

CHAPTER «PHYSICAL EDUCATION AND SPORT»

CHONDROMALATION: DIAGNOSIS, TREATMENT, REHABILITATION

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DOI: <https://doi.org/10.30525/978-9934-26-221-0-17>

Abstract. Chondromalacia of the patella is one of the most common problems of childhood, especially now, when children's lifestyle can increasingly be described as sedentary, and physical activity is minimized. Disorders of the knee joint can have varying intensity and severity, but in any case, this problem requires a mandatory and immediate solution, because the self-healing of cartilage can't be expected. This problem is widespread in different countries and we have accumulated a lot of information about it, which we have systematized in this material. The aim of the study was to comprehensively characterize the problem of chondromalacia and to draw up a program of physical rehabilitation for chondromalacia for school-age children. Thus, we considered the theoretical issues of determining chondromalacia, diagnosis and treatment of this condition, as well as rehabilitation approaches. In particular, it can be noted that physical therapy is quite effective in cases of uncomplicated chondromalacia. However, in neglected conditions or particularly severe conditions, including those accompanied by additional pathology, there is a need for medical or even surgical intervention. In children, the initial development of chondromalacia, as a rule, can be corrected by the use of therapeutic exercise, which helps to increase mobility and weight loss, which are among the major risk factors for the development of chondromalacia of the patella. Therefore, in the research

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part of the work we have proposed a scheme of therapeutic physical culture and concomitant ozokerite therapy for children of primary, secondary and senior school age, taking into account their belonging to these age groups. The program provides a set of physical exercises that must be performed for rehabilitation in chondromalacia and for prophylactic purposes to prevent its occurrence. There is a set of exercises that can be used for children with signs of chondromalacia. Exercises are performed from different positions, however, common to most of them is that there is an increase in the load on the lower body, in particular on the extremities, to improve the condition of the joints. Exercises can also be performed with an additional load, which is assigned depending on age. The total duration of the set of exercises is 30-45 minutes in different age groups. Recommendations on ozokerite therapy and the possibility of adding aerobics to the pool to improve the condition of children are also provided.

1. Introduction

Diseases of the musculoskeletal system are quite common and occur in people of different ages. They are considered typical for the older age groups, however, there are cases of diseases among children [5; 9; 12].

The World Health Organization ranks musculoskeletal disorders as the 4th leading cause of disability and death from cardiovascular and cancer diseases and diabetes [5].

In Ukraine, chronic diseases of the musculoskeletal system are also one of the most common problems [12]. About 3.5 million Ukrainians are registered in connection with diseases of the musculoskeletal system [9], which requires constant long-term therapy [4; 8].

Among the problems of children that can be classified as chondropathy, there are mainly those that are associated with growth processes or are the result of trauma [22; 23; 24]. Also causes of chondropathy can be: weak superficial thigh muscles, stabilizing bones in the correct position, congenital abnormal bone structure, poor blood circulation, which does not allow sufficient nutrition of cartilage, inadequate footwear, overload during sports training and overweight [27; 28].

According to the current classifier of diseases (ICD-10) chondropathy assigned code M91-M94 [10]. The classification of the disease includes several forms, and each has its own characteristics and causes of development.

In particular, most diseases belong to the category of osteochondrosis and osteochondropathy, i.e. have a mixed origin, associated mainly with bone destruction and subsequent degradation of cartilage. Such diseases include juvenile osteochondrosis of the spine, femoral head and other osteochondrosis, other osteochondropathies (dissecting osteochondritis, apophysitis, epiphysitis, etc.) [13; 17; 18]. Chondropathies, which are primarily associated with cartilage damage, include costal chondritis, polychondritis, chondromalacia, chondrolysis, and specified and unspecified cartilage diseases [11; 18].

All these diseases are manifested as pain after physical activity, swelling in the affected joint, atrophic processes in muscle tissue, crunch when moving and stiffness of movements [25; 29; 30]. If such symptoms are observed, it is mandatory to consult a doctor to diagnose the disease and prescribe adequate treatment.

The treatment of chondropathy is always complex: it includes drug therapy and non-drug approaches.

Drug therapy consists of the use of the following drugs:

- non-steroidal anti-inflammatory drugs;
- analgesics;
- hormonal drugs;
- chondroprotectors [3; 11; 16].

Among the non-drugs are joint fixation (rigid orthoses, bandages, sometimes plaster casts), skeletal traction (in some cases), physiotherapy (magnetic and laser therapy, electrophoresis, ultra-high frequencies and phonophoresis), massage and physical therapy. It is important to adhere to the regime and regularity of treatment measures: only in this case, the therapy will have an effect. The patient should take care of the affected joint and not overload it. In the acute period of the disease, bed rest is important [1; 14; 21].

Late detection of chondropathy or avoiding of treatment at all or with adequate methods can have very serious consequences:

- violation of the normal position of the knee or hip joints;
- deforming arthrosis;
- chronic inflammatory-degenerative process with gradual loss of limb functionality [18].

The negative effects can be reducing if the treatment start quickly.

It is possible to reduce risk of development of pathology, carrying out prevention. Chondropathy most often occurs in childhood, so prophylaxis should start at this age. The most effective prevention measures are:

- swimming;
- maintaining a normal body weight;
- selection of comfortable shoes;
- proper balanced nutrition;
- alternation of load and rest [3; 6].

Only a doctor can notice degenerative changes in cartilage in the early stages with the help of special equipment. Therefore, especially in hereditary forms of pathology in the family, it is important to show the child to an orthopedist at least once a year.

One of the most common types of chondropathy in children is chondromalacia – a wear of the knee joint, which usually heals and manifests itself in symptoms such as deep pain in the knee and around the patella when performing certain movements, which are treated with anti-inflammatory drugs, exercise, use physiotherapy methods, and in some cases surgery.

Chondromalacia of the patella is the most common pathological manifestation in children and is often associated with weakening of the quadriceps muscle in the front of the thigh and the shape of the child's knee or the location of the foot. These conditions, associated with overweight and repetitive exertion, are the main causes of the disease [7; 13; 27; 28].

The aim of the research is to theoretically consider the issue of chondromalacia: its definition, classification, diagnosis, treatment and rehabilitation.

2. Chondromalacia: definition and classification

Local lesions of the cartilage of the knee joint, or chondromalacia (ChM) – is a violation of the integrity of its cartilage (Figure 1), resulting from injuries or diseases, limited mainly to one section of the joint, extending to the depth of articular cartilage or reaching subchondral bone common degenerative-dystrophic joint damage [11; 18].

Chondromalacia was first described by Budinger in 1906, and the term “chondromalacia” was used by Alemann in 1928 to describe degeneration of the patellar cartilage. Otherwise, the pathology is called Budinger-Ludloff-Leven disease.

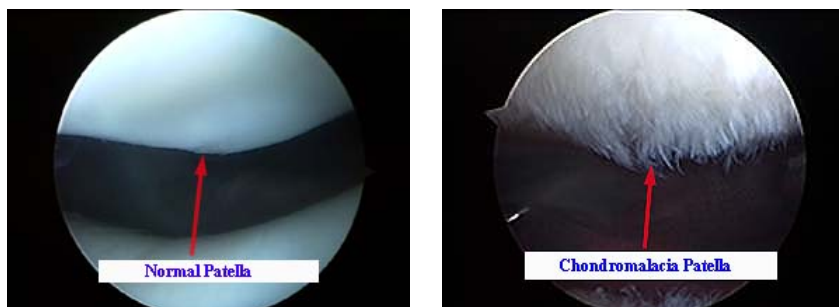


Figure 1. Normal and damaged patellar cartilage

Source: <https://sportklinika.ru/ortopediya/hondromaljacija-kolennogo-sustava-nadkolennika.html>

Typically cause of cartilage damage is acute trauma or chronic microtrauma of the knee joint. Most often, cartilage pathology is secondary and develops in the presence of ruptures of the menisci and ligaments of the knee joint. Both acute and chronic damage leads to the progressive destruction of this vital structure of the knee joint and ultimately contributes to the development of deforming osteoarthritis.

Cartilage damage is a common cause of pain and dysfunction of the knee joint, and are found both in isolation and in combination with other pathologies in 14-26% of patients [18].

Code of the International Classification of Diseases-10:

- M22.4 – Chondromalacia of the patella;
- M94.2 – Chondromalacia;
- M94.8 – Other specified lesions of cartilage [10].

Numerous classifications have been developed to assess the severity of acute and chronic articular cartilage damage [18]. The systems proposed by Waterbridge in 1961 and Boyer and Jackson in 1988 were the most widespread in clinical practice due to their simplicity.

Waterbridge described four degrees of cartilage damage:

- I degree – local edema and softening of cartilage;
- II degree – superficial stratification (fibers), fragmentation and cracking of cartilage in the area with a diameter of not more than 1.25 cm;
- III degree – not full-layer fibrillation, fragmentation and cracking of cartilage with a diameter of more than 1.25 cm;

– IV degree – cartilage defect with exposure of subchondral bone.

Boyer and Jackson identified six types of cartilage damage:

– Type I – linear cartilage crack;

– Type II – cracking of cartilage of irregular star shape;

– Type III – patchwork damage;

– Type IV – crater-like damage penetrating the subchondral bone;

– Type V – stratification of cartilage into fibers;

– Type VI – degenerative (exposure of subchondral bone with cartilage fibrillation at the edges of the defect) [18].

It is believed that the predominant cause of injuries of types I-IV are traumatic factors, while types V and VI are mainly found in degenerative-dystrophic diseases of the knee joint, ie in the advanced stages of the disease.

When describing the condition of articular cartilage in addition to the type and depth of damage, it is customary to note its size, as well as anatomical and functional localization (areas that experience maximum mechanical load, not loaded areas).

The most common classification of articular cartilage damage, based on magnetic resonance imaging data: it was identified 4 degrees of destruction depending on the changes in the signal inside the cartilage layer and at the level of the bottom of the defect:

– 1 degree – changes inside the cartilage without violating its integrity;

– 2nd degree – violation of the continuity of the cartilage of medium degree with local damage up to 50% depth;

– 3 degree – severe violation of cartilage continuity with local changes of more than 50%;

– 4 degree – absence of articular cartilage, exposure of subchondral bone [18; 28].

There is a modern system for assessing cartilage damage, proposed by the International Cartilage Repair Society (ICRS) (2000):

– Stage 1 – softening of cartilage without compromising its integrity;

– Stage 2 – partial separation of the cartilage, stable in the study;

– Stage 3 – violation of continuity, due to the death of cartilage on the spot, without dislocation;

– Stage 4 – violation of the continuity of cartilage with the formation of a free fragment, which may be within the formed defect or outside it.

Defects of cartilage of traumatic origin are classified as follows:

- 0 degree (norm): cartilage without macroscopically visible defects;
- 1 degree (almost normal): superficial lesion of cartilage;
- 1A: cartilage with intact surface, but soft when probed and / or with some defoliation;
- 1B: cartilage with surface cracks and fissures;
- Grade 2 (pathology): the damage spreads deeper, but less than 50% of the cartilage depth;
- Grade 3 (severe pathology): the defect penetrates more than 50% of the cartilage depth, but does not penetrate into the subchondral bones;
- 3A: defects that do not reach the calcified layer;
- 3B: defects affecting the calcified layer;
- 3C: defects that spread through the calcified layer but do not affect the subchondral bone plate;
- 3D: cartilage edema (also included in this group);
- Grade 4 (severe acute pathology): full-layer osteochondral lesion;
- 4A: the defect extends to the subchondral plate;
- 4B: the defect penetrates the underlying bone [<https://cartilage.org>].

3. Diagnosis of chondromalacia

The following methods are used to diagnose ChM and other cartilage injuries of the knee joint:

- clinical (complaints and medical history, objective examination of the patient);
- radiation (radiography, MRI);
- arthroscopy.

Complaints and medical history are an integral part of the diagnosis from which it begins. Careful history taking and clinical examination are recommended during the examination of the patient [11; 18].

The main complaint in all patients with local cartilage damage is pain in the knee joint. In most patients, they are aching, which intensifies after exercise and when the weather changes. In one third of patients the pain is acute convulsive and occurs and/or worsens when walking, especially up and down stairs. The localization of pain is determined by the intra-articular site of cartilage damage: in isolated chondromalacia of the patella frontal pain is noted, in cartilage damage of the inner femoral-tibial joint, they spread to the anterior inner surface of the joint, and in the external in

a quarter of patients the pain is diffuse in nature without clear localization [5; 11; 13].

A characteristic complaint of patients with ChM joint is crepitation, which they call the “cross” in the joint. Periodic swelling of the joint affects less than half of patients.

The amplitude of movements in most patients with cartilage damage is complete, in a third of patients there are periodic “soft” easy-to-stop blockades. About a third of patients with local ChM complain of a feeling of instability in the joint (in foreign literature, this symptom is called “giving way” – “slipping syndrome”) [18].

Physical examination can be effective only if performed by an experienced physician and in any case there is a need to use laboratory methods for differential diagnosis.

The main symptom in the objective examination of patients with limited damage to the cartilage of the knee joint is palpatory pain, more often located in the projection of the injury, less often without a clear location. Correlations between the degree of ChM and the severity of palpatory pain were not observed. It is not possible to localize the morbidity in every fifth patient with CM of various degrees, it is spread all over the joint [13; 18].

Synovitis of the knee joint in the form of diffuse sealing of the synovial membrane is observed in less than half of patients, effusion in the joint is mostly absent.

For ChM of different degrees is characterized by the limitation of active bending to 45-50 degrees. Passive flexion and extension are in line with physiological norms (indicators of contralateral healthy joint). Moderate malnutrition of the thigh and leg muscles occurs in almost half of patients. A fairly common symptom of ChM is crepitation during active and passive movements in the knee joint [18].

Laboratory diagnosis is recommended to clarify the general condition of the patient as a preoperative examination (standard blood tests, urine, coagulogram and others according to the indications).

The first of the instrumental methods is radiography of the knee joint, but its informativeness is low [11].

At ChM of I-II degree on radiographs there are no signs of bone and cartilage pathology, at III-IV degrees insignificant subchondral sclerosis is

found. Nonspecific radiological signs of CM can be considered darkening of the upper torsion and diamond-shaped space.

The recommended effective method for assessing the condition of cartilage is magnetic resonance imaging (MRI) of the knee joint [18].

By changing the signal intensity and breaking the continuity of the joint surface contour, it is often possible to identify surface damage up to 1 mm deep, and when the defect size increases to 3 mm, the diagnostic accuracy is close to 100%.

Among other diagnostic methods, diagnostic arthroscopy is recommended, which changes the color, luster, density of cartilage, the presence of defibering, allows to establish the location and degree of damage to the cartilage of the patella and condyles of the femur and tibia [32].

Grade I damage (according to Waterbridge) is characterized by swelling and softening on palpation of the cartilage or its slight fibrillation in an area up to 1 cm in diameter; at the II degree easy fibrillation of a cartilage on a site with a diameter more than 2 cm or rough fibrillation of a joint surface with a diameter less than 1 cm only on one of articulated surfaces is noted; at III degree there is a rough fibrillation with a diameter more than 1 cm on one of articular surfaces or less than 1 cm on both articular surfaces, isolated exposure of subchondral bone with a diameter up to 2 mm is possible; Stage IV is accompanied by exposure of the subchondral bone in the area with a diameter of more than 2 mm with degenerative changes in the surrounding cartilage [11; 18].

4. Treatment and prevention of chondromalacia

Treatment of chondromalacia can be performed surgically or conservatively.

In patients with cartilage damage of varying degrees, surgery is recommended to begin with diagnostic arthroscopy, which for several minutes to assess the condition of all intra-articular structures, allows to accurately determine the severity, prevalence and location of articular cartilage damage [18; 32].

Most reconstructive interventions or their individual stages can be performed without arthrotomy, under endoscopic supervision. Surgery is performed under conduction or local anesthesia with neuroleptanalgesia or intravenous anesthesia.

At visually revealed I degree of ChM endoscopy comes to the end with washing of a joint of 1,5-2 liters of 0,9% of solution of sodium chloride.

In cases of II and III degrees of ChM, resection of unstable areas of the affected cartilage to healthy tissue is performed, using arthroscopic scissors and basket bites or shavers. In recent years, for this purpose, widely used ablaters, which allow to achieve maximum alignment of the articular surface. Resection cartilaginous rags and areas of fibrosis with an arthroscopic hook are checked for the integrity of adjacent tissues. If necessary, they are additionally resected, the endoscopic stage of the operation ends with abundant (2-3 liters of saline) flushing of the joint.

The most severe injuries of the IV degree are characterized by large destruction of articular cartilage with exposure of the subchondral bone. Arthroscopic cartilage resection should be supplemented by tunneling the sclerotized subchondral bone with a thin awl or Kirchner needle or creating «microfractures», forming multiple holes in the subchondral bone with an arthroscopic awl 2-4 mm deep at a distance of 3-4 mm from each other. It should be noted that mesenchymal stimulation techniques are indicated for small defect size (up to 4-5 mm) or its localization in the unloaded area of the condyles of the femur or tibia. With a full-layer defect, more than 5 mm in diameter, localized in the loaded area of condyles of the femur or tibia, as well as on the patella, it is recommended to perform mosaic cartilage autoplasty, transplantation of autogenous chondrocytes or stem cells [26; 31].

There are no significant differences in the technique of surgical interventions for fresh and old cartilage damage. However, in the near post-traumatic period, arthroscopy is significantly complicated by severe intra-articular effusion containing blood, as well as severe edema and bleeding of the synovial membrane.

At detection of separate linear cracks of a cartilage its mobility is checked by an arthroscopic hook. In the case of cartilage exfoliation, it is necessary to resect these areas. When the cartilage is detached from the subchondral bone, the flap is removed, the adjacent edges are gently smoothed, the exposed subchondral bone is drilled with a Kirchner needle.

Mosaic bone and cartilage autoplasty in the treatment of deep local lesions of the cartilage of the knee joint is recommended to replace the affected area of the articular surface, localized in the concentration of loads,

bone and cartilage autograft cylindrical or intercondylar fossa, anterior to the site of attachment of the anterior cruciate ligament [11; 18; 26].

At the stage of diagnostic arthroscopy the condition of all intra-articular structures is determined, the localization and area of the center of cartilage destruction are specified, free intra-articular bodies are removed. Next, the operation of mosaic bone and cartilage autoplasty is performed endoscopically or retreat the operating field and perform arthrotomy. After arthrotomy, the size and number of grafts required for the most complete filling of the joint surface defect is determined by special meters. Empty cutters of the required diameter are used to collect cylindrical bone and cartilage autografts 15-20 mm high from unloaded parts of the outer or inner condyles of the femur. In the area of destruction of the articular surface with a cutter or drill holes are formed, which are placed bone and cartilage autografts in the required amount, they are tightly killed, forming a smooth articular surface of the condyles. A small difference in the diameters of the cutters for drilling holes or drills for their formation and collection of grafts (1 mm) provides a tight fit (presfit) of transplanted autografts, without requiring additional fixation. Donor wells in some patients can be filled with cylindrical autografts of appropriate diameter, obtained from the area of cartilage damage during the formation of wells, or allograft. In other patients, the donor wells remain unfilled when stable graft fixation is not possible. Having restored the defect of the articular surface, it is necessary to check the stability of the fixation of autografts during passive movements in the knee joint. The joint is drained; the wound is sutured in layers. When transplanting 1-2 transplants, the limb is not immobilized, if three or more transplants are transplanted, the posterior plaster splint is applied [18; 31].

Comprehensive conservative treatment is recommended for ChM I-II degrees, if the clinical examination of the joint does not show symptoms of damage to the capsular ligament or severe synovitis with intra-articular accumulation of fluid, standard radiographs and MRI of the knee show no signs of pathology [11].

The complex therapy recommended to patients necessarily includes:

- limitation of total physical activity on the joint;
- therapeutic physical education, swimming lessons;
- rhythmic contractions of the quadriceps femoris in the position of extension of the knee joint, repeated repeatedly during the day;

– physiotherapeutic procedures (laser therapy, ultrasound, ozokerite, magnetic therapy, medicinal phono- and electrophoresis, shock wave therapy, etc.);

– non-steroidal anti-inflammatory drugs, such as diclofenac 100-150 mg per day orally for a month, followed by the drug 1 tablet per day for 2-3 weeks [1; 11].

The feasibility of drugs containing glucosaminoglycans (glucosamine sulfate and chondroitin sulfate) of plant or animal origin is questionable due to the lack of convincing data that reliably confirm their clinical significance in the treatment of acute and chronic articular cartilage damage.

Conservative treatment is recommended for 1-1.5 months in a clinic or outpatient rehabilitation center at the patient's place of residence [11].

At full acquisition of pains and restoration of function of a knee joint patients are recommended to start usual loadings and sports. At considerable decrease in intensity of a pain syndrome, but the remained discomfort in a knee joint at loadings, it is recommended to limit physical activity and in 2-3 months to pass repeated course of conservative treatment. If conservative therapy did not lead to improvement or it was insignificant, the patient is hospitalized for surgical treatment [11; 18].

Measures to prevent the development of ChM of the knee joint include the exclusion of injuries and re-microtrauma of the knee joint.

Dispensary observation is recommended to be performed on an outpatient basis in 2 months after surgery (clinical examination and control radiography) and in 6 months (control study and MRI). Further, as needed, determined by the doctor or the patient on the basis of existing complaints [11].

Prevention also involves reducing injuries and maintaining a healthy lifestyle. Patients with overweight should limit the caloric content of food [7], women at risk should give up heels [5; 7].

5. Rehabilitation for chondromalacia

It is recommended in the postoperative period after cartilage resection and subchondral bone tunneling that the first ligation is performed the next day, and the joint puncture is performed on the second day after the

operation. Walking with additional support on crutches without load on the operated leg is allowed from the second day. Therapeutic physical exercises in the form of rhythmic contractions of the thigh and leg muscles, movements of the toes, as well as passive and active movements in the knee joint at full amplitude are recommended from the second postoperative day [11; 23; 24].

On the seventh day it is recommended to remove the sutures. If an arthrotomy was performed, the plaster cast is also removed, patients are discharged for outpatient rehabilitation treatment (exercise therapy, massage, water treatments, physiotherapy procedures – magnetic therapy, UHF, electromyostimulation, and later – ozokerite, laser therapy and others).

Dosed load is recommended to start in 4 weeks, full – in 8 weeks after surgery.

After fixation of the cartilaginous fragment, it is recommended to remove the metal needles in an average of 8-10 weeks, the limitation of the axial load is maintained until the appearance of radiological signs of adhesion [11; 18].

In the postoperative period, patients are recommended to parenterally administer broad-spectrum antibiotics for 3 days and analgesics as indicated. The first dressing is performed the next day; the drains are removed after 24-48 hours. After removing the drainage, the patient is allowed to get up and walk with additional support on crutches without straining the operated leg. After the wound has healed, a circular plaster cast is applied from the upper third of the thigh to the fingertips when transplanting three or more grafts, and immobilization is not used when transplanting one or two grafts. The duration of immobilization (2-4 weeks) depends on the number of transplanted autografts and the stability of their fixation. Dosed loading is recommended to start in 6 weeks [11].

After immobilization, a comprehensive rehabilitation treatment is recommended, which includes therapeutic exercise aimed at strengthening the muscles of the limb and restoring the amplitude of movements in the joint, massage, water and physiotherapy treatments. Full load is allowed in 8-10 weeks after surgery. For 2-3 months, patients are recommended to use a cane when walking, fix the joint with an elastic bandage or kneecap [2; 11; 15].

6. Comprehensive program of recovery and rehabilitation for chondromalacia in school-age children

Wellness programs are always comprehensive and are compiled on an individual basis, in accordance with the sanatorium card of the child and (when conducted in groups during the stay in sanatorium treatment) are unified into groups based on age. The comprehensive program in all cases includes exercise therapy, and ozokerite therapy and hygienic massage of the lower extremities may be recommended.

7. Therapeutic exercise for chondromalacia

The use of therapeutic exercise to increase physical activity is daily for all children, in addition to the indications formed a group to perform exercises for chondropathy.

Additional classes aimed at improving the condition of the knee joint with confirmed chondromalacia or its symptoms can be used once every 2 days: for children of primary school age classes lasted 30 minutes, for older and middle-aged – 45 minutes. The exercise program was developed taking into account the allowable physical activity for the health of the child according to its underlying pathology (diseases of the respiratory and digestive systems).

Exercises are performed taking into account the tonic effect on the body. Features of exercises in this mode are: starting position standing, sitting and lying down depending on the exercise; special exercises of low and single medium difficulty without objects or with additional equipment. For dumbbell exercises for children aged 6-8 years use dumbbells for fitness with a rubber coating weighing 0.5 kg, for children aged 9-10 years – 1 kg, for children aged 11-13 years – 1.5 kg, for children aged 14-15 years – 2 kg and for children aged 16-17 years – 2.5 kg.

When developing an intervention scheme for pathology additional to the underlying disease (the main goal of recovery is prevention / treatment of diseases or their recurrence in children with chronic respiratory and digestive diseases), these features were taken into account based on recommendations [6; 20].

A set of additional exercises for the knee joint was developed for the predominant activity of the lower body. It is held in an additional lesson.

The set of exercises is the same in all age groups, however, in the younger group it is recommended to perform 5 movements less in each exercise (table 1).

Complex of exercises for the knee joint

№ of exercises	Starting position	Sequence of movements	Number of movements*
1	Lying on your back, one leg bent at an angle of 90 degrees, foot on the floor, the other leg fully extended	Tighten the quadriceps muscle and raise the straight leg at a 45-degree angle. Keep your foot in a raised position for a second or two before slowly lowering it back to the floor. For both legs alternately	15-20
2	Lying on his side, legs together, injured leg on top; the lower arm can be placed under the head	Keeping the heels folded together and the pelvis pressed to the ground, raise the knee of the upper leg as high as possible, hold for 1-2 s, then lower it	10-15
3	Lying on your back, arms slightly apart, knees bent, feet on the floor	Straighten the leg, lift the buttocks so that from the shoulder blades to the toe of the raised leg, a straight line**	5-10
4	The heels should be at a distance of about 15 cm from the wall, and the feet – at a width of 30-40 cm. The back should be pressed to the bench	Slowly slide your waist down the wall until your knees are bent at an angle of about 45 degrees. Hold in this position for about 5 s, and then slowly return to starting position. It is important not to do squats too fast or too deep, as this can damage the knee!	10-15
5	Lying down, legs outstretched, relaxed. Under the knee of one leg – a roller	Tension the muscles of the leg under which the roller is located so that the knee is fully straightened. Hold the leg for 5 seconds, then relax the quadriceps and slowly lower the leg to its original position. The exercise is performed on both legs	15-20
6	Legs shoulder-width apart, arms lowered with dumbbells (0.5-2.5 kg depending on age)	Slowly squat with dumbbells (angle less than 90 degrees). The body is kept straight, the head is raised, the dumbbells are close to the body. Hold in this position for a few seconds. Perform the reverse movement, tensing the muscles of the legs, back, press and return to starting position	3-5

Note: all exercises perform 2 approaches for the younger age group and 3 approaches for the middle and older groups; * – lower value – the number of exercises for children of younger age groups, upper value – the number of exercises for children of middle and older age groups; ** – exercise is not performed if both knees have signs of chondromalacia III or IV degree. Perform only when the supporting leg is healthy.

Source: [2; 6; 8; 15; 20]

All exercises are aimed at strengthening the muscles of the legs and thighs without increasing the pressure between the patella and the groove of the femur, to prevent deterioration of cartilage [2; 6; 15]. When using lying exercises, fitness mats and mats are used, while standing exercises with the back touching the wall surface are performed on a bench press on the Swedish wall. Exercise and safety must be supervised by an instructor.

8. Ozokerite therapy

Ozokerite therapy is carried out immediately after the completion of additional exercise classes, ie once every 2 days.

Before the procedure, ozokerite is pre-melted in a water bath and sterilized (at 100 °C) for 10-15 minutes. Then cool ozokerite (up to 48 °C) and apply to the surface of pre-lubricated with Vaseline skin. Lubrication is evenly distributed over the entire surface of the knee on all sides in the area of 10 cm above and below the knee. The method of application is used, for which gauze is immersed in ozokerite, impregnated with molten ozokerite and then applied around the knee over the area lubricated with vaseline. The area of the body with the applied ozokerite is covered on top with a disposable polymer film, and the floor is covered with a blanket. The duration of the procedure is 20 minutes, during which children rest from exercise [1; 21]. After ozokerite is removed with napkins. The knee is not washed immediately.

9. Exercises recommended for swimming

In addition to the sanatorium card, additional instructions are being developed for children with suspected chondromalacia. Among the proposed measures are also recommended aerobics in the pool, which reduces the load on the knee joints during training and helps to restore their functionality [16; 19]. Exercises in the pool should be carried out with the alternate use of different muscle groups, with chondromalacia they should be mandatory for the rehabilitation of the knee joint.

Tasks in the period of restoration of function of a knee joint are the following:

- restoration of normal gait and adaptation to long and fast gait;
- strength training of the muscles of the thighs, buttocks and legs;
- restoration of active flexibility of the knee joint;
- adaptation to slow running;
- psychological readaptation.

The following physical exercises should be used:

- squats – 20 times;
- swing your legs back and forth, sideways – 20 times for each leg;
- lifting the knees to a height of 30-40 cm – 20 times for each knee;
- semi-squats without resistance – 20 times;
- imitation of running movements with support;
- swimming on the back in any mode with the work of the lower extremities;
- swimming on the abdomen with knees («mermaid») with the use of a board.

All exercises should be performed in at least 3 times. The total time of recommended classes is 45 minutes 2-3 times a week.

10. Conclusions

Children should lead a normal life. Their level of physical activity should be adjusted. To avoid pain, very active children should use knee bandages with a knee strap (clamp) [2].

If necessary, you can take health courses in sanatoriums, where peloidotherapy is practiced [6].

The best prevention of age-related pain and complications of patellar problems is a healthy lifestyle with sufficient amounts of physical activity [7].

In the long run, it is desirable to take into account the exercises of this complex when compiling a gymnastic complex for physical education classes in secondary schools, because most modern children have a sedentary lifestyle and minimized physical activity, which can provoke chondromalacia.

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