Management of Medial Tibial Plateau Fracture using Antero- and Posteromedial Rim Plates

Manejo de fractura de platillo tibial medial utilizando placas rim anteromedial y posteromedial

Nicolás Franulic[1,2] Tomás Pineda[3] Diego Valiente[1] José Laso[1,4] Nicolás Gaggero[1,5]

[1] Knee Team, Hospital del Trabajador ACHS, Santiago, Chile
[2] Knee Team, Hospital Militar de Santiago, Santiago, Chile
[3] Knee Team, Hospital el Carmen, Santiago, Chile
[4] Knee Team, Hospital Barros Luco Trudeau, Santiago, Chile
[5] Knee Team, Clínica Las Condes, Santiago, Chile

Address for correspondence Nicolás Franulic Mandujano, MD, Knee Team, Hospital del Trabajador ACHS and Hospital Militar de Santiago, Ramón Carnicer 185, Providencia, Metropolitan region, Santiago, Chile (e-mail: nicofranulic02@gmail.com).

Rev Chil Ortop Traumatol 2024;65(1):e9–e15.

Abstract

Introduction In recent years, the use of horizontal plates has been described to achieve fixation of fractures that compromise the articular ridge of the tibial plateau; these plates are known as "rim plates." Most publications report their use in the posterior and posterolateral columns of the tibial plateau, and to date there are few reports of its use for the fixation of the anteromedial column and none for the posteromedial column. The objective of the present article is to report two clinical cases of comminuted fractures of the medial tibial plateau, showing their treatment with the use of medial rim plates.

Clinical Cases The first case presented with an anteromedial and posteromedial tibial plateau fracture, and the second, a posteromedial fracture. In both cases, reduction was achieved through a posteromedial approach, and the fixation was performed with a 2.7-mm locked rim plate. The reduction strategy and postoperative management were detailed in each case.

Results Both patients achieved bone consolidation during the 14th and 18th weeks after the definitive osteosynthesis, without presenting loss of reduction. Both patients achieved full range of joint motion (0°–125°) and returned to work after four and six months respectively.

Conclusions These plates offer a good treatment option for comminuted fractures of the rim of the tibial plateau, for both the anteromedial and posteromedial columns. Despite the absence of large series of patients with the use of medial rim plates, the results of the two cases herein presented enables us to propose it as a useful tool when dealing with fractures of the medial rim of the tibial plateau.

Level of evidence V.

Keywords
- tibial plateau fracture
- internal fracture fixation
- posteromedial approach
- horizontal rafting plate
- rim plate

received
October 18, 2021
accepted
June 6, 2022

DOI https://doi.org/10.1055/s-0042-1753548.
ISSN 0716-4548.

Thieme Revinter Publicações Ltda., Rua do Matoso 170, Rio de Janeiro, RJ, CEP 20270-135, Brazil

Resumen

Introducción En los últimos años, se ha descrito el uso de placas horizontales para la fijación de fracturas que comprometen el reborde articular de los platillos tibiales, lo que se conoce como placa *rim*. La mayoría de las publicaciones al respecto describen su uso en columnas posteriores y posterolaterales de los platillos tibiales, y a la fecha hay escasos reportes del uso de este tipo de placa en la columna anteromedial y ninguno para la posteromedial. El objetivo de este artículo es presentar dos casos clínicos de fracturas conminutas del platillo tibial medial mostrando su tratamiento con el uso de placas *rim*.

Casos Clínicos El primer caso presentaba compromiso anteromedial y posteromedial, y el segundo, compromiso posteromedial. En ambos casos, se logró la reducción mediante un abordaje posteromedial y su fijación con placa bloqueada de 2,7 mm como placa *rim*. En cada caso, se detalló la estrategia de reducción y el manejo postoperatorio.

Resultados Ambos pacientes consiguieron la consolidación ósea entre las semanas 14 y 18 tras la osteosíntesis definitiva, sin presentar pérdidas de reducción. Ambos lograron rango de movilidad articular completo (0°–125°), y retornaron a sus trabajos a los 4 y 6 meses respectivamente.

Conclusiones Estas placas ofrecen una buena opción de tratamiento para fracturas articulares conminutas del borde del platillo tibial, tanto en la columna anteromedial como en la posteromedial. A pesar de la ausencia de grandes series de pacientes con uso de placas *rim* mediales, el resultado de los casos presentados aquí nos permite plantear su utilidad al momento de enfrentarnos a fracturas del reborde articular.

Nivel de evidencia V.

Palabras clave

- fractura de platillos tibiales
- fijación interna de fractura
- abordaje posteromedial
- placa horizontal
- placa *rim*

Introduction

Tibial plateau fractures are complex injuries that require rigorous planning to obtain optimal surgical results.[1]

Compromise of the medial column is a relatively common diagnosis, with the anterior region being classically affected by a mechanism of varus and hyperextension, while the posteromedial column is affected by a mechanism of varus and flexion.[2–5] The involvement of the latter has been classically described as a single fragment with a shearing metaphyseal trait that reaches between 25% and 58% of the total articular surface of the medial plateau,[4,5] for which fixation with plates is necessary in a position that enables the counteraction of said displacement.[1] However, the aforementioned deforming forces are also capable of generating impaction and comminution of the articular surface and its rim.[6] The latter turns out to be a problem, since the direction and distribution of the proximal screws of the commonly used implants have a limited capacity to contain the comminution of the joint rim. The use of horizontal plates, also known as rim plates, has been described in recent years as an extremely useful alternative to deal with these fractures.[6–13] To date, several reports have been published on fixation of the lateral and posterior columns with rim plates.[6–13] However, their use in the anteromedial region continues to be of limited knowledge,[12] and, as far as we know, there are no reports in the literature of its use in the posteromedial region.

The objective of the present paper is to report two clinical cases of comminuted medial tibial plateau fractures and their treatment using anteromedial and posteromedial rim plates, respectively, for fixation and containment of the joint edges; we also show the preoperative planning and approaches used, and perform a review of the literature on the matter.

Case report #1

A 45-year-old male patient, healthy, foreman, who suffered a fall from a horse, presented with a varus crushing of his left knee. The patient was admitted to the Emergency Department, in which X-rays and computed tomography (CT) scans of the left knee were requested, which showed a Schatzker-IV comminuted fracture of the medial tibial plateau, with the identification of three main fragments (►**Figure 1A-C**) associated with a joint step of 3 mm. In sagittal sections, posteromedial and anteromedial fragments were distinguished. Vascular involvement was ruled out by CT angiography of the lower extremities. Magnetic resonance imaging (MRI) scans showed no associated ligamentous or meniscal injuries. The definitive surgery was performed after seven days. The patient was placed in supine position. A classic posteromedial approach was performed in the plane between the semimembranosus tendon and the medial gastrocnemius. The posteromedial fragment was located, reduced, and fixed with a 3.5-mm posteromedial anatomical plate. Using the same approach, an anterior dissection was performed, and

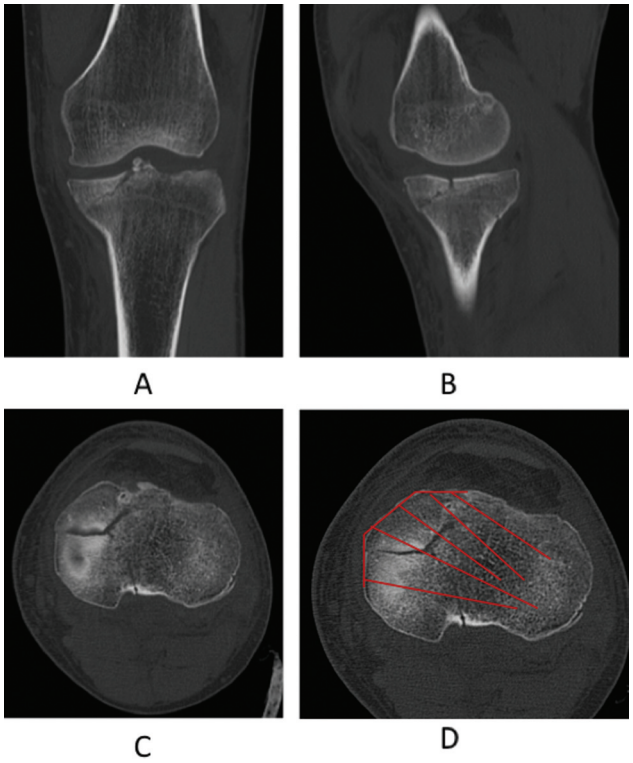

Fig. 1 (**A-C**) Preoperative CT scan of the left knee showing a posteromedial fragment and a small anteromedial articular fragment. (**D**) Preoperative planning based on CT axial slices, which enables knowledge of the curvatures to make and the length of the screws to use.

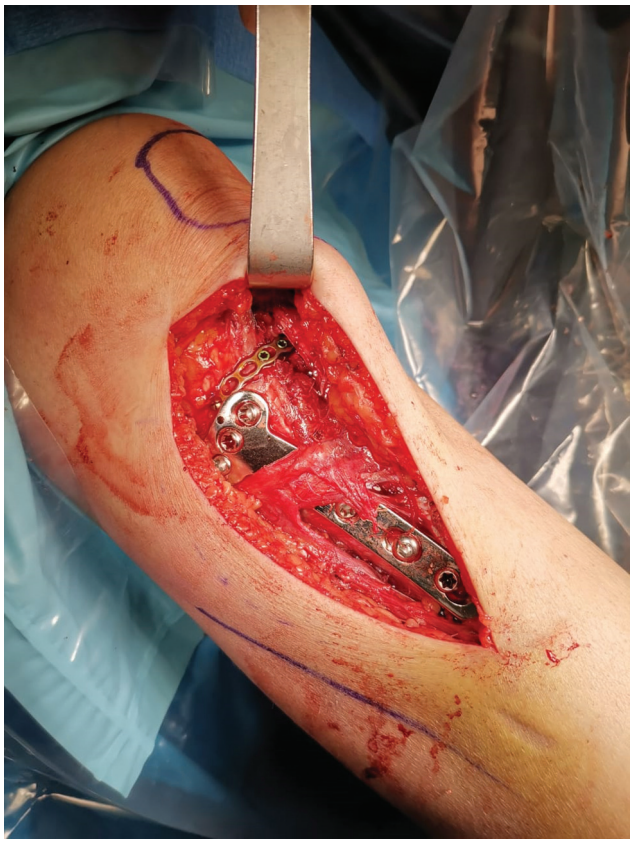

Fig. 2 Definitive fixation with posteromedial proximal tibia plate and anteromedial rim plate, using the same approach and preserving goose foot.

the anteromedial fragment was located and reduced with a reduction forceps, and a 2.7-mm locking rim plate (Compact Foot, DePuy Synthes, Raynham, MA, United States) with 8 holes previously molded on the adjoining table was positioned according to the preoperative planning based on the preoperative CT scan (►**Figure 1D**). Finally, the anterior screws were placed percutaneously, and definitive fixation was achieved (►**Figure 2**).

Case report #2

A 46-year-old patient, with no medical history, who received a direct blow from a gallon of water on his left knee presented to the Emergency Department, where a Schatzker-VI fracture of the tibial plateaus was diagnosed (►**Figure 3**). Due to the soft-tissue compromise, reduction and transitory fixation with a transarticular external fixator were performed. Subsequently, a study with CT and three-dimensional (3D) reconstruction of the knee was completed, highlighting the presence of posteromedial comminution of the medial tibial plateau (►**Figure 3**). Ten days after the accident, and with the soft tissue in good condition, the external fixator was removed for reduction and definitive osteosynthesis.

Initially, a posteromedial approach was performed with the patient in the prone position. An inverted L-shaped skin incision was made over the medial gastrocnemius. The same deep plane was made between the semimembranosus tendon and the medial gastrocnemius. The popliteus muscle was exposed and incised in the shape of an inverted L, partially disinserting, thus exposing the posterior metaphyseal surface of the proximal tibia. The fracture focus was identified, and the posterior cortical fragment was reduced and fixed with a locking one-third tubular plate. A posteromedial submeniscal arthrotomy was performed, and rein-type meniscocapsular sutures are passed, enabling proximal traction of the capsule, thus achieving direct visualization of the fracture focus and joint surface. The main posteromedial joint fragment and joint comminution were lifted with a spatula for the subsequent performance of temporary fixation with Kirschner wires. After this, a 2.7-mm locking rim plate (Compact Foot, DePuy Synthes) was positioned (►**Figure 4**).

In a second time, the patient was placed in the supine position, and anteromedial and anterolateral approaches were performed, through which reduction and osteosynthesis of the anterior columns with 4.5-mm plates was carried out in a traditional manner (►**Figure 5**).

Postoperative management

After surgery, a Robert Jones bandage was applied for 48 hours. In none of the cases was the use of drainage necessary. The affected extremity was kept elevated, and early isometric strengthening exercises of the muscles of

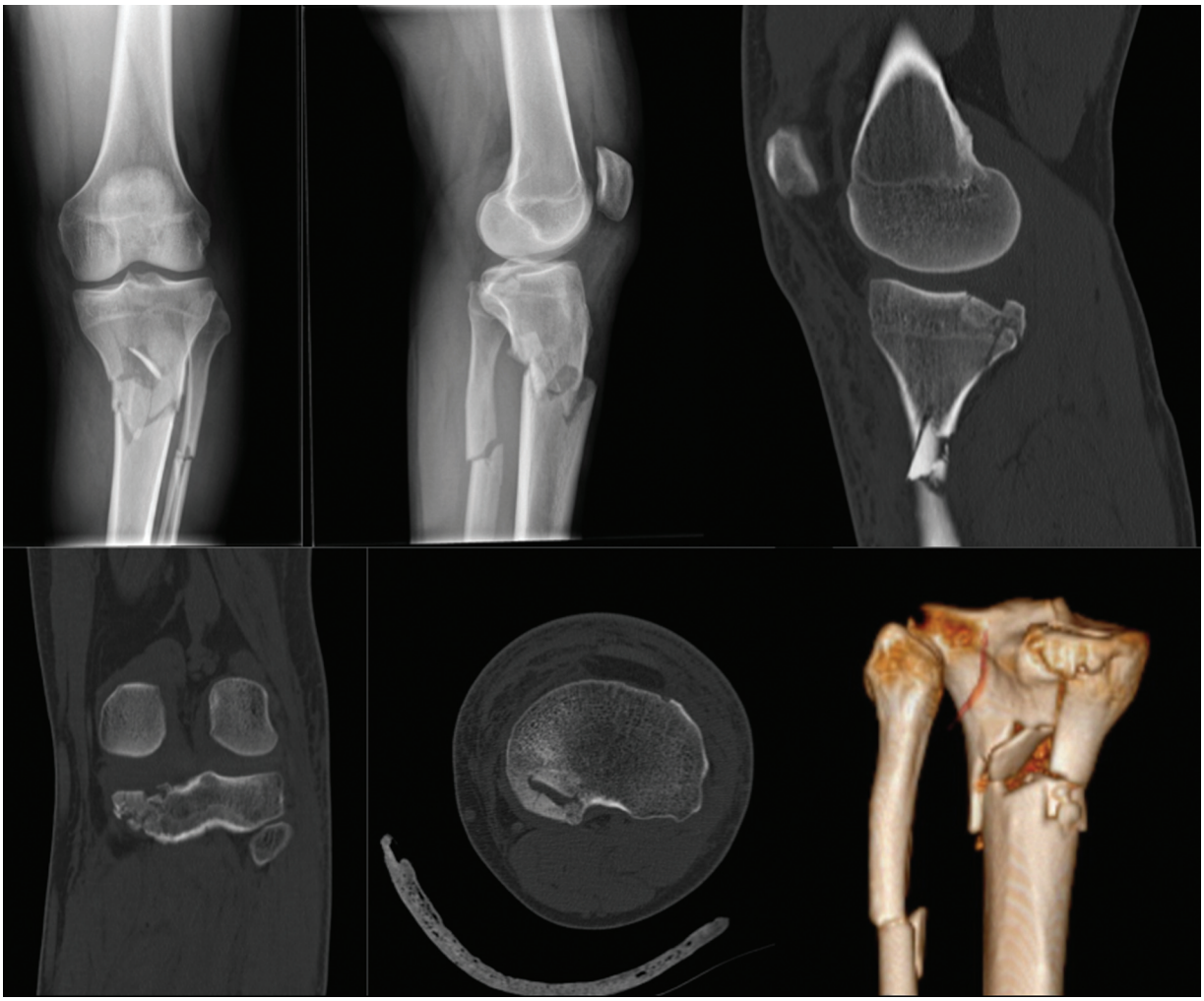

Fig. 3 Preoperative study with X-ray, CT scan, and 3D reconstruction of the left knee showing a Schatzker-VI tibial plateau fracture with posteromedial and metaphysodiaphyseal comminution.

both lower extremities with the leg in extension and elevated were initiated to improve quadriceps strength. Limb range of motion exercises were started the day after surgery, aiming to achieve 90° of flexion in the second postoperative week. Walking with two canes and total weight loss of the extremity was maintained for eight weeks, when progressive partial load bearing was started while waiting for bone consolidation. Radiographic controls were performed at 6, 10 and 18 weeks postoperatively. Control with CT scans was performed four months postoperatively to objectify advanced consolidation.

Results

The postoperative course was uneventful. Both patients achieved advanced radiological bone consolidation evidenced on CT scans during postoperative weeks 14 and 18 (►**Figures 6** and **7**) respectively, without presenting loss of reduction in that period. The range of motion obtained at the end of the follow-up was complete, and adequate muscle trophism was achieved in both cases. The first patient returned to work 4 months after the accident, while the second patient, after 6 months.

Discussion

The surgical management of tibial plateau fractures is a great challenge, since multiple variables must be taken into account in the treatment, such as subsidence, displacement, alignment, stability, and preservation of soft tissues.[1,14,15] On the other hand, the growing number of elderly adults with comorbidities and poor bone quality further complicates the treatment of these fractures.[16] Due to the above, adequate preoperative planning is essential. Currently, the most widely-used classifications are mainly based on the location of the fragments, and they enable us to infer the mechanism by which these lesions are generated.[1,17–21] Kfuri and Schatzker[21] prepared an update of the Schatzker et al.[17] classification. This article[21] mentions the importance of the rim to define a subsidence as contained or not contained, and the incorporation of the columns already described by other authors.[1] However, it does not include rim compromise

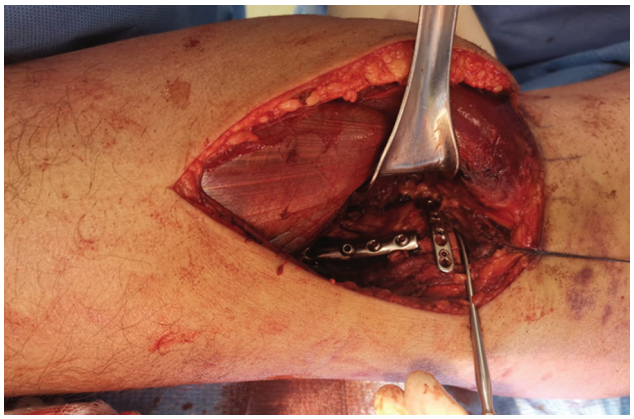

Fig. 4 Reduction and fixation of posteromedial comminution with rim plate. Meniscocapsular rein traction, direct vision of the articular surface, and palpation of it with a spatula are observed.

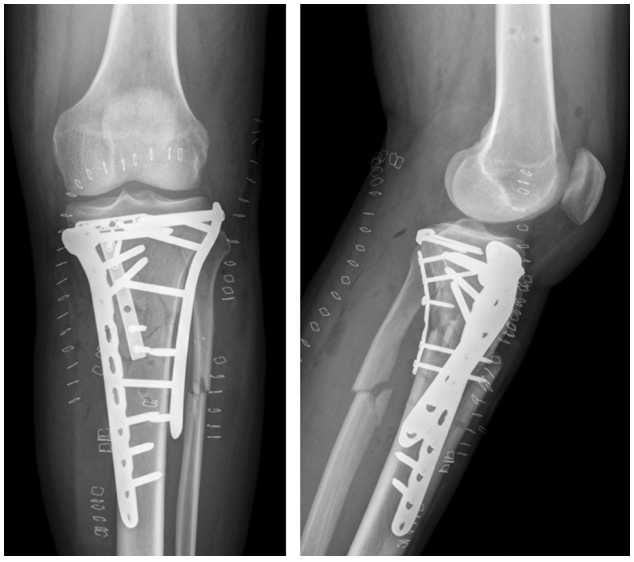

Fig. 5 Anteroposterior and lateral postoperative radiographs of clinical case #2.

Fig. 6 Control CT scan showing adequate joint reduction and signs of advanced consolidation of the medial tibial plateau fracture.

within the classification, like the rest of the classifications.[1,17–21]

Although the importance of joint rim containment has not yet been fully elucidated, it has been described that its inadequate reduction can lead to altered contact pressures on the joint surface and varus valgus instability with the knee in flexion, which generates unacceptable functional results.[22,23]

In addition, it has been shown that during the normal range of motion of the knee, both the central and peripheral areas of the tibial plateaus are loaded. In 2013, Immerman et al,[24] in a cadaveric study with computerized models, determined the size of the posteromedial fragments that remain free of load against axial loads in various degrees of flexion. They found that the critical value of the posteromedial fragment is between 10 mm and 20 mm, that is, less than 30% of the articular surface, and that fixation would be necessary above this value. However, this study[24] only evaluates axial loads without considering other forces to which the joint is subjected, and that could affect the load on these fragments.

Two years later, Cuéllar et al.[25] evaluated the effect of axial loads on these fragments at different degrees of flexion associated with varus, valgus, and rotation forces in a biomechanical cadaver study. The authors[25] found that there is displacement of the posteromedial fragments from the first degrees of flexion for both 20-mm and 10-mm fragments.

Considering that currently there are no fragment-specific plates for articular rim fractures, and that the direction and distribution of the proximal screws of the commonly-used implants have a limited capacity to contain the comminution of the articular rim, multiple authors[6–13] have described the use of rim-type plates for its containment. Its use has become more popular especially for the management of posterolateral fragments, or for both posterior columns.[6–13]

In 2008, Bermudez et al.[7] initially described the use of 3.5-mm reconstruction plates positioned horizontally in 2 cases of comminuted fractures of both posterior columns. In 2020, Hu et al.[26] used a horizontal locking plate from a distal radius T-plate for fixation of isolated posterolateral spine fractures. In 2016 and 2017, Cho et al.[9,10] used a 2.7-mm plate to contain the articular rim of the posterolateral endplate through a modified anterolateral approach. In 2017, Giordano et al.[6] described the use of a precontoured one-third

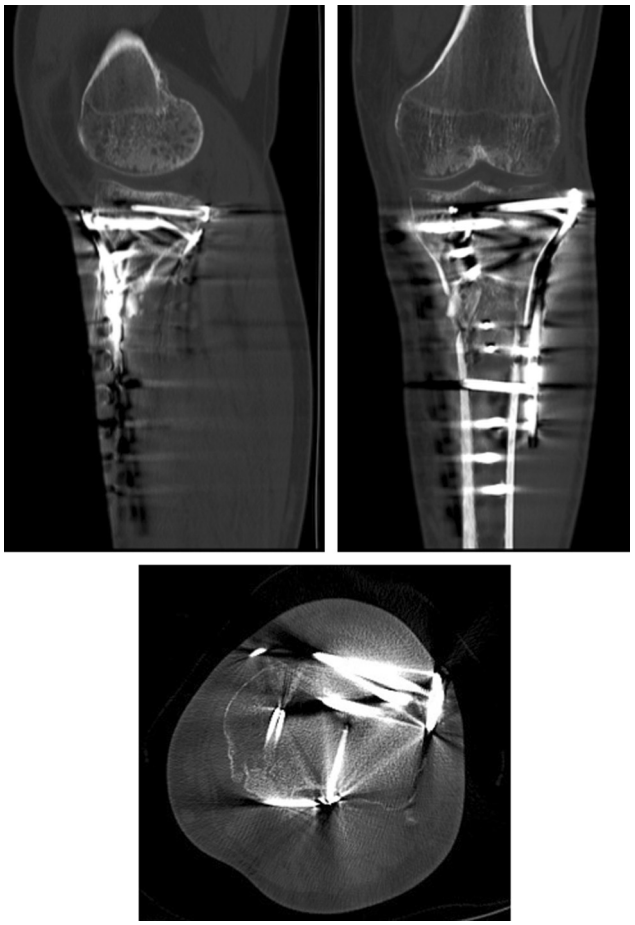

Fig. 7 Control CT scan showing adequate joint reduction and signs of advanced consolidation of a Schatzker-VI tibial plateau fracture.

tubular plate for fracture containment of both posterior columns with good results.[6] In 2020, Yi et al.[11] presented a modification of the approach previously described by Frosch for the placement of a modified locking T-plate, additionally achieving posteroanterior fixation of the horizontal plate, which was called "barrel hoop plate".

Regarding the medial plateau, there is limited evidence of the use of rim plates, and its use is anecdotal in the anteromedial region, with no reports of its use in the posteromedial column in isolation found in the literature.

Regarding the use of anteromedial rim plates, recently Huang et al.[12] evaluated 25 cases in which they used this type of plate in fractures caused by varus and hyperextension with good clinical and radiological results after 1 year of evolution, but with a lot of variability in terms of the implants used.

For our part, as shown in the cases herein presented, our group prefers the use of 2.7-mm locking plates (Compact Foot, DePuy Synthes), such as the rim plate for the fixation of both the anterior and posteromedial articular rims. This is extrapolated from the use of this implant for the fixation of posterolateral fragments as previously described by Cho et al.[9,10] The low profile of these plates gives them the ability to be easily molded, which enables them to adapt to the joint contour as well as the easy placement of subchondral screws if necessary. Both 2.7-mm cortical and locking screws have been shown to provide adequate biomechanical stability. In an osteoporotic model of simple distal fibula fractures,[27] 3 screws measuring 2.7 mm demonstrated biomechanical stability comparable to that of 2 cortical screws measuring 3.5 mm. On the other hand, considering that these screws have a central diameter of 2.3 mm, their rigidity and pull-out resistance may be comparable to those of conventional 3.5-mm cortical screws that have a central diameter that is only 0.1mm larger.[28] Regarding the length of the screws, their required length will depend on the function attributed to them. If the aim is only to fix the articular rim, then a minimum length that manages to cross the articular fragment is required. On the other hand, if the purpose of the screws is to support a fragment, preventing it from collapsing, then a longer length is recommended, ideally reaching the contralateral plateau.

In addition to the above, it should be considered that these plates can be used in conjunction with the plates classically described for the fixation of the different columns, as described in the first case herein presented, in which an anatomical posteromedial proximal tibial plate was used and a 2.7-mm anteromedial locking plate.

Although the 2.7-mm locking plate can be used as a rim plate for both lateral and medial fractures, we believe that the great difference in these cases is the technical difficulty in its positioning. Due to a direct anteromedial approach and the lack of medial neurovascular structures compared to the lateral side, it is easy to position this plate on the anteromedial aspect of the proximal tibia. For its part, the positioning of the posteromedial rim may be more complex; however, by means of the approach described in the second case herein presented, this task is facilitated. At the same time, we highlight the performance of a posteromedial submeniscal arthrotomy to facilitate the reduction of posteromedial joint fragments, since this approach enables a detailed direct visualization of the joint rim as presented in the aforementioned case.

Conclusion

We presented two cases of comminuted medial tibial plateau fractures managed with medial rim plates in which anatomical reduction, adequate fixation, satisfactory functionality, and absence of complications were achieved. Although the presentation of these cases shows medial rim plates as a promising alternative, studies with a larger series are required to draw conclusions.

Funding
The authors declare that they have not received any type of institutional or private funding for the performance of the present study.

References

1 Luo C-F, Sun H, Zhang B, Zeng B-F. Three-column fixation for complex tibial plateau fractures. J Orthop Trauma 2010;24(11): 683–692

2 Xie X, Zhan Y, Wang Y, Lucas JF, Zhang Y, Luo C. Comparative Analysis of Mechanism-Associated 3-Dimensional Tibial Plateau Fracture Patterns. J Bone Joint Surg Am 2020;102(05):410–418
3 Yang G, Zhai Q, Zhu Y, Sun H, Putnis S, Luo C. The incidence of posterior tibial plateau fracture: an investigation of 525 fractures by using a CT-based classification system. Arch Orthop Trauma Surg 2013;133(07):929–934
4 Higgins TF, Kemper D, Klatt J. Incidence and morphology of the posteromedial fragment in bicondylar tibial plateau fractures. J Orthop Trauma 2009;23(01):45–51
5 Barei DP, O'Mara TJ, Taitsman LA, Dunbar RP, Nork SE. Frequency and fracture morphology of the posteromedial fragment in bicondylar tibial plateau fracture patterns. J Orthop Trauma 2008;22(03):176–182
6 Giordano V, Schatzker J, Kfuri M. The "Hoop" Plate for Posterior Bicondylar Shear Tibial Plateau Fractures: Description of a New Surgical Technique. J Knee Surg 2017;30(06):509–513
7 Bermúdez CA, Ziran BH, Barrette-Grischow M-K. Use of horizontal rafting plates for posterior elements of complex tibial plateau fractures: description and case reports. J Trauma 2008;65(05): 1162–1167
8 Hu S-J, Chang S-M, Zhang Y-Q, Ma Z, Du S-C, Zhang K. The anterolateral supra-fibular-head approach for plating posterolateral tibial plateau fractures: A novel surgical technique. Injury 2016;47(02):502–507
9 Cho J-W, Kim J, Cho W-T, et al. Approaches and fixation of the posterolateral fracture fragment in tibial plateau fractures: a review with an emphasis on rim plating via modified anterolateral approach. Int Orthop 2017;41(09):1887–1897
10 Cho J-W, Samal P, Jeon Y-S, Oh C-W, Oh J-K. Rim Plating of Posterolateral Fracture Fragments (PLFs) Through a Modified Anterolateral Approach in Tibial Plateau Fractures. J Orthop Trauma 2016;30(11):e362–e368
11 Yi Z, Hui S, Binbin Z, et al. A new strategy to fix posterolateral depression in tibial plateau fractures: Introduction of a new modified Frosch approach and a "Barrel hoop plate" technique. Injury 2020;51(03):723–734
12 Huang Y-C, Jiao J, Cheng W-J, Xiao F, Zuo W, Wang J-W. Joint line plate fixation for tibial plateau fractures caused by hyperextension varus. Exp Ther Med 2021;21(06):621–628
13 Liu ZY, Zhang JL, Liu C, Cao Q, Shen QJ, Zhao JC. Surgical Strategy for Anterior Tibial Plateau Fractures in Hyperextension Knee Injuries. Orthop Surg 2021;13(03):966–978
14 Bennett WF, Browner B. Tibial plateau fractures: a study of associated soft tissue injuries. J Orthop Trauma 1994;8(03): 183–188
15 Gardner MJ, Yacoubian S, Geller D, 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(02):79–84
16 He QF, Sun H, Shu LY, et al. Tibial plateau fractures in elderly people: an institutional retrospective study. J Orthop Surg Res 2018;13(01):276–283
17 Schatzker J, McBroom R, Bruce D. The tibial plateau fracture. The Toronto experience 1968–1975. Clin Orthop Relat Res 1979; (138):94–104
18 Müller ME. The Comprehensive Classification of Fractures: Part 1: Long Bones. With Radiographic Examples and Proposed Treatments. Version 1.0 for the PC [Internet]. Berlin Heidelberg: Springer-Verlag; 1994 [citado 27 de agosto de 2021]. (Müller,M. E.:ComprehensiveClassification Fractures (PC)). Disponible en: https://www.springer.com/gp/book/9783540141563
19 Chang S-M, Hu S-J, Zhang Y-Q, et al. A surgical protocol for bicondylar four-quadrant tibial plateau fractures. Int Orthop 2014;38(12):2559–2564
20 Krause M, Preiss A, Müller G, et al. Intra-articular tibial plateau fracture characteristics according to the "Ten segment classification". Injury 2016;47(11):2551–2557
21 Kfuri M, Schatzker J. Revisiting the Schatzker classification of tibial plateau fractures. Injury 2018;49(12):2252–2263
22 Waldrop JI, Macey TI, Trettin JC, Bourgeois WR, Hughston JC. Fractures of the posterolateral tibial plateau. Am J Sports Med 1988;16(05):492–498
23 Brown TD, Anderson DD, Nepola JV, Singerman RJ, Pedersen DR, Brand RA. Contact stress aberrations following imprecise reduction of simple tibial plateau fractures. J Orthop Res 1988;6(06): 851–862
24 Immerman I, Bechtel C, Yildirim G, Heller Y, Walker P, Egol K. Stability of the Posteromedial Fragment in a Tibial Plateau Fracture. J Knee Surg 2013;26(02):117–126
25 Cuéllar VG, Martinez D, Immerman I, Oh C, Walker PS, Egol KA. A Biomechanical Study of Posteromedial Tibial Plateau Fracture Stability: Do They All Require Fixation? J Orthop Trauma 2015; 29(07):325–330
26 Hu S, Chen S, Chang S, Xiong W, Tuladhar R. Treatment of Isolated Posterolateral Tibial Plateau Fracture with a Horizontal Belt Plate through the Anterolateral Supra-Fibular-Head Approach. BioMed Res Int 2020;2020:4186712
27 Kim MB, Lee YH, Kim JH, Baek GH, Lee JE. Biomechanical comparison of three 2.7-mm screws and two 3.5-mm screws for fixation of simple oblique fractures in human distal fibulae. Clin Biomech (Bristol, Avon) 2013;28(02):225–231
28 Wittenberg RH, Lee KS, Shea M, White AA III, Hayes WC. Effect of screw diameter, insertion technique, and bone cement augmentation of pedicular screw fixation strength. Clin Orthop Relat Res 1993;(296):278–287

