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Fracture of the lateral tibial condyle with depression of the articular surface – A case study

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abstract

Background: Fractures of the proximal epiphysis of the tibia constitute one of the more frequently occurring types of sports injuries, and at the moment constitute about 1% of all reported bone fractures. They appear mainly as a result of traffic accidents, falls from heights, as well as being observed in groups of physically active people whose disciplines involve high-impact landings. From time to time, improperly executed movements or steps without falling result in injury.

Case study: We present a case study of a 21-year-old male football player with fracture of the lateral tibia condyle with indentation of articular surface. The patient came to the clinic with increasing pain in the knee joint, resulting from torsional injury which occurred the same day.

Conclusions: A quick and accurate diagnosis as well as treatment of fractures of the lateral tibia which includes surgery, rehabilitation and supportive orthobiology, minimize the risk of chronic symptoms of the injury such as limited range of motion and subsequent osteoarthritis.

Key words: knee joint, tibia plateau, fracture, depression of the articular surface.

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INTRODUCTION

Fracture of proximal tibia may be characterized as severe, intra-articular impairment which usually results from traffic accidents among youth and falls from relatively small heights among the elderly. They also occur among physically active people performing sports such as: skiing, soccer, basketball and other disciplines in which landing is integral. With respect to gender, such injuries are observed more often among men than women [1,2]. This particular fracture is a relatively frequent type of sports injury, representing about 1% of all reported bone fractures. Considering only lower extremities, fracture of the proximal epiphysis of the tibia constitutes about 7% of all such fractures [1].

The epiphysis of the tibia is composed of the medial and lateral condyle, and injuries are reported significantly more often in the lateral part (55−70%) in comparison to fractures of the medial condyle (10−23%). It results from manoeuvres which are associated with valgus and internal rotation moment of the knee. Furthermore, in the majority of people fractures of the proximal epiphysis of the tibia damage not only the articular surface in the site of the fracture, but also in the parts of the joint which are not directly affected by force causing the injury. Among concomitant injuries of soft tissues, injuries of the medial collateral ligament (MCL), and the lateral meniscus are predominant [1, 3].

In light of the incidence and characteristics, many medical classifications are discussed in this paper, regarding the type of injury. In the conventional way, these fractures may be grouped as: cleft, in cases when part of the condyle detaches from the rest of the remaining bone, or depression when a piece of bone undergoes crushing and compression. In most clinical cases, the depression injuries or depression-cleft injuries appear in the lateral condyle of the tibia (type B2, B3 according to AO/ASIF: type II and III according to Schatzker) [4, 5, 6].

The characteristic symptoms of the fracture of proximal epiphysis of the tibia are: oedema of the knee, strong pain under pressure or while attempting movement, in addition to frequent valgus distortion of the axis of lower extremities. When observing such symptoms, joint aspiration usually reveals the presence of a hematoma or occasionally by a droplet of adipose tissue [7].

The characterization of an injury and selecting an appropriate method of therapeutic procedure require a detailed medical history, physical examination, joint aspiration and diagnostic imaging. X-ray, magnetic resonance imaging (MRI) or computed tomography (CT) allow for a precise diagnosis when determining the type of fracture, degree of damage to the bone, and alternatively a type of soft tissue injuries [4, 8].

The most important aim of the treatment is to pursue anatomical reconstruction of the articular surface. The vast majority of fractures of the lateral condyle of the tibia are treated surgically. In this case, anastomosis of bone fragments should be stable in order to minimize the necessity of applying a cast in the post-surgical period which precludes the patient from participating in rehabilitation in early phases of post-surgical treatment [9, 10].

The selected treatment method and rehabilitation protocol has a great influence on the final result, i.e. range of motion in the knee joint and muscle strength. During the rehabilitation process, it is obligatory to draw attention to tissue mobility within the post-surgical scar. Increasing the range of motion has to occur hand in hand with increasing elasticity of tissues around the scar in order to assure comfort while performing movement. To improve mobility and elasticity around the scar, platelet-rich plasma (PRP) may be applied [11, 12].

Considering the aforementioned issues, it needs to be highlighted that proximal tibia fracture, both due to its variable biomechanical course and the frequently serious clinical form, poses a difficult challenge, diagnostically, therapeutically, socially and economically [13, 14].

CASE DESCRIPTION

Twenty-one year old male patient, right-footed professional football player, came to orthopedic and sport medicine specialist due to pain in the left knee resulting from indirect, varus injury with external rotation of the left foot during soccer training. Pain of high intensity was experienced during every attempt of motion in the knee joint. Additionally, major edema in the joint was present.

The patient was physically active – a professional soccer player (defender). Body mass index (BMI) was 24.28, which indicates adequate BMI, yet approaching overweight.

During the physical examination significant oedema in suprapatellar recess while extending the knee was detected. Additionally, painful motion limitation was observed in the patient (range 0−20°); therefore, carrying out stability tests of the knee was not viable. After the preliminary orthopaedic and ultrasound examination, hematoma (2 centimetres in length) was shown and removed (60 ml). The patient was directed to MRI.

MRI of left knee was performed in T1-dependent, T2-dependent sequences and in the PD sequence with fat saturation (PD FAT SAT), multiplied. Based on MRI images, the presence of fresh cleft-depression fracture of the lateral condyle of the tibia with a small displacement of the side section was observed – Fig. 1. A fracture cleft with a width of approx. 4 mm spanned the posterior part of the tibio-fibular joint and the front part to the lateral edge of tibial tuberosity, and in the upper part, it passed through the articular surface with indentation of intermediate fragments to a depth of up to 5 mm (in the area with a diameter of approximately 18 mm). In addition, damage to the articular cartilage was observed in the area of indentation and intra-articular cleft of the fracture. At the height of the distal end of the fracture, perpendicular bone fragments of the cortical layer of approx. 10 mm were visible. There was also blood and fat exudate in the joint and post-traumatic lesions in periarticular soft tissues with fluid reservoirs. The presence of fracture was unexpected due to the fact that the patient did not report any fall or collision with another player or person, which could have led to the observed damage. The injury happened when the patient hooked the lower limb to the ground (grass) at the time of receiving the ball, and then crossed the lower limbs with the hit by the right lower limb from the back to the left lower limb.

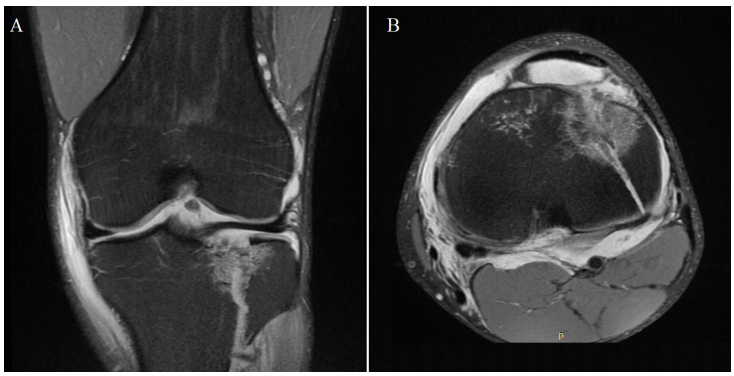

Fig. 1. Magnetic resonance in PD sequence with fat saturation:
A) frontal cross-section, B) axial cross-section

To obtain additional diagnostic information, it was also decided that a CT scan should be performed using a spiral technique without contrast enhancement. Moreover, reconstructions in various planes (multiplanar reformatted reconstruction, MPR) and three-dimensional volume reconstruction (3D volume rendering, VR) were performed. The diagnostics yielded by the computed tomography technique confirmed the conclusions from the MR study – Fig. 2. To view the damage site better, advanced three-dimensional visualization of the fracture area was performed using software for medical analysis and processing - Osirix MD (v.7.5., Osiris Foundation, Geneva, Switzerland) – Fig. 3.

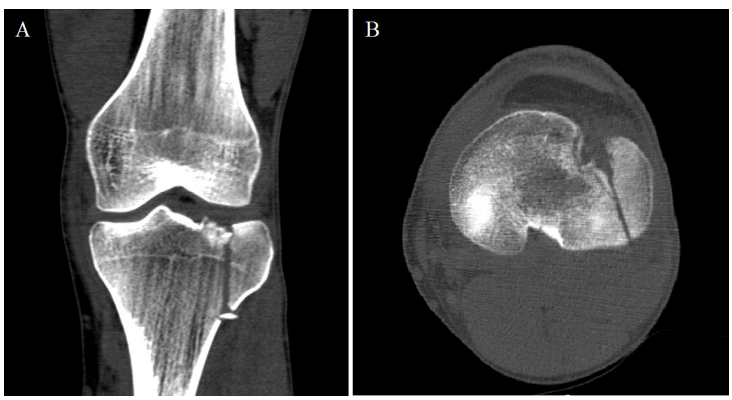

Fig. 2. Computed tomography cross-sections: A) frontal, B) axial

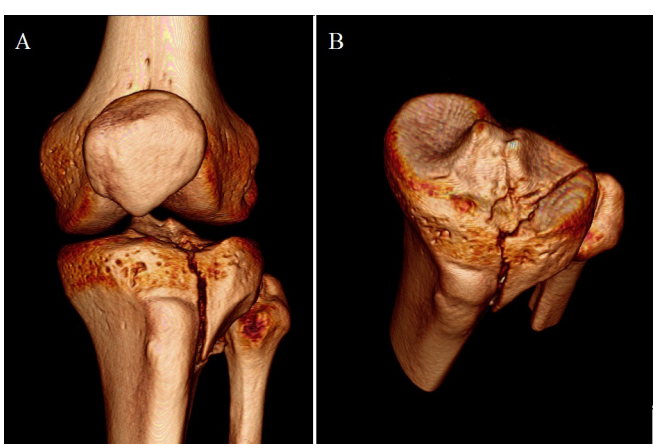

Fig. 3. 3D visualization of the knee joint bones on the basis of computed tomography data:
A) from the front, B) from the side of the tibia plateau.

After the diagnosis, the patient was referred to an anastomosis surgery. Until the surgery, Adam's trace was put on the left lower limb, as well as anticoagulant prophylaxis (Clexane) and the use of elbow crutches was recommended to reduce loading on the left limb. Determining the level of vitamin D (the metabolite 25 (OH) in the blood) was also deemed necessary. The resulting 34.35 ng / ml was within the normal range.

Four days after the injury, surgery was performed − a bloody reposition and anastomosis of the left lateral condyle of the tibia with dedicated LCP plate and with six screws from Synthes. Both perioperative and postoperative periods were without complications. Thrombophilic prophylaxis and perioperative antibiotic therapy were used. On the fifth day after the procedure, the patient was discharged in good overall condition with the following recommendations: walking with the assistance of crutches without loading of the operated limb, immobilization in the orthosis with a range of bending: 0−40° for a period of 2 weeks, continuation of active and isometric exercises, continuation of thrombotic prophylaxis. Rehabilitation started from the first day after the surgery − in the form of instruction, while the intensive rehabilitation procedure, conducted in a medical centre, was implemented about 2 weeks after the surgery. The initial knee joint range of motion (ROM), at the time of the patient's admission to rehabilitation treatment, was 0−90°. Reduced mass of the quadriceps muscle was observed. The contour of the knee joint was correct, and there was no exudate. The surgical scar was healed. Postoperative rehabilitation included activities in the field of manual therapy, exercises to increase the ROM and strengthen the muscles of the operated limb, and re-education of walking with crutches. Techniques of myofascial relaxation of the knee joint, thigh and shank area were used, as well as patellar, patellar retinaculum and postoperative scar mobilization. Also the detonation of quadriceps muscle, tibialis anterior and ilium-tibial band were performed. Particular attention was paid to exercises activating the quadriceps, gluteus, and sciatic muscles in order to increase the strength of the operated lower limb. After about a week of rehabilitation, the range of motion of the knee joint increased to 0−120°. The patient was also advised to exercise at home.

In the next stage of physiotherapy, from about the 3rd week after the surgical procedure, exercises to improve walking pattern were introduced, initially with crutches (with a load of 15−20% of the body weight), followed by the use of an antigravity treadmill, which enables training in unloading conditions, starting from 80% unloading − Fig. 4. The innovative and pioneering application of the antigravity treadmill allowed the patient to avoid long-term uneven loading, disturbances of coordination, step asymmetry, and resulted in proper foot propulsion and a faster return to the normal gait.

One month after the surgery, resistance exercises on a stationary bike were implemented as part of the rehabilitation protocol, a group of exercises strengthening the lower limb muscles was added, exercises directed towards central stabilization of the trunk were introduced and the antigravity treadmill walking continued, gradually reducing the unloading level. An important element was to introduce proprioception exercises aimed at improving the deep sensation of the lower limb, which had a huge impact on the knee joint's stability. After the initial post-surgical rehabilitation cycle, the patient reported a significant improvement in the range of motion and strength in the knee joint.

Fig. 4. Training on the antigravity treadmill:
A) side view, B) view from the back of the pressure chamber

About six weeks after the surgery, the patient came to a check-up appointment at an orthopaedic clinic. He reported a feeling of increased tension in the initial segment of the gastrocnemius muscle coinciding with intensive exercise. In the orthopaedic examination, very good stability and full range of motion of the knee joint were demonstrated. In the ultrasound examination, no knee effusion was observed. In order to support the process of wound healing, orthobiological treatment with autogenous platelet-rich plasma was used. It was prepared based on the whole blood collected from the patient, centrifuged for 8 minutes. Under sterile conditions, the dose of platelet-rich plasma, in a volume of 16 ml and a concentration of approximately 600 x 103 plates/μL, was delivered in the middle part of the postoperative scar and its upper and lower segments. The patient was allowed to partially load the limb with a definite load 8 weeks after surgery. Motor work and continued rehabilitation protocol at home were recommended, and due to the nature of the physical structure of the patient, special attention was paid to the need to work on improving muscle mobility and flexibility.

The control X-ray examination, performed 11 weeks after the surgery, indicated the proper course of healing of the tibial lateral condyle after anastomosis. The X-ray picture also showed a plate and screws stabilizing the bone fragments in the proper position − Fig. 5. During the follow-up visit, the patient reported periodic pain in the patellar area. In the control ultrasonography examination, knee joint effusion was not detected. The area of postoperative scars was once again injected with one dose of platelet-rich plasma (prepared as above). In addition, an ampoule of hyaluronic acid (in a volume of 3 ml, 2% concentration, molecular weight of 1 million Da and dynamic viscosity in the range of 100−300 mPa*s) was supplied in order to improve hydration, address joint depreciation and reduce pain reported by the patient.

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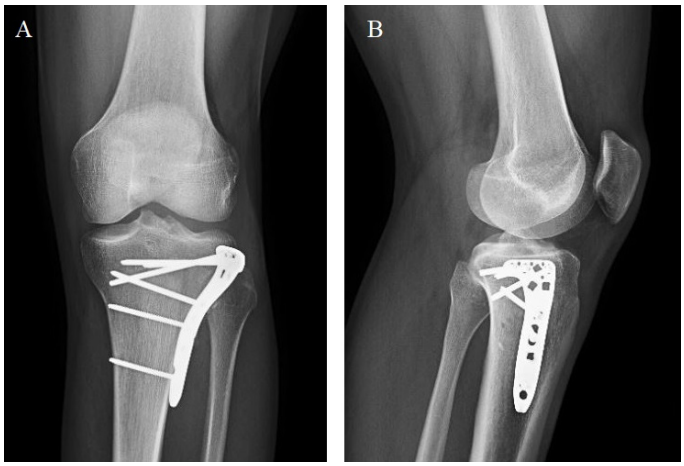

Fig. 5. X-ray pictures of the left knee 11 weeks after surgery: A) AP projection, B) side projection

Fifteen weeks after the surgery the patient underwent an objective motor assessment. The assessment of muscular strength of the knees on the isokinetic dynamometer BTE Primus RS indicated a weakening of extensor muscles of the left knee joint in relation to the healthy right lower limb by 20−30%, as well as a disrupted strength ratio of extensors to flexors − the sciatic muscles were weaker by 7%. The ratio of force in the right lower limb was within the normal range. The result of the Functional Movement Screen test (FMS) was 15/21, which identified limitation of shoulder mobility, weakening of the deep muscles of the torso and limitation of the range of motion of the ankle joint. For functional assessment in the motor preparation of the patient, Movement Compensation Screen tests (MCS) were carried out. They identified correct landing mechanics after jumping down from a certain height and the incorrect performance of the squat on one leg (left). The assessment of sensomotor control on unstable ground using the Prokin system indicated stabilization of the lower limbs within the normal range − Fig. 6A. The tests on a force platform Gamma indicated an increased loading on the right lower limb during jumping and landing − Fig. 6B. In addition, physical examination showed normal ROM of the hip and knee joint, increased tension of the sciatic-shin muscles, quadriceps muscle, iliac-tibial band of the lower left limb, and reduced tissue mobility within the postoperative scar. Furthermore at the control visit in the orthopaedic clinic, the patient still reported periodic pain in the knee joint. The upper segment of the postoperative scar and its middle part were again injected with another dose of platelet-rich plasma. Continued rehabilitation was also recommended.

Twenty weeks after the surgical procedure, the patient returned to the orthopaedic clinic for a check-up visit along with a current X-ray of the operated knee – Fig. 7. In the ultrasound examination of the knee, there was no exudate or enlargement of the synovium. The patient did not report any pain. The X-ray image revealed proper healing of the bone tissue and features of its adhesion with remodelling, as well as correct fixation of material of anastomosis and remineralization of subchondral bone. In the X-ray pictures, the fracture cleft was not visible, which testified to the full assembly of bones. Treatment was terminated and the patient was allowed to return to football training.

Fig. 6. Platforms used in motor assessment: A) balance (Prokin System), B) force plate (Gamma)

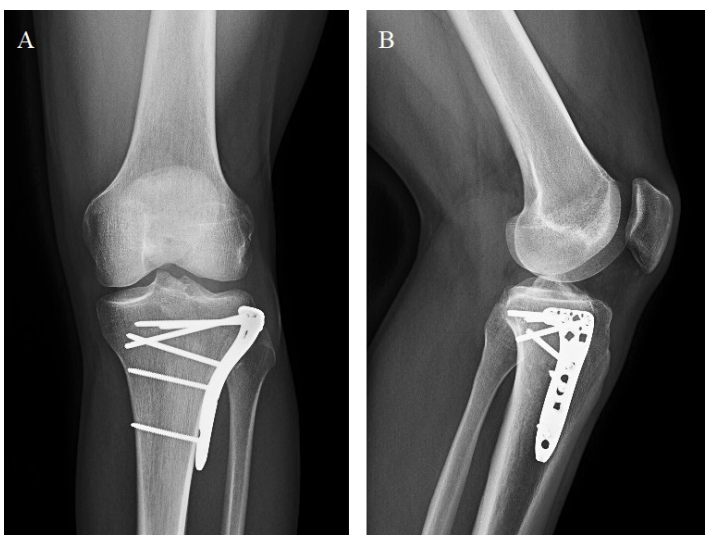

Fig. 7. X-ray pictures of the left knee joint 20 weeks after surgery: A) AP projection, B) side projection

From the time of the first control motor assessment, the patient gradually returned to regular football training with the prospect of returning to active playing on the pitch. Less than 8 months after the surgery, after introducing the patient to active training, a re-objective motor assessment was performed to determine the progress of rehabilitation. An increase in muscle strength in the left lower limb was observed. The measurement carried out on the BTE Primus RS showed the correct ratio of strength of the extensors to flexors and weakened extensor muscles of the left knee joint by only 17% in relation to the right lower limb. The result of the FMS test was improved (17/21 points) which testifies to the good motoric basis of the patient − the result below 14 points indicates a significant predisposition to injury. MCS tests showed proper landing mechanics after jumping down from a certain height and an average score during a one-leg squat − during the first assessment, the squat on one leg was inefficient and abnormal. The result of the test performed using the Prokin system assessing the balance, proprioception and neuromuscular

control in conditions of unstable medium, indicated good stability of the left lower limb. In comparison to the previous study, the result was 2.5 and it was within the normal range. Evaluation of the load symmetry on the Gamma platform showed the patient's inclination to increase the load on the right lower limb, but only during the jump phase.

The results obtained in the patient's motor re-assessment showed a positive effect of a properly conducted rehabilitation protocol on increasing muscle strength and improving the stability of the left lower limb.

DISCUSSION

Fractures of the lateral condyle of the tibia with indentation of the articular surface are a relatively frequently observed type of injury within the knee joint, and especially affect people who are physically active and practice sports such as football, basketball or downhill skiing [1].

The injury in the form of proximal tibia fracture most frequently is a result of a deforming or crooked injury − strong bending of the knee joint to the side or to the medial with an additional force acting on it in the axis of the lower limb. At the time of the injury there is a collision of the bones forming the knee joint − the femur and tibia, which usually causes the fracture within the tibia [7, 15].

There is no one, universal for every case, "golden standard" for the tibia epiphysis fracture treatment. This is due to the multitude of types of damage: the type of fracture, the degree of instability, as well as the accompanying soft tissue damage. In the majority of observed clinical cases, surgery which aims to restore normal anatomical relations within the knee joint is necessary. The range of therapeutic options includes procedures from percutaneous stabilization of bone fragments using screws (under the control of arthroscopy and X-ray) to extensive open-procedure treatments with elevation of the joint surface, the use of bone grafts as well as the stabilization of bone fragments with a massive plate. In addition, it is also very important to properly treat ligamental or meniscus damage accompanying the fracture of the tibia [16, 17, 18].

During the convalescence after surgery, until the bone union can be confirmed by diagnostic imaging methods, the limb cannot be loaded. After a period of about 6 weeks it is possible to partially load the limb, and full loads are possible even after 3 months. Particular attention should also be paid to the early activation of the knee joint [17].

It is extremely important that the occurrence of an intra-articular fracture, especially inadequately managed, may result in permanent consequences in the form of reduced range of motion and/or late post-traumatic arthrosis of the knee joint. The pivotal aspects concern a lack of anatomical reconstruction of the articular surface, untimely loading of the limb, abandonment of early function of the joint or late knee instability as a result of faulty healing of meniscal and ligamental injuries [2, 18]. In the case of such an injury, the therapy can be associated with complications such as: infections, loss of reposition, occurrence of deep venous thrombosis, non-union, or damage to the stabilizing material.

Properly conducted rehabilitation is a supplement to the invasive treatment of patients after bone fracture within the knee joint. Managing the specific rehabilitation protocol should focus on achieving the full range of mobility of the knee and hip joint, increasing muscle strength and improving the stability of the knee joint. Additional supportive orthobiological treatment, e.g. with platelet-rich plasma, has a beneficial effect on the flexibility and mobility of tissues within the postoperative scar ensuring comfort during movements in the knee joint. The effects of PRP are based on the increase in platelet concentration, enabling the release of growth factors that affect the process of tissue regeneration and healing. Platelet-rich plasma is an autologous biological material; therefore, it involves minimal risk of immunological reactions. It is widely used in orthopaedics and sports medicine in the treatment of tendinopathy (e.g., rotator cuff, Achilles tendon), muscle, tendon and cartilage injuries, and in plastic surgery to improve the appearance of postoperative or traumatic scars [19, 20].

Despite the time and the degree of involvement that should be invested, a correct early diagnosis of the observed pathology allows for the selection of an appropriate therapeutic path. This effort gives the patient an opportunity to return to full physical fitness, as characterized before the injury, which in the case presented is connected with doing sports.

CONCLUSIONS

The correct treatment of a tibia epiphysis fracture is not limited to reposing the fracture and stabilizing bone fragments on a case-by-case basis, but also mandates proper rehabilitation procedure, as well as orthobiological or pharmacological treatment as a support.

In conclusion, fractures of the proximal tibia require extraordinary care, both at the stage of diagnosis, as well as in subsequent treatment which should be thoroughly thought out and carried out decisively, and implemented in a consistent manner.

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