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External Fixation: the Useful Information for Patients



Dear patient!

This is a brochure in which you will find answers to the questions to frequently arise during treatment using a method of External Fixation. Certainly, any manual can not substitute live dialogue with practicing doctors and nurses. Therefore before you start carrying out some recommendation it is necessary to consult your orthopedic surgeon.

Remember: as there are no two completely identical people so there are not also two completely identical variants of treatment. That is why only the orthopedic surgeon can recommend or forbid carrying out of each of the recommendations presented in the brochure given.

1. General Information to Know

1.1. What is “External Fixation”?

External fixation is a method of treating bone and joint injuries as well as correcting skeletal deformities by attaching bones to an external device that stabilizes the injured limb. Additionally it allows manipulation of the limb segments to achieve restoration of length and alignment. Synonyms of “external fixation” are terms “transosseous osteosynthesis”, “external fixing” and “external osteosynthesis” as a counterbalance to “internal fixation”, i.e. to an osteosynthesis with the use of internal fixators (plates, nails, screws).

In comparison with methods of internal fixation external fixation has unique advantages: minimum traumatic interventions, possibility of wires and pins insertion beyond bone and soft tissues damage zones, possibility of the closed bone fragment reduction and controlling rigidity fixation.

Nowadays more than 1000 devices for external fixation have been known. In 1952 in Russia G.A. Ilizarov (Fig. 1) developed an original apparatus. Being improved over the years, now it is one of the most perfect external fixation devices.

Thanks to its possibilities both the device and the Ilizarov method have won wide international popularity and began to be applied in many countries of the world (Australia, the USA, Japan, Italy, Portugal, Brazil, India, etc.) There is an international Association for the Study and Application of the Method of Ilizarov - ASAMI.

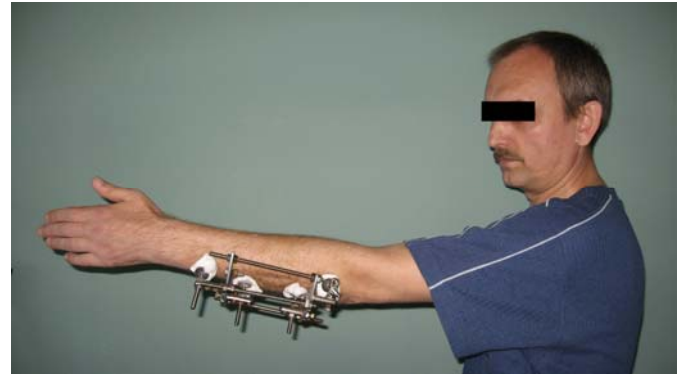


Fig. 1. Prof. G.A. Ilizarov

However it is necessary to understand that Ilizarov apparatus and other ExFix devices are only things of metal. There are no absolutely identical fractures, non-unions, deformations and bone defects. Therefore your orthopedic surgeon will pick out the device and its application method to be optimum for your treatment. In Fig. 3.2 some variants of Ilizarov frame are presented.



a



b



c



d

Fig. 2a-d. External Fixation Devices

1.2. Design of ExFix Devices

ExFix apparatus consists (Fig. 3) of *transosseous elements* and *frame*. To form the frame supports of different geometry can be used: a ring, half-ring and arches. External supports are connected by threaded and telescopic rods.

Transosseous elements are 1,5-2 mm wires and 4-6 mm half-pins. They connect bone fragments and the frame. Wires and half-pins are inserted through a bone and soft tissues. It imposes special requirements to pin-site care. Transosseous elements are fixed to the frame by means of special clips and bolts.

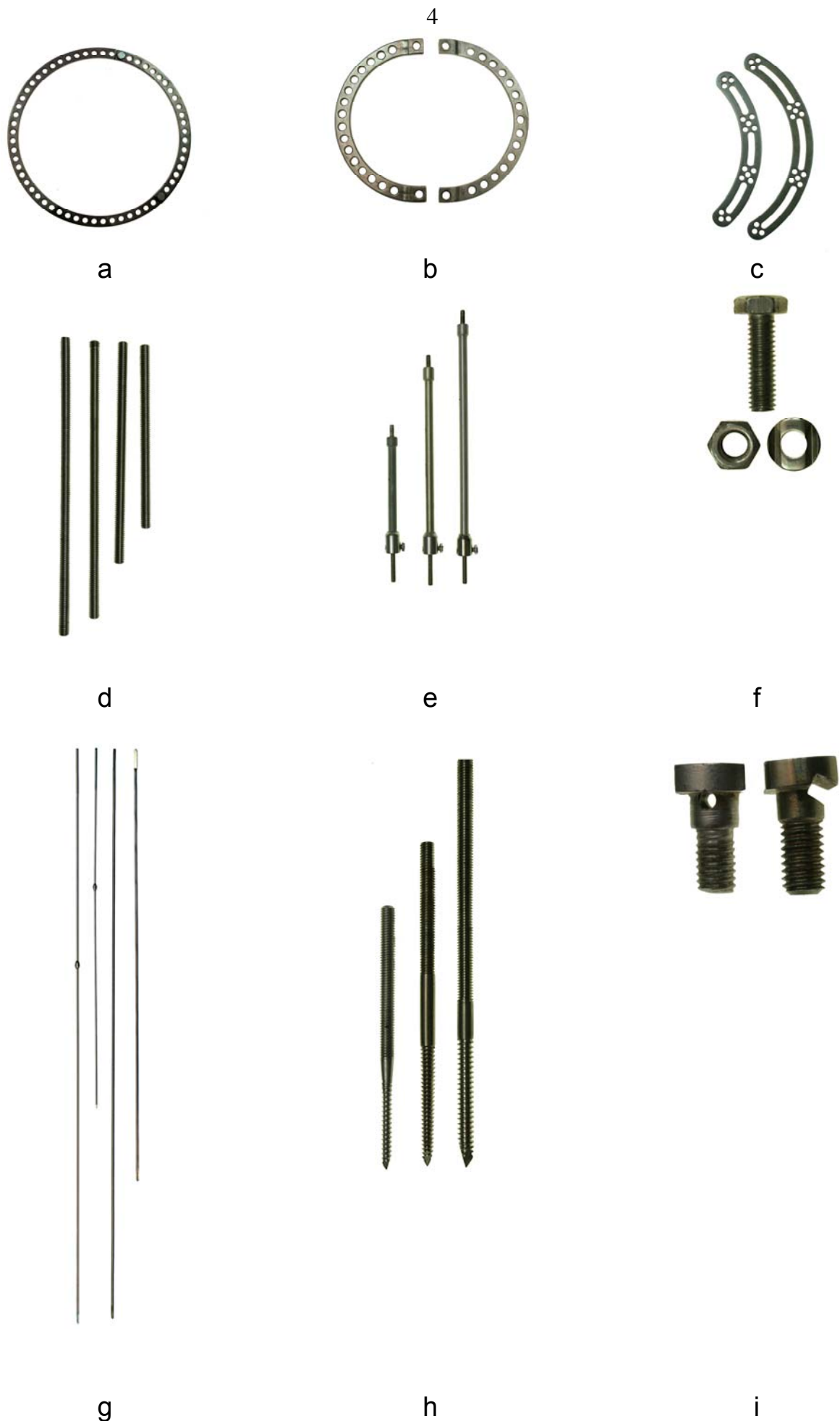


Fig. 3a-i. The main parts of the Ilizarov apparatus: a – ring, b – half-rings, c – arches, d – connecting rods, e – telescopic rods, f – bolts, nuts, washers, g – wires, h – half-pins, k – wire and half-pin fixators

1.3. How the new bone is formed?

If you have bone fracture or non-union the use of the external fixation device provide optimum conditions for regenerate ("bone callus") formation between bone fragments. At bone deformations, shortenings and defects formation of a new bone tissue resembles house building. Firstly, the building skeleton is built - external fixation frame is assembled. The walls are put up brick by brick – new bone tissue is formed. Growth of vessels and muscular fibres is alike to construction of partitions between rooms and a lining of communications. Growth of a skin can be compared to facing a building.

The biological law opened by academician G.A. Ilizarov says if a bone is cut and bone fragments are strongly fixed by the external fixation device, and after that at applying dozen distraction, new bone tissue is formed. Thus, at deformity correction, lengthening, bone defect replacement it is possible to conventionally allocate two periods: *distraction* (deformity correction) and *fixation*.

Distraction is a period for the new bone to be grown up and deformity correction is performed. It starts after bone cutting by osteotomy and frame assembling. On the 5-th - 7-th day after operation the distraction starts at a rate of 1 mm a day. Thus, the distraction period at 4 cm bone lengthening will take 45 days.

The fixation period is required for transformation of distraction regenerate (newly formed "young" bone tissue) into the normal bone, capable to bear functional loading. On the average it takes 1 month to transform 1 cm of distraction regenerate. Thus, the fixation period at 4 cm lengthening will occupy 4 months. To reduce the period of fixation with the help of the external fixation device is possible having replaced it with an internal fixator – a plate or a nail. You can discuss with your surgeon positive and negative features of bone fixator replacement.

1.4. Your Care Team

You are the main actor in the process of treatment and you must understand the difficulties that you should overcome. Your will-power, understanding of treatment method and active participation are the key to success. To achieve the goals you need help of relatives and friends. Let you have at hand their telephone numbers in case of emergency. They should be involved in the process of treatment. They will help you in the external fixation device adjustments and care. It is necessary for believers to communicate with a spiritual mentor prior to hospitalization.

Your orthopedic surgeon. During treatment you will be supported by the professionals who love their work and willing to assist with your recovery. Recommending treatment with Ilizarov apparatus (or other device), the doctor is convinced that it is the best way for you.

Treatment with the help of external fixation devices, in contrast to other methods, requires the participation of external fixation specialist at each stage of treatment, prior to the removal of the frame. He will advise, plan treatment, perform surgery, monitor compliance with appointments and answer your questions.

Therapist is involved in your preparation to the surgery. If you have any chronic illness, he will appoint a prophylactic treatment to prevent acute condition

of disease. If you have an elective operation, you should sanify nidus of infection and visit the dentist.

Nurse helps the doctor at every stage of treatment, carrying out the procedures assigned. She can answer your questions and advise, if your question is out of her competence, who to apply to. While in the hospital, pay attention to the work of dressing nurse, remember the sequence of her actions in dressing. Perhaps, after discharge from hospital, you will need to perform some stages of this work yourself.

2. Treatment Planning

As a rule, treatment consists of three stages: the preoperative period, operation and postoperative period.

In the preoperative period it is necessary for you to prepare crutches, a walking stick or a go-cart. Buying crutches make sure they conform to your growth and weight. Orthopedic shop may provide you with this information. In Fig. 4 the traditional crutches is shown.

Note!

Both too high and low crutches cause a chronic pain in a shoulder joint along with spine and you cannot correctly lean against them.



The overlay from foam rubber, on an axilla crossbar

The overlay from foam rubber on hand crossbar

Rubber tip

Fig. 4. Traditional crutches

The back of a man standing with the help of crutches should be straight. The upper crossbar should be 4 to 5 cm as low as an axilla (Fig. 3.5). The forearm should press a crutch to the body, and hand crossbar is to be located

at a level of a wrist. At leaning against the hand crossbar an elbow joint should be approximately flexed at an angle of 160° .

Note!

Do not suppose pressure upon axilla! Non-observance of this rule can cause so-called "crutch paralysis" - disturbance of sensitivity and movements in an upper limb. If you have crutches with a rigid upper crossbar, make a foam lining.

Note!

All kinds of adaptations for walking should be supplied by the rubber tips (nozzle) preventing sliding on a floor. Nozzles are erased in process of use and crack eventually. It can lead to falling which can lead to crisis. If tips require replacement, it is necessary to replace all of them at once. Remember that use of the erased or cracked nozzle - is dangerous! Clean(Remove) carpets in the house for traumatism prevention.

At use of adaptations for walking it is necessary to use correctly chosen footwear: on a low persistent heel, with the corrugated and elastic sole, convenient and comfortable the footwear is preferable to a foot.

Installation of hand-rail will facilitate using of a bathroom(bath) and a toilet bowl after your returning home.

Except the aforesaid, it is necessary for you to prepare covers for the device, special clothes, and at operations on a lower leg – foot supporter. The detailed information on it is resulted(brought) in the end of this grant, in "Appendix" section.

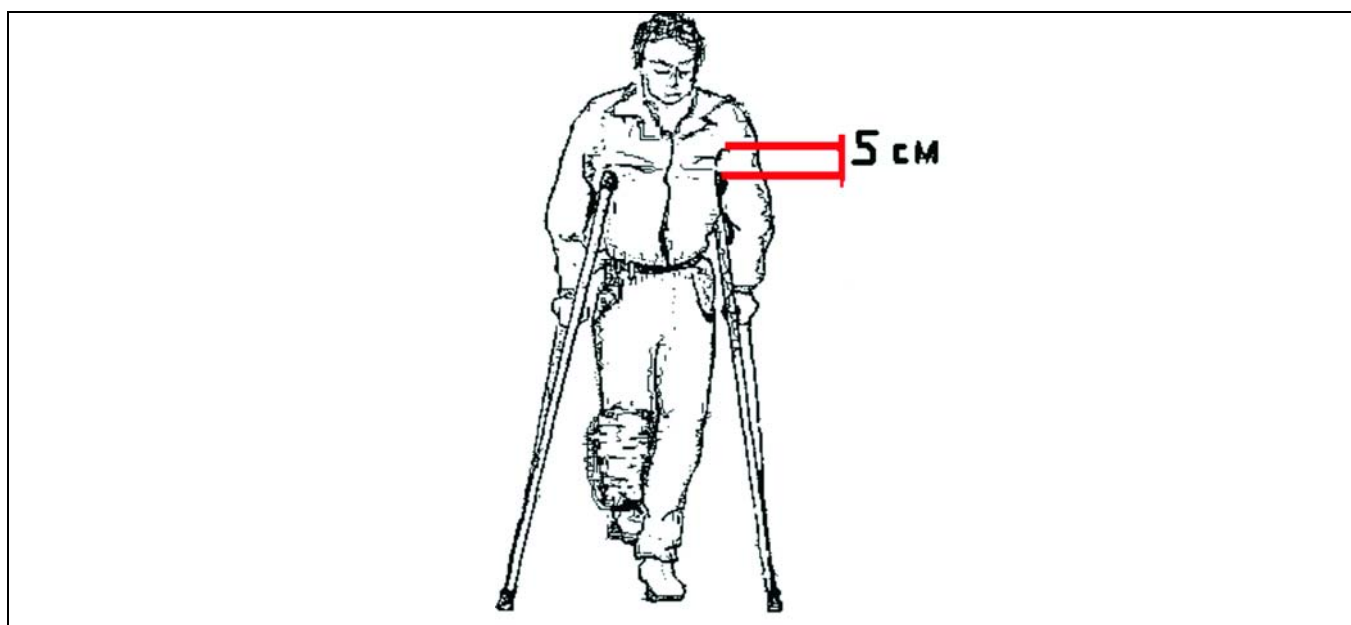


Fig. 5. A distance between axilla and upper crossbar should be 5 cm

"Canadian" crutches (Fig. 6) are similar to the high cane reaching elbow and having a special flexible support. You must adjust height of the crutches so that your back be straight and the flexible support seize back surface of forearm, as slightly low as elbow joint



Fig. 3.6. "Canadian" crutches

Cane is shown in Fig. 3.7. The Support on a cane allows reducing leg loading by up to 20% of body weight. Adjust the cane according to your height. Length of the cane should be defined when standing. The arm supporting the cane should be bent in elbow at an angle 20° .

Note!

The short cane reduces its efficacy, and long one causes an overload of arm muscles. The cane should be positioned on "the healthy" side!



Fig. 7. Cane

Go-cart (Fig. 8) is a support intended for the aid to those who because of illness or a trauma, is weakened and cannot go without crutches and canes. The size of the go-cart should be adjusted according to your height. The arm supporting the go-cart should be bent in elbow at an angle $15-20^\circ$.



Fig. 8. Go-cart

Before operation you will be examined by the anesthesiologist for selection of optimum method of anesthesia. Your physician will explain you again the plan of operative procedure and will suggest signing a number of the documents certifying your agreement for operation, and also that you are warned about possible complications, their preventive maintenance and treatment.

If operation planned, take a hygienic bath directly ahead of operation in the morning and the hair coat in the field of operative intervention is shaved off. Then you will given special "preoperative" medicines and transported into the operating room.

3. The Postoperative Period

Analgesics are used for the first 2 or 3 days after the operation. The need for further administration of drugs is determined individually.

After external fixation of lower leg has made it is necessary to locate the lower extremity at raised position for 2-4 days. If the frame was applied on a forearm, the hand should be in hand-hammock (Fig. 9a).

If the lower leg was operated, it is obligatory to use foot-hammock (Fig. 9b). At deformity correction of and lengthening do not remove foot-hammock even for the night! More detailed information is resulted in "Appendix" section.

At femur external fixation when you are in bed the knee joint should be flexed at 90° and more. For this purpose you can use fixation of the distal frame support to the Balkan frame. A belt should be prepared in advance (Fig. 9c).



a



b



c

Fig. 3.9a-c. Necessary positions of the operated extremities: a – hand-hammock; b – foot-hammock; c – patient is in bed after femur external fixation

Staying in hospital varies from 3-5 days at fractures to 1-2 months at complex deformity correction. It is necessary for you to learn to correctly walk under the control of experts by means of crutches (cane, go-cart), to master physiotherapy exercises, to keep an orthopedic status diary. Further information is available in "Appendix" section.

It is necessary to pay a special attention to correct movements in the frame: "compression", "distraction", etc. You need to do these manipulations after discharge from the hospital by yourself or by means of relatives and friends. Further information is available in "Appendix" section.

After discharge you will be recommended a patient care institution. Note that external fixation unlike internal fixation requires that you were under the control of attending medical doctor all fixation period.

Note!

During a stage of out-patient treatment there can be a necessity of repeated hospitalization for partial reassembling of the frame, "reinsertion" of transosseous elements, etc.

3.1. Food

An adequate food will provide formation and growth of a new bone tissue; will support your body in the good shape at the increased physical and emotional loadings. The balanced diet with sufficient amount of easily acquired proteins (proteins - a building material for a bone), minerals and vitamins is necessary for formation of a new bone, healing of wounds, functioning of soft tissues. Try to keep in your diet vegetables and fruits. Consult your dietitian if necessary. When indicated the attending physician will prescribe calcium preparations. During treatment try to avoid the overuse of the aerated drinks containing phosphoric and carbonic acids - they prevent from assimilation of calcium.

3.2. Weight

At walking over weight is the increased loading on joints, ligaments, muscles, cardiovascular and respiratory systems. It will be difficult to you to support increasing loading during rehabilitation. If necessary consult your dietitian about ways of keeping fit.

3.3. Body hygiene

Under the permission of your attending physician you can take a warm shower if there is a central water supply with the chlorinated water, using antibacterial soap. After a shower dry the frame and your skin by the hair dryer (warm air), have a bandage and change a frame cover, having ironed it.

3.4. Sex

Both doctors and psychologists say having sex is not only pleasant and also useful. Sex will take off stress, banish a sleeplessness and improve function of heart and vessels. You can lead a habitual sexual life. Cover the frame with a dense fabric not to injure the spouse (spouse).

3.5. Give up smoking!

Tobacco is unique legally sold goods which using correctly will do you harm. Annually in Russia about 500000 people die of the diseases connected with smoking. Nicotine slows down process of new bone formation, causes narrowing of vessels, breaks blood circulation and weakens immunity. It is scientifically proved that at smoking fractures united slower, the new bone is formed worse, a danger of complications is higher. Passive smoking is as dangerous as active one.

3.6. Physiotherapy Exercises

Physiotherapy exercises are obviously necessary. Oxygen, as well as all mineral substances, is delivered to the damaged bone by a blood flow. The venous blood, in its turn, deletes products of tissues disintegration and vital activity of cells. Intensively working muscles strengthen blood flow several times, thereby considerably improving process of restoration of the damaged tissues. Flaccid muscles do not provide delivery of necessary quantity of oxygen and minerals. Besides they slow down venous blood outflow that leads to the profound edema causing trophic disturbances. To avoid negative consequences compelled immobiliza-

tion, in the first days after an osteosynthesis isometric gymnastics and active-passive movements in joints are recommended.

At *isometric gymnastics* muscles contract, but movements in joints are absent. The most known example is tension of. A man strains stomach muscles by an effort of will and we see thus "small squares" of muscles, but no movements are present. Therefore it is very important before hospitalization to learn to strain muscles of upper and lower limbs. Let the muscles work as frequently as possible, for example, when you read the book, watch TV, etc.

Besides you should use not only active movements in joints, but also passive ones. Joint passive movements are such ones which are carried out not by the tension of muscles, intended to make movements in this joint but those made by a healthy hand or hands of the doctor and by means of special mechanical devices.

After external fixation of femur and lower leg loading for the operated limb is recommended, as a rule, on first days after operation. For individual selection of loading one steps by the operated limb on floor scales. After that you should gradually increase loading up to some discomfort appears: pain, sense of soft tissues tension in the area of wires, etc. This value of weight loading is taken as initial one and it should be written down in the medical card and in your orthopedic status diary. Later an increment of weight loading is supervised weekly. More details could be found in "Appendix" section.

Note!

You will pay particular attention to restoration of correct gait. A great mistake is a gait when the patient makes a first step by the operated limb and then "puts" to it other leg. Pay attention to uniformity of steps. In the first days after operation do small, but equally long steps. At each step put a heel at level of a sock of the other foot. Later you should gradually increase length of each step as you used to do before fracture.

Your physicians along with the exercise therapy specialist will choose necessary exercises from the list placed in "Appendix" section.

Development and improvement of your physical condition are of great importance. Preservation and development of your abilities is the important psychological factor. As feeling return of the force of muscles and increase range of motion, you will find that how much easier to live. Respiratory and cardiovascular systems are strengthened by the regular exercising. The body starts to faster take away by-products and toxins. You become more mobile and endure against stresses and physical activities.

You should start to work over yourself before operation and continue to do it at home. To use a proper technique of trainings, it is not mandatory to visit expensive fitness studios. Using simple tools, as a ball, dumbbells, a rubber plait and an expander you can reach the result desirable. However you will estimate your abilities not to be disappointed. It is up to your initial form and assertiveness to be applied.

3.7. Removal of the External Fixation Device

Removal of the apparatus is usually done according to your doctor's prescription in out-patient department. Before the removal you will be proposed to take a bone union clinical test and walk with the destabilized (dynamized) device for 5 to 7 days. The attending physician will explain you what it is and why it should be done. The doctor is likely to make a decision on using a plaster bandage or brace after removal of the frame.

After removal of transosseous elements wounds will heal in 1 to 2 weeks. According to recommendations do limit a weight bearing.

4. Possible Complications

As well as at any other methods of surgical treatment, complications can arise after external fixation. There is a list of complications in the Tabl. 1.

Table 1
Complications

Complications	Possible reasons of complications
The pin-tract infection is accompanied by a pain, an edema, skin reddening and suppuration	Most often this complication arises because of non-observance of hygienic actions for care of the device of external fixation
Partial necrosis of soft tissues is accompanied by their dimness and getting less sensitive	As a reason it could be excessive pressing of the disc clips fixed gauze dressings. Do not press disc clips into soft tissues!
Dermatitis goes with inflammation, edema and skin desquamation	Complication occurs as an allergic reaction. At dressing use only those medicines which are recommended by the doctor! Warn the doctor about all allergic reactions you have had
Neurovascular disorders are characterized by the reflected pain below the device of external fixation, changing skin sensitivity, feeling creeping sensation, change of skin color and edema appearance	As the reason for this complication can be extra distraction. Strictly observe distraction rate recommended by the attending physician!
Contractures and pin-induced joint stiffness (restriction of range of movements in joints)	Do use special, recommended by the doctor, poses of the operated extremities in the postoperative period. Do not imitate ROM, but maintain and increase amplitude of movements daily
Refracture (repeated fracture), secondary deformation	To prevent them exclude overloads after removal of the frame.

	Agree with the doctor a weight bearing
The malunited union, the non-union	It is most often at the compound fractures. The most frequent cases are associated with smokers and alcohol abused.
Deformation and damage details and parts of the device	The reason, as a rule, is the inadequate loading exceeding mechanical durability of the device of external fixation. Follow your doctor's recommendations

Note!

If the signs of complications appeared do inform your attending doctor to prevent their development.

Appendix 1: Dressings

Dressing should be done by a nurse in a dressing room. As an exception you are allowed to do it yourself.

You will need (Fig. 10):

- 1) a basin or a rubber sheet
- 2) a pair of sterile gloves
- 3) pincers
- 4) a pair of sterile scissors
- 5) a 10 ml syringe
- 6) 70% ethyl spirit (preparation is shown in Fig. 11) or spirit solution chlorhexidine gluconate (it can be bought in a pharmacy)
- 7) 3% solution of hydrogen peroxide
- 8) 5x5 cm sterile napkins
- 9) a clean cover for the frame



Fig. 10. A dressing set

Sequence of actions:

1. Take a cover off the external fixation device;
2. Put a basin under the frame or spread an oilcloth;
3. Wash up hands with bactericidal soap or process with antiseptic gel; put on sterile gloves;
4. Clean the frame with a napkin moistened by 3% solution of hydrogen peroxide. Then wipe it by spirit solution of chlorhexidine;
5. Wipe hands by spirit solution of chlorhexidine;
6. Move aside disc clips and throw away napkins (Fig. 12);
7. By means of 3% solution of hydrogen peroxide clean skin near transosseous elements;
8. Wipe skin near transosseous elements by 70% ethanol or spirit solution of chlorhexidine;
9. Put on napkins impregnated by 70% ethanol or spirit solution of chlorhexidine and slightly press them using disc clips (Fig. 12). Do not wrap napkins round wires and half pins!
10. Having ironed put on a clean cover.

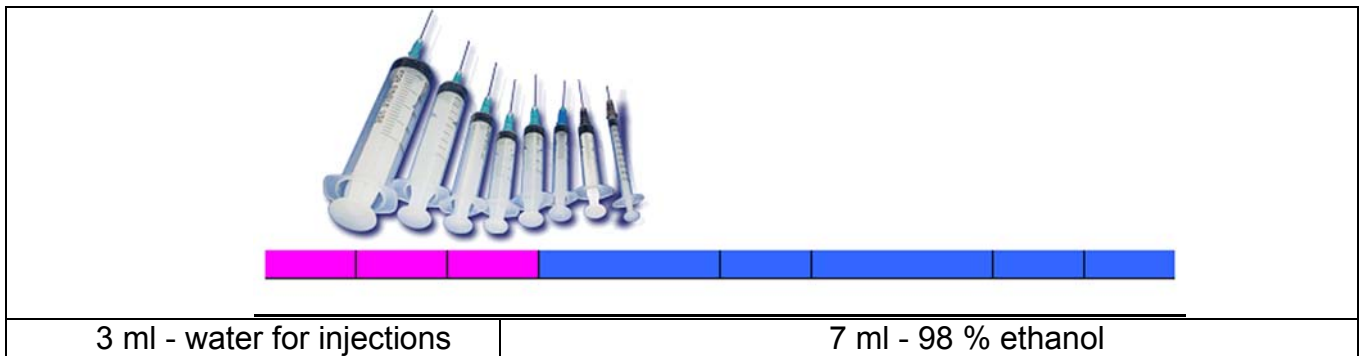


Fig. 11. Making of 70% ethanol. Take 3 ml of sterile water for injections in a syringe and add 7 ml of 98% of ethanol. Shake it up

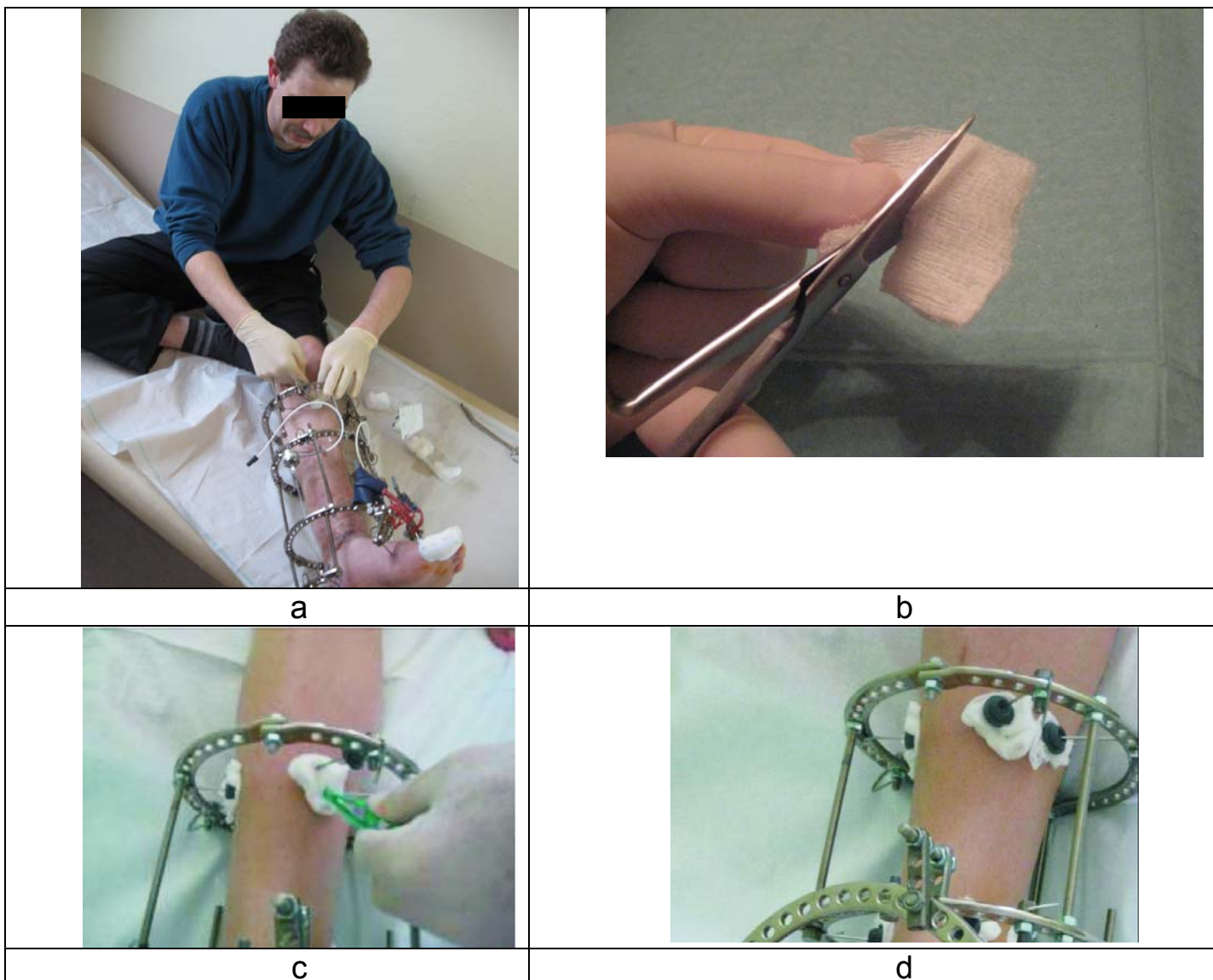


Fig. 12a-d. Some stages of dressing. a – put on sterile gloves before dressing. b - take a 5x5 cm sterile napkin and cut it to the middle. c – put the napkin on the wire making use of napkin slit. d - slightly press the napkin using disc clips

You should consult your attending doctor about frequency of dressings! Usually, if there is no suppuration and napkins remain dry, do dressing 1 time in 7-10 days. Simultaneously change a cover for the clean one. If napkins get wet – it is necessary to change them in process of pollution - probably, every day.

Appendix 2: Frame manipulation

Moving of external supports of the frame

You will need two 10 mm wrenches to rotate nuts on the connecting rods and hinges for compression, distraction and so on (Fig. 13).



Fig. 13. Wrenches

Your doctor will specify which nuts you should screw to move bone fragments in the right direction. To control screwing connecting rods should have labels, for example, 5 mm plaster strips. Every label must have a serial number of the connecting rods and an arrow showing a direction of nuts screwing (Fig. 14).

Of two nuts one moves a support, and the second (check-nut) serves for rigidity of support fixation.



Fig. 14. Labels of the connecting rods, nuts and check-nuts

One full circle of nut (360°) provides 1 mm movement of support along the rod.

Turning the nut at 90° corresponds to a support move to 0.25 mm. The number of 0.25 mm-cycles can vary from 1 to 8 times a day, and it may be different for each of the connecting rods. To control turning one face of the nut could be marked.

To move a support at 0.25 mm one should follow the next procedure. With the help of a wrench you should move check-nut away from the support at 0.5-1 mm. Then the nut is to turn at 90° . This nut is located on the site of the label. To find a turn of 90° it is convenient to use the right angle of a sheet of paper (Fig.

15). After that the check-nut is turned tight to stabilize the support. The rest of connecting rods should be adjusted in the same way.

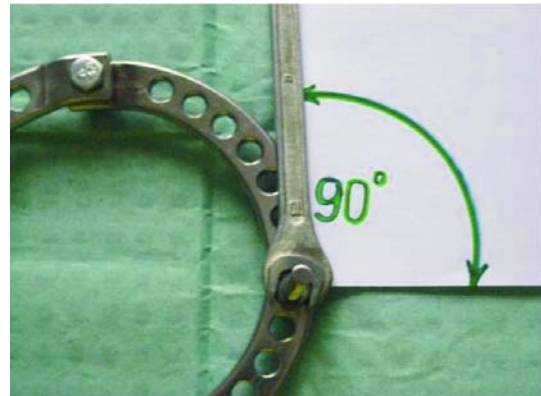


Fig. 15a,b. 90° nut turn. a - initial position, b - nut is rotated by 90°

The number of nut turns of all connecting rods will be informed by your doctor. If you are recommended a distraction 0.25 mm 4 times per day, it is better to perform these manipulations at 8.00 AM, 12.00 AM, 04.00 PM and 08.00 PM.

Throughout the period of treatment the rate of compression (distraction) may vary. Therefore it is necessarily to register all your procedures as it is in the example in Table 3.2.

Table 2
Diary of compression and distraction

Scheme of apparatus	the days of compression (distraction), the value and rate					

Appendix 3: Keeping an orthopedic diary

Measuring the weight bearing, limb circumference and range of motion of joints are the most important information for your doctor. These parameters enable to evaluate restoration of function of limbs and provide appropriate recommendations for your rehabilitation. These data must be entered by you weekly resulted in a special table 3.3.

Table 3.3
The dynamics of the orthopedic status

		Before the operation	1st day	7th day	14th	21th	28th	35th
circumference	On the level __							
	On the level __							
	On the level __							
movement in the joints	proximal joint							
	distal joint							
axial load								

	On the level __	42th	49th	56th	63th	70th	77th	84th
	On the level __							
circumference	On the level __							

movement in the joints	proximal joint							
	distal joint							
Weight bearing								

To measure the weight bearing (Fig. 16) first measure your own weight. To do this step onto the balance with the healthy leg. After that step on the balance with operated leg and load it to the feeling of discomfort: pain, feelings of tension of soft tissue, etc. Remember these feelings and do not overload the leg when walking.



a



b

Fig. 16a,b. Measuring weight bearing. a - measuring body weight. b – measuring most possible limb loading

To measure the limb circumference you will need a measuring tape (Fig. 17a). Generally measurements are taken at three levels: at the level of damage, above and below it. To be compared circumference at symmetrical levels of healthy limb are measured before the treatment. Your doctor will specify exact levels for measurement.



a



b



c



d

Fig. 17a-d. Measuring the circumference lower leg at three levels. a - measuring tape. b - measuring the circumference above the area damaged bone. c – measuring the circumference at the level of bone damage area, d - measuring the circumference below the zone of damaged bone

To control ROM you need a papillary protractor (Fig. 18). The accuracy of measurements will be checked by your doctor.

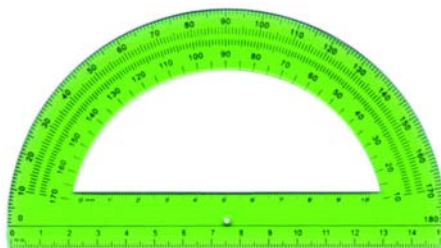


Fig. 18. Protractor

Appendix 4: The use of crutches or canes

Using crutches requires both of good balance and coordination of movements, as well as the strength of muscles. Before walking on crutches learn properly and safely to use them. Having practiced for a short while, you will learn how to walk with the help of crutches.

Walking on crutches with complete unloading of the operated leg.

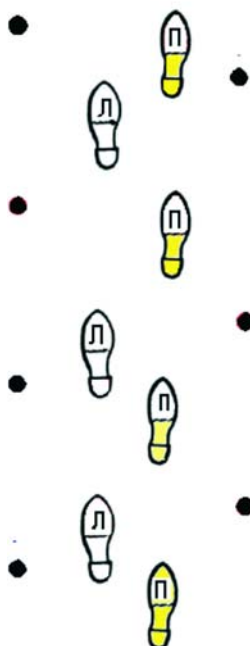
Initial position: standing on healthy leg. Crutches are positioned at 6 cm forward and 15 cm laterally off the feet (Fig. 19).

Put crutches at 25-35 cm forward. Lean on crutches. Transfer the body and lean on the healthy leg at the distance 25-35 cm in front of crutches. The upper part of crutches should be firmly pressed by hands to the chest causing no pressure on the axilla. Support should be done by hands only.



Fig. 19. Initial position when walking with crutches

Initial position at walking with partial loading of damaged leg is the same as if at walking with complete unloading of the operated leg (Fig. 19). Put crutches forward at the 25-30 cm and make a step by the operated leg, placing it on the level of the crutches. Having unloaded the damaged leg with the help of the crutches, move a healthy leg forward placing it at 25-30 cm in front of the operated one. Again move the crutches ahead and repeat the walking cycle (Fig. 20).



make a step by the right leg (loading 25 kg)

make a step by the left leg (full loading)

make a step by the right leg (loading 25 kg)

make a step by the left leg (full loading)

make a step by the right leg (loading 25 kg)

Fig. 20. Walking at partial loading with the help of crutches. Л - Healthy left leg. П – operated right leg. Painful load – over 25 kg

Note!

If a step of the healthy foot was shorter than that one taken by the operated leg, the further step of the operated leg should be shorter. You should do equal steps, they could be short though. Pay a particular attention to this! Go upstairs with the healthy leg, downstairs with the operated one.

Using a cane

Note!

When placing the cane on the side of the operated leg load on the joints will increase by means of body swing.

The first step should be done by the damaged leg. At the same time the cane is moved ahead. When leaning on the damaged leg you should support with your cane. Then the healthy leg is placed between the cane and the operated one. At first, steps need to be short (shorter than the foot length) but of equal length. Then move on to walking by the steps of usual length.

You can use a cane to walk effectively if you are able to firmly hold the handle of it and have sufficient strength in the upper limb, not feeling pain in the joints. Using the stick outside the house will attract pedestrians to realize that you are in need of attention and more space. A special winter cane is to walk safely when it is icy condition of roads. By pressing a special button a pin appears at the bottom of the cane to prevent slippage.

Take a walking stick in hand, which is opposite to the damaged leg (Fig. 21). Thus, a part of your weight is transferred on the stick, and the area of body support will increase. This gives a body balance and confidence when walking. Leaning on the cane is made simultaneously with the step by the operated leg. This way of walking enables to unload the operated leg and prevent from a swinging of pelvis. When using two canes it is easier to maintain body weight on both sides.

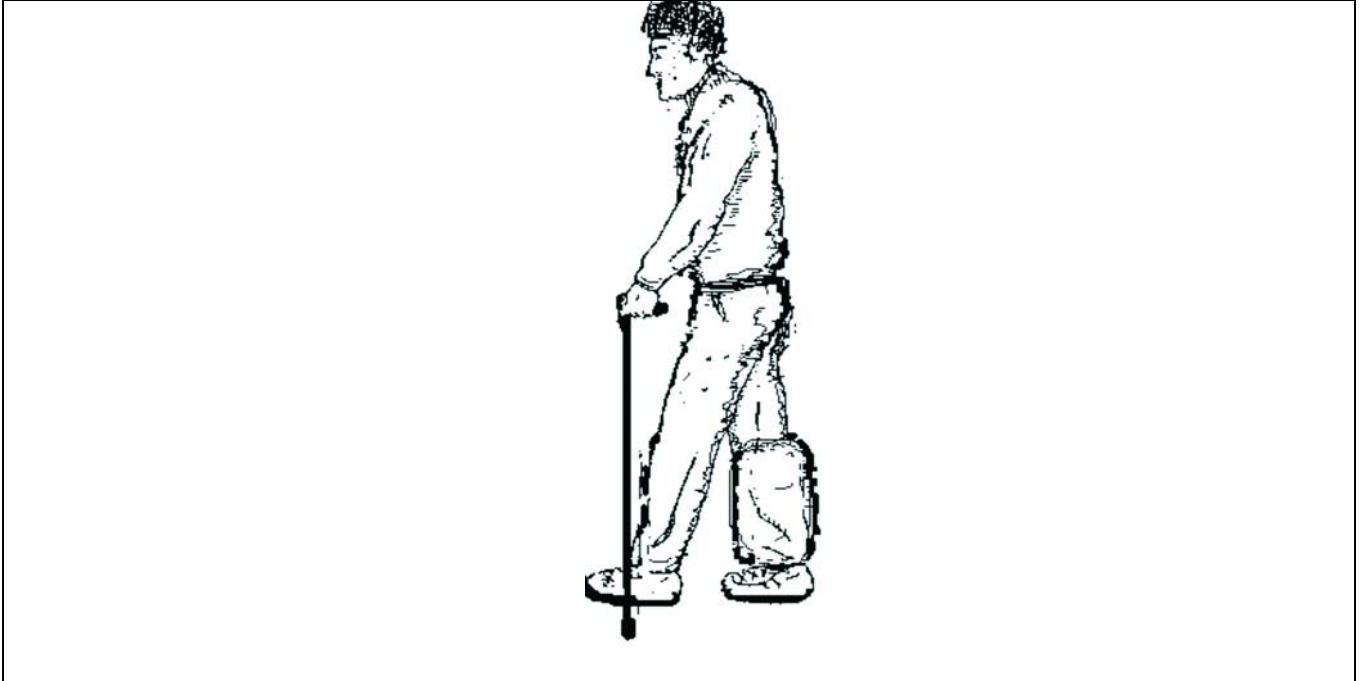


Fig. 21. Cane positioning while walking

Appendix 5: Adjusting clothes

The correctly adjusted clothes will help you to disguise the frame as well as provide with warmth and ventilation. Besides, it will protect the place of transosseous elements insertion from dirt and infection.

You should use loose clothes with a broadened sleeve or trouser leg. Pants can be ripped along the inner or external seam. You should place a triangular piece of fabric into the slit and put a zip or a Velcro (Fig. 22a).

Prepare at least two covers for the apparatus of the «breathing» cotton. Cover should not stretch like stockings or trouser leg. Its length should not cover fingers of hand or foot. At the upper and lower edges of cover put laces to fix it above and below the frame. On the front of cover place a zip or a Velcro or buttons (Figs. 22b and 22c). In the cold time of year use an additional cover made of warm material (Fig. 22d).

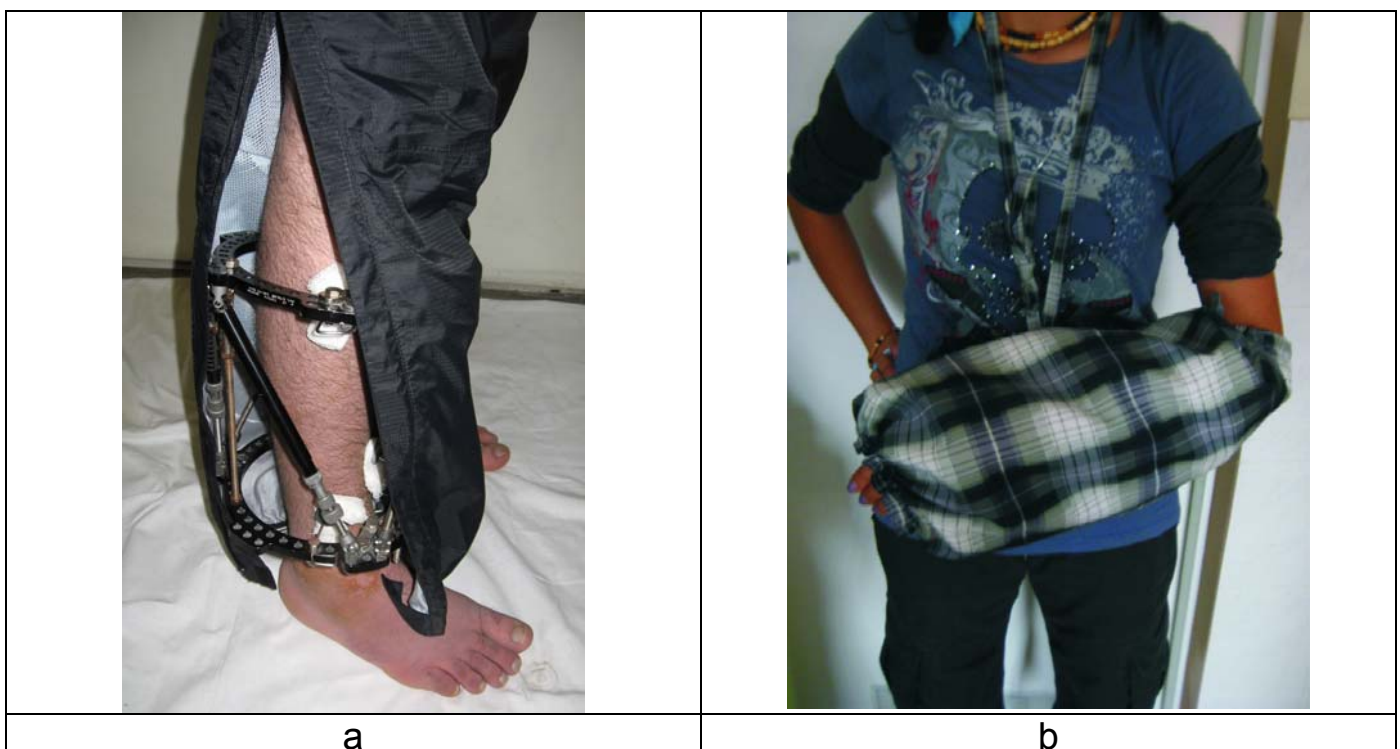
If external fixation device is on lower leg, you should apply a foot-hammock to prevent pes equinus (tip foot). To make the foot-hammock draw a rectangle corresponding to a size of forefoot, as it is shown in Figure 22e. Make the foot-hammock from 3-5 mm plywood and drill holes in the corners of it to fix elastic recoils (rubber cords). Rubber cords should be fixed to the upper ring of the external fixation device (Fig. 22c).

The foot-hammock is to ensure the foot position at the right angle to the axis of the tibia.

You can use polyurethane foam slippers as they are light, durable, flexible and hygienic. Some models of slippers can simulate arch of foot. Place a rubber tape under the fore part of shoe sole (Fig. 22f) and fix it on the frame with tension.

Note!

You should not use a hard foot-hammock in the form of the sole, as it will hinder the proper walk.





c



e



d



f



g

Fig. 3.22a-f. Clothes, covers and foot-hammocks. a - Adjusted trousers. b – the frame cover on forearm. c - Cover and foot-hammock. d - heat-insulated cover. e - manufacturing foot-hammock. f – slipper based foot-hammock. g – finger-hammock

Some patients are allowed to develop crutches on their own, using art design (Fig. 23).



a

Fig. 3.23a,b. Art design of crutches



b

10 Appendix 6: Physiotherapy

Isometric exercises

The basis of isometric exercise is muscle tension without motion in the joints. This is achieved by resting the foot (hand) against the immobile support or muscle straining, as it happens at straining prelum abdominale (Fig. 24).

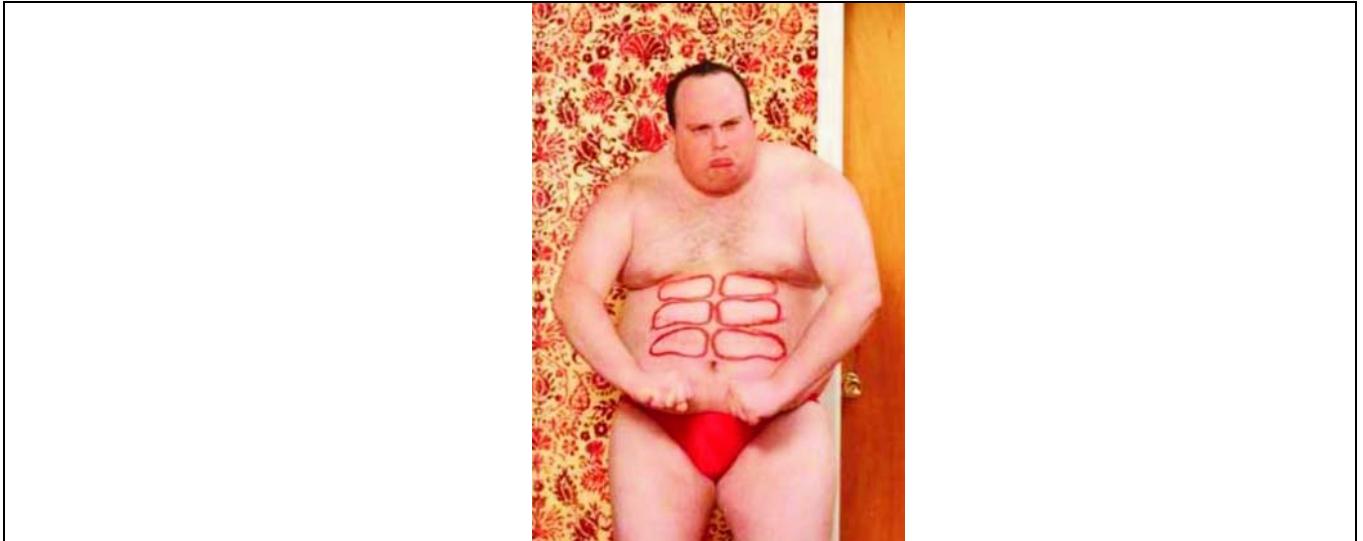


Fig. 3.24. Isometric abdominal straining

Regular execution of isometric exercises will help you in postoperative rehabilitation. Doing exercises several times at 10 minutes a day you will feel positive changes - increase in a tone and strength of muscles.

Basic principles to isometric exercises:

- Exercise with a maximum efforts; strain and relaxes muscles smoothly;
- Breathe rhythmically (6 seconds - inhalation, 6 seconds - expiration), straining the muscles during exhalation;
- Do each exercise 6-10 times, then - pause for 30-60 seconds.

Do 9-12 exercises for the first two months. Then change 3-6 exercises for the new ones, adding other three each month to reach a rate of 20-24 exercises per one training.

Of the following exercises, your doctor will choose the best ones for you. You should agree your load (number of exercises) with the physician or a specialist in exercise therapy.

The isometric exercises at upper limb injuries

1. Hold out your arms and put bent fingers against a table. Breathe in and while breathing out press your fingers on the table, as if you want to drive him to the floor.

2. Bend your arms, make your fingers a fist and press them against the table. Press upon the table with an effort as if you are trying to push it away.

3. Put you hands under a table-top and push up trying to lift it.

4. Lay your arms behind the back of a chair and try to lean forward, despite the resistance of hands.

5. Take a seat of your chair by hands and try to lift yourself.

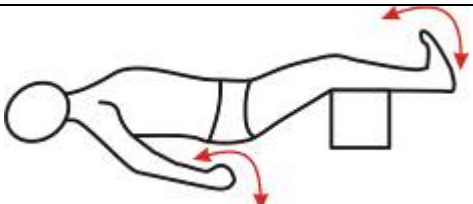
6. Stand behind a chair, take its back and try to alternately compress and stretch it, as if you are playing the accordion.
7. Lean your elbows against a table having folded your hands on your forehead. Try to overcome the resistance of hands, tilt the head forward. Relax the neck and shoulder girdle muscles and repeat the exercise in a minute.
8. Lean your elbows against a table and move the head back. Press the chin on the palms try to lower your head.
9. Having joined your hands behind the neck, try to lean it forward. At the same time resist it by the muscles of your neck using all your power.
10. Stretch out your arms bent in the elbows. One hand should be a fist. Other one should clasp the fist. Push one hand against the other. Shift hands.
11. Sit on a chair, join your legs together and put your hands under the thighs close to the knees. Try to lift your shoulders up, not bending the hands press your palms to the underside of the thighs.
12. Stand your face to a wall at a distance of about one step from it. Raise your hands high above your head and having placed them against the wall, try to move it away.
13. Pull your hands forward, palms inward. Press your palms against each other in full strength. Turn the palms outward and push again.
14. Pull your hands forward and join fingers together. Not releasing your fingers, try to stretch your hands apart.

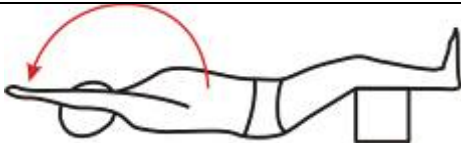
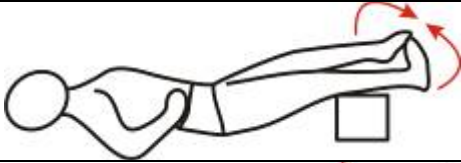


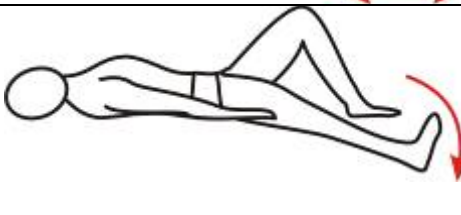

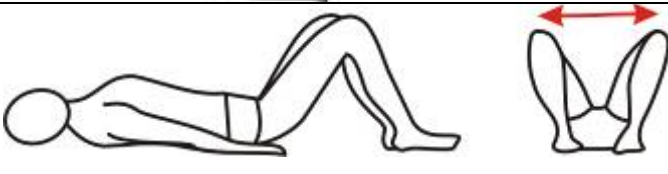
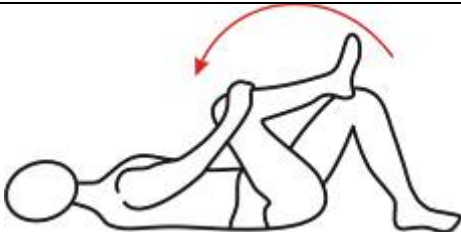
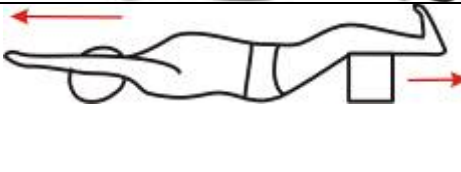
The isometric exercises at lower limb injuries

1. Lying or sitting, straining muscles in your buttocks.
2. In supine position straining thigh muscles try to move the kneecap upwards. Repeat it with other leg.
3. Sitting on a chair, clasp its legs by your feet and straining all the leg muscles try to press the chair.
4. Sit on a chair. Having lifted and straighten legs, put your hands on your thighs. Press your hands on your legs and try to lift both legs not bending the knees.
5. Lying on the bunk put your feet to its back. Pushing against the back of the bunk stretch your feet as if you are trying to stand on tiptoes.
6. Strain your sural muscles of one of your lower leg. Repeat it with the other lower leg.

Curative gymnastics is presented in tables 3.4 and 3.5.

Table 3.4
Physiotherapy exercises set #1

	<p>1. Initial position (IP) is lying, roll under your feet. Bend and unbend feet. At the same time flex and unclasp fingers.</p>
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	<p>2. IP - lying on your back, roll under your feet. Raise your hand up by turns, and then lift both hands up together.</p>
	<p>3. IP - lying on your back, roll under your feet, legs apart. Rotate your legs inwards and outwards.</p>
	<p>4. IP - lying on your back, roll under your feet. Unbend your knees by turns.</p>
	<p>5. IP – lying, one leg is bent at knee. Bend and unbend the other leg, slipping your heel along the bed. Do it on each leg in turn.</p>
	<p>6. IP - lying down, one leg bent at knee. Allow the other leg to the side, sliding on the heel bed. In turn - each foot</p>
	<p>7. IP - lying down, both legs are bent at knee. In turn bend the legs to the stomach.</p>
	<p>8. IP - lying down, both legs are bent at knee. First move your knees apart in turn. Then do the same with both legs at time.</p>
	<p>9. IP - lying down, both legs are bent at knee. While breathing out lean in turn your knee to the stomach.</p>
	<p>10. IP - lying on your back, roll under your legs. At the same time, pull out your hands up and unbend legs in the knee joints.</p>

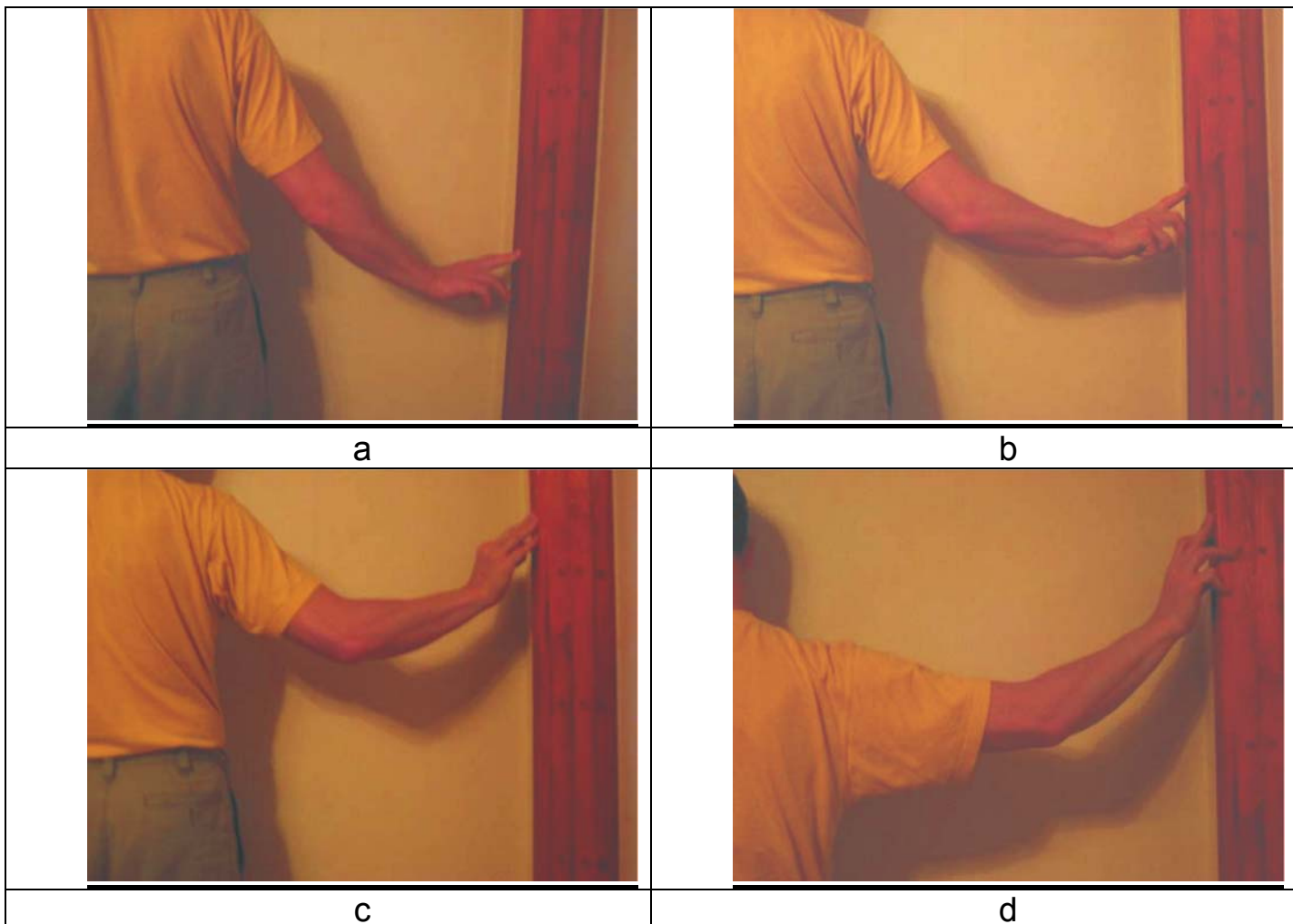
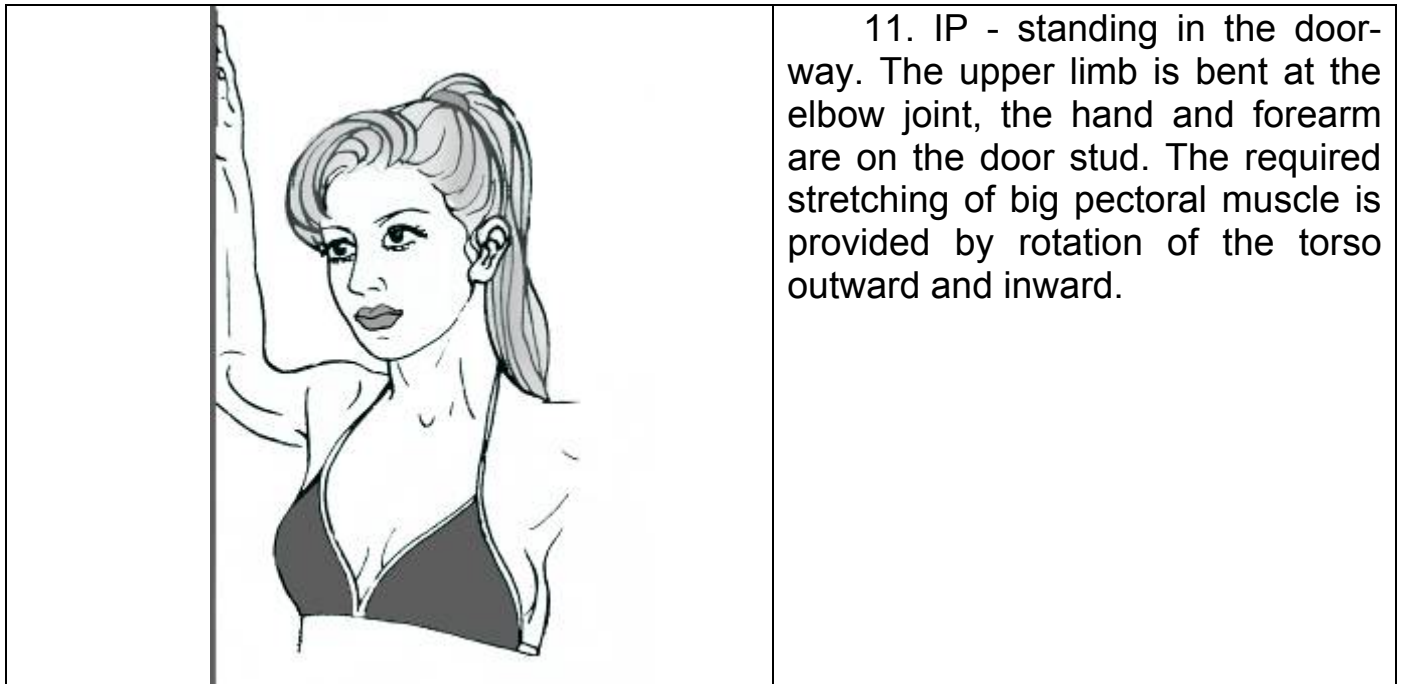
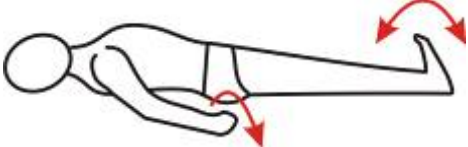
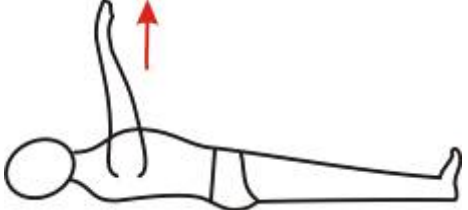
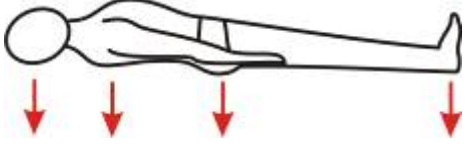

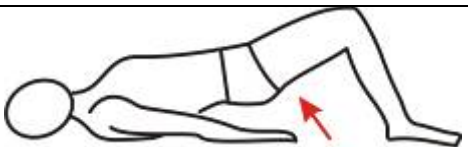

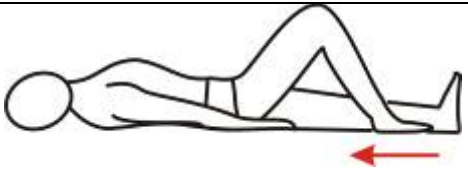


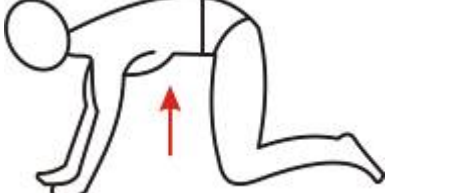
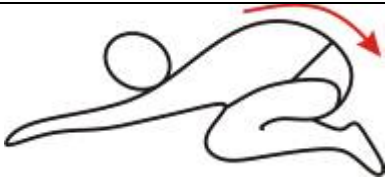
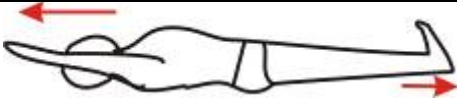


Fig. 3.25a-d. Exercise for the development of movements in the shoulder joint: «go by fingers»

Table 3.5
Physiotherapy exercises set # 2

	1. IP lying down, legs straight. At the same time, bend and unbend feet, clench your fingers intensively for 4-6 seconds
	2. IP lying down, legs straight. In turn raise arms up, moving the shoulder off the surface intensively for 4-6 seconds. The head can be a little up.
	3. IP lying down, legs straight. Push the back of the head to the lying surface for 4-6 seconds, relax the muscles for 7-8 seconds, press it to the surface by 4-6 seconds again and relax the muscles for 7-8 seconds. Do the same for shoulder-blade, buttocks and heels.
	4. IP lying down, legs bent. Lift your head while breathing out. At the same time strain your abdominal muscles for 4-6 seconds.
	5. IP lying down, legs bent. Lift your pelvis at breathing out leaning against the shoulder-blades and heels.
	6. IP lying down, legs bent. One hand is raised up while breathing in. Then this hand goes down, head and shoulders move up. Along with this lean forewards to other knee while breathing out. Do it for both hands alternately.
	7. IP lying down, legs straight. Alternately bend the legs at the knee joint. When straightening slightly push the heel on the bed.
	8. IP lying down, legs straight. Bend both legs at the knee joint.
	9. IP lying, roll under the feet. Lift your pelvis and hold it for 4-6 sec.
	10. IP kneeling. Deflect your spine up (do not sag down when returning to the IP!).

	<p>11. IP kneeling. Sit down on your heels, not removing hands off the bed. Fixing this position for 4-6 seconds get back to the IP (do not sag down when returning to the IP!).</p>
	<p>12. IP lying down, legs straight. At the same time, stretch out your hands up and heels away for 4-6 seconds with effort.</p>

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