Posteromedial Intergastrocnemius Approach to the Tibial Plateau. Description of the Surgical Technique

Matías A. Beatti, Carlos M. Zublin Guerra, Diego M. Guichet, Tomás S. Pellecchia
Orthopedics and Traumatology Service, Hospital Médico Policial Churruca-Visca, Autonomous City of Buenos Aires, Argentina

ABSTRACT

Introduction: There are multiple approaches described in the literature for the treatment of fractures that involve the posterior columns of the tibial plateau. We present an anatomical intergastrocnemius approach for the treatment of all fractures involving the posterior component. It allows access with complete visualization of the entire posterior region, facilitating the reduction and placement of the osteosynthesis material necessary to achieve the most stable configuration. **Surgical technique:** We describe the posteromedial intergastrocnemius approach to access the tibial plateau performed by our team. **Conclusion:** We consider that this approach represents an option to consider when treating fractures that affect both posterior columns, some of them in isolation, or the tibial insertion of the PCL. Although the neurovascular structures require constant attention during the surgical procedure, their direct vision and their meticulous protection, performed by experienced surgeons, minimizes the risk of injury, and their manipulation is not a contraindication for using this approach.
Key words: Tibial plateau fractures; intergastrocnemius approach; posteromedial tibial plateau approach; posterior tibial plateau approach; tibial plateau osteosynthesis.
Level of Evidence: IV

Abordaje intergemelar posteromediano del platillo tibial. Descripción de la técnica quirúrgica.

RESUMEN

Introducción: Se han publicado múltiples abordajes para el tratamiento de las fracturas que involucran las columnas posteriores de los platillos tibiales. Presentamos un abordaje anatómico intergemelar para tratar todas las fracturas con compromiso del componente posterior. Este procedimiento permite el acceso con visualización completa de toda la región posterior facilitando la reducción y colocación del material de osteosíntesis necesario para lograr la configuración más estable. Se describe el abordaje intergemelar posteromediano de acceso al platillo tibial descrito por nuestro equipo. **Conclusiones:** Consideramos que esta vía de abordaje representa una opción por tener en cuenta al tratar fracturas que afecten ambas columnas posteriores, alguna de ellas de manera aislada o la inserción tibial del ligamento cruzado posterior. Si bien las estructuras neurovasculares requieren atención constante durante el acto quirúrgico, la visión directa de ellas y su protección meticulosa, realizada por cirujanos experimentados, reduce al mínimo el riesgo de lesión y su manipulación no es una contraindicación para la elección de esta vía.
Palabras clave: Fracturas de platillo tibial; abordaje intergemelar; abordaje posteromediano; abordaje posterior del platillo tibial; osteosíntesis.
Nivel de Evidencia: IV

Received on September 13th, 2021. Accepted after evaluation on February 4th, 2022 • Dr. MATÍAS A. BEATTI • dr.beatti@hotmail.com ID https://orcid.org/0000-0001-9575-6473

How to cite this article: Beatti MA, Zublin Guerra CM, Guichet DM, Pellecchia TS. Posteromedial Intergastrocnemius Approach to the Tibial Plateau. Description of the Surgical Technique. *Rev Asoc Argent Ortop Traumatol* 2022;87(2):273-284. https://doi.org/10.15417/issn.1852-7434.2022.87.2.1437

INTRODUCTION

Several approaches have been described for the treatment of fractures involving the posterior columns of the tibial plateaus. 7% of all tibial plateau fractures compromise the posterolateral column,[1] which, due to its anatomical features, is difficult to access. To date, no single approach has been described that allows the treatment of this entire sector. The management principles of all tibial plateau fractures are based on the anatomical reconstruction of the articular surface, the restoration of the mechanical axis and length of the tibia in the coronal and sagittal planes, and the absolute stability to allow early mobilization and avoid joint collapse.[2]

For many years, tibial plateau fractures were treated only anteriorly or using a posteromedial approach that allowed, with some limitations, to stabilize the posteromedial column. The use of posterior accesses was disregarded due to their technical difficulty associated with high complication rates. Surgery in the posterior region of the knee can be challenging due to the presence of neurovascular structures at risk, such as the tibial nerve, popliteal artery and vein, lateral and medial sural cutaneous nerve, anterior tibial vascular bundle (known as trifurcation), and the common fibular nerve, so it is rarely used in routine practice. A safe and successful posterior approach requires detailed anatomical knowledge of the location of these structures and their possible variants.[2-4] Tomaszewski et al.[5] proposed a classification based on the variations in the origin of the anterior tibial artery in relation to the popliteus muscle, which we consider very useful to know in order to reduce the risk of vascular injury.

Currently, multiplanar and 3D CT reconstructions are used for the evaluation of joint involvement.[6-10] Based on these new imaging advances, Luo et al.[11] proposed the three-column theory, emphasizing the relevance of fractures oriented in the coronal plane. Chang et al.[12] proposed dividing the articular surface into four quadrants to better understand these injuries.

The new Kfuri-Schatzker[13] classification brings these concepts together and introduces the idea of the "main fracture plane". The recognition of the main fracture plane is essential for preoperative planning, as well as the correct positioning of the patient, the choice of the surgical approach, and determining where to place the osteosynthesis material to achieve the most stable fixation.

We know that placing the osteosynthesis material in the fracture plane is essential to achieving correct stabilization of the tibial ring.[13,14] Direct access to the fracture site is the only way to achieve this. In cases of compromise of the posterior columns, not treating them by direct access leads to poor reduction and insufficient stabilization which translates into worse functional results.[15]

The objective of this study is to present a gastrocnemius splitting anatomic approach to treat all fractures with posterior component involvement. This approach achieves complete visualization of the entire posterior region, facilitating the reduction and placement of the osteosynthesis material necessary to achieve the most stable configuration.

Surgical technique

Patient position: The surgical position of choice is ventral decubitus, with a subsequent positional change of the patient for a lateral or medial anterior parapatellar approach depending on the involvement and need for implant placement; or a floating position (Figure 1) that allows the change in the position of the patient with external and internal rotation of the affected limb without the need to change the surgical fields.

Figure 1. Floating position. It allows changes in the position of the limb for intraoperative access to the posterior and anterior plateau as needed.

Description of the approach: Patient under subarachnoid anesthesia (spinal block). It is preferred not to use a hemostatic cuff, as this makes it easier to recognize the vascular structures, protect them during surgery, and perform correct hemostasis and the necessary ligatures for the release and mobilization of the popliteal neurovascular bundle. It also facilitates closure without soft tissue edema and minimizes the possibility of deep vein thrombosis.

Skin incision: A vertical approach centered on the midline is performed, taking the skin line between the gastrocnemius heads as a reference (Figure 2). The approach will be extended proximally and distally on demand as required by the fracture. An inverted L-shaped skin approach with a longitudinal branch at the medial level and a transverse branch at the level of the fold can also be used (Figure 3).

Figure 2. Dermographic marking of the medial posterior approach.

Figure 3. Dermographic marking of the inverted L-shaped posterior approach.

The superficial fascia is sectioned and the small saphenous vein is immediately visualized together with the sural cutaneous nerve running over the gastrocnemius midline (Figure 4).

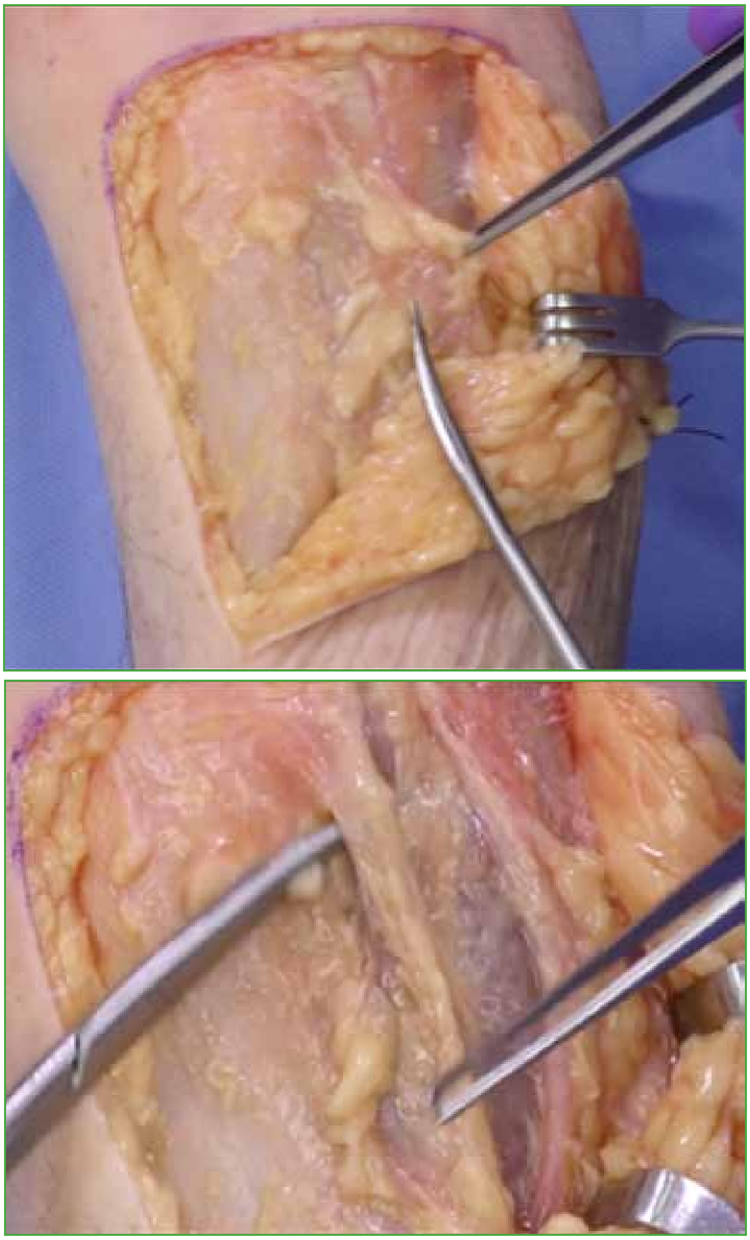

Figure 4. Opening of superficial fascia, visualization of the small saphenous vein and sural cutaneous nerve, and release for their repair.

By means of blunt dissection, the gastrocnemius heads are separated, exposing the popliteal fossa (Figures 5 and 6). The release of the popliteal neurovascular bundle in order to mobilize it usually requires ligation of its inferomedial and inferolateral genicular branches without compromising the irrigation of this anatomical sector due to its multiple anastomoses. It is advisable to perform this maneuver with slight knee flexion to avoid its tension. If necessary, the release can be extended to the soleus arch. Special care should be taken with the medial gastrocnemius nerve whose iatrogenic injury may cause its denervation and consequent atrophy.

Figure 5. Blunt dissection of both gastrocnemius bellies performed with the index finger.

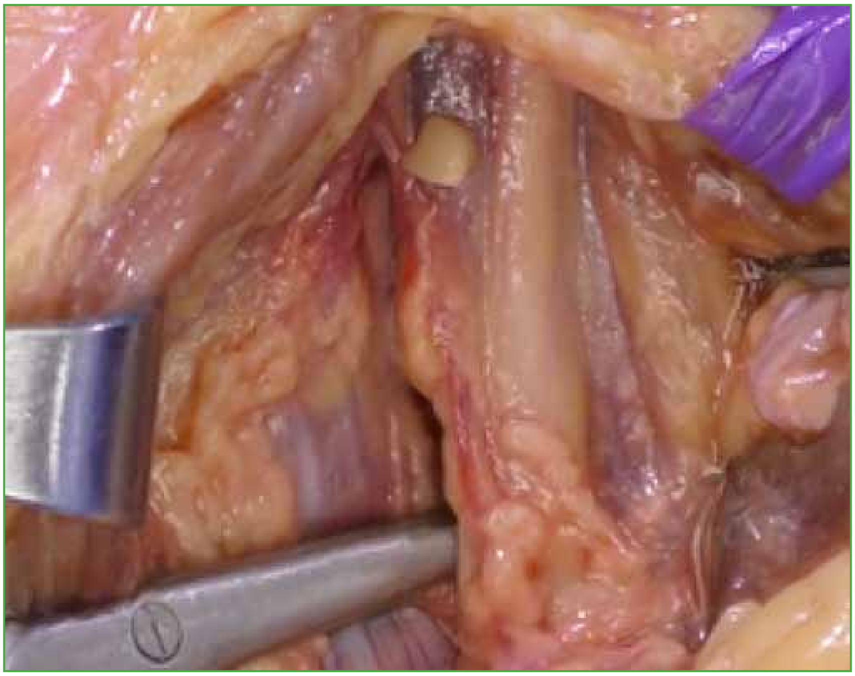

Figure 6. Popliteal neurovascular bundle recognition and release. If necessary, ligation of its collateral vessels is performed on demand to be able to mobilize the bundle as needed.

With a blunt separator, the popliteal bundle can be lateralized or medialized as required, thus creating two triangular working windows, one medial and one lateral. The medial window is framed by the popliteal bundle (artery) on its lateral side and the semimembranosus and medial belly of the gastrocnemius (Figure 7). The lateral window is framed by the popliteal bundle (nerve) on its medial side, the biceps femoris muscle, and the lateral belly of the gastrocnemius (Figure 8).

Figure 7. The medial window is completely exposed. The popliteal neurovascular bundle can be seen on the right side of the image forming the base of a triangle with its sides formed by the internal gastrocnemius and the semimebranosus at its upper part.

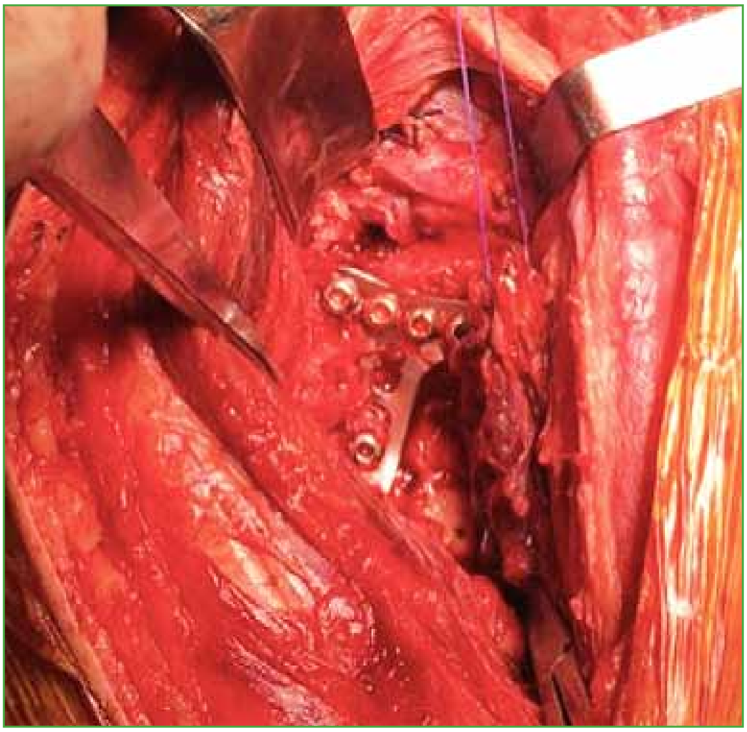

Figure 8. The lateral window is observed in its complete exposure. The image does not correspond to the same subject since the fracture did not require reaching the posterolateral wall. It is observed how the popliteal bundle is displaced medially, forming the base of the window, with its upper side formed by the biceps femoris and the common fibular nerve (external popliteal sciatic nerve) and its lower side formed by the external gastrocnemius.

To widen the approach, tenotomy of one or the other head of the gastrocnemius can be performed taking into account its subsequent reinsertion. The plantaris muscle can be split in the lateral window. The dissection of the popliteus muscle is performed from its insertion at the medial side in a superolateral direction towards the posterior side of the external plateau (Figure 9).

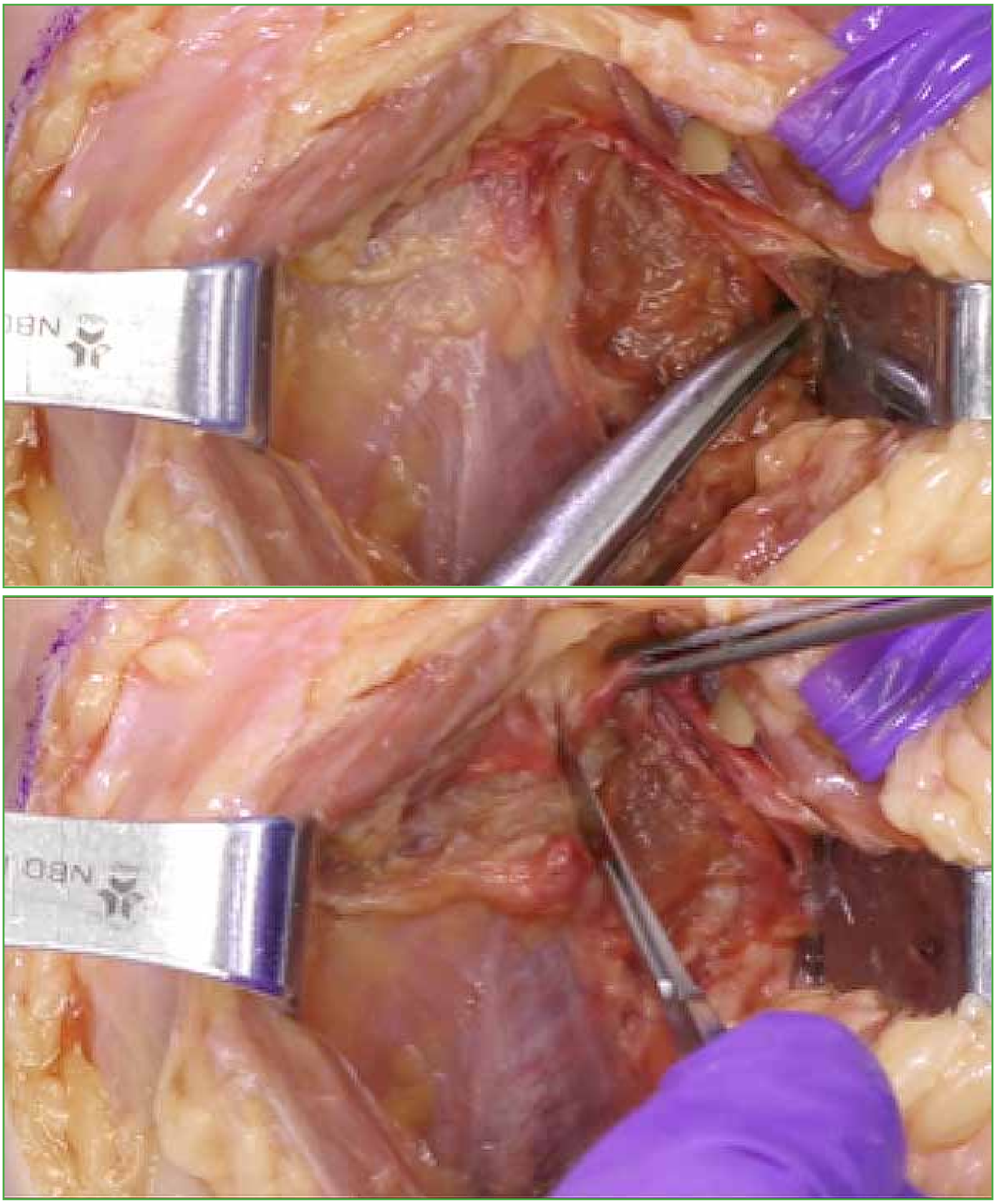

Figure 9. The dissection of the popliteus muscle is observed from the lateral end of the articular side of the plateau towards medial to expose the posterior aspect of the plateau.

The curettage of the popliteus muscle in a distal direction exposes the entire bone surface (Figure 10). This should be done neatly and with correct visualization to avoid any possible injury in case there is an aberrant anterior tibial artery below this muscle. If the approach is used to repair the PCL, it is not necessary to resect the popliteus muscle.

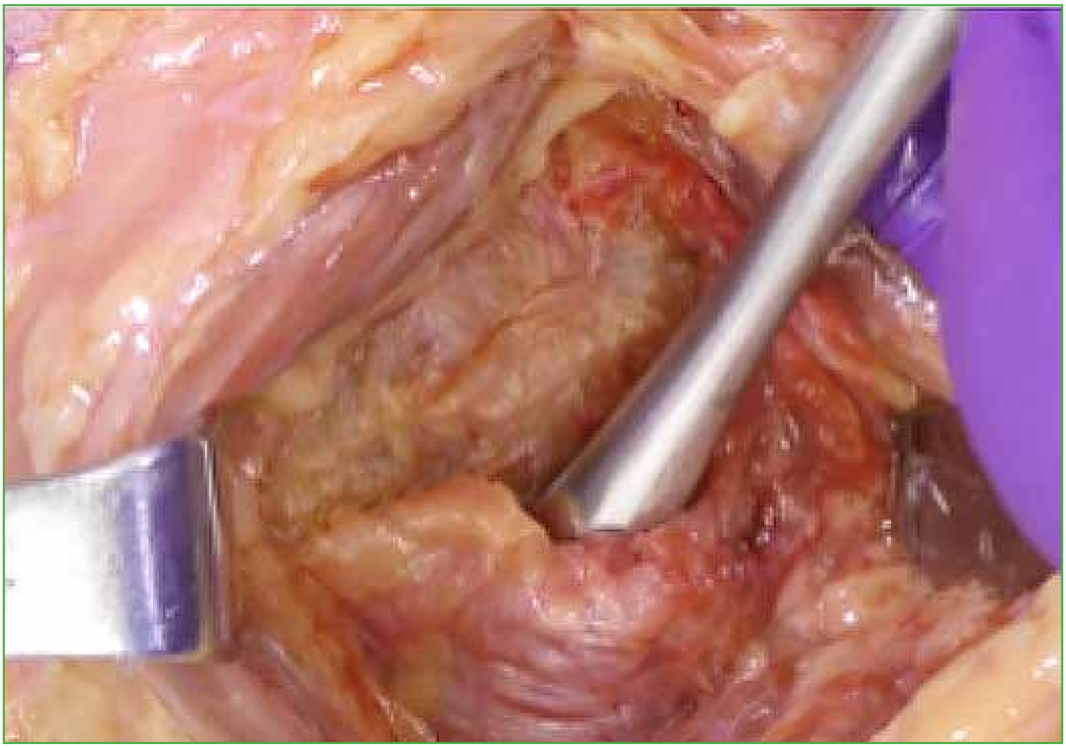

Figure 10. The curettage of the popliteus muscle leaves the entire bone surface exposed.

Capsulotomy allows the joint to be exposed in order to place the osteosynthesis material (Figures 11). We use the femoral distractor to obtain greater joint visualization.

For the closure, it is important not to forget to reinsert the popliteus muscle and the gastrocnemius heads in those cases where their dissection was necessary. Then, the deep and superficial fascia, subcutaneous cellular tissue, and skin are closed with simple sutures.

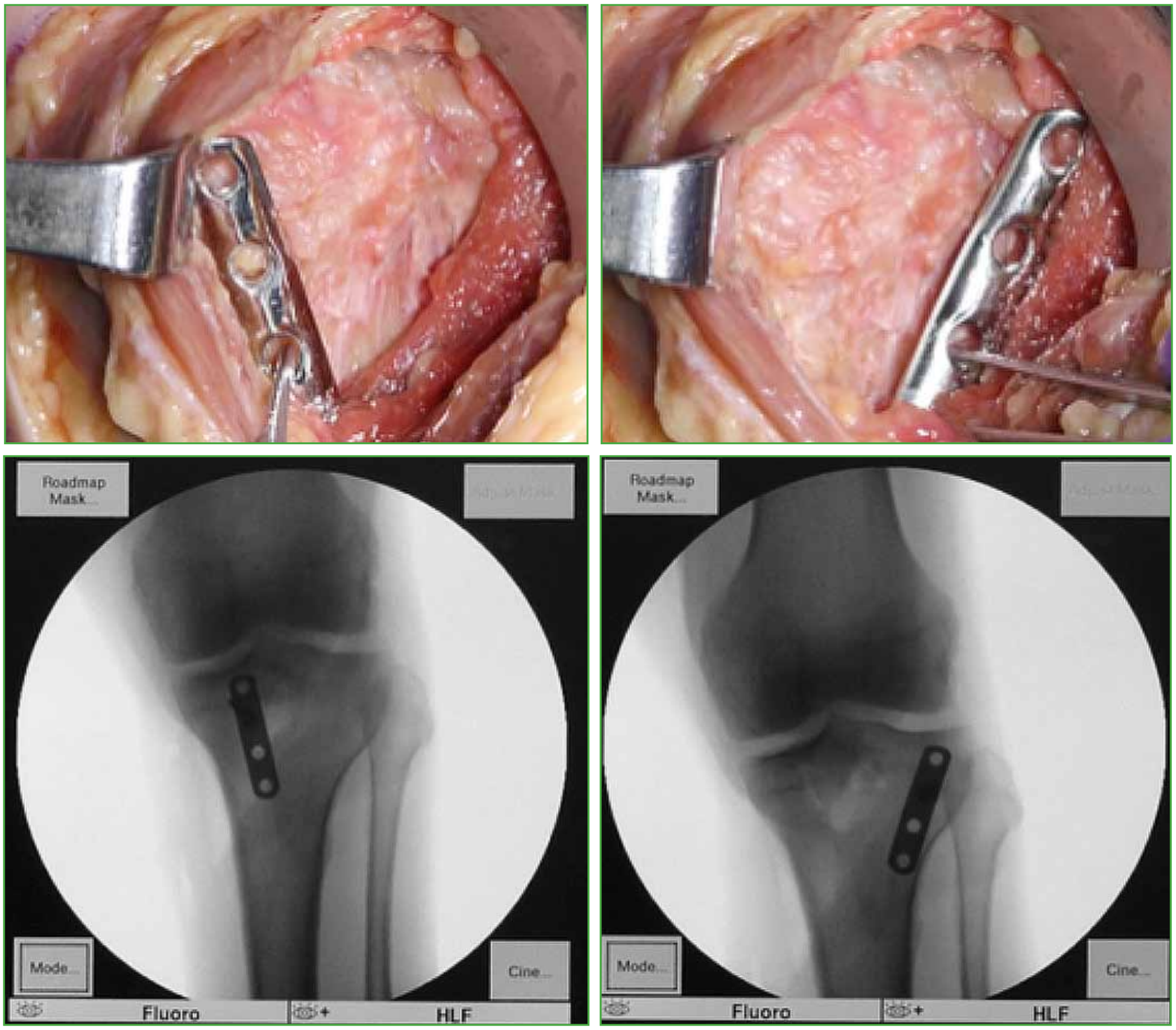

Figure 11. The posterior and lateral aspects and the possible placement of the osteosynthesis material with their respective radioscopic controls are observed.

DISCUSSION

Tibial plateau fractures account for about 1% of all fractures; 55-70% correspond to the lateral plateau; 10-23%, to the medial plateau; and 30% involve both.[16] The study by Yang et al.[1] revealed that of all posterior column injuries, 45.7% compromise the posteromedial column; 35.1%, the posterolateral column; and 19.2%, both posterior columns.

It is important to highlight the importance of understanding the anatomical variables of the popliteal artery and its branches as described in the research of Tomaszewski et al.[5] and Bose and Ramanathan[17]. The former proposed the classification based on the origin of the anterior tibial artery and its variants which we consider vital to understand in order to avoid any risk of vascular injury. We suggest including an angiotomography study for pre-surgical planning.

Open reduction and internal fixation are traditionally performed by anterolateral and medial approaches. Initially, posterior approaches were discouraged due to their technical difficulty due to both the complex anatomy of the region and the high risk of both vascular and nerve iatrogenic injury. Currently, not performing adequate stabilization of the fragments by posterior approach is understood as a failure in the treatment of the fracture, due to the worse functional outcomes.[18]

In the decade of 1960, Trickey[19] described the use of a similar interval to the approach proposed by our team for the reinsertion of the posterior cruciate ligament. The field of work was very limited and, due to its use, the modifications introduced by our team for the extension of the approach or the opening of the popliteus muscle to reach the posterolateral region were not necessary.

In 1993, Hoppenfeld and DeBoer[20] described a posteromedial approach that they did not initially use for the treatment of fractures. Continuing this line of work, in 1997, De Boeck and Opdecam[21] published an article about seven patients treated by this approach. Georgiadis[22] treated four patients with a double approach, anterior and posteromedial, for the said fragment.

In 1997, Lobenhoffer et al.[10] described an approach that allowed access to the posteromedial region of the tibial plateau and PCL, reproducible and relatively safe in vascular terms, by using the interval between the pes anserinus and the internal gastrocnemius. Its limitation is that it does not allow reaching the posterolateral region. At the same time, they described a posterolateral approach with osteotomy of the fibular neck, which improves the limited access described by Minkoff for the treatment of an osteoid osteoma and later modified to treat fractures together with Jaffe and Menendez.[23] The proximal fibular osteotomy achieves an acceptable working field, but it is a traumatic procedure that adds comorbidities, such as the release of the posterolateral angle and great periosteal separation, with important structures at risk, such as the common fibular nerve (external popliteal sciatic nerve).

In 2010, Frosch and Balcarek[24] described an approach without fibular osteotomy that allowed adequate visual access and reduced iatrogenic injury to the soft tissues and structures of the posterolateral angle. When using the interval between the biceps femoris muscle and the head of the lateral gastrocnemius, it is necessary to identify the common fibular nerve (external popliteal sciatic nerve) and its mobilization in the surgical procedure, with the risk of a possible intraoperative injury.

Our approach uses the intergastrocnemius interval, anatomically located in a medial position that allows access to both posterior columns at the same time. Thus, it offers an adequate surgical field that enables correct visualization and simplifies achieving adequate reduction and stabilization. The possibility of extending it and using the popliteal bundle as a mobile element, medializing it to generate a second working window, is useful when simple lateralization is insufficient to comfortably reach the posterolateral angle. This allows all fractures involving the posterior columns to be treated with a single approach and makes it a reproducible, useful, and versatile way of working. The presence of the popliteal bundle in the surgical field allows us to protect it correctly, reaching a high level of safety.

CONCLUSIONS

We believe that this approach represents an option to consider when treating fractures involving both posterior columns, either one of them in isolation, or the tibial insertion of the PCL. Although the neurovascular structures require constant attention during the surgical procedure, the direct vision of these structures and their meticulous protection, performed by experienced surgeons, minimizes the risk of injury and their manipulation is not a contraindication for the choice of this approach.

Conflicts of interest: The authors declare no conflicts of interest.

C. M. Zublin Guerra ORCID ID: https://orcid.org/0000-0002-7333-8219
D. M. Guichet ORCID ID: https://orcid.org/0000-0003-4259-0179
T. S. Pellecchia ORCID ID: https://orcid.org/0000-0002-6070-9690

REFERENCES

1. 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):929-34. https://doi.org/10.1007/s00402-013-1735-4
2. Scheu Gonçalves M, Carredano González X, Colmenares Sandoval O, Yáñez Lagos C, Donoso Martínez R, et al. Principios quirúrgicos en fracturas de platillos tibiales con compromiso de columna posterior. *Rev Chil Ortop Traumatol* 2018;59(01):22-34. https://doi.org/10.1055/s-0038-1641563
3. Berihu BA, Debeb YG. Anatomical variation in bifurcation and trifurcations of sciatic nerve and its clinical implications: in selected university in Ethiopia. *BMC Res Notes* 2015;8(01):633. https://doi.org/ 10.1186/s13104-015-1626-6
4. Kim D, Orron DE, Skillman JJ. Surgical significance of popliteal arterial variants. A unified angiographic classification. *Ann Surg* 1989;210(06):776-81. https://doi.org/10.1097/00000658-198912000-00014
5. Tomaszewski KA, Popelsuzko P, Graves M, Pekala P, Henry B, Roy J, et al. The evidence-based surgical anatomy of the popliteal artery and the variations in its branching patterns. *J Vasc Surg* 2017;65(2):521-529.e6. https://doi.org/10.1016/j.jvs.2016.01.043
6. Hackl W, Riedl J, Reichkendler M, Benedetto KP, Freund M, Bale R. Preoperative computerized tomography diagnosis of fractures of the tibial plateau. *Unfallchirurg* 2001;104(6):519-23. https://doi.org/10.1007/s001130170115
7. Brunner A, Horisberger M, Ulmar B, Hoffmann A, Babst R. Classification systems for tibial plateau fractures; does computed tomography scanning improve their reliability*? Injury* 2010;41(2):173-8. https://doi.org/ 10.1016/j.injury.2009.08.016
8. Doornberg JN, Rademakers MV, van den Bekerom MP, Kerkhoffs GM, Ahn J, Steller EP, et al. Two-dimensional and three-dimensional computed tomography for the classification and characterization of tibial plateau fractures. *Injury* 2011;42(12):1416-25. https://doi.org/10.1016/j.injury.2011.03.025
9. Castiglia MT, Nogueira-Barbosa MH, Messias AMV, Salim R, Fogagnolo F, Schatzker J, et al. The impact of computed tomography on decision making in tibial plateau fractures. *J Knee Surg* 2018;31(10):1007-14. https//doi.org/10.1055/s-0038-1627464
10. Lobenhoffer P, Gerich T, Bertram T, Lattermann C, Pohlemann T, Tscherne H, et al. Treatment of posterior tibial plateau fractures via posteromedial and posterolateral exposures. *Unfallchirurg* 1997;100(12):957-67. https://doi.org/10.1007/s001130050218
11. Luo CF, Sun H, Zhang B, Zeng BF. Three-column fixation for complex tibial plateau fractures. *J Orthop Trauma* 2010;24(11):683-92. https://doi.org/10.1097/BOT.0b013e3181d436f3
12. Chang SM, Hu SJ, Zhang YQ, Yao MW, Ma Z, Wang X, et al. A surgical protocol for bicondylar four-quadrant tibial plateau fractures. *Int Orthop* 2014;38(12):2559-64. https://doi.org/10.1007/s00264-014-2487-7
13. Kfuri M, Schatzker J. Revisiting the Schatzker classification of tibial plateau fractures. *Injury* 2018;49(12):2252-63. https://doi.org/10.1016/j.injury.2018.11.010
14. Müller M, Algöwer M, Schneider R, Willeneger H. *Manual of internal fixation. Techniques recommended by the AO-ASIF group*. Springer-Verlag Science & Business Media; 1991.
15. Zeng ZM, Luo CF, Putnis S, Zeng BF. Biomechanical analysis of posteromedial tibial plateau split fracture fixation. *Knee* 2011;18(1):51-4. https://doi.org/10.1016/j.knee.2010.01.006
16. Purnell ML, Larson AI, Schnetzler KA, Harris NL, Pevny T, Diagnosis and surgical treatment of Schatzker type IV variant biplanar medial tibial plateau fractures in alpine skiers. *Tech Knee Surg* 2007;6(1):17-28. Available at: http://citeseerx.ist.psu.edu/viewdoc/download?doi=10.1.1.622.1809&rep=rep1&type=pdf
17. Bose E, Ramanathan V. Anatomical variations and morphometric analysis of popliteal artery and its terminal branches in south indian population. *Int J Anat Res* 2017;5(3.3):4388-93. https://doi.org/10.16965/ijar.2017.346
18. Van den Berg J, Reul M, Nunes Cardozo M, Starvoyt A, Geusens E, et al. Functional outcome of intra-articular tibial plateau fractures: the impact of posterior column fractures. *Int Orthop* 2017;41(09):1865-73. https://doi.org/10.1007/s0
19. Trickey EL. Rupture of the posterior cruciate ligament of the knee. *J Bone Joint Surg Br* 1967;50(2):334-41. PMID: 5651340
20. Hoppenfeld S, DeBoer P. *Surgical exposures in Orthopaedics*. 2nd ed. Philadelphia, PA: Lippincott Williams Wilkins; 1994.

21. De Boeck H, Opdecam P. Posteromedial tibial plateau fractures. Operative treatment by posterior approach. *Clin Orthop Relat Res* 1995;320:125-8. PMID: 7586815
22. Georgiadis G. Combined anterior and posterior approaches for complex tibial plateau fractures. *J Bone Joint Surg Br* 1994;76(2):285-9. PMID: 8113294
23. Minkoff J, Jaffe L, Menendez L. Limited posterolateral surgical approach to the knee for excision of osteoid osteoma. *Clin Orthop Relat Res* 1987;(223):237-46. PMID: 3652582
24. Frosch KH, Balcarek P, Walde T, Stürmer KM. A new posterolateral approach without fibula osteotomy for the treatment of tibial plateau fractures. *J Orthop Trauma* 2010;24(8):515-20. https://doi.org/10.1097/BOT.0b013e3181e5e17d