

Methodology for the rehabilitation treatment of the posttraumatic knee in athletes

Metodologia tratamentului de recuperare a genunchiului posttraumatic la sportivi

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Abstract

The knee is the largest and the most complex joint of the body. It is an intermediate joint of the lower limb involved in orthostatism and walking dynamics. It is also the most common site for injuries in athletes during sports competition and training, affecting soft tissues and joints.

The main objectives of rehabilitation treatment are to relieve pain, to improve mobility deficit and stability, and to restore a normal walking pattern. It is essential to set an early, complex, individualized treatment to recover functional deficit and to prevent degenerative complications that can appear prematurely and in severe forms in athletes following injuries, but also because of joint overloading due to repetitive mechanical stress.

The rehabilitation program must include electrotherapy with antalgic, antiinflammatory and myorelaxant effects, thermotherapy: cold and cryotherapy in acute phases, followed by warm procedures, massage for myorelaxant or muscle toning effects. A central role in the recovery treatment should be played by kinetotherapy and hydrotherapy and also, balneotherapy based on natural physical factors: mineral water, mud pack and climate, with prophylactic, therapeutic and recovery effects.

The traumatic disorder of the knee in athletes requires special attention regarding the rehabilitation treatment, due to their predisposition to develop arthrosis at relative young ages.

Key words: posttraumatic knee, rehabilitation treatment, arthrosis.

Rezumat

Genunchiul este cea mai mare și cea mai complexă articulație a corpului. Este o articulație intermediară a membrului inferior, implicată în asigurarea ortostatismului și a dinamicii mersului. Traumatismele la nivelul genunchiului survin frecvent la sportivi, în timpul competițiilor sportive și a antrenamentelor, afectând părțile moi, structurile osoase și cele articulare.

Tratamentul de recuperare are ca principale obiective combaterea durerii, a deficitului de mobilitate și stabilitate și refacerea schemei normale de mers. Este esențial instituirea precoce a unui tratament complex de recuperare, individualizat, pentru refacerea deficitului funcțional și prevenirea complicațiilor degenerative ce pot surveni prematur și în forme severe la sportivi în urma traumatismelor, dar și din cauza suprasolicitărilor articulare produse de stresul mecanic repetat.

Tratamentul de recuperare trebuie să includă proceduri de electroterapie cu efect antialgic, antiinflamator și miorelaxant, proceduri de termoterapie: reci și crioterapia în fazele acute, urmate de cele calde, masajul cu rol miorelaxant sau de tonifiere musculară. Un rol central în cadrul tratamentului de recuperare trebuie să îl aibă kinetoterapia și hidrokinetoterapia. De asemenea, în cadrul tratamentului de recuperare ar trebui să fie inclus și tratamentul balnear bazat pe factori naturali de cură - ape minerale, nămolul și climatul - cu scop profilactic, terapeutic și de recuperare.

Patologia traumatică la nivelul genunchiului, survenită la sportivi, impune o atenție deosebită în ceea ce privește tratamentul de recuperare, datorită predispoziției acestora pentru apariția artrozei la vârste relativ tinere.

Cuvinte cheie: genunchi posttraumatic, tratament de recuperare, artroză.

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Introduction

The knee is the largest and most complex joint of the body. It is an intermediate joint of the limb involved in providing orthostatism and walking dynamics. Injuries to the knee frequently occur in athletes during sports competitions and training, affecting soft tissues, bones and joint structures.

Elements of anatomy

The knee consists of three joints: the femorotibial and femoropatellar joints participating in its active movements and the superior tibiofibular joint that contributes to ankle movements and just to sliding movements of the knee. The knee has one degree of freedom, flexion and extension. In fact, the knee can achieve six directions of movement: flexion-extension, lateral and medial rotation, valgus and varus, anterior and posterior translational, medial and lateral translational, compressive and tensile. In addition to flexion and extension movement, the rest form the "joint play" (Sbenghe, 1987).

In the biomechanics of the knee, the most important issue is related to stability, which is a priority in terms of recovery objectives compared to mobility. Stability has two components: passive and active (Popescu & Florea, 2008).

An important factor of stability is joint loading, the knee being a hinge joint, subject to load, such as gravitational pressures, represented by body weight, dynamic ones, and those caused by muscle strength. Although the pressure exerted on articular cartilage is a risk factor for the development of degenerative changes, in the case of the knee, the load is a stability factor. The minimal pressure per unit area occurs when the knee is in full extension, the matching of the joint is high and the joint contact area is maximized. In two-leg stance, the knee load is equal to half of the body weight, while in single-leg stance the load of the knee is equal to the body weight (Sbenghe, 1981).

The passive stability of the knee is given by the shape of the articular surfaces, by the capsular ligament elements; the joint capsule is reinforced by six ligaments: the patellar ligament, the internal and external side, the anterior and posterior cruciate ligament and the coupled femorotibial axes.

Active stability is given by the muscles. Hamstrings-semimembranosus muscles, femoris biceps and semitendinosus provide knee flexion, while the quadriceps-rectus femoris muscle, vastus medialis, lateralis and intermedius provide extension and pull the knee back. The sural-gastrocnemius and soleus triceps pull back the femoral condyles and tibia (Popescu & Florea, 2008).

Traumatic pathology of the knee

- injuries of the soft tissues, skin and subcutaneous tissue: burns, bruises, wounds; muscles and tendons: stretching, tears, cuts and disinsertion; vessels and nerves: tears and cuts;
- bone lesions in the tibial, femoral and peroneal epiphysis: trabecular faults, cracks, fractures;
- joint injuries: sprains, dislocations, joint wounds, ligament tears, meniscal injuries

Posttraumatic sequelae in athletes consist of: stability and mobility impairment, impaired motor control, decreased muscle strength and endurance, pain and joint swelling, muscle contractures, axial deviation, flexor or extensor paralysis (Popescu & Florea, 2008).

Posttraumatic chondral and subchondral knee lesions are persistent on MRI imaging for several years. Cartilage biopsy shows chondrocyte degeneration and necrosis, and loss of proteoglycans (Atsuo et al., 2006).

Some studies carried out in vitro show chondrocyte apoptosis after traumatic injury and bone changes in cellular metabolism (Colwell et al., 2001).

Bursitis, tendonitis, muscle spasms, meniscal injuries can all cause the same knee pain syndromes (Cibere et al., 2004).

Varus or valgus deviations of the knee are responsible for the occurrence of osteoarthritic changes in the medial or lateral tibiofemoral compartment. Both lead to the reduction of the mobility of the joint, of the articular space and to degenerative changes (Gary et al. 2009, Sharma, 2004, Brauwer et al. 2007, Sharma, 2004; Cahue et al., 2004).

The diagnosis of posttraumatic disorders

The diagnosis of traumatic injuries involves clinical and imaging investigations; laboratory tests are not relevant, they are only useful for differential diagnosis. The radiographic imaging investigations may reveal a narrowing of the joint space, which is suggestive for both degenerative changes and meniscal lesions (Gary et al., 2009; Raynauld et al., 2004).

Meniscal ligament tears, synovitis, chondral and subchondral lesions and soft tissue lesions can be identified using nuclear magnetic resonance. Their appearance and the progression of degenerative changes associated with bone edema can also be viewed by nuclear magnetic resonance, but this is controversial (Gary et al., 2009, Conaghan, 2006, Garnero et al., 2005, Torres et al., 2006, Raynauld et al., 2006).

Treatment of posttraumatic pathology

Recovery treatment has as a main objective pain relief, mobility and stabilization of the deficit, and restoration of normal walking.

Pain occurring regardless of the type of trauma to the knee appears as continuous intermittent mechanical in nature, inflammatory or mixed, of variable intensity. The rich innervation of the knee explains the appearance of pain in any trauma of the knee.

Pain should be combated with specific means.

A key point in the recovery treatment is fighting functional deficit.

Pharmacological therapy includes depending on the intensity of pain: analgesic and anti-inflammatory medication as a general or local administration form, intra-articular and peri-articular infiltration, anxiolytic and antidepressant medication, opioid or corticosteroid therapy. Considering that major trauma or sports microtrauma, in addition to joint overloading, are predisposing factors for the development of osteoarthritis, chondroprotective treatment should also be established, either as oral

preparations of glucosamine and chondroitin sulfate, avocado oil, soybean oil, or intra-articular infiltration of viscous substitute preparations based on hyaluronic acid.

Hot or cold thermal therapy procedures, depending on the stage of the disease, are used as pain relief.

Postural rest is required either by immobilization in recent lesions, with the knee slightly flexed, or by wearing crutches, a cane or walker for the time duration dictated by the type and location of traumatic injury.

The procedures for low, medium and high frequency electrotherapy and phototherapy have a role in pain relief, fighting muscle contraction, as well as in the prevention and recovery of muscle hypotrophy and atrophy frequently occurring posttraumatically.

When pharmacological and non-pharmacological treatment fails to control symptomatology, the patient requires surgery.

The recovery of the mobility function is primarily aimed at obtaining functional angles necessary to daily activities, first recovering the extension movement and fighting flexum, then maintaining and increasing the flexion movement. To increase joint mobility, all possible means are used. Correct posture is important to adopt in genu flexum for intraarticular pressure reduction and at the level of the capsular ligament apparatus, it is achieved for short periods. In the acute phase of posttraumatic disorders, thermotherapy procedures, electrotherapy and massage have an important role and are applied prior to kinetotherapy treatment. Occupational therapy is aimed at exercise, especially in open kinetic chain, such as riding, swimming, cycling or sports such as basketball and volleyball (Popescu & Florea, 2008).

The restoration of stability is a priority objective in the rehabilitation program for restoring joint mobility. Treatment varies depending on the type of emotional stability: active stability provided by muscle-tendon structures and passive stability provided by the capsule-ligamentous device.

The restoration of active stability concerns the toning of all muscles, which contributes to its achievement, the priority being the quadriceps muscle. The quadriceps plays an important role in stabilizing the knee, especially in the last degrees of extension and in the 60-90 degrees of flexion. The weakness of the quadriceps muscle is a major predictive factor for the occurrence of degenerative changes. Having in view that it can rapidly cause atrophy, immobilization has to be as short as possible, and it is recommended to start a number of exercises as early as possible to maintain and increase the toning and resistance of this muscle.

For quadriceps muscle toning, isometric exercises and progressive loading exercises are recommended. The recovery of quadriceps muscle strength takes 3-6 weeks.

Muscular strength and endurance are recovered by using repeated exercises with small counter-resistance, riding exercises, squats up to 50% of the total weight, up and down exercises, walking and running, rowing exercises. In addition to quadriceps muscle toning, special attention should be paid to the toning of hamstrings, sural triceps and fascia tensor muscles through a series of analytical exercises, exercises in unipodal support from

various degrees of flexion and specific rotation exercises.

Hamstring muscle strength is less affected in knee injuries. As a result, an imbalance of forces appears between the extensor and flexor muscles of the knee; the extensor muscles must normally have a force three times higher than the flexor muscles. Exercises to increase muscle strength and isometric exercises include hamstring counter-resistance. Hamstring muscle toning does not vary with the isometric angle, it can be practiced at any angle of flexion (Popescu & Florea, 2008).

The sural triceps muscle, as well as the quadriceps muscle, is quickly atrophied through immobilization, even if isometric exercises are performed under a plaster cast. Rotator muscles will involve selective activation. The objective is to restore the last 20 degrees of extension (Sbenghe, 1981).

Quadriceps muscle toning is performed by isometric exercises with progressive loading.

In the recovery of posttraumatic knee, toning exercises of the tensor fasciae latae muscle are also indicated.

Restoring the normal walking pattern is a further objective after regaining stability and motor control. Normal walking supposes the absence of any inequality in the lower limbs, proper muscular strength, proper range of motion, coordination, control and balance and absence of pain. At the beginning, the exercises are done without loading, and subsequently, with progressive loading (Popescu & Florea, 2008).

Particular attention should be paid to the four subdivisions of walking: bead attack, average position, separation and balancing and the two important components: support and balance.

Secondary prophylaxis rules - orthopedic hygiene in posttraumatic pathology - must be known and respected by the patient. The rules include normal weight or even underweight, avoiding to walk on uneven ground, climbing in and out of the stairs, prolonged walking and standing, postural standing twice a day, following the kinetotherapy program in the long term, avoiding lameness through a permanent control of walking, stick support, free movements of flexion in the transition from sitting to standing position, avoiding prolonged monotonous positions of flexion at the knee, wearing proper shoes with flexible soles, soft heel of 2-3 centimeters, the use of inserts for flat feet.

The peculiarities of recovery are different depending on the type of lesion occurring at knee level.

In case of cutaneous and subcutaneous lesions, there are no special problems of recovery, only when complications arise, such as penetrating wounds, vascular lesions, nerve, ligament or tendon-retractile scars post-burns.

In case of burns, the recovery treatment includes correct postures and mobilization, creating a balance between these two phases; retractile scars can severely limit movement. Active mobilization should be done carefully because the stretching of tissues can trigger their rupture, with bleeding and the formation of new scars. Recovery treatment provides: correct posture, hydrokinetotherapy, massage with ointment, potassium iodide ion galvanization, ultrasound with hydrocortisone, diapulse (Popescu & Florea, 2008).

Muscle-tendon injuries require a differentiated recovery by affecting the extensor or flexor apparatus. In case of damage to the extensor apparatus during immobilization, isometric quadriceps exercises, bipolar electrotherapy, excitomotor currents, thigh and calf toning massage, and also venous lymphatic drainage and diapulse massage are required. After immobilization, it is recommended to continue with isometric exercises, electrotherapy and toning massage. Prior to kinetotherapy, thermotherapy procedures are introduced and the toning of the quadriceps is initiated by resistive exercises with progressive loading, increasing the joint mobility through active and passive mobilization and resumption of walking, at the beginning with partial support.

In case of damage to the flexor apparatus, toning exercises on flexion and extension muscle groups are required, as well as a series of electrotherapy procedures with anti-inflammatory role, painkillers and muscle relaxants, thermotherapy, therapeutic massage and kinetotherapy.

Ligament injuries occur in the context of abnormal movements exceeding the knee ligament strength. Depending on their severity, they are classified as mild sprains with stable joint and severe sprains with unstable joint.

For mild sprains, mobility and stability is affected due to ligament distension and eventually, to the rupture of some fibers. In the early stages, in addition to appropriate pharmacological therapy and anti-inflammatory painkillers, the following are required: application of ice, infiltration with lidocaine, preferably without glucocorticoids, which can hide more serious symptoms, wearing knee braces, electrotherapy as ion galvanization, currents of low, medium and high frequency and kinetotherapy treatment in the treatment room or as hydro-kinetotherapy.

Moderate sprains require the application of ice, symptomatic pharmacological treatment, partial load in the affected knee, immobilization in a cast or brace, electrotherapy, mobilization of neighboring joints, massage and kinetotherapy exercises during isometric immobilization, subsequently progressive mobilization exercises and increase of muscle toning in the knee stabilizing muscles. The peculiarities of recovery include:

- for external sprains, particularly toning of the tensor fasciae latae and biceps crural muscles;
- for internal sprains, particularly toning of the semimembranosus, semitendinosus, and the tailor's muscle;
- in the traumatic pathology of the anterior cruciate ligament, particularly toning of hamstrings;
- in the traumatic pathology of the posterior cruciate ligament, particularly toning of the sural triceps muscle.

Anterior cruciate ligament rupture mostly occurs in young people under 30 years of age, in women 3-5 times more frequently than in men, as well as in those who practice sports involving pivoting (Friel & Chu, 2013).

Strong mechanical forces acting on the knee during high impact activities, in addition to inducing ligament injuries, especially in the anterior cruciate ligament, favor the emergence of early degenerative changes (Yeow et al., 2008).

Sprains that severely affect the stability of the knee often involve, besides the tearing of a ligament, associated capsule-ligament and meniscal injuries, especially in the internal meniscus. Complications can also occur, such as paralysis of the external popliteal sciatic nerve, as well as early osteoarthritic changes. After the immobilization period, which is longer than in mild to medium sprains, i.e. 8-10 weeks, treatment should be complex, involving drug therapy and focusing on recovery thermotherapy, electrotherapy, hydrotherapy, massage and kinetotherapy. Surgical treatment is required in the case of complex injuries, followed by the early initiation of treatment with certain peculiarities: postoperative immobilization is performed at 45 degrees and lasts for 2 weeks, walking braces are recommended, a flexion deficit can remain, usually, extension is fully recovered (Popescu & Florea, 2008).

Knee sprains involve capsule-ligament injuries, often associated with neurovascular injuries. Mild tibiofemoral dislocations can be reduced on the spot and the method of application is the same as for sprains. Severe sprains, after being reduced in hospital, require pelvipodal plaster cast for 1-3 months. During immobilization, isometric exercises, anti-sloping positioning, leg pumping exercises can be performed. Diapulse as an electrotherapeutic procedure can be carried out even with plaster cast 2-3 times per week. After immobilization, it is recommended to perform exercises to increase muscle toning, strength and muscle strength, joint mobility; walking is progressively achieved.

Patellar dislocations require orthopedic reduction, knee braces, and the recovery methodology is generally valid, generally requiring only conservative treatment; in severe forms, surgery is required.

Knee fractures occur in the context of severe trauma and can be located at the upper end of the tibia-fibula or tibial plateau or tibial spine and upper epiphysis, the lower end of the femur - unicondylar, supracondylar, supraintercondylar, upper epiphysis and the kneecap. Knee fractures require immobilization, medication for symptom relief; isometric exercises are necessary for maintaining muscle toning and normal function in the neighboring joints; respiratory gymnastics facilitates venous-lymphatic drainage. After immobilization, complex recovery treatment is initiated, which is focused on the recovery of mobility, stability, strength and muscle strength. It is very important to initiate the recovery treatment as early as possible to prevent joint instability, the risk of repeated fractures or sprains and dislocations, the degenerative process, pain and joint stiffness, vicious callus, muscle atrophy and retractsures, etc.

Fractures of the tibial plateau affect joint mobility and muscle function, the recovery is lengthy, often patients do not recover completely in one year (Gaston et al., 2005).

For axial deviations of the knee, congenital or acquired, conservative treatment is effective only in mild cases under 10-15 degrees and consists of exercises to increase knee stability, orthopedic footwear and normal weight.

Injuries affecting the crural nerve, which plays an important role in thigh flexion and leg extension quickly go to an atrophy of the thigh muscle. In the case of total paralysis, both the quadriceps and iliopsoas are involved,

while in partial paralysis, which is more common, only the quadriceps is involved. The recovery program consists of applying knee orthoses for genu recurvatum, myorelaxant procedures for lumbar paravertebral muscle contraction, maintaining muscle tone in the denervated muscle, rehabilitation of muscle strength through a series of isometric exercises, passive-active, actively assisted, suspension therapy, dynamic exercises with progressive resistance, electrical stimulation and medium excitomotor frequency currents (Sbenghe, 1987).

Algoneurodystrophy is a frequent posttraumatic complication, involving rehabilitation treatment appropriate to its development stage.

Algoneurodystrophy consists of pain and swelling of the lower limbs, accompanied by local trophic skin changes, vasomotor instability and functional impotence (Collier, 2002; Doury & Dequeker, 1998; Herrick, 2003; Ionescu, 2006).

In addition to drug therapy and sometimes surgery, the rest of the affected segment is recommended only at the beginning; cold treatment should be applied at the beginning, then a series of hot thermal procedures, hydrotherapy, analgesic and anti-inflammatory electrotherapy and kinetotherapy.

Knee surgery consists of posttraumatic pathology: synovectomy, pruning, total or partial meniscectomy, patellectomy, arthrodesis, arthroplasty, mosaicplasty, chondrocyte transplant. Recovery begins as early as possible after surgery depending on its scale: 4 days after synovectomy, 10-12 days after meniscectomy, one month after osteotomy, 3 weeks after patellectomy, three days after arthroplasty.

Positioning is aimed at avoiding genu flexum, isometric exercises will be performed. At the beginning, mobilizations will be passive, then passive-active, active and active resistant, walking will be progressively loaded. Earlier isometric exercises for the quadriceps and hamstrings, exercises at the level of the contralateral limb for thigh and leg muscle activation are indicated, maintaining mobility and normal functionality in the adjacent joints. It is important to fight joint inflammation and avoid overstressing the joints. The general objectives of the recovery of the posttraumatic knee are the restoration of mobility and joint stability, muscle strength and endurance, motor control and pain relief.

There is no surgery to restore a lasting functionality of the articular cartilage. A number of experimental approaches have been proposed which combine regenerative therapeutic procedures such as gene therapy, stem cell transplant, biological glue, but none has yet been completed (Scott et al., 2013).

Recovery treatment should be individualized, beginning as early as possible after surgery, with specific treatment in traumatic pathology.

Peculiarities of recovery

The peculiarities of recovery depend on the extent and type of surgery.

- after synovectomy, it is important to combat the inflammatory process; one week postoperatively, walking with crutches is started, after 10-12 days, walking with a

cane, and only after 3 weeks is full support initiated. The recovery based on the etiopathogenesis of the inflammatory process and functional deficits can take up to 6 months.

- after meniscectomy, the knee remains immobilized in extension for 10 days, after which it is recommended to walk with a cane, with the progressive loading of the affected lower limb; giving up the cane is indicated only after 3-4 weeks. However, immediately after surgery, exercises for maintaining muscle toning in the thigh are initiated.

- after meniscectomy, even if performed at a young age, up to 89% of patients will develop osteoarthritis (Klippel, 2001).

- after intraarticular interventions, the recovery treatment begins early. Resumption of walking is done after three weeks, upon the full recovery of knee extension and the possibility to perform hip flexion with extended knee.

- after osteotomy surgery, immobilization in a cast takes 30-45 days, and then the recovery treatment is started. When using external fixation systems, gypsum is no longer needed, from the second day the passive mobilization of the knee is initiated, from the tenth day it is recommended to walk with discharge and active exercises, and on the tenth day, progressive support on the affected limb begins.

- after patellectomy, which by affecting the stability of the knee is an important functional injury of the knee, immobilization in a cast for 3 weeks is recommended, then, the recovery treatment starts.

Arthroplasty may be partially performed and consists of replacing the femoral condyles or tibial plateaus, a bivalve plaster in extension is applied postoperatively, loading is progressively achieved and normal walking is achieved 3 months after surgery. In case of total arthroplasty, walking with progressive loading is resumed in the second week.

Regardless of the type of surgery, orthopedic hygiene rules for the knee are recommended (Popescu & Florea, 2008).

Although a clear physical-pathogenic mechanism has not yet been established, there is a close link between ligament injuries, cartilage alterations in the context of sports injuries, meniscal lesions, impaired biomechanics leading to instability and the emergence of degenerative changes over time (Riordan et al., 2013).

The early initiation of a complex individualized recovery treatment is essential for restoring functional deficits and prevent degenerative complications that can occur early in athletes after severe trauma, but also because of joint saturation caused by repeated mechanical stress. Early onset severe arthritis means absenteeism, affecting professional activity and leading to a major economic impact (Fautrel et al., 2005).

Recovery treatment should include electrotherapy procedures with pain relievers, anti-inflammatory and muscle relaxants, thermotherapy procedures: cold and cryotherapy in the acute phase, followed by warm massage or muscle toning. An important role in the recovery treatment should be played by physiotherapy and hydrokinetotherapy. Also, the recovery treatment should include spa treatment based on natural cure factors - mineral waters, mud and climate - with prophylactic and therapeutic effects.

Conclusions

1. It is important to involve a multidisciplinary team, including orthopedic specialists, physical therapists, medical rehabilitation specialists and kinesiologists.

2. Complex rehabilitation treatment should be started as early as possible to shorten the recovery time of athletes, facilitating recovery of functional deficit and resumption of sport competitions.

3. In order to early prevent the onset of osteoarthritis, patients should receive long-term rehabilitation treatment as necessary, which will be repeated twice a year for preventive and prophylactic purposes.

Conflicts of interests

There are no medical or financial conflicts of interest.

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