ARTROSKOPSKI ASISTIRANA OSTEOSINTEZA PRELOMA PLATOA TIBIJE ŠACKER III TIPA - PRIKAZ SLUČAJA

Nemanja Jovanović1, Lazar Mičeta1,2, Dejan Aleksandrić3, Nikola Bogosavljević3, Nemanja Slavković1,2

1 Institut za ortopediju „Banjica”, Beograd, Srbija
2 Medicinski fakulteta Univerziteta u Beogradu, Beograd, Srbija

SAŽETAK

Uvod. Prelomi platoa tibije su složene povrede koje u najvećem broju slučajeva zahtevaju hirurško lečenje kako bi se sprečile dalekosežne posledice. Iako su opisane brojne hirurške tehnike, poznato je da tehnika artroskopski asistirane reparacije ima potencijal da preuzme vodeće mesto u zbrinjavanju ovih tipa povreda.

Prikaz slučaja. Prikazujemo pijacičkinju staru 36 godina povređenu u saobraćajnom udaru, sa prelomom platoa leve tibije, prema Šackeroj klasifikaciji. Nakon sprovedene dijagnostike i pripreme, pijacičkinja je operisana artroskopski asistiranim prepozivanjem i unutrašnjom fiksacijom uz popunjavanje koštanog defekta kombinacijom koštanog grefona i sintetske zamene za kost.

Zaključak. Iako se ova vrsta povreda tradicionalno zbrinjava otvorenom hirurškom pristupom, smatramo da je minimalno invazivna hirurgija budućnost, kada su u pitanju prelomi platoa Šacker tipa I-III. U literaturi i dalje nema dovoljno podataka koji bi se odnosili na dugoročne ishode ovakvih lečenja, ali rani posleoperativni rezultati su izuzetno održivi i ohrabrujući, stvarajući osnovu za daljnje istraživanje o svim aspektima ovog tipa povreda.

Ključne reči: artroskopska hirurgija, prelomi tibije, rana mobilizacija

ABSTRACT

Introduction. Tibial plateau fractures are complex injuries that, in most cases, require surgical treatment in order to prevent far-reaching consequences for the functionality and quality of life of the patient. While numerous surgical techniques have been described, it is evident that the technique of arthroscopically assisted repositioning (reduction) and internal fixation has the potential to take the lead in the management of these types of injuries.

Case report. We present the case of a 36-year-old patient injured in a traffic accident with a fracture of the left tibial plateau, type III by Schatzker classification. After the diagnostic procedures and preparation, the patient was operated on using arthroscopically assisted repositioning (reduction) and internal fixation, with the filling of the bone defect with a combination of allogenic and synthetic bone graft. No other intra-articular injuries were diagnosed intraoperatively. The postoperative recovery went without complications, and after a period of 10 weeks of non-weight bearing and functional rehabilitation, the fracture healed completely, while the patient regained full range of motion in the knee.

Conclusion. Although this type of injury has traditionally been treated with open surgery, we believe that minimally invasive surgery is the future, when it comes to tibial plateau fractures Schatzker types I-III. There is still not enough data in literature regarding the long-term outcomes of this type of treatment, but the early postoperative results are extremely encouraging, since this surgical technique enables faster recovery and fewer postoperative complications.

Keywords: arthroscopic surgery, tibial fractures, early mobilization
UVOD

Prelomi proksimalnog okrajka tibije predstavljaju složene povrede koje uključuju oštećenja koštanih i mekotkivih struktura kolena. Najčešće nastaju pri dejstvu sile uzdužnog pravca visokog intenziteta i/ili usled velikog valgus/varus stresa u zglobu kolena. Nelečeni i neadekvatno lečeni prelomi dovode do razvoja sekundarne zglobne inkongruencije i degenerativne bolesti [1,2]. Uprkos relativno maloj učestalosti ovih povreda, njihovo adekvatno zbrinjavanje je od velike važnosti jer su pacijenti u većini slučajeva radno aktivni [1,3].

Glavni cilj lečenja ovih povreda jeste uspostavljanje što bolje, po mogućstvu i anatomske, repozicije zglobne površine tibije i ligamentarne stabilnosti zgloba, te poravnavanje osovine kolena i dobijanje punog obima pokreta [4]. Budući da se radi o unutarzglobnim prelomima, ovakvi ciljevi ostvarivi su gotovo isključivo operativnim putem.

Danas postoji izvesno neslaganje oko izbora hirurške tehnike u lečenju ovih preloma. Najčešće se primećuju otvorena repoziacija i unutrašnja fiksacija (engl. open reduction and internal fixation – ORIF) i arthroskopski asistirana repoziacija i fiksacija (engl. arthroscopically assisted reduction and internal fixation – ARIF) [1,4-7].

Postoji više klasifikacija ovih preloma, a od najvećeg kliničkog značaja su AO klasifikacija i Šackerova klasifikacija (engl. Schatzker classification) [8,9]. Lakši tipovi preloma (Šacker I-III) mogu se zbrinjavati kako ORIF tako i ARIF hirurškom tehnikom, dok se teži prelomi (Šacker IV-VI) obično rešavaju otvorenom hirurškom tehnikom, mada ima autorova koji su mišljenja da se ARIF hirurška tehnika može primjeniti i u ovim slučajevima [10].

Prednosti ARIF hirurške intervine se u direktnom sačuvaju zglobne površine tokom čitave intervencije, mogućnosti arthroskopskog zbrinjavanja udruženih unutarzglobnih koštanih i mekotkivih povreda, manjoj trumi okolnog tkiva, bržem postoperativnom oporavku i manjem broju postoperativnih komplikacija [1,10-12]. Sa druge strane, prednosti otvorene hirurške intervine se u mogućnosti zbrinjavanja svih tipova preloma, posebno složenih preloma ili preloma kod pacijenata sa osteoporozom, kod kojih je sama repoziacija zahtevna, a stabilizacija je moguća upotrebom potpornih ili zaključavajućih ploča [13-15]. Nezavisno od izbora hirurške tehnike, lošo zbrinuti prelomi imaju značajne i dugoročne posljedice na funkcionalnost i ukupno zadovoljstvo pacijenta, kao i na povećan rizik od razvoja sekundarne degenerativne bolesti, koja zahteva artroplastiku [16,17].

Cilj ovog rada je prikaz slučaja pacijentkinje sa prelomom platoa tibije Šacker III tipa, koji je lečen metodom arthroskopski asistirane repozijacije i unutrašnje fiksacije, uz prikaz rezultata rane postoperativne reha-

INTRODUCTION

Fractures of the proximal tibia are complex injuries which involve damage to the osteal and soft tissue structures of the knee. They most commonly occur due to the impact of high intensity vertical force and/or as the result of great valgus/varus stress in the knee joint. Untreated or improperly treated fractures lead to the development of secondary joint incongruency and degenerative disease [1,2]. Despite a relatively low incidence of these injuries, their appropriate treatment is of great significance as the patients are, in most cases, members of the active work force [1,3].

The main goal in the treatment of these injuries is establishing the best possible, hopefully anatomical, repositioning of the tibial joint surface and achieving ligamentous stability of the joint, while also achieving knee axis alignment and a full scope of movement in the joint [4]. As these are intra-articular fractures, such goals are attainable almost exclusively with the surgical method.

At present, there is a certain dissensus as to which surgical technique should be applied in the treatment of these fractures. The procedures most commonly applied are open reduction and internal fixation – ORIF, and arthroscopically assisted reduction and internal fixation – ARIF [1,4-7].

There is a number of classifications of these fractures, the two clinically most significant being the AO classification and the Schatzker classification [8,9]. Simpler fracture types (Schatzker types I-III) can be treated both with the ORIF and with the ARIF surgical technique, while more severe fractures (Schatzker types IV-VI) are usually resolved with open surgery, although there are authors who feel that ARIF surgery can also be carried out in such cases [10].

The advantages of ARIF surgery are as follows: direct view of the joint surface during the entire procedure, possibility of arthroscopic treatment of the associated intraarticular osteal and soft tissue injuries, lesser trauma to the surrounding tissue, swifter postoperative recovery, and fewer postoperative complications [1,10-12]. On the other hand, the advantages of open surgery lie in the possibility of treating all types of fractures, especially complex fractures or fractures in patients with osteoporosis, in whom the repositioning itself is challenging, while stabilization is possible with the application of buttress plates or locking plates [13-15]. Independently of the choice of surgical technique, poorly treated fractures have significant and long-term effects on the function and overall satisfaction of the patient, as well as on the increased risk of the development of secondary degenerative disease, which requires arthroplasty [16,17].

The aim of this paper is to present the case of a female patient with a fracture of the left tibial plateau, type III by
PRIKAZ SLUČAJA

A 36-year-old patient was admitted to the ER with an injury to the left knee sustained in a car accident after direct impact of the lateral side of the left knee with the vehicle. At admission, she complained of diffuse pain in the region of the left knee, which was exacerbated by putting weight on it, and of restricted movement in the knee, caused by pain. On examination, a moderate swelling was noted in the anterolateral aspect of the knee and the lower leg, with the presence of a hematoma on the posterolateral side of the proximal end of the lower leg. On the lateral side of the lower leg there was an abrasion, 1 cm x 0.5 cm in size, which was not in communication with the deeper structures. Active and passive movement in the knee joint was limited by pain – flexion of around 20 °, and extension 180 °. Ligament stability tests were prevented by pain. Neurological and vascular findings of the left leg were normal, with pal-
Nakon pregleda, učinjena je planarna radiografija levog kolena u dva pravca - anteroposteriornom (AP) i levom lateralnom (LL). Na radiografskim snimcima uočen je prelom spoljašnjeg kondila tibije sa utonućem prelomljenog fragmenta (tip III preloma, prema Šackeroj klasifikaciji), bez znakova koštane povrede ostalih struktura. U sklopu dalje dijagnostike, radi preciznije evaluacije i klasifikacije preloma, učinjena je kompjuterizovana tomografija (CT). Na snimcima je uočen izolovan prelom lateralnog platoa tibije, sa centralnim utonućem. Potvrđeno je odsustvo drugih koštanih povreda (Slika 1).

Odmah nakon sprovedene dijagnostike, postavljena je natkolena gipsana longeta (meniskus šina), te je pacijentkinja primljena u bolnicu radi operativnog lečenja. U cilju procene stanja mekih tkiva povređene regije i smanjenja uočenog otoka, koji je mogao ugroziti ishod planiranog terapijskog postupka, pacijentkinja nije operisana odmah nakon prijema. Savetovan je hod uz pomoć štaka bez oslonca na povređenu nogu do operacije. Davana je tromboem-pable pulsation above the magistral blood vessels. Clinically, there were no signs of compartment syndrome of the lower leg. The patient had no other injuries.

After the examination, planar radiography of the left knee was performed in two directions -anteroposterior (AP) and left lateral (LL). A fracture of the lateral condyle of the tibia with a sinking of the broken fragment (type III fracture, by Schatzker classification), without signs of bone injury in the surrounding structures, was noted on the radiographic images. For the purpose of more precise evaluation and fracture classification, as a part of further diagnostics, computerized tomography (CT) was performed. An isolated fracture of the lateral tibial plateau, with central sinking, was noted on the CT images. The absence of other bone injury was confirmed (Figure 1).

Immediately after the diagnostics, an above the knee plaster-of-Paris splint (meniscus splint) was placed, and the patient was admitted to hospital for surgical treatment. For the purpose of assessing the condition of the soft tissue in the injured region and reducing the observed swelling, which could have jeopardized the

Slika 2. Arthroscopy image of the fracture (A), fluoroscopic image of the positioning of a blunt instrument into the canal in the bone (B), fluoroscopic image after the implantation of the combination of allogenic and synthetic bone graft substitute (C), arthroscopic image after repositioning (D).
bolijska profilaktička terapija - nadroparin-kalcijum u dozi od 3.800 I.J., dva puta dnevno subaktanulo, uz analgetsku terapiju paracetamolom u dozi od 1.000 mg, četiri puta dnevno u sporoj intravenskoj infuziji, uz dodatnu primenu metamizol-natrijuma, u dozi od 2,5 g u sporoj intravenskoj infuziji, u fazama pogoršanja bola.

Operacija je izvršena četvrtog dana od dana povređivanja, po smanjenju otoka i hemotoma povređene regije, u uslovima opšte endotahealne anestezije. Pe rioperativno je administrirana profilaktička antibiotska terapija u vidu spore intravenske infuzije ceftriaksona od 1.000 mg u jednoj dozi. Neposredno po uvođenju u anesteziju, primenom kliničkih testova, utvrđena je stabilnost kolena u sagitalnoj i frontalnoj ravni. Pacijentkinja je postavljena u ležeći položaj na leđima, sa stabilnost kolena u sagitalnoj i frontalnoj ravni. Pacijentkinja je postavljena u ležeći položaj na leđima, sa

Standardnim tibijalnim vodičem za rekonstrukciju prednje ukrštene veze (ACL) ušlo se kroz AM portal i smanjenje zahteva potrebni za uklanjanje tibijalnog vodiča, a preko igle vodilje, po-

deđivanja, oružja za održavanje, a po-

djedan bolesti, a u uslovima ranog

naabol. Pacijentkinja je postavljena u ležeći položaj na leđima, sa

Standardnim tibijalnim vodičem za rekonstrukciju prednje ukrštene veze (ACL) ušlo se kroz AM portal i smanjenje zahteva potrebni za uklanjanje tibijalnog vodiča, a preko igle vodilje, po-

na naljudi}

Kroz formirani koštani kanal je u metafiznu regiju utisnuta smesa grefona iz koštane banke i sintetske za- mene za kost kako bi se popunio nastali subhONDralni koštani defekt. Ostatak koštanog kanala ispunjen je

planned therapeutic procedure, the patient was not operated on immediately after admission. The patient was advised to walk with the aid of crutches without putting any weight through the injured leg, until surgery. The following therapy was administered: prophylactic thromboembolic therapy – 3,800 IU of nadroparin calcium, administered subcutaneously, twice a day; analgesic therapy – 1,000 mg of paracetamol, four times a day in slow intravenous infusion, with additional administering of 2.5 g of metamizole sodium, in slow intravenous infusion, in periods of pain exacerbation.

On the fourth day after injury, once the swelling and the hemotoma in the injured region had subsided, the operation was performed under general endotra cheal anesthesia. Prophylactic antibiotic therapy was administered perioperatively in the form of slow intravenous infusion of a single dose of 1,000 mg of cef triaxone. Just before the administering of anesthesia, stability of the knee was established in the sagittal and the frontal pane, with the application of clinical tests. The patient was placed to lie on her back, with the in- jured leg resting on the surgical leg holder at the level of the middle of the left lower leg, making it possible to perform full passive knee flexion. The right leg was positioned in abduction. A pneumatic tourniquet was positioned above the knee, and was, after extremity el evation and compressive exsanguination, pumped up to the internal pressure of 220 mmHg.

After the operative field was prepared, the knee joint was accessed via the two standard arthroscopic portals: the anterolateral (AL) and the anteromedial (AM). Arthroscopy was performed in the form of slow intravenous infusion of a single dose of 1,000 mg of cef triaxone. Just before the administering of anesthesia, stability of the knee was established in the sagittal and the frontal pane, with the application of clinical tests. The patient was placed to lie on her back, with the in- jured leg resting on the surgical leg holder at the level of the middle of the left lower leg, making it possible to perform full passive knee flexion. The right leg was positioned in abduction. A pneumatic tourniquet was positioned above the knee, and was, after extremity elevation and compressive exsanguination, pumped up to the internal pressure of 220 mmHg.

After the operative field was prepared, the knee joint was accessed via the two standard arthroscopic portals: the anterolateral (AL) and the anteromedial (AM). Hemarthrosis was determined arthroscopically, which is why the joint was rinsed with saline solution under pressure. An impression fracture of the lateral tibial plateau was detected (Figure 2.A). Arthroscopically, no pathological changes were found on the remaining osteal and soft tissue structures.

Entry was made via the AM portal with the standard tibial guide for the reconstruction of the anterior cruciate ligament (ACL), and its tip, controlled by an optical instrument was placed above the identified depression of the lateral condyle. At the site of the inferior end of the guide, at the level of the medial tibial plateau, a vertical incision was made into the skin and subcutaneous tissue, around 2 cm in length, and the tip of the guide was leaned against the cortex. With the control of an optical instrument and fluoroscopy a guide-needle was introduced via the guide to the middle of the depression of the lateral plateau, taking care not to rupture the joint cartilage. After the removal of the tibial guide, a drill, 10 mm in diameter, used to penetrate the cortex and enter the metaphyseal region, was positioned via the guide-needle. Then, the depression of
Pod kontrolnom fluoroskopije, perkutano su uvedene dve paralelne igle vodilje sa lateralne strane plateoa tibije u pravcu medijalno, subhondralno, i paralelno sa zgloboom površinom. Preko njih su uvedena dva kanulirana zavrtnja sa parcijalnim navojima dimenzija 6,7 mm x 70 mm sa podloškama. Nakon toga učinjena je kontrolna radiografija radi provere pozicije *rafting* zavrtnja. Po fiksiranju preloma proverena je stabilnosti kroz pokrete u zglobu kolena (Slika 3).

Artroskopski je uklonjen preostali tkivni debris iz zglobove šupljine, a nakon provere hemostaze, postavljen je unutarzglobo dren, nakon čega je učinjena sutura rane pojedinačnim šavovima. Potom je u zglobovu šupljinu ubrizgan analgetsko-hemostatski koktel (8 ml 0,5% rastvora za injekciju bupivakaina, 1 ml rastvora 1% adrenalina i 500 mg rastvora tranexamične kiseline). Po previjanju rana sterilnim zavojem aplicovan je elastični zavoj radi prevencije venske staze, te je postavljena natkolenogipsana lonjeta, a operisana nogu u postelji pozicionirana u elevaciji.

Rani postoperativni period protekao je uredno, bez lokalnih i sistemskih komplikacija. Nakon inicijalne observacije u jedinici intenzivnog lečenja, pacijentkinja je prevedena na odeljenje i istog dana vertikalizovana i osposobljena za hod uz pomoć dve štake, bez oslonca na operisanoj nogi.

Prvog postoperativnogdana uklonjen je dren i započeto je sa pasivnim vežbama za povećanje obima pokreta u kolenu. Drugog postoperativnog dana pacijentkinja je otpuštena kući sa svetom da hoda sa dve štake bez oslonca na operisanu nogu tokom na-rednih 10 nedelja, te da u kućnim uslovima nastavi the lateral plateau was repositioned with the aid of a blunt instrument and a hammer, under direct control of fluoroscopy and an optical instrument (Figure 2.B).

A mixture of bone graft from the bone bank and synthetic bone graft substitute was implanted into the metaphyseal region via the canal created in the bone, in order to fill the subchondral bone defect. The remainder of the canal was filled with the mixture up to the level of the cortex (Figure 2.C and 2.D).

With the use of fluoroscopic control, two parallel needles were introduced subcutaneously from the lateral side of the tibial plateau, directed medially, subchondrally and parallel to the joint surface. Through these needles, two cannulated partially threaded screws, 6.7 mm x 70 mm, were introduced, with foundations. After that, a follow-up radiography was carried out in order to check the position of the rafting screw. After the fixation of the fracture, stability was checked through knee joint movement (Figure 3).

The remaining tissue debris was arthroscopically removed from the joint cavity, and, after a test of hemostasis, an intraarticular drain was placed, after which a suture with individual stiches was made. Then, a cocktail with analgesic and hemostatic effects (8 ml of 0.5% bupivacaine injection solution, 1 ml of 1% adrenalin solution and 500 mg of tranexamic acid solution) was injected into the joint cavity. After the wounds were dressed with a sterile bandage, an elastic bandage was applied in order to prevent venostasis, upon which an above the knee plaster-of-Paris splint was placed, and the surgically treated leg was elevated while the patient was in bed.

Early postoperative recovery was normal, without lo-
sa pasivnim vežbama za povećanje obima pokreta u operisanom kolenu. Gipsana imobilizacija zamenjena je funkcionalnom ortozom za koleno sa otključanom fleksijom. Pacijentkinja je savetovana da, nakon sprovođenja vežbi, dugog stajanja ili hodanja, u ležećem položaju sa eleveranom nogom vrši masažu kolena hladnim oblogama u cilju smanjenja otoka.

Tokom postoperativnog bolničkog lečenja nastavljeno je sa tromboembolijskom profilaktičkom terapijom nadroparin-kalcijumom u dozi od 3.800 I.J., dva puta dnevno, aplikovano subkutano, kao i sa analgetskom terapijom - paracetamol u dozi od 1.000 mg, četiri puta dnevno, ketorolak u dozi od 30 mg, tri puta dnevno, uz dodatak metamizol-natrijuma u dozi od 2,5 g, u fazama pogoršanja bola. Na otpustu je propisana tromboembolijska terapija - rivaroksaban tablete od 15 mg, jednom dnevno, do isteka 21 postoperativnogdana, kao i analgetska terapija etorikoksibom od 90 mg, jednom dnevno tokom prva tri dana, a zatim samo u slučaju pojave bolova većeg intenziteta. Savetovana je i lokalna aplikacija heparin-natrijuma od 1.000 I.J./g u obliku gela, tri puta dnevno i masaža kolena ledom, tri do četiri puta dnevno, u pravilnim vremenskim razmacima, do isteka 30. dana od dana operacije. 

Prvi kontrolni pregled obavljen je 12 dana nakon operativnog zahvata, kada su uklonjeni konci iz ope- rativnih rana. Pacijentkinja se tokom kućnog lečenja pridržavala uputstava datih na otpustu iz bolnice. Ope- rativni ozlijeđi bili su mirti, bez znakova infekcije, zarasli per primam intentionem. Registrovan je diferentni broj blagi otok kolena. Tokom pregleda izvedena je pasivna fleksija u operisanom kolenu do 90º, a ekstenzija je zaostala za 5º. Neurološki i vaskularni nalaz levog ale bili su normalni. Nakon prve radiografije, konstatirano je da je srastanje preloma od operacije. Klinički pregled obavljen je nakon 6 nedelja od prvog dana operacije. Pacijentkinja je savetovana da, nakon sutura, poslije动感, do isteka 12. postoperativnogdana, da se nose zaštitni oblogi i, nakon 30. dana od dana operacije, da se nosi otvoreni ortoz, do isteka 30. dana od dana operacije.

Drugi kontrolni pregled obavljen je nakon 6 mjeseci od prvog dana operacije. Pacijentkinja je savetovana da, nakon sutura, poslije动感, do isteka 6. postoperativnogdana, da se nose zaštitni oblogi i, nakon 30. dana od dana operacije, da se nosi otvoreni ortoz. Pacijentkinja je savetovana da, nakon sutura, poslije动感, do isteka 30. dana od dana operacije, da se nose zaštitni oblogi i, nakon 30. dana od dana operacije, da se nosi otvoreni ortoz. Pacijentkinja je savetovana da, nakon sutura, poslije动感, do isteka 30. dana od dana operacije, da se nose zaštitni oblogi i, nakon 30. dana od dana operacije, da se nosi otvoreni ortoz.

Nakon 30. dana od dana operacije, pacijentkinja je savetovana da, nakon sutura, poslije动感, do isteka 30. dana od dana operacije, da se nose zaštitni oblogi i, nakon 30. dana od dana operacije, da se nosi otvoreni ortoz. Pacijentkinja je savetovana da, nakon sutura, poslije动感, do isteka 30. dana od dana operacije, da se nose zaštitni oblogi i, nakon 30. dana od dana operacije, da se nosi otvoreni ortoz. Pacijentkinja je savetovana da, nakon sutura, poslije动感, do isteka 30. dana od dana operacije, da se nose zaštitni oblogi i, nakon 30. dana od dana operacije, da se nosi otvoreni ortoz.
Slika 4. Kontrolna radiografija nakon 10 nedelja od operacije: AP (A) i LL (B).

Figure 4. Follow-up radiography, 10 weeks after the operation: AP (A) and LL (B).

no odbacivanje pomagala i uspostavljanje normalne šeme hoda sa punim osloncem. Sledeca kontrola planirana je nakon 16 nedelja od operacije, kada ce biti razmotreno postepeno vracanje u sportske aktivnosti niskog intenziteta.

DISKUSIJA

Prelomi tibijalnog platoa predstavljaju terapijski izazov čak i za iskusnog hirurga, s obzirom na složenost preloma, širok spektar udruženih mekotkivnih povreda, zahtevnu hiruršku tehniku i invalidnost koja zaostaje kod nelećenih i neadekvatno lećenih preloma, a koju ponekad nije moguće izbaci ni nakon veome precizno izvršenih operacija. Kao i kod većine unutarzglobnih preloma, najbolji rezultati se očekuju nakon hirurškog lećenja, no kod određenog broja pacijenata metoda izbora je neoperativno lećenje.

Neoperativno lećenje primenjuje se kod sta-rih pacijenata sa izrazito osteoporotičnim kostima, malim funkcionalnim zahtevima; kod pacijenata sa brojnim komorbiditetima, koji čine hirurško lećenje neprihvatljivo rizičnim po život; kod nedislociranih ili minimalno dislociranih preloma; kao i kod manje depresije lateralnog platoa tibije, bez osovinskog deformiteta [14,18]. Kod takvih pacijenata prelomi se leče imobilizacijom natkolenom gipsanom longetom ili, ako je moguće, šarkastom longetom sa bočnim uzdužnim ojačanjima, koja dozvoljava pokrete u kolenu, tromboembolijskom i analgetskom terapijom, uz fizikalnu terapiju. Hod uz pomoć štaka bez oslonca na povređenu nogu preporučuje se u trajanju od najmanje četiri do osam nedelja, u zavisnosti od tipa preloma [14].

so as to increase the scope of movement in the knee and to strengthen the upper leg musculature.

The second follow-up examination was carried out six weeks after the operation. Through clinical examination, active flexion of 140º and extension up to -5º were noted. Follow-up radiography showed healing of the fracture in unchanged position.

The third follow-up examination was performed 10 weeks after surgery. Clinically, full painless movements were noted, while radiographically, healing of the fracture was confirmed in unchanged position (Figure 4). The patient was advised to discontinue wearing the functional orthosis and to start walking with the aid of crutches with partial weight-bearing through the surgically treated leg during the following two weeks, and after that gradual rejection of the orthopedic aids and the establishing of a normal walking regimen with full weight-bearing. The next follow-up was planned for 16 weeks after surgery, when gradual return to sports activities of low intensity might be planned.

DISCUSSION

Fractures of the tibial plateau are a therapeutic challenge, even for an experienced surgeon. This is due to the complexity of these fractures, the wide array of associated soft-tissue injuries, the demanding surgical technique, as well as invalidity occurring as the consequence of untreated or inadequately treated fractures, which is sometimes impossible to avoid even after very precisely executed surgical procedures. As in most intraarticular fractures, the best results are expected after surgical treatment, however, in a certain number of patients, the method of choice is nonsurgical treatment.

Slika 4.
Izolovana depresija lateralnog platoa tibije od 10 i više milimetara, koja zahvata mali deo zglobovnih hrskavica, može se uspešno lečiti i neoperativno, ali ukoliko je udržana sa razdvajanjem bijelinskog platoa ili ukoliko je zahvaćen veći deo zglobovnih površina, često prouzrokuje sekundarni valgus osovinski deformitet, te se takve povrede leče operativno [14]. U brojnim studijama prikazani su dobi do odlični rezultati neoperativno lečenih pacijenata sa platoima bijelinskog platoa [19-22]. U svojoj studiji, Vadel i saradnici navede da se depresija ili razdvajanje lateralnog platoa manje od 10 mm uspešno leči neoperativno, dok su Honkonen i saradnici u svom radu objavili da se razdvajanje od 5 mm i depresija lateralnog platoa tibije od 3 mm dobro tolerišu kod neoperativno lečenih pacijenata, dok su nelikvidno povređenih kondila ne treba lečiti neoperativno [23,24].

Ipak, preovladava stav da se ovi unutarzgloboznji plomi leče operativno, kada god je to moguće. Najčešće indikacije za operativno lečenje su: dislocirani, nestabilni plomi sa depresijom košnog fragmenta većom od 5 mm i osovinskog deformitetom većim od 10º u koronarnoj ravni, u poređenju sa suprotnom, zdravom nogom, potom plomi sa metafizno-dijфизnom propagacijom ili nestabilni bikondilarni plomi, otvoreni plomi, plomi sa udruženim ili pretečim kompartment sindromom, plomi udruženi sa neurovaskularnim povredama i plomi proškornog okrajka tibije udruženi sa plomima distalnog okrajka lukaste kosti (floating knee) [25]. Hung i saradnici navede da su kao indikacije za operativno lečenje uzimali varusne ligamentarne nestabilnosti u punoj ekstenziji - kod ploma medijalnog platoa tibije, varusne i valgusne ligamentarne nestabilnosti veće od 10º - kod ploma lateralnog platoa tibije, kao i utonuća bijelinske plote od 10 or more millimeters, which covers only a small surface of the joint cartilage, can be treated successfully non-surgically. However, if it is accompanied with tibial plateau separation, or if a significant portion of the joint surface is affected, it frequently causes secondary valgus axial deformity, which is why such injuries are treated surgically [14]. Numerous studies have reported good to excellent results in the nonsurgical treatment of patients with tibial plateau fractures [19-22]. In their study, Waddell et al. report that a depression or separation of the lateral tibial plateau smaller than 10 mm can be successfully treated non-surgically, and Honkonen et al., in their study, report that a separation of 5 mm and a depression of the lateral tibial plateau up to 3 mm are well tolerated in non-surgically treated patients, while fractures of the medial condyle should not be treated nonsurgically [23,24].

Nonsurgical treatment is applied in elderly patients with markedly osteoporotic bones, with low functional requirements; in patients with numerous comorbidities, which render surgical treatment unacceptably risky, i.e., life-threatening; in non-displaced or minimally displaced fractures; as well as in the case of a lesser depression of the lateral tibial plateau, without axial deformity [14,18]. In such patients, fractures are treated by immobilizing the leg with an above-the-knee plaster-of-Paris splint, or, if possible, with a hinged knee brace with longitudinal side reinforcements, which allows movement in the knee, as well as with thromboembolic and analgesic therapy and physical therapy. Walking with crutches without putting any weight through the injured leg is recommended for a period of at least four to eight weeks, depending on the type of fracture [14].

An isolated depression of the lateral tibial plateau of 10 or more millimeters, which covers only a small surface of the joint cartilage, can be treated successfully non-surgically. However, if it is accompanied with tibial plateau separation, or if a significant portion of the joint surface is affected, it frequently causes secondary valgus axial deformity, which is why such injuries are treated surgically [14]. Numerous studies have reported good to excellent results in the nonsurgical treatment of patients with tibial plateau fractures [19-22]. In their study, Waddell et al. report that a depression or separation of the lateral tibial plateau smaller than 10 mm can be successfully treated non-surgically, and Honkonen et al., in their study, report that a separation of 5 mm and a depression of the lateral tibial plateau up to 3 mm are well tolerated in non-surgically treated patients, while fractures of the medial condyle should not be treated nonsurgically [23,24].

Nevertheless, the pervasive view is that these intraarticular fractures should be treated surgically, whenever possible. The most common indications for surgical treatment are the following: displaced, unstable fractures with bone fragment depression of more than 5 mm and axial deformity greater than 10º in the frontal plane, as compared to the other, healthy leg; also, fractures with metaphyseal-diaphyseal propagation or unstable bicondylar fractures, compound fractures, fractures with accompanying or impending compartment syndrome, fractures with accompanying neurovascular injuries, and fractures of the proximal tibia with accompanying fractures of the distal end of the femur (floating knee) [25]. Hung et al. have reported that they took, as indications for surgical treatment, varus ligament instabilities in full extension – in fractures of the medial tibial plateau, varus and valgus ligament instabilities greater than 10º - in lateral tibial plateau fractures, as well as depression of the tibial joint surface greater than 3 mm...
Klasična, otvorena hirurška intervencija izvodi se najčešće kroz anterolateralni pristup, uz potrebu za submeniskalnom arthrotomijom, radi boljeg uočavanja zglobne površine i kontrole rezopicije preloma [29]. Velika incizija mekih tkiva i arthrotomijom, koja može biti praćena transverzalnom sekcijom meniskusa, postoperativno mogu prouzrokovati brojne komplikacije: poremećaj propriocepcije, bolove koji remete normalnu funkciju zgloba, smanjenje obima pokreta, ukočenost kolena, hematom u preduel operativne rane, postoperativnu secernaciju iz rane, produženo zarastanje rane, nekrozu ivica, te dehiscenciju i infekciju [1,6,11,30]. U svojim studijama, Savoe i Lachiviz navode dobre do odlične rezultate preloma lateralnog platoa lečenih ORIF tehnikom [31,32].

Od kada su Kaspari i Dženings prvi objavili svoje studije o seriji pacijenata lečenih arthroskopski asistiranim osteosintezom, 1985. godine, ova hirurška tehnika postaje sve prihvaćenija metoda u lečenju preloma lateralnog platoa tibije [33,34].

Artroskopski asistirana hirurgija omogućava bolje sagledavanje zglobnih površina, direktnu procenu i istovremeno adekvatno zbrinjavanje pojedinih unutarzglobnih koštanih i mekotkivih povreda, koje se prema nekim studijama javljaju u 30% do 71% pacijenata sa prelomima tibijalnog platoa [11]. Pored toga, kao i svaka endoskopska procedura, i ova, u odnosu na klasičnu, otvorenu hirurgiju ima prednosti kao što su: manji broj postoperativnih komplikacija, manje incizije i ožiljci, manji gubitak krvi, manje postoperativne komplikacije, manje od poštovanja mekih tkiva i artrotomija, koja može biti praćena infekcijom [31,32].

Artroskopski asistirana hirurgija omogućava bolje sagledavanje zglobnih površina, direktnu procenu i istovremeno adekvatno zbrinjavanje pojedinih unutarzglobnih koštanih i mekotkivih povreda, koje se prema nekim studijama javljaju u 30% do 71% pacijenata sa prelomima tibijalnog platoa [11]. Pored toga, kao i svaka endoskopska procedura, i ova, u odnosu na klasičnu, otvorenu hirurgiju ima prednosti kao što su: manji broj postoperativnih komplikacija, manje incizije i ožiljci, manji gubitak krvi, manje postoperativne komplikacije, manje od poštovanja mekih tkiva i artrotomija, koja može biti praćena infekcijom [31,32].

Foubi i saradnici navode daleko bolje rezultate kod pacijenata lečenih ARIF metodama u odnosu na ORIF [37]. Kifer, Van Glabik i Odera su prikazali bolje do odlične rezultate pacijenata lečenih artroskopski asistiranim hirurgijom [38-40]. ARIF i ORIF tehnikama dobijeni su dobro postopek sustavni obrt na kojem postoji manja šansa na izlazak iz hirurške intervencije, uz značajno veću šanse na uspješno zbrinjanje komplikacija vrlo sličnih komplikacija kod ORIF. U nekim slučajevima, ARIF interventije su sigurnije i hitrije u izvršnjuju se sa manjim neprikladnostima od ORIF [31,32].

The exact size of the joint surface depression is often difficult to measure on AP and LL X-ray images. Martin et al. state that, when different observers independently measure radiographic discrepancies, their measurements differ by 12 or more millimeters [26]. For this reason, some authors believe that the number of millimeters is a simplified and not always reliable method for determining surgical indications [14]. The size of the tibial joint surface depression can be measured precisely and with great certainty on CT scans. In this way, fractures are classified more precisely, and the choice of surgical technique is more reliable [15,27]. Chan et al. have demonstrated significant changes in the preoperative plan upon introducing CT diagnostics to follow standard radiographic imaging of the knee [28].

Classical, open surgery is most often performed through the anterolateral access, with the need for submeniscal arthroscopy, for the purpose of a better view of the joint surface and better control of fracture reduction [29]. A large incision into the soft tissue and arthroscopy, which may be accompanied by a transversal section of the meniscus, may postoperatively cause numerous complications, including the following: disruption in proprioception, pain which upsets normal joint function, reduction of the scope of movement, knee stiffness, hematoma in the area of the surgical wound, postoperative wound discharge, prolonged wound healing, necrosis of the wound margins, wound dehiscence, and infection [1,6,11,30]. In their studies, Savoe and Lachiewicz have reported good to excellent results with lateral plate fracture treated with the ORIF technique [31,32].

Since Kaspari and Jennings first published their studies on series of patients treated with arthroskopically assisted osteosynthesis, in 1985, this surgical technique has become an increasingly accepted method in treating lateral tibial plate bone fractures [33,34].

Arthroskopically assisted surgery enables a better view of the joint surfaces, direct assessment and, at the same time, appropriate treatment of certain intraarticular and soft-tissue injuries, which, according to certain studies, occur in 30% to 71% of patients with tibial plate bone fractures [11]. In addition, like any endoscopic procedure, this one also, when compared to classical, open surgery, has advantages, such as: a lesser number of postoperative complications, smaller incisions and scars, less blood loss, reduced postoperative swelling and hematoma, possibility of removing hematoma and tissue debris from the joint, reduced soft tissue trauma, and thereby, swifter and easier recovery [7,29]. According to some studies, in tibial plate bone fractures, intramedullary vasculization is jeopardized, while periosteal...
Upkros preporukama pojedinih studija da se uzme u obzir činjenica da se korišćenjem pumpe može razviti kompartment sindrom [3,11,42], mi smo se odlučili za takav način ispiranja zgloba kolenja, ohrabreni studijama koje navode da je ova komplikacija ređa kod preloma lateralnog platoa tibije, budući da se na taj način tkivni debris iz zglobove okoline bolje otklanja [43]. Po ispiranju zgloba konstatovali smo izolovani impresionii prelom lateralnog tibijalnog platoa. Nije bilo udruženih povreda koštanih i mekotkivnih struktura, za razliku od studije Verone i saradnika, u kojoj se su mekotkivne povrede javile kod 52,5% pacijenata, i studije Kajalija i saradnika, u kojoj je ovakve povrede imalo 67% pacijenata [7,11]. Vang i saradnici u svom radu navode da su prelomi lateralnog platoa tibije bili udruženi sa nekim vidom kompliciranja kod 48% ispitanika [44]. Koštani deo smrtnih povreda 46% pacijenata [44]. Koštani defekt smo popunili kombinacijom alografta (grefon iz koštane banke) i sintetske stukaste komponente za kost, a prelom smo izolovani impresioni prelom lateralnog tibijalnog platoa. Nije bilo udruženih povreda koštanih i mekotkivnih struktura [45].

Neposredno postoperativno, noga je imobilisana i elevirana, uz primenu hladnih obloga na operisanu nogu [1]. Dužina nošenja imobilizacije razlikuje se od studije do studije, u razdoblju od 2 dana do 12 nedelja, najčešće od 3-6 nedelja [45]. Usled nedovoljnog iskustva hirurga sa ovom vrstom hirurške tehnike u lečenju preloma lateralnog platoa tibije, kod našeg pacijenta, kolenje smo imobilisali funkcionalno ortozom, koja dozvoljava pune pokrete u zglobu, u trajanju od 10 nedelja. Sa pasivnim povećanjem obima pokreta u operisanom polje i aktivnim izometričkim vežbama natkole nekorektno su kompenzirana, započeto je prvog postoperativnog dana, po vađenju drena, u skladu sa studijom Boldina i saradnika [46]. Sa aktivnim vežbama u operisanom polje započeto je nakon uklanjanja konca.

Prema pregledu Arnolda i saradnika, u čak 79% slučajeva postoperativno vreme hoda bez oslonca na operisanu nogu bilo je kraće od 10 nedelja, dok je hodi sa delimičnim osloncem u 46% slučajeva uvođen između 4. i 6. postoperativne nedelje [45]. Budući da nema jasnih preporuka o uvođenju oslonca kod pacijenata operisanih ORIF hirurškom tehnikom, mi smo se odlučili za konzervativniji pristup i pacijentkinji smo savetovali hodi uz pomoć štaka bez oslonca tokom 10 nedelja, što je u skladu sa važećim AO preporukama i drugim većim studijama [1,45,47]. Nakon deset nede-

vascularization is mostly preserved [35]. Arthroscopically assisted percutaneous fracture fixation protects the periosteal vascularization, thereby reducing the risk of the fracture failing to heal, the risk of osteonecrosis and soft-tissue necrosis, as well as the risk of infection [36].

Fowble et al. have reported far better results in patients treated with ARIF methods as compared to those treated with ORIF [37]. Kiefer, Van Glabbeek, and Ohdera have shown good to excellent results with patients treated with arthroscopically assisted surgery [38-40]. With ARIF and ORIF techniques, good clinical and radiographic results have been achieved, without statistically significant differences in complication rates, while patients treated with arthroscopically assisted surgery were hospitalized for a shorter period of time, and achieved full weight bearing earlier [3,11]. Certain authors feel that arthroscopic surgery is a very demanding procedure, in the technical sense, and that it should be carried out exclusively by an experienced surgeon and applied only in fractures of the lateral condyle of the tibia (Schatzker types I-III) [41].

Despite recommendations by certain studies to be aware of the fact that the use of a pump may lead to the development of the compartment syndrome [3,11,42], we decided to use that particular method of rinsing the knee joint, encouraged by the studies stating that this complication is rarer in fractures of the lateral tibial plateau, since, in this way, tissue debris is better removed from the joint fissure [43]. After rinsing the joint, we noted an isolated impression fracture of the lateral tibial plateau. There were no accompanying injuries of the bone and soft-tissue structures, as opposed to the study by Verona et al., where soft-tissue structures occurred in 52.5% of the patients, and a study by Kayali et al., where such injuries were present in 67% of patients [7,11]. In their paper, Wang et al. have stated that fractures of the lateral tibial plateau were accompanied by some form of injury to the anterior cruciate ligament in around 80% of cases, out of which 48% had a complete lesion, while 48% of the subjects sustained injury to the lateral meniscus [44]. We filled the bone defect with a combination of allograft (graft from the bone bank) and synthetic bone graft substitute, while the fracture was stabilized with cannulated screws, positioned parallel to each other, subchondrally, by means of the rafting technique, as described by numerous authors [1,7,11,14,15,36].

Immediately after the operation, the leg was immobilized and elevated, with the application of cold compresses on the injured knee, in keeping with the recommendations by Hung et al. [1]. Patients used immobilization from two days to twelve weeks, but most commonly from three to six weeks, which varies from study to study [45]. Due to insufficient experience by
the surgeon in the use of this particular type of surgical technique for treating lateral tibial plateau injuries, in the case of our patient, we immobilized the knee with a functional knee orthosis which allows for full movement in the knee joint, for a period of 10 weeks. Passive increase of the scope of movement in the surgically treated knee and active isometric exercises of the upper leg muscles began on the first postoperative day, upon drain removal, in keeping with a study by Boldin et al. \[46\]. Active exercises for the surgically treated knee began after the removal of sutures.

According to the review by Arnold et al., in as many as 79% of the cases, the postoperative time of non-weightbearing walking was shorter than 10 weeks, while partial weightbearing was introduced, in 46% of the cases, between the fourth and the sixth postoperative week \[45\]. As there are no clear recommendations on introducing increasing levels of weight bearing in patients treated with the ARIF surgical technique, we decided on the more conservative approach, recommending our patient to walk with crutches without putting weight through the injured leg, for a period of 10 weeks, which is in keeping with the current AO recommendations and other larger studies \[1,45,47\]. Ten weeks after the operation, at the latest check-up, full scope of movement in the knee was achieved.

In the presented patient there were neither any iatrogenic injuries nor were there any intraoperative or early postoperative complications. We are aware that the follow-up period is short, and that rehabilitation is not yet over, however a good early functional result and the radiographic findings are encouraging as to the further application of this surgical procedure, motivating us to try and perfect it further and improve the surgical technique, as well as postoperative recovery. We will definitely continue to monitor the patient, both clinically and radiographically. Analysis and monitoring of a larger number of patients over a longer period of time would provide more relevant data, which would indicate whether arthroscopically assisted osteosynthesis of lateral tibial condyle fracture is an appropriate and cost-effective method.

**Conflict of interest:** None declared.
LITERATURA / REFERENCES

1. Hung SS, Chao EK, Chao YS, Yuan LJ, Chung PC, Chen CY, et al. Arthroscopically assisted osteosynthesis for tibial plateau fractures. J Trauma. 2003; Feb; 54(2):356-63.

2. Benea H, Tomaia G, Martin A, Bardas C. Arthroscopic management of proximal tibial fractures: technical note and case series presentation. Clujul Med. 2015; 88(2):233-6.

3. Elabjer E, Bençić I, Ćutić T, Cerevčki T, Ćurić S, Vidović D. Tibial plateau fracture management: arthroscopically-assisted versus ORIF procedure - clinical and radiological comparison. Injury. 2017 Nov; 48 Suppl 5:561-564.

4. Hermanowicz K, Malinowski K, Góralczyk A, Guszczyn T, LaPrade RF, Sadlik B. All-Arthroscopic Treatment of Schatzker Type III Lateral Tibial Plateau Fracture Without Fluoroscopy. Arthrosc Tech. 2019 May 17; 8(6):e567-e574.

5. Mthethwa J, Chikate A. A review of the management of tibial plateau fractures. Musculoskelet Surg. 2018 Aug; 102(2):119-27.

6. Le Baron M, Cermolacce M, Flecher X, Guillotin C, Bauer T, Ehlinger M. Tibial plateau fracture management: ARIF versus ORIF - clinical and radiological comparison. Orthop Traumatol Surg Res. 2019; Feb; 105(1):101-6.

7. Kayali C, Oztürk H, Altay T, Reisoglu A, Agus H. Arthroscopically assisted percutaneous osteosynthesis of lateral tibial plateau fractures. Can J Surg. 2008 Oct; 51(5):378-82.

8. Meinberg EG, Agel J, Roberts CS, Karam MD, Kellam JF. Fracture and Dislocation Classification Compendium-2018. J Orthop Trauma. 2018 Jan; 32 Suppl 1:S1-S170.

9. Schatzker J, McBrone R, Broughton CR, Bruce D. The tibial plateau fracture. The Toronto experience 1968–1975. Clin Orthop Relat Res. 1979 Jan-Feb; (138):93-104.

10. Dall’oca C, Maluta T, Lavini F, Bondi M, Micheloni GM, Bartolozzi P. Tibial plateau fractures: compared outcomes between ARIF and ORIF. Strategies Trauma Limb Reconstr. 2012 Nov; 7(3):163-75.

11. Verona M, Cermolace M, Felle G, Capone A. Tibial plateau fracture management: arthroscopically-assisted versus open reduction and internal fixation (ORIF) - a comparative study. J Orthop Surg Res. 2019 May 24; 14(1):155.

12. Robertson GA, Wong SJ, Wood AM. Return to sport following tibial plateau fractures: A systematic review. World J Orthop. 2017 Jul 18; 8(7):574-87.

13. Prat-Fabregat S, Camacho-Carrasco P. Treatment strategy for tibial plateau fractures: an update. EFORT Open Rev. 2017 Mar 13; 2(5):225-32.

14. Marsh JL, Karam MD. Tibial Plateau Fractures. In: Court-Brown CM, Heckman JD, McQueen MM, Ricci W, Tornetta P, editors. Rockwood and Green's fractures in adults. 8th ed. Philadelphia: Wolters Kluwer Health; 2017; p.2712-816.

15.  Wasserstein D, Henry P, Paterson JD, McQueen MM, Ricci W, Tornetta P, et al. Impact of CT scan on treatment plan and fracture classification of tibial plateau fractures. J Orthop Trauma. 2015 Oct; 11(7):484-9.

16. Chan PS, Klimkiewicz JJ, Lachiewicz PF, Eloranta ST, editors. Campbell’s Operative Orthopaedics. 13th ed. Philadelphia: Elsevier Inc; 2017; p.2712-816.

17. Lansinger O, Bergman B, Körner L, Andersson GB. Tibial condylar fractures. A twenty-year follow-up. J Bone Joint Surg Am. 1986 Jan; 68(1):13-9.

18. Scotland T, Wardlaw D. The use of cast-bracing as treatment for fractures of the tibial plateau. J Bone Joint Surg Br. 1981; 63B(4):575-8.

19. Duwelius PJ, Connolly JF. Closed reduction of tibial plateau fractures. A comparison of functional and roentgenographic end results. Clin Orthop Relat Res. 1988 May; (230):116-26.

20. Waddell JP, Johnston DW, Neidre A. Fractures of the tibial plateau: a review of ninety-five patients and comparison of treatment methods. J Trauma. 1981 May; 21(5):376-81.

21. Martin J, Marsh JL, Nevola JP, Dirschl DR, Hurwitz S, DeCoster TA. Radiographic fracture assessments: which ones can we reliably make? J Orthop Trauma. 2000 Aug; 14(6):379-85.

22. Dodd A, Oddone Paolucci E, Korley R. The effect of three-dimensional computed tomography reconstructions on preoperative planning of tibial plateau fractures: a case-control series. BMC Musculoskeletal Disord. 2015 Jun 13; 16:144.

23. Martin J, Marsh JL, Nevola JP, Dirschl DR, Hurwitz S, DeCoster TA. Radiographic fracture assessments: which ones can we reliably make? J Orthop Trauma. 2000 Aug; 14(6):379-85.

24. Honkonen SE. Indications for surgical treatment of tibial condyle fractures. Clin Orthop Relat Res. 1994 May; (302):199-205.

25. Rajasekaran S, Kamath V, Dheenadhayalan J. Tibial Plateau Fractures. In: Sivananathan S, Sherry S, Warnke P, Miller MD, editors. Mercer’s Textbook of Orthopaedics and Trauma. 10th ed. London: Hodder Education; 2012; p.372-6.

26. Martin J, Marsh JL, Nevola JP, Dirschl DR, Hurwitz S, DeCoster TA. Radiographic fracture assessments: which ones can we reliably make? J Orthop Trauma. 2000 Aug; 14(6):379-85.

27. Dodd A, Oddone Paolucci E, Korley R. The effect of three-dimensional computed tomography reconstructions on preoperative planning of tibial plateau fractures: a case-control series. BMC Musculoskeletal Disord. 2015 Jun 13; 16:144.

28. Martin J, Marsh JL, Nevola JP, Dirschl DR, Hurwitz S, DeCoster TA. Radiographic fracture assessments: which ones can we reliably make? J Orthop Trauma. 2000 Aug; 14(6):379-85.

29. Martin J, Marsh JL, Nevola JP, Dirschl DR, Hurwitz S, DeCoster TA. Radiographic fracture assessments: which ones can we reliably make? J Orthop Trauma. 2000 Aug; 14(6):379-85.

30. Martin J, Marsh JL, Nevola JP, Dirschl DR, Hurwitz S, DeCoster TA. Radiographic fracture assessments: which ones can we reliably make? J Orthop Trauma. 2000 Aug; 14(6):379-85.

31. Savoie FH, Vander Griend RA, Ward EF, Hughes JL. Tibial plateau fractures: a case-control series. J Orthop Trauma. 2017 Mar; 31:143-53.

32. Savoie FH, Vander Griend RA, Ward EF, Hughes JL. Tibial plateau fractures: a review of operative treatment using AO technique. Orthopedics. 1987 May; 10(5):745-50.

33. Lachiewicz PF, Funkic T. Factors influencing the results of open reduction and internal fixation of tibial plateau fractures. Clin Orthop Relat Res. 1990 Oct; (259):210-5.

34. Caspari RB, Hutton PM, Whipple TL, Meyers JF. The role of arthroscopy in the management of tibial plateau fractures. Arch Orthop Trauma Surg. 2000 May; 120(5):225-32.

35. Caspari RB, Hutton PM, Whipple TL, Meyers JF. The role of arthroscopy in the management of tibial plateau fractures. Arch Orthop Trauma Surg. 2000 May; 120(5):225-32.
40. van Glabbeek F, van Riet R, Jansen N, D’Anvers J, Nuyts R. Arthroscopically assisted reduction and internal fixation of tibial plateau fractures: report of twenty cases. Acta Orthop Belg. 2002 Jun; 68(3):258-64.

41. Tornetta P 3rd. Arthroscopic elevation with grafting. J Orthop Trauma. 2002 Jul; 16(6):444-6.

42. Belanger M, Fadale P. Compartment syndrome of the leg after arthroscopic examination of a tibial plateau fracture. Case report and review of the literature. Arthroscopy. 1997 Oct; 13(5):646-51.

43. Herbort M, Domnick C, Petersen W. Arthroscopic treatment of tibial plateau fractures. Oper Orthop Traumatol. 2014; 26:573–88.

44. Wang Y, Cao F, Liu M, Wang J, Jia S. Incidence of Soft-Tissue Injuries in Patients with Posterolateral Tibial Plateau Fractures: A Retrospective Review from 2009 to 2014. J Knee Surg. 2016 Aug; 29(6):451-7.

45. Arnold JB, Tu CG, Phan TM, Varghese VD, Thewlis D, et al. Characteristics of postoperative weight bearing and management protocols for tibial plateau fractures: Findings from a scoping review. Injury. 2017 Dec; 48(12):2634-42.

46. Boldin C, Fankhauser F, Hofer HP, Szyszkiowitz R. Three-year results of proximal tibia fractures treated with the LISS. Clin Orthop Relat Res. 2006 Apr; 445:222-9.

47. Cong-Feng L. Tibia, proximal. In: Buckley RE, Moran CG, Apivatthakakul T, editors. AO Principles of Fracture Management, 3rd ed. New York: Thieme; 2017; p.877-98.