarities. When taking history the presence of injuries to the joint should be elicited. The absence of the history of trauma suggests the haematogenic way of infection.

Inspection should focus on half-bent forced position of joint, hyperemia of the skin and the extent of distortion of the joint configuration. The affected joint has to be compared to the symmetrical healthy one. Palpation shows a higher temperature over the affected joint, tenderness, fluctuation, which indicates the accumulation of fluid in the joint space or the presence of paraarticular phlegmon. With large amounts of fluid accumulated in the knee joint, the patella is found to be floating. The extent of motion in the affected joint has to be assessed. The extent of limitations in the affected joint is an indirect indication of the severity of the inflammatory process.

Blood tests show the usual signs of suppurative inflammation: leucocytosis, neutrophilia, high ESR and disproteinemia.

X-ray in acute suppurative arthritis shows a widening of the joint spaces, osteoporosis at the epiphyseal bone ends of the affected joint.

Puncture or a tap of the joint is crucial: the aspirate can be used to identify the type of inflammation (serous, purulent, purulo-hemorrhagic etc.). The aspirated fluid is sent for microbiological investigations to determine the type of pathogenic microorganisms and their sensitivity to antibiotics.

Treatment. Treatment of acute suppurative arthritis combines both local and general therapeutic measures. Local measures include: a) puncture of the joint with aspiration of its contents, irrigation or washing of the joint cavity with antiseptic followed by infusion of

antibiotics (fig. 110). Therapeutic punctures are done daily until the accumulation of inflammatory exudates into the joint has stopped; b) immobilization of the joint with either POP slab or a therapeutic splint; c) physiotherapy: high-frequency therapy, quartz irradiation, electrophoresis with trypsin, antibiotics etc.; d) after the inflammation has subsided the patient is prescribed exercise therapy, massage and other manipulations to restore the joint functions.

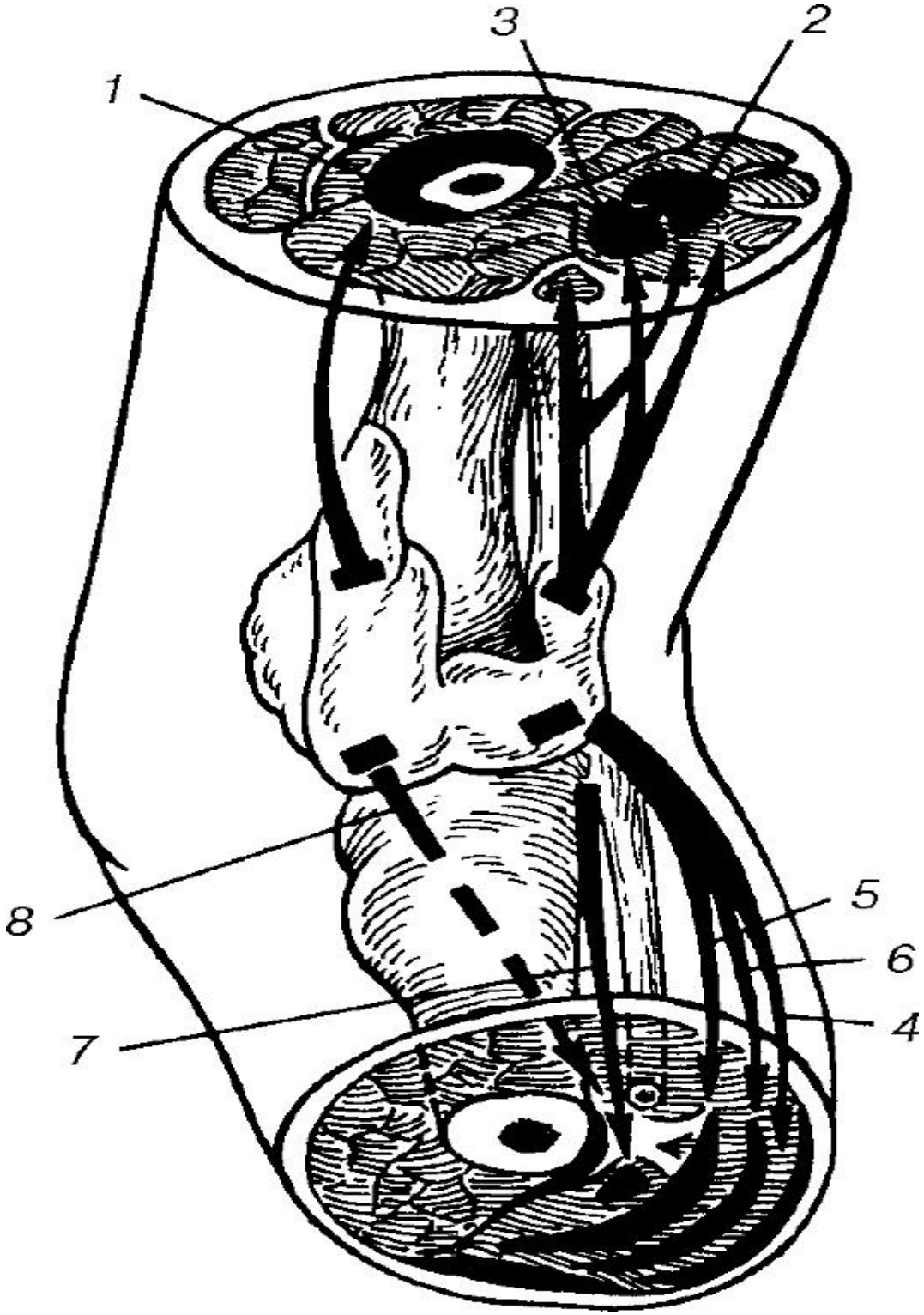


Fig. 109. Topography of suppurative gonitis: *1* - deep superior anterior; *2, 3* - superior posterior; *4* - inferior superior posterior, between the *gastrocnemius* and *sole-us muscles; 5* - inferior posterior, under the deeper layer of the crural fascia; *6* - between the soleus muscle and the deeper layer of the crural fascia; *7* - the posterior surface of the interosseous membrane; *8* - inferior posterior, along the interosseous membrane.

General therapeutic measures include antibiotic therapy tailored to the results of microbiological investigations, immunotherapy, blood transfusion, plasma, protein blood substitutes, detoxication therapy, rational nutrition rich in protein and vitamins.

Surgical treatment involves arthrotomy, which is indicated only where the puncture and aspiration, local and general antibiotic therapy prove unsuccessful. During arthrotomy the joint cavity is cleared of all the purulent effusion and fibrinous deposit whereupon a drainage tube is placed for long-term washing sanitation (fig. 111). Paraarticular phlegmon has to be incised and drained followed by subsequent treatment along the standard lines.

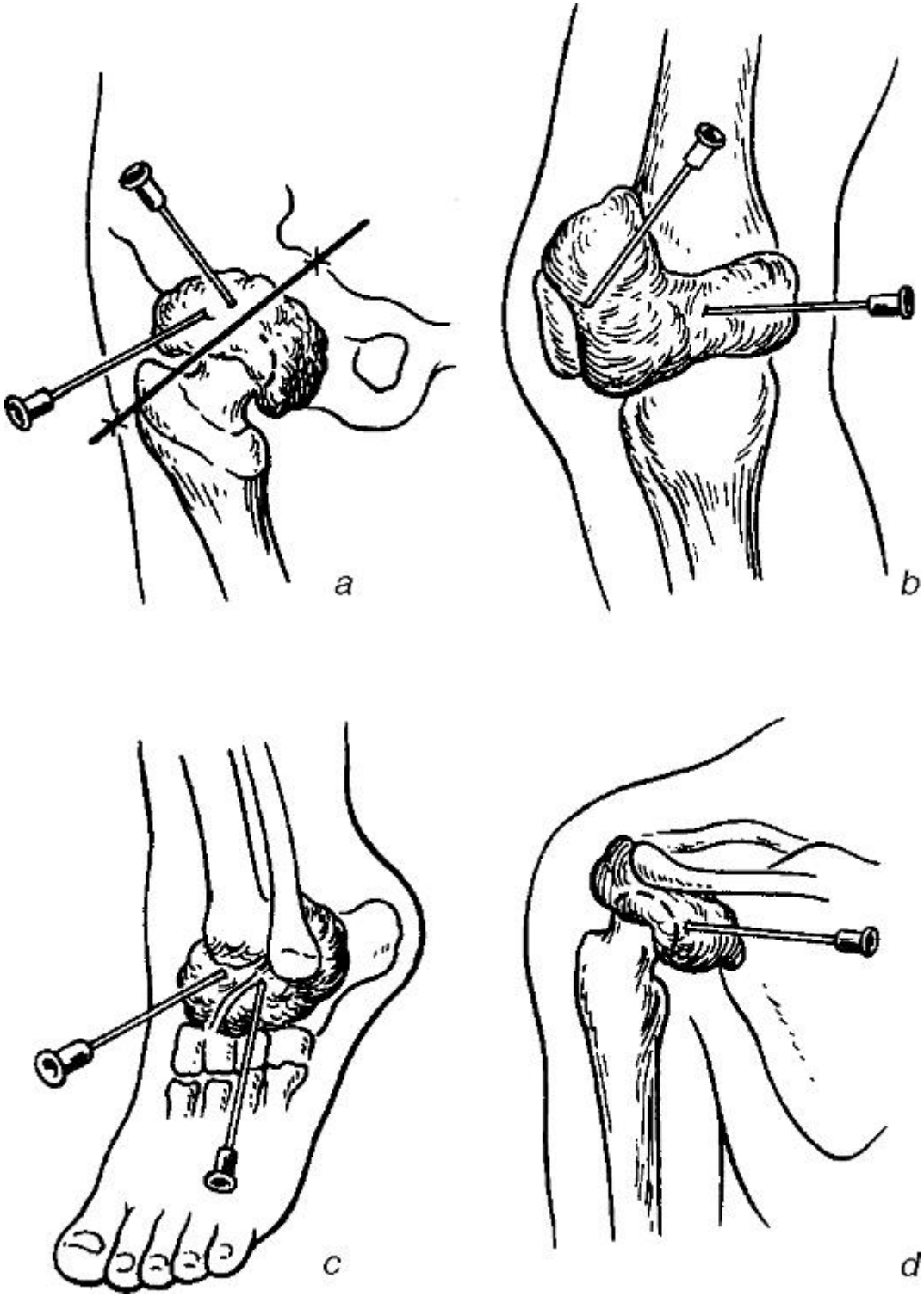


Fig. 110. Arthrocentesis in suppuration of the hip (a), knee (b), ankle (c) and shoulder (d) joints.

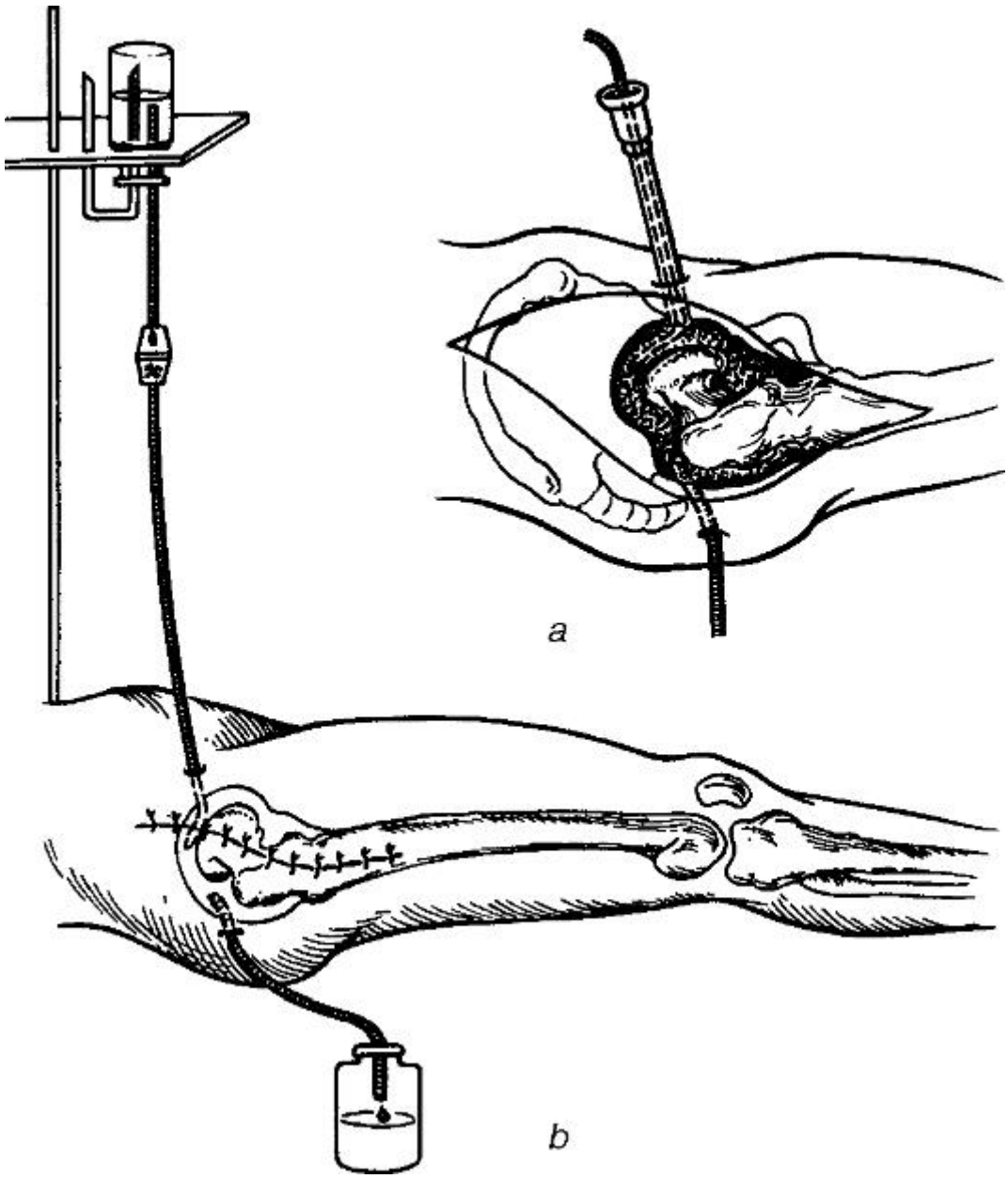


Fig. 111. Through drainage of the hip joint after arthrotomy: *a* - arthrocentesis followed by insertion of the microirrigator; *b* - through drainage of the hip joint with antibiotics.

Prophylaxis of acute suppurative arthritis involves a thorough execution of the primary surgical wound debridement, especially when the joint is affected, strict compliance with aseptic measures during orthopedic operations and correct treatment of suppurative inflammations of contiguous tissues (abscess, phlegmon, osteomyelitis, furuncle etc.).

11.6 ACUTE THROMBOPHLEBITIS

This is an inflammation of the vein concurrently with the formation of thrombus. Two types of processes are identified: *phlebothrombosis* - thrombosis developing as a result of blood stasis and changes in the blood clotting system, and *thrombophlebitis* - thrombosis developing on the background of inflammatory changes in the walls of the vein. Factors that cause the development of the disease have to be elicited during examination of the patient:

1) blood stasis (reduction of the rate of blood flow);

2) changes in the blood composition;

3) damage to the vascular intimae.

Such conditions are encountered during surgical manipulations especially in women - in diseases of the uterus, operations on the kidneys, and urinary tract and during femoral neck fractures. Venous stasis and the reduction of blood flow may occur when patients are immobile, in cardiac failures, and in pregnancy. The source of infection can be acute or chronic infections (typhoid, pneumonia, influenza, septicemia etc.). Damage to the vascular intimae occurs during trauma (fractures, contusions, haematoma, crush, immobilization and catheterization of vessels). Changes in the blood composition occur in diseases of the blood (anemia, leukemia etc.), treatment with certain types of drugs (digitalis, mercury containing diuretics, vitamin K, corticoids and antibiotics, especially penicillins).

Acute superficial thrombophlebitis. This kind of thrombophlebitis is often easy to diagnose. Patients complain of pains, infiltration and tenderness along the affected vein. Pains intensify on walking as well as during active and passive motions. Varicose-enlarged veins of the leg and thigh are often affected. The body temperature rises, and inspection of the limb shows a firm infiltrate along the vein that is tender on palpation. The skin is hyperemic and edematous (fig. 112, colour inset). When intact veins are affected especially in obese patients a firm tender threadlike induration is palpated along the vein.

Treatment. Conservative therapy in the acute stage of the disease when the patient is febrile includes rest with the limb raised, anti-inflammatory and anticoagulant therapy (acetyl salicylic acid, butadion, rheopirin, venoruton, troxevasin; compress with heparin, venoruton ointments, novocain block with heparin), physiotherapeutic measures (electrophoresis with trypsin, potassium iodide, soluxe, high-frequency current therapy); minimum walking exercise with the limb bandaged with an elastic bandage.

Indications for surgery (absolute and relative) are when the thrombus is situated at the ostium of the superficial vein (the danger of the process extending into the deep veins and thromboembolism); suppurative thrombophlebitis (the danger of sepsis). The thrombosed vein is excised or ligated at the point of entry into the deep vein.

Thrombophlebitis of the deep veins. This condition is more serious than the superficial one. Patients mainly complain of pains and oedema of the limb. Pain is spontaneous and varies in intensity and character: in thrombosis of the deep veins of the leg the pain is localized in the calf muscles and tends to increase on walking; in thrombosis of the deep veins of the thigh or in ileofemoral thrombosis as a result of the rapidly developing oedema the pain is severe and throbbing.

In ileofemoral thrombosis the patient's general condition deteriorates as a result of the intoxication: the patient becomes weak, there may be tachycardia, fast respiratory rate, dullness in the heart sounds. Examination of the limb reveals oedema, the location of which depends on the spread and site of thrombosis: oedema of the ankles is characteristic of thrombosis of the popliteal veins; oedema stretching to the knee is characteristic of thrombosis of the common femoral vein; oedema of the thigh occurs in thrombosis of the femoral and iliac veins; oedema of the legs and the abdominal wall - in thrombosis of the inferior vena cava. Oedema is most pronounced in thrombosis of the femoral and iliac veins. It presents in two forms: a) phlegmasia alba dolens - white shiny skin, smooth, waxy, oedema is firm, no mark is left on the skin when it is pressed down with the finger; b) phlegmasia coerulea dolens - bluish skin, spotty, moist, shiny with a reduced skin temperature. Oedema is found early in the course of disease when the patient is standing but it increases very fast and is associated with extreme intoxication. Pulsation on the peripheral arteries is absent.

In thrombophlebitis of the deep veins of the leg, palpation of the calf muscles reveals tenderness along the deep veins, pains in the calf muscle appear on dorsal flexion of the foot or 5 minutes after the pressure in the blood pressure cuff has been increased to 40 mm Hg. Pains are felt at the site of thrombosis on coughing, sneezing or tapping on the anterior surface of the tibia bone.

Treatment. Bed rest with the leg raised, anticoagulants and fibrinolitic therapy (heparin injections, fibrinolysin, streptase, streptokinase, urokinase), followed by indirect anticoagulants (neodicumarin, pelentan, phenylinum etc.). At the same time preparations that improve the rheologic properties of blood are prescribed (reopolyglucin, hemodes, trental and nicotinic acid).

Surgical treatment includes thromboectomy, ligation of the vein, autovenous shunts and prosthesis after resection of the vein with the thrombus, plication of the vein, the implantation of filters into the vena cava inferior as a prophylactic measure against thromboembolism of the pulmonary arteries.

In thrombosis there is always the possibility of the superficial process spreading to the deep veins (through the ostium of the superficial or communicant veins), embolism of the pulmonary arteries, further progression (spread to other organs). Deep vein thrombosis often leads to the development of post-thrombophlebitis disease.

11.7 SUPPURATIVE DISEASES (PURULENT INFECTIONS) OF SEROUS CAVITIES

Purulent (suppurative) peritonitis - this is the inflammation of the parietal and visceral peritoneal layers accompanied by local changes and intoxication.

Classification

1. According to the extent of spread of the disease: a) localized peritonitis: circumscribed (enclosed), unlimited (not enclosed);

   b) generalized peritonitis: diffuse;

   c) general (total) peritonitis.

2. According to the stage (phase) of development:

   a) the reactive stage (1st 24 hrs);

   b) toxic phase (24 to 72 hrs);

   c) the phase of polyorganic failure (after 72 hrs).

The main processes that determine the clinical picture of suppurative peritonitis are the inflammation of peritoneum and paresis of the intestines. The inflammation of peritoneum is accompanied by profuse exudation into the peritoneal cavity. The exudate is initially serous, then seropurulent and then purulent. When fibrin is present the exudate becomes purulofibrinous, and in the case of ichorous tissue disintegration, it becomes ichorous. Excessive exudation causes the escape of proteins from the blood flow into the peritoneal cavity, primarily albumins, then water and electrolytes. The amount of exudates accumulated into the peritoneal cavity can reach several liters with protein content of 5% or more. Protein loss (including the exudates, vomitus etc.) varies between 50-250 gm a day, and in cases of continuous perfusion of the abdominal cavity can reach up to 400 gm a day. The protein content of the blood sharply decreases, the patient develops disproteinemia. Large amounts of protein loss during peritonitis compromise the nutritional status of the organism. All this leads to the mobilization and depletion of the energy reserve (glycogen, fat deposits) and disorders in all types of metabolic activities - protein, carbohydrates, fat, and water-electrolyte.

The accumulation of fluid in the abdominal cavity as well as its loss through vomitus leads initially to cellular dehydration and later to water deficit both intracellular and in the extracellular space. Water is lost together with large amounts of salts, the deficiency in water is augmented by electrolyte deficiency, especially potassium. The acid-base imbalance is characterized by a shift in the direction of metabolic acidosis or alkalosis and closely linked to the imbalance of electrolyte metabolism, functions of the respiratory, cardiac and renal systems.

A special feature of peritonitis is the spread of infection and the intensive absorption by the peritoneum of toxic products - bacterial toxins, and products of tissue disintegration. The

development of peritonitis is accompanied by the paralysis of the gastrointestinal tract. The intestinal lumen is filled with contents that undergo decomposition and contain large amounts of microorganisms. The absorption from the intestines of bacterial toxins, toxic products of putrefaction and fermentation worsen the already serious intoxication caused by the purulent inflammation of the peritoneum.

Hemodynamic disorders figure significantly in the complex of pathophysiological reactions that occur in purulent peritonitis. Common to them is the inconsistency between the vascular space volume and the amount of blood in circulation, which is associated with a decrease in the blood pressure, disorders in the microcirculation, cardiac function and the blood supply to the organs. The changesin the rheologic properties of blood are instrumental in the development of microcirculatory disorders.

Purulent peritonitis is normally a secondary disease caused by the spread of infection from an organ in the abdominal cavity onto the visceral and parietal peritoneum. Peritonitis may be attributed to one of the following causes: acute appendicitis, acute cholecystitis, perforated stomach and duodenal ulcers, intestinal obstructions, acute pancreatitis, trauma to the abdominal organs and pelvic inflammatory diseases (the internal female genital organs). Peritonitis can also result from surgery (postoperative peritonitis), when contamination of the peritoneum occurs accidentally during operation or as a result of the breakdown of anastomosis after the operation. Purulent peritonitis is classified according to the spread and phase of the disease process.

In clinical practice after the diagnosis of peritonitis has been established it is imperative to identify the source of infection, the extent of its spread and the disease stage. Localized unlimited (not enclosed) peritonitis according to the extent of spread occupies up to 2 out of the 9 anatomic areas of the peritoneal covering. The process can spread along the peritoneum involving new areas in the inflammation. Localized circumscribed peritonitis is characterized by formation of inflammatory infiltrate, adhesions, scars that prevent the infection from spreading to other areas of the peritoneal cavity, resulting in the formation of intraabdominal abscesses.

When the inflammatory process involves more than 2 of the anatomical areas but less than 5 (more than one but less than two floors of the abdominal cavity) without the signs of limitation (encapsulation), such peritonitis is called diffusely spread. Such a process occupies up to 60% of the peritoneal covering.

When more than 5 anatomic areas or 2 floors of the abdominal cavity are involved, which constitutes more than 60% of the peritoneal covering, peritonitis is termed generally spread.

Generalized peritonitis is the total involvement of all the areas of the parietal and visceral peritoneum.

Continuous spread of the infection along the peritoneum is accompanied by deterioration in the disease phase. Local unlimited and diffuse peritonitis correspond to the reactive phase which quickly moves into the toxic phase and as the process spreads and moves into the general or generalized phase, the condition reaches the terminal phase.

The *reactive phase* of peritonitis persists for 12-24 hrs and is characterized by intensive inflammatory changes in the peritoneum. Patients complain of pains in the stomach, which are intense and are initially located at the source of peritonitis, the pain later spreads to adjacent areas and can involve half or even the whole abdomen. Vomiting of stomach contents and later of bile is a common occurrence. General clinical symptoms include a rise in body temperature up to 38 °C and above, tachycardia (pulse rate of up to 120 beats per min), increase in blood pressure and respiratory rate (up to 24-28 per min), restlessness, motor agitation.

The face is initially flushed, then becomes pale. The abdomen is retracted or slightly distended; the abdominal wall or half of it is not involved in the act of breathing. On palpation the patient demonstrates severe tenderness and tensing of all the abdominal muscles depending on the spread of the process along the peritoneum. Bowels sounds are absent on auscultation.

Laboratory blood tests show leucocytosis with a mild shift of the leukocyte formula to the left.

The *toxic phase* of peritonitis persists for 24-72 hrs and is characterized by severe intoxication and paresis of the GI (tract). Patients become adynamic, gaunted and hollow-eyed, skin is pale. Pulse rate is more than 120 beats per min and weak, blood pressure reduces. Body temperature is high (39-40 °C) hectic in nature, patients sometimes have chills. Abdomen is distended, tender on palpation but muscle rigidity is less than in the reactive period, abdominal percussion reveals meteorism, bowel sounds are absent. Vomiting is common of the intestinal contents. Blood tests show leucocytosis with a marked shift of the leukocyte formula to the left (the appearance of immature forms) and toxic granular leucocytes.

The phase of polyorganic failure (after 72 hrs) is characterized by extreme intoxication of the organism. The patient is depressed, adynamic, apathetic to his surroundings, may be confused, quiet often develops toxic psychosis (inadequate behavior, agitation and hallucinations). The face is grayish-yellow, livid, bluish or sunken (Hippocratic face). There is profuse vomiting with the odour of faeces.

The pulse is fast, weak and thready, blood pressure is low. Abdomen is very distended, tender to palpation all over. Peristaltic bowel sounds are absent («grave silence»). The body temperature reduces; the skin is covered with cold sweat. Blood tests show leucocytosis with a marked shift of the leukocyte formula to the left. Urine output is reduced, with a high proteinuria and cylinders present.

Peculiarities of the examination of the patient with peritonitis.

When the infection spreads to the peritoneum from an inflamed abdominal organ the signs of peritonitis add to the signs of the originally infected organ that happened to be the cause of infection. Subsequently when the process spreads and moves into the next phase, it becomes difficult to establish the original source of infection.

Patients with peritonitis *complain* of abdominal pains, thirst, weakness, vomiting and dyspnea. Pain is persistent and the location differs according to the source of infection at the onset of the disease, then the pain spreads to half or the entire abdomen. When fluid accumulates in the subphrenic space, the pain can radiate to the shoulders, scapula; and if it accumulates in the pelvis - there is pain in the rectum and perineum.

Pain can increase gradually (when an organ is inflamed) or suddenly and become intense when a hollow viscus perforates, as in stomach and duodenal ulcers. The character and location of pain depends on the main (original) disease: for example in acute cholecystitis the pain is griping and located in the right hypochondria, in acute intestinal obstruction the pain is intense, colicky and with the onset of peritonitis (paresis of the intestines), it reduces in intensity and becomes persistent.

Inspection reveals a patient with sunken hollow eyes, pale, sharpened face, with fast breathing. Pulse is rapid and increases as the disease progress, blood pressure reduces, dry and coated tongue.

The abdomen is initially not changed or just a little distended. Extreme distension is found in fullblown peritonitis. It is not involved in the act of breathing or some part of it is left out, breathing becomes shallow and intercostal. In peritonitis caused by ruptured viscus, the abdomen can be retracted at the initial stage of the disease. Peristaltic bowel sounds are absent during the toxic and terminal phases. A high tympanic sound is heard on auscultation of the abdomen, it is dull over the areas of fluid accumulation.

During the initial phases there is tenderness over the areas of the source of infection, this later spreads over several areas, half or the entire abdomen.

One of the vital symptoms of peritonitis is abdominal guarding. To elicit this symptom both hands are used to palpate the abdomen gently, placing the palms over two symmetrical areas of the abdominal wall. Moving the hands over the abdominal wall with minimal pressure the amount of resistance from the muscles on both sides is compared: tensing of the abdominal wall and resistance from it indicate the presence of muscular rigidity. Intense muscular rigidity is encountered in perforations of viscus (board-like stomach). The cause of guarding is involuntary resistance, reflex reaction of the abdominal wall caused by pain. Together with abdominal guarding a constant feature of peritonitis is rebound tenderness, the Shotkin-Blumberg's sign. This sign is based on the increase in pain on shaking the peritoneum. To elicit this sign the abdominal wall is pressed deeply and gently using the fingers and then the pressure is quickly released. The resulting irritation of the peritoneum causes severe pain at affected area which is a sign of peritoneum inflamation.

Laboratory blood tests show leucocytosis, which can reach up to $15\text{-}20x10^9$/l with a shift of the leukocyte formula to the left, anemia; ESR is high; protein and cylinders are present in the urine.

Plain abdominal x-rays can show free gas if peritonitis resulted from a perforated viscus; in ileus there are distended intestinal loops with fluid accumulation in them.

To establish the diagnosis of peritonitis, several symptoms have to be present of which the most reliable are: abdominal pains, tenderness on palpation, guarding or rigidity of the abdominal wall muscle, Shotkin-Blumberg's sign, dry tongue, rapid pulse, high body temperature, deficit of pulse versus temperature, high leucocytosis with a shift to the left, the presence of free gas in the abdominal cavity. To confirm the diagnosis in unclear situations and to establish the source of infection, laparoscopy is done. After the diagnosis has been established the spread of peritonitis as well as its phase of development are determined.

Treatment. Purulent peritonitis is an indication for emergency operation. The objective of surgery is to liquidate the source of infection, sanitation of the abdominal cavity and evacuation of the purulent exudate in the abdominal cavity or the contents of the GIT in case of perforated viscus, drainage of the abdominal cavity for the infusion of antibiotics and evacuation of exudate.

The preoperative assessment must be short - not more than 2 hours and aimed at the restoration of blood circulation, improvement of water-electrolyte imbalance and restoration of the circulating blood volume. Evaluation of the cardiovascular system during the preoperative period is especially important in patients who frail and elderly and who as a result of the severe intoxication easily develop cardiac decompensation (ref. Chapter VII).

In spreading peritonitis the best surgical approach is the mid-line laparotomy incision. *Liquidation of the source* of infection involves the excision of the affected organ (appendectomy, cholecystectomy, removal of fallopian tubes, resection of the intestine etc.), closure of the perforation in the case of stomach or duodenal ulcers.

Sanitation (toileting) of the abdominal cavity is aimed at evacuation of the exudate with the help of electric suction machine (fig. 113) or dry cleaning the abdominal cavity with gauze swabs, clearing of the fibrin deposits, washing the abdominal cavity with antiseptic solutions (dioxidin, soluble furagin, sodium hypochloride, ultrasonic cavitation).

To combat the intestinal paresis the intestines are *decompressed.* In intestinal resection decompression is done through the open ends of the bowel: the bowel is brought out of the abdominal cavity, the clamps are removed and by pressing down the bowel contents and gas are emptied. In case one or both ends of the bowel are brought out in the form of a fistula, decompression will be achieved after the operation through this fistula (enterostomy or colostomy).

Where the source of peritonitis is liquidated without opening the lumen of the intestines (appendectomy, cholecystectomy, closure of a perforation), then decompression of the intestine during and after the operation is achieved by using soft long small-intestinal tubes with lots of holes on the sides which are passed through the nose, oesophagus, stomach and into the small intestine at the time of operation. This tube can be pushed into the small intestine during laparotomy as well; through it the intestinal contents are evacuated and left in situ for long-term decompression during the postoperative period.

Decompression, which is continued into the postoperative period is aimed at evacuating the intestinal contents in order to prevent them from being absorbed into the organism and to prevent intoxication, as well as to reduce the extent of circulatory and nutritional imbalance in the intestinal walls that have been overstretched by gas. Moreover, the distended abdomen impedes the excursion of the diaphragm and causes the shift of the heart and lungs leading to cardiac and respiratory dysfunction. After deflating the intestines, 150 mls of 0.25% solution of novocain are injected into the mesentery of the small bowels.

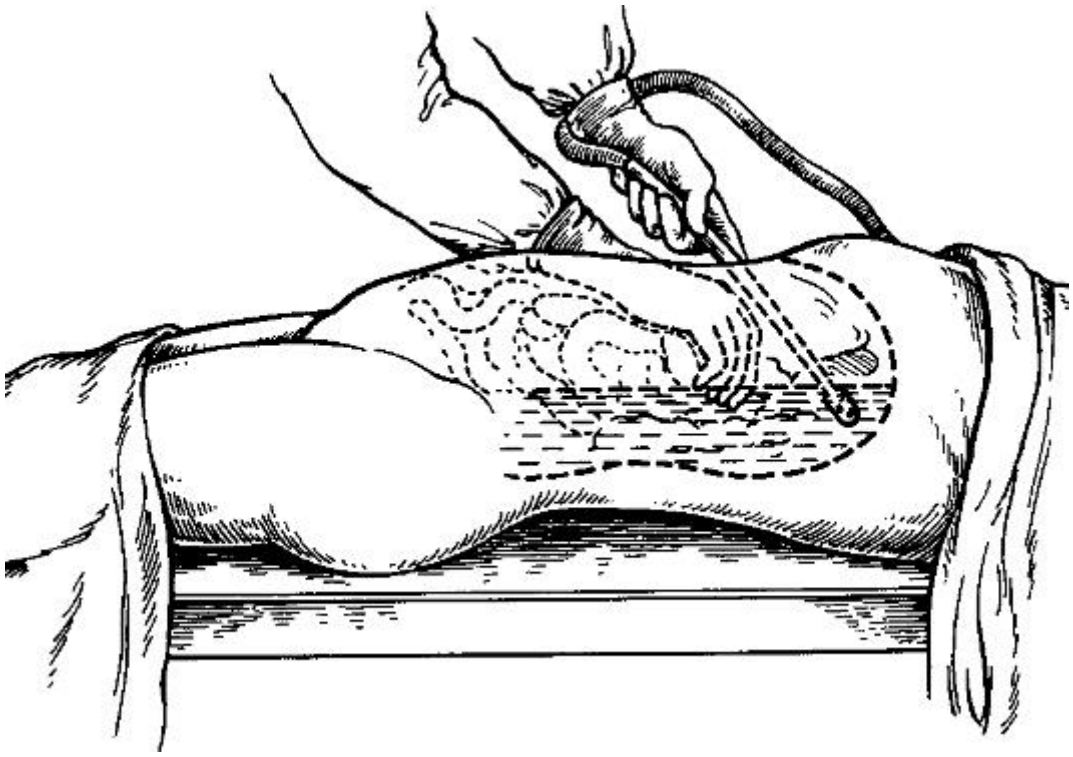


Fig. 113. Electric suction of exudate in peritonitis.

The operation is completed by *abdominal drainage* (fig. 114). Vinyl chloride or silicone drainage tubes with a diameter of 0,2-0,8 cm are used. The tubes are passed through separate punctures in the abdominal wall. The laparotomy incision is normally sutured tight. In generalized peritonitis drainage tubes are inserted for periodic (fractional) irrigation of the abdominal cavity during the postoperative period with antiseptic solutions. This method of continuous-flow peritoneal dialysis is only used in situations when it was not possible to fully evacuate all the purulent exudates and also in terminal stages of peritonitis (fig. 115, 116).

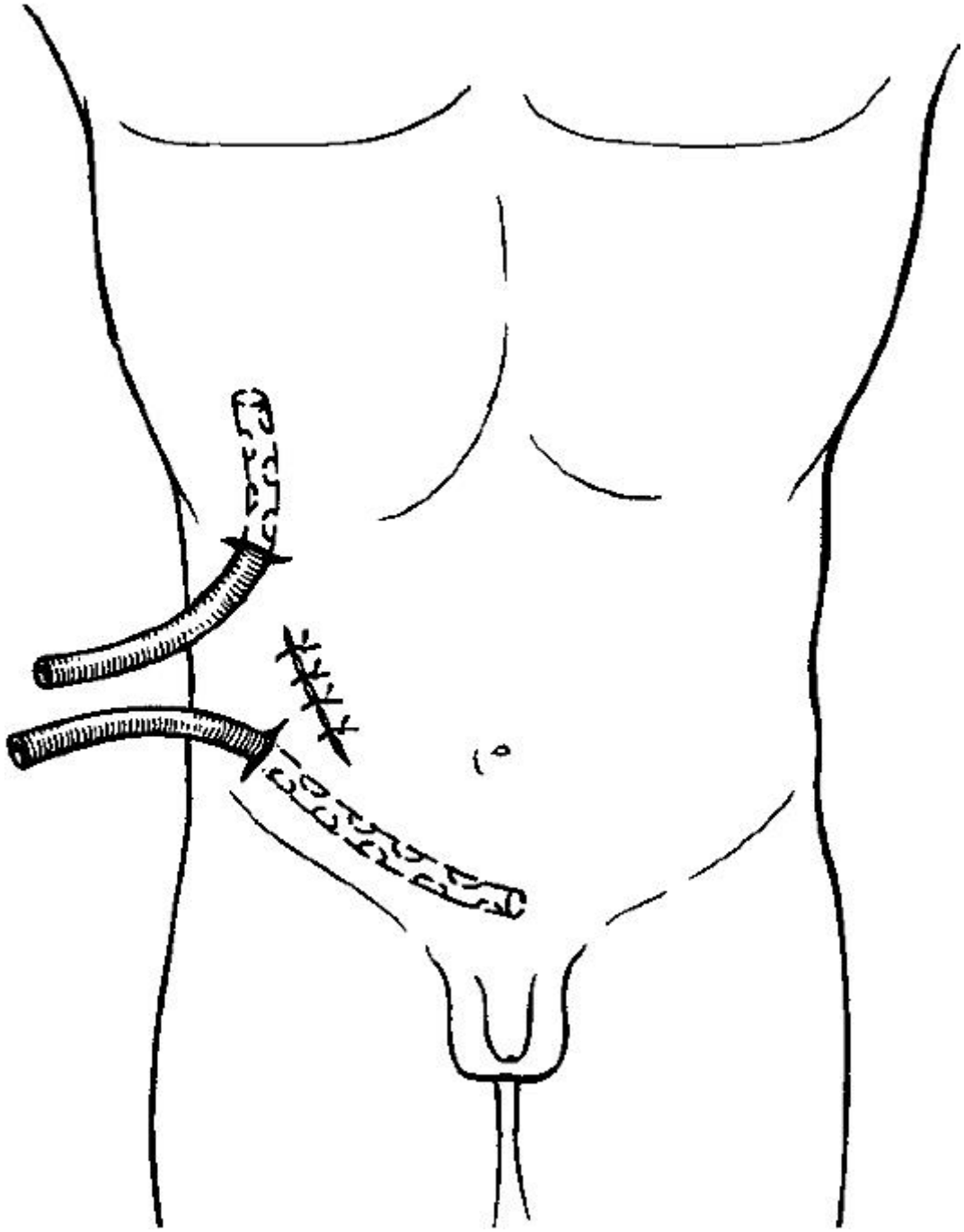


Fig. 114. Abdominal drainage in destructive appendicitis complicated by local peritonitis.

Repeated toileting of the abdominal cavity in generalized peritonitis can be done by means of*laparostomy*. To do this, the operation is completed by suturing a zipper along the wound edges. After the operation the zipper is periodically opened, the exudate is aspirated, the abdominal cavity is washed with antiseptic solutions (fig. 117). This procedure is continued till complete eradication of inflammation in the abdominal cavity, the zipper is then removed and the wound is sutured.

Treatment of patients with suppurative peritonitis in the postoperative period is focused on the following: 1) toileting (sanitation) of the abdominal cavity; 2) antibacterial therapy; 3) detoxication therapy; 4) reestablishment of metabolic balance of blood (water-electrolyte, acid - base balance, protein composition and the circulating blood volume); 5) restoration of intestinal peristalsis.

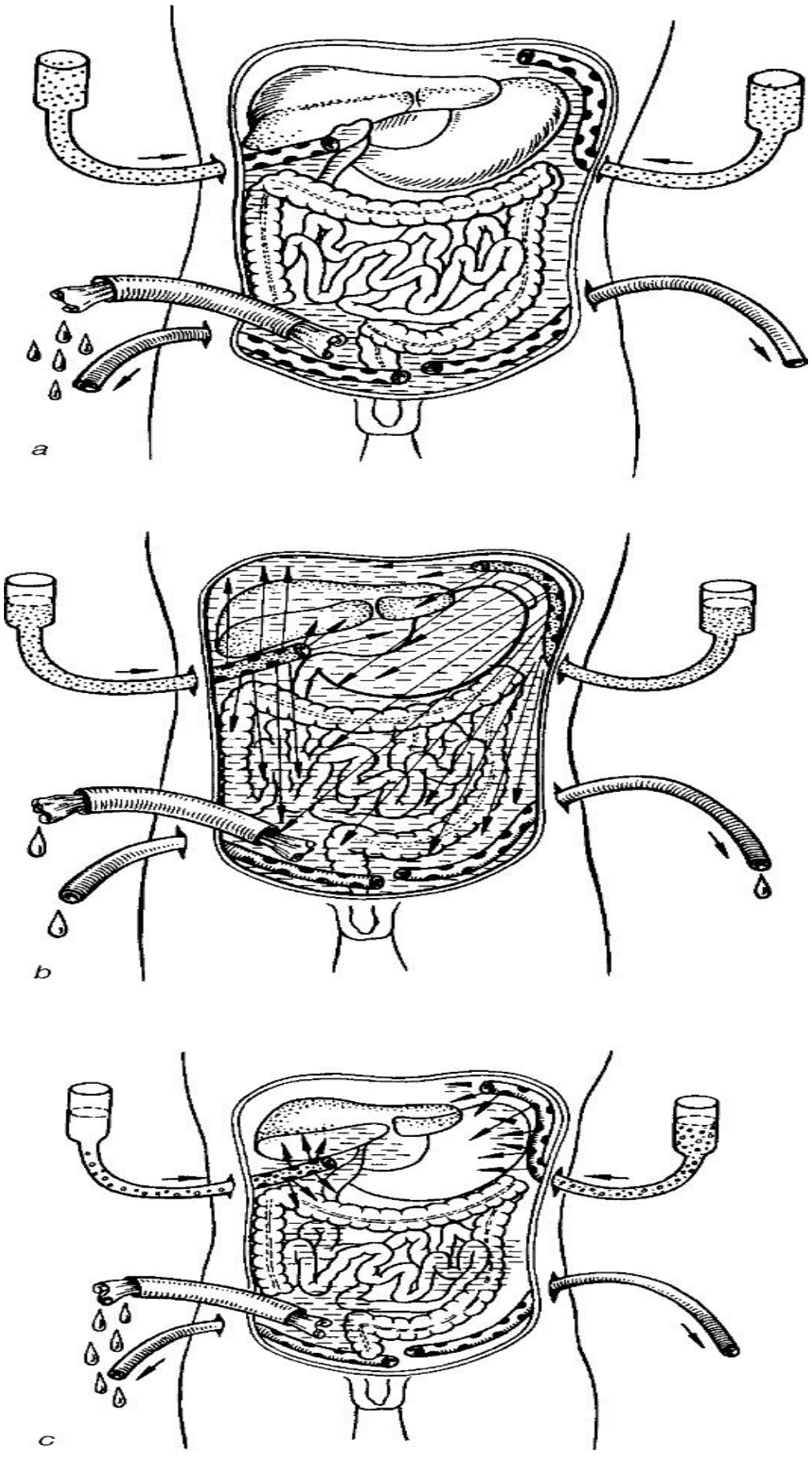


Fig. 115. Peritoneal lavage: *a* - appropriate technique; *b* and *c* - inappropriate lavage as a result of a decrease in dialysate outflow.

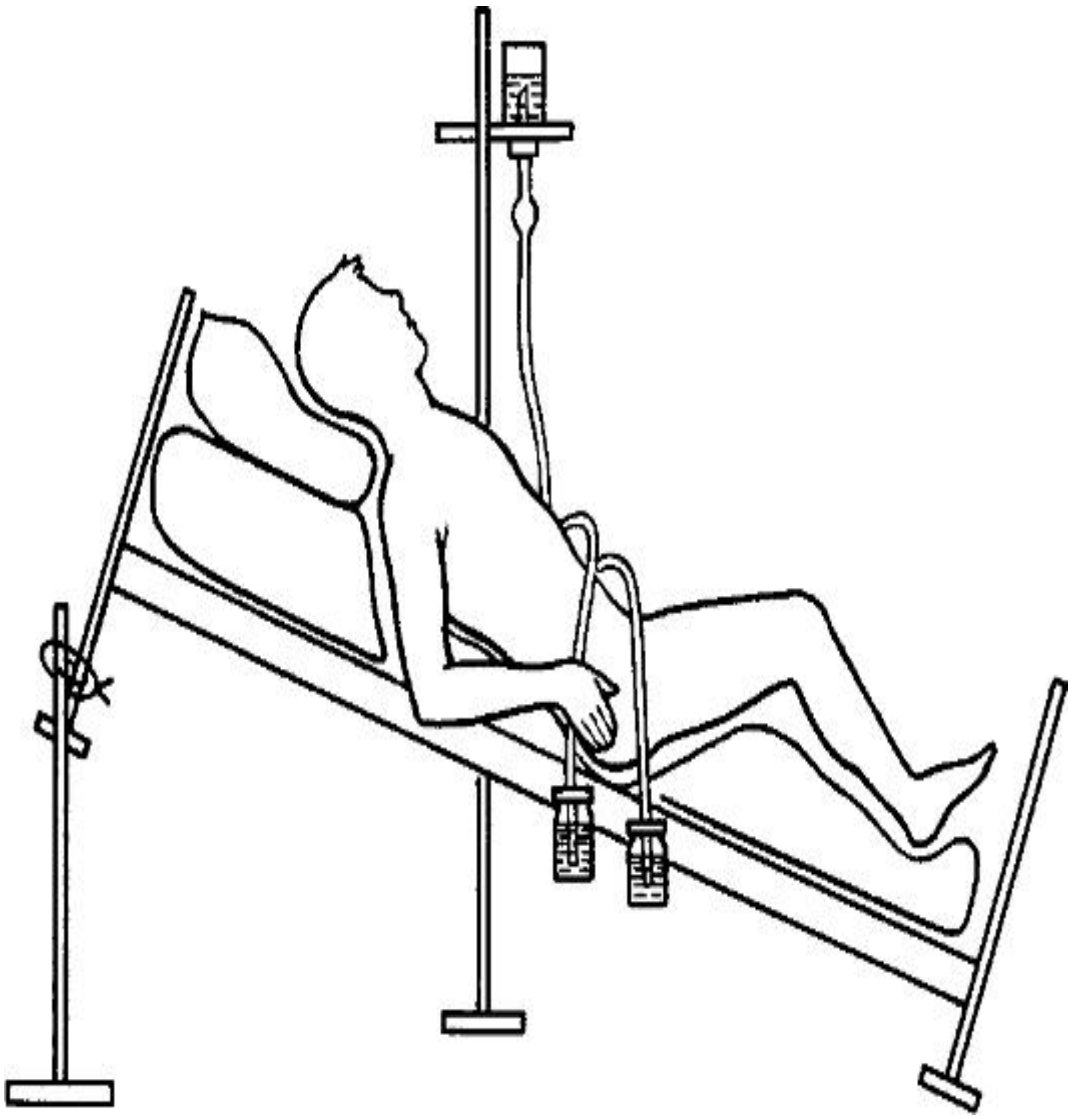


Fig. 116. The optimum patient's position during peritoneal lavage.

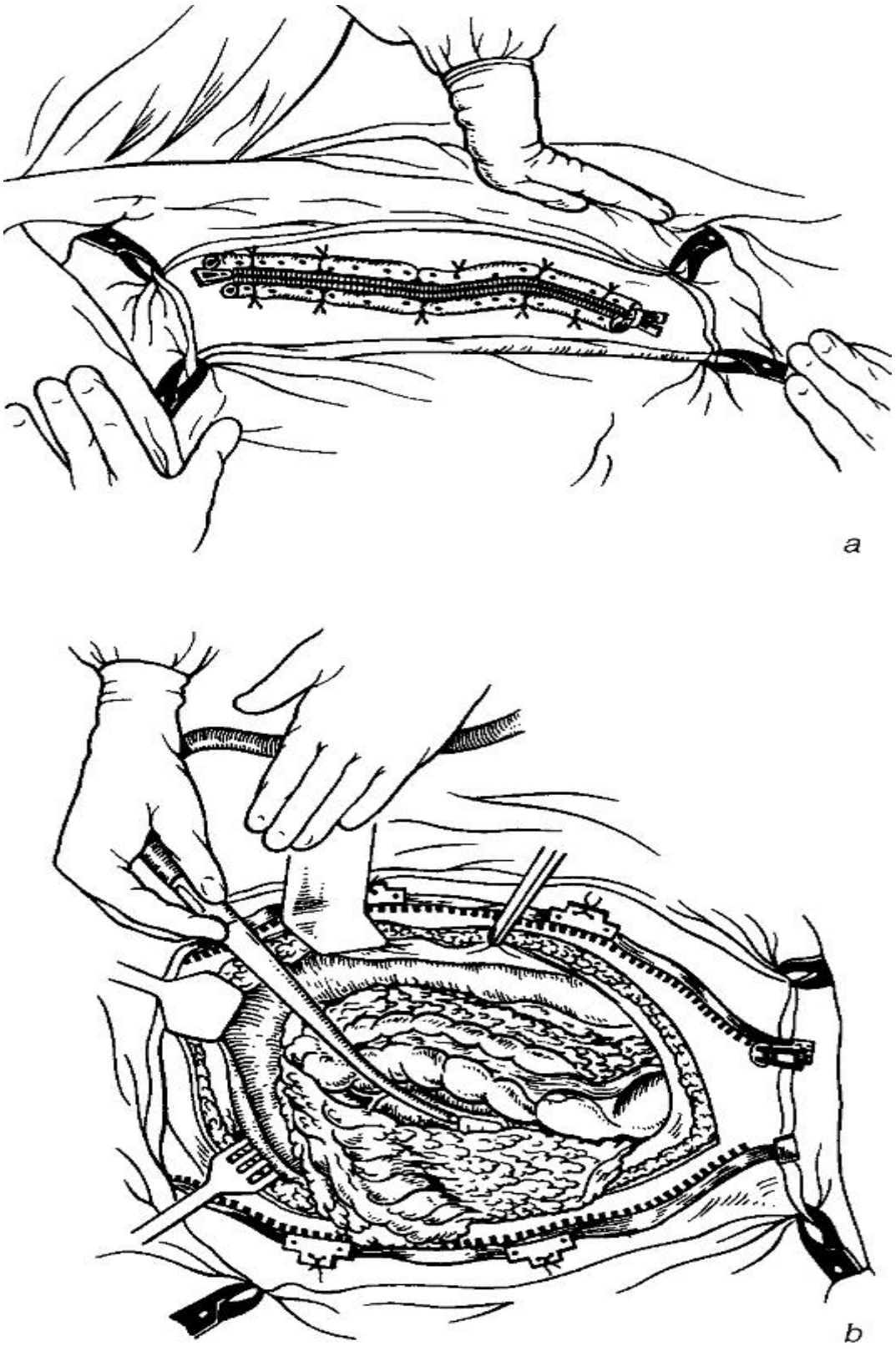


Fig. 117. Laparostoma *(a)* followed by elective (scheduled) cleaning the abdominal cavity *(b)*.

During the postoperative period before the intestinal functions are fully restored the patient is placed on complete parenteral feeding (ref. Chapter VI «Blood components, blood products and nutritional support»). As the intestinal functions are restored, the patient is gradually returned to enteral feeding. To ensure detoxication, blood substitutes with detoxication properties are given as well as forced diuresis, haemadsorption, plasmapheresis etc. are used.

11.8 ACUTE SUPPURATIVE PLEURISY (PLEURAL EMPYEMA)

Suppurative (purulent) pleurisy (pleural empyema) is the suppurative inflammation of the parietal and visceral pleura that is associated with local changes and intoxication.

Classification

1. According to the *etiology:* streptococcal, pneumococcal, staphylococcal, diplococcal, mixed etc.

2. According to the *pus distribution:* free-total, average, minimal, encapsulatedsingle or multiple chambered (basal, attached to the pleural wall, paramedisternal, interlobar, and apical).

3. According to the *character of the pathological changes:* acute suppurative, ichorous, puruloichorous, pyopneumothorax and hemopyothorax.

4. According to the *presenting clinical features:* acute and chronic.

Supurative pleurisy is a secondary disease (fig. 118) that often occurs as a complication of infectious processes in the lungs - croupous or postinfluenzal pneumonias. Para and metapneumonic suppurative pleurisy are identified. Parapneumonic pleurisy is a complication of pneumonia at the height of the disease process whereas metapneumonic or postpneumonic occurs after the pneumonia has resolved. Metapneumonic pleurisy is more common than parapneumonic and is mostly associated with the development of seropurulent or purulent effusions. Contamination of the pleural cavity can occur through lymphogenic or haematogenous spread from non-pulmonary sources of infections (suppurative appendicitis, suppurative cholecystitis, pancreatitis, retroperitoneal phlegmon etc.). This type of infection occurs rarely and starts with the formation of serous effusions which later change into seropurulent and purulent. The most common cause of purulent pleurisy is acute lung abscess. Contamination of the pleural cavity in such a situation is by direct contact, lymphogenic or through the rupture of the abscess into the pleural cavity with formation of pyopneumothorax. Primary suppurative pleurisy occurs from penetrating chest injuries.

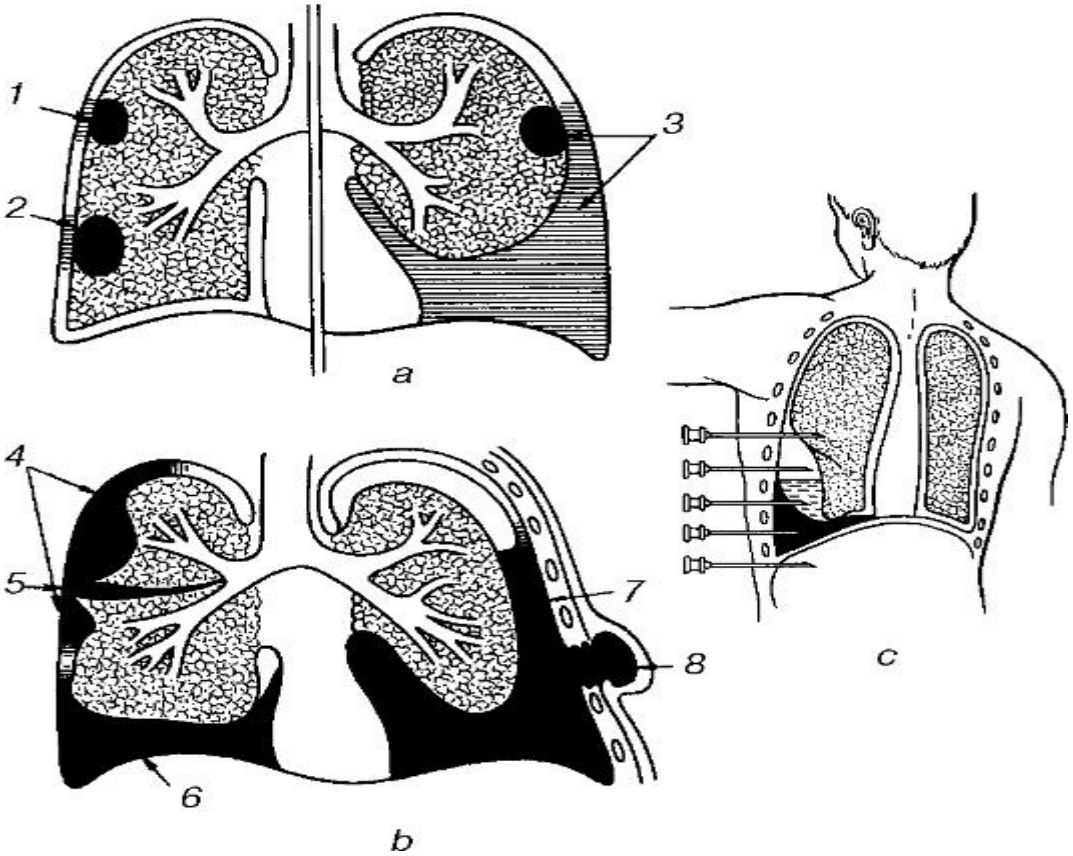


Fig. 118. Purulent pleurisy: thoracic empyema (a, b); pleurocentesis, typical errors (c).

1-3 - superficial pulmonary abscesses with pleural adhesions; *4* - sacculated empyema; *5* - interlobular empyema; *6* - diaphragmatic empyema; *7* - pyopneumothorax; *8* - empyema necessitatis.

Acute suppurative pleurisy is divided into primary and secondary: according to the *pus distribution* - free (total, average, minimal), encapsulated (single or multiple chambered, interlobar, and apical); according to the *character of the exudates:* purulent, ichorous, puruloichorous.

The *clinical presentation* of the disease features:

1) symptoms of the main disease that gave rise to pleurisy;

2) signs of suppurative intoxication;

3) symptoms resulting from the accumulation of fluid into the pleural cavity.

Patients with suppurative pleurisy *complain* of pains in the side of the chest, cough, a feeling of fullness or heaviness in the side, difficulty in breathing, being unable to inhale deeply, dyspnea, a rise in body temperature and weakness. Chest pains are more intense at the onset of the disease, are felt as piercing and as the disease progresses and more fluid is accumulated, pain reduces and there is a feeling of heaviness in the side. Dyspnea gradually worsens. Cough as a rule is dry, but when the process is secondary to lung abscess or pneumonia, mucous or purulent sputum is coughed out, sometimes in large quantities. When pleurisy sets in, the character of cough changes from that in the original disease; cough becomes more persistent, violent, disturbing the patient mostly in the night, it may become paroxysmal and tends to increase on lying on the affected side.

Dyspnea can be extreme, increasing like the pain when the patient sleeps on the healthy side. Therefore, the patients are forced to sleep on the sick side, which makes breathing easier and reduces the chest pains.

Body temperature rises to a high level (39-40 °C), and is of constant or hectic character. Pulse rate reaches 120-130 beats/min, which indicates both suppurative intoxication and a shift of the heart and mediasternum vessels to the healthy side as a result of the fluid accumulation.

The *rupture of a lung abscess* situated beneath the pleura with the entry of pus and air into the pleural cavity is associated with the development of pleural shock. The rupture is preceded by a strong persistent cough that ends with the appearance of intense sharp pain in the side of chest. The patient cannot breath in deeply; the face becomes pale and is covered by cold sweat. Pulse is rapid and weak, blood pressure decreases. Breathing is shallow and fast because of the extreme pain, there is acrocyanosis and dyspnea worsens. The reason for this serious clinical picture is the pleural irritation, which causes pain, the pressure on the lungs exerted by pus and air, the shift of organs in the mediasternum to the healthy side with its accompanying disturbance of cardiac functions. After the acute phase has subsided and the patient has been helped to overcome shock, intoxication develops; this intoxication is more severe than those which occur during parapneumonic and metapneumonic empyema of the pleura.

As this condition being secondary to an inflammatory process elsewhere in the body so, at the time of anamnesis investigation one should take note of functional disorders that occurred during the original disease: chest pains located at the sides, change in the character of cough, difficulty in inhalation, a rise in body temperature, increasing weakness, malaise or the appearance of a sudden sharp pain in the side of chest.

General *examination* of the patient reveals pallor, dyspnea, and uncomfortable position in bed - half-sitting or on the side. Sometimes the patient is found to be pressing on the side, which reduces the pain on inhalation. Breathing rate increases to 20-25 and in extreme cases to 30-40 per min.

Inspection of the chest reveals limitations in the breathing excursion of the chest with the sick side impaired or even not taking part in the process. When large amounts of fluid are accumulated in the pleural cavity, a swelling in the posterior lower parts of the chest is found and the intercostal spaces are filled up. Palpation of the intercostal spaces causes some tenderness. Tactile fremitus on the affected side is reduced or is not determined at all.

Percussion of the chest reveals dullness in the percussion note over the areas of accumulation, in total pleural empyema there is dullness over the whole half of the chest, in case of large amounts of accumulation (but not total), the upper level of dullness is located on the C-shaped Ellis-Damoiseau's line. In this situation the Garland's triangle and Grocco's-Rauchfuss' triangles are determined. Percussion also reveals the shift of the mid dullness towards the healthy side, which indicates the shift of the mediasternum exerted by the accumulated fluid in the pleural cavity.

Auscultation reveals a marked decrease in breath sounds or their total absence over the areas of accumulation.

Blood tests show leucocytosis, a shift of the leukocyte formula to the left and a high ESR.

Body temperature increases to 38-40 °C, and is of a constant or remittent hectic nature.

X-ray examination (roentgenoscopy and roent-genography) is done to determine the presence of fluid in the pleural cavity. The x-ray shows the amount and location of the fluid. At the beginning of the disease fluid accumulation is at the posterior lower parts of the pleural cavity - in the costodiaphragmal sinus, as the fluid increases, the shadow over the lung field increases as well. In hydrothorax, the fluid accumulation in a pleural effusion has a C-shaped border and never assumes a horizontal level. In pyopneumothorax a free layer of gas is evident over the horizontal level of fluid in the pleural cavity.

These physical and x-ray investigations help to establish the correct diagnosis of pleural effusion. The increased body temperature as well as severe intoxication; changes in the blood picture (leucocytosis and a high ESR) are all signs of the development of suppurative pleurisy. To confirm the diagnosis of suppurative pleurisy, determine the causative agent and carry out the proper antibacterial therapy a diagnostic puncture of the pleural cavity is performed.

The *point for puncture* is chosen at the area of maximum tenderness, a typical point is in the eighth or ninth intercostal space in-between the scapular and posterior axillary lines. In limited and encapsulated pleurisy, small amounts of fluid accumulations, the puncture point is determined together with the radiologist during the roentgenoscopy investigation.

A 20 ml syringe and 0,5, 1 and 2 mm diameter needle, a three-way cock, a 0,5% solution of Novocain are needed for the puncture. The procedure is similar to that for surgery: the hands are scrubbed, and sterile gloves are used. The patient is put in the sitting position on a table with the trunk slightly bent and the back out. The nurse or assistant stands in front of the patient and holds him in position. The back is cleaned with antiseptics; using a small needle the skin and the deep lying tissues are anesthetized. The needle is then changed for a bigger one (1-2 mm), the skin is pierced, displaced slightly to the side, and the needle is pushed along the upper side of the lower rib sending forth a jet of Novocain. A sure sign of the needle being inside the pleural cavity is the fact that it no longer encounters any resistance as it did when piercing the parietal pleura. The aspiration of a purulent fluid confirms the diagnosis of pleural empyema. Some pus is collected into the syringe, the three-way cock is closed at the needle and the syringe disconnected, the contents are put into a tube and sent for laboratory and bacteriological investigations, evacuation of the fluid is then continued until a negative pressure appears in the syringe.

Treatment. Treatment of suppurative pleurisy involves the evacuation of pus, fighting the infection, detoxication therapy and the restoration of impaired organ functions.

The prompt eradication of foci of suppurative pleural infection and the expansion of collapsed lungs helps to achieve the main aim of treatment - restoration of the close contact between the visceral and parietal pleura and their union. The subsequent obliteration of the suppurative cavity leads to healing of the patient. The earlier treatment is started for a pleural empyema the better the outcome, since in that way irreversible changes do not have time to develop in the collapsed lung, nor does thick fibrous deposition (pleural plagues) have a chance to form in the inflamed pleura. In the presence of this thick fibrous layer (plagues) the lung cannot fully expand and some amount of space with thick walls is left over in between the pleura, which results in the acute process turning into a chronic one.

The main method used to treat a pleural empyema is the closed method, during which the pleural cavity is not opened. In the open method the chest is opened through a wide incision for the evacuation of pus and fibrin deposits and plagues (decortication).

The closed method of treatment of pleural empyema includes therapeutic puncture and drainage of the pleural cavity by way of pleural taps through the chest drainage tube. The drainage tube can also be passed through the bed of a resected rib, suturing the surrounding soft tissues around the tube to create an airtight condition (fig. 119, 120).

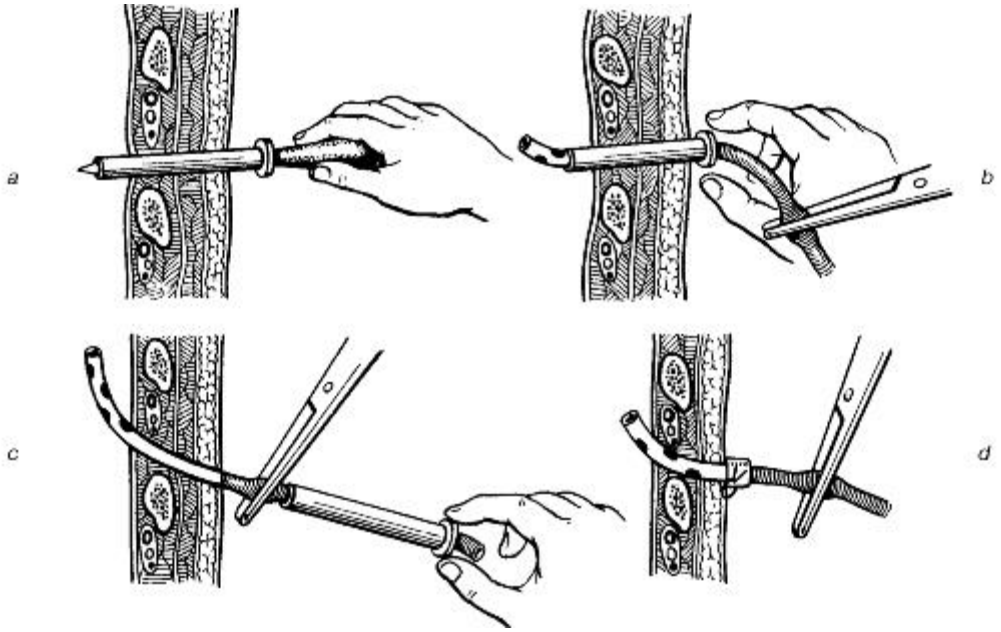


Fig. 119. Pleural drainage using a trocar: *a* - pleurocentesis; *b* - insertion of the drain through the trocar's cannula; *c* - removal of the trocar's cannula; *d* - fixation of the drain.

Treatment of suppurative pleurisy is started with a pleural tap. It is a must to do it under local anesthesia. A wide bore needle (1 - 1,5 mm) has to be used; a three-way cock is necessary as well as a rubber tube with a clamp to close the needle when the syringe is disconnected. This helps to prevent pyopneumothorax, which can result from the entry of atmospheric air into the pleural cavity. The evacuation of pus, especially in the case of massive effusion should be done gradually, so as not to cause the development of hyperemia ex vacuo and a sharp shift of the mediasternum. This can lead to the development of shock.

Evacuation of the fluid is continued until a negative pressure appears in the syringe (when drawing back the piston, fluid does not appear and when the syringe piston is released, it returns to its original position). Pleural drainage is completed by the infusion into the cavity of proteolytic enzymes and antibiotics. Puncture is repeated daily.

When the first puncture is not successful, active constant aspiration of pus from the pleural cavity can be employed. Permanent drainage tubes are placed into the pleural cavity. To achieve this the skin is first anesthetized, scalpel is used to make a stab incision in the skin, a wide trocar is pushed into the pleural cavity through the intercostal space, the stylet is removed

and the drainage tube is passed through the trocar into the cavity, whereupon the trocar is also removed. The drainage tube is fixed to the skin either by sutures or adhesive plaster and the tube connected to a closed drainage system at a constant vacuum of 50-100 mm of H_2O, using the flowing water system or an electric aspirator. Pus from the pleural cavity is evacuated constantly and with the help of the negative pressure the two pleural layers unite and stick together, thereby eliminating the suppurative cavity (fig. 121).

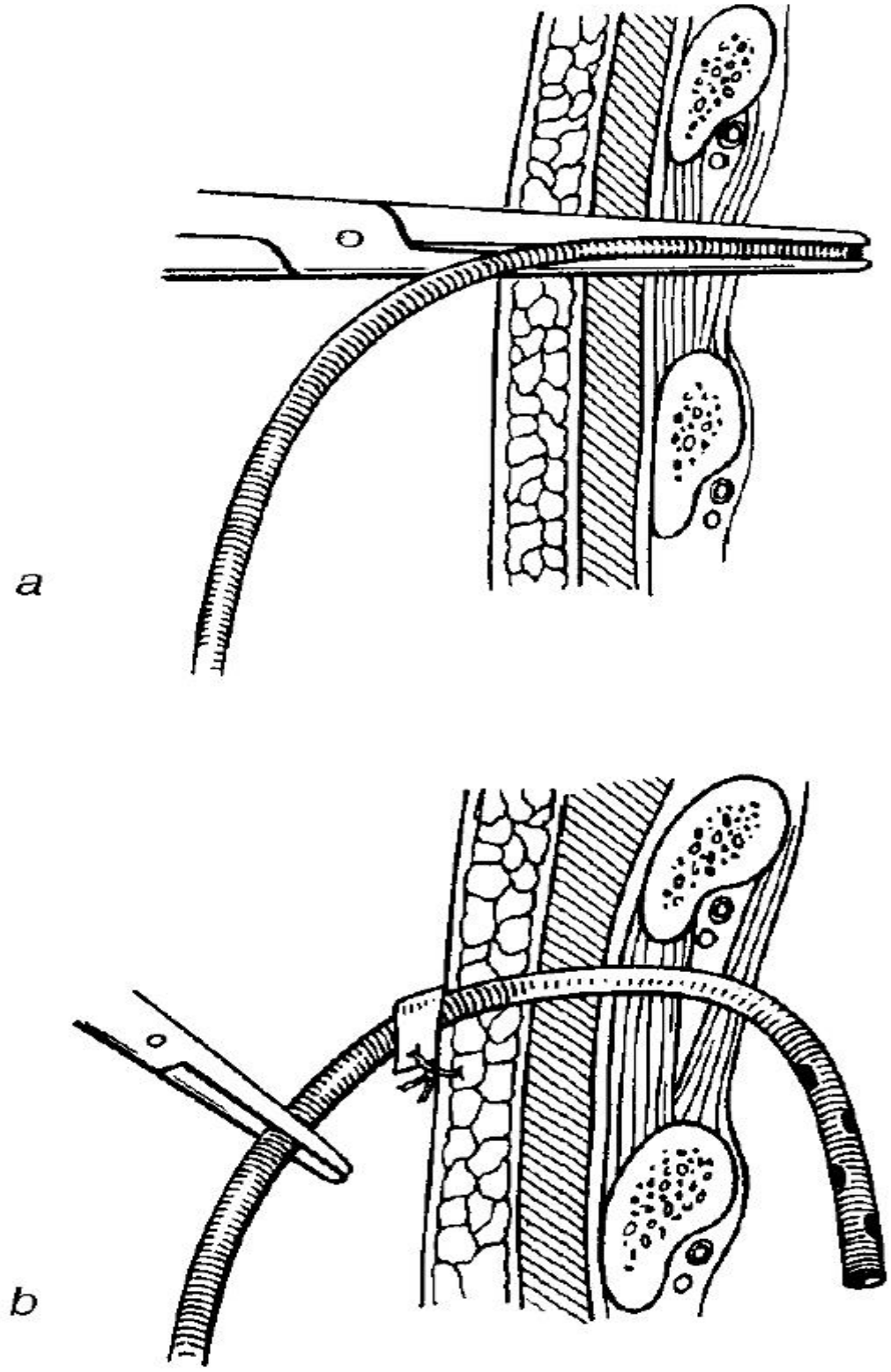


Fig. 120. A type of closed pleural drainage in purulent pleurisy: a - insertion of the drain using haemostatic forceps; b - fixation of the drain.

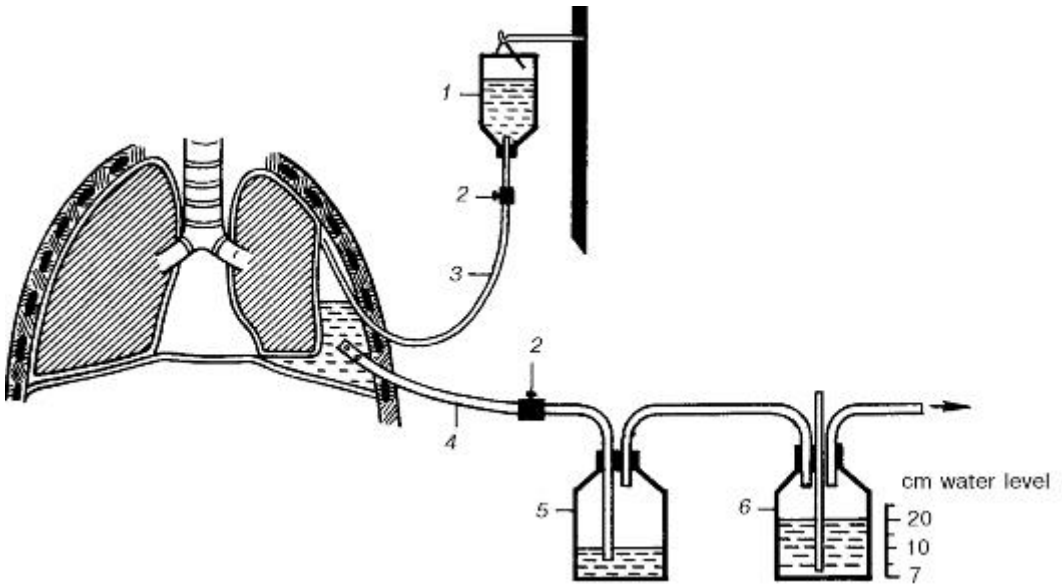


Fig. 121. Vacuum pleural drainage in purulent pleurisy: *1* - drainage solution; *2* - rack; *3* - through drain; *4* - suction drain; *5* - vessel for exudate; *6* - water vacuummeter; *7* - the site for connection with VK1 compressor.

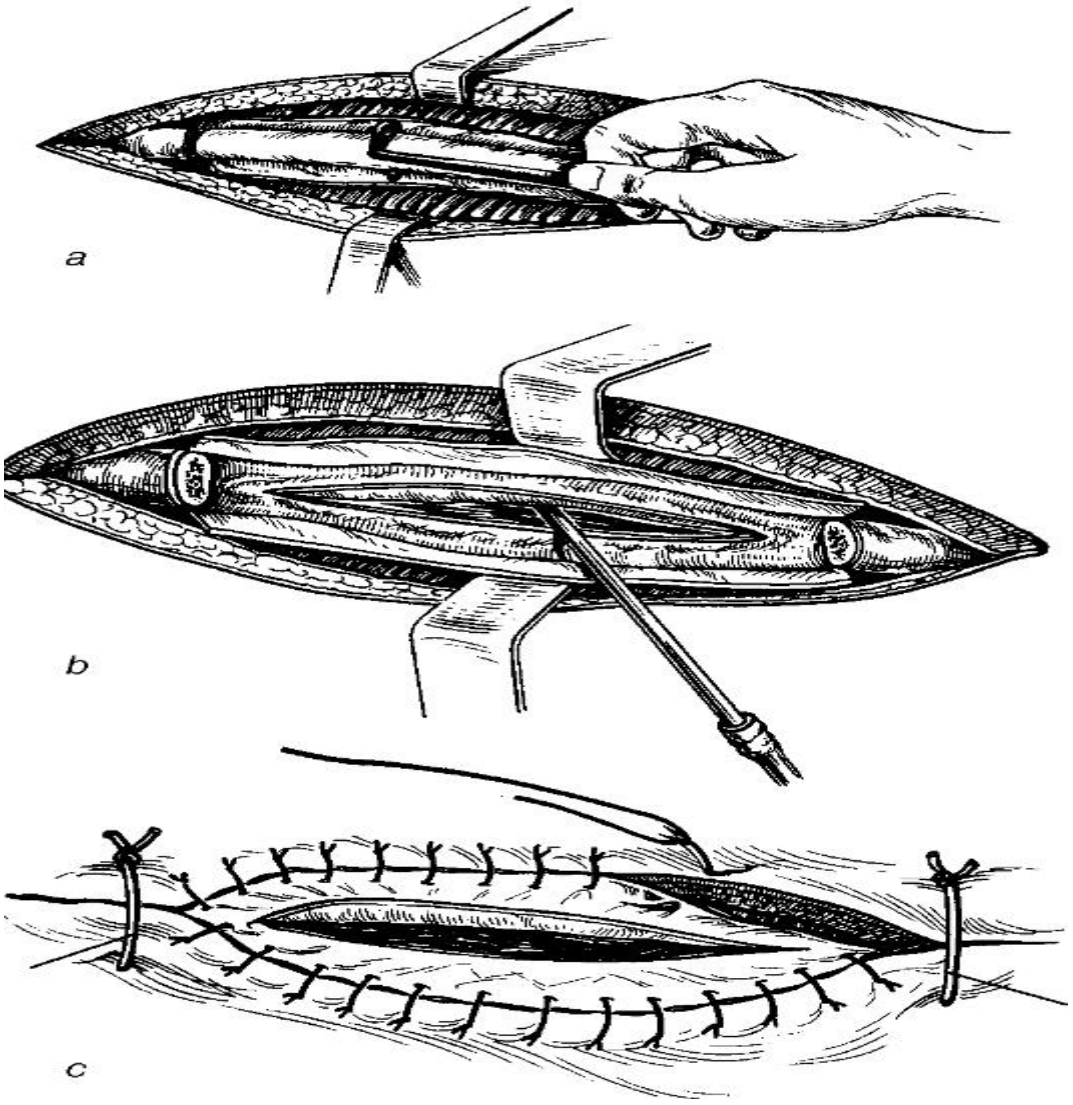


Fig. 122. Thoracostomy: *a* - subperiosteal resection of the rib; *b* - dissection of the resected rib's bed followed by opening the pleural cavity and suction of pus; *c* - making the

thoracostomy followed by suturing the periosteum with cutaneous wound margins. The costal ends are covered with the periosteum and soft tissues sewn with removable sutures through all the layers of the wound (1, 2).

When it is not possible to provide for a constant drainage, a valve made of glove rubber is slipped over the tip of the drainage tube, which is then placed into a bottle with antiseptic (Buelau's method of siphon drainage). The valve allows pus and air (in case of pyopneumothorax) to flow into the bottle, and closes when there is a negative pressure in the pleural cavity, preventing air and fluid back into the pleural cavity during inhalation.

In rare cases when the closed method is ineffective, the open method is applied - thoracotomy for the evacuation of the thick pus, fibrin, sequestra of lung tissue which cannot be removed through the needle or drainage tube (fig. 122).

11.9 SEPSIS (GENERALIZED SUPPURATIVE INFECTION)

This is a severe secondary infectious disease caused by polymicrobial strains with a peculiar response of the body and clinical picture.

Classification

1. According to the *etiology:*

a) staphylococcal,

b) streptococcal;

c) pneumococcal;

d) gonococcal;

e) colibacillar;

f) anaerobial;

g) mixed.

2. According to the *source:*

a) traumatic;

b) from internal infections (tonsillitis, pneumonia etc.);

c) postoperative;

d) cryptogenic.

3. According to the *location* of the primary focus:

a) gynecological;

b) urological;

c) otogenic;

d) odontogenic etc.

4. According to the *clinical* picture:

a) fulminant;

b) acute;

c) subacute;

d) recurrent;

e) chronic.

5. According to the *time* of development:

a) early (developing up to 10-14 days from the onset of disease or from the time of injury);

b) late (developing after 2 weeks).

6. According to the reaction of the patient's organism:

a) hyperergic form;

b) normal reaction (normergy);

c) hypergic form.

Sepsis is an overwhelming suppurative infection seriously aggravating the course of local suppurative inflammatory processes. Sepsis is caused by different infectious agents and their toxins presenting in the form of peculiar reactions of the organism without any specific features.

Patient complaints differ and do not always reflect the severity of the condition. In eliciting the complaints it is important to take special note of any increase in the body temperature, its pattern within 24 hrs; the presence of chills, duration and recurrence. The patient's general condition has to be assessed as well as his appetite and psychological state (euphoria or apathy).

On inspection the patient is found to be fatigued, sometimes apathetic to his surroundings. The face initially is hyperemic with glowing cheeks, but after a few days it becomes pale. Pallor of the face is more pronounced during the episodes of chills. In severe cases the face is marked by sunken cheeks and hollow eyes.

In acute sepsis, icterus (jaundice) of the sclera sets in very fast followed by the skin and visible mucus layers. The skin becomes dry and sometimes covered with sticky sweat. Profuse sweating interchanging with strong chills can be very intensive, and patients have to change their clothing several times in the day. In some cases one can find petechial hemorrhagic spots or marks on the skin of the internal surfaces of the forearm and leg.

Herpes on the lips occurs quite often as well as an increased bleeding tendency of the gums and mucus membranes in the mouth. There can be bleeding spots on the conjunctiva of the eyes, the lips as a rule are pale and in severe cases cyanotic. In critical cases there is difficulty in breathing: the nasal alae are blown out and the neck muscles are tense.

In some cases an area of infiltration appears over the skin with the skin over them hyperemic, which is an indication of the development of metastasis of the suppurative infection in septicopyemia. Pressure points on the skin (the sacral region, scapula, spinal processes of the vertebrae and the ischial tubercle) are found to be very hyperemic, pale or even necrotic, which indicates an incipient or an already developed bedsore which appears rather too early in patients with sepsis.

The increase in body temperature is a common feature of sepsis. At the beginning or during the peak of the disease the body temperature pattern is of three types: 1) remitting, in which the difference between the morning and evening temperatures is 2-3 °C, this is evidenced in septicopyemia (sepsis with metastasis); 2) constant fever, when the temperature is persistently high and the difference between the morning and evening temperatures is 0,5 °C rarely 1 °C, it occurs in septicemia; 3) wave-like fever in septicopyemia: the period of subfebrile temperature after incision and drainage changes into a high temperature rise of up to 39-40 °C, which indicates the appearance of new suppurative metastasis. In longer lasting septic conditions and with the process moving into a chronic one the temperature pattern becomes irregular. The febrile period can continue for several days to a few months, in the terminal stages when the patient is debilitated by disease the body temperature usually becomes normal.

One of the constant symptoms of sepsis is chills. The appearance of chills corresponds to the massive entry into the blood stream of microorganisms and their toxins from the foci of

infection. The recurrence of chills differ: they can occur once a day, several times a day or reappear after several days. After the episode of chills there is normally a high increase in the body temperature. Profuse sweating is quite common in sepsis.

As a result of the intoxication of cardiac muscles (toxic myocarditis) the patients are found to have a rapid pulse rather early, as the process advances, the pulse volume reduces, tachycardia worsens, reaching 120-140 beats per min. tachycardia persists long after the temperature has dropped to normal or even subfebrile. Arterial and venous blood pressure drops, especially sharply in septic shock, as a complication of the sepsis. Heart boundaries enlarge, heart sounds become dull and murmurs appear at the apex. Murmurs in the heart are transitional and disappear after the patient has recovered. If ulcerative endocarditis sets in, the heart murmurs become permanent.

In septicopyemia, suppurative metastases occur in the lungs leading to a quick development of lung abscess or gangrene of the lung. This is most often associated with diffuse bronchitis and hypostatic pneumonia (as a result of the inadequate lung ventilation). Examination of the patient reveals a rapid breathing rate (sometimes up to 30-50 per min), cough with scanty amounts of mucus or mucopurulent sputum, and in the case of an abscess complicating pneumonia, the cough is productive of massive purulent sputum. Percussion note is dull over the lung and on auscultation - breath sounds are reduced, crepitations and moist bubbly rales are heard in accordance with the existing pneumonia.

Patients with sepsis suffer insomnia, and often underestimate their critical state and seem not to be much concerned about their condition, in some instances, however, there is euphoria. In cases of very high body temperatures and serious chills patients look anxious and delirious. Sometimes they are confused and can develop acute psychosis.

Examination of the GIT reveals loss of appetite, nausea, belching and sometimes diarrhea, which results from the development of stomach acidity (achillia), reduced pancreatic function, the depression of enteritis or colitis. There can be sometimes gastric or intestinal bleedings in the form of bloody vomitus or melaena (tarry) stools.

The oral cavity inspection reveals dry tongue covered with brown or grey fur or crimson in colour, often with hemorrhagic gums. In long - lasting cases there are cracks on the tongue edges. Jaundice of the skin and the eye in sepsis is not a common occurrence (affecting every fourth patient), but increased serum bilirubin is common. Palpation reveals an enlarged liver with the edges below the costal margin, tender firm in hepatitis and soft flaccid in fat dystrophy. In long - standing sepsis the patient can develop cirrhosis of the liver.

Abdominal palpation of the patient with sepsis reveals an enlarged tender spleen that is initially soft but turns to firm as the disease progresses.

In the case of traumatic sepsis an initially red bright and healthy granulation tissue becomes pale, friable, watery and bleeds easily on touch. Wound epithelization stops. Wound discharge is scanty, seropurulent and sometimes dirty brown with offensive odour. Oedema of the surrounding tissues worsens: wound edges get puffy with palebluish colouration. This condition is usually accompanied by lymphangitis, lymphadenitis and thrombophlebitis.

Changes in the blood picture are a constant feature. The patient quickly becomes anemic: within a few days after the onset of disease hemoglobin level falls to 70-80 g/l, at the same time the amount of erythrocytes drops to $3x10^{12}$/l and below, there is anisocytosis and poikylocytosis. There is a change in the composition of leucocytes: neutrophilosis is often in the range of 8-$15x10^{9}$/l, sometimes up to $20x10^{9}$/l. Lymphocytes and eosinophyles decrease up to aneosinophylia. The appearance of immature elements and myelocytes in the leukocyte formula with a simultaneous increase in toxic granules of neutrohiles and aneosinophylia are an unfavourable prognostic sign. ESR increases to 60-80 mm/hr with minimal or average leucocytosis.

Hypoproteinemia proceeds at a fast rate: protein content is less than 70g/l and in severe cases as low as 60-50 g/l and below, albumin reduces to 30-40%, globulin levels increase mainly through the α_1 and α_2 fractions.

Respiratory insufficiency and the metabolic disorders in the organism lead to the imbalance in the acid-base state of blood and the development of acidosis. Changes occur in the clotting and anticoagulation properties of blood: prothrombin and fibrinogen levels decrease while the fibrinolytic activity of blood plasma as well as that of heparin increase. The blood changes that are found on laboratory investigations are actually not specific to sepsis alone, but when these results are used in complex with the presenting clinical picture, they facilitate the establishment of the correct diagnosis and help to assess the severity of the condition.

Bacteremia is not a constant feature of sepsis but it occurs very often (in about 90% of cases). Blood specimens for culture have to be taken several times and at different times of the day at the height of fever. Urine, sputum, wound secretions or contents of serous cavities also have to be sent for bacteriological investigations. The isolation of microorganisms from blood is an important diagnostic feature of sepsis. However, a negative blood culture result does not rule out the diagnosis of sepsis. Urine investigation shows a low specific gravity, the presence of proteins, cylinders, leucocytes and bacteria, which increase as the disease progresses.

The transition of a local suppurative process into septic is not always easy to establish. The beginning of sepsis can take different forms: the incubation period can be very short or take several days. Fulminant sepsis starts suddenly often with severe chills. Acute sepsis is often preceded by general body weakness (fatigue), headache, pains in the muscles and joints that can persist for 2-3 days. The rise in body temperature can either be of a constant nature or sudden and associated with chills.

The main clinical and laboratory signs of sepsis.

1. Acute or subacute development of the disease in the presence of a primary focus (suppurative disease, wound, surgery).

2. High body temperature, hectic or constant, with chills and profuse sweating.

3. Progressive worsening of the patient's general condition, pronounced general clinical presentations compared to minimal local features in the primary focus (wound, mastitis etc.), despite the vigorous therapeutic measures (liquidation of the focus of infection, incision and drainage etc.).

4. Cardiovascular disorders (weak pulse, tachycardia, low blood pressure); divergence between the pulse rate and body temperature (rapid pulse with minimal rise in body temperature).

5. Progressive weight loss and anemia.

6. Yellowish colouration (icterus) of the skin and sclera; enlarged liver and spleen.

7. Characteristic changes in the wound (septic wound).

8. High ESR with normal or minimal increase in the leucocytes and neutrophils and a shift of the leukocyte formula to the left, lymphopaenia.

9. Kidney dysfunction (low specific gravity, protein cylinders and blood cells in urine).

10. Periodic watery stools or diarrhea.

11. Early development of trophic disorders (bed sores).

12. Bacteremia.

In *fulminant sepsis* symptoms develop and progress very fast. The primary foci in these cases are often furuncles and carbuncles of the face, the patient quickly develops oedema of the face, and the eyes are closed as a result of oedema of the fatty layers on the side of the

suppurative focus. Patients develop severe chills; temperature increases to 39-40 °C, leucocytosis with a shift to the left. Patients are found to be agitated but soon become lethargic, on the 2nd-3rd day they lose consciousness; there is extreme tachycardia (pulse rate up to 120-140 beats per min).

Acute sepsis that presents as septicemia is characterized by sudden onset in the presence of a primary focus, as in fulminant sepsis. The patient's body temperature increases, chills develop, anemia worsens at a fast rate, there is leucocytosis, the liver and spleen enlarge. Blood culture shows the presence of microorganisms.

When secondary (metastatic) suppurative foci appear (on the skin, or subcutaneous layers, rarely in the lungs) at the beginning of acute sepsis or septicemia in the presence of a primary suppurative focus, then this should be taken as evidence of septicopyemia.

The presence of a *primary focus* is an indispensable condition for the diagnosis of sepsis. In the presence of corresponding clinical features but the absence of any primary focus, in order to establish the diagnosis of sepsis, acute infectious diseases have to be excluded (typhoid, paratyphoid, tuberculosis, brucellosis, tularemia) or other systemic diseases (collagen diseases), diseases of the blood, lymphogranulomatosis etc.

The *constant symptoms* of sepsis are: the increase in body temperature, leucocytosis with a shift to the left, progressing anemia, tachycardia, decrease in blood pressure, chills, profuse sweating.

Clinical features of diseases with similar presentations as sepsis in the presence of a primary suppurative focus (acute suppurative diseases of the soft tissues, purulent diseases of serous cavities - pleurisy, peritonitis, infected burns, infected wounds) may be evident in purulent absorption fever.

Purulent absorption fever - This is caused by suppuration and the absorption from the purulent foci of products of purulo-ichorous tissue disintegration and accompanies all types of suppurative inflammations. Absorption enhances the formation of suppurative accumulations and pockets leaving in the focus nonresolvable necrotic tissues, crushed tendons, fascia, muscles, bone sequestra and foreign bodies - bullets, missile fragments, pieces of clothing etc. In such conditions granulation boundary that normally prevents absorption fails to develop around the spread and accumulation of pus in the tissue spaces.

Unlike sepsis the intensity of suppurative absorption fever corresponds to the severity of the suppurative infectious process, there is a direct relationship between them: the fever subsides when the purulent focus is liquidated. The main clinical features of suppurative (purulent) absorption fever are the temperature reaction, the character and nature of which are not constant and nonspecific.

The prevention of suppurative absorption fever consists largely in the early surgical treatment of pyogenic infections - elimination of focus of infection, incision and drainage, adequate primary surgical wound debridement and the correct timing of drainage of pockets of pus etc.

Bacterial - toxic shock - this is sometimes referred to as septic shock. It can occur as a complication of sepsis at any of its stages of development. Bacterial - toxic shock is an altered reaction of the organism to the entry into the bloodstream of pyogenic microorganisms or their toxins. Initial signs of bacterial - toxic shock are high body temperature (up to 40-41 °C), terrific chills, which interchange with profuse sweating and a reduction of the temperature to normal or subfebrile. Changes in the psychological status of the patient (restlessness, motor agitation and sometimes psychosis) appear early in the disease process and are accompanied by the decrease in blood pressure and oliguria or even preceding them. Pulse is fast (up to 120-150 beats per min) and weak, arrhythmia is often found with a low blood pressure. The skin is pale, with

acrocyanosis; breathing is fast (up to 30-50 per min). Changes in the urine output set in very fast as evidenced by progressing oliguria.

Treatment. Treatment of sepsis must be based on underlying etiologic and pathologic factors.

Primary suppurative *focus* (the entry point) plays not only the initial but also supportive role. *Surgical treatment* of suppurative foci (abscess, phlegmon, infected wounds) involves the surgical debridement: a thorough excision of dead tissues, incision and drainage.

Antibiotic therapy in sepsis has the following peculiarities.

1. The use of maximal dosage of the preparations. Antibiotics of the second group (cephalosporins, semisynthetic aminoglycosides) are prescribed and if they are found ineffective, a quick switch is made to the tienam.

2. Combination of two antibiotics with different spectra of action or an antibiotic with one of the chemical antiseptics (nitrofuran, dioxidin, metronidazol);

3. Giving antibiotics according to the sensitivity of the isolated microorganisms to the intended drug and making corrections when necessary;

4. Combination of topical (intrapleural, endotracheal, intraosseous etc. depending on the location of the infection) and general (intramuscularly, intravenous, intraarterial) routes of administration of the antibiotics and antiseptics;

5. The duration of antibiotic therapy depends on the patient's condition (treatment is continued for two more weeks after the clinical recovery of the patient and after two negative blood cultures).

Detoxication therapy includes the use of haemodes and saline solutions. Efficient detoxicating is achieved by the method of forced diuresis. The amount of fluid infused (polyion solutions, 5% solution of glucose, polyglucin) constitutes 50-60 ml/kg a day in addition to 400 ml of haemodes. The amount of diuresis per day should be around 3l. To improve diuresis, lasix and mannitol are given. The absorption methods of detoxication are also used - hemoand lymph adsorption.

Transfusion therapy is achieved by using solutions that correct the imbalances in acid-base composition and electrolyte imbalance (1% solution of potassium chloride in alkalosis or 5% solution of sodium bicarbonate in acidosis), as well as protein preparations: amino acid solutions (aminon, aminozol, alvesin), protein, albumin, dry and native blood plasma. Anemia is treated by the transfusion of fresh frozen blood.

Nutrition of the septic patient should be balanced, containing different varieties of food and of high caloric value (4000-5000 kcal/day), with adequate protein content (1-1,5 g/kg per day) and vitamins. The patient's daily diet should contain a variety of fruits and fresh vegetables in adequate amounts. The patient with normal GIT functions should be fed enterally as much as the condition allows. In cases where it is impossible to feed enterally the patient should be placed on either full or partial parenteral feeding.

Specific acting preparations that are often used include antistaphylococcal and anticolibacillar plasma, antistaphylococcal gamma globulins, and pentaglobin. In case of cellular immune deficiency (a decrease in the absolute values of T lymphocytes) leukocyte mass from immunized donors is indicated. Passive immunization is indicated in acute sepsis. In chronic sepsis or during recovery from an acute sepsis, preparations for active immunization are indicated - anatoxin, autovaccine. Nonspecific immune therapeutic substances - lysocim, prodigiosan and thymalinum are also used.

Taking into account the role cytokines play in sepsis, interleukin - 2 (roncoleikin) is prescribed. Indications for its use are extremely low levels of T-lymphocytes.

Corticosteroids are used for substitution therapy after the hormone status has been assessed. It is only when sepsis has been complicated by the development of bacterial - toxic shock that corticosteroids are given in the first days; prednizolon - up to 500-800 mg stat, and then 150-50 mg a day for a short period (2-3 days). Corticosteroids in the usual therapeutic dosage (100-200 mg a day) are prescribed when there is some allergic reaction in the septic patient.

Considering the high concentrations of kininogens in sepsis and the role of kinin in microcirculatory disorders, inhibitors of proteolysis (gordox - 200,000-300,000 units a day or contrycal - 40,000-60,000 units a day) are included in the complex therapeutic measures.

Supportive measures include cardiac drugs, vascular drugs, analgesics, anticoagulants, substances that increase vascular permeability etc.

Intensive therapy of sepsis should be continued for a long time until the patient becomes very stable and hemostasis is restored.

TESTS

Chapter XI. SUPPURATIVE INFLAMMATORY DISEASES

Soft tissues

1. Therapeutic measures in furuncles are as follows:

1. Cleansing the surrounding skin with ethyl alcohol.

2. Pressing necrotic masses out and bandaging with 70% alcohol.

3. Injection of penicillin and novocain around the affected area.

4. Administration of oral sulphonamides.

5. Local ultraviolet irradiation.

Choose the right combination of answers:

A. 1, 3, 4, 5. B. 1, 2. C. 1, 2, 4, 5. D. 3, 5. E. 1, 2, 3, 4, 5.

2. The therapies of erythaematous erysipeloid localized in the shin are as follows:

1. Moist bandaging with furacillin.

2. Antibiotics IM.

3. Desensitization (dimedrol, calcium chloride).

4. Local ultraviolet irradiation.

5. Warm bath with the potassium permanganate.

Choose the right combination of answers:

A. 1, 2, 3. B. 2, 3, 4. C. 2, 3, 5. D. 1, 2, 3, 5. E. 1, 2, 3, 4, 5.

3. Therapy of acute serous mastitis includes which of the following:

1. Incision.

2. Prevention of lactostasis.

3. Fixing the breast with scarf bandage.

4. Antibiotics.

5. Retromammary novocain block with antibiotics and proteolytic enzymes.

Choose the right combination of answers:

A. 1. B. 1, 2, 3. C. 3, 4, 5. D. 2, 3, 4, 5. E. 1, 2, 3. 4, 5.

4. The preferable direction and site of incision when opening retromammary abscess should be:

A. Radial; the upper quadrant of the breast.

B. Semi-oval; the lower edge of the breast.

C. Radial; the lower half of the breast.

D. Semi-oval; the upper edge of the breast.

E. Circular; around the nipple.

Choose the correct answer.

5. The clinical signs of axillary hydradenitis are as follows:

1. Dense painful node.

2. Follicular pustule.

3. Creamy pus.

4. Necrotic centre.

5. Dense infiltrate.

Choose the right combination of answers:

A. 1, 2, 5. B. 2, 3, 4. C. 2, 3, 5. D. 3, 4, 5. E. 1, 3, 5.

6. The local increase in temperature is not typical of the following conditions:

A. Shoulder abscess.

B. Thigh phlegmon.

C. Knee joint tuberculosis.

D. Thumb felon.

E. Suppurative bursitis of the elbow joint.

Choose the correct answer.

7. The clinical signs characteristic of carbuncle are as follows:

1. Tender infiltrate.

2. Non-tender infiltrate.

3. Skin necrosis and pus pustules.

4. Necrosis with small haemorrhagic blisters.

5. Regional lymphadenopathy.

Choose the right combination of answers:

A. 1, 3, 5. B. 2, 3, 5. C. 2, 4, 5. D. 1, 3, 4. E. 1, 4, 5.

8. The clinical stages of erysipelas are as follows:

1. Erythaematous.

2. Bullous.

3. Phlegmonous.

4. Suppurative.

5. Necrotic.

Choose the right combination of answers:

A. 1, 2, 3, 4. B. 2, 3, 4, 5. C. 1, 2, 3, 5. D. 1, 3, 4, 5. E. 1, 2, 3, 4, 5.

9. Phlegmon of soft tissues in the stage of softening requires one of the following:

A. Local application of cold.

B. Extensive incision and drainage.

C. Puncture with subsequent bacteriologic culturing.

D. Warm compression.

E. Injection of novocain and antibiotics.

Choose the correct answer.

10. The direction of surgical incision in parotitis is one of the following:

A. Horizontal.

B. Parallel to the direction of the facial nerve.

C. Parallel to he mandible.

D. Perpendicular to the facial nerve.

E. Vertical.

Choose the correct answer.

Hand infection

1. Felon in the form of cuff-link is as follows:

A. Thecal with spreading of process to the hand.

B. Subcutaneous with spread of in the epidermis.

C. Paronychia.

D. Osteal felon with spread of process to the joint.

E. Aritcular felon.

Choose the correct answer.

2. The types of early felon that require puncturing both for diagnosis and treatment are as follows:

A. Cutaneous.

B. Subcutaneous.

C. Tenosynovitis.

D. Paronychia.

E. Osteal.

Choose the correct answer.

3. The risk of suppurative spreading onto the forearm is high in the following felons:

1. The I finger.

2. The II finger.

3. The III finger.

4. The intravenous finger.

5. The V finger.

Choose the right combination of answers:

A. 1, 3. B. 2, 3, 4. C. 1, 5. D. 2, 5. E. 1, 2, 3, 4, 5.

4. Subungual felon requires the following surgeries:

1. Oval incision by Klapp.
2. Perforation of the nail.
3. Semi-oval incisions.
4. Resection of the nail bed.
5. Removal of the nail plate.

Choose the right combination of answers:

A. 1, 4, 5. B. 2, 3, 4. C. 2, 4, 5. D 3, 4, 5. E. 1, 3, 5.

5. The clinical signs of paronychia are as follows:

1. Swelling of the cutaneous margin.
2. «Floating» nails.
3. Secretion of pus from under the cutaneous margin.
4. Suppurative fistula.
5. Extensive contracture of finger.

Choose the right combination of answers:

A. 1, 2, 3. B. 1, 3. C. 3, 4, 5. D. 2, 4. E. 1, 3, 4.

6. The local signs of tenosynovitis are as follows:

1. Throbbing pain.
2. Swelling of the entire finger.
3. The finger is extensively straightened out.
4. Fixation of the finger.
5. Painful sensation along the tendon on palpation with a probe.

Choose the right combination of answers:

A. 1, 2. B. 1, 2, 3. C. 1, 3, 4. D. 1, 3, 4, 5. E. 1, 2, 4, 5.

7. The cross (V-form) hand phlegmon is characterized by the following clinical signs:

1. Tenderness.
2. Hand dysfunction.
3. Localization of suppurative exudate in proximal area of the palm.
4. Localization of suppurative exudate in the distal areas of the palm.
5. Extensive contracture of fingers.

Choose the right combination of answers:

A. 1, 2, 3. B. 1, 2, 4. C. 2, 3, 4. D. 1, 2, 4, 5. E. 1, 2, 3, 5.

8. The local signs of middle space phlegmon are as follows:

1. Tension of the skin being in the centre of the palm.
2. Fluctuation.
3. Tenderness.
4. Swelling of the dorsal hand surface.
5. Finger flexion.

Choose the right combination of answers:

A. 1, 2. B. 1, 4. C. 1, 3, 5. D. 1, 3, 4. E. 1, 3, 4, 5.

Osteomyelitis

1. The bones that are commonly affected in haematoge-nous osteomyelitis are as follows:

1. The femur.

2. The ischium.

3. The vertebrae.

4. The tibia.

5. The brachium.

Choose the right combination of answers:

A. 1, 4. B. 2, 3, 5. C. 1, 4, 5. D. 2, 4, 5. E. 1, 3, 4.

2. The common age of patients with haematogenous osteomyelitis is:

1. 1-10 years.

2. 11-20 years.

3. 21-30 years.

4. 31-40 years.

5. 41-50 years.

Choose the right combination of answers:

A. 1. B. 2. C. 1, 2, 3. D. 1, 2. E. 3, 4, 5.

3. Bone sequestration is typical of which of the followius types of osteomyelitis:

1. Brodie's abscess.

2. Post-traumatic osteomyelitis.

3. Ollier's osteomyelitis.

4. Garre's osteomyelitis.

5. Haematogenous osteomyelitis.

Choose the right combination of answers:

A. 1, 2, 5. B. 2, 3, 4. C. 2, 4, 5. D. 2, 5. E. 3, 5.

4. In acute haematogenous osteomyelitis, X-ray findings are evident:

A. Within 3 days.

B. Within 3 months.

C. Within 10-15 days.

D.Within 20-30 days. E. Within 30-40 days.

Choose the correct answer.

5. The following are distinctive signs of Brodie's abscess:

1. Cavity with sequestrum.

2. Cavity without sequestrum.

3. Mucous exudates.

4. Purulent exudates.

5. Diffuse osteosclerosis.

Choose the right combination of answers:

A. 1, 4. B. 2, 4, 5. C. 2, 4. D. 1, 3, 5. E. 1, 4, 5.

6. The following are distinctive signs of Garre's osteomyelitis:

1. Metaphyseal cavity.

2. Bone thickening.

3. Sequestrum.

4. Albuminous exudates.

5. Osteosclerosis.

Choose the right combination of answers:

A. 1, 4. B. 1, 2, 3. C. 3, 4, 5. D. 2, 4. E. 2, 5.

7. Sequestra are formed in the following types of osteomyelitis:

1. Brodie's abscess.

2. Haematogenous osteomyelitis.

3. Garre's osteomyelitis.

4. Tumorous osteomyelitis.

5. Post-traumatic osteomyelitis.

Choose the right combination of answers:

A. 1, 2, 5. B. 2, 3, 4. C. 2, 4, 5. D. 2, 5. E. 3, 5.

8. The major signs of chronic haematogenous osteomyelitis are as follows:

1. Tendency to relapsing.

2. Muscular atrophy.

3. Suppurative fistulas

4. Sequestral box with sequestrum inside

5. Osteosclerosis

Choose the right combination of answers:

A. 1, 2, 4. 5. B. 1, 3, 4, 5. C. 1, 2, 3, 4, 5. D. 2, 4, 5.

9. The characteristics of chronic haematogenous osteomyelitis are as follows:

1. The diaphyses of long bones are more frequently affected.

2. The metaphyses and epiphyses of long bones are more frequently affected.

3. Muscular atrophy is only rare.

4. Muscular atrophy is common.

5. Lesions of neighbouring joints are uncommon.

Choose the right combination of answers:

A. 1, 3, 5. B. 2, 3, 5. C. 1, 2, 5. D. 4, 5. E. 1, 4, 5.

10. The clinical signs suggestive of advanced acute hae-matogenous osteomyelitis are as follows:

1. Skin hyperaemia.

2. Bone deformation.

3. Positive fluctuation sign.

4. Skin necrosis.

5. Suppurative fistulas.

Choose the right combination of answers: A. 1, 2, 5. B. 1, 3, 5. C. 3, 4, 5. D. 2, 3, 5. E. 1, 4, 5.

11. The aetiologies of osteomyelitis are as follows:

1. *E. coli.*

2. *Staphylococcus spp.*

3. *Drumstick bacillus.*

4. *Corynebacterium diphtheriae.*

5. *Proteus mirabilis.*

6. *Streptococcus spp.*

Choose the right combination of answers:

A. 1, 3, 5, 6. B. 1, 2, 5, 6. C. 2, 4, 5, 6. D. 1, 3, 4, 6. E. 2, 3, 5, 6.

12. The surgical procedures indicated for acute haematog-enous osteomyelitis are as follows:

1. Incision of phlegmon.

2. Incision of phlegmon with incision of the periosteum.

3. Trepanation along the affected bone.

4. Resection of the affected bone.

5. Decompression drainage of the bone canal.

Choose the right combination of answers:

A. 1, 3, 4. B. 2, 4, 5. C. 2, 3, 5. D. 1, 3, 5. E. 2, 5.

13. The most effective methods after radical sequestrecto-my are as follows:

1. Filling with plaster.

2. Myoplasty.

3. Prolonged flow washing.

4. Tamponade.

5. Plastics with collagen sponge and antiseptics.

Choose the right combination of answers:

A. 1, 2, 3. B. 2, 3, 4. C. 3, 4, 5. D. 2, 3, 5. E. 1, 3, 5.

14. The appropriate extension of the surgery in chronic osteomyelitis may be as follows:

1. Fistula excision.

2. Bone perforation.

3. Sequestrectomy.

4. Phlegmon incision.

5. Bone cavity plastics.

6. Prolonged active flowing drainage

Choose the right combination of answers:

A. 2, 3, 4, 5. B. 1, 2, 5, 6. C. 1, 3, 5, 6. D. 3, 4, 5, 6. E. 1, 3, 4, 6.

15. The most common chronic complications of chronic osteomyelitis are as follows:

1. Liver cirrhosis.

2. Renal amyloidosis.

3. Endocarditis.

4. Myocardial dystrophy.

5. Chronic anaemia.

Choose the right combination of answers:

A. 1, 2. B. 2, 3. C. 2, 5. D. 1, 4. E. 1, 5.

16. The most adequate preparations and methods of immune and antibacterial therapy of acute osteomyelitis are as follows:

1. Lincomycin hydrochloride.

2. Ampiox.

3. Antibiotics IM.

4. Prodiogiosane.

5. Bacteriophages.

Choose the right combination of answers:

A. 2, 4, 5. B. 1, 2, 4, 5. C. 1, 4, 5. D. 1, 2, 4, 5. E. 1, 2, 3, 4, 5.

Peritonitis, pleuritis

1. The factors of peritoneal inflammation are as follows:

1. Direct transition of inflammation from the organs onto the serous membrane.

2. Abdominal penetrating wound.

3. Injury of abdominal parenchymal organ.

4. Dehiscence of suture of anastomosis of hollow organs.

5. Ulcerous perforation of the intestinal wall.

Choose the right combination of answers:

A. 2, 3, 4. B. 2, 3, 4, 5. C. 1, 2, 4, 5. D. 3, 4, 5. E. 2, 3, 4, 5.

2. The specific pathogenic factors of peritonitis are as follows:

1. Spreading of the process.

2. GI paralysis.

3. Toxic dysfunction of the viscera.

4. Absorption of bacterial toxins by the peritoneum.

5. Absorption of bacterial toxins from the intestines.

Choose the right combination of answers:

A. 1, 3, 4, 5. B. 1, 2, 3, 4, 5. C. 1, 3, 4. D. 1, 3, 5. E. 2, 3, 5.

3. Diffuse peritonitis is diagnosed if the inflammation affects:

A. One area.

B. Three areas.

C. Four areas.

D. More than five areas.

Choose the correct answer.

4. The signs of generalized suppurative peritonitis are as follows:

1. Bradycardia.
2. Abdominal muscle guarding.
3. Gaseous abdominal distension.
4. Fluid accumulation in sloping areas of the abdominal cavity.
5. Continual fever.

Choose the right combination of answers:

A. 1, 3, 4. B. 2, 4, 5. C. 2, 3, 4, 5. D. 2, 4, 5.

5. The clinical stages of peritonitis are as follows:

1. Paralysis.
2. Toxicity.
3. Generalized.
4. Multiple organ failure.
5. Transude.
6. Reactive.

Choose the right combination of answers:

A. 1, 4, 6. B. 2, 4, 6. C. 2, 4, 5. D. 1, 2, 3. E. 2, 3, 4.

6. The clinical signs of toxic phase of peritonitis are as follows:

1. Abdominal distension.
2. Hypotension.
3. Tachycardia.
4. Vomiting and thirst.
5. Dyspnoea.
6. Absence of intestinal peristaltic sounds.

Choose the right combination of answers:

A. 1, 2, 4, 5. B. 2, 3, 4, 5. C. 1, 2, 5, 6. D. 2, 4, 5, 6. E. 1, 2, 3, 4, 5, 6.

7. The risk factors of generalized peritonitis that preclude urgent surgery are as follows:

1. Recent myocardial infarction.
2. Severe traumatic shock with concomitant injury.
3. Agony.
4. Post-operative peritonitis.
5. No risk factors.

Choose the right combination of answers:

A. 1, 2, 3. B. 1, 3, 4. C. 2, 3. D. 1, 3. E. 5.

8. The treatment of generalized peritonitis involves the following measures:

1. Elimination of the causative agent.
2. Abdominal cleansing and drainage.
3. Correction of fluid and electrolyte imbalance.
4. Antibacterial therapy.
5. Detoxication therapy.

Choose the right combination of answers:

A. 1, 3, 5. B. 3, 4, 5. C. 3, 4. D. 2, 3, 4. E. 1, 2, 3, 4, 5.

9. The signs of acute suppurative pleuritis are as follows:

1. Rest dyspnoea.

2. Fever.

3. Fluid in the thorax.

4. Chest pain.

5. Dislocation of mediastinum towards the affected area.

Choose the right combination of answers:

A. 1, 2, 3, 4. B. 2, 3, 4. C. 1, 2, 3, 4, 5. D. 2, 3, 5.

10. The most effective therapeutic method in acute pleural empyema is one of the following:

A. Intratracheal insufflation of antibiotics with pro-teolytic enzymes.

B. Thoracotomy with pleurectomy.

C. Siphon drainage of thorax after Balau.

D. Drainage of thorax with active aspiration.

E. Puncture of thorax with daily evacuation of pus.

Choose the correct answer.

11. In penetrating pulmonary trauma or lung abscess with spreading of pus and gas into thorax, the following may occur:

1. Acute pain in the side of thorax.

2. Violent cough.

3. Shallow breathing.

4. Tachycardia.

5. Squeezing of lung and dislocation of the mediastinum to the intact side.

Choose the right combination of answers:

A. 1, 2, 4, 5. B. 1, 2, 3. C. 2, 3, 5. D. 1, 2, 3, 4, 5.

12. The most important diagnostic method in suppurative pleuritis if fluid accumulation in the thorax is suspected is one of the following:

A. Chest X-ray.

B. Chest CT.

C. Chest puncture.

D. Chest ultrasonography.

Choose the correct answer.

Sepsis

1. The local signs of septic wounds are as follows:

1. Copious purulent exudate.

2. Scanty purulent exudate.

3. Marked local hyperaemia.

4. Dirty-grey wound tissues.

5. Pronounced local oedema.

Choose the right combination of answers:

A. 1, 3, 5. B. 4, 5. C. 2, 4, 5. D. 2, 4. E. 2, 5.

2. The common clinical signs of sepsis are as follows:

1. Fever.

2. Dizziness.

3. Adynamia.

4. Bradycardia.

5. Rigors.

6. Profuse perspiration.

Choose the right combination of answers:

A. 4, 5. B. 2, 4, 5. C. 2, 3, 5. D. 1, 2, 3. E. 1, 3, 5, 6.

3. The typical signs of sepsis are as follows:

1. Fever.

2. Rigors.

3. Primary focus.

4. Bacteraemia.

5. Jaundice.

Choose the right combination of answers:

A. 1, 2, 3. B. 2, 4, 5. C. 1, 4, 5. D. 3, 4, 5. E. 2, 3, 4. 5.

4. The septic fever may be of the following types:

1. Remittent.

2. Hectic.

3. Intermittent.

4. Inaccurate.

5. Continual.

Choose the right combination of answers:

A. 1, 2, 3, 5. B. 3, 4, 5. C. 1, 2, 4. D. 1, 3, 5. E. 1, 2, 3, 4, 5.

5. Suppurative absorption fever is characterized by the following signs:

1. Extensive primary purulent focus.

2. Evident in all types of the inflammation.

3. Specific causative agent.

4. Rapid exhaustion of patient.

5. Resolution with elimination of the purulent focus.

Choose the right combination of answers:

A. 1, 2, 3. B. 1, 3, 5. C. 3, 4, 5. D. 1, 3, 4. E. 1, 2, 4, 5.

6. The major signs of bacterial toxic shock are as follows:

1. Fever.

2. Bradycardia.

3. Rigors.

4. Hypotension.

5. Oliguria.

Choose the right combination of answers:

A. 1, 3, 4, 5. B. 1, 2, 3, 5. C. 2, 3, 4, 5. D. 1, 3, 4. E. 1, 2, 3, 4, 5.

7. What methods of treatment would you apply for intoxication:

1. Blood transfusion.

2. Detoxication.

3. Complete bed rest.

4. Antibacterial therapy.

5. Immunotherapy.

Choose the right combination of answers:

A. 1, 2, 3, 4. B. 2, 3, 4, 5. C. 3, 4, 5. D. 4, 5. E. 1, 2, 3, 4, 5.

8. The initial therapy of primary focus in sepsis may be as follows:

1. Surgical debridement of the wound.

2. Proteolytic enzymes.

3. Hyperbaric oxygenation.

4. Wound tamponade.

5. Wound suturing.

Choose the right combination of answers:

A. 1, 2, 3. B. 2, 3, 4. C. 3, 4, 5. D. 2, 4, 5. E. 2, 3, 5.

Chapter XII. TUBERCULOSIS OF BONES AND JOINTS

Caused by *Mycobacterium tuberculosis,* tuberculosis (TB) most commonly affects the lungs, lymph nodes and serous membranes, the bones and joints being the last to be involved with the incidence as low as about 10%.

The major sites of osseous and articular tuberculous lesions include the epiphyses of the long bone shafts, bodies of the short bones: f.e. vertebrae and diaphyses of the digital phalanges. Anatomically, this type of tuberculosis falls into three major forms:

- tuberculous spondylitis, or spinal TB (40%);
- tuberculous coxitis, or hip joint TB (20%);
- tuberculous gonitis, or knee joint TB (15-20%).

Tuberculosis of the bones and joints is usually due to a secondary TB infection, which implies its lymphohaematogenous spread from the primary pulmonary focus or that of other organs. *M. tuberculosis* bacteria induce specific inflammatory reaction within the bone marrow of epiphyses, the site known to have a slower blood flow. This results in primary ostiitis, or *tuberculous osteomyelitis.*The initial tuberculous focus undergoes caseous («cheese-like») necrosis around which further tubercles form to merge with the initial focus. Subsequently, granulation occurs which, in turn, is subject to necrosis. This leads to sequestration: the bony tissues involved in the necrosis become completely separated from the underlying bone.

The progression of tuberculous inflammation into the joint forms an articular sac with subsequent caseous necrosis of the joint cartilage and contiguous osseous tissues.

Primary synovial tuberculosis (TB synoviitis) only occurs in about 5% of cases, with a favourable outcome as it is unlikely to cause the damage to the joint ends of the bones.

According to P.G. Kornev, the pathogenesis of tuberculosis of the bones and joints involves the three stages:

stage 1 - pre-arthritis-formation of the bone focus in the epiphysis around the joint;

stage 2 - *arthritis* - extension of the process to the joint with resultant secondary arthritis;

stage 3 - *post-arthritis*- stabilisation of the disease with the evidence of its complications.

Therefore, to distinguish the pathological stage is of practical importance for the identification of

the clinical picture and deciding on the therapeutic strategies.

Examination of the patient

A. History

1. Complaints

- loss of appetite;
- easy fatigability;
- difficult walking;
- weight loss;
- low grade fever.

2. History of present illness

- impaired limb function followed by pain on moving (most often in the back, hip and knee joints) which, as a rule, worsens on walking and bending.

3. Family and past medical history

- evidence of tuberculosis in the family (e.g. parents);
- contacts with contagious tuberculosis cases;
- provoking factors (e.g. trauma);
- history of an infection.

B. Physical examination

- weight loss;
- muscle atrophy at the limb affected;
- skin and mucosal pallor.

C. X-ray of bones (to detect changes in the spongy bone tissues at metaphyses):

- osteoporosis;
- foci of sequestration coupled with clear areas in the form of a soft shadow («a piece of melting sugar» sign);
- widening of the joint space followed by its narrowing;
- notching of joint cartilaginous and osseous tissues;
- osteosclerosis and periostitis are usually absent.

It is noteworthy that tuberculosis of the bones has to be differentiated from chronic haematogenous osteomyelitis (see tab. 8).

Tuberculous spondylitis

A. Epidemiology

- the vertebrae are the most common site for bone-joint tuberculosis;
- children in their early years are primarily affected;
- vertebrae Th2 - 4 are usually involved.

Table 8. Chronic haematogenous osteomyelitis vs tuberculosis of the bones: differential diagnosis

Chronic haematogenous osteomyelitis	Tuberculosis of the bones
History	
Acute phase disease	Gradual development
Clinical signs	
Predominant involvement of the diaphyses of the long bone shafts	Predominant involvement of the epiphyses and metaphyses of the long bone shafts and vertebrae
No contact with contagious TB patient	Contact with contagious TB patient (+)
No signs of TB intoxication	Signs of TB intoxication (+)
Rare joint involvement	Adjacent joints are often involved
Muscle atrophy is rare	Muscle atrophy is invariable
Normal limb development	Impaired limb development (due to the damage to the germinal zone)
Alexandrov's sign negative	Alexandrov's sign positive
No cold abscesses	Cold abscesses
Laboratory findings	
Neutrophilia in the blood film	Lymphocytosis in the blood film
Tuberculin (Mantoux and Pirquet) tests negative	Tuberculin (Mantoux and Pirquet) tests positive
Non-specific pyogenic flora on pus culturing (commonly, *Staphylococcus* spp.)	*M. tuberculosis* isolated
Radiological findings	
Osteosclerosis with periostitis	Osteoporosis *without* periostitis
Sequestration present	No sequestrum box-cavity without clear-cut boundaries
Hard bone sequestra	«Melting sugar» sequestra

B. The clinical picture (depends on the phase of the disease process).

Stage 1 - *prespondylolytic* - the inflammation is confined to the vertebral body:

- symptoms and signs of tuberculous intoxication (anorexia, weight loss, misbehaviour) without clinical signs of vertebral involvement;
- laboratory findings indicative of active TB;
- mantoux test positive;
- lymphocytosis;
- high ESR;
- spinal X-ray films (of importance!);
- the foci of osteoporosis and destruction in the vertebral bodies.

Stage 2 - *spondylolytic* - destruction of the vertebral bodies with the process spreading to the intervertebral disks and the contiguous tissues

- symptoms and signs of tuberculous intoxication;
- pain on bending and limitations in the spinal mobility (the child is unable to pick up things while standing and has to squat);

• *Inspection of the spine* shows;

• distorted spine with the spinal processes jolting out and gibbus;

• «reins» sign (tension of the back muscles on unbending);

• «a piano key» sign (pain on palpating the prominent spinal processes). Cold abscesses and purulent fistulae appear at this phase, and a shift in the vertebra can lead to compression of the spinal cord and paralysis of the limbs, impaired micturition and defecation (fig. 123).

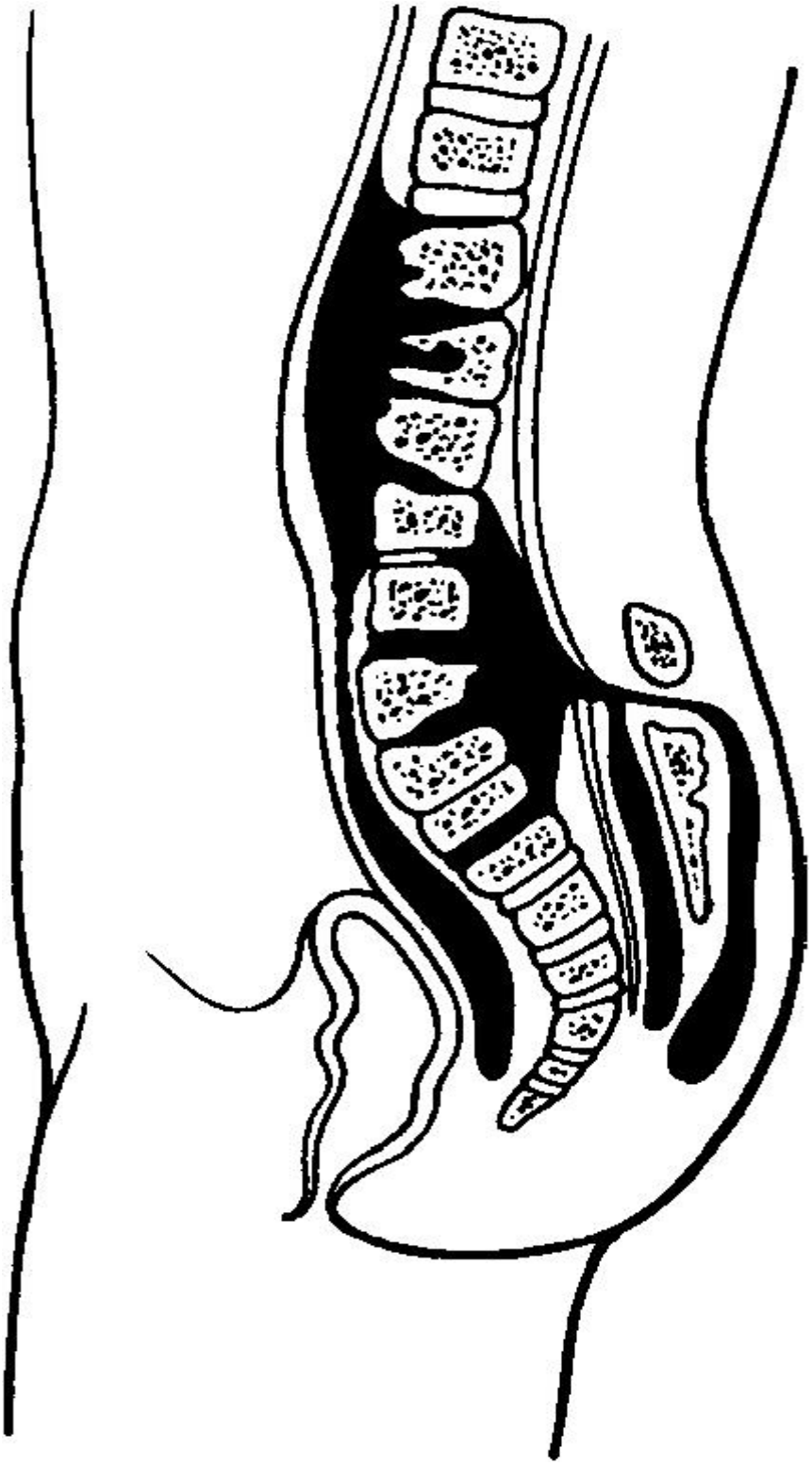


Fig. 123. Wandering abscesses in tuberculous spondylitis.

X-ray films show flattening the vertebral bodies, which is a sign of their destruction due to pathological compression fracture, a shadow of the stretching cold abscesses can be noted.

Stage 3 - *postspondylolytic*- is characterized by the subsiding of the inflammation. The cold abscesses, fistulae and impaired spinal innervation can still persist.

Tuberculous coxitis

A. Epidemiology.

• Tuberculous coxitis accounts for about 20% of all cases of bone and joint tuberculosis.

• Children of 3-7 years of age are most commonly affected:

B. Clinical picture.

• symptoms and signs of tuberculous intoxication;

• pain at the hip joint irradiating to the knee joints and getting worse on walking (which forces the child to assume the position with his/her thighs bent up as the relaxation of the joint capsule alleviates the pain);

• muscle atrophy;

• smoothened inguinal and gluteal folds;

• purulent fistulae.

X-ray pictures show narrowed joint spaces, severe osteoporosis, destruction of the femoral head or the gluteal cavity.

Tuberculous gonitis (tuberculous destruction of the knee joint).

A. Epidemiology.

• Young children are most commonly affected.

• It accounts for 15-20% of cases of osseous and articular TB.

B. The clinical course.

Stage 1 - *prearthritic* - the disease is localized in the epiphyses:

• the syndrome of tuberculous intoxication;

• functional disorders of the limb involved (the patient is lame in his/her leg affected and easily gets tired);

• no pain.

Stage 2 - *arthritic* - the process spreads to the joint:

• arthralgia due to an increase in joint size;

• sleek skin overlying the joint affected;

• loss of joint shape (it becomes fusiform);

• the "balloting patella" sign (i.e. the patella sinks on pressing and assumes its initial position immediately when it is released);

• half-bent leg;

• purulent fistulae with discharge of small particles of bone sequestra (uncommon);

• enlarged circumference of the joint affected and reduced circumference of the thigh on the limb involved as compared to that of the intact one;

• a thicker skin fold on the lateral surface of the limb affected than that of the intact one (Alex-androv's sign).

X-ray image demonstrates:

• osteoporosis of the bones at the joint ends;

• narrowed joint space;

• destruction of the joint ends of the bones (in advanced cases).

Tuberculosis of the bones of the fingers and toes (spina ventosa)

A. Epidemiology:

— children of the first year of life are commonly affected.

B. Clinical picture:

— pain in the hyperaemic fingers, which gets worse on moving;

— Fusiform and oedematous finger. X-ray films show:

• osteoporosis with marked periosteal changes in the phalanges.

Treatment of TB involves both conservative and surgical methods. Of great importance are such supportive measures as nutrition with adequate amounts of protein, vitamins, trace elements as well as resort treatment.

Antibacterial chemotherapy requires the use of specific antituberculous antibiotics (e.g. PASA, isoniazid).

The affected organ must be immobilised from the very beginning, which prevents bone deformation and favours healing. For this purpose, splints, POP jackets and dressings are applied. The patient is allowed to walk about after the process has subsided.

In tuberculous spondylitis it is advisable to wear a POP jacket for several years.

Surgery is one of the major modalities in complex management of bone and joint TB.

Radical operation:

• *necrectomy*, or the excision of peri-articular tuberculous foci from the vertebral bodies and the bone epiphyses;

• *bone resection,* or the removal of the joint ends of bones destructed (fig. 124, 125).

Ancillary operation:

• *arthrodesis* (i.e. forming artificial ankylosis), or the immobilisation of the joint, especially in the case of tuberculous spondylitis (spondylodesis) when the vertebral column is fixed using bone transplants or metallic constructions;

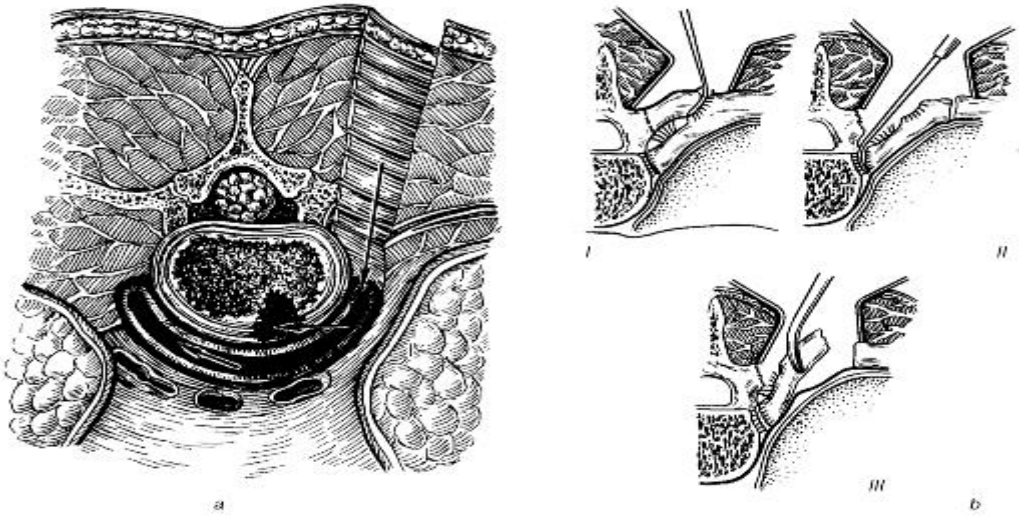


Fig. 124. Approach to the cervical vertebral bodies: *a* - costotransversectomy; *b* - costotransversectomy: steps I-III.

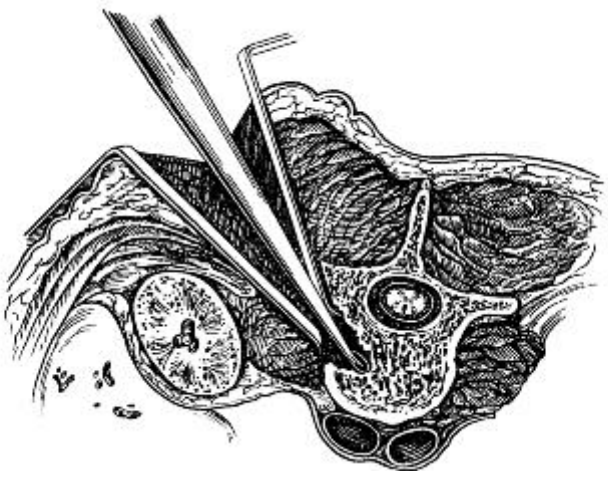


Fig. 125. Approach to the lumbar spine, debridement of the lumbar vertebral body.

• *laminectomy* is indicated in compression of the spinal cord.

Reconstructive opeartion:

• *osteotomy and joint trepanation* to restore the organ's (limb, joint, spine) function after the inflammation has been eliminated.

Chapter XIII. NECROSIS, VARICOSE ULCERS AND ARTERIAL OCCLUSION

Necrosis is the death of tissues of part or a whole organ of the living body.

Causes of necrosis are as follows:

• physical

• high or low temperatures;

• radiation or electrical energy (see «Thermal injuries»);

• chemicals.

• Mechanical

• pressure on or crushing of tissues (see «Closed injuries to soft tissues»).

These types of injury directly lead to necrosis of tissues. Local circulatory disorders (e.g. thrombosis, embolism or vascular occlusion) often result in indirect necrosis. The condition is accompanied by abnormal innervation when the nerves are damaged (e.g. leprosy, syringomyelia).

Necrosis can be:

• coagulative, or dry (burns, dry gangrene);

• colliquative, or wet (alkaline burns, wet gangrene).

The signs of necrosis become obvious within 4 to 6 hours after tissue death. The necrotic tissue undergoes rejection and, if located on the surface of an organ, an ulcer develops. Extensive necrosis with widespread tissue decay results in systemic absorption of toxic products, which, in turn, leads to intoxication.

13.1 GANGRENE AND VARICOSE (STASIS) ULCERS

Necrosis due to primary blood circulatory disorders is referred to as *gangrene.*

Causes:

• extensive crushing;

- severe pressure on tissues;
- vascular injuries;
- organ compression (e.g. POP bandage);
- volvulus with compression of the vessels;
- leaving the tourniquet on a limb for a long time;
- vascular thrombosis and embolism;
- obliterating endarteritis;
- obliterating arteriosclerosis.

Most commonly acute and chronic *arterial occlusion* lead to gangrene.

Dry gangrene is caused by fast dehydration of the necrotic tissues without bacterial contamination.

This results in tissue mummification. In *wet gangrene,* colliquative tissue necrosis occurs, which is usually complicated by an ichorous infection, with subsequent disintegration of the devitalised tissue and severe intoxication. The tissue debris is dirty-green or black in colour and smells very offensive.

Gangrene resulting from acute ischaemia of an organ is accompanied by severe ischaemic pain that is normally felt below the level of vascular occlusion. The colour of the limb changes very fast from pale to marble-bluish; it becomes cold and skin sensations disappear.

In dry gangrene, the gradual drying up of the necrotic area is followed by a clear-cut demarcation between the intact and necrotic areas (fig. 126, colour inset). The skin becomes black, which is accompanied by minimum, if at all, intoxication. In wet gangrene the patient's condition is generally severe from the very onset (fever, tachycardia, chills, thirst, and dehydration) because of absorption of ichorous tissue disintegration products into circulation.

Over the areas of necrosis (often in the foot and the lower third of the leg) the skin becomes bluish with dark-red patches and haemorrhagic blisters. The extremity is oedematous, enlarged, and dirty-greyish tissues with offensive odour are visible (see fig. 126, colour inset).

Once the signs of necrosis appear, the limb is to be immobilised and an aseptic dressing applied.

The treatment of necrosis depends on its cause. The common strategy of the management of all types of necrosis is the removal of the necrotic tissue, or *necrectomy.*

Necrectomy requires that several parallel incisions be done in the necrotic area without anaesthesia and an antiseptic dressing be applied (see «Antiseptics»). This contributes to the removal of the degenerated necrotic tissues and, therefore, reduces the intoxication of the body.

Necrectomy can be performed with a scalpel or scissors (mechanical necrectomy), proteolytic enzymes (chemical necrectomy), physical factors - ultrasound or laser rays (physical necrectomy).

It is advisable:

- in progressive *wet* gangrene, to undertake above-knee amputation (without waiting for tissue demarcation) without delay;
- in *dry* gangrene, to first allow the demarcation line appear and then amputate the limb above it within the intact area.

As a form of necrosis a varicose ulcer is an intractable defect in the skin or mucous membranes (fig. 127, colour inset) which usually develops after the necrotic tissue has fallen off.

The aetiologic factors responsible for the development of varicose ulcers are as follows:

1. Traumas:

a) burns

— chemical;

— thermal;

— radiation;

— electric;

b) frost bite;

c) extensive degloving wounds of whatever origin.

2. Chronic blood or lymph circulatory disorders: chronic arterial and venous insufficiencies, elephantiasis.

3. Diseases of the nervous system:

a) injury to the peripheral nerves;

b) syringomyelia;

c) tabes dorsalis.

4. Metabolic disorders:

a) diabetes mellitus;

b) vitamin deficiency.

5. Systemic disease:

a) connective tissue disorders;

b) haematological conditions (anaemias, haemorrhagic and myeloproliferative disorders).

6. Infections:

a) tuberculosis;

b) syphilis;

c) leprosy;

d) erysipelas;

e) systemic fungal infections.

7. Tumours (disintegration of malignant tumours).

Whatever its cause, the signs of impaired tissue nutrition, or *degeneration*, and tissue decay, or*necrosis,* are evident in a varicose ulcer.

Degeneration can be classified as follows:

1. localized:

• vascular defect;

• the effect of trauma;

• tumour lysis;

2. generalised:

• systemic diseasel;

• metabolic disorders.

Types of varicose ulcers.

• *Vasculogenic* ulcers are commonly due to the cessation of blood or lymph flow into or out of the area.

• *Post-traumatic,* or scar-associated, ulcers, develop because the scar tissue affects circulation around the wound, which leads to degeneration.

• *Neurotrophic* ulcers result from defective sensory innervation.

In surgical practice, the commonest varicose ulcers are those caused by blood circulatory disorders of the extremities (chronic arterial or venous insufficiency).

13.2 EVALUATION OF THE PATIENT

Examining the patient with varicose ulcers one should found out the cause, as this dictates the therapeutic modality.

1. Inspection of the ulcer for the following parametres:

• size;

• shape;

• the wound edges and base: the wound edge can either be even or uneven, undermined, firm or raised; the base can be lined with necrotic masses, fibrin or granulation (fig. 128, colour inset).

Atherosclerotic ulcers are small in size and oval or round in shape and tend to occur in the elderly and be located on the lower third of the leg or on the foot. The granulation is scanty, pale; the wound edges are usually firm, uneven; there are signs of marked chronic arterial insufficiency (see "Arterial occlusions").

Varicose ulcers are commonly large and deep, and located over the medial malleolus; surrounding tissues are indurated and blotchy. The ulcers are unlikely to be tender on palpation. It is noteworthy that one of the diagnostic clues is a combination of ulcer and varicosity of the superficial veins.

Post-thrombophlebitic ulcers result from chronic venous insufficiency in lower limb and are generally located around the medial malleoli. The size of an ulcer may range from tiny (a few centimetres in diameter) to gigantic.

Huge ulcers stretch circularly around the whole lower third of the leg (in the form of a cuff). These are often superficial and have flat margins, their surface being covered by nonviable granulation tissues.The skin on the lower limb, particularly that around the ulcer, is oedematous, firm and markedly indurated *(indurative cellulitis).*

Post-radiation ulcers usually result from ionising radiation (e.g. radiotherapy, accidental exposure). Necrosis is preceded by skin changes such as focal pigmentation, bright red teleangiectasia, alopecia and skin atrophy; necrosis and ulcer follow. Such ulcers tend to be deep, round or oval in shape with sheer edges with occasional protrusion into the muscles and bones. Areas of sclerotic subcutaneous fat and skin atrophy are commonly found around the ulcer.

Ulcerated tumours are characterised by induration, deep extension, immobility and firm adherence to the surrounding tissues and organs, and have an ulcer on their surfaces. The ulcer has thickened firm, nodular and uneven edges; the base is lined with necrotic tissues, areas of growth *(vegetation)*are commonly identified along the wound edges *(progressive tumour growth).*

In a persistent ulcer with firm callous edges (so called «callous ulcer») a biopsy of edge and base is mandatory to confirm either its malignant character or its aetiology (tuberculosis, syphilis, leprosy etc.).

The three therapeutic principles are as follows:

1. Pathogenesis-oriented measures aimed to hamper the tissue degeneration:

— restoring circulation [e.g. excision of the varicose veins of the lower limbs; arterioplasty (see "Arterial insufficiency");

— excising necrotic tissues (see Chapter XIII)].

2. Topical measures (that may either precede or accompany pathogenesis oriented measures) aim at fast cleansing necrotic tissues and eradicating causative microorganisms with enzymatic proteolysis and excision of the ulcer. To enhance tissue regeneration, both physiotherapy and dressing with reparative agents (methyluracyl, pentoxyl) can be applied. Also, skin graft *(autodermoplasty)*accelerates wound healing (fig 129, 130, see fig. 128, colour inset).

3. Supportive measures:

— adequate vitamin and trace element supplementation;

— healthy diet;

— anabolism promotion.

A fistula is a pathologic narrow canal within tissues with the walls covered by the epithelium or granulations. It connects organs, normal or pathologic cavities with body surfaces or cavities with one another.

The causes of pathologic fistulae are diverse; the pathologic fistulae can be either *congenital* (due to defective intrauterine development) or *acquired* (due to inflammation, trauma or tumour). In contrast, artificial (external or internal) fistulae result from surgeries, e.g. gastrostomy, enterostomy, colostomy, epicystostomy.

Depending on the structure, the following types of fistulae are identified:

• epithelised, or tubular (i.e. the walls of the fistula are covered by the epithelium);

• labial, i.e. the mucous epithelium of the hollow organ spreads as far as the skin;

• granulated, the walls are covered by granulations.

The epithelised fistulae, which are (usually congenital, granulated) are pathologic, while the labial ones usually are typically artificial.

Each fistula has the external skin opening, the canal of different size and the internal opening.

The diagnosis of fistula is based on routine examination of the patient:

1. History: the presence of fistula; the character and the volume of effusion; problems associated with feeding, defaecation, urination, etc.; the genesis of the fistula (congenital versus acquired - trauma, operation).

2. Inspection: presence of the fistula, its localization, structure (tubular, labial), the character and the volume of effusion.

3. Laboratory investigation: intubation, X-ray techniques (fistulography, fistuloscopy), endoscopy.

The treatment of external bowel fistula includes the three aspects:

1. Local therapy;

2. Systemic therapy;

3. Surgery.

13.3 ARTERIAL OCCLUSION (ACUTE AND CHRONIC ARTERIAL INSUFFICIENCY)

Examining the patient with arterial diseases the surgeon has to consider a number of peculiarities:

1. The examination must occur in a warm room.

2. It is required that the symmetrical sites of the limbs be inspected.

Skin colour is compared on both limbs. Pale or violet-bluish discolouration acquired on moving the limb from the horizontal position to the vertical one strongly suggests deficient circulation. The skin is usually dry and scaly, and the nails are deformed, thickened and brittle; a loss of hair and muscle atrophy may also be observed.

The feeling of the arteries shows a weak or absent pulse. On the lower limb the pulse is to be felt on the femoral artery (below the middle of the Poupart's ligament), popliteal artery (in the popliteal fossa with the leg flexed in the knee joint and the muscles maximally relaxed), dorsalis pedis artery (between the first and second metatarsal bones) and tibialis posterior artery (behind the medial malleolus). Pulsation on the upper limb will be evaluated on the subclavian, humeral and radial arteries (fig. 131).

To assess the severity of arterial circulatory disorder special tests are performed.

Oppel test. Have the patient lie supine with his/ her leg raised at an angle of 45°. The appearance of paleness on the sole (the plantar ischaemic sign) serves as the evidence of arterial circulation insufficiency.

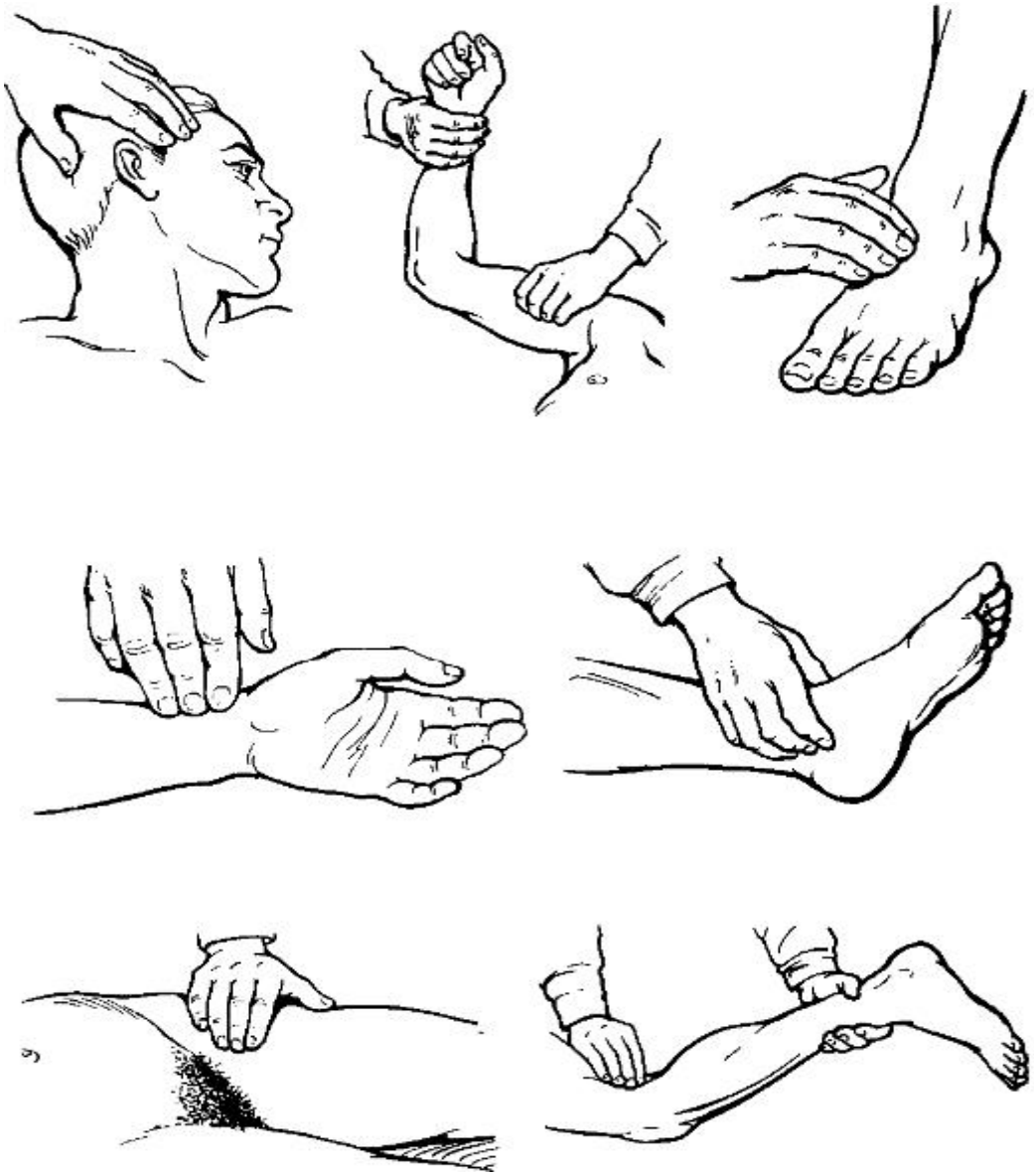


Fig. 131. Feeling the peripheral artery pulse.

Samuel's test. Have the patient lie in the position as described above and do 20 to 30 flexions in the ankle joint. The appearance of paleness on the sole is also a sign of arterial circulation insufficiency.

Moshkovich's test. Have the patient lie supine raise his/her leg and apply a tourniquet for 5 minutes. The period needed for the skin to regain hyperaemia following the removal of the tourniquet is normally 5 to 30 seconds whereas that in arterial occlusion is as long as 3 to 5 minutes.

The above-mentioned tests can only be diagnostic at initial, or compensated, stages of the disease. If intermittent claudication appears, the diagnosis is easy to make (the suband decompensation stages of circulatory failures).

Special methods are used to assess the severity of circulatory disorders, monitor pathologic progression and the efficacy of therapy. These are primarily as follows:

1. Thermometry, the technique of measuring skin temperature at symmetrical limb areas using an electric thermometer. A reduction in temperature by 0,5-0,7 °C strongly suggests deficiency in the blood flow.

2. Oscillography, recording oscillations produced by changes in electrical potentials caused by vibrations of an artery. A decrease in vibration amplitude indicates deficient circulation.

3. Impedance rheovasography, the technique to register the resistance produced by pulsating limb arteries as a result of their filling. In health, the rheographical index is as high as 0.8-1.0; its reduction being evident of deficiency in the arterial circulation.

4. Doppler ultrasound, the method of listening to the arterial blood flow with the velocity detector (Doppler probe) to recognise arterial occlusion or stenosis.

5. Capillaroscopy, microscopical examination of the capillary vessels of the skin or nail beds. In occlusive arterial diseases the capillaries become convoluted, winding and constricted.

6. Arteriography, the visualisation of arteries by means of X-rays after injection of radio-opaque material. In obliterating atherosclerosis, the vessels with the «eaten up» internal contours, as well as areas of the constricted, or occluded, lumen are seen. In endarteritis, the arterial lumina are markedly narrowed, often over wide areas. Thrombosis/thromboembolism cause obstruction of the artery.

13.4 ACUTE ARTERIAL OCCLUSION

Acute arterial occlusion is the condition that results from the sudden arrest of the blood flow in an artery and is the commonest cause of gangrene.

The factors that contribute to arterial occlusion include trauma, the excessive pressure from a tourniquet, intra-operative ligation of the artery, thromboembolism (i.e. the obstruction of a vessel, mainly by thrombus and occasionally by air, fat).

Arterial embolism results in ischaemia of the limb, the severity of which depends on the size of the thrombosed vessel, the level of obstruction, the capacity of the collateral circulation as well as the duration of the problem (the time lag between the moment of occlusion and the reporting time).

In thromboembolism of a major artery, the sign of acute organ ischaemia (e.g. the limb) is observed. Thromboembolism causes the following pathogenic changes:

- obstruction of a main vessel;
- acute distension of the vessel above the area of obstruction;
- reflex spasm of all the arterial network of the limb - the obstructed vessel, its branches and collaterals beneath the area of obstruction;

• formation of a sequel thrombus beneath the area of obstruction because of a decrease in blood flow and defects of blood coagulation and anti-coagulation systems.

To verify the diagnosis and identify of the level of occlusion special investigations are applied: cutaneous thermometry, oscillography, rheography and angiography.

According to V. Saveliev, the clinical course of thromboembolism of the major vessels divides into three stages:

• stage 1 - ischaemia causing functional disorders. This lasts a few first hours. The clinical picture includes (1) acute pain in the limb affected, (2) pale and cool skin, (3) absent pulse on the peripheral arteries. It is noteworthy that pain and touch senses usually remain intact, active joint motions are slightly limited. The restoration of blood supply to the limb at this stage leads to a full functional recovery;

• stage 2 - *structural changes* - includes such signs as absent pain and touch sensations, markedly limited active and passive joint movements, muscular oedema and contractures, bluish discolouration of the skin. This stage lasts for 12 to 24 hours. The restoration of blood supply within the above-mentioned period, can save the limb although its functions are, as a rule, either partially or fully lost;

• stage 3 - *necrosis* - is characterised by the development of gangrene. It follows within 24 to 48 hours after embolisation. At this stage, due to gangrene virtually all forms of sense and movement will be lost, while resume of the blood flow in the vessel can occasionally reduce the level of the demarcation line, hence the level of amputation.

The staging of ischaemia helps choose the therapeutic modality:

• stages 1 and 2 require radical treatment - restoration of the artery's patency (i.e. restoration of the blood flow);

• stage 3 precludes the aforementioned therapy as the necrosis of an extremity is a life-threatening condition and thus calls for urgent options, of these the amputation of the limb affected being the mainstay.

The clinical features of the disease, *leg pain* particularly, may readily be identified the moment embolisation has occurred. The severe ischaemic pain, which results not only from occlusion but also from the reflex spasm of collateral vessels, is of sudden onset and of persistent duration. Occasionally, it can produce shock. The pain is mostly often located at the distal parts of the limb; it sometimes appears at the area of occlusion and spreads distally later on. Alternatively, the patient may present with numbness sensation, paraesthesia (tingling), while coolness to touch and pain come on thereafter. This suggests that the incomplete occlusion of the artery by an embolus precedes the complete one due to secondary thrombosis that causes limb ischaemia.

The incidence of the subacute course of thromboembolism of a major artery is as high as ten percent.

The patients with arterial thromboembolism are usually those with serious cardiac disease, which accounts for the severity of their condition. Physical examination yields helpful clinical signs as follows:

1. Vital signs:

• increased pulse rate;

• low blood pressure (a sign of impending shock);

• labial and mucosal cyanosis;

• fast breathing.

2. Skin:

• a change in the skin colour, which becomes cyanotic, pale or even white with bluish patches («the marble skin») that resemble those of the cadaver;

• coolness to touch is more pronounced at the peripheral areas; skin temperature is reduced by 2-3 °C as compared to that of the intact side;

• both pain and touch sensations checked with a needle are diminished. The inability of the patient with their eyes closed to distinguish between being pricked by a sharp object and touched by a blunt one indicates the loss of both pain and touch sensations. This suggests irreversible damage to the tissues as the circulation in the limb fails to maintain the viability of tissues.

3. Pulses:

• absent lower limb pulse is a typical sign.

4. Neurologic signs.

It should be emphasised that neurological signs (numbness sensation and paraesthesia with subsequent loss of all kinds of sensation) become visible very fast. The pain can shortly be followed by motor deficit of various degrees (finger and toe paralyses).

The combination of pulselessness with paraes-thesias, acute pain, pallor and palsy are therefore diagnostic of acute arterial ischaemia.

If measures are not taken to restore circulation, the signs of acute ischaemia progress and gangrene, which is usually dry ensues.

Treatment. The first aid in arterial thromboembolism includes:

(I) analgesia and cardiac medications;

(II) transport immobilisation of the limb either by a standard or an improvised splint;

(III) application of ice packs to the affected limb;

(IV) immediate transportation of the patient to the surgical unit.

The management of the patient with arterial thromboembolism must be individualised depending on (1) the location of the embolus; (2) the stage of disease and (3) its duration.

The preoperative treatment should start with *conservative measures.* Failure of ischaemia to subside and that of pain to relieve and touch sensations to recover within $1^1/_2$-2 hours of the therapy is an indication for surgery.

The conservative treatment is applicable:

(I) at the initial stages of the disease (i.e. within 6 hours from its onset of disease);

(II) in critically-ill patients;

(III) in embolism of small arteries (i.e. those of the foreleg and forearm);

(IV) in obscure clinical picture;

(V) as a method additional to surgery. It involves the following:

1. anticoagulation therapy (heparin, indirect anticoagulants) and fibrinolytic agents (streptokinase, streptodecase, urokinase) to prevent formation of clots and lyse the the preformed ones;

2. antispasmodic therapy to eliminate the vascular spasm (vasodilators, novocain block, papaverin, carbacholin);

3. improvement of collateral circulation (Bernard's current; vacuum apparatus applied to the limb).

Surgical treatment implies radical operations (i.e. embolectomy (fig. 132), arterioplasty and vascular shunting) to restore the patency of arteries, whereas palliative ones are performed to improve the collateral circulation without restoring the patency of the main vessel (e.g. sympathectomy). The gangrenescent limb is subject to amputation.

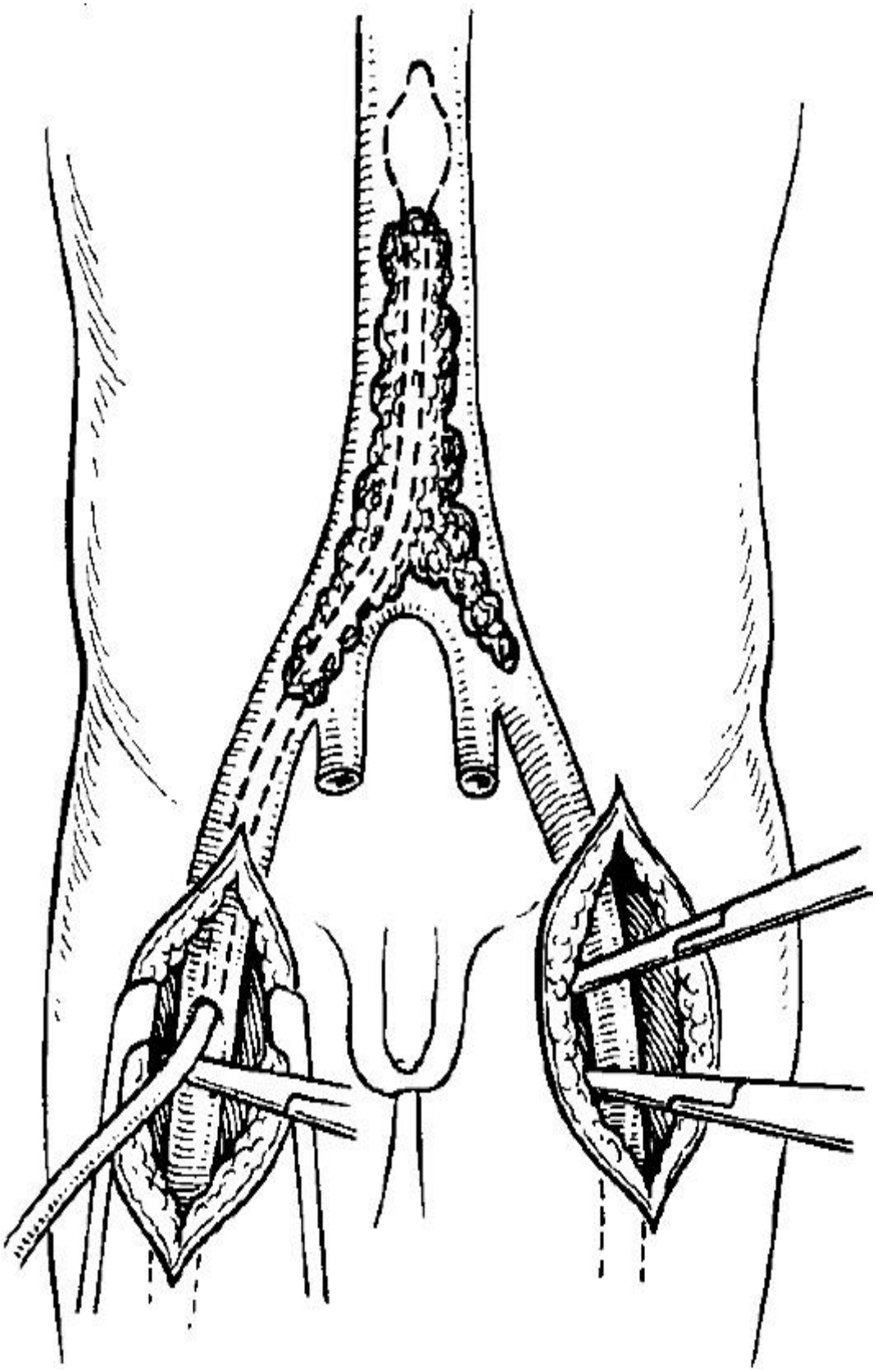


Fig. 132. Embolectomy using a balloon catheter.

13.5 CHRONIC ARTERIAL OCCLUSION

Chronic arterial occlusion is a condition caused by the gradual narrowing of an artery with the resultant ischaemia of the limb.

Causes of chronic ischaemia of the limb include the following:

Thromboangiitis obliterans (Indarteritis Buerger's disease) and *Raynaud's disease.* Thromboangiitis is the inflammation of the entire wall and connective tissue surrounding medium - sised arteries and views especially of the legs of young and middle-aged men.

Raynaud's disease has a vasospastic origin and affects mainly the upper limbs.

1. Obliterating artheriosclerosis that results from artheriosclerotic narrowing and occlusion of the vascular lumina.

It is chronic arterial insufficiency that underlies each of these diseases and produces the ischaemic syndrome. The diagnosis is based on the degree of the arterial insufficiency and its progression rate.

History:

• *pain* (it is usually the earliest complaint);

• *intermittent claudication:* severe pain in the legs, tension and weakness on walking which makes the patient stop. The symptoms increase as walking proceeds until further progress is impossible (being the chief but late symptom, it indicates pronounced disorder in the limb circulation, even though most patients associate it with the beginning of their disease).

The severity of the syndrome correlates directly with the degree of ischaemia:

• degree I (the pain follows the walking of 500 m);

• degree II (the pain is evident on walking 200 m);

• degree III (the pain appears after walking 20-30 m or at rest);

• degree IV (the signs indicative of necrosis, or gangrene).

The clinical stages of chronic arterial insufficiency are as follows:

Stage I, or *compensation* History:

• fatigability, a feeling of pressure and pain in the gastrocnemii muscles on walking;

• coolness in the feet, intermittent claudication on walking 200-500 m, numbness and tingling sensation at the finger and toe tips, muscular weakness;

• past medical history indicative of heavy tobacco smoking, long exposure to cold and frequent stress.

Physical examination of the limbs:

• minimum physical signs: hair loss, skin pallor, coolness to touch mostly confined to the fingers and toes, diminished peripheral pulses, "white patches" on pressing the feet.

Stage II, or *subcompensation,* is characterised by transient ischaemia History:

• a feeling of cold fingers and toes; intermittent claudication more pronounced than at stage I;

• transient ischaemia (subsides on resting);

• effectiveness of conservative therapy. Physical examination:

• pallor and coolness of the foot skin. Stage III, *or decompensation* History:

• severe pain at the fingers or toes, sole, dorsum of the foot and occasionally in the leg, both on walking and at rest, presumably nocturnal, which makes the patient sit up in bed with their legs on the floor and therefore interferes with their night sleep.

Physical examination:

• dry and pale skin with bluish patches of ulceration (i.e. foci of necrosis) and oedema on one of the toes and fingers;

• thickened and brittle nails;

• muscle atrophy;

• absent arterial pulse on the feet. Stage IV, or *gangrene* History:

• persistent and unbearable pain. Physical examination:

• marked oedema and cyanosis with bluish black discolouration of the whole foot;

• wrinkling of the skin (which suggests *dry* gangrene);

• superimposed infection (which leads *wet* gangrene).

13.6 OBLITERATING ARTERIOSCLEROSIS

Obliterating arteriosclerosis, which is a local presentation of generalised atherosclerosis, often produces chronic deficiency of arterial blood supply to the lower limbs and is manifested by ischaemia of the anatomic sites. The major arteries - bifurcation of the aorta, and iliac, femoral and the popliteal arteries - are most commonly involved. In contrast, the upper limb vessels may hardly ever be affected.

History

The risk factors include the following:

• age over 50 years;

• heavy tobacco smoking;

• coronary heart disease (e.g. myocardial infarction);

• cerebrovascular disease;

• hypertension;

• metabolic disorders (e.g. diabetes mellitus, hypercholesterolaemia, vitamin deficiency);

• history of long exposures of the feet to cold;

• stress.

Clinical picture:

• patients tend to look old for their age;

• femoral pulses are often absent;

• the areas of necrosis on the foot may not be present.

Diagnostic studies:

• *angiography* shows jagged and defective arterial walls with proximal occlusion of the arteries.

• *X-ray* films help detect calcifications of the vessels.

Treatment:

• vasodilating agents;

• anticoagulant therapy (indicated in thrombosis);

• health resort therapy.

Occlusion of main artery is an indication for *reconstructive surgical procedures* (e.g. bypass graft), while gangrene invariably requires amputation of the limb affected.

13.7 ENDARTERITIS OBLITERANS

The disease starts with the involvement of the small vessels of the lower limbs; occasionally, those of the upper limbs may also be affected. History

The risk factors are usually as follows:

• age under 40 years;

• frequent psychological stress;

• heavy tobacco smoking;

• rarely, history of

• coronary heart disease;

• cerebrovascular disease;

• hypertension;

• diabetes mellitus;

• history of long exposures of the feet to cold/ frostbites.

Clinical picture:

Pulsation in the foot, and rarely thigh, is reduced or absent. In spite of the pressure of pulsation on one of the arteries of the foot or the popliteal pulse, necrosis appears over the toes.

Diagnostic studies:

• *angiogram* demonstrates smooth vascular walls and narrowing of the peripheral arteries.

In thromboangiitis obliterans, apart from the characteristic features of endarteritis, there is evidence of phlebitis or thrombophlebitis. The progression of the disease may often lead to wet gangrene.

Treatment:

• analgesics;

• nonsteroidal anti-inflammatory drugs;

• antihistamines;

• vasodilating agents, including those that paralyse transmission across the synapses;

• female sex hormone therapy (synoestrol, folliculin);

• physiotherapy (ultra-high frequency current; Bernard's current; electrophoresis with drug preparations);

• health resort therapy.

Of the surgical methods, operations on the sympathetic nervous system are commonly performed (lumbar, thoracic and periarterial sympathectomy). Amputation takes priority in gangrene.

TESTS

Chapter XIII. NECROSIS, VARICOSE ULCERS AND ARTERIAL OCCLUSION

1. The complications of lower limb thrombophlebitis are commonly due to:

1. Superficial vein thrombosis.

2. Superficial vein dilatation.

3. Femoral artery thrombosis.

4. Lower limb deep vein thrombosis.

Choose the right combination of answers:

A. 1, 2. B. 2. C. 3, 4. D. 4.

2. The typical signs of obliterating endarteritis are as follows:

1. Creeping sensation.

2. Chilly sensation in the feet.

3. Local hair falling.

4. Intermittent claudication.

5. Thickening nails.

Choose the right combination of answers:

A. 1, 2, 3. B. 3, 4, 5. C. 1, 3. D. 2, 4. E. 1, 2, 3. 4, 5.

3. The characteristic signs of lower limb arterial throm-boembolism are as follows:

1. Slowly progressing pain.

2. Sudden acute pain.

3. Bluish discolouration of the skin.

4. Skin pallor.

5. The limbs' coolness to touch.

Choose the right combination of answers:

A. 1, 2, 3. B. 2, 3, 4. C. 4, 5. D. 2, 4, 5.

4. The causes of lymphatic circulatory disturbance are as follows:

1. Lymphatic vessel hypoplasia.

2. Erysipelas.

3. Chronic lymphadenopathy (tuberculosis, syphilis).

4. Vascular constriction by tumours or scars.

5. Atherosclerosis obliterans.

Choose the right combination of answers:

A. 1, 2. B. 1, 2, 3, 4. C. 2, 3, 4, 5. D. 3, 4, 5. E. 1, 3, 4.

5. Treatment of post thrombophlebitis involves the following methods:

1. Anticoagulants.

2. Antibiotics.

3. Bypass of the occluded vessel.

4. Insertion of a probe into the affected vessel's lumen.

5. Ligation and removal of the affected vein.

Choose the right combination of answers:

A. 1, 2, 3. B. 1, 4. C. 1, 3, 5. D. 2, 5. E. 1, 2.

6. To assess the potency of venous valves, the following methods are used:

1. Trials by fingers and tourniquets signal.

2. Rheovasography.

3. Doppler ultrasonography.

4. Infrared thermography.

5. Contrast phlebography.

Choose the right combination of answers:

A. 1, 2, 3. B. 1, 3, 5. C. 1, 2, 3, 4, 5. D. 2, 3, 4. E. 2, 3, 4, 5.

7. The causes of pulmonary embolism are as follows:

1. Obliterating thrombosis of superficial veins.

2. Thrombus of the femoral artery.

3. Floating thrombus of the vena cava.

4. Diffuse thrombus of the skin and femoral veins.

5. Thrombus of the sapheno-femoral anastomosis.

Choose the right combination of answers:

A. 1, 2, 5. B. 2, 3, 4. C. 2, 3. D. 3, 4, 5. E. 3, 4.

8. The agents for pathogenic treatment of obliterating en-darteritis are as follows:

1. Desensitizors.

2. Corticosteroids.

3. Vasodilators.

4. Platelet aggregation inhibitors.

5. Antibiotics.

Choose the right combination of answers:

A. 1, 2, 3. B. 2, 3, 4. C. 2, 4. D. 1, 3, 4. E. 2, 3.

9. The risk groups of obliterating endarteritis are as follows:

1. Children.

2. 20-40 year-old men.

3. 50-60 year-old women.

4. Smokers.

5. Patients after frostbite.

Choose the right combination of answers:

A. 1, 5. B. 1, 2, 3. C. 2, 3, 5. D. 2, 4, 5. E. 2, 4.

10. The causes of acute vein insufficiency are as follows:

1. Vein thrombosis.

2. Deep vein thrombophlebitis.

3. Obesity.

4. Varicose veins.

5. Traumatic venous injury.

Choose the right combination of answers:

A. 1, 3, 5. B. 1, 2, 4, 5. C. 2, 3, 4. D. 2, 3, 5. E. 1, 2, 5.

11. Preventive measures in post surgery deep vein thrombophlebitis include the following:

1. Antibacterial therapy.

2. Lower limbs bandaging preand postoperatively.

3. Prolonged postoperative bed rest.

4. Prevention of prolonged immobilization after surgery.

5. Intake of vasodilators.

Choose the right combination of answers:

A. 1, 2. B. 4, 5. C. 2, 3, 5. D. 2, 4. E. 1, 3, 5.

12. The signs characteristic of acute deep vein thrombosis are as follows:

1. Acute local pain (in the affected limb).

2. Cutaneous pallor or cyanosis.

3. Fever.

4. Hyperaemia.

5. Pronounced swelling of the limbs.

Choose the right combination of answers:

A. 1, 4. B. 1, 2, 5. C. 1, 3, 5. D. 2, 4. E. 3, 5.

13. The causes of gangrene are as follows:

1. Major vessel embolism.

2. Arterial injuries.

3. Arterial thrombosis.

4. Frostbite.

5. Burn.

Choose the right combination of answers:

A. 1, 2. B. 1, 3, 4. C. 2, 4, 5. D. 1, 2, 3, 4, 5.

14. Common causes and risk factors of moist gangrene are as follows:

1. Acute circulatory defect in the limbs.

2. Obesity.

3. Putrid wound infection.

4. Defective perfusion of the viscera (the bowel, lungs).

5. Obliterating endarteritis.

Choose the right combination of answers:

A. 1, 2, 3, 5. B. 1, 3, 4, 5. C. 1, 2, 3, 4. D. 1, 2, 4, 5. E. 1, 2, 3, 4, 5.

15. Dry gangrene is characterized by:

1. Inclination to putrid infection.

2. Demarcation line.

3. Pronounced intoxication.

4. Absence of intoxication.

5. Mummification of necrotic tissues.

Choose the right combination of answers:

A. 1, 2. B. 2, 3. C. 1, 3. D. 1, 4. E. 2, 4, 5.

16. The clinical signs of limb moist gangrene are as follows:

1. Oedema and local skin discolouration.

2. Intoxication.

3. Delimitation of necrotic areas.

4. Offensive smell.

5. Absence of the demarcation line.

Choose the right combination of answers:

A. 1, 2. B. 1, 3, 4, 5. C. 2, 4. D. 1, 2, 4, 5. E. 2, 3.

17. The appropriate treatment of limb moist gangrene with severe intoxication and fever may be as follows:

1. Necrectomy.

2. Limb bandaging with antiseptics.

3. Intra-arterial injection of antibiotics.

4. Local hyperbaric oxygenation.

5. Amputation of the affected limb.

Choose the right combination of answers:

A. 1, 2. B. 2, 3. C. 1, 2, 3, 4. D. 3, 4. E. 5.

18. The appropriate surgery for varicose ulcers may be as follows:

1. Ulcer dissection.

2. Autodermic plastics.

3. Secondary suturing.

4. Pathogenic treatment.

5. Grafting of the ulcer surface with jump graft.

Choose the right combination of answers:

A. 1, 2. B. 3, 4. C. 2, 4, 5. D. 2, 3. E. 1, 2, 4, 5.

19. The causes of varicose ulcers are as follows:

1. Venous circulatory defect.

2. Arterial circulatory defect.

3. Lymph circulatory defect.

4. Spinal or neural.

5. Diabetes mellitus.

Choose the right combination of answers:

A. 1, 2, 3. B. 2, 3, 4. C. 1, 2, 3, 4. D. 1, 2, 3, 5. E. 1.

20. The treatment of lip-shaped intestinal fistulas involves the following measures:

A. Conservative treatment.

B. Fistular filling.

C. Fistular diathermocoagulation.

D. Resection of the affected intestinal region.

E. Fistular tract ligation.

Choose **the correct answer.**

Chapter XIV. TUMOURS

Tumour is the pathological overgrowth of tissues, which arises spontaneously and is characterised by structural polymorphism and functional independence, these properties being inherited during cell division.

14.1GENERAL EVALUATION OF THE ONCOLOGICAL PATIENT

Early detection of a malignant tumour is a prerequisite for its successful treatment.

History of the patient usually offers clues that may be suggestive of a malignant process:

• the living conditions and habits (e. g. such carcinogenic factors as smoking or chewing of tobacco);

• the area of living (e.g. skin cancer is much more common in those living in the South; lung cancer predominates in industrialised areas with an excessive air pollution).

At its initial stages a tumour is unlikely to produce any complaints. As the suspicion of a malignancy is sometimes based only on a few indistinct symptoms, the meticulous questioning is mandatory. It is therefore necessary to inquire whether there has been any minor change in the patient's well-being. Of great importance is what is referred to as the syndrome of minor symptoms and signs, i.e. the state of discomfort that may be indicative of a malignancy:

• fatigability without apparent cause and a reduction in working capability;

• rejection or unwillingness to eat certain foods

• drowsiness;

• apathy to what used to be of interest;

• «a foreign body» sensation;

• abdominal discomfort rather than pain (e.g. a feeling of heaviness);

• lack of satisfaction after micturition or defecation, etc.

Furthermore, a change in size, colour or consistency of a pre-existing lesion (e.g. a birthmark) is not infrequently of a diagnostic value.

It has to be, however, noted that such symptoms do not necessarily suggest a malignant tumour.

The earlier the diagnosis of the malignant tumour, the better the prognosis. As the patient with malignancy may first report to a physician of whatever speciality, the oncological alertness is important for each health care professional. The oncological alertness implies:

1. Physician's knowledge of early and/or atypical symptoms and signs of malignancy and its complications.

2. Physician's knowledge of the clinical pictures of premalignant conditions and their treatment.

3. The timely referral of patients with supposedly malignant conditions to specialised medical centres.

4. The adequacy of the patient's examination by the physician who was the first to suspect the malignancy irrespective of their speciality.

Persistent progression of symptoms is often a hallmark of a malignant condition. The history of the disease is often short in duration; on the other hand, a long-standing chronic inflammation or benign tumour may precede a malignant process. The physical examination is invariably based on routine methods: inspection, palpation and auscultation.

Historically, physicians were inclined to emphasise the patient's appearance in their seeking for the cause of the disease and even the location of the tumour, which was relevant to advanced forms of cancer. In fact, at the initial stages patients with malignancy do not show any clinical signs of the disease. Moreover, some may look virtually healthy and even gain body weight.

Premalignant conditions include diffuse and focal overgrowth of the epithelium of the skin and mucous membranes, which can be recognised through inspection and endoscopy.

The examples might be as follows:

• leukoplakia, or «white spots», i.e. vegetations of the epithelium covering mucous membranes, the changes being undetectable on palpation;

• certain benign cutaneous lesions (e.g. papillomas, polyps, birth marks);

• different forms of senile dyskeratosis.

The syndrome of pathological discharge (bloodstained discharge or bleeding) can be encountered in advanced stages of carcinoma. Diagnostically, blood-stained discharge is a common sign of malignancy, which is not the case with bleeding .

The syndrome of malfunction is due to structural and functional disorders of the organ involved. Tumours that grow inside, especially those of smaller organs, tend to cause early symptoms of obstruction (e.g. the tumour of the Vater's papilla leads to early development of jaundice). In contrast, when the tumour affects the lumen of a larger organ (e.g. the large intestine) intestinal obstruction is typical of an advanced malignancy.

Assessing the functional state of the organ affected the physician has to consider both the functional disorder of the organ and the functional presentation of the tumour itself. Most often, the competence of the organ involved is reduced (e.g. a decrease in the acid output as a result of gastric carcinoma), while the clinical signs of intoxication can be associated with hormonal overactivity of the tumour itself.

Pain is not a characteristic feature of tumour, with the exception of tumours arising from blood vessels and neural tissues, which exert pressure on the tissues. Usually, the pain is related to the distention of the adjacent tissues, infiltration of the nerves or organ insufficiency. Hence, intestinal obstruction resulting from the adluminal growth of a tumour causes spastic pains. In addition, persistent pain suggests either serous involvement or tumourous infiltration of the organ (e.g. tenesmus is a symptom of a rectal tumour)

Palpation is one of the major methods used in the physical examination as it provides the physician with vital information of the tumour. The palpation of the tumour is to be gentle and with appropriate pressure, the finger tips being used to feel first the intact adjacent tissue while approaching the tumour itself. It is sometimes performed with both hands, as is the case with feeling the lymph nodes, breast tumours.

The size of a tumour measures from millimetres to centimetres. The tumour shape is accounted for by its nature (benign vs. malignant). Nodularity of the surface and adherence to the neighbouring tissues, coupled with firm consistency, is characteristic of a malignancy, in contrast to a benign overgrowth or a cyst which has smooth surface and is often round and mobile . It is noted that metastatic nodules on the surface of a malignant tumour are likely to be smooth.

The consistency of a tumour appreciably depends on its type:

• soft (normally implies a benign nature of the tumour, e.g. lipomas or polyps of mucous membranes; in some cases, however, this can be a finding of an undifferentiated tumour (e.g. sarcoma);

• hard (associated with an overgrowth of the connective tissue, e.g. fibroma);

• firm (firm consistency, together with elasticity without fluctuation, is typical of an encapsulated tumour filled with fluid);

• wooden-like without demarcation (providessubstantial evidence of a malignant overgrowth, i. e. carcinoma).

The mobility of a tumour can be either spontaneous (active) or induced (passive). Of special importance is the tumour motility in relationship to the skin or muscles.

The tumour can move spontaneously:

• when it originates from a mobile organ in the abdominal cavity;

• on changing the body position;

• on swallowing (goitre);

• on muscular contraction (muscle tumour).

The physician has to evaluate the tumour's mobility. It is of particular significance in infiltrating immobile tumours, which most commonly appear malignant by nature.

It is noteworthy that in numerous cases it is the metastases that are identified first. To confirm the diagnosis of a malignant lesion or its metastases, special investigations have to be performed. The following are the examples:

• tumours of the umbilicus;

• tumours of the ovaries (Krukenberg's tumour);

• Wirchow's metastasis (the metastasis to the supraclavicular lymph nodes) suggesting gastric carcinoma with distant metastases;

• hepatic enlargement with nodules on its surface in an ascitic patient requires ruling out an abdominal malignant tumour.

In confirmed cases these signs invariably serve as the evidence of a stage IV malignant tumour.

Similarly, all the lymph nodes have to be thoroughly palpated. Metastatic lymph nodes differ from intact ones in that they are enlarged, round, firm and occasionally nodular and adhered to the surrounding tissues and other lymph nodes. However, unlike inflamed nodes, they commonly lack tenderness.

Because the malignancies of numerous organs (e.g. the lung, prostate, breast) produce osseous metastases, a meticulous skeletal investigation is required.

The liver may also harbour metastases from various types of tumours, which necessitates its thorough examination. The metastatic liver is enlarged, the edges being nodular, firm and non-tender. It is sometimes even possible to palpate separate clear-cut metastatic nodules.

Also, rectal, oral and pharyngeal tumours have to be examined by way of palpation. The digital examination of these tumours yields additional information about their size, form, mobility and consistency.

All the women suspected of having a malignant tumour are to undergo bimanual gynaecological examination.

Percussion and auscultation are performed within the routine physical examination.

To confirm the diagnosis of a malignant lesion or its metastases special investigations have to be performed:

1. Endoscopy.

2. Cytology (swabs, aspirates).

3. Histology (biopsy).

4. X-ray investigations (roentgenoscopy, roentgenography, tomography, angiography, lymphography).

5. Radioisotope methods (scanning, scintigraphy).

6. Ultrasonography.

7. Computerised axial tomography.

8. Laboratory tests (blood cell morphology, enzyme activity etc, as indicated).

One of the crucial points in evaluating the patient suspected of having a malignant disease is the staging of the tumour, for this helps decide on the appropriate management.

According to the clinical classification, the four stages of pathological overgrowth are identified:

Stage I - tumour is localised, occupies a limited area, does not infiltrate into the wall of the organ, metastases are absent.

Stage II - tumour is of a big size, can infiltrate into the organ wall but does not spread beyond the organ, there can be solitary metastases to the regional lymph nodes.

Stage III - tumour is of a big size with degeneration, infiltration into the hollow organ wall; multiple metastases to the regional lymph nodes are present.

The TNMGP classification

Stage IV - tumour with distant metastases to organs and lymph nodes and with infiltration of surrounding organs.

The TNMGP classification may read as follows: T1-4 N0-3 M0-1 G1-3 P1-4.

The T criteria vary with the organ affected:

Colonic cancers

- T1 - tumour occupying part of the bowel wall;
- T2 - tumour occupying half the circumference of the bowel;
- T3 - tumour occupies the whole circumference of the bowel, constricting the lumen and causing symptoms of intestinal obstruction;
- T4 - tumour circularly narrows the bowel lumen or completely obstructs the lumen of the bowel, leading to intestinal obstruction.

Breast tumours

T1 - tumour measures less than 2 cm.

T2 - tumour measures 2 to 5 cm with skin and nipple involvement.

T3 - tumour, measuring more than 5 to 10 cm, is adherent to the skin or fixed to chest wall as well as fungating tumours.

T4 - tumour measures more than 10 cm with skin and chest wall involvement or fungating tumour.

GENERAL PRINCIPLES OF TUMOUR TREATMENT

The malignant diseases call for immediate therapy, whereas benign masses require treatment if they

- cause dysfunction of the organ affected;
- result in cosmetic defects;
- are found premalignant;
- are suspected of transforming into malignant ones.

Abbreviation	Stands for	Characteristics to be considered	Stages
T	Tumour	Size of the primary tumour	T1-T4
N	Nodes	Involvement of the lymph nodes	NO - nodes are not palpable N1 - metastases to the regional nodes N2 - metastases to the second level nodes N3 - metastases to distant nodes
M	Metastases	Presence of organ metastases	MO - no metastases M1 - metastases present
G	Grade	Tumour differentiation	G1 - low level of malignancy (highly differentiated tumour) G2 - moderate level of malignancy (low differentiated tumour) G3 - high level of malignancy (undifferentiated tumour)
P	Penetration	Depth of the tumourous infiltration into the walls of a hollow organ (histological criteria)	P1 - cancer infiltrating into the mucous membrane P2 - cancer infiltrating into the submucosal layer P3 - cancer infiltrating ito as deep as the serous layer P4 - cancer infiltrating into the serous layer or extending beyond the organ wall

The *therapeutic methods* for malignant disease include surgery, radiation, chemo- and/or hormone therapy.

Surgery is the main method of treatment of malignant tumours and it is often combined with radiation or chemotherapy. This is referred to as *combined therapy* (for example, in breast cancer, cancer of the uterus, ovaries, etc.). The radiation therapy can be either employed preor postoperatively. This can also accompany chemotherapy, as is the case, for example, in myeloma or Hodgkin's lymphoma.

Surgery is not applied if the condition can be treated by radiation or drug therapy alone (e.g. cancer of the lip).

When the tumour has advanced so far that successful surgery in view of a metastatic spread is very unlikely, the case is considered inoperable.

Operating on patients with malignant tumours, the surgeon should follow *the principle of ablasty*,which implies the prevention of spread of tumour cells during the surgery by means of removing the mass within the intact tissues. To avoid damaging the tumour, it is necessary to ligate the veins as early and excise the tumour, fat tissues and lymph nodes en bloc.

The principle of antiblasty involves:

1) the measures aimed at destroying the cancer cells in the operation site (in the wound, in the lymph vessels and veins using electrocautery, laser or plasmatic scalpels;

2) cleansing the wound after excision of the tumour with 70% alcohol solution;

3) regional infusions of chemotherapeutic drugs.

As the tumour cells can spread beyond the organ affected to the lymphatic vessels, lymph nodes and surrounding tissues, it is recommended that a large portion or the entire organ involved be removed together with the surrounding tissues and fasciae. This is known as *the principle of zones.* An operation for breast cancer serves as an illustration, in which case the breast with the fatty tissues, fasciae and the sub-clavial, axillary lymph nodes as well as the pectoralis major muscles is removed en bloc.

The *radical* operation involves the removal of the entire organ (e.g. the breast, uterus) or its large portion (the stomach, bowel) together with the regional lymph nodes.

The *combined* surgery during which the organ affected is excised with part of or the entire organ into which the tumour has spread is also regarded radical.

Palliative operations are performed to remove part or the entire organ if the metastases are not liable to ablation. They are indicated when complications of the malignancy are found (e.g. tumour decay with bleeding, perforation of gastric or colonic cancer).

Symptomatic operations are aimed at eliminating complications caused by the enlarged tumour without removing the tumour itself (e.g. gastrostomy in oesophageal cancer; inter-intestinal anastomosis in bowel cancers complicated by intestinal obstruction, tracheostomy in cancer of the larynx).

Radiation therapy. Above half of the patients with malignant tumours are exposed to radiotherapy. It can either be used as an independent method for early stages of the disease (e.g. cancer of the lower lip, cervix of the uterus and the skin) or is included in the combined therapy. Radiation therapy is commonly coupled with surgery and undertaken either preor postoperatively. In addition, radiotherapy can be combined with chemoor hormone therapy.

The curative effect on the tumour and its metastases is achieved through external, intra-cavitary or interstitial radiation.

External radiation involves g-therapy with radioisotopes (^{60}Co, ^{137}Cs, etc.).

In intracavitary radiation therapy the source of radiation is introduced into a natural cavity (e.g. the oral cavity or uterine cavity, urinary bladder, maxillary antrum etc.). To perform interstitial radiation, isotopes are inserted directly into the tissues using needles or capsules after the removal of the tumour (e.g. postmastectomy). Staying in the tissues for long periods the isotopes act on the residual tumour cells and their metastases to the lymph nodes.

Chemotherapy. The most common malignant tumours (e.g. cancers of the lung, breast, stomach and intestines) are known to respond poorly to drug therapy as compared to surgical and

radiation therapy. Hence, the use of chemotherapy in combination with other methods of treatment.

If combined with surgery, chemotherapy is employed to treat, for instance, ovarian cancer. Also, it is of great importance for the treatment of systemic oncological diseases (e.g. leukaemia, Hodgkin's lymphoma). At the early stage of malignancy, i.e. when the tumour can be removed surgically, chemotherapy alone should not be attempted.

The following groups of chemotherapeutic preparations are used:

1. Cytostatics (novembihin, cyclophosphan, TEPA [triethylenethiophospharamide], dopan, vinblastin, vincristin, etc.) hamper the growth of tumour cells, affecting cellular mitosis.

2. Antimetabolites alter the metabolism of cancer cells by

— suppressing the synthesis of purins (mercaptopurin);

— acting on the enzyme systems (fluoruracil, phthorafur) or on the transformation of folic acid (metotrexate).

3. Anti-cancer antibiotics are a group of compounds produced by fungi or microorganisms: actinomycin D, bruneomycin, mytomycin.

Hormone therapy. Hormones are a treatment of choice for hormone receptor-positive tumours.

These medications supplement the combined therapeutic methods of surgery, radiotherapy and chemotherapy. The preparations of the male sex hormone - androgen (testosterone propionate, methyl testosterone) are indicated in breast cancer, whereas those of female sex steroid - estradiol (synestrol and diethylstilboestrol) are known to be effective in cancer of the prostate.

Hormone therapy of tumours also includes surgeries on the endocrine glands e.g. surgical or radiation castration of women with breast cancer.

TESTS

Chapter XIV. TUMOURS

1. The absolute indications for removal of benign tumours are as follows:

1. Functional disorders of the affected organ.

2. Persistent injury to superficial benign tumours with clothes and footwear.

3. Progressive tumour growth.

4. Persistence of tumour.

5. Suspicion of malignant degeneration.

Choose the right combination of answers:

A. 1, 2, 3, 4. B. 1, 3, 4, 5. C. 1, 2, 3, 5. D. 2, 3, 4, 5. E. 1, 2, 3, 4, 5.

2. Malignant tumour is characterized by:

1. Expansive growth.

2. Lymphogenous spreading.

3. Inclination to recurrence.

4. Infiltrative growth.

5. Incapsulation.

Choose the right combination of answers:

A. 1, 2, 3. B. 3, 4, 5. C. 2, 3, 4. D. 2, 3, 5. E. 2, 3, 4, 5.

3. GI endoscopy helps:

1. Identify the localization of the tumour.

2. Recognise the colour of the tumour.

3. Stage the tumour.

4. Assess regional lymphadenopathy.

5. Identify the decay of the tumour.

Choose the right combination of answers:

A. 1, 2, 3. B. 1, 3, 4. C. 1, 4, 5. D. 2, 3, 4. E. 1, 2, 5.

4. During surgery, the gastric tumour with regional metastases was found to have penetrated all the layers of the stomach. The tumour was mobile. Stage the tumour:

A. Stage I.

B. Stage II.

C. Stage III.

D. Stage IV.

E. The malignant character of the tumour is doubtful.

Choose the correct answer.

5. The antiblastics includes:

1. Careful, non-traumatic removal of tumour.

2. Removal of visible metastases.

3. The use of electrotomes and laser scalpels.

4. Ligation of hollow organs above and below the tumour.

5. Cleansing of the wound with alcohol.

Choose the right combination of answers:

A. 1, 2. B. 1, 3. C. 3, 5. D. 1, 4, 5. E. 2, 4.

6. The ablastics includes the following:

1. The cleansing of surgical wound with alcohol.

2. Preoperative radiotherapy.

3. Frequent change of instruments and linen.

4. Preliminary ligation of blood vessels.

5. Surgery within intact tissues.

Choose the right combination of answers:

A. 1, 2. B. 2, 3. C. 1, 4. D. 3, 5. E. 4, 5.

7. The examples of palliative surgeries for malignant tumours involve the following:

1. Removal of metastasis together with the tumour.

2. Internal bypass anastomosis in obstruction of the affected organ's lumen.

3. Arrest of haemorrhage from the tumour.

4. Removal of the primary tumour with metastases left intact.

5. Major radical surgery.

Choose the right combination of answers:

A. 1, 2, 3. B. 2, 3, 4. C. 2, 3, 4, 5. D. 1, 5. E. 2, 3, 5.

8. The patient who has had the malignant tumour removed is considered cured:

A. When the initially small tumour was removed completely.

B. If metastases were not found during surgery.

C. If signs of recurrence have not been found for at least 5 years postoperatively.

D. If the surgery was performed with all oncological rules observed.

E. All of the above are correct.

Choose the correct answer.

9. Usually, superficial benign tumour:

1. Is round.

2. Is not attached to the neighbouring tissues.

3. Is attached to the neighbouring tissues.

4. Is tender on palpation.

5. Has regional lymphadenopathy.

Choose the right combination of answers:

A. 1, 2. B. 1, 3, 4. C. 1, 2, 3. D. 2, 4, 5. E. 1, 2, 5.

Chapter XV. PARASITIC SURGICAL DISEASES

The number of parasites that may cause illness in a human body approximates one hundred and fifty species, some of the conditions requiring surgery as the definitive treatment

15.1 ECHINOCOCCOSIS (HYDATID DISEASE)

Ehinococcosis is a tissue tapeworm infection of humans caused by the larval stage (a hydatid cyst) of*Echinococcus granulosus.*

The adult worm measuring 5 mm in length and consisting of a scolex and three proglottids is found in the small intestines of dogs, wolves and other canines, sheep, and cattle that are infected from contaminated pastures or water. The terminal or gravid proglottid splits, releasing eggs into the stool. These eggs pass to the external environment and are ingested by an intermediate host (e.g. sheep or human). Humans may ingest the eggs by handling a dog or drinking contaminated water. The embryo is liberated from the ovum in the small intestine (60-70% of these remain at this site) and gains access to the blood stream and thus to the liver, or beyond (in about 10-15% of cases) to the lung, brain, kidney, bones, and other tissues. The resultant cyst grows very slowly (1 mm a month), sometimes intermittently (and may outlive the patient) to produce pressure symptoms and aseptic productive inflammation around the cyst. It is fluid-filled and contains scolices, brood capsules, and 2nd generation (daughter) cysts containing infectious scolices. When the intermediate host is eaten by a carnivore, the scolices are released into the GI tract, where they develop into adult worms.

The dog is the principal definitive host and the sheep the most common intermediate. Human infection, often acquired in childhood during play with infected dogs, is most common in the sheep-raising areas of the world, including Caucasus, West Siberia, Central Asia.

The majority of cysts are found in the liver, where, after remaining asymptomatic for decades *(stage*1), they finally produce clinical signs and symptoms such as abdominal pain or a palpable mass *(stage*2). The pressure symptoms vary, depending on the organ or tissue involved. In nearly 75% of patients with hydatid disease the right lobe of the liver is invaded and contains a single cyst. In others, a cyst may be found in the lung, bone, brain or elsewhere. At stage 3,

complications may occur e. g. jaundice, if the bile duct is obstructed. Rupture into the bile duct, abdominal cavity, peritoneal cavity, or lung may produce fever, urticaria, or a serious anaphylactoid reaction. The released scolices may produce metastatic infection. Pulmonary cysts are usually discovered on routine chest X-ray. Some rupture, and cough, chest pain, and haemoptysis result.

The diagnosis depends on the clinical, radiological (a round, often irregular, pulmonary mass of uniform density on chest X-ray or CT scan, or an avascular area on angiography) and ultrasound findings (fluid-filled cysts) in a patient who has lived in close contact with dogs in an endemic area. Serologic tests (complement fixation and enzymelinked immunosorbent assay) are positive in approximately 60% of pulmonary and 90% of hepatic lesions.

Complete blood count may reveal eosinophilia, sometimes being as severe as 10-13%, often following palpation of cyst or *Cazoni's skin test*, which involves intradermal injection of 0,2 ml of echinococcal cyst fluid. Marked hyperaemia and oedema help confirm the diagnosis. In 10-20% of cases the reaction may be false-negative.

Surgery, or *echinococcectomy*, is the only definitive treatment of the hydatid cysts which involves their removal. The cyst may be removed together with the fibrous capsule or with part of the organ affected, e.g. pulmonary resection. Incision of the cyst, or *echinococcotomy*, is indicated if the removal of the cyst cannot be performed. Prevention of dissemination of the neighbouring tissues with the scolices should be borne in mind during the procedure. The cyst fluid and daughter cysts are removed by incision of the superficial and, in part, fibrous capsule. The resultant cavity should be cleansed with antiseptic solutions of specific activity (formaldehyde or hypertonic saline with hydrogen peroxide) and drained. The cavity may also be shrunk by means of suturing the fibrous capsule.

Alveococcosis is a parasitic disease with primary damage to the liver caused by larvae of *Alveococ-cus multilocularis.*

Alveococcosis is an endemic disease with prevalence lower than that of echinococcosis. It is found in Canada, Alaska, Austria, Japan and Germany, in some regions of Siberia and the Far East.

Foxes, dogs, wild cats, and other small carnivores are the definitive hosts of the helminth.

The intermediate hosts include voles and other microtine rodents, and humans. It is noteworthy that humans are a «dead-end» intermediate host only and cannot serve as final host for intestinal adult *A. multilocularis.*

After ingestion of eggs from handling fur of infected carnivores oncospheres which form multi-chambered solid cysts without an enveloping membrane are released in the intestine and penetrate it with subsequent entering bloodstream of the intermediate host. The cysts continue to grow in the liver, usually with fatal outcome.

As a result of definitive hosts' feeding on infected rodents the worms attach to their small intestines, mature and produce eggs which leave their bodies with faeces.

The metastases take place in the liver, lungs and brain. Compression of the bile ducts results in obstructive jaundice.

The cysts of the tapeworm resemble porous cheese with small cavities that are filled with puslike contents.

Secondary suppuration evolves into hepatic abscess of the liver or purulent cholangitis.

The disease develops slowly with a long asymptomatic period. It is usually recognised accidentally (e. g. clinical screening accompanied by ultrasound investigation).

The complications of the disease (cholangitis, obstructive jaundice or pulmonary or cerebral metastases) may be its early signs. Peripheral localization of the worm in the liver may

produce tumourlike appearance of the organ. On palpation, non-tender hepatomegaly with hard consistency of the liver is a common presentation. The patient's general condition is usually satisfactory.

Parahilar localization of the cyst brings about early jaundice which occurs due to compression of the bile ducts.

The historical data (i.e. residing 5-15 years ago in endemic regions, episodes of contact with wild animals via hunting, processing animal carcasses and skins, intake of wild berries) should raise suspicion of the condition.

To confirm the diagnosis, laboratory (eosinophilia) and skin tests (Cazoni's reaction or haemagglutinin with latex, which are positive in 70-75% of cases) are used.

For the differential diagnosis X-ray, angiography, CT, radioisotope or US scanning may be helpful. Chest X-ray is mandatory, persistent headache requires meticulous neurological examination.

Treatment. Surgery, i.e. hepatic resection coupled with the solid cyst enucleation, should be combined with specific drug therapy. Small residual part of the parasite should be infiltrated with antiparasitic drugs (20 ml Tripaflavine 0,1%).

For systemic therapy levamisole and mebendazole are used.

Prevention of both echinococcosis and alveococcosis includes strict epidemiological control at slaughterhouses and destruction of infected organs of killed animals. Moreover, contacts with dogs should be minimised, especially those of children who are unaware of the danger of infection and safety measures. The veterinary control of guard dogs is also of importance.

15.2 OPISTHORCHIASIS

Opisthorchiasis is an important hepatic and pancreatic fluke of humans. It is caused by *Opisthorhis felineus* or *Distomum sibiricum.* The other principal mammalian hosts of the disease are dogs, cats, foxes, pigs, while the *first* and *second* intermediate hosts are snails and fresh-water fish (e. g. the carp and salmon), respectively.

The egg, on reaching fresh water, hatches into a free-swimming miracidium. After multiplication and further development within the snail, thousands of free-living cercariae are released and must enter the second intermediate host, where they encyst to form metacercariae. Infections follow ingestion of raw, dried, salted, or pickled fish containing the metacercariae. The larvae are released in the duodenum, enter the common bile duct, and migrate to the 2^{nd} order bile ducts (or, occasionally, the gallbladder and pancreatic ducts), where they mature in about 1 month into adult, flat flukes varying from a few mm to several cm in length. Endemic in West Siberia, Kazakhstan, in the regions of the Volga, Dnieper, and Neman Rivers, the infection is found elsewhere most frequently among immigrants from those areas and in fish imported from there.

The mode of spread of the fluke is via ova in faeces or water.

The parasite may cause hepatic dystrophy and necrobiosis. The common surgical complications of opisthorchiasis are suppurative cholangitis with hepatic abscess. The perforation of the bile ducts results in peritonitis and hepatic abscess penetration into abdominal or thoracic cavities. Often, chronic opisthorchiasis may even cause hepatic carcinoma. Opisthorchiasis of the pancreas may be complicated by acute pancreatitis or pancreatic carcinoma.

The complications of opisthorchiasis lack characteristic signs. However, clinical and epidemiological findings often suggest the diagnosis, which can be confirmed only by identification of the eggs in faeces or duodenal contents.

The treatment of the complicated opistorchiasis involves conventional methods applied in parasitic diseases coupled with preand postoperative medical therapy with hexachlorparaxicol. The surgery on the organs other than the liver or bile ducts or pancreas requires that specific therapeutic agents should be given postoperatively.

15.3 ASCARIASIS

Ascariasis is a human infection caused by a roundworm

Ascaris lumbricoides and characterized by early *pulmonary* and later *intestinal* symptoms. Being the only reservoir humans are infected by eating food (e. g. vegetables) contaminated with mature ova. These hatch in the duodenum and the larvae migrate through the wall of the small intestine and are carried by the lymphatics and bloodstream to the lungs. Here they pass into alveoli, ascend the respiratory tract and are swallowed. They mature in the jejunum, where they remain as adult worms. Disease may be caused by both the larval migration through the lung and the presence of the adult worm in the intestine.

Infection with the adult worm is usually diagnosed by finding eggs in the stool. Occasionally, adult worms are passed in the stool or vomited. Larvae are occasionally found in the sputum during the pulmonary phase.

A tangled mass of worms may cause *intestinal obstruction* (mostly in children or young adults) with typical colicky pains, «acute abdomen» syndrome, vomiting with intestinal contents and specific X-ray findings; a heavy infestation will compete for nourishment and contribute to malabsorption.

The complications of ascariasis may require surgery. The surgical approach in intestinal obstruction requires that the tangled mass of the worms should be descended to the large intestine during laparotomy with subsequent medical therapy; enterotomy and removal of the helminth may occasionally be indicated.

Ascaris limbricoides-associated appendicitis lacks specific signs. The adult worms may inadvertently be found in a patient operated on for acute appendicitis, in which obstruction of the appendix can be evident.

Other complications include *blockage of the bile or pancreatic duct,* which may only rarely be found. The maturation of the worms in the intestine can lead to penetration through Vater's ampulla into the common bile duct and the biliary tree. This, in turn, results in obstructive jaundice, suppurative cholangitis, acute cholecystitis, hepatic abscess.

The clinical picture of biliary ascariasis includes the signs of obstructive jaundice, suppurative cholangitis, hepatic abscess with acute onset and rapid progression of sepsis characterized by severe toxaemia.

ERCP, ultrasound scanning, CT may help establish the definitive diagnosis.

The surgical methods include cholecystor choledochectomy, parasite extraction with external bile duct drainage.

Pancreatic involvement (inflammation) *in ascariasis* occurs if the worms gain entrance to the main pancreatic duct, which results in chronic indurative or acute (e. g. haemorrhagic) pancreatitis. The only option is surgery - pancreaticotomy with removal of the worms and postoperative specific antiparasitic drug therapy.

Ascaris lumbricoides-associated GI tract (oesophagus, stomach, intestine) perforation results from ulcerative and necrotic changes of the mucosal membranes, which, in turn, may produce the clinical signs of peritonitis.

Postsurgical complications of ascariasis are due to active migration of the worms following the operation. They may also be vomited with occasional subsequent mechanical asphyxia caused by their penetration into respiratory tract.

Surgeries that involve incision of hollow organs may be complicated by discharging of the worms into the free abdominal cavity through sutures with subsequent suppurative peritonitis.

Severity of the postsurgical complications of ascariasis requires that each elective surgery should be preceded by identification of the ova in faeces. Once the diagnosis of ascaris has been confirmed, preoperative drug therapy is mandatory.

15.4 AMOEBIASIS

Amoebiasis is an infection usually caused by *Entamoeba histolytica* and mainly characterized by ulcers in the colon and possible haematogenous spread of the parasite to visceral organs (the liver, lung, brain, etc.) with development of abscesses. The parasite formerly termed *E. histolytica* is now known to consist of two separate species, *non*-pathogenic *E. dispar* and pathogenic *E. histolytica*, which are distinguished by molecular techniques, isoenzyme studies, or monoclonal antibody typing after culture of trophozoites.

The disease is common throughout the tropics, particularly in Central Asia, the Caucasus, occasionally in other regions.

The motile trophozoite, the parasitic form, dwells in the bowel lumen where it feeds on bacteria or tissue. With diarrhoea, the fragile trophozoites pass unchanged in the liquid stool and rapidly die. If diarrhoea is not present, the organisms usually encyst before leaving the gut. The cyst, the infective form of the orgamism, resists environmental changes and may be spread either directly, i.e. from person to person, or indirectly, i.e. via food (e.g. lettuce) and water.

The main reservoir of the infection is human who discharges amoebic cystic with faeces.

In the colon, the parasite penetrates the submucosal layer, which results in inflammation, necrosis of tissues and ulcers. Via the intestinal vessels, amoebae spread to the internal organs where they cause abscesses. The intestinal wall may perforate to lead to suppurative peritonitis. Clinical signs of intestinal amoebiasis are similar to those of bacterial dysentery and includes fever, weakness, fatiguability or malaise, bloody and mucous diarrhoea, sometimes resembling of «raspberry jelly» in appearance. Identification amoebae in faeces and specific serologic reactions confirm the diagnosis.

Perforation and gangrene of the colon lead to suppurative peritonitis. The diagnosis is based on clinical signs of peritonitis characterized by endotoxic shock, but peritoneal irritation is usually slight. Abrupt deterioration of the patient's condition or onset of the signs suggestive of peritonitis should serve as an indication for laparoscopy. Once the diagnosis has been made urgent surgery is necessary to perform. Intestinal gangrene requires bowel resection, while in pronounced necrosis around the perforating ulcers the resection should be followed by with colostoma if suturing is inopera.

Amoebiasis-associated colitis may occasionally be complicated by *amoebic granuloma* (i.e. perifocal infiltrate in the intestinal wall around the ulcer) as a result of absence of specific treatment. Morphologically, the granuloma is productive inflammation with necrotic foci in the intestinal wall. The caecum and ascending colon are most commonly affected.

Abdominal palpation reveals tender mass of rubbery consistency in the right lower quadrant.

The diagnosis is based on history of chronic amoebiasis, clinical data and the results of colonos-copy. Identification of amoebae in faeces is a direct confirmation of the diagnosis. The suppuration of the infiltrate may cause bowel perforation and faecal peritonitis. Large amoebic granulomas may result in intestinal obstruction. In non-complicated amoebic granuloma, drug therapy is indicated. Failures of medical therapy may require elective surgery, while in suppuration and intestinal obstruction urgent surgery is needed.

Amoebic appendicitis results from specific ulcers in the appendicular mucosa with suppuration and lacks specific clinical signs.

In extensive ulcers *intestinal bleeding* is possible. The source of bleeding localized in the distal part of the large bowel produces profuse haemorrhage with scarlet blood, while that in the upper part of the GI tract results in discharge of tarry blood. Conservative measures to replenish the circulating blood volume are used to control bleeding (see Chapter V) which should be coupled with antiprotozoal therapy.

Surgery (resection of intestine) may be necessary in profuse intestinal bleeding, colonoscopy helping identify the source of bleeding.

Liver abscess is the most common surgical complication of amoebiasis and occurs in 2-10% of cases. The specificity of the liver abscess consists in the absence of the suppurative membrane, it contains necrotised tissues with odourless coffee-like liquid pus, while suppuration produces offensive green or whitish pus.

In 80-90% of cases abscesses are found in the right lobe of the liver.

Amoebic abscess is a severe complication with toxaemia, hepatic failure, exacerbation of intestinal amoebiasis. The patients complain of the pain in right hypochondriac region radiating to the right scapula and right shoulder.

In superficial abscesses, swelling of the skin, tenderness at intercostal spaces and the liver with hepatomegaly may be found.

In chronic liver abscess the signs of severe debilitating disease predominate: dry flabby grey skin, icteric sclerae, signs of malnutrition, sometimes pedal or shin oedema. The liver is enlarged (but less tender than in acute condition), of dense consistency, sometimes bosselated. Liver abscess may perforate the abdominal or thoracic cavities, retroperitoneal space, bile ducts and even the abdominal wall.

To make the diagnosis of liver amoebiasis abscess special methods of examination are used: X-ray, scintigraphy, ultrasound and CT scanning. USor CT-guided laparocentesis may help confirm the diagnosis as does identification of amoebae in pus.

The treatment of liver abscess includes combination of amoebicides, antibacterial and detoxication therapy. Small, even multiple abscesses, may be treated by USor CT-guided laparocentesis coupled with aspiration and administration of amoebicidic and antibacterial drugs.

In unsuccessful conservative treatment or abdominal perforation, the incision and drainage of the abscess are indicated.

Lung abscess. The spread of amoebae to the lungs leads to pneumonia or lung abscess. The clinical signs or X-ray findings of amoebic pneumonia and abscess are similar to those of non-specific pulmonary conditions.

Abscess requires antibacterial therapy and, if in vain, is tapped and pus aspirated with following administration of antiseptics into the cavity.

Brain abscess (mostly multiple) is a rare complication. Apart from clinical methods, special methods of investigation (cerebral CT, US) are used to make the diagnosis of brain amoebiasis. Antiamoebic and antibacterial drugs are indicated; however, in formed abscesses surgery (removal of the abscess together with its capsule) may be necessary.

All surgical complications invariably require antiamoebic therapy (emetine, metronidazole, chloroquine).

The prevention of the amoebic complications includes personal precautions against contracting amoebiasis in tropics and subtropics, i.e. not eating fresh uncooked vegetables nor drinking unboiled water and aggressive treatment of patients with intestinal amoebiasis.

15.5 FILARIASIS

Filariasis is a group of diseases occurring in tropical and subtropical countries (Africa, South America and South Asia) and caused by *Filarioidea.*

For surgery, the conditions due to infection with *Wuchereria bancrofti* and *Brugia malayi* are of prime significance, the two nematodes affecting the lymphatic system.

Wuchereria bancrofti is found only in humans; *Brugia malayi* is often spread to man from an animal host. The adult filarioidea are found in the human lymphatic system. Microfilariae released by gravid females are found in the peripheral blood, usually at night. Infection is spread by many species of mosquitoes; vectors of *W. bancrofti* are *Aedes, Culex,* and *Anopheles;* of *B. malayi, Anopheles* and*Mansonia*. The microfilariae are ingested by the mosquito, undergo development in the insect's thoracic muscles for eight to thirty-five days, and, when mature, migrate to its mouthparts. When the infected mosquito bites a new host (humans, monkeys, dogs, cats), microfilariae penetrate the bite puncture and eventually reach the lymphatics, where they develop to the adult stage. This, in turn, affects the function of the lymphatics and causes allergic lymphangitis or even lymphatic obstruction (e.g. in the thoracic duct).

The persistent lymphatic obstruction results in elephantiasis.

The clinical features of the disease include bouts of fever accompanied by pain, headache, malaise*(stage* 1). The lymph nodes tend to be hard and tender, the lymphatic vessels are tender and show erythaema along their course. Lymphangitis extends from proximal to distal limb segment. Inflammation of the spermatic cord and axillar lymph nodes precedes lymphangitis. Simultaneously, urticaria-like rash with pruritus is evident at various body areas.

Further attacks follow in several months or years, temporary oedema becomes more persistent and regional lymph nodes enlarge. Progressive enlargement, coarsening, corrugation and fissuring of the skin and subcutaneous tissue with warty superficial excrescences develop gradually, causing irreversible «elephantiasis» with vascular rupture, chyluria and chylous effusions *(stage* 2).

Complication by pyogenic infection results in abscesses or phlegmons.

Stage 3 of the disease is characterized by elephantiasis of the lower limbs and scrotum, and occasionally of the upper limbs, breast and vulva. The diagnosis is based on the clinical features and identification of microfilariae in blood or lymph fluid.

Treatment. At initial stages, the antiparasitic drug therapy with diethylcarbamazine (0,1 g q 8 hours for 7-10 days) is indicated, with regular identification of micrifilariae in the blood. If required, the course may be repeated.

Secondary infection serves as an indication for antibacterial therapy.

Abscesses, pleural empyema, peritonitis and elephantiasis all require surgery (debridement of the skin, subcutaneous fat, fasciae). To cover the skin defect, the dermatome flaps from intact removed skin areas or other body areas (skin grafting) are used.

In scrotal elephantiasis, the skin, subcutaneous fat, testicle capsules are removed within the limits of intact tissues.

The surgery should be performed it the parasite is no longer found on serial blood tests. The identification of the filarioidea requires preoperative specific drug therapy.

15.6 FASCIOLIASIS

Fascioliasis is a parasitic disease caused by a trematode *Fasciola hepatica* (a liver fluke) and characterized by involvement of the liver and bile ducts.

The condition is found worldwide, most often in France and Cuba.

Apart from human, other mammalian hosts are sheep, goats and cattle, while intermediate ones are freshwater snails.

F. hepatica is only accidentally transmitted to humans via consumption of wild watercress or other plants grown on the grazing land of infected animals. These excrete eggs in their faeces, from which ciliated miracidia emerge. They enter the intermediate host in which larval development takes place. Eventually, cercaria are released and these encyst on aquatic or surface vegetation. After ingestion by a mammalian host, the parasites encyst, migrate through the intestinal wall and penetrate the liver capsule after traversing the peritoneal cavity. Immature flukes reach the bile duct by passing through hepatic parenchyma and after maturation begin to produce ova. Adult flukes remain within the biliary tract or gallbladder for many years.

The fluke affects the epithelium of the bile ducts to increase the risk of suppurative infection (suppurative cholecystitis, liver abscess, cholangitis) or obstructive jaundice that require surgery. The signs of suppuration of the gallbladder, bile ducts in the patients with established fascioliasis strongly suggests the complications of fascioliasis. The destruction in the liver, bile ducts of whatever origin requires urgent surgery, during which the flukes may be identified.

Irrespective of the site of *F. hepatica,* the surgery is performed in compliance with the general principles. Specific drug therapy is with hexachlorparaxicol or emetine hydrochloride.

15.7 PARAGONIMIASIS (ENDEMIC HAEMOPTYSIS)

Paragonimiasis is a disease caused by several species of flukes of the genus *Paragonimus* (the most common being *Paragonimus westermani)* and mainly characterized by involvement of the lungs and brain.

Human infections are most frequent in the Far East (China, Korea, Japan, Philippines) but there are also endemic foci in South America, West Africa, Somalia and India.

The adult flukes measuring 10x6 mm live in small «nests» in the lung or elsewhere. The sputum contains ova, which may be expectorated or swallowed and passed in the faeces. Miracidia emerge in water from these eggs and seek the first intermediate host, a fresh-water snail. Larvae emerging from the snail within four weeks encyst as metacercariae in freshwater crabs or crayfish within further two to three months. Humans or certain other mammals become infected if they eat the crustacea raw or inadequately cooked.

The adult flukes lie in cysts up to 1 cm in diameter, situated chiefly in the lung and containing reddish-brown fluid that results from inflammation. In severe infections, cysts may also be present in the pleural or peritoneal cavities, in the brain, muscles, skin or elsewhere.

The clinical features of paragonimiasis depend on the stage of infestation, migration and life cycle of the parasite. The first symptoms are slight fever, cough and the expectoration of brown or black sputum. Occasionally, there are bouts of frank haemoptysis with severe chest pain. Increasing clinical signs in the chest may simulate acute bronchitis, lobar pneumonia, haemorrhagic pleurisy or pulmonary tuberculosis, which may coexist. On auscultation of the lungs, rales are audible; shortness of breath is evident in half of the cases. The intoxication of pulmonary paragonimiasis manifests itself by tachycardia, neurologic symptoms (headache, fatigability, irritability, dizziness) or even myocardial dystrophy.

When the parasites lodge in the abdomen there may be symptoms of enteritis or hepatitis. Laparoscopy or laparotomy may demonstrate fibrinous or fibrino-purulent exudates. If the flukes settle in the abdominal wall they may produce sinuses discharging through the skin. Cysts in the central nervous system may cause signs of cerebral irritation, encephalitis or myelitis. The most typical cerebral symptoms and signs include intense headache, visual impairment, and convulsive fits similar to epileptic ones and may be accompanied by complete and incomplete unconsciousness.

The disease may be extremely chronic as the adult worms may survive for twenty years.

Paragonimiasis is diagnosed based on specific history (eating crabs or crayfish in the endemic focus), clinical and laboratory data. Eggs may be identified on microscopic examination of the faeces, sputum or discharge. The pulmonary X-ray appearance may vary; however, the lesions are usually located close to the pleural surfaces. Extra-pulmonary sites of the disease may be recognised by angiography or biopsy. Complete blood count will demonstrate eosinophilia, lymphocytosis, hypochromic anaemia.

Intradermal test with the specific antigen is positive, i.e. emerging erythaema of 3-4 cm, infiltrates above 1 cm in diameter, severe pruritus or lymphangitis.

Treatment involves oral intake of bithinol 30-40 mg/kg/day in divided into 2-3 doses for 10 days.

Unsuccessful medical treatment, recurrent pulmonary haemorrhage, persistent haemoptysis, or clinical deterioration (severe neurological and mental signs) are all indications for surgery (pulmonary resection or cerebral cyst removal).

Tests

Chapter XV.

PARASITIC SURGICAL DISEASES

1. The clinical stages of echinococcosis are the following ones:

1. Asymptomatic.

2. Slight clinical signs.

3. Pressure symptoms.

4. Complicated echinococcosis.

5. Remission.

Choose the right combination of answers:

A. 2, 3, 4. B. 1, 2, 4. C. 1, 2, 3, 4. D. 1, 3, 4. E. 1, 3, 5.

2. The clinical signs of echinococcosis result from

1. Absorption of metabolites produced by the parasites.

2. Mechanical compression of the neighbouring tissues.

3. Suppuration of the cyst.

4. Break of the cyst.

Choose the right combination of answers:

A. 1, 2, 4. B. 2, 3, 4. C. 1, 3, 4. D. All answers are correct.

3. The major route of acquiring echinococcosis is one of the following:

A. Ingestion of *E. granulosus* ova.

B. Ingestion of *E. granulosus* larvae.

C. Larval penetration of the skin.

D. Penetration the blood resulting from bite of wild animals.

Choose the correct answer.

4. Treatment of the patients with echinococcosis includes the following options:

1. Removal of the cyst.

2. Incision of the cyst.

3. X-ray therapy.

4. Chemotherapy.

5. Antiparasitic drug therapy.

Choose the right combination of answers:

A. 1, 3, 5. B. 2, 3. C. 1, 2. D. 1, 5. E. All answers are correct.

5. The life-cycle of *E. granulosus* within the human body lasts

A. 5-6 months.

B. 2-10 years.

C. 20-30 years.

D. 30-40 years.

E. 60-70 years.

Choose the correct answer.

6. Which of ascaridosis' complications require surgical tret-ment?

1. Intestinal obstruction.

2. Appendicitis.

3. Ascaridosis of bile ducts.

4. Ascaridosis of lungs.

5. Perforation of hollow organs.

6. Ascaridosis of pancreas.

Choose the right combination of answers:

A. 1, 3, 5, 6. B. 1, 2, 3, 5, 6. C. 1, 3, 5, 6. D. 1, 2, 3, 4, 5. E. All answers are correct.

7. What is a source of ascaridosis' contamination?

1. Cat.

2. Dog.

3. Fox.

4. Man.

Choose the right combination of answers:

A. 1, 2, 3. B. 2, 4. C. 4. D. All answers are correct.

8. What is most frequent complication of amoe-biasis?

1. Colitis.

2. Formation of specific granuloma.

3. Appendicitis.

4. Abscess of the liver.

5. Intestinal hemorrhage.

Choose the right combination of answers:

A. 1, 3, 5. B. 2, 3, 4. C. 1, 5. D. All answers are correct.

9. Fascioliasis is a disease of:

A. Lungs.

B. Brain.

C. Intestine.

D. Liver and bile ducts.

E. Pancreas.

Choose the correct answer.

10. In case of filariasis helminthes exist in:

A. Blood vessels.

B. Liver.

C. Lymphatic vessels.

D. Intestine.

E. Pancreas.

Choose the correct answer.

11. Paragonimus in early stage of the disease manifests as:

A. Paragonimus of lungs;

B. Abdominal syndrome;

C. Paragonimus of brain;

D. Peritonitis;

E. Joint syndrome.

Choose the correct answer.

12. Which of opisthorchiasis' complications require surgical treatment?

1. Suppurative cholangitis.

2. Perforation of bile ducts, abscess of liver.

3. Acute hepatitis.

4. Cancer of liver.

Choose the right combination of answers:

A. 1, 3, 4, 5. B. 1, 2, 3, 5. C. 1, 2, 3, 4. D. 3, 4, 5. E. All answers are correct.

13. For diagnosis of amoebic abscess of the liver which of the following methods are used:

1. X-ray examination.

2. US examination.

3. Nucleonic-scanning examination.

4. CT.

5. Puncture fluid formation under US-control.

Choose the right combination of answers:

A. 1, 2, 3. B. 2, 5. C. 2, 4, 5. D. 2, 3, 5. E. All answers are correct.

14. Clinical signs of filariasis in acute period are:

1. Fever.

2. Existence of lymphadenitis.

3. Painful lace-like infiltration in area of lymphatic vessels.

4. Enlargement of liver.

Choose the right combination of answers:

A. 1, 2, 3, 4. B. 2, 3, 4, 5. C. 1, 3, 4. D. 1, 2, 4, 5. E. All answers are correct.

15. Clinical signs in case paragonimus of lungs may look like:

1. Bronchopneumonitis.

2. Acute bronchitis.

3. Hemorrhagic pleuritis.

4. Abscess of lung.

5. Cancer of lung.

Choose the right combination of answers:

A. 1, 2, 3. B. 1, 3, 4, 5. C. 2, 3, 4. D. 1, 4, 5. E. All answers are correct.

CLUES

Chapter I.

ASEPSIS AND ANTISEPSIS

• Asepsis

1 - B, 2 - D, 3 - D, 4 - E, 5 - B, 6 - D, 7 - A, 8 - B, 9 - B, 10 - E, 11 - B, 12 - E, 13 - B, 14 - B.

• Antisepsis

1 - C, 2 - C, 3 - C, 4 - E, 5 - B, 6 - D, 7 - B, 8 - B, 9 - B, 10 - B, 11 - C, 12 - C, 13 - E, 14 - D, 15 - E.

Chapter II. ANAESTHESIA

1 - E, 2 - C, 3 - C, 4 - D, 5 - E, 6 - D, 7 - D, 8 - A, 9 - D, 10 - D, 11 - D, 12 - D, 13 - C, 14 - E, 15 - C, 16 - C, 17 - C, 18 - D, 19 - A, 20 - E, 21 - C, 22 - C, 23 - B, 24 - E, 25 - C, 26 - C, 27 - E, 28 - D, 29 - D, 30 - A, 31 - D, 32 - D.

Chapter III.

CARDIOPULMONARY RESUSCITATION

1 - C, 2 - D, 3 - D, 4 - A, 5 - C, 6 - C, 7 - C, 8 - D, 9 - C, 10 - C, 11 - D, 12 - C, 13 - D, 14 - D, 15 - B, 16 - C.

Chapter IV. HAEMORRHAGE

1 - C, 2 - D, 3 - A, 4 - C, 5 - E, 6 - C, 7 - E, 8 - D, 9 -C, 10 - C, 11 - B, 12 - A, 13 - A, 14 - A, 15 - D, 16 - A, 17 - D, 18 - B, 19 - B.

Chapter V.

BLOOD TRANSFUSION

1 - A, 2 - D, 3 - B, 4 - C, 5 - E, 6 - A, 7 - B, 8 - D, 9 -C, 10 - E, 11 - A, 12 - D, 13 - E, 14 - C, 15 - A, 16 - B, 17 - D, 18 - D, 19 - C, 20 - D, 21 - D, 22 - D, 23 I - B, 23 II - D, 24 - B, 25 - A, 26 - B, 27 - B.

Chapter VI.

BLOOD COMPONENTS, BLOOD PRODUCTS AND NITRITIONAL SUPPORT

1 - A, 2 - B, 3 - D, 4 - A, 5 - D, 6 - C, 7 - B, 8 - C, 9 - C, 10 - B, 11 - D.

Chapter VII.

PREOPERATIVE PERIOD

1 - A, 2 - A, 3 - C, 4 - A, 5 - D, 6 - D, 7 - C, 8 - C, 9 -E, 10 - B, 11 - C, 12 - E, 13 - E, 14 - A.

Chapter VIII.

POSTOPERATIVE PERIOD

1 - D, 2 - E, 3 - E, 4 - D, 5 - C, 6 - C, 7 - C, 8 - A, 9 -E, 10 - A, 11 - C, 12 - A, 13 - A.

Chapter X. TRAUMA

• Injury of soft tissues. Traumatic toxicosis.

1 - D, 2 - B, 3 - D, 4 - C, 5 - B, 6 - E, 7 - E, 8 - C, 9 - C, 10 - D.

• Fractures and dislocations

1 - B, 2 - A, 3 - D, 4 - C, 5 - B, 6 - B, 7 - D, 8 - C, 9 -E, 10 - E, 11 - C, 12 - E, 13 - C, 14 - E, 15 - D.

• Burns, frostbites and electric burns

1 - C, 2 - E, 3 - C, 4 - B, 5 - B, 6 - E, 7 - C, 8 - D, 9 - B, 10 - E, 11 - B, 12 - C.

• Contaminated wounds. Suppurative wounds

1 - D, 2 - C, 3 - D, 4 - B, 5 - D, 6 - D, 7 - B, 8 - B, 9 - D, 10 - A, 11 - C, 12 - B, 13 - A, 14 - C, 15 - D, 16 - E, 17 - D, 18 - D, 19 - D, 20 - D, 21 - D.

Chapter XI.

SUPPURATIVE INFLAMMATORY DISEASES

1 - A, 2 - B, 3 - D, 4 - B, 5 - E, 6 - C, 7 - A, 8 - C, 9 - B, 10 - B.

• Hand infection

1 - B, 2 - C, 3 - C, 4 - C, 5 - A, 6 - E, 7 - A, 8 - E.

• Osteomyelytis

1 - A, 2 - D, 3 - E, 4 - C, 5 - C, 6 - E, 7 - D, 8 - B, 9 -A, 10 - B, 11 - B, 12 - C, 13 - D, 14 - C, 15 - C, 16 - E.

• Peritonitis, pleuritis

1 - C, 2 - B, 3 - D, 4 - C, 5 - B, 6 - E, 7 - C, 8 - E, 9 - A, 10 - D, 11 - D, 12 - C.

• Sepsis

1 - C, 2 - E, 3 - A, 4 - D, 5 - E, 6 - A, 7 - E, 8 - A.

Chapter XIII.

NECROSIS, VARICOSE ULCERS AND ARTERIAL OCCLUSION

1 - D, 2 - E, 3 - D, 4 - B, 5 - A, 6 - B, 7 - D, 8 - D, 9 -D, 10 - B, 11 - D, 12 - B, 13 - D, 14 - B, 15 - E, 16 - D, 17 - E, 18 - C, 19 - E, 20 - D.

Chapter XIV. TUMOURS

1 - C, 2 - C, 3 - E, 4 - C, 5 - C, 6 - E, 7 - B, 8 - C, 9 - A.

Chapter XV.

PARASITIC SURGICAL DISEASES

1 - D, 2 - D, 3 - A, 4 - C, 5 - D, 6 - B, 7 - D, 8 - D, 9 -D, 10 - C, 11 - B, 12 - B, 13 - E, 14 - A, 15 - A.

ДОПОЛНИТЕЛЬНЫЕ ИЛЛЮСТРАЦИИ

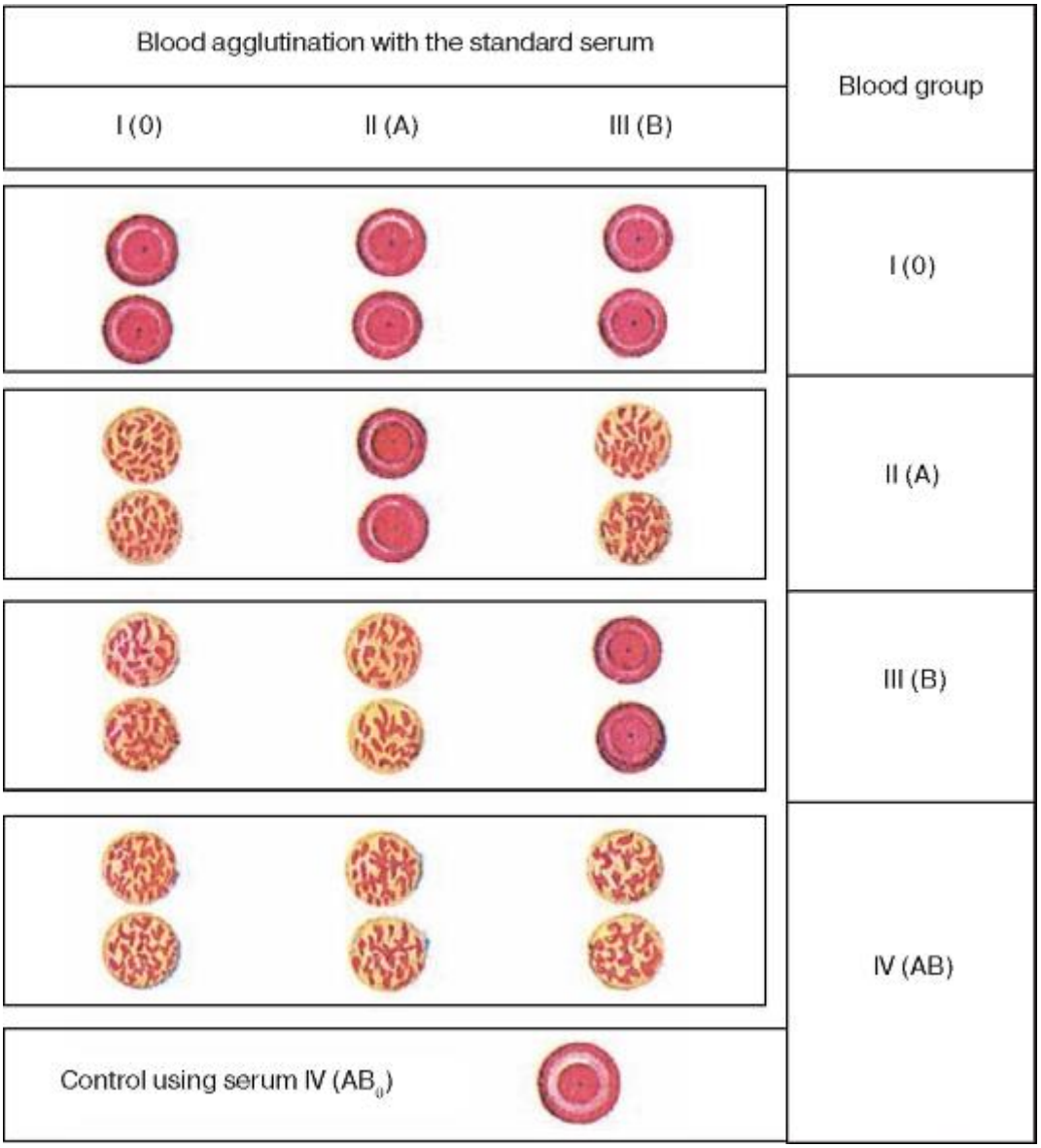


Fig. 33. ABO blood grouping.

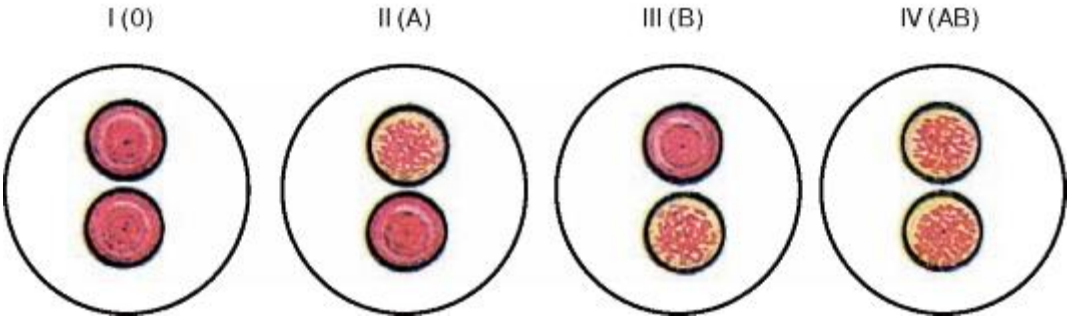


Fig. 34. Blood grouping using monoclonal antibodies.

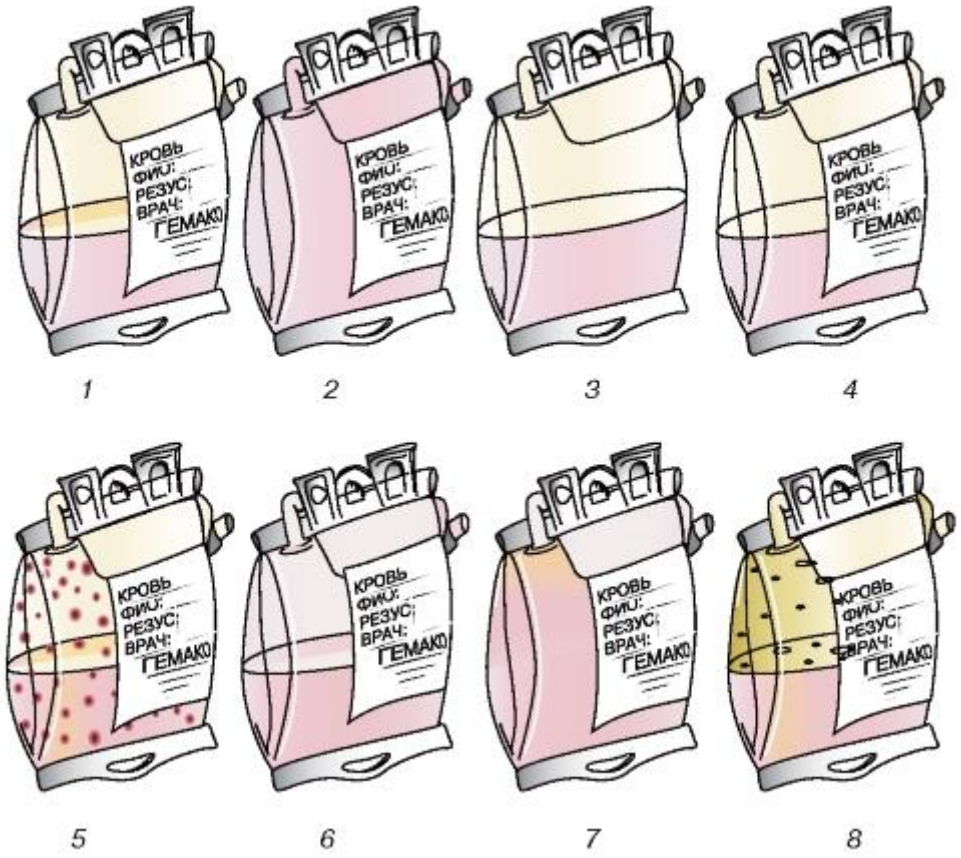


Fig. 37. Assessing the suitability of blood for transfusion: *1* - blood suitable for transfusion; *2* - blood unsuitable for assessment (because of blood being suspended) *3* - absence of labelling; *4* - the vial is not closed airtight; *5* - the presence of blood clots; *6* - haemolysis; *7* - contaminated blood (turbid appearance, absence of layers); *8* - contaminated blood (plasma sediments and film).

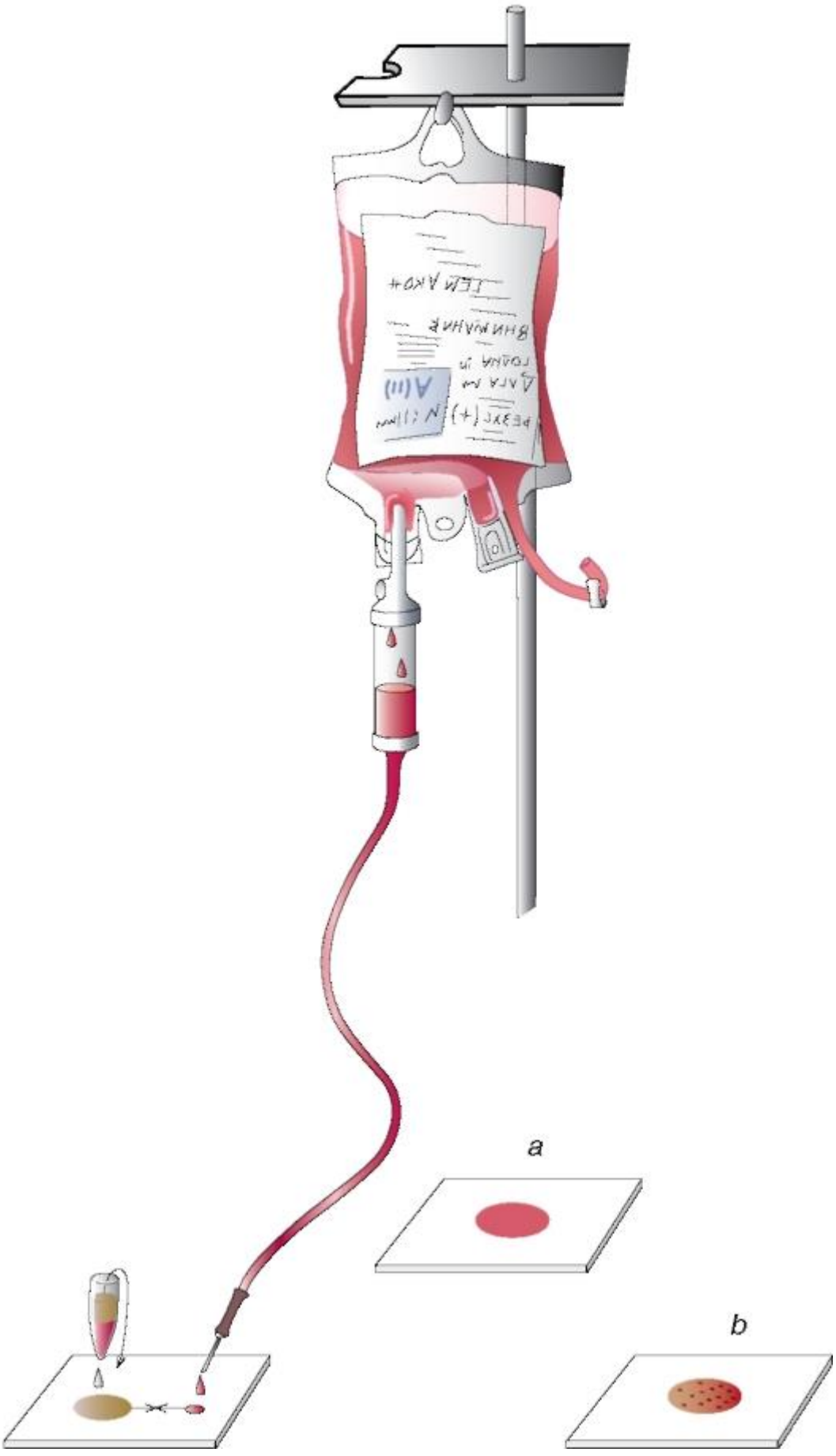


Fig. 38. ABO blood compatibility test: *a* - blood is compatible; *b* - blood is incompatible.

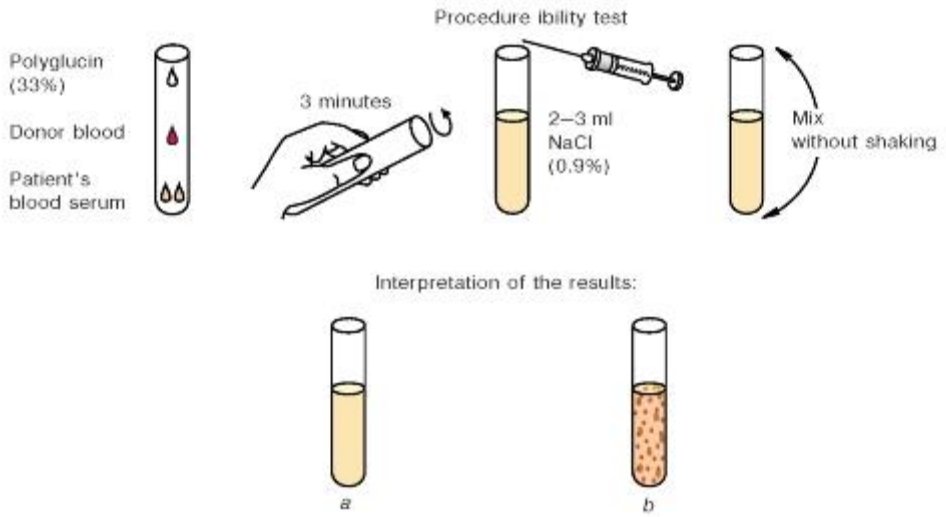


Fig. 39. Rhesus factor compat.

a - blood is compatible; *b* - blood is incompatible.

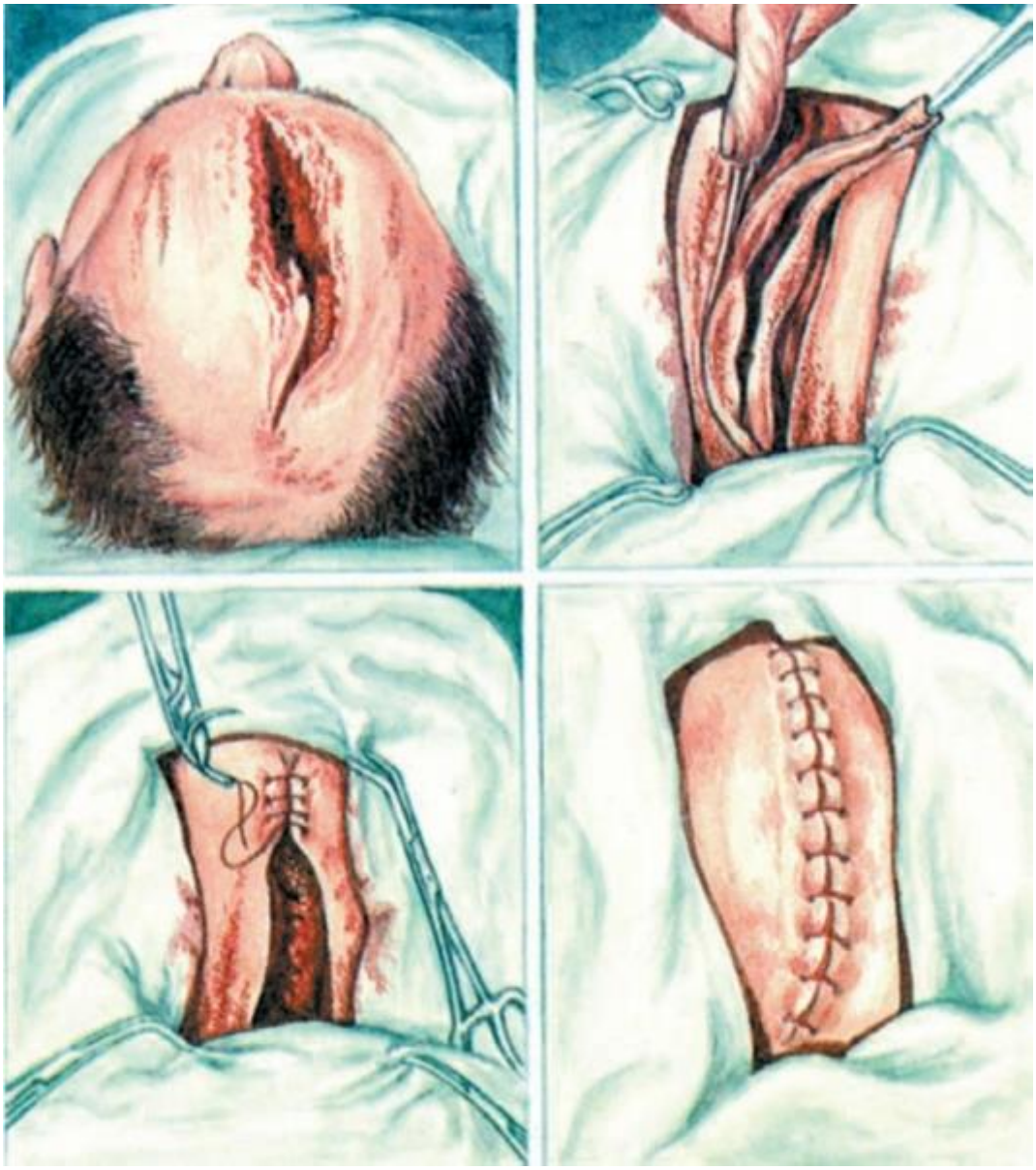
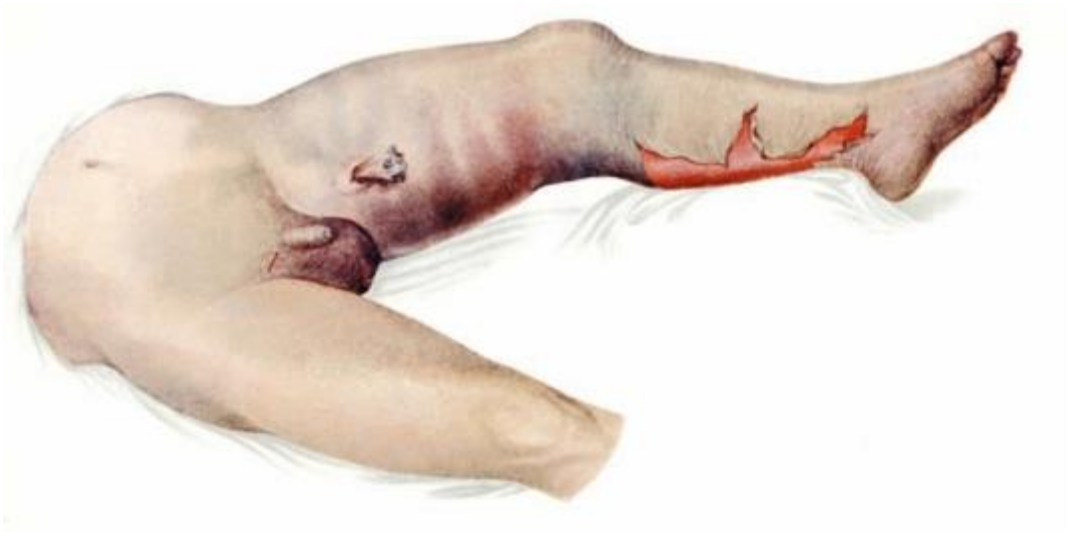
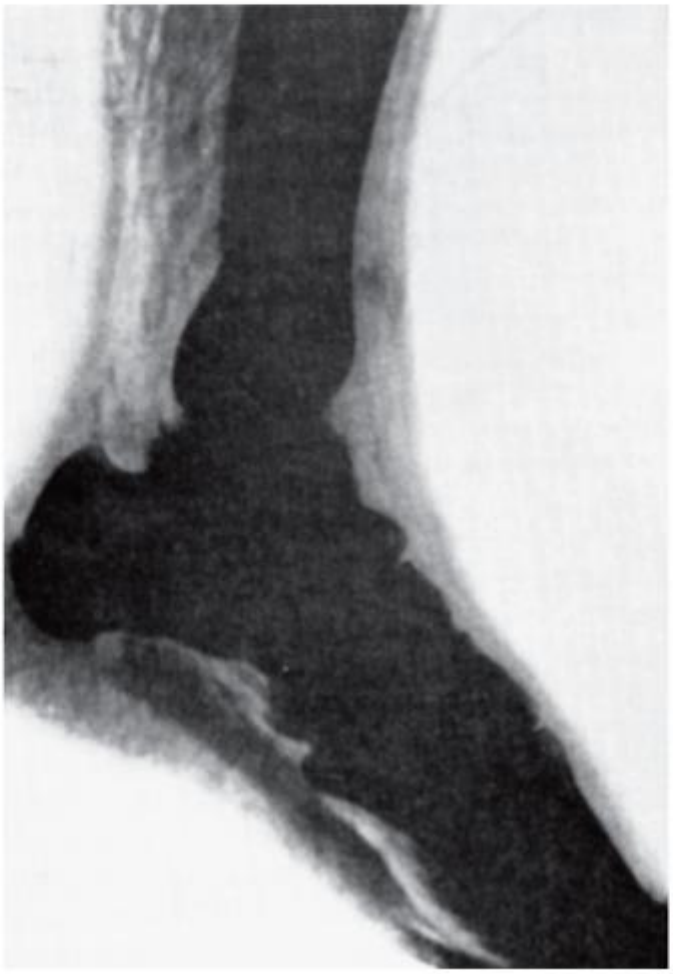


Fig. 78. Primary surgical debridement of a scalp wound (stages).



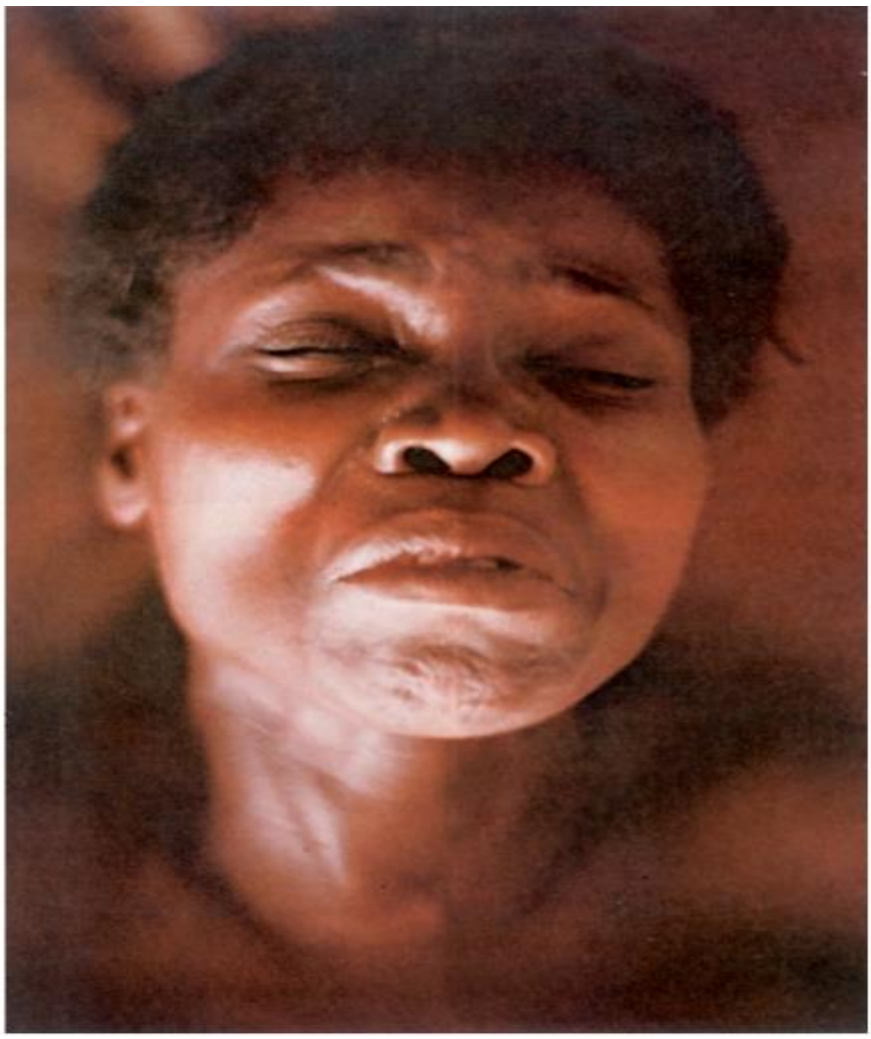
a



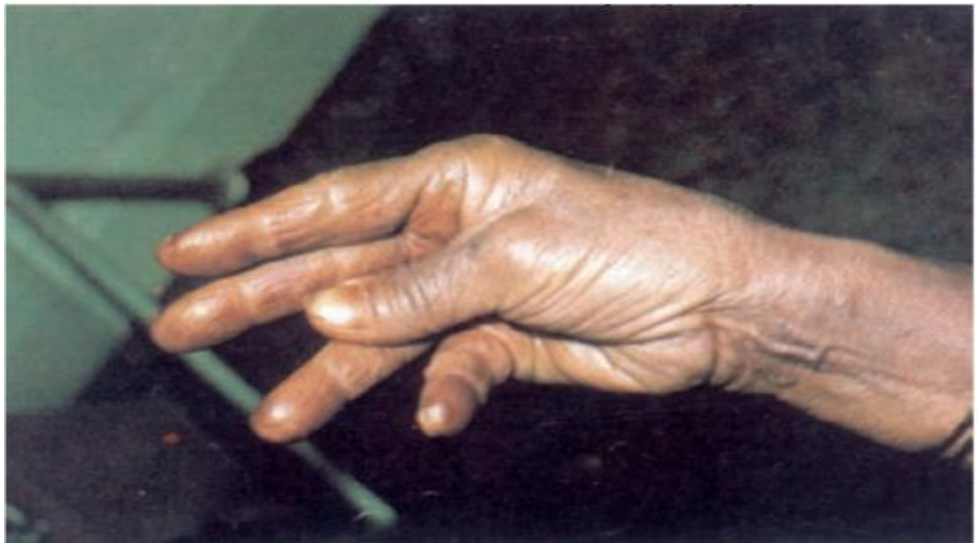
b

Fig. 79. Gas gangrene.

a - fulminant course of gas gangrene of the left lower limb, perineum and abdomen resulting from blind fragmentation effect on the femoral soft tissues; *b* - X-ray evidence of gas accumulation in the soft tissues.



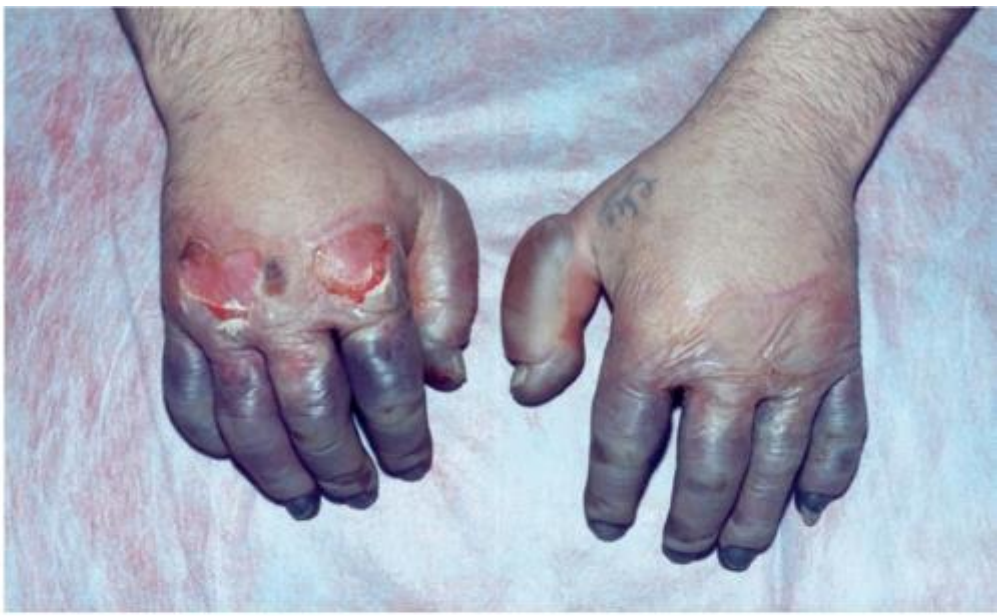
a



b

Fig. 80. Tetanus: *a* - risus sardonicus; *b* - obstetricians' hand (From Zatouroff M.A. Colour Atlas Of Physical Signs In General Medicine. - London, 1976).

a



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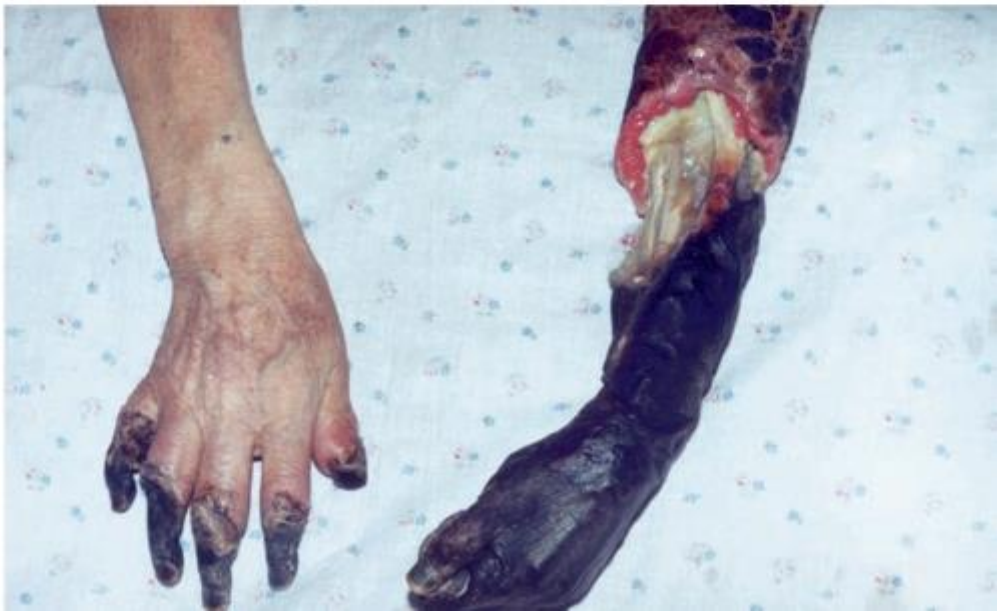


Fig. 83. Frostbite of hands: *a* - degree 2 or 3; *b* - degree 4 of the right hand (dry gangrene of the fingers) and left foream.

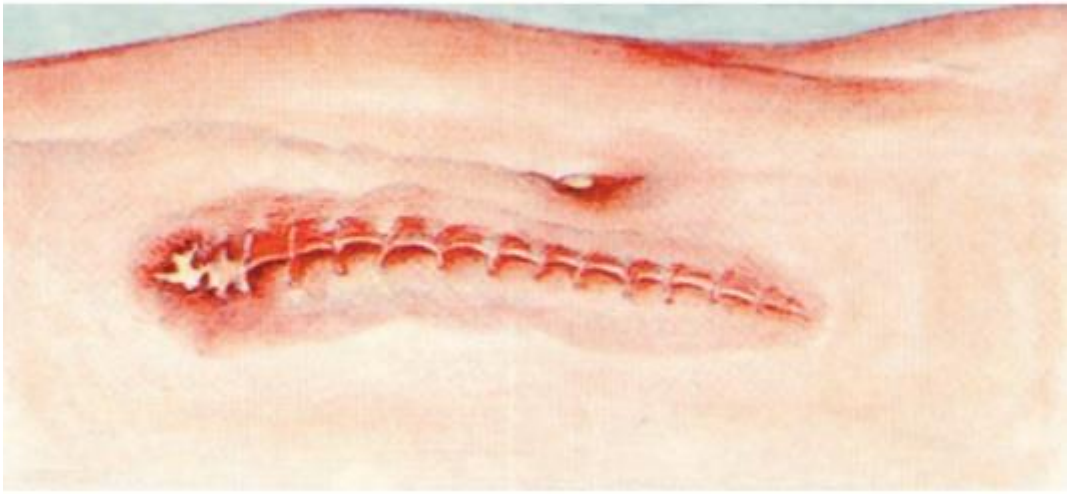


Fig. 84. Phlegmon at the site of the postoperative scar on the anterior abdominal wall.

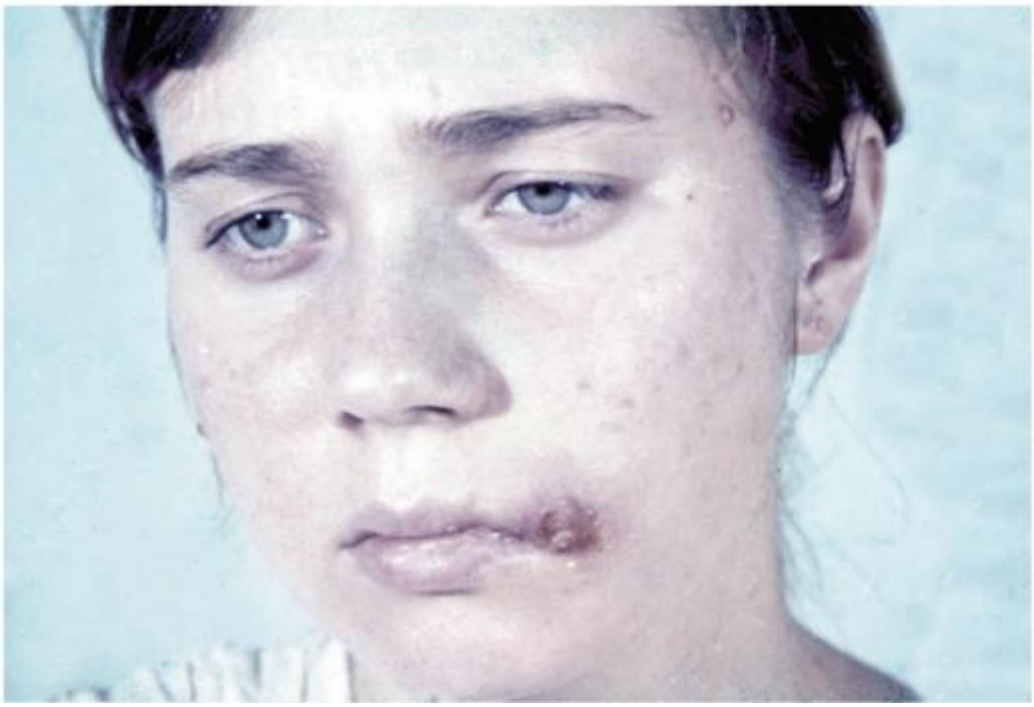


Fig. 85. Upper lip furuncle (boil).

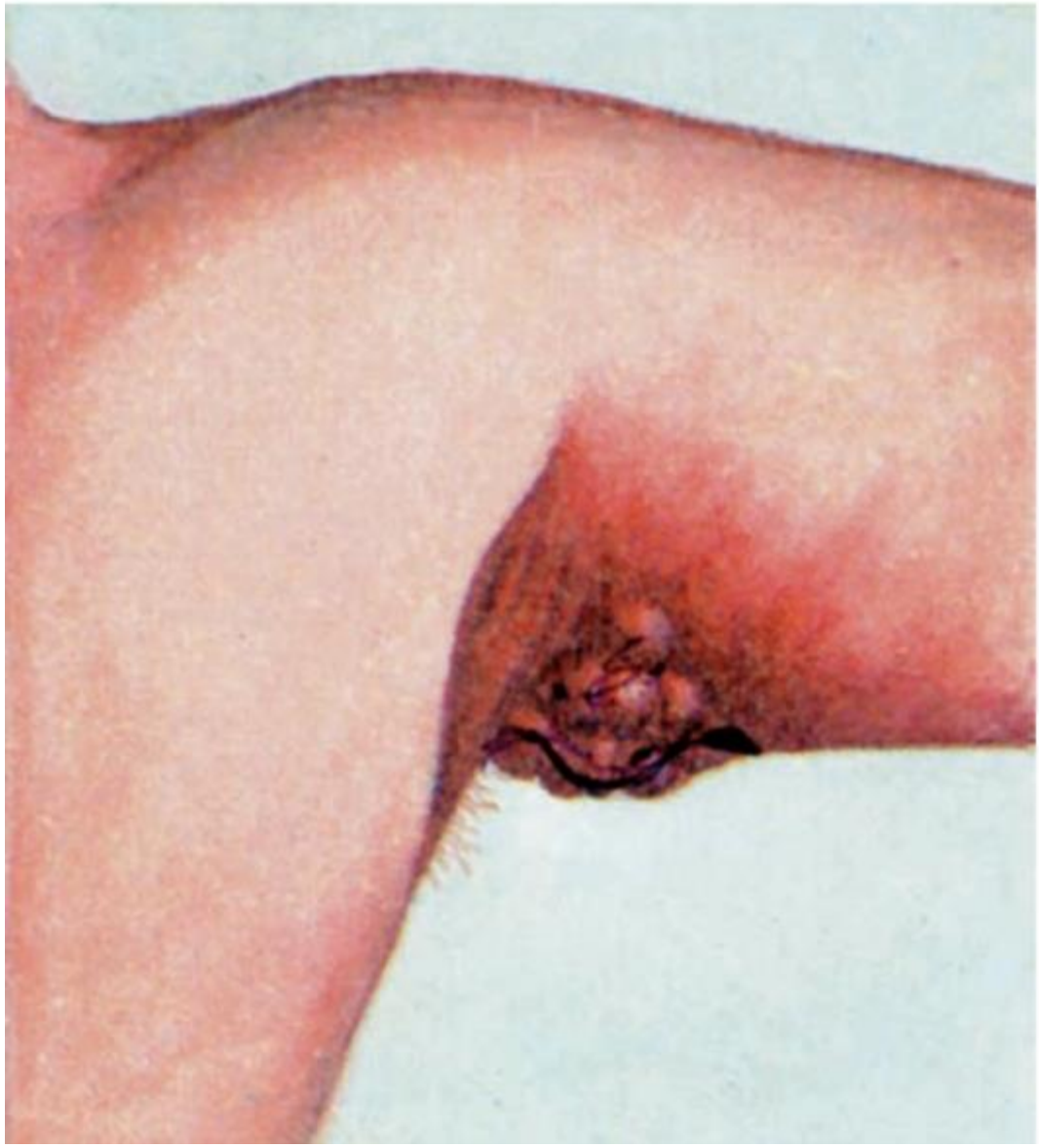


Fig. 88. Axillary hidradenitis.

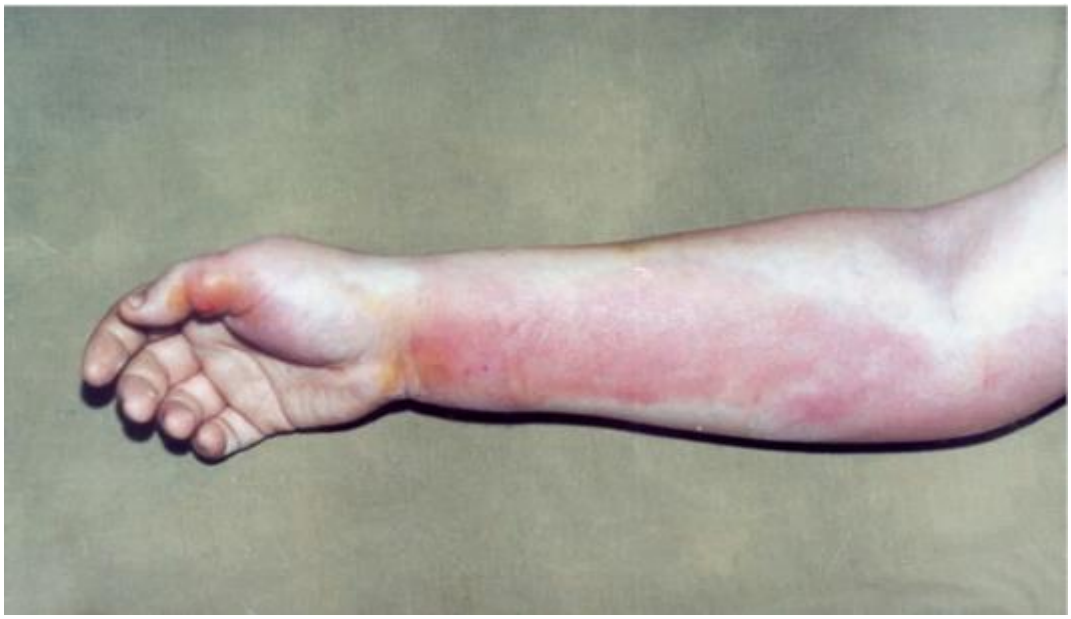


Fig. 89. Reticular lymphadenitis of the forearm.

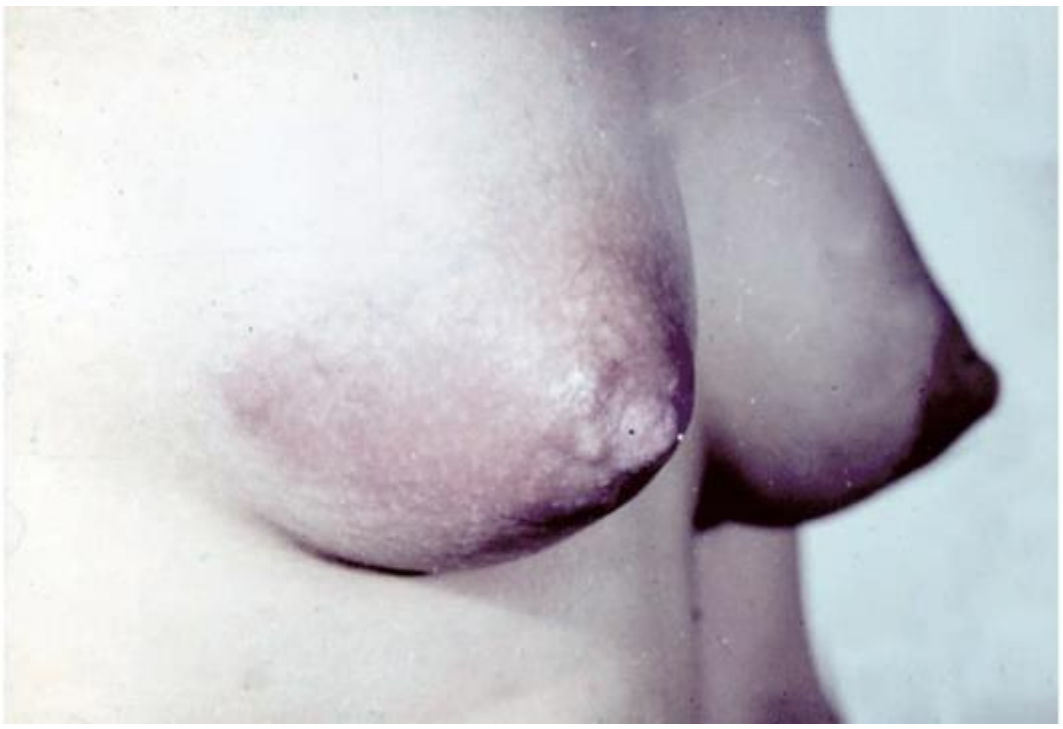
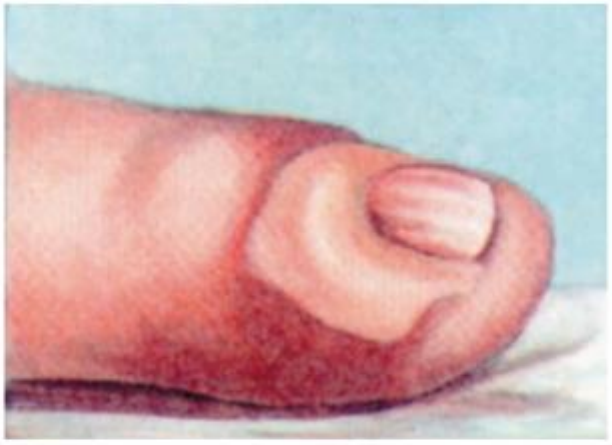


Fig. 90. Acute suppurative mastitis.



a

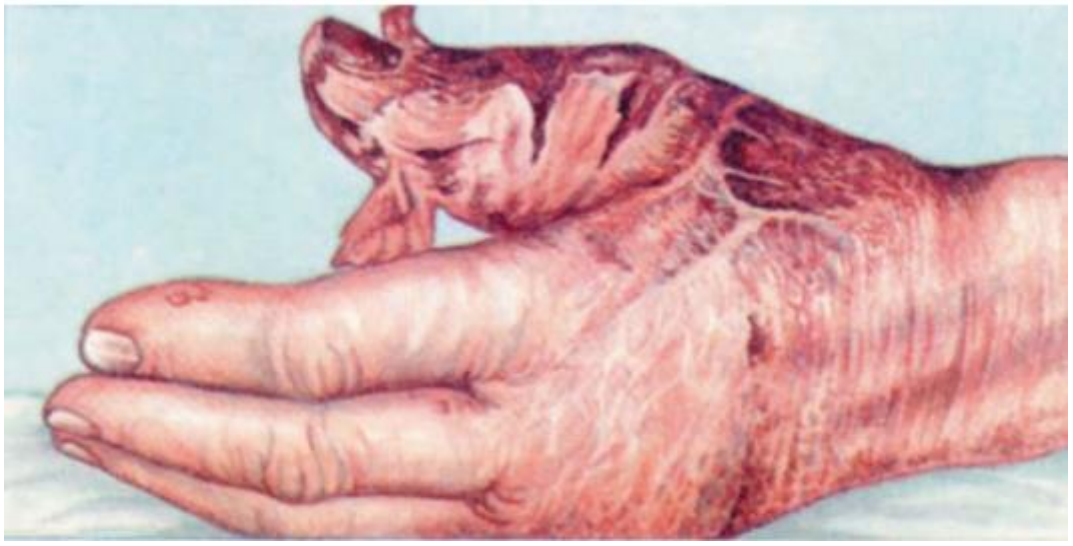


Fig. 96. Suppurative hand infections: *a* - paronychia; *b* - pandactylitis of the thumb.

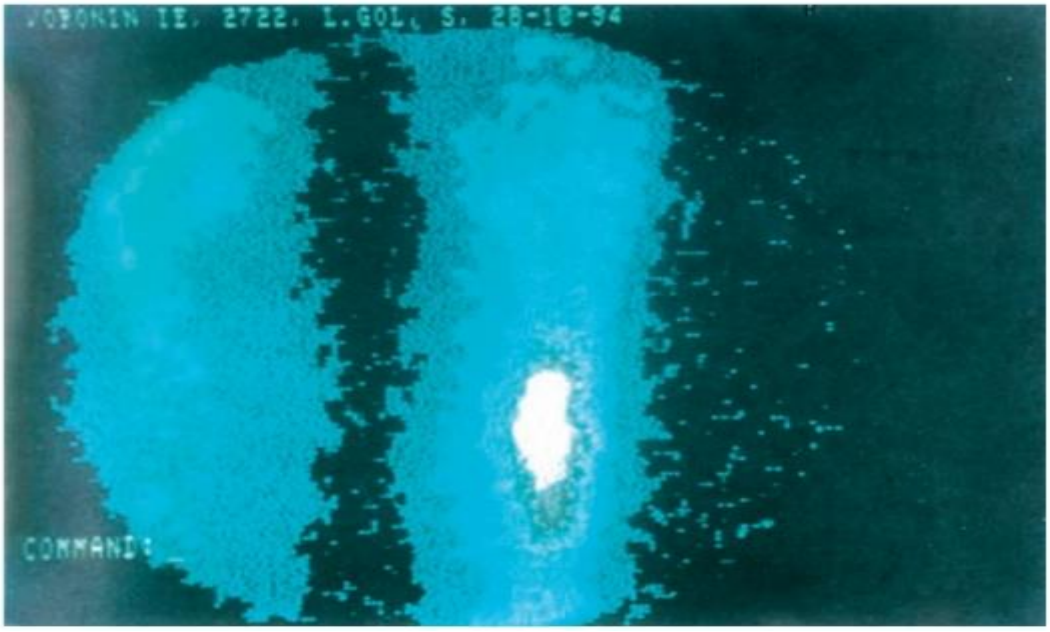
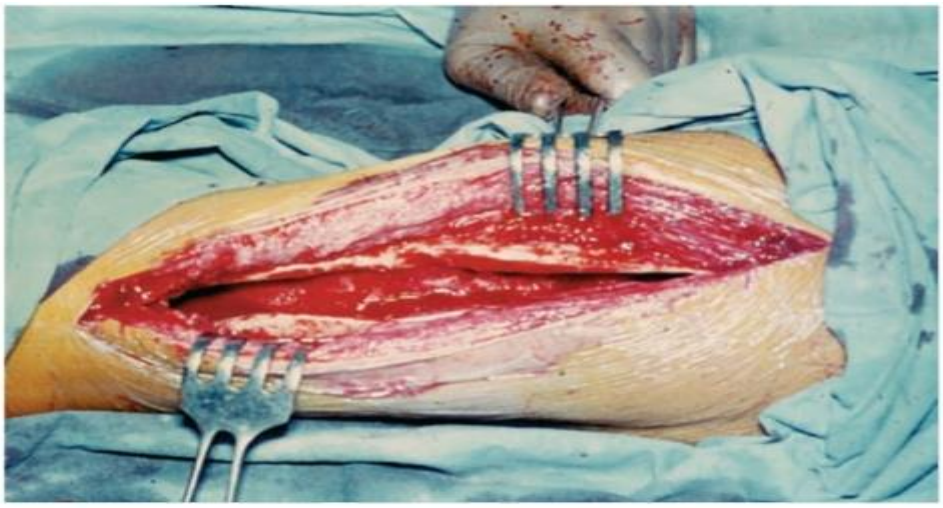
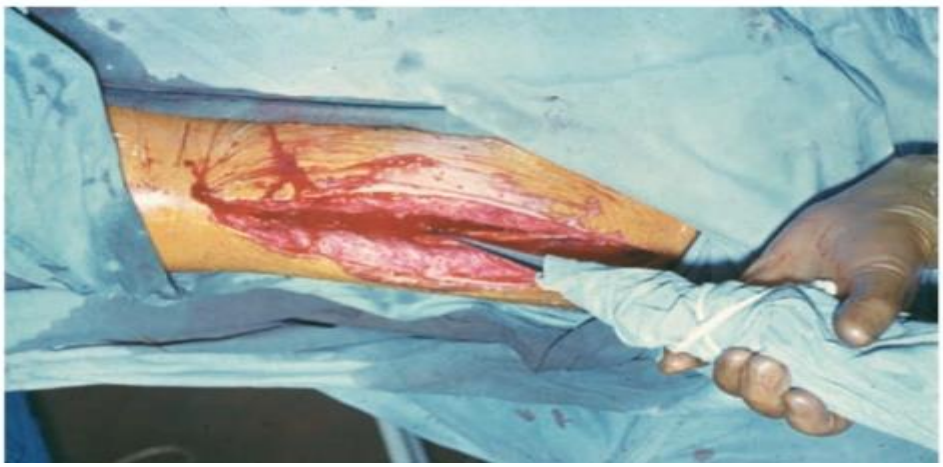


Fig. 103. Femoral scintigram demonstrating the uptake of radionuclide in the left femoral artery.

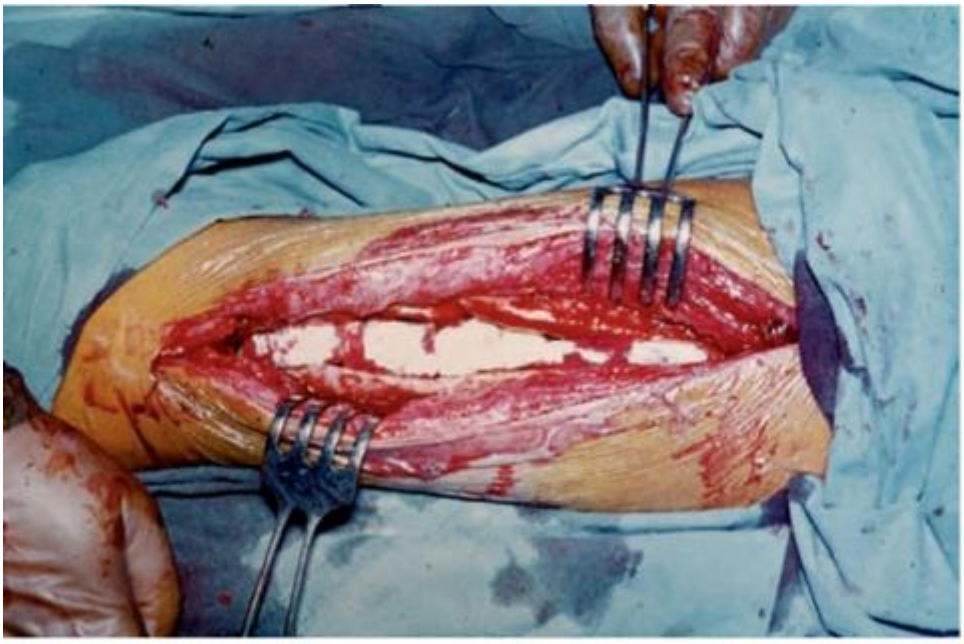


a

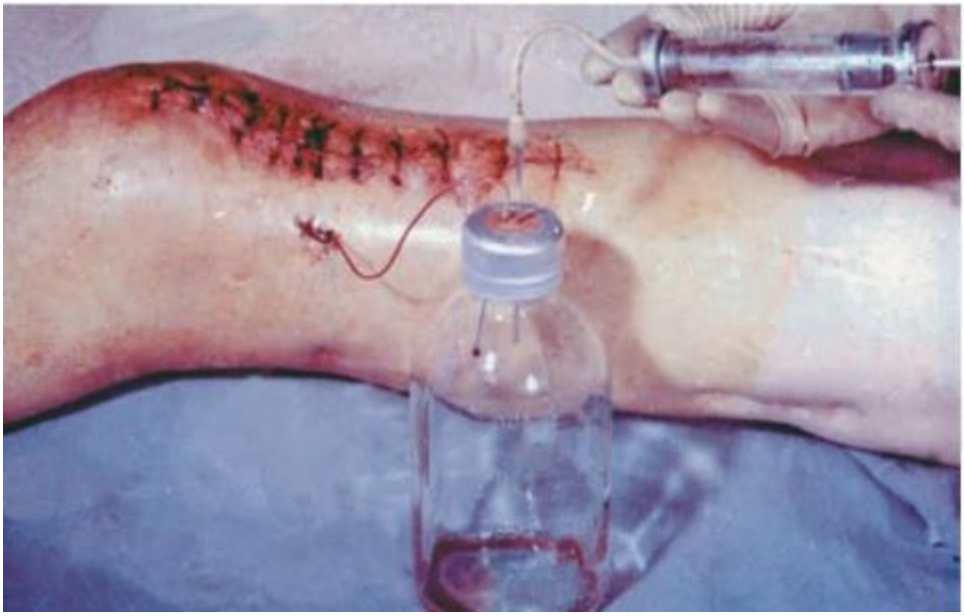


b

Fig. 105. Surgery for chronic femoral osteomyelitis: *a* - bone cavity after necrectomy; *b* - bone cavity ultrasound cavitation; *c* - bone cavity filled with antiseptic collagen sponge; *d* - vacuum drainage of the wound using micro-irrigators.



c



d

Fig. 105. Contd.

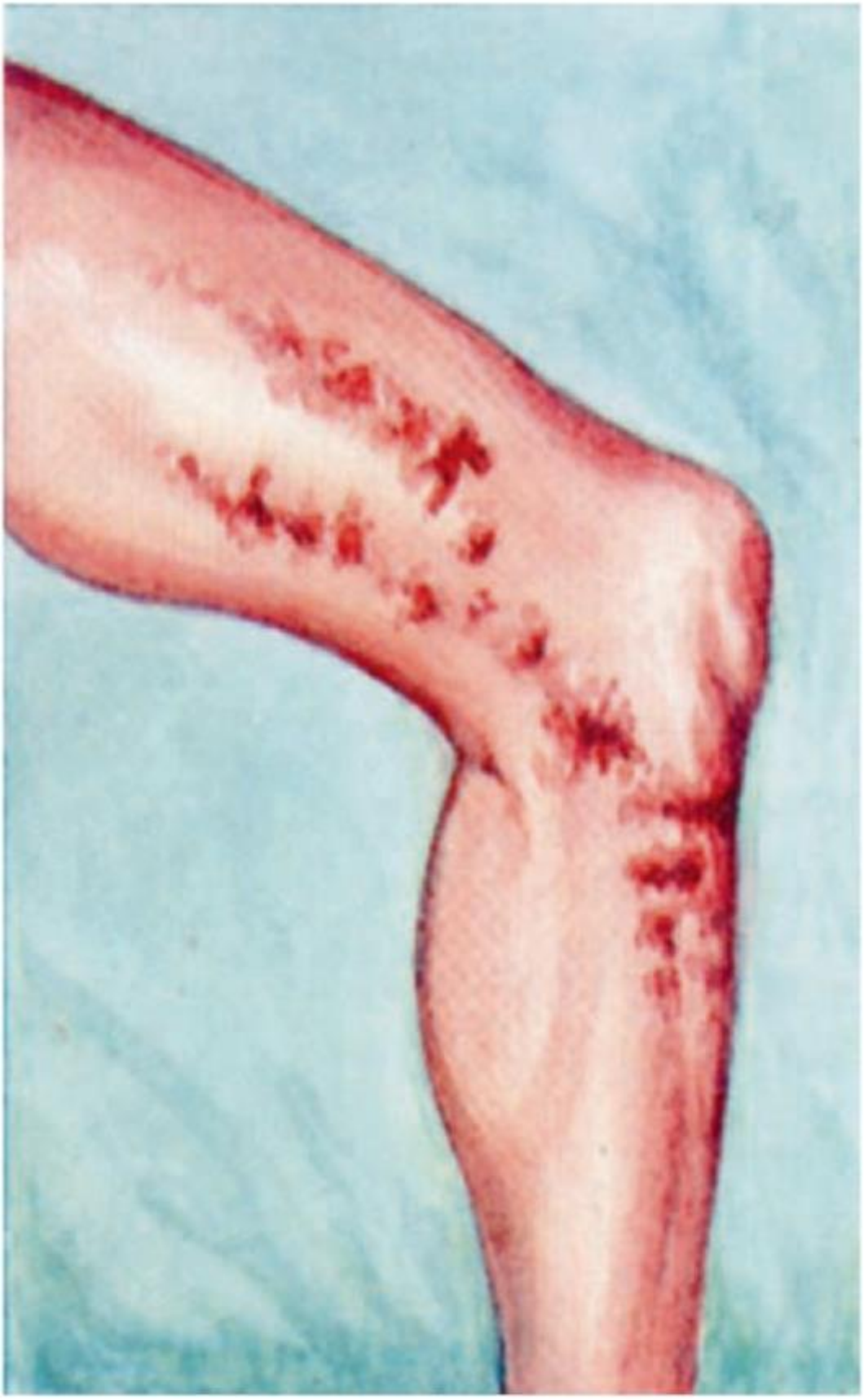
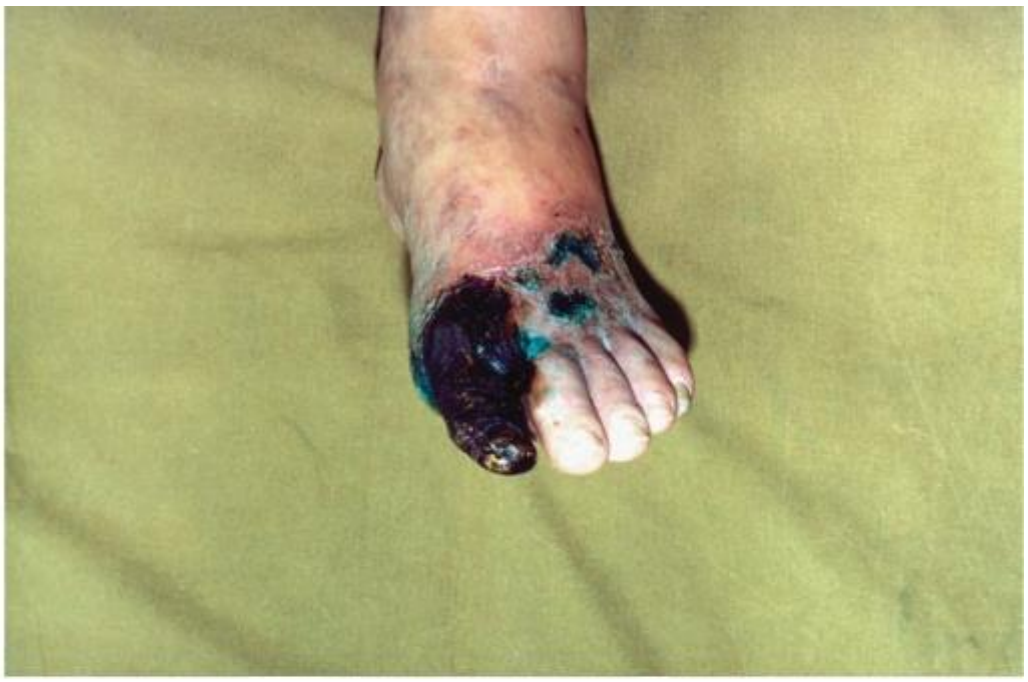


Fig. 112. Acute thrombophlebitis of the long saphenous vein.

a



b

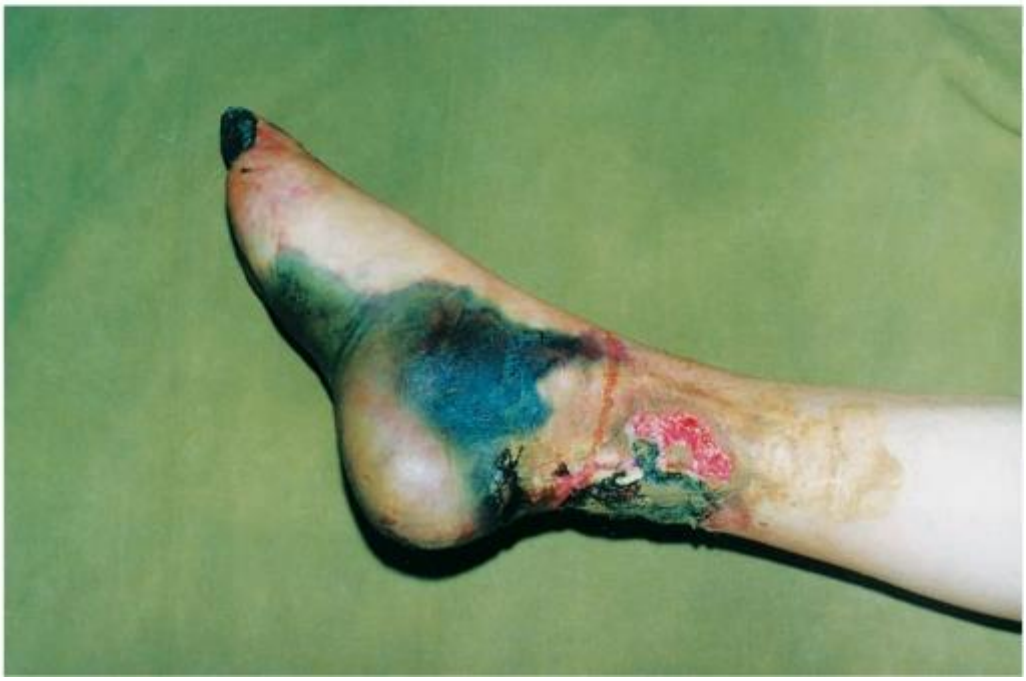


Fig. 126. Dry gangrene of the 1st toe (a) and wet gangrene of the foot (b).

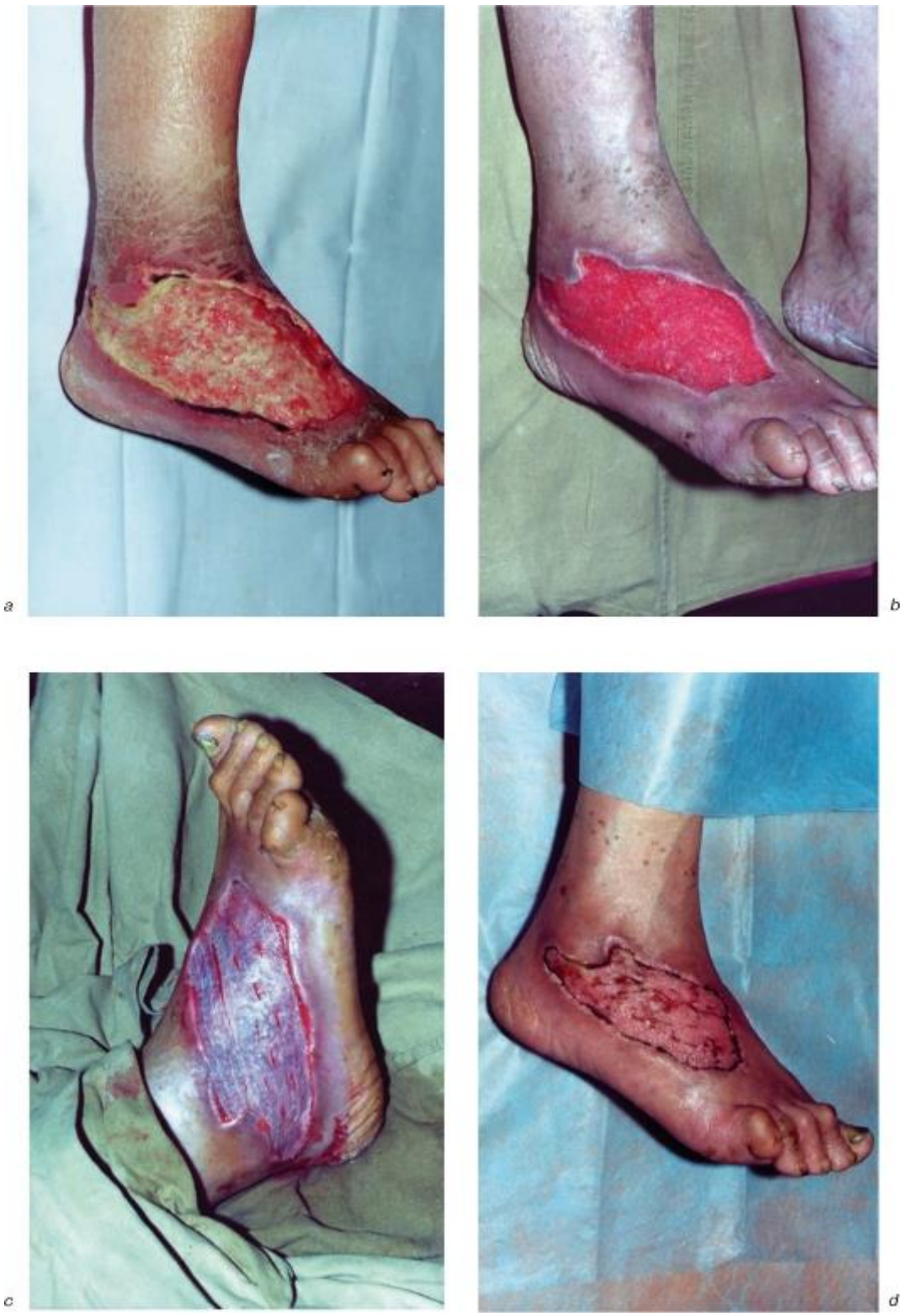
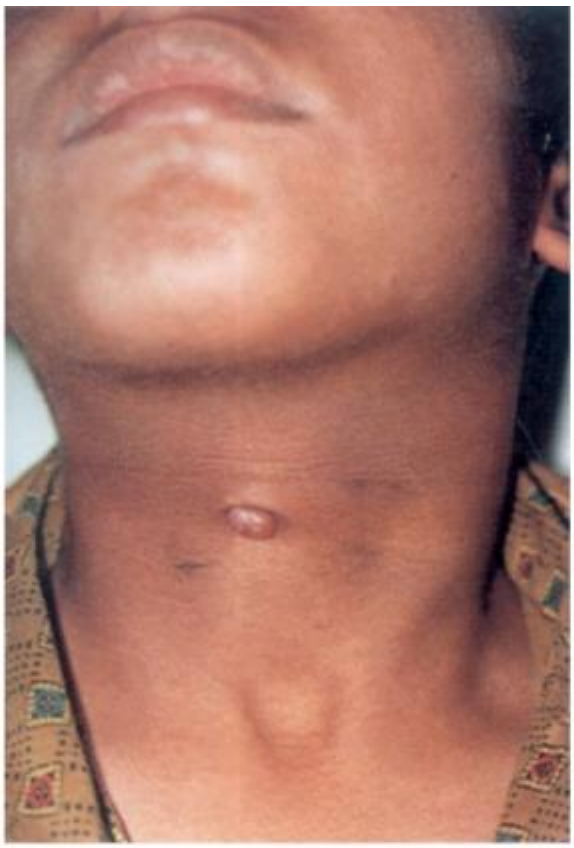
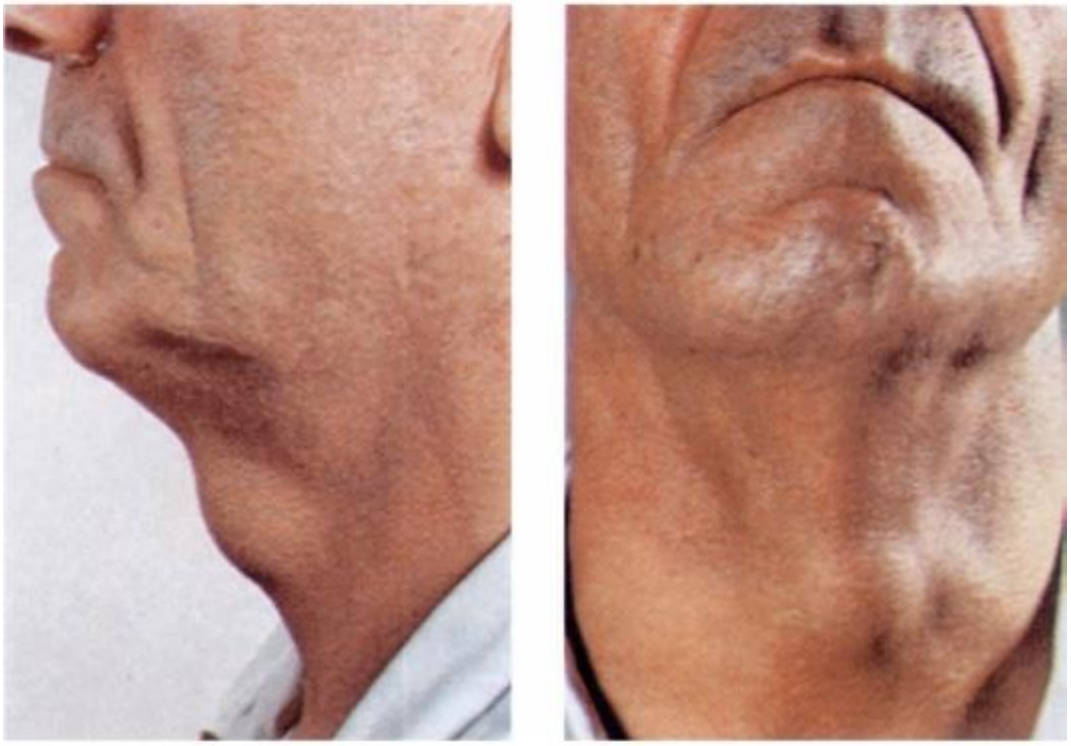


Fig. 127. Varicose ulcers of the right foot, autodermic plastics using a free graft: *a* - varicose ulcer of the foot; *b* - the ulcer prepared for plastics; *c* - the ulcerous surface covered with the cutaneous graft; *d* - successful grafting.



a



b

Fig. 128. Midline neck fistula (a) and cyst (b).

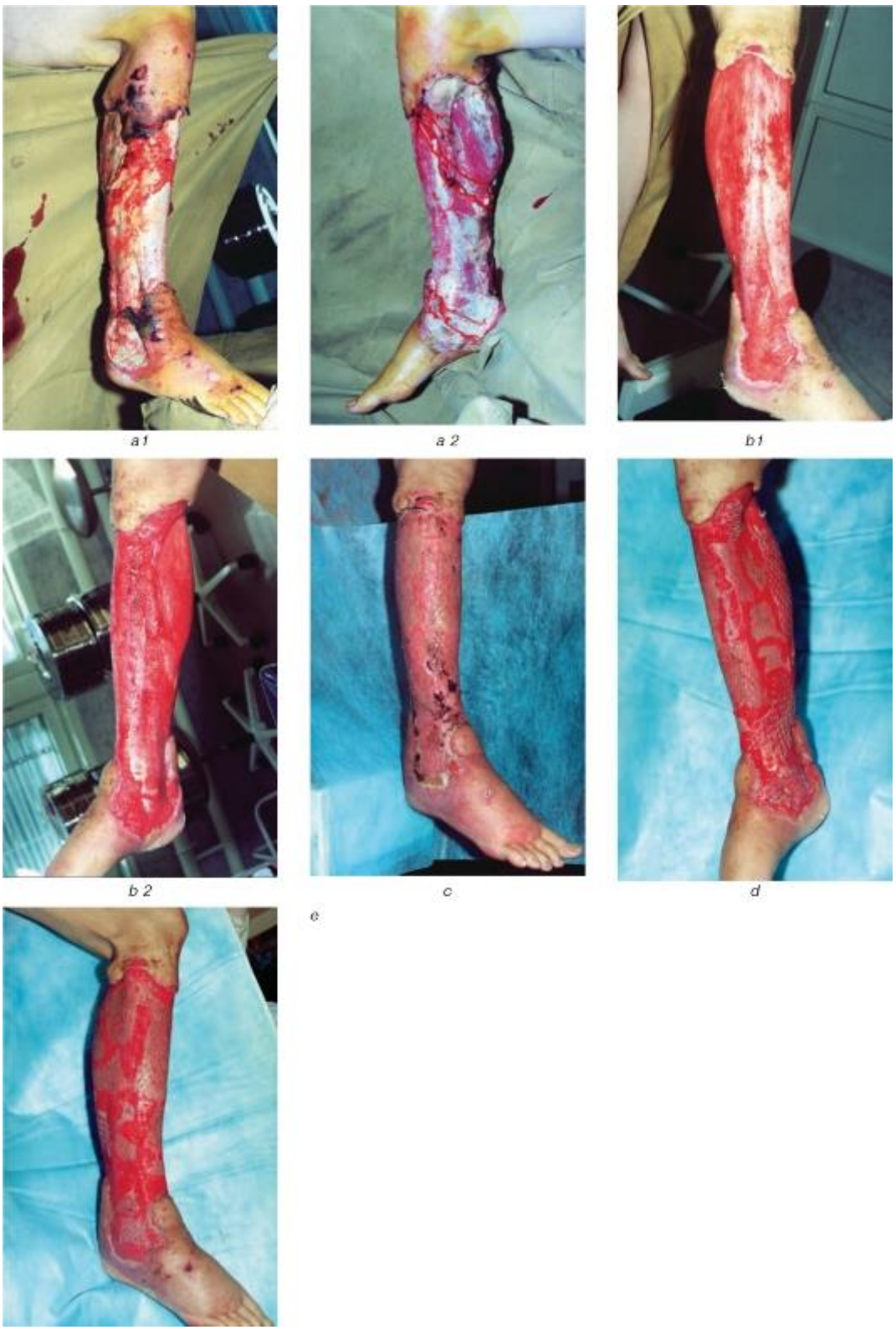


Fig. 129. Dermatoplasty of extensive skin defects.

a - extensive circular leg skin defect following necrectomy for necrotic erysipelas (lateral,1, and medial, 2, aspects of the leg); b - granulated wound prepared for dermatoplasty; c - dermatoplasty with a reticular sieve flap; d - dermatoplasty with a sieve graft (the medial aspect of the leg); e - the result of dermatoplasty.

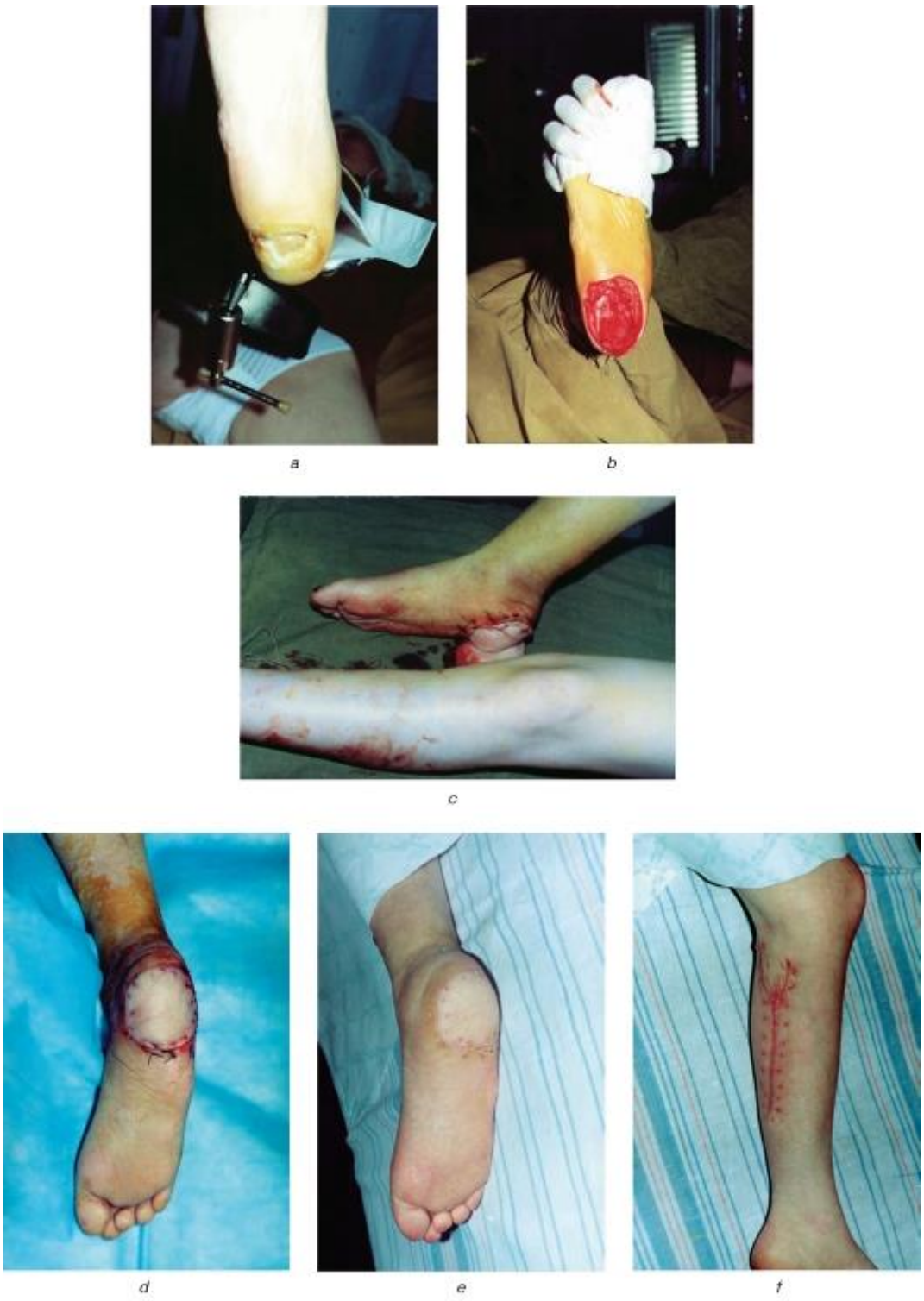


Fig. 130. Soft tissue plastics, «Italian method».

a - trophic heel ulcer; *b* - heel ulcer dissected; *c* - tissue defect closed with flap; *d* - the flap has been dissected; *e* - the result of the plastics; *f* - cicatrix following cutting of the flap.