

Large fracture of the anteromedial tibial plateau with isolated posterolateral knee corner injury: case series of an often missed unusual injury pattern

Jordi Tomás-Hernández^{a,*}, Joan Minguell Monyart^b, Jordi Teixidor Serra^a, Merce Reverté Vinaixa^b, Ernesto Guerra Farfan^a, Vicente Molero García^a, Enric Castellet Feliu^b

^aDepartment of Orthopaedic and Trauma Surgery, Trauma Unit, Hospital Vall d'Hebron – Universitat Autònoma de Barcelona (UAB), Passeig Vall d'Hebron, Barcelona, Spain

^bDepartment of Orthopaedic and Trauma Surgery, Knee Unit, Hospital Vall d'Hebron – Universitat Autònoma de Barcelona (UAB), Passeig Vall d'Hebron, Barcelona, Spain

KEY WORDS

Posterolateral complex injury
Anteromedial tibial plateau fracture
Anteromedial compression
Posterolateral knee corner

ABSTRACT

Tibial plateau fractures are a heterogeneous group of lesions with multiple fracture patterns. They are often associated with soft tissue injuries, the lateral meniscus and the anterior cruciate ligament (ACL) being the most common structures affected. The purpose of this article is to present a case series of an often missed unusual injury pattern that consists on the association of a large anteromedial tibial plateau fracture with a posterolateral (PL) knee corner injury without involvement of the cruciate ligaments. The diagnosis of PL complex injury may go unrecognized in a considerable number of cases and delay on the treatment decreases the success rate of soft tissue repairing. The importance of a high index of suspicion and a proper early diagnosis with an MRI is of paramount importance. We also describe the current surgical management used by the authors and review of the current literature.

© 2016 Elsevier Ltd. All rights reserved.

Introduction

Tibial plateau fractures represent approximately 1% of all fractures. [1] In a number of cases in addition to the underlying fracture, the injury sustained is associated with ligamentous damage. The compressive forces applied during the traumatic event produce a complex injury where meniscus, ligaments, tendons and other soft tissues may be involved. The structures more frequently affected are the lateral meniscus and the anterior cruciate ligament (ACL) [2,3]. Injuries to the ACL and posterior cruciate ligament (PCL) are connected sometimes with marginal fractures of the tibial plateau the so called “Segond fracture” [4] or the “reversed Segond” fracture [5]. Noteworthy, posterior lateral (PL) knee corner injuries are uncommon; their incidence ranges from 5% to 9% of all injuries around the knee [6,7]. However, they can result in severe disability due to instability and articular cartilage degeneration [8]. Major stabilizers of the PL corner of the knee include the lateral collateral ligament (LCL), the biceps femoris tendon, the arcuate ligament, the popliteus muscle and tendon and the fabellofibular ligament. Their injury in association with tibial plateau fractures is scarcely documented in the literature,

and most cases are related with small marginal fracture compressions of the anteromedial tibial rim in association with injuries to the PCL [9–11].

We report on a case series of an unusual injury pattern of large anteromedial fracture compression of the tibial plateau associated with PL corner injury without involvement of the cruciate ligaments. In addition, we describe the current surgical management in one procedure being used by the authors. A review of the existing literature in regards to this injury pattern is also included.

Case presentation and surgical management

Three cases of a large anteromedial fracture compression of the tibial plateau associated with PL corner injury without involvement of the cruciate ligaments were treated in our center between 2010 and 2013. The cause of injury was a traffic accident in all cases and the mechanism of injury was thought to be hyperextension and varus displacement.

Case 1

A 40-year-old man sustained a motorcycle accident during January 2010. He was admitted in our center with pain and functional restriction in the left knee. Plain radiographs (Figure 1a) and CT-scan (Figure 2a) showed a large compression fracture of the anteromedial

* Corresponding author: Trauma Unit Staff Hospital Vall d'Hebrón, Department of Orthopaedic and Trauma Surgery, University Hospital Vall d'Hebron – UAB, Passeig de la Vall d'Hebron 119-129 08035 Barcelona, Spain. Tel.: +34 93 489 40 00
E-mail address: jotomas@vhebron.net (J. Tomás-Hernández).



Fig. 1. Plain radiographs of the three cases.

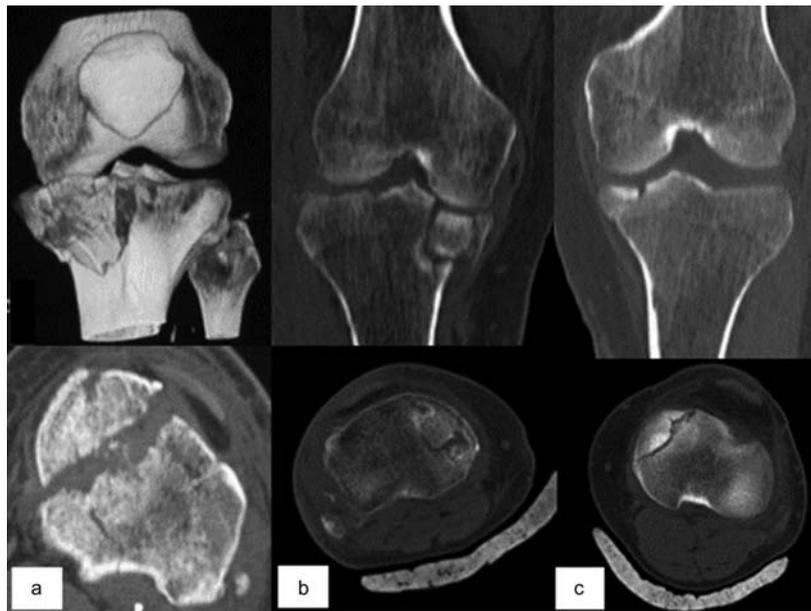


Fig. 2. CT-scan images.

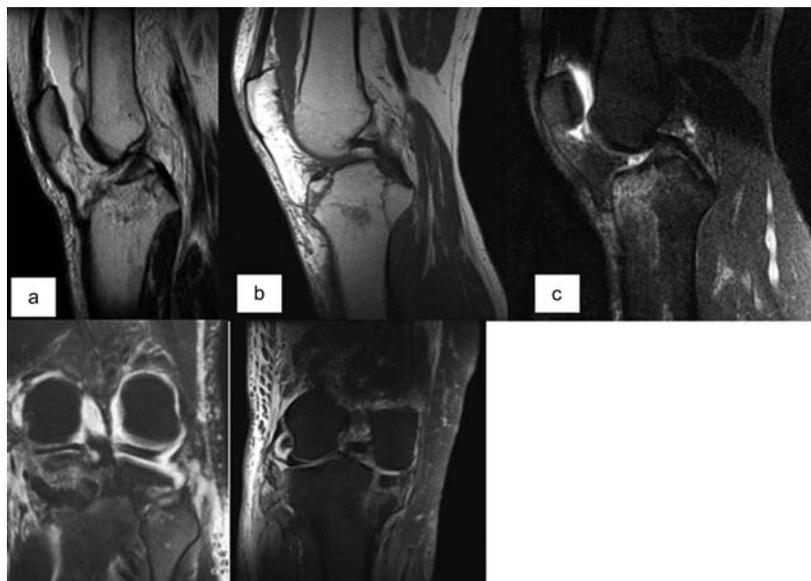


Fig. 3. MRI findings, with intact PCL in all cases.



Fig. 4. A characteristic posterolateral hematoma was present after the injury.

tibial plateau in association with an avulsion in the fibula head. Magnetic resonance imaging (MRI) was ordered to complete the investigations because of the suspicion of associated ligament injury. The MRI scan demonstrated a complete rupture of the LCL and biceps tendon in association with severe bone edema in the medial femoral condyle (Figure 3a).

Case 2

A 67-year-old woman was hit by a car and admitted in our center during January 2013 with pain and reduced functional capacity of the right knee. Plain radiographs (Figure 1b) and CT-scan (Figure 2b) showed a large compression fracture of the anteromedial tibial plateau in association with a complete avulsion in the fibula head and a marginal avulsion of the lateral tibial plateau. The MRI scan acquired revealed a complex fracture-avulsion of the fibula head with complete rupture of the biceps tendon and LCL. Fracture-avulsion of the iliotibial band and a partial rupture of the popliteal muscle was also noted (Figure 3b).

Case 3

A 30-year-old man sustained a motorbike accident during September 2013. He was transferred to our center with pain, swelling and reduced movement of the left knee. Plain radiographs (Figure 1c) and CT-scan (Figure 2c) showed a large anteromedial tibial plateau compression fracture. Fibula head was intact. The MRI showed a subtotal avulsion of the peroneal insertion of the biceps tendon and the LCL (Figure 3c).

The cruciate ligaments were not affected in any of the 3 cases. However, a characteristic posterolateral hematoma was present after the injury (Figure 4). Patients were immobilized in a cast until surgery

was performed. In all cases surgery was performed in the first two weeks after the injury. The surgical steps in all cases were as follows:

Patients underwent surgery in a supine position without the use of a tourniquet. All patients received antibiotic prophylaxis, Cefazolin. Knees were flexed around 50° using a bump. Injury was managed in one stage through a double (anteromedial and lateral) approach without parapatellar knee arthrotomy (Figure 5). The first step was fracture reduction through an anteromedial tibial approach and internal fixation with a T-shaped *Periloc VLP*® pre-contoured plate (Smith & Nephew, Memphis, Tennessee) acting as a buttress plate. In one case, additionally cannulated screws were used to support the fixation (Figure 6). After fracture fixation, intraoperative fluoroscopic knee varus stress views were done in order to assess varus instability. Next step was the repair of the PL complex. A lateral curve approach from Gerdy's tubercle to supracondylar lateral femoral aspect and dissection to iliotibial band layer was performed. Three windows were open in the fascia to identify the injured structures: An inferior window to identify and protect the external popliteal sciatic nerve, a middle window two centimeters proximal to the fibula head to identify the LCL and a proximal window, centered on the lateral femoral epicondyle, to identify the femoral attachment of the popliteal tendon and the LCL (Figure 7). Ruptures of the LCL, biceps tendon and iliotibial band without bone avulsions were repaired with primary sutures (Figure 8) but injuries with bone avulsions were reattached by using suture-anchors (Figure 9). In Cases 1 and 2, where soft tissue injury was severe and complete, the primary suture was supplemented with a peroneal tendon allograft plasty following the Larson's method [12]. A 6-mm tunnel was created in the fibula head to locate the graft and femoral graft fixation was carried out with a 9-mm reabsorbable interference screw (Figure 10).

All patients had a good post-operative course without any perioperative complications. They all receive thromboprophylaxis for 12 weeks. In the postoperative period no weight-bearing for 12 weeks was instructed of the affected extremity. Moreover, flexion movement was restricted by the application of a brace for 6 weeks. At 1 year of follow-up, all patients were walking without signs of instability and the knee joint range of motion was 0 to 130 degrees (Figure 11). X-rays showed complete bone healing without signs of subluxation (Figure 12).

Discussion

The fixation and functional results of tibial plateau fractures continue to attract great interest by both clinicians and scientists [13–17]. PL corner injury in association with tibial plateau fracture is, to our knowledge, a rare combination with very few cases documented in the literature. Most cases are related to small marginal fracture compressions of the anteromedial tibial rim in association with cruciate ligament injuries, generally the PCL [9–11]. The largest series documented to date by Chiba et al. include 12 cases of this injury pattern [18]. Only 1 case of that series show the same injury pattern



Fig. 5. Injury was managed in one stage through a double (anteromedial and lateral) approach.

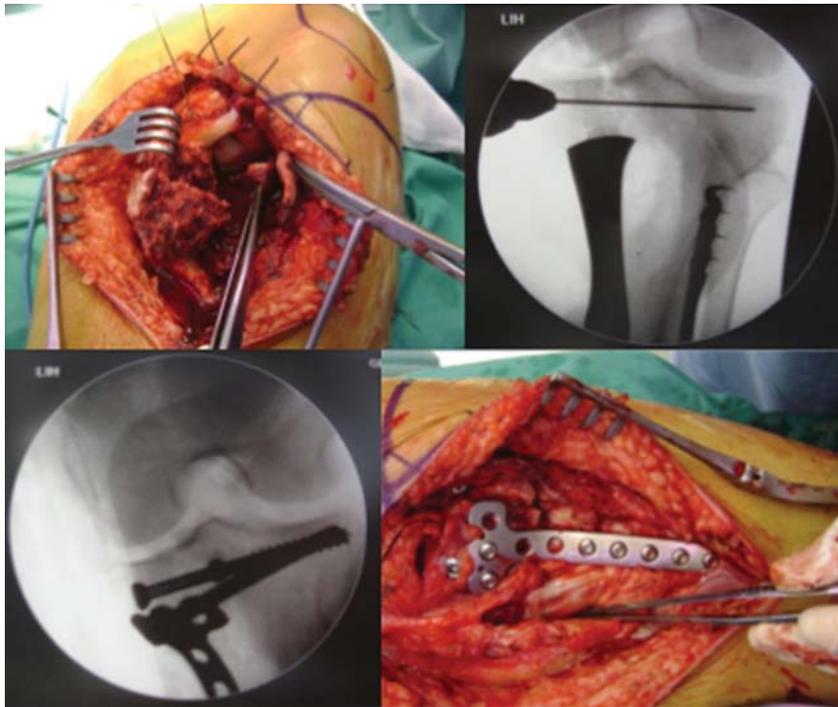


Fig. 6. Anteromedial tibial approach and internal fixation with a buttress plate.

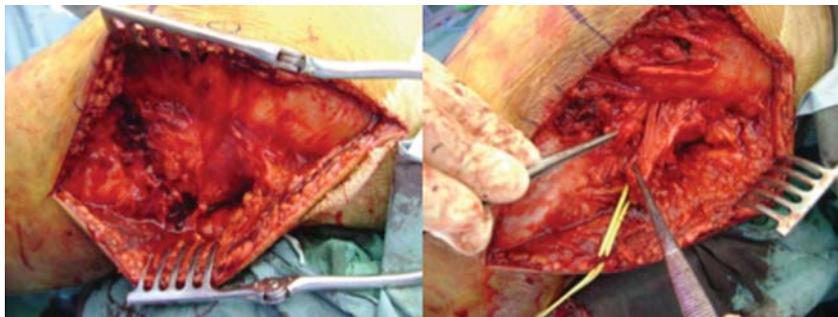


Fig. 7. Lateral approach to identify disruption of the iliotibial band, biceps femoris tendon and LCL.



Fig. 8. Ruptures of the LCL, biceps tendon and iliotibial band without bone avulsions were repaired with primary sutures but injuries with bone avulsions were reattached by using suture-anchors.

described by us: isolated PL corner injury with a large anteromedial fracture of the tibial plateau without cruciate ligament injury. The authors concluded that a compression fracture of the anterior part of the medial tibial plateau indicates a coexistent PL injury, and that especially a small compression fracture strongly suggests an accompanying PCL injury, as well. We can add, based on our findings and according to the findings of other authors [18], that when the anteromedial fragment is large (more than a quarter of the

anteroposterior length of the medial tibial plateau in the CT-scan axial view) the PCL can be intact. This is possible because when the mechanism of hyperextension and forced varus occurs with a preserved PCL, the impact is produced at the weight-bearing area and this leads to fracture of the anteromedial tibial plateau with a large anterior bone fragment. In contrast, if the PCL is disrupted the tibia suffers a posterior translation reducing the impact on the anteromedial weight-bearing area and producing only a small marginal avulsion.

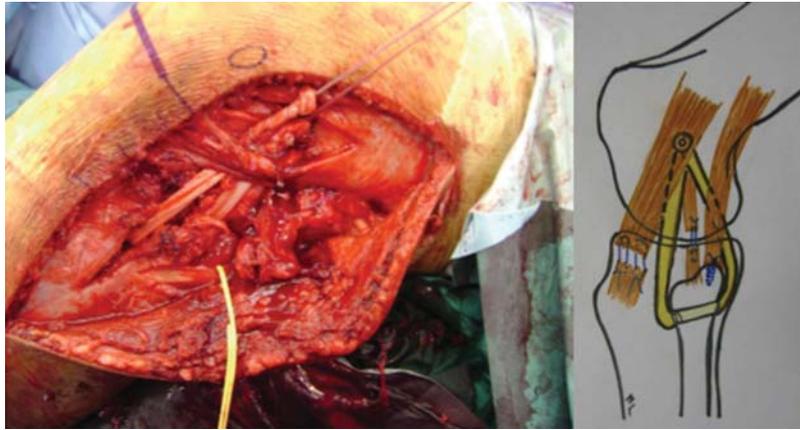


Fig. 9. Primary suture was supplemented with a peroneal tendon allograft plasty following the Larson's method.

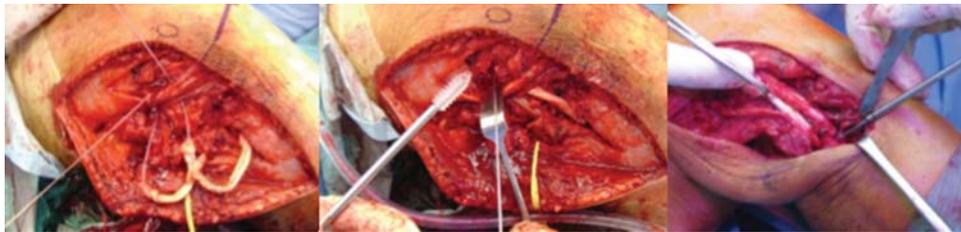


Fig. 10. A 6-mm tunnel was created in the fibula head to locate the graft and femoral graft fixation was carried out with a 9-mm reabsorbable interference screw.



Fig. 11. Radiological outcome with varus stress x-rays and clinical outcome.



Fig. 12. X-rays showed complete bone healing without signs of subluxation at 2 years.

Regarding the diagnosis, we found that there was an excellent correlation between the MRI and the operative findings as it has been previously documented in other articles [10,19,20]. For this reason, if an anteromedial tibial fracture compression is seen in the plain radiographs, sometimes in association with avulsions in the fibula head ("arcuate sign" [21,22]), the patient must be studied with an MRI scan in order to clarify which structures of the PL corner are injured and which ones must be repaired.

There is some discrepancy regarding the most appropriate therapeutic approach for this type of injuries [23,24] (acute primary repair versus delayed reconstruction) but we obtained good functional results by the application of one stage reconstruction of the fracture and the PL corner injury in the acute phase (less than 3 weeks from the injury). In the acute phase, the identification and the primary repairing of the soft tissue injuries are easier because there is no adhesions between layers or scar tissue and there is no soft tissue retraction. In conclusion we believe that fractures of the anterior part of the medial plateau are usually associated with ligament lesions being the PL corner and the cruciate ligaments the structures most commonly affected [9,10,11,18]. If bone fragments are small avulsions the cruciate ligaments are usually involved but if bone fragments are large the cruciate ligaments may be intact especially ally the PCL. The MRI findings have a good correlation with the operative findings and it is a mandatory investigation to perform when a PL complex injury associated with an anteromedial tibial fracture is suspected in order to plan the sequence of operative reconstruction. Finally, acute repairing of the fracture and soft tissue injury in one stage rather than delayed treatment provides good functional outcomes in our hands. A supplementation with an allograft in addition to primary suture of the PL complex can be useful to reinforce primary repairing in cases with complete disruption of the PL structures [25].

Conflict of interest

Dr Tomás, Dr Teixidor and Dr Guerra are faculty members in Smith & Nephew courses and our unit receives grants from Smith & Nephew for current studies.

Dr Tomás and Dr Teixidor are faculty members in Zimmer-Biomet courses and Dr Tomás is member of the EMEA Advisory Board.

All other authors have no conflicts of interest to disclose.

References

- [1] van Dreumel RL, van Wunnik BP, Janssen L, Simons PC, Janzing HM. Mid- to long-term functional outcome after open reduction and internal fixation of tibial plateau fractures. *Injury* 2015;46:1608–12.
- [2] Gardner MJ, Yacoubian S, Geller D, Suk M, Mintz D, Potter H, et al. The incidence of soft tissue injury in operative tibial plateau fractures: a magnetic resonance imaging analysis of 103 patients. *J Orthop Trauma* 2005;19:79–84.

- [3] Abdel-Hamid MZ, Chang CH, Chan YS. Arthroscopic evaluation of soft tissue injuries in tibial plateau fractures: retrospective analysis of 98 cases. *Arthroscopy* 2006;22:669–75.
- [4] Goldman AB, Pavlov H, Rubenstein D. The Segond fracture of the proximal tibia: a small avulsion that reflects major ligamentous damage. *AJR Am J Roentgenol* 1988;151:1163–7.
- [5] Escobedo EM, Mills WJ, Hunter JC. The "reverse Segond" fracture: association with a tear of the posterior cruciate ligament and medial meniscus. *AJR Am J Roentgenol* 2002;178:979–83.
- [6] Pacheco RJ, Ayre CA, Bollen SR. Posterolateral corner injuries of the knee: a serious injury commonly missed. *J Bone Joint Surg Br* 2011;93:194–7.
- [7] LaPrade RF, Terry GC. Injuries to the posterolateral aspect of the Knee. *Am J Sports Med* 1997;25:433–8.
- [8] Kannus P. Nonoperative treatment of grade II and III sprains of the lateral ligament compartment of the knee. *Am J Sports Med* 1989;17:83–8.
- [9] Cohen AR, King D, Gibbon AJ. Impingement fracture of the anteromedial tibial margin: a radiographic sign of combined posterolateral complex and posterior cruciate ligament disruption. *Skeletal Radiol* 2001;30:114–6.
- [10] Bennett DL, George MJ, El-Khoury GY, Stanley MD, Sundaram M. Anterior rim tibial plateau fractures and posterolateral corner knee injury. *Emerg Radiol* 2003;10:76–83.
- [11] Yoo JH, Kim EH, Yim SJ, Lee BI. A case of compression fracture of medial tibial plateau and medial femoral condyle combined with posterior cruciate ligament and posterolateral corner injury. *Knee* 2009;16:83–6.
- [12] Sidles JA, Larson RV, Garbini JL. Ligament length relationships in the moving knee. *J Orthop Res* 1988;6:593–610.
- [13] Hoekstra H, Rosseels W, Luo CF, Nijs S. A combined posterior reversed L-shaped and anterolateral approach for two column tibial plateau fractures in Caucasians: a technical note. *Injury* 2015;46:2516–9.
- [14] Conserva V, Vicenti G, Allegretti G, Filipponi M, Monno A, Picca G, Moretti B. Retrospective review of tibial plateau fractures treated by two methods without staging. *Injury* 2015;46:1951–6.
- [15] Haller JM, O'Toole R, Graves M, Barei D, Gardner M, Kubiak E, Nascone J, Nork S, Presson AP, Higgins TF. How much articular displacement can be detected using fluoroscopy for tibial plateau fractures? *Injury* 2015;46:2243–7.
- [16] Qiu WJ, Zhan Y, Sun H, Xu YF, Wang YK, Luo C. A posterior reversed L-shaped approach for the tibial plateau fractures-A prospective study of complications (95 cases). *Injury* 2015;46:1613–8.
- [17] Yoon YC, Sim JA, Kim DH, Lee BK. Combined lateral femoral epicondylar osteotomy and a submeniscal approach for the treatment of a tibial plateau fracture involving the posterolateral quadrant. *Injury* 2015;46:422–6.
- [18] Chiba T, Sugita T, Onuma M, Kawamata T, Umehara J. Injuries to the posterolateral aspect of the knee accompanied by compression fracture of the anterior part of the medial plateau. *Arthroscopy* 2001;17:642–7.
- [19] Ross G, Chapman AW, Newberg AR, Scheller AD. Magnetic resonance imaging for the evaluation of acute posterolateral complex injuries of the knee. *Am J Sports Med* 1997;25:444–8.
- [20] Recondo JA, Salvador E, Villanua JA, Barrera MC, Gervas C, Alustiza JM. Lateral stabilizing structures of the knee: functional anatomy and injuries assessed with MR imaging. *Radiographics* 2000;20:S91–102.
- [21] Shindell R, Walsh WM, Connolly JF. Avulsion fracture of the fibula: the "arcuate sign" of posterolateral knee instability. *Nebr Med J* 1984;69:369–71.
- [22] Huang GS, Yu JS, Munshi M, Chan WP, Lee CH, Chen CY. Avulsion fracture of the head of the fibula (the "arcuate sign"): MR imaging findings predictive of injuries to the posterolateral ligaments and posterior cruciate ligament. *AJR Am J Roentgenol* 2003;180:381–7.
- [23] Ranawat A, Baker CL, III, Henry S, Harner CD. Posterolateral corner injury of the knee: evaluation and management. *J Am Acad Orthop Surg* 2008;16:506–18.
- [24] Stannard JP, Brown SL, Farris RC, McGwin G, Jr, Volgas DA. The posterolateral corner of the knee: repair versus reconstruction. *Am J Sports Med* 2005;33:881–8.
- [25] Conesa X, Minguell J, Cortina J, Castellet E. Fracture of the anteromedial tibial plateau associated with posterolateral complex injury: case study and literature review. *J Knee Surg* 2013;26(Suppl 1):S34–9.