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Case Report

An unclassified tibial plateau fracture: Reverse Schatzker type IV

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ABSTRACT

The most commonly accepted system of classification for tibia plateau fractures is that of Schatzker. Increasingly, both high energy injuries and atypical osteoporotic fragility failures have led to more complex, unusual and previously undescribed fracture patterns being recognized. We present a case of a patient with a previously unreported pattern of tibia plateau fracture and knee dislocation. We highlight the challenges confronted and present the management and the outcomes of his injury. A 28-year old male motorcyclist was involved in a head on collision with a truck and was transferred by helicopter to our level 1 major trauma centre emergency department. His injuries were a circumferential degloving injury to his left leg and a right lateral tibial plateau fracture/knee dislocation. The pattern of the lateral tibial plateau fracture was unique and did not fit any recognised classification system. The patient received a spanning external fixator initially and after latency of 12 days for soft tissue resuscitation he underwent definite fixation through an antero-lateral approach to the proximal tibia with two cannulated 6.5 mm partially threaded screws and an additional lateral proximal tibia plate in buttress mode. A hinged knee brace was applied with unrestricted range of motion post-operatively and free weight bearing were permitted post operatively. At the 6 months follow up, the patient walks without aids and with no limp. Examination revealed a stable joint and full range of motion. Plain radiographs revealed that the fracture healed with good alignment and the fixation remained stable. High energy injuries can lead to more complicated fracture patterns, which challenge the orthopaedic surgeons in their management. It is crucial to understand the individual fracture pattern and the possible challenges that may occur. This study reports a lateral tibia plateau fracture/dislocation which perhaps is best described as a reverse Schatzker IV type fracture.

Introduction

Multiple classification systems have been proposed in the literature relating to tibial plateau fractures. They serve to describe the fracture pattern, guide management and predict outcome. The most widely used classification of tibial plateau fractures is the system first proposed by Schatzker.[1] Lately the increase in frequency of high energy injuries and fragility fractures have led to more complex fracture patterns.

The Schatzker type IV is considered to be a fracture caused by a high-energy mechanism of injury and accounts for approximately 10% of all tibial plateau fractures.[2] The fracture line of a type 4 typically passes through the medial tibial plateau in combination with a dislocated/subluxed knee joint (Fig. 1). It is generally understood that a Schatzker type IV fractures are high energy injuries leading to axial load combined with varus stress on the knee.[3] However, the patient we discuss in this study presented with a fracture line passing through the lateral tibial plateau with a dislocated knee joint – in what we have termed a 'reverse Schatzker type IV' fracture pattern (Fig. 2). This fracture pattern, to our knowledge is the first to be described in the literature.

Understanding the fracture pattern and the mechanism behind it is of great use to the operating surgeon as the pattern influences the surgical approaches and patient positioning, the fixation construct and rehabilitation protocol, allows early identification of any risks and complications and can even predict the prognostic outcome of the patient.[2]

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Fig. 1. Typical Schatzker IV fracture pattern.

Case report

Incident

A 28-year old male motorcyclist was involved in a head on collision with an incoming truck. He was attended to at the scene of the accident by the regional helicopter emergency medical services (HEMS) and was found trapped under the truck. He was transferred to the regional level 1 major trauma center by air.

On arrival he was managed with standard major trauma resuscitation protocols. Airway, breathing and circulation were stable. A pelvic splint was applied initially. The patient was alert and orientated with a Glasgow Coma Scale (GCS) noted as 15. The upper limbs were intact. Sensation and motor function was intact on both lower limbs. Pulses were present on the right lower limb but absent on the left.

On clinical examination there was an extensive degloving injury to his left leg distally to the knee, on the right lower limb he had a closed injury with knee swollen, deformed and tender. Radiographic imaging revealed no bony injuries to the left leg and a lateral tibia plateau fracture/dislocation of the right knee with a proximal fibula fracture (Fig. 2). A pelvic injury was excluded radiologically and clinically and the pelvic binder was removed. The right leg was immobilized with an above knee full leg backslab and the left leg was dressed with saline soaked dressings. The patient transferred to theaters for surgical management urgently.

Perioperartive

The patient was transferred to theaters urgently for the management of the left leg degloving injury by the plastic surgeons and the right knee fracture/dislocation by the orthopaedic trauma surgeons. The left leg degloving injury was treated initially with surgical debridement, washout and application of vacuum assisted closure (VAC) dressing. The aim of the first urgent surgical treatment of the right knee fracture/dislocation was to reduce the dislocation of the joint, maintain the height and alignment, in order to give time for soft tissue resuscitation. This was achieved by using a spanning external fixator (Hoffmann 3, Stryker, Kalamazoo, MI, USA). Intraoperatively a femoral distractor was used to aid reduction, as the reduction of the joint has not achieved with other means.

After a latency period of 12 days (adequate time for soft tissue resuscitation), the patient went to theaters for the definite fixation of his right tibia plateau fracture. An antero-lateral approach to the proximal tibia was performed. The fracture was identified, prepared, cleaned and reduced. The reduction was held temporarily with two 3.2 mm k-wires. Two cannulated 6.5 mm partially threaded screws (ASNIS III 6.5 mm, Stryker, Kalamazoo, MI, USA) were applied from proximal to distal and antero-lateral to medial, to provide compression across the shear plane of the fracture. An additional lateral proximal tibia plate was applied in buttress mode (AxSOS 3, Stryker, Kalamazoo, MI, USA) (Fig. 3A and B). There were no complications during the procedure.

The patient was closely monitored in the immediate postoperative period for compartment syndrome. Elevation and ice therapy was applied. A hinged knee brace was fitted with unrestricted range of motion, in order to support the medial collateral ligament which was clearly damaged by the force of the injury. He received regular physiotherapy, with early range of motion exercises of the knee and ankle joint. Instructions for early weight bearing as tolerated was given.

Follow-up

The patient was discharged home ten days after the operative treatment of the right tibia plateau fracture, once his left leg was managed with skin grafting by the plastic surgeons. In hospital he was receiving daily physiotherapy and he managed to walk with crutches, weight-bearing through his right leg.

At the 6 weeks follow up, the wound had healed, with no signs of infection. He was walking using one crutch. The range of motion of the knee was 0^o–$90°$. At that time point the hinged knee brace was removed, and the patient continued the physiotherapy.

At the 3 months follow up, the patient attended the clinics without aids for walking and with no limb. The knee examination revealed stable joint and the range of motion was 0^o–$120°$. Radiographic evaluation showed that the fracture was healing with good alignment and the fixation remained stable.

At the 6 months follow up the patient had returned to normal activity levels, his joint was stable and the range of motion was full. Radiologic evaluation revealed that the fracture healed completely, in good alignment and the fixation remained unchanged (Fig. 4).

Discussion

Although the classifications of the tibia plateau fractures are numerous and describe multiple fracture patterns, we present an

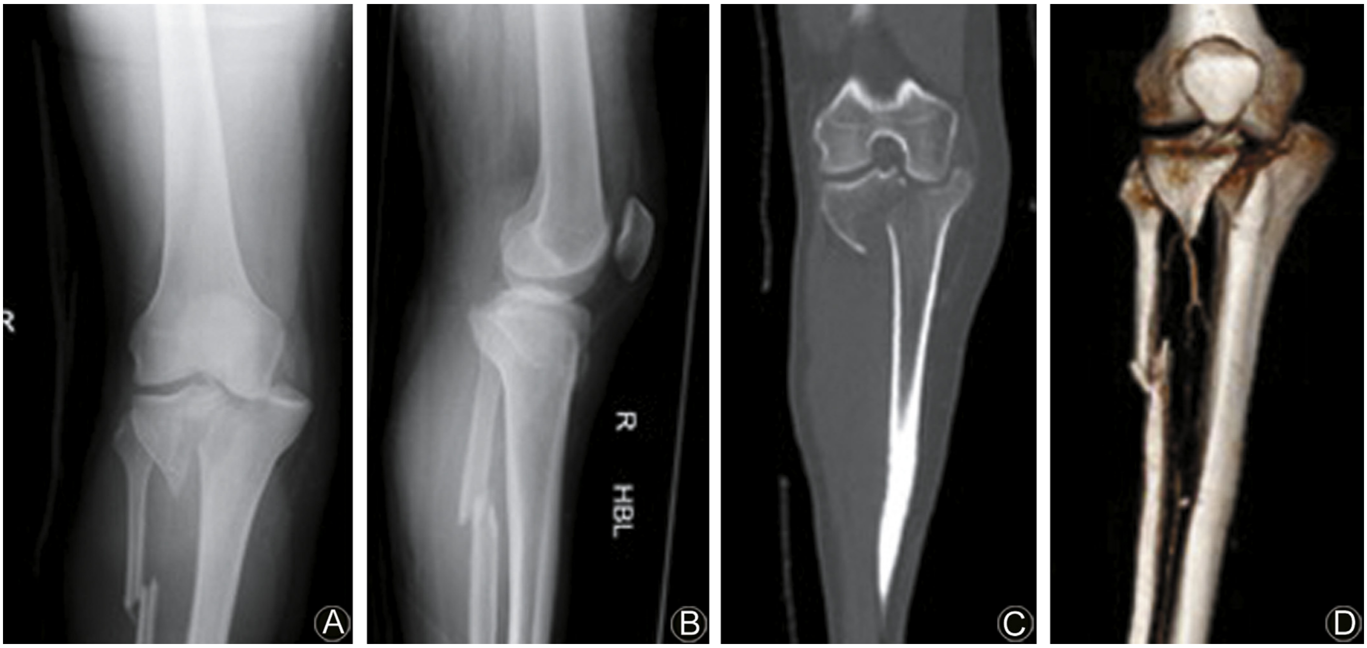

Fig. 2. A: Anteroposterior; B: lateral view of a plain radiograph of the injury; C: coronal view of the CT scan; D: 3D reconstruction depicting the right proximal tibia at the time of injury.

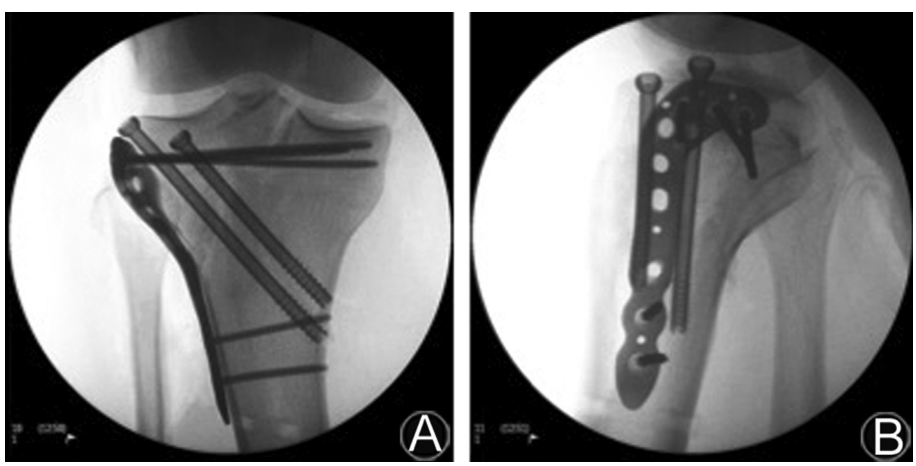

Fig. 3. Anteroposterior (A) and lateral (B) intra-operative view of an image identifier radiograph depicting the right proximal tibia surgical fixation.

unusual fracture pattern, previously unreported and unclassifiable in any known system. In this instance, an oblique shear pattern fracture split the tibial condyles apart. The lateral tibial condyle remained in its anatomic location anchored by the lateral ligamentous structure to the femur. The medial tibial condyle remained attached to the tibial shaft and was entirely dislocated. The medial femoral condyle was located between the two tibial condyles. It is akin to the Schatzker IV fracture pattern where the lateral tibial condyle and shaft dislocate, leaving the medial condyle behind. This is the only tibial plateau fracture type which includes a subluxation of the knee joint.[4] Thus perhaps this fracture pattern is best described as a reverse Schatzker IV type fracture.

Along with the Schatzker classification there are currently more than six classification models mentioned in literature describing tibial plateau fracture patterns, however, there is no universally accepted model used to describe these fracture patterns yet. Other frequently used models include, but are not limited to, Arbeitsgemeinschaft für Osteosynthesefragen (AO/OTA), Luo's classification and Hohl and Moore.[5,6]

A study published by Zhu et al[7] compared the reliability of Luo's Three-Column classification[5] for tibial plateau fractures using the AO/OTA and Schatzker classification as a reference standard. Luo's classification is based on multiplanar computer tomography (CT) images and essentially splits the tibial plateau into three parts:lateral, medial and posterior columns.[5] Zhu et al[7] along with several studies were in an agreement that the utilization of a multiplanar CT scans in addition to a 3D reconstruction enhanced the reliability in classifying tibial plateau fractures when compared with Schatzker and AO/OTA classifications.[8,9] Schatzker's and AO/OTA systems were originally based on plain radiographs, however, CT imaging is now often utilized in addition to plain radiographs to classify tibial plateau fractures.

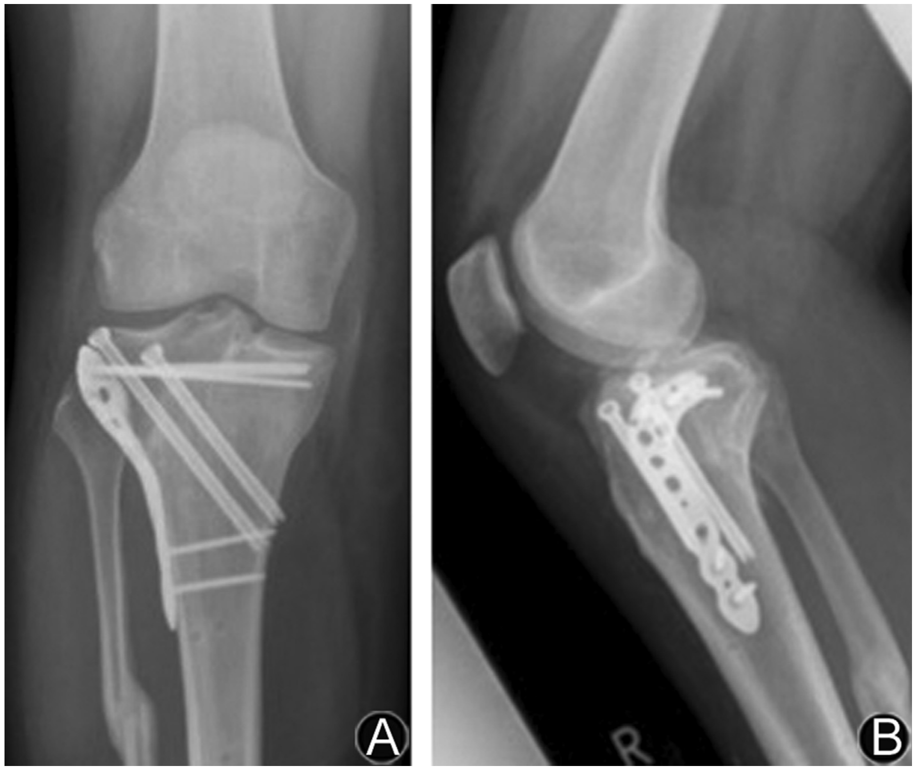

Fig. 4. A: Anteroposterior view of a plain radiograph depicting the right knee at 6 months follow up; B: Lateral view of a plain radiograph depicting the right knee at 6 months follow up.

Charalambous et al[10] also concluded that there was high inter- and intra-observer variations in classifying tibial plateau fractures when using the Schatzker or AO/OTA models with plain radiographs. Interestingly, however, Maripuri et al[11] concluded that the AO/OTA, Schatzker's and Hohl and Moore systems were not ideal fracture classifications systems, but that Schatzker's had fewer inter and intra-observer variability when compared with AO/OTA and Hohl and Moore's classifications. Hohl and Moore classification was identified as the least reliable of the three classifications studied.[11]

Chang et al[2] identified a sub-classification within the Schatzker type IV fracture pattern. Essentially this described different variants of a Schatzker type IV fracture patterns and categorized them into eight subtypes. These subtypes were split into two groups; group 1 contained the classic medial plateau fractures and group 2 included the medial plateau fractures with lateral plateau extension. Each subtype would further be defined by the fracture line location, the fracture line orientation and the fracture type (split, split-depressed etc).[2] As vast as this sub-classification was, it did not, however, contain a description of a lateral tibial plateau fracture-dislocation pattern as described in this case study.

The uniqueness of this case study endeavors to highlight the challenges encountered along with the management options that were used to treat this patient. Challenges from this particular fracture pattern can include an increased risk of peroneal nerve or popliteal vessel injury, the difficulty of reduction of the fracture and the need of addressing the oblique shear fracture plane.[12] The operative procedure of this fracture was not typical of a Schatzker type IV as an anterolateral approach was adopted as opposed to a medial approach which is often used in a Schatzker IV fracture pattern. It is noteworthy, however, that the majority of case studies based on Schatzker type IV tibial plateau fracture patterns are in-fact on young males involved in road traffic accidents.[13]

On first inspection of the coronal CT image, the fracture appearance could be mistaken for a Schatzker type I or II, due to the fracture line passing through the lateral tibial plateau. However, inspection of the plain radiograph in combination with CT images (coronal and 3D reconstruction) clearly depicts a lateral tibial condyle fracture with a subluxation of the knee joint (Fig. 2).

The surgical plan of management for type IV tibial plateau fractures relies heavily on radiographical imagery. Wicky et al[14] found that surgical management plans for a type IV tibial plateau fracture made based on plain radiograph images were changed after seeing a CT image, in 60% of cases, and 21% of surgical plans were modified after seeing a magnetic resonance image (MRI) of the tibial plateau fractures. Our patient had a plain radiograph (Anteroposterior and lateral view) and CT with 3D reconstruction (Fig. 2). Planning in this instance was based heavily around understanding the mechanism of the injury.

Surgical management of the right tibial plateau fracture involved reduction and stabilization with two large inter fragmentary screws plus a supplementary plate in buttress mode (Fig. 2A and B), which would act to counteract the shear force acting on the lateral plateau. An extensile anterolateral approach was utilized to allow visualization of the joint and the primary fracture line.

Internal fixation can be associated with complications, such as deep infection or fracture displacement leading to mal-alignment of the mechanical axis of the leg or articular incongruity.[15,16] However, at three months' follow-up in fracture clinic, our patient demonstrated a range of motion from 0^{o}-120° of his knee without any of the post-operative complications associated with the procedure. At the six months follow up the fracture was healed in good alignment.

One of the most concerning complications with internal fixation is deep infection. Ramos et al[17] proposed an alternative to internal fixation for tibial plateau fractures - the Ilizarov fine wire external fixator. This study described how the Ilizarov technique had a short operating time, and a short hospital stay along with improved knee flexion. Additionally, Keightley et al[18] found that the absence of deep infection when using the Ilizarov technique in compromised soft tissue made this a viable alternative when compared with internal fixation. Barei et al[16] studied 83 tibial plateau fracture patients over a 77-month period and found that 8.4% deep infection rate with internal fixation. The Canadian Orthopaedic Trauma Society[15] also conducted a similar study and described following 83 internally fixed tibial plateau fracture patients over two years with an 18% incidence of deep infection. However, according to a study conducted by Metcalf et al[19] the total number of infections associated with the Ilizarov frame is far greater than with internal fixation. More importantly, one of the most challenging factors in using a fine wire fixator in the management of specifically Schatzker IV plateau fractures is control of the posteromedial fragment and provision of compression across the primary coronal fracture plane. Fine wires are challenging to place proximally on the posteromedial plateau, and often the injury necessitates a degree of open reduction and limited internal fixation for the articular component, obviating many of the benefits of a fine wire fixation construct.

A recent study by Yang et al[13] described the different mechanisms behind the location and directions of tibial plateau fracture lines. The study found that the direction of a tibial plateau fracture line was related to the degree of knee joint flexion during the time of injury. This study found that the medial tibial plateau fractures occurred when the knee joint was in a neutral position, in contrast to the common notion that a medial tibial fracture line was due to a varus force acting on the knee joint. Additionally, Yang et al[13] explained that a posteromedial and anteromedial fracture occurred due to the knee joint being in flexion or extension at the time of injury. However, in this case study the fracture line passed through the lateral tibial plateau with a medial joint dislocation. The rareness of this fracture pattern made it challenging to find any literature pertaining to the mechanism of injury, therefore the mechanism of injury can only be hypothesized in possible combination of axial and valgus stress with the knee in extension. The general consensus, however, is that a fracture-dislocation (Schatzker type IV) requires a high-energy mechanism of injury.[4]

Further studies need to be conducted to expand on the current fracture classifications. The findings in our case report can be used to supplement the Schatzker classification and can therefore lead to the development of new surgical management plans and possibly identify new challenges associated with a reverse Schatzker type IV fracture.

The Schatzker classification is useful in describing the majority of tibial plateau fractures, however, as our case study has shown, not all fracture patterns are accounted for. A re-evaluation of current criteria should be performed in order to accommodate for all possible permutations of the fracture pattern, and as a result novel management plans can be realized.

Appendix A. Supplementary data

Supplementary data related to this article can be found at https://doi.org/10.1016/j.cjtee.2018.03.003.

References

1. Schatzker J, McBroom R, Bruce D. The tibial plateau fracture. The Toronto experience 1968-1975. *Clin Orthop Relat Res*. 1979;138:94–104.
2. Chang SM, Zhang YQ, Yao MW, Du SC, Li Q, Guo Z. Schatzker type IV medial tibial plateau fractures: a computed tomography-based morphological subclassification. *Orthopedics*. 2014;37:e699–e706. https://doi.org/10.3928/01477447-20140728-55.
3. Junior MK, Fogagnolo F, Bitar RC, Freitas RL, Salim R, Jansen Paccola CA. Tibial plateau fractures. *Rev Bras Ortop*. 2009;44:468–474. https://doi.org/10.1016/S2255-4971(15)30142-7.
4. Markhardt BK, Gross JM, Monu JU. Schatzker classification of tibial plateau fractures: use of CT and MRI imaging improves assessment. *Radiographics*. 2009;29:585–597. https://doi.org/10.1148/rg.292085078.
5. Luo CF, Sun H, Zhang B, et al. Three-column fixation for complex tibial plateau fractures. *J Orthop Trauma*. 2010;24:683–692. https://doi.org/10.1097/BOT.0b013e3181d436f3.
6. Hohl M. Tibial condylar fractures. *JBJS*. 1967 Oct 1;49(7):1455–1467.
7. Zhu Y, Hu CF, Yang G, et al. Inter-observer reliability assessment of Schatzker, AO/OTA and three-column classification of tibial plateau fractures. *J Trauma Manag Outcomes*. 2013;7:7. https://doi.org/10.1186/1752-2897-7-7.
8. Hu YL, Ye FG, Ji AY, et al. Three-dimensional computed tomography imaging increases the reliability of classification systems for tibial plateau fractures. *Injury*. 2009;40:1282–1285. https://doi.org/10.1016/j.injury.2009.02.015.
9. Brunner A, Horisberger M, Ulmar B, et al. Classification systems for tibial plateau fractures; does computed tomography scanning improve their reliability? *Injury*. 2010;41:173–178. https://doi.org/10.1016/j.injury.2009.08.016.
10. Charalambous CP, Tryfonidis M, Alvi F, et al. Inter-and Intra-observer variation of the Schatzker and AO/OTA classifications of tibial plateau fractures and a proposal of a new classification system. *Ann R Coll Surg Engl*. 2007;89:400–404.
11. Maripuri SN, Rao P, Manoj-Thomas A, et al. The classification systems for tibial plateau fractures: how reliable are they? *Injury*. 2008;39:1216–1221. https://doi.org/10.1016/j.injury.2008.01.023.
12. Bryant G. Isolated medial plate fixation for a medial tibial plateau fracture with lateral diaphyseal extension: an atypical bicondylar tibial plateau fracture. *J Orthop Trauma Case Rep*. 2015:e1–e4.
13. Yang G, Zhu Y, Luo CF, et al. Morphological characteristics of Schatzker type IV tibial plateau fractures: a computer tomography based study. *Int Orthop*. 2012;36:2355–2360. https://doi.org/10.1007/s00264-012-1646-y.
14. Wicky S, Blaser PF, Blanc CH, Leyvraz PF, Schnyder P, Meuli RA. Comparison between standard radiography and spiral CT with 3D reconstruction in the evaluation, classification and management of tibial plateau fractures. *Eur Radiol*. 2000 Jul 1;10(8):1227–1232.
15. Canadian Orthopaedic Trauma Society. Open reduction and internal fixation compared with circular fixator application for bicondylar tibial plateau fractures. Results of a multicenter, prospective, randomized clinical trial. *J Bone Jt Surg Am*. 2006;88:2613–2623.
16. Barei DP, Nork SE, Mills WJ, et al. Complications associated with internal fixation of high-energy bicondylar tibial plateau fractures utilizing a two-incision technique. *J Orthop Trauma*. 2004;18:649–657.
17. Ramos T, Ekholm C, Eriksson BI, et al. The Ilizarov external fixator – a useful alternative for the treatment of proximal tibial fractures. A prospective observational study of 30 consecutive patients. *BMC Musculoskeletl Disord*. 2013;14:11. https://doi.org/10.1186/1471-2474-14-11.
18. Keightley AJ, Nawaz SZ, Jacob JT, et al. Ilizarov management of Schatzker IV to VI fractures of the tibial plateau: 105 fractures at a mean follow-up of 7.8 years. *Bone Joint J*. 2015;97-B:1693–1697. https://doi.org/10.1302/0301-620X.97B12.34635.
19. Metcalfe D, Hickson CJ, McKee L, et al. External versus internal fixation for bicondylar tibial plateau fractures: systematic review and meta-analysis. *J Orthop Traumatol*. 2015;16:275–285. https://doi.org/10.1007/s10195-015-0372-9.