A New Posterolateral Approach Without Fibula Osteotomy for the Treatment of Tibial Plateau Fractures

Karl-Heinz Frosch, MD,† Peter Balcarek, MD,† Tim Walde, MD,† and Klaus Michael Stürmer, MD†*

Summary: The selection of a surgical approach for the treatment of tibia plateau fractures is an important decision. Approximately 7% of all tibia plateau fractures affect the posterolateral corner. Displaced posterolateral tibia plateau fractures require anatomic articular reduction and buttress plate fixation on the posterior aspect. These aims are difficult to reach through a lateral or anterolateral approach. The standard posterolateral approach with fibula osteotomy and release of the posterolateral corner is a traumatic procedure, which includes the risk of fragment denudation. Isolated posterior approaches do not allow sufficient visual control of fracture reduction, especially if the fracture is complex. Therefore, the aim of this work was to present a surgical approach for posterolateral tibial plateau fractures that both protects the soft tissue and allows for good visual control of fracture reduction. The approach involves a lateral arthrotomy for visualizing the joint surface and a posterolateral approach for the fracture reduction and plate fixation, which are both achieved through one posterolateral skin incision. Using this approach, we achieved reduction of the articular surface and stable fixation in six of seven patients at the final follow-up visit. No complications and no loss of reduction were observed. Additionally, the new posterolateral approach permits direct visual exposure and facilitates the application of a buttress plate. Our approach does not require fibular osteotomy, and fragments of the posterolateral corner do not have to be detached from the soft tissue network.

Key Words: knee, tibia plateau, fracture, posterolateral, popliteal corner, surgical approach

(*J Orthop Trauma* 2010;24:515–520)

INTRODUCTION

Articular stepoffs and angular deformities after operative treatment of tibial plateau fractures are observed in 19% to 26% of cases.[1,2] There is evidence in the literature that the quality of the reduction correlates with the clinical outcome.[3,4] This correlation is further supported by the fact that painful intra-articular malunions of the tibial plateau require complicated operations such as combined extra- and intra-articular osteotomies to improve their outcome.[5] These results indicate that an anatomic fracture reduction without intra-articular stepoffs is an important goal in the treatment of tibial plateau fractures.[2,4,6,7]

At least 7% of all tibia plateau fractures lie in the region of the posterolateral corner.[2] Fractures in this region usually cannot be adequately treated by using a lateral or anterolateral approach.[8,9] The fragments are often covered by the fibula head and the ligamentous structures in the corner region of the popliteus muscle; hence, they are difficult to reduce and fix.[10] To minimize this problem, a posterolateral approach was developed by Lobenhoffer et al.[6] With this approach, a fibular osteotomy and detachment of the joint capsule and meniscotibial ligaments from the lateral tibia plateau allow for the exposure and examination of the posterolateral joint surfaces of the tibia. However, in addition to the fibular osteotomy, dissection of the posterolateral structures and ligaments was necessary in this instance.[6]

According to our own experience, Lobenhoffer's approach[6] provides a good view of the posterolateral corner of the tibia plateau. However, this strategy may lead to relatively extensive trauma of the soft tissue of the posterolateral corner.

Isolated posterior approaches allow for fragment fixation,[10,11] but the visual control of fracture reduction is limited, especially if the fractures are more complex.

Therefore, in this article, a modified surgical technique for the treatment of posterolateral tibia plateau fractures is introduced. This technique includes a posterolateral approach for fracture reduction and fixation combined with a lateral arthrotomy to visually control the fracture alignment and the joint surface. A case example is presented, and the relative benefits and limitations of this novel approach are considered. To our knowledge, this approach has not yet been described.

Surgical Technique

In addition to conventional x-rays, computed tomography scans of the tibial plateau are recommended for precise analysis of the fracture type and to confirm the involvement of the posterolateral corner (Fig. 1).[12] For the modified posterolateral approach, the patient lies in a lateral position. The knee is supported by a thick, rolled pillow because the weight of the leg itself applies varus stress, which causes the joint gap to be laterally opened. In addition, through ligamentotaxis, partial reduction of the lateral and posterolateral fracture is achieved without any further traction.

Accepted for publication April 29, 2010.
From the *Department of Trauma and Reconstructive Surgery, Asklepios Clinic St Georg, Hamburg, Germany; and †Department of Trauma Surgery, Plastic and Reconstructive Surgery, Georg-August-University of Goettingen, Germany.
No funds were received in support of this work.
Reprints: Karl-Heinz Frosch, MD, Head of the Department of Trauma and Reconstructive Surgery, Asklepios Clinic St Georg, Hamburg, Lohmühlenstrasse 5, 20099 Hamburg, Germany (e-mail: k.frosch@asklepios.com; www.unfallchirurgie-hamburg.com).

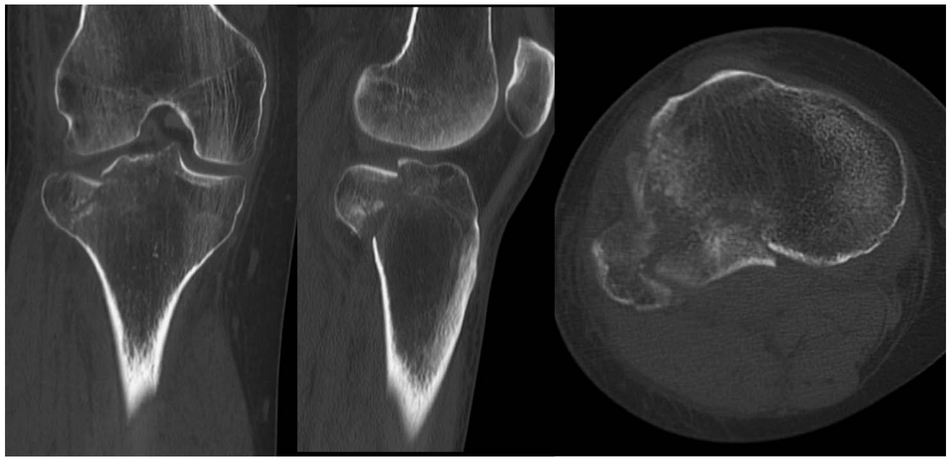

FIGURE 1. A 48-year-old female patient sustained a posterolateral tibia plateau fracture in a traffic accident. The preoperative computed tomography scan shows posterolateral involvement of the tibial plateau (Type 41 B3 according to the OTA classification).

An approximately 15-cm-long posterolateral skin incision is required (Fig. 2, dashed black line). The fibula head is used as an anatomic landmark. The incision starts 3 cm above the joint line and follows the fibula in a distal direction. To avoid scar contractions, care must be taken so that the incision is not made too far dorsally. Before the popliteal fossa is dissected, a lateral standard arthrotomy is performed (Fig. 2). The tractus iliotibialis is incised from the dorsal side, and the dorsal fibers are detached from the Gerdy's tubercle (incision 1 in Fig. 2). Thereafter, the lateral capsule is incised, and the ligamentum meniscotibiale is dissected approximately 2 mm away from its insertion in the tibia, parallel to the joint surface. Now the joint surface can be inspected from the lateral side.

The entire lateral tibial plateau, including the posterolateral corner, can be viewed by using this lateral arthrotomy, and the fracture can be assessed. Manipulation of the posterolateral fragments is seldom successful using this lateral approach alone because both the fibula and the strong ligamentous and tendinous structures of the popliteal corner prevent direct reduction of the fragments. Therefore, in most posterolateral tibial plateau fractures, an additional posterolateral exposure of the fragments is necessary. Both approaches (1 and 2 in Fig. 2) are performed through one skin incision (Fig. 3).

After direct incision of the fascia, the peroneal nerve is exposed to the rear edge of the M. biceps femoris. The nerve should be carefully dissected and gently mobilized for protection during the operation.

A blunt dissection of the popliteal fossa is initially performed between the lateral head of the M. gastrocnemius and the M. soleus, and the inspection begins on the muscle belly of the M. soleus (Figs. 2 and 3).

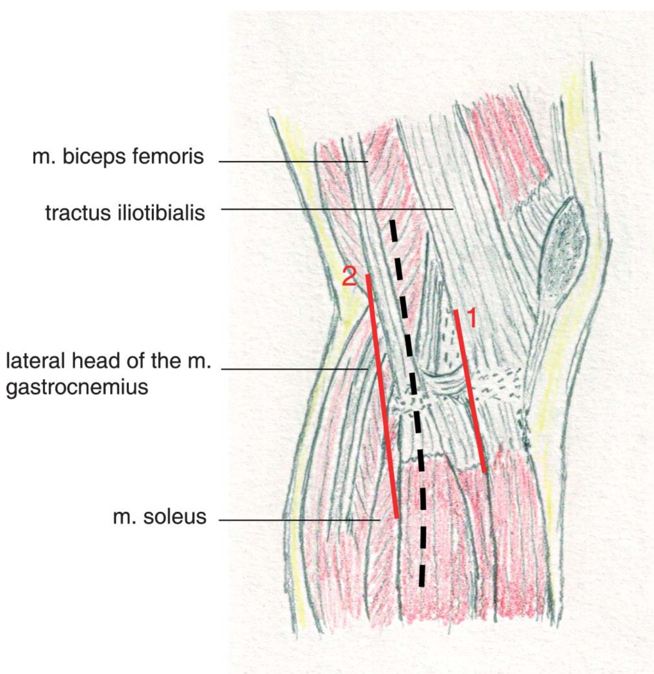

FIGURE 2. An anatomic drawing of the lateral and posterolateral region of the knee. Dashed black line: skin incision; 1: lateral standard arthrotomy; and 2: blunt dissection of the popliteal fossa between M. soleus and M. gastrocnemius (lateral head).

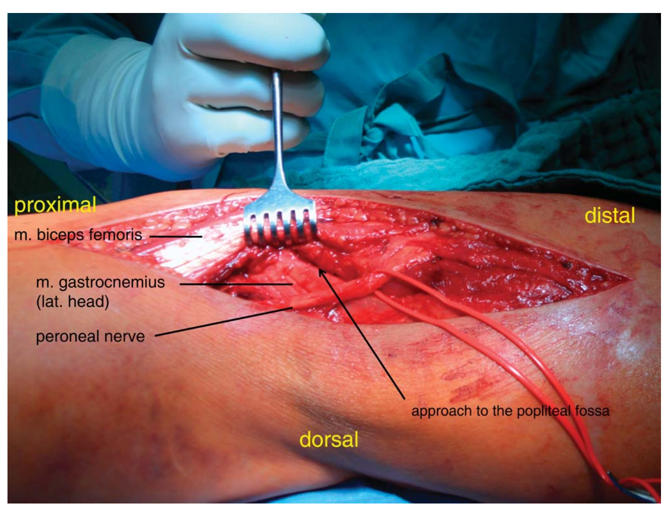

FIGURE 3. After the lateral arthrotomy, the popliteal fossa is dissected.

After the blunt preparation in the popliteal fossa, the A. and V. poplitea and the M. popliteus are exposed. The A. and V. poplitea are protected by the lateral head of the M. gastrocnemius, which is retracted by a Langenbeck retractor (Fig. 4). The A. and V. genicularis inf. are ligated only if necessary. At the distal edge of the M. popliteus, a Langenbeck hook is applied, and the muscle is pulled back toward the medial and cranial direction. Then, the M. soleus is carefully detached from the dorsal surface of the fibula (Fig. 4). The soleus muscle should be detached distally until the peroneal nerve at the fibular neck enters into the musculature. The peroneal nerve should not be dissected after it enters into the musculature because muscle branches leading off in an atypical fashion can be easily damaged. Furthermore, care must be taken so that small nerve branches innervating the M. soleus, which penetrate the muscle at the cranial edge, are not damaged. The muscle can be mobilized approximately 4 to 5 cm in the distal direction (Fig. 4). With a raspatory, soft tissue can be removed from fragments, which can be exposed in an L-shaped area at the dorsal side of the lateral tibial plateau (Fig. 4).

The visual control of fracture reduction is achieved by using a lateral standard arthrotomy to the lateral tibia plateau, as described previously. Impacted, depressed articular segments can be mobilized laterally and elevated with a bone plunger that is introduced in the tibial head through a small lateral rectangular cortical window. The posterolateral fragments are manipulated and reduced from the dorsal side with a raspatory or with pointed reduction forceps. Usually, there are one to two main posterolateral fragments, which, after reduction, are held in place using Kirschner wires. To ensure that the reduction procedure does not lead to overall varus alignment, plain radiographs need to be performed intraoperatively. After radiologic control of fracture reduction, a conventional radius T-plate (3.5 mm titanium; Clinical House, Bochum, Germany) can be pinched off with lateral cutters so that a two-hole L-plate is obtained (Fig. 5). To buttress the fracture, the plate can be slightly undercontoured and dorsally fixed with conventional screws. The lateral edge of the plate lies immediately next to the fibular head (Fig. 6). The position of the posterolateral plate is demonstrated by the postoperative x-ray (Fig. 7).

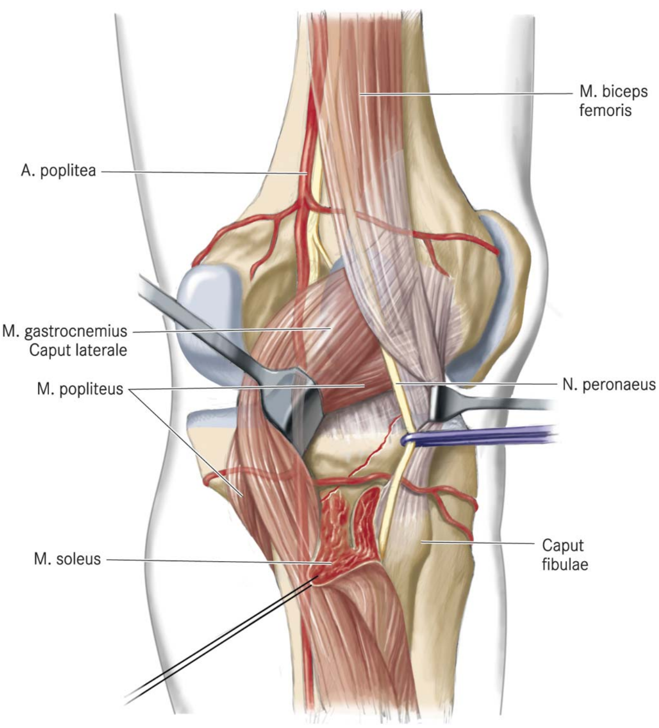

FIGURE 4. An illustration of the posterolateral corner of the tibia. In the distal direction, the M. soleus and the peroneal nerve border the situs. In the medial direction, the operation site is bordered by the A. and V. poplitea. In the cranial direction, the operation site is bordered by the M. popliteus and in the lateral direction by the fibular head, the lateral collateral ligament, the tendon of the M. biceps femoris, and the peroneal nerve. The dissected area at the tibial head is approximately 3 cm wide in the cranial direction, L-shaped, and approximately 4 to 5 cm length from the cranial to caudal direction.

Clinical Results

In a period of 2 years, seven patients with posterolateral tibial plateau fractures received open reduction and internal fixation with the new posterolateral approach. According to the OTA classification, there were three 41B3, one 41C1, and three 41C3 fractures. Four patients were operated on within 1 week after trauma, and three patients presented 3 to 4 months after trauma with residual stepoffs (greater than 5 mm) or a depressed joint surface (greater than 5 mm), which required intra-articular osteotomy, open reduction, and plate fixation.

The patients were clinically examined between 12 and 24 months after surgery. Six patients were pain-free with full range of motion and stable knees. Radiologically, good fracture reduction was achieved in six cases. In one patient with a posterolateral comminuted dislocation fracture, a stepoff of greater than 3 mm and a gap were observed. This patient reported pain after walking and has limited range of motion

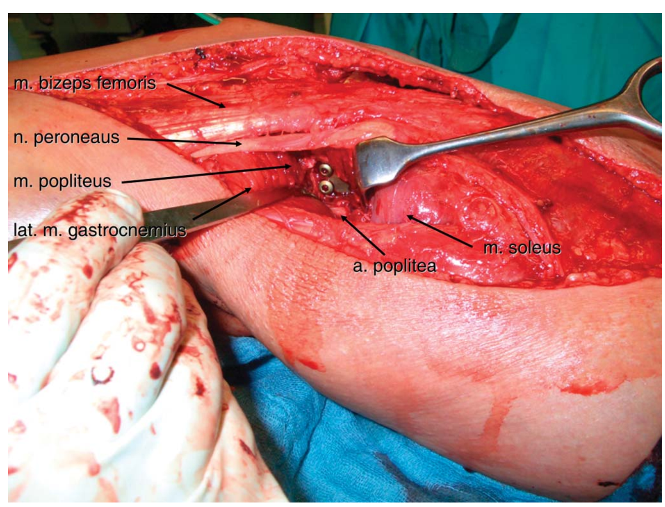

FIGURE 5. The intraoperative situs of the right knee from the posterolateral view after reduction of the fracture and plate osteosynthesis.

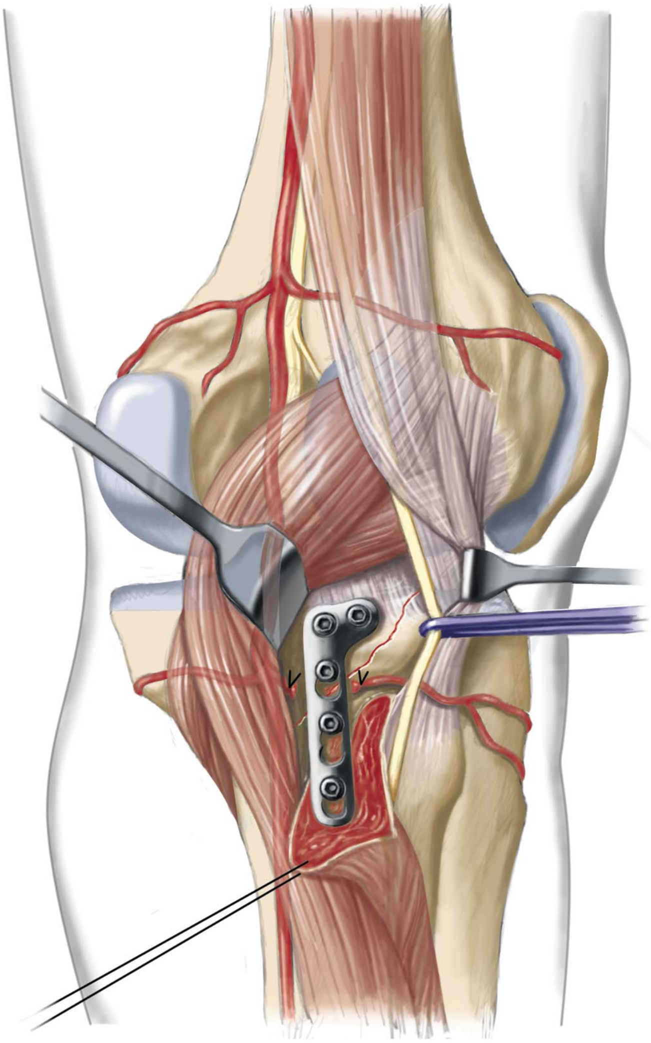

FIGURE 6. A schematic drawing of the intraoperative situs from the posterolateral view. The lateral gastrocnemius is held medially, and the plate is positioned under the proximally dissected soleus muscle. At the distal edge, the plate is close to the popliteal artery.

FIGURE 7. A conventional x-ray in two planes 18 months postoperatively. The posterolateral fragment was fixed with a posterolateral plate. In this case, an additional lateral buttress plate was necessary to fix the lateral main fragment. As demonstrated by the x-ray, anatomic reconstruction accompanied by complete fracture healing was achieved. The patient reported no pain, could use her leg normally, and was able to work. A clinical examination revealed no tenderness on palpation, and the ligaments were stable with a free range of motion.

(0-0-110°). Only one patient needed an extension of the presented posterolateral approach with additional fibula osteotomy for a 4-month-old posterolateral tibial plateau fracture, which required intra-articular osteotomy of the posterolateral corner. This patient was pain-free at follow-up after 24 months. No complications were found with this approach. In particular, no peroneal nerve injuries were detected.

DISCUSSION

In recent years, three-dimensional imaging has contributed enormously to the improvement of the operative treatment of joint fractures. In particular, preoperative fracture analysis allows surgeons to precisely plan their approach and treatment strategies.[12,13] Specifically, on the tibia plateau, the dorsal parts of the plateau are generally unsatisfactorily dealt with by the well-established medial and lateral standard access strategies.[14] Therefore, multiple authors recommend that tibial plateau fractures involving the posteromedial region should be treated using posteromedial approaches.[4,7,15] Barei et al demonstrated that 74% of bicondylar tibial plateau fractures involve the posteromedial parts.[13] For this type of fracture, they used an anterolateral and a posteromedial standard approach.[4] Although posterolateral and posteromedial tibial head fractures occur with similar frequency,[6] the posterolateral approach is used less frequently than the posteromedial approach.[7]

The posterolateral approach described by Lobenhoffer et al[6] allows an optimal overview of the posterolateral tibia plateau. However, in our opinion, the disadvantage of Lobenhoffer's approach is the considerable trauma to the soft tissue caused by extended exposure, particularly to the posterolateral structures. The loss of reduction observed in 50% of cases with tibia plateau fractures treated with this approach[6] could also be caused by trauma to the posterolateral corner soft tissue and the associated reduced blood circulation in the fragments. Thus, a good view and exposure of the posterolateral fragments might be gained but at the expense of tissue nutrition.

In our opinion, the isolated posterior approaches to the posterolateral corner[8–11,14,16] have some disadvantages compared with the approach outlined here. With dorsal approaches, a dorsal arthrotomy in the posterolateral area is necessary. In this area, strong and important ligaments like the ligamentum popliteum obliquum, ligamentum popliteum arcuatum, popliteal tendon, joint capsule, ligamentum meniscotibiale, and others have to be dissected. With our approach, these ligaments can be preserved. We laterally dissected the capsule and the ligamentum meniscotibiale to expose the entire lateral tibial plateau. Therefore, the damage to the soft tissue might be even higher with the isolated posterior approaches compared with our approach. In particular, the peroneal nerve needs to be exposed in posterior approaches in a similar manner[10,14] as described here. In 1968, Trickey[17] introduced the popliteal midline S-shaped incision. However, because elevation of a large skin flap is necessary for visualization, an injury to the sural cutaneous nerve is much more likely to occur. Furthermore, this approach requires extensive dissection of the popliteal neurovascular bundle. Tao et al[10] recently introduced a modified L-shaped incision to expose the posterior aspect of the lateral plateau through the intervals among the medial gastrocnemius, lateral gastrocnemius, popliteus, and soleus. Although blunt dissection among muscle intervals is preferred, exposure and retraction of the popliteal neurovascular bundle is unnecessary, tedious, and risky. A very similar approach to the dorsal parts of the proximal tibia was presented by Zhang et al.[14] A disadvantage of this technique is that it is performed in the prone position.[14] By using the isolated posterior approaches,[8–11,14,16,17] only a limited view of the lateral plateau is possible. It is also very difficult to extend isolated dorsal approaches, especially when the fractures are more complex and involve the lateral or anterolateral parts of the tibia plateau, as seen in the patient presented here. Therefore, the presented approach is performed in a lateral position.

For the modified posterolateral approach that is presented here, visual control of the reduction of the fracture is achieved through a conventional, lateral standard arthrotomy, which is accomplished through the same skin incision. The anatomic reduction of the fracture and internal fixation are performed from the dorsal side. Therefore, as a result of the modified posterolateral approach, the fragments are not denuded. In the event of complex damage to the posterolateral corner, the modified posterolateral approach described here can be extended, if necessary, by additional fibular osteotomy, as described by Lobenhoffer.[6] In our clinic, seven patients to date have been treated by the described approach, and only one needed additional fibula osteotomy for a 4-month-old posterolateral tibial plateau fracture, which required intra-articular osteotomy of the posterolateral corner.

The avoidance of fibula osteotomy in most patients with posterolateral tibial plateau fractures is an advantage of the approach presented. Damage to the upper tibiofibular joint and nerve injuries caused by an oscillating saw blade can be avoided by using the presented technique. Nevertheless, peroneal nerve injuries can occur as a result of manipulation during surgery. Nerve injuries were not observed in any of our seven patients.

A limitation of the presented modified posterolateral approach is that it cannot be extended distally because of the trifurcation vessels that traverse the interosseous membrane approximately 5 cm below the joint line.[14] However, because the lateral tibial metaphysis has a posterior inclination angle of approximately 45°[14] and the posterolateral split fracture segment is usually less than 4 cm in cortical length,[14] this limitation does not seem to be a problem in practice. Therefore, iatrogenic injuries of blood vessels did not occur in our series. To avoid such possible injuries, it is very important that the posterolateral plate is not placed too far distally, that the popliteal artery is carefully dissected, and that the plate is positioned under visual control. When inserting the plate, it is also important that the distal end of the plate has continuous contact with the tibial bone so that the vessel cannot extend under the plate.

Another disadvantage of the presented operation technique is that it can be difficult to address additional medial plateau fractures when the patient is lying in the described lateral position. In case of additional involvement of the medial plateau, we either recommend to intraoperatively switch the patient from a lateral to a supine position or to use Lobenhoffer's approach, which can be performed in the supine position and allows an additional medial approach without changing the patient's intraoperative position.

Precise knowledge of the anatomy of the posterolateral corner is required to perform the presented approach because nerves and vessels that border the operation site and almost encircle this area must be dissected and separated from one another. To avoid damage to vessels and nerves, the surgery must be done very carefully.

CONCLUSION

The modified and combined lateral and posterolateral approach to the tibia plateau presented here has not been previously described in the literature. This approach could potentially be used to treat posterolateral tibia plateau fractures. The modified posterolateral approach demands precise knowledge of the anatomic structures of that region. The advantages of the presented modified posterolateral approach are the protection of soft tissue and ligamentous structures, the ability to dispense with fibular osteotomy, and the preservation of soft tissue around the posterolateral fragments.

ACKNOWLEDGMENT

We thank Bianca Lumpp for providing anatomic illustrations.

REFERENCES

1. Cole PA, Zlowodzki M, Kregor PJ. Treatment of proximal tibia fractures using the less invasive stabilization system: surgical experience and early clinical results in 77 fractures. *J Orthop Trauma*. 2004;18:528–535.
2. Partenheimer A, Gösling T, Müller M, et al. Management of bicondylar fractures of the tibial plateau with unilateral fixed-angle plate fixation. *Unfallchirurg*. 2007;110:675–683.
3. Stevens DG, Beharry R, McKee MD. The long-term functional outcome of operatively treated tibial plateau fractures. *J Orthop Trauma*. 2001;15:312–320.
4. Barei DP, Nork SE, Mills WJ, et al. Functional outcomes of severe bicondylar tibial plateau fractures treated with dual incisions and medial and lateral plates. *J Bone Joint Surg Am*. 2006;88:1713–1721.
5. Kerkhoffs GM, Rademakers MV, Altena M, et al. Combined intra-articular and varus opening wedge osteotomy for lateral depression and valgus malunion of the proximal part of the tibia. Surgical technique. *J Bone Joint Surg Am*. 2009;91(Suppl 2):101–115.
6. Lobenhoffer P, Gerich T, Bertram T, et al. Spezielle posteromediale and posterolaterale Zugänge zur Versorgung von Tibiakopffrakturen. *Unfallchirurg*. 1997;100:957–967.
7. Ruedi TP, Buckley RE, Moran CG. *AO-Principles of Fracture Management*. 2nd expanded edition. New York: Thieme; 2007:814–833.

8. Carlson DA. Posterior bicondylar tibial plateau fractures. *J Orthop Trauma*. 2005;19:73–78.
9. Bhattacharyya T, McCarty LP 3rd, Harris MB, et al. The posterior shearing tibial plateau fracture: treatment and results via a posterior approach. *J Orthop Trauma*. 2005;19:305–310.
10. Tao J, Hang DH, Wang QG, et al. The posterolateral shearing tibial plateau fracture: treatment and results via a modified posterolateral approach. *Knee*. 2008;15:473–479.
11. Brunner A, Honigmann P, Horisberger M, et al. Open reduction and fixation of medial Moore type II fractures of the tibial plateau by a direct dorsal approach. *Arch Orthop Trauma Surg*. 2009;129: 1233–1238.
12. Chan PS, Klimkiewicz JJ, Luchetti WT, et al. Impact of CT scan on treatment plan and fracture classification of tibial plateau fractures. *J Orthop Trauma*. 1997;11:484–489.
13. Barei DP, Mara TJ, Taitsman LA, et al. Frequency and fracture morphology of the posteromedial fragment in bicondylar tibial plateau fracture patterns. *J Orthop Trauma*. 2008;22:176–182.
14. Chang SM, Zheng HP, Li HF, et al. Treatment of isolated posterior coronal fracture of the lateral tibial plateau through posterolateral approach for direct exposure and buttress plate fixation. *Arch Orthop Trauma Surg*. 2009;129:955–962.
15. Fakler JK, Ryzewicz M, Hartshorn C, et al. Optimizing the management of Moore type I postero-medial split fracture dislocations of the tibial head: description of the Lobenhoffer approach. *J Orthop Trauma*. 2007;21:330–336.
16. Minkoff J, Jaffe L, Menendez L. Limited posterolateral surgical approach to the knee for excision of osteoid osteoma. *Clin Orthop Relat Res*. 1987; 223:237–246.
17. Trickey EL. Rupture of the posterior cruciate ligament of the knee. *J Bone Joint Surg Br*. 1968;50:334–341.

