



Extended Anterolateral Approach and Rim Plate Fixation for Posterolateral Fragments in Tibial Plateau Fractures

Abordaje anterolateral extendido y fijación con placa rim en fragmentos posterolaterales en fracturas de platillo tibial

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Rev Chil Ortop Traumatol 2021;62:39–45.

Abstract

Posterolateral fragments (PLFs) are commonly seen in tibial plateau fractures, but their reduction and fixation are challenging. There is no consensus about the ideal approach to fix this particular fragment. Even though an anterolateral approach is a safe option, it may impair a correct reduction. The posterolateral and posterior approaches offer direct visualization of the fragment, and enable a fixation with a biomechanical advantage; however, they are more demanding and expose the patient to a higher risk if morbidity. The following technical note describes the reduction and fixation of PLFs with a rim plate through an extended anterolateral approach using the paralateral collateral ligament space.

Keywords

- ▶ approach
- ▶ fracture
- ▶ posterolateral fragment
- ▶ rim plate
- ▶ tibial plateau

Resumen

Los fragmentos posterolaterales (FPLs) en fracturas de platillo tibial son frecuentes, pero difíciles de reducir y estabilizar. Actualmente existe controversia sobre cómo deben ser abordados; si bien un abordaje anterolateral es más seguro, este puede ser insuficiente para lograr una correcta reducción. Los abordajes posterolaterales y posteriores ofrecen una visión directa y permiten una fijación con ventaja biomecánica; sin embargo, son más demandantes y exponen al paciente a una mayor morbilidad. A continuación, se presenta una nota técnica sobre la reducción y fijación de FPLs con una placa *rim* por medio de un abordaje anterolateral extendido a través del espacio paraligamento colateral lateral.

Palabras claves

- ▶ abordaje
- ▶ fractura
- ▶ fragmento posterolateral
- ▶ placa rim
- ▶ platillo tibial

received
July 21, 2020
accepted
January 21, 2021

DOI <https://doi.org/10.1055/s-0041-1728737>.
ISSN 0716-4548.

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

Introduction

The concept of column fixation in tibial plateau fractures was described by Luo et al.¹ 10 years ago. However, the decision to fixate posterior fragments through a posterior approach is still controversial.² According to the current AO Foundation/Orthopaedic Trauma Association (AO/OTA) classification modified by Kfuri and Schatzker,³ the posterolateral fragment (PLF) is located at the lateral plateau, posterior to the tip of the fibula.^{3,4} Although FPLs are more frequent than previously thought (36% to 80%),⁵⁻⁷ a malreduction rate between 50% and 70% has been described.⁷

There is no consensus on how to approach PLFs.^{8,9} Although the anterolateral approach is safe and widely known, it has proven to be insufficient for proper visualization, reduction and fixation of these fragments.⁹ The posterolateral and posterior approaches provide direct visualization, enabling fixation with a biomechanical advantage,^{10,11} but they are technically demanding and expose the patient to increased morbidity.¹² Posterolateral and posterior approaches increase the risk of damage to the common peroneal nerve, the anterior tibial artery, and the sciatic-popliteal bundle.¹³⁻¹⁵ This is especially true for posterior approaches which require operating the patient in prone position; if a fracture anterior to the midline of the plateau is found, the position of the patient needs to be changed during the procedure, increasing the surgical time and the risk of infection.¹⁶

The present is a technical note on PLF reduction and fixation with a rim plate using an extended anterolateral approach and the paralateral collateral ligament space.

Patient and Surgical Technique

Patient

A 75-year-old male patient with hypertension was run over on a public road and sustained a left tibial plateau fracture classified as AO/OTA 43C3.1 (t, u), that is, a multifragmentary fracture of the lateral tibial plateau with anterolateral and posterolateral traces (► **Figure 1**). The physical examination revealed swelling of soft tissue and valgus alignment of the affected knee.

The patient was duly informed before and after surgery, and agreed to participate in the present research by signing an informed consent form.

Extended Anterolateral Approach

On a radiolucent operating table, the patient was placed in supine position, with the affected knee in 20° to 30° of flexion and a lift at the level of the ipsilateral gluteus. The following anatomical landmarks for the approach were indicated: the proximal tibial anterolateral (Gerdy) tubercle, the anterolateral rim of the tibia, the fibular head, the lateral joint line, the proximal tibial anterior tubercle, and the patellar tendon. A curvilinear incision was made from the Gerdy tubercle (GT) towards the lateral joint line, extending proximally and distally over the anterolateral rim of the tibia as required. Subcutaneous tissue elevation in a flap continued until exposing the iliotibial band (ITB) and its attach-

ment into the GT. The femoral fascia and ITB were then incised distally up to the subperiosteal elevation of the tibialis anterior muscle. Although the original article¹³ on this approach stated that the ITB should be incised in its midline, we recommend an individual evaluation according to the fracture pattern and the presence of more fragments. In this case, we decided to incise the fascia at its most anterior point (leaving a 3-mm to 5-mm remnant for posterior closure) for better exposure of the anterolateral fragment. With the anterolateral fragment exposed, a submeniscal arthrotomy was added, and the lateral meniscus next to the capsule was elevated with lace-like sutures, enabling the proper visualization of the articular surface and the meniscus. A controlled varus maneuver is recommended to increase visualization.

Next, we continued the extension towards the posterolateral portion of the tibia through the space called “parafibular collateral ligament space” by Cho et al.,¹⁷ that is, the paralateral collateral space (► **Figure 2**). The lateral collateral ligament (LCL) was identified with the knee flexed at 90° to relax the common peroneal nerve and the LCL.¹⁷ Using a retractor at the paralateral collateral space, the LCL was retracted laterally, and then, the tissue of the bone capsule tissue of the lateral plateau rim was dissected to expose the PLF (► **Figure 3A**). Finally, the extended approach enables the separation of the para-LCL space with a Hohmann retractor, and the fragment may be reduced in flexion or extension (► **Figure 3B**).

Reduction Sequence and Use of the Rim Plate

In this case, the anterolateral line and diastasis were used to elevate those depressed fragments at the described central comminution and the PLF. Using Kirschner wires, the height of the fragments was maintained, and the anterolateral fracture was reduced. The reduction was complemented with anteroposterior wires to consolidate both fragments; next, it was stabilized with a proximal lateral tibial locked plate with variable angle (Peri-loc VLP, Smith & Nephew, Watford, England, UK), directing one of the screws towards the PLF. Since the FPL remained unstable, the anterolateral approach was extended through the para-LCL space for detailed visualization of the fragment, enabling proper reduction and stabilization with a rim plate. This was a 2.7-mm trefoil-shaped locked plate, with variable angle, from the mid/forefoot system (LCP®, DePuy Synthes, Raynham, MA, US).

The plate must be molded according to the anatomy of the patient (► **Figure 4**). It is important to mold the plate hole after hole for correct shaping; in addition, it is advisable to ensure that the end is in contact with the bone. ► **Figure 5** shows the positioning of the rim plate through the extended anterolateral approach, leaving the trefoil-shaped segment posteriorly, and providing FPL fixation for further reduction. For the fixation of the rim plate, it is advisable to use a reduction forceps at the posterior segment of the plate, and begin by inserting a cortical screw at the first hole for proper apposition between plate and bone. As many screws as possible were inserted, ensuring an adequate direction to maintain the reduction and central comminution of the PLF.



Fig. 1 Preoperative imaging evaluation. The anteroposterior and lateral radiographs of the left knee revealed a lateral tibial plateau fracture, showing widening and a non-displaced fibular head fracture. Computed tomography confirmed the presence of an anterolateral and a posterolateral fragment along with central comminution. According to the current AO Foundation/Orthopaedic Trauma Association (AO/OTA) classification, this is an AO/OTA 43C3.1(t,u) injury.⁴

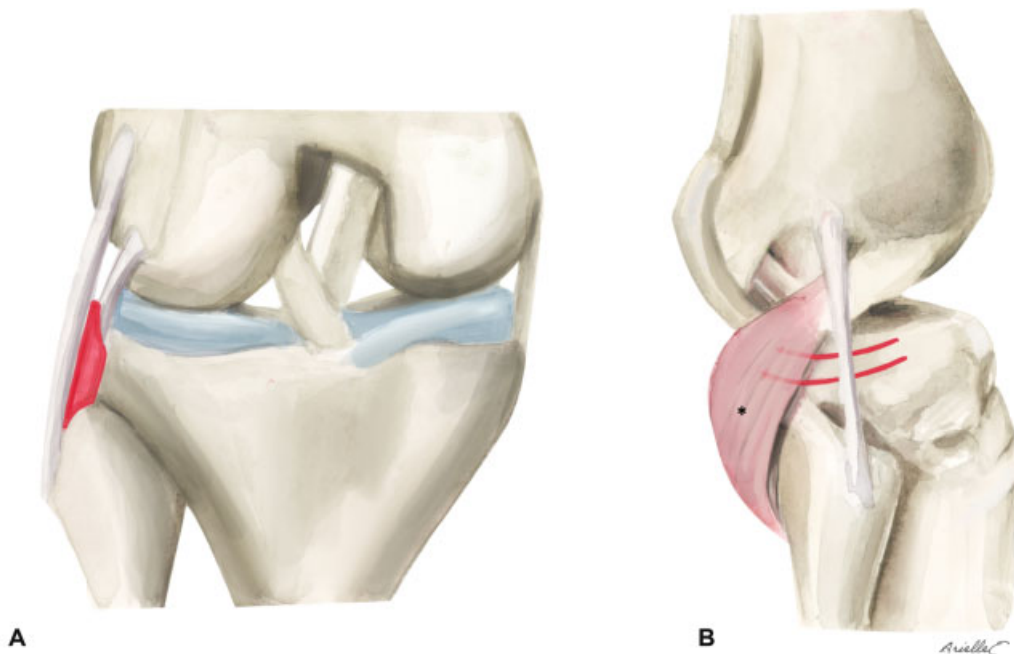


Fig. 2 Para-lateral collateral ligament space. (A) The para-lateral collateral ligament space (in red) lies between the lateral collateral ligament and the lateral tibial rim (anteroposterior view). (B) The dissection must be below the popliteal muscle belly (*) that runs from the posteroinferior to the anterosuperior area (lateral view). Redrawn from Cho et al.¹⁷

Stabilization can be increased with anteroposterior screws. Fixation was finalized by placing the screws of the proximal tibial side plate (→ **Figures 6** and **7**).

Rehabilitation

The authors of the present study recommend a discharge protocol supporting the operated limb with canes or a walker for 6 to 8 weeks, followed by progressively increasing loads according to the degree of comminution of the fracture. Passive-active joint range exercises should start early to avoid stiffness, along with isometric quadriceps and ham-

strings exercises. Then, according to the patient's symptoms, concentric exercises in closed chain are allowed, followed by open chain exercises when adequate neuromuscular control is resumed.

Discussion

Detection of FPLs in tibial plateau fractures is more frequent than previously thought. While Partenheimer et al.¹⁸ described a rate of 7%, the current literature⁵⁻⁷ reports a detection rate of up to 80%, with a malreduction rate ranging

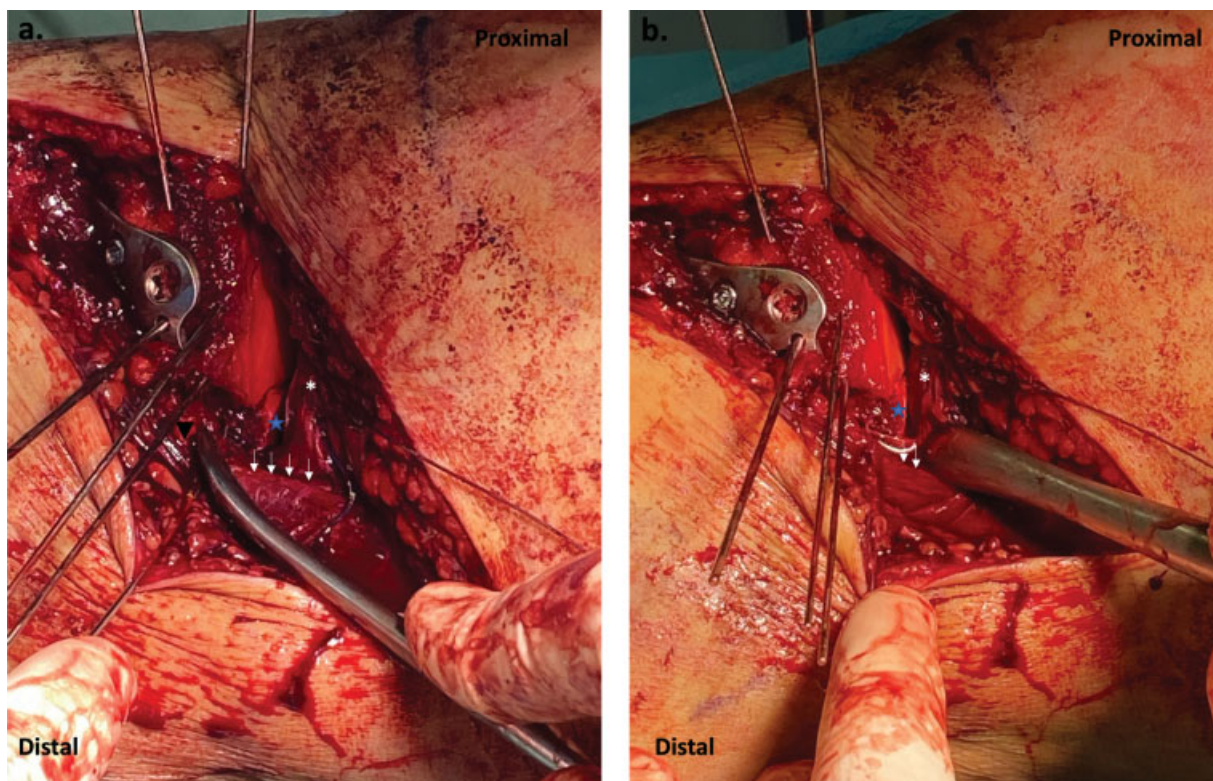


Fig. 3 Extended anterolateral approach. (A) Dissection throughout the para-lateral collateral ligament (LCL) space (inverted black triangle), which, combined with submeniscal arthrotomy (white asterisk), enables the adequate exposure of the posterolateral fragment (PLF) of the tibial plateau (blue star). The white arrows indicate the anterior margin of the iliotibial band above the LCL. In this case, despite an attempted reduction with wires from anterior to posterior through the classic anterolateral approach and the use of a variable angle screw through the posterior plate, reduction and stabilization of the PLF was insufficient. (B) The extended anterolateral approach enables the placement of a reducer posterior to the fragment to achieve reduction.

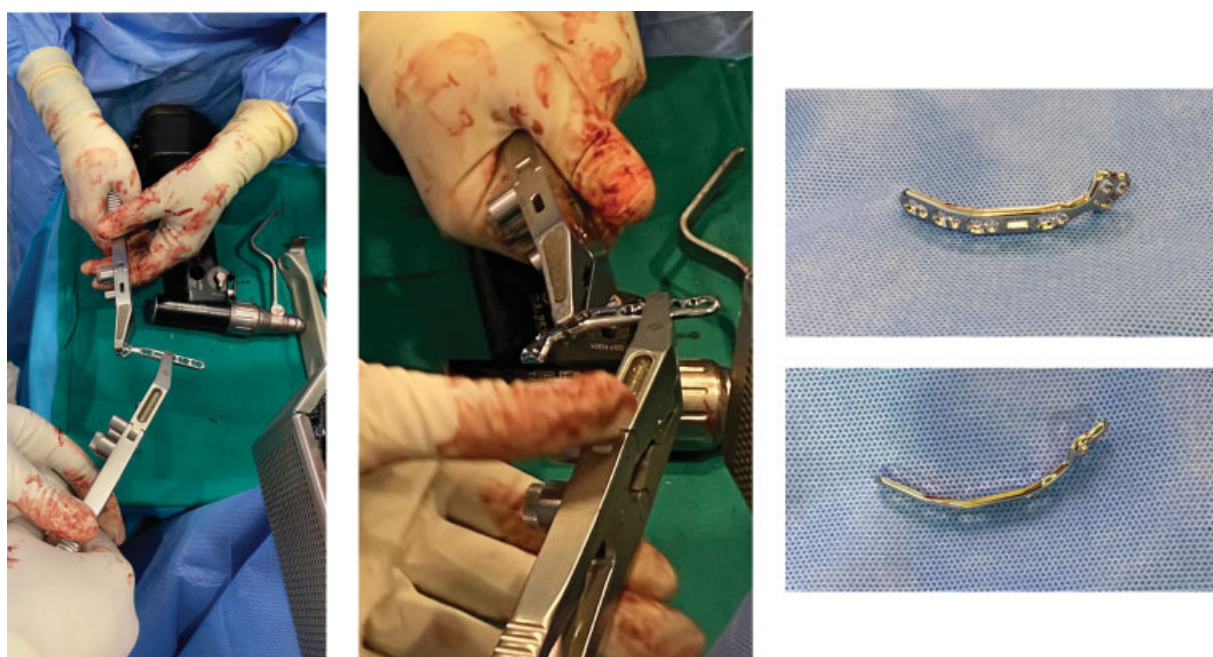


Fig. 4 Molding of the rim plate: the plate should be molded on a separate table according to the anatomy of the patient's plateau. The recommendation is to mold the plate in stages (space after space) to obtain the proper shape. It is important to use the correct instruments to mold the plate, otherwise the holes may be deformed and prevent screw locking. Be sure to bend the anterior end to avoid any protrusion.

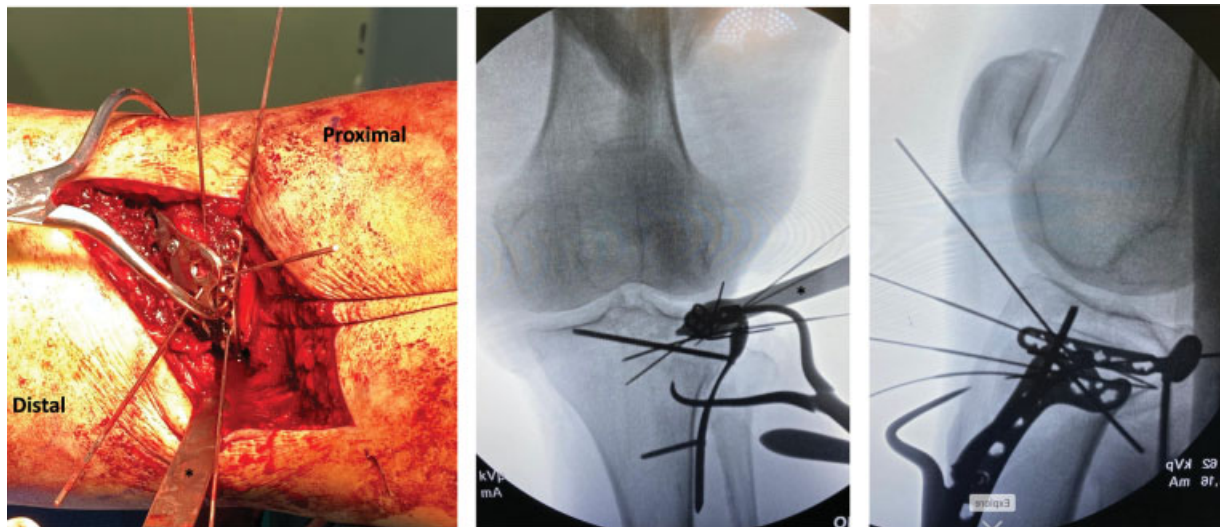


Fig. 5 Positioning of the rim plate through the extended anterolateral approach: the use of the rim plate is shown. The trefoil segment of the plate is placed posteriorly, providing support to the posterolateral fragment. The reduction forceps assists in keeping the plate attached to the bone posteriorly. Note how the Hohmann retractor (*) at the posterior tibia enables a direct visualization of the posterolateral fragment for its reduction and correct plate positioning.

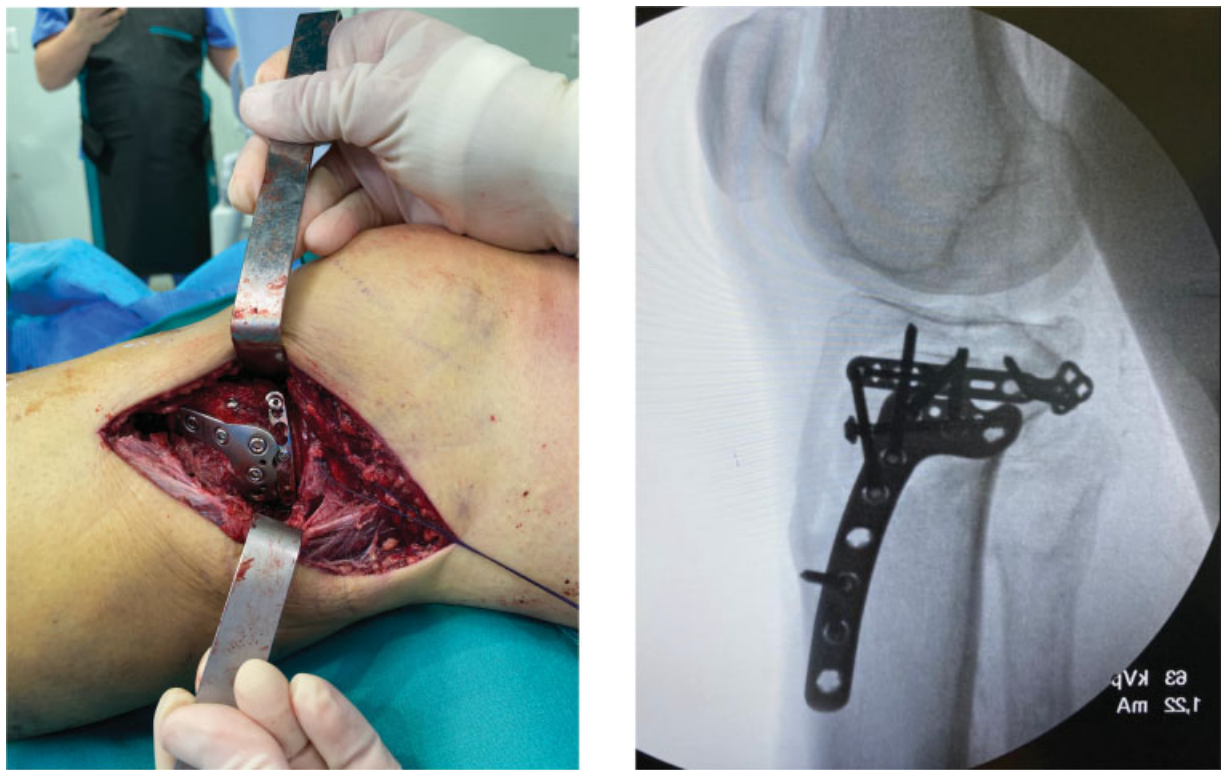


Fig. 6 Reduced and stabilized fracture. Note the final intraoperative result. The fracture was reduced and stabilized with a locked lateral proximal tibia plate, a rim plate, and a cannulated screw placed anteroposteriorly.

from 50% to 70%. These fragments are difficult to reduce mainly because of the obstruction by the fibular head and the components of the posterolateral corner.¹⁹

The anatomical reduction and stabilization of tibial plateau fractures has shown good long-term outcomes; FPL malreduction has been associated with knee instability during flexion.^{17,19} However, there is no consensus on how these FPLs should be managed.^{8,9} In fractures with joint separation (split fractures), support (buttress) plates are preferred to

counteract the shear force of the axial load.^{3,11,20,21} Ideally, these plates should be placed parallel to the fracture and supported on the apex of the lesion.^{3,21} Several approaches have been described for fractures with a posterior apex to achieve satisfactory reduction and stabilization.^{19,21-23} In these cases, there is a tendency to prefer direct posterior approaches in prone position, especially when the joint fracture is at the coronal plane with a posterior apex. However, a fracture anterior to the midline of the plate would require



Fig. 7 Postoperative radiographs. Note the proper reduction of the articular surface (step < 2 mm) and the width of the tibial plateau. The rim plate is located at the proximal margin of the lateral plateau, from the posterolateral to the anterolateral regions.

repositioning the patient during the procedure, increasing the surgical time and the risk of infection.¹⁶ Additionally, there is a risk of damaging neurovascular structures, such as the anterior tibial artery,¹⁴ and the physiological consequences of keeping an anesthetized patient in prone position.

Therefore, in the presence of a non-shearing FPL, it is important to assess whether a direct posterior approach is really necessary. The present article illustrates a surgical approach that allows the patient to be operated in supine position and an optimal stabilization method for comminuted, depressed FPLs requiring fixation. Cho et al.¹³ were the first to describe this approach and fixation method, and they stated the following advantages: 1) full exposure of the lateral and posterolateral portions of the lateral plate, allowing enough space to avoid a fibular head osteotomy; 2) patient positioned in supine recumbency; 3) fracture reduction and fixation under direct visualization; 4) the approach enables the simultaneous

fixation of the anterolateral and posterolateral columns with plates; 5) simultaneous visualization of the FPL and the articular surface, which would not be possible with the direct posterior approach; 6) it can be performed by less experienced surgeons, reducing the potential limitation of the direct posterior approaches; 7) the removal of osteosynthesis material is simpler and less risky; and 8) it does not require the identification of the common peroneal nerve or posterolateral vascular structures. Moreover, the authors¹³ also said that this is a safe option, with no reported ligament or neurovascular complications.

It is important to mention that the rim plate does not function as a buttress; therefore, we believe that this approach and reduction method would be insufficient for shear fractures at the coronal plane with the apex at the posterolateral region. **Box 1** describes tips and pitfalls of the surgical technique.

Box 1 Tips and pitfalls of the surgical technique

| Tips | Pitfalls |
|--|---|
| <ol style="list-style-type: none"> 1. When dissecting the paralateral collateral ligament (LCL) space, flex the knee at 90° to relax the LCL and the common peroneal nerve. 2. Fold the rim plate in stages (space after space), and make sure to bend the previous tip to avoid protrusions. 3. Place a pointed reduction forceps through the rim plate, ideally into one of the holes from the trefoil segment, to ensure its adhesion to the posterior cortex. | <ol style="list-style-type: none"> 1. Consider that all the posterolateral fragments of the tibial plateau can be successfully reduced from a standard anterolateral approach or using anteroposterior screws. 2. Extend the dissection of the para-LCL space proximal to the joint line. This may result in damage to the popliteal tendon, leading to iatrogenic instability. 3. Place the proximal lateral tibia (subchondral) plate too proximally, preventing the use of the rim plate. 4. Bending the rim plate with an unsuitable material risks deforming the holes and preventing the screws from locking. |

Conclusion

The extended anterolateral approach through the para-LCL space and fixation with a rim plate is an optimal surgical technique for the visualization, reduction, and fixation of comminuted FPLs and depressed joints requiring fixation.

Conflict of Interests

Dr. F. Figueroa reports he is an Editor for *Acta Ortopedica Mexicana*. None of the remaining authors has conflict of interests to declare.

Acknowledgments

We would like to thank Karen Illesca, technician in nursing and surgical instrumentation, for being an essential part of the surgical team, and Arielle Ergas, for providing the illustration.

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