Technical Note

Arthroscopic Controlled Closed Reduction and Percutaneous Fixation of Posterolateral Tibia Plateau Impression Fractures

Christine Ackermann, M.D., Jannik Frings, M.D., Lena Alm, M.D., and Karl-Heinz Frosch, M.D.

Abstract: Posterolateral impression fractures of the tibial plateau are common, and open reduction and fixation can be demanding, including exposure of the peroneal nerve. Based on a patient example, the surgical technique of an arthroscopic controlled closed reduction and percutaneous screw fixation of a posterolateral tibia plateau impressed fracture is described. A patient sustained a posterolateral impression currently described as an "apple bite" fracture of the tibial plateau. The surgical technique includes standard arthroscopic portals and posteromedial and (transseptal) posterolateral portals. The posterolateral tibial plateau is visualized by incision of popliteomeniscal fibers, retraction of the popliteus tendon, and exposure of the posterolateral plateau. The impression area is marked with a K-wire using an anterior cruciate ligament target device. A cannulated ram is placed over the K-wire. The fracture is lifted under arthroscopic guidance and can be supported with allograft bone chips. To stabilize the reduction, 3 K-wires are positioned from anterior to posterior, and 3 cannulated screws are inserted directly under the joint surface to support the fractured area. In comparison with open surgical techniques, this procedure is exclusively performed under arthroscopic control and enables an anatomic reduction and fixation of the posterolateral tibial plateau.

There is currently no "gold standard" method to stabilize posterolateral tibia plateau fractures. The main problem is the difficulty in visualizing the posterolateral corner.[1] By using anterior standard portals, arthroscopic visualization of impressed or depressed posterolateral fractures of the tibial plateau is crucial, and in most cases no sufficient exposure is possible. Therefore, most published approaches describe an open technique that occasionally requires osteotomy of the femoral epicondyle or of the fibula head to improve the visualization of the fracture.[2-4] Krause et al.[5] have already described the possibility of additional arthroscopy of the fracture called "fracturoscopy."[5]

To reduce morbidity of an open or extended approach including osteotomies and exposure of the peroneal nerve, the surgical technique of an arthroscopically controlled closed reduction and percutaneous screw fixation of a posterolateral tibia plateau impressed fracture is presented.

Surgical Technique

Arthroscopic visualization and stabilization of the posterolateral tibia plateau fracture (Fig 1), the so-called apple-bite fracture,[1] are performed. A reruptured anterior cruciate ligament (ACL) reconstruction existed as well. This is a common combination of injuries.[6,7]

In addition to a physical examination including testing the stability of the ligaments, the objective diagnosis is determined by standard anteroposterior and lateral radiographs of the knee, computed tomography with 3-dimensional reconstruction, and magnetic resonance imaging to support and verify the diagnosis.

Patient Position and Setup

The patient is in a supine position. Physical examination is reviewed, with the patient under general

From the Department of Trauma, Hand and Reconstructive Surgery, University Medical Center Hamburg-Eppendorf (C.A., J.F., K-H.F.); and Department of Trauma and Reconstructive Surgery, Asklepios Clinic St. Georg (L.A.), Hamburg, Germany.

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Address correspondence to Karl-Heinz Frosch, Department of Trauma, Hand and Reconstructive Surgery, University Medical Center Hamburg-Eppendorf, Martinistraße 52, 20246 Hamburg, Germany. E-mail: k.frosch@uke.de

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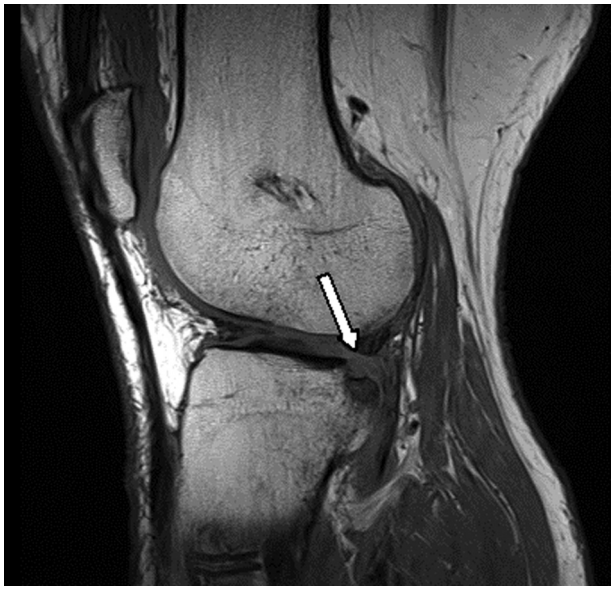

Fig 1. Sagittal view of the patient's left knee with a magnetic resonance image. The arrow points to the posterolateral impressed fracture of the tibia plateau.

anesthesia to explore if there is any other instability or injury of another ligament of the knee. The patient presents with a first-degree positive Lachman maneuvre as well as a considerably positive pivot-shift sign and no injuries of the posterior cruciate ligament or medial and lateral collateral ligaments.

A standard arthroscopic examination is performed. The injured left knee is placed in an electric leg holder and surrounded with a tourniquet. In our case it was not necessary to inflate the tourniquet.

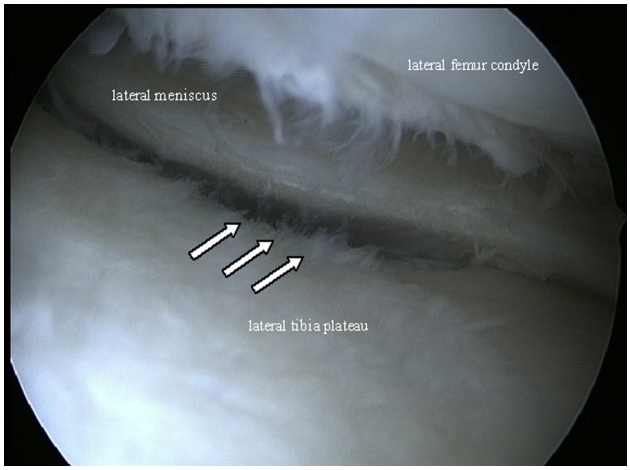

Fig 2. Left knee, visualization through the anteromedial portal. The 3 arrows show the missing posterolateral tibia plateau.

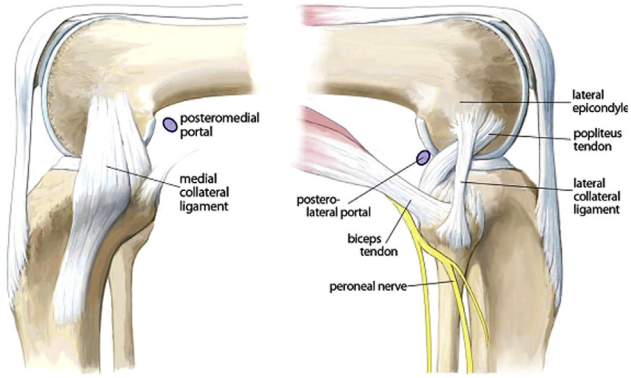

Fig 3. Posteromedial and posterolateral arthroscopic portal to fully visualize the posterolateral tibia plateau to achieve an anatomic reduction of the fracture.

Surgical Approach

Standard anterolateral and anteromedial portals are used. Diagnostic arthroscopy is used to examine the knee joint and to evaluate the fracture and additional injuries. Arthroscopy confirmed in this case a rerupture of the ACL graft.

By evaluation of the lateral knee compartment using an anterolateral portal, the posterolateral tibia plateau directly under the posterior horn of the lateral meniscus cannot be visualized (Fig 2), so the exact nature of the fracture could not be assessed through anterior portals.

Two further portals posteromedial and (transseptal) posterolateral are indispensable to improve the visualization of the posterolateral tibia plateau and the fracture (Fig 3; Table 1).

First a posteromedial portal is installed. With a shaver (Excalibur, Arthrex, Naples, FL) through the posteromedial portal, the dorsal septum is resected (Video 1). Care should be taken to stay directly dorsal to the posterior cruciate ligament to prevent injuries of the vascular bundle. For fully visualizing the fracture, a posterolateral portal is created. Then the arthroscope is inserted through the posteromedial portal and the shaver is inserted through the posterolateral portal. Preparation is started at the hiatus popliteus with a radio frequency electrode (VAPR Temperature Control Electrode, Depuy Synthes) by dissecting popliteomeniscal fibres dorsally to the popliteus tendon (Figs 4 and 5). Dissection is performed until the tendon can be retracted with a raspatory or a hook to visualize the sulcus popliteus, as described elsewhere.[8] A multifragmentary depressed fracture of the posterolateral tibia plateau is shown (Figs 6-8).

Reduction of the Fracture

An ACL tibial drill guide is inserted through the anteromedial portal, aiming at the impressed posterolateral tibia plateau (Figs 9 and 10). A K-wire is drilled through the tibia (Fig 11), a cannulated ram is placed

Table 1. Pearls and Pitfalls

Steps	Pearls	Pitfalls
Visualization of the fracture	Proper visualization of the posterolateral tibia plateau and the fracture is achieved by using posteromedial and (transseptal) posterolateral portals.	It is impossible to visualize the fracture by using only anteromedial and anterolateral portals.
Approach to the posterolateral tibial plateau	During preparation through the dorsal septum, stay directly dorsal to the posterior cruciate ligament to prevent injuries of the vascular bundle.	Care should be taken by resecting the dorsal septum through the posteromedial portal not to injure neurovascular structures.
Preparations of the sulcus popliteus	To visualize the sulcus popliteus, and to retract the tendon, dissecting the popliteomeniscal fibers is necessary.	The tendon of the popliteus hides the full visualization of the posterolateral tibial plateau.
Aiming at the depressed posterolateral corner	A drill guide for anterior cruciate ligament reconstruction is used to aim at the impression of the posterolateral tibial plateau with a K-wire and to place a cannulated ram over it to lift up the depressed parts of the tibial plateau.	The depressed area should be lifted up stepwise and gently under arthroscopic control to achieve anatomic reduction. Perforation with the ram should be prevented.
Support the reduced fracture	Support the reduced fracture by filling the tibial defect with allograft bone chips (optional).	Delayed healing should be avoided.
Fixation	K-wires should be drilled parallel directly underneath the joint surface as guide wires for cannulated screws.	Intra-articular or malpositioning of the screws should be prevented as well as missing the reduced fragment by the screws.
Postoperative mobilization	Partial weight bearing up to 20 kg, full extension, and limited flexion are recommended for at least 6 weeks.	Prevention of arthrofibrosis and secondary fracture dislocation.

over the K-wire (Fig 12, diameter 8 mm), and the depressed posterolateral corner of the tibia plateau is lifted up stepwise (Fig 13) until an anatomic articular reduction is achieved.

The movement is continuously supervised by the arthroscope through the posterolateral and posteromedial portal. Reduction can be supported as needed by a raspatory. Furthermore, the reduction of the fracture is evaluated by fluoroscopy (Fig 14).

Fixation of the Fracture

After anatomic reduction, 3 K-wires 1.4 mm in diameter are drilled parallel from anterior to posterior directly underneath the joint surface of the lateral tibia plateau (Figs 14 and 15), followed by reaming 2.7 mm and inserting 3 cannulated screws 4.0 mm (Asnis III Cannulated Screw 4.0 mm, Stryker; Figs 16 and 17). The achievement of anatomic articular reduction by

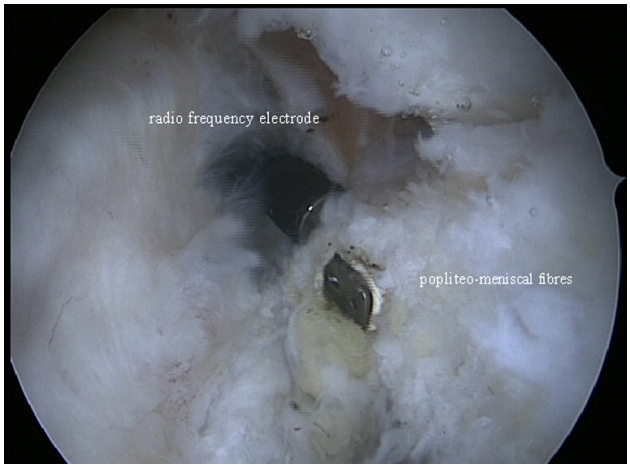

Fig 4. Left knee, visualization from the posteromedial portal. The radiofrequency electrode is inserted through the posterolateral portal and dissects the popliteomeniscal fibers.

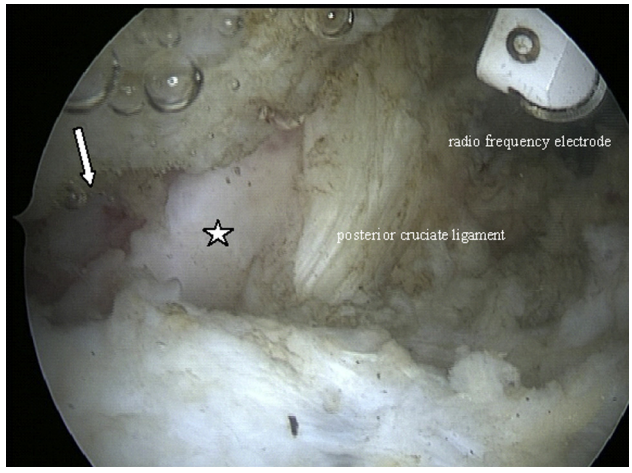

Fig 5. Left knee, visualization from the posterolateral portal. The radiofrequency electrode is inserted through the posteromedial portal. The star marks the dropped fragment of the fractured posterolateral tibia plateau. The arrow points to the impressed tibial plateau.

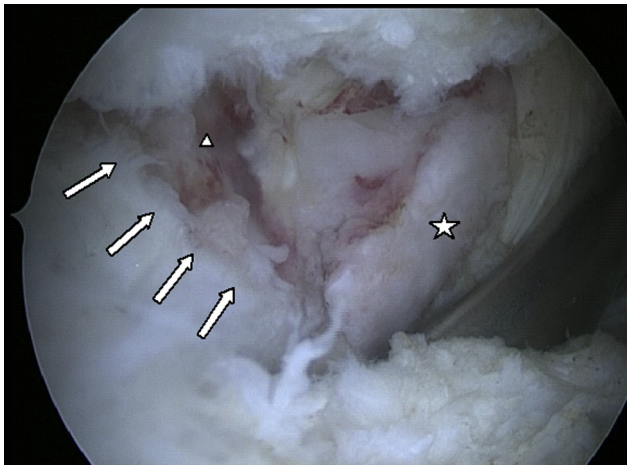

Fig 6. Left knee, visualization from the posterolateral portal. The star marks the dropped fragment of the fractured posterolateral tibia plateau. The triangle marks the depressed tibial plateau. The arrows point at the rim of the fracture.

lifting the fracture is supported by filling up the tibial defect with allograft bone chips (DIZG, Berlin, Germany).

Preparing the ACL Tunnels (due to ACL Rerupture)

For reconstruction of the ACL in the future, the ruptured ACL graft has to be completely removed. A K-wire marks the tibial channel under radiologic and arthroscopic support. The tibial channel was cleaned up by drilling with a 9-mm reamer and shaver. Samples of the ACL reconstruction are taken for microbiology and histology examination. The tunnel is filled up with allograft bone chips (DIZG).

Postoperative Protocol

After surgery the patient is mobilized with crutches and partial weight bearing up to 20 kg for 6 weeks. Full

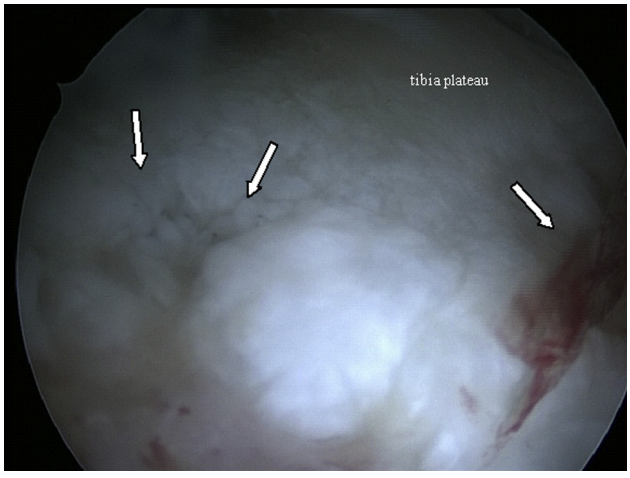

Fig 7. Left knee, visualization through the posterolateral portal. The arrows point to the rim of the fracture.

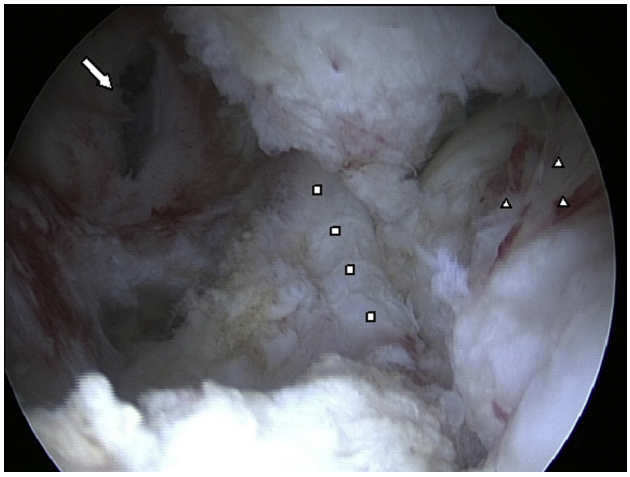

Fig 8. Left knee, visualization through the posteromedial portal. The arrow shows the entrance of the posterolateral portal. The squares mark the popliteus tendon. The triangles mark the depressed tibia plateau.

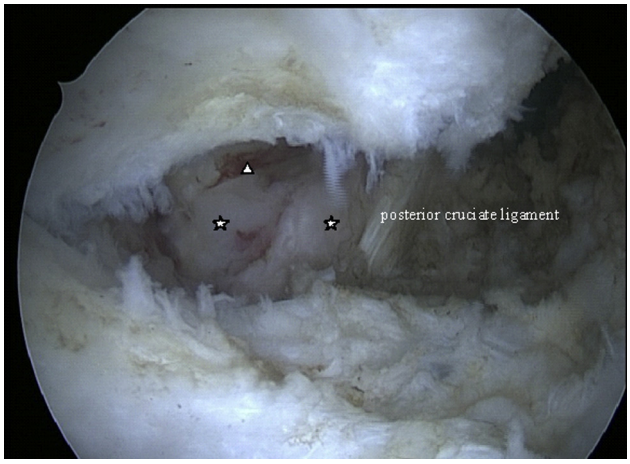

Fig 9. Left knee, visualization through the posterolateral portal. The stars mark the dropped fragments of the fractured posterolateral tibia plateau. The triangle marks the impressed tibial plateau.

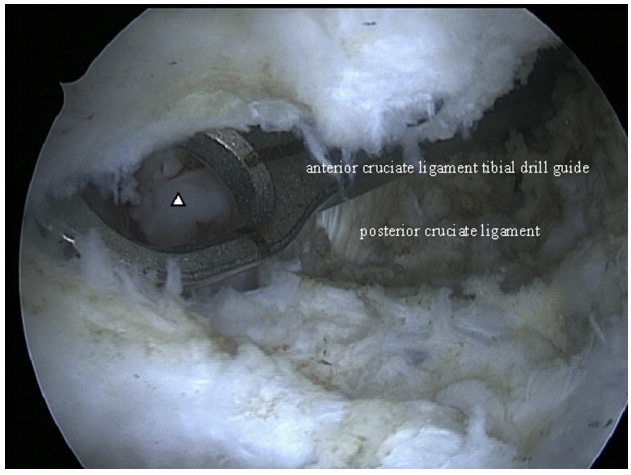

Fig 10. Left knee, visualization through the posterolateral portal. The triangle marks the depressed tibia plateau. The anterior cruciate ligament drill guide is aiming at the posterolateral impressed tibia plateau to place a K-wire. Afterward the cannulated ram is placed over the K-wire.

Fig 11. Intraoperative fluoroscopy of the left knee. The K-wire points to the posterolateral fractured tibia plateau.

extension is allowed, with limited flexion to 60° for 4 weeks. After another 2 weeks the range of motion is limited to 0°-0°-90°.

The femoral and tibial channel has to be examined by computer tomography after 4 to 6 months to prove the consolidation of the channels before planning a new ACL reconstruction.

Discussion

Up to now fractures of the tibia plateau have been mostly treated through open approaches with or without additional arthroscopy like the "fracturoscopy" mentioned by Krause et al.[5,9] Based on the literature and our own experiences, the following indications for arthroscopy-assisted fracture fixation in the knee are considered: (1) simple fractures of the tibial plateau and depression fractures of the tibial plateau, (2) arthroscopic control of reconstruction of the articular surface in complex fractures (fracturoscopy), (3) bony avulsions of the posterior or ACL, (4) osteochondral flakes, (5) therapy of concomitant intra-articular lesions in fractures of the knee joint, and (6) arthroscopy in post-traumatic situations.[10] In particular, simple fractures as classified AO type B1 or B2 are mainly in the central or anterior parts of the plateau, which enable a sufficient arthroscopic visualization, whereas posterolateral depressions or impressions are difficult to visualize by anterior arthroscopic portals. As shown in the present case, additional posteromedial and posterolateral portals are necessary.

Arthroscopic reduction and fixation of tibia plateau fractures are described in the literature.[11,12] The differences are that they use anterior portals and talk about tibial plateau depressed fractures like Schatzker type II and III.

The proper visualization of a fracture of the posterolateral tibia plateau is hard to achieve, especially if the posterolateral joint surface is impressed or depressed. But it is indispensable for an anatomical reduction.

Therefore it is necessary to differentiate between the different localizations of the fractures at the tibia plateau, which is considered in a new classification

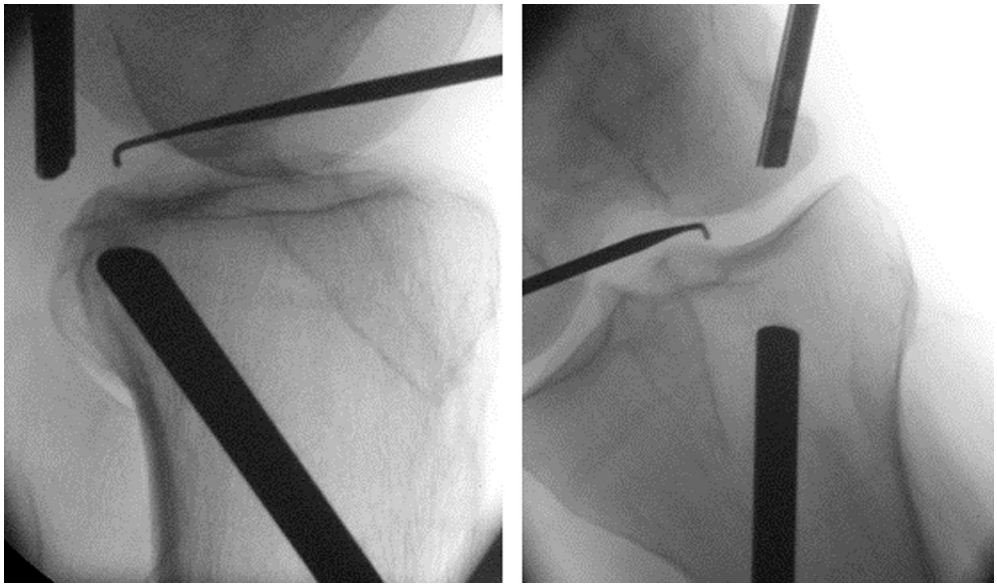

Fig 12. Intraoperative imaging of the left knee. The ram is placed over the K-wire to lift up the fracture.

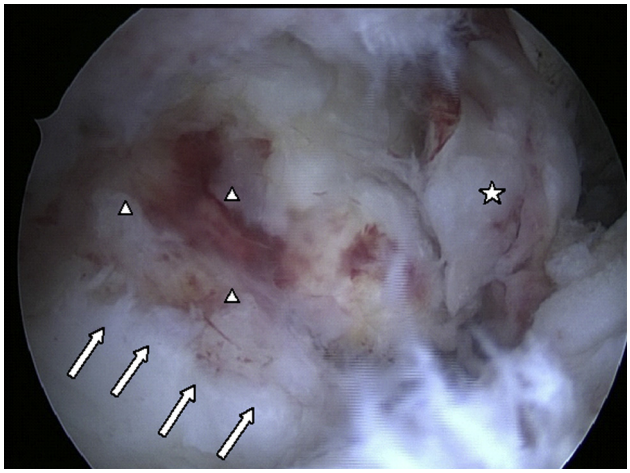

Fig 13. Left knee, visualization through the posterolateral portal. The star marks the dropped fragment of the fractured posterolateral tibia plateau. The triangles mark the depressed tibia plateau. The arrows point at the rim of the fracture.

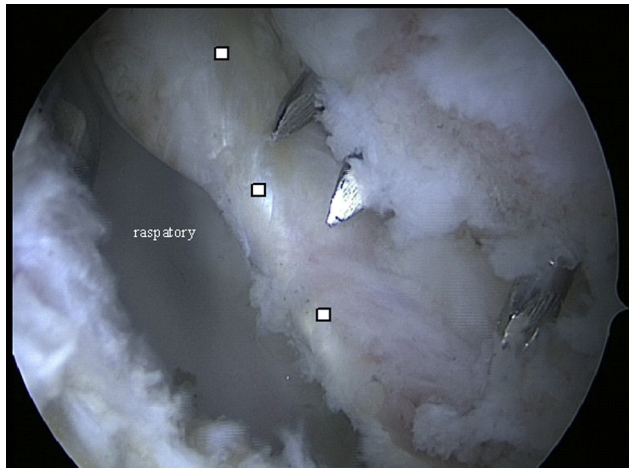

Fig 15. Left knee, visualization through the posteromedial portal. Three K-wires fix the reduced posterolateral tibia plateau. The raspatory holds back the tendon of the popliteus. The squares mark the popliteus tendon.

system of these fracures.[1,11] The "restricted visibility of posterior segments, whose reduction and fixation is crucial for long-term success"[13] by standard anterior approaches has already been described.[1,13] To prevent malreduction, an optimal visualization of the fracture by using different approaches like the posterolateral approach[4] or other lateral approaches[2,3,14] may be necessary, including osteotomy of fibula[3] or osteotomy of the lateral femoral epicondyle.[4] All of these approaches are at risk of damaging soft tissue structures (nerves, muscles, tendons, and ligaments) and might have higher postoperative risks like infections and nonunions.

This Technical Note shows an arthroscopically assisted anatomic reduction of a posterolateral tibia plateau fracture. To achieve this, additional portals such as the posterolateral and posteromedial as well as skills and experience in arthroscopic surgery and fracture treatment are necessary (Table 2).

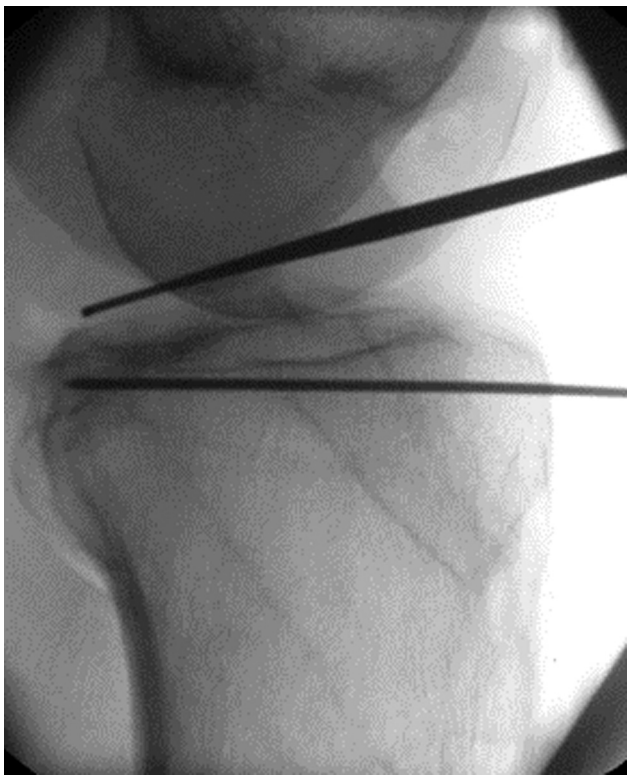

Fig 14. Intraoperative imaging of the left knee. A K-wire fixes the reduced posterolateral fragment.

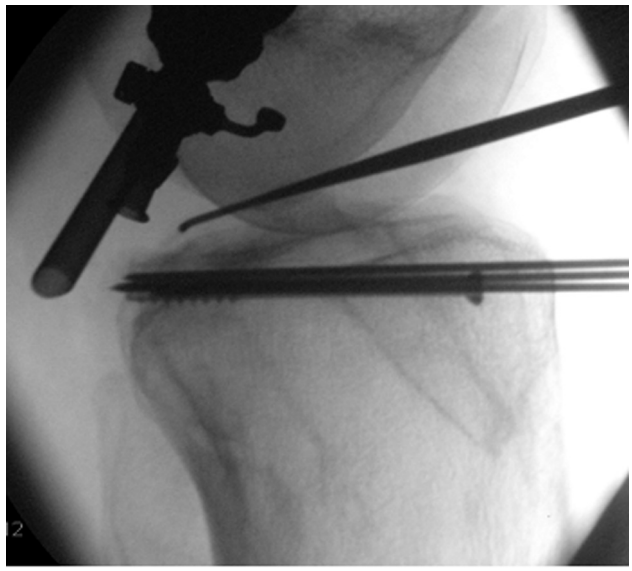

Fig 16. Intraoperative fluoroscopy of the left knee. Three K-wires fix the reduced posterolateral tibial plateau, and 1 cannulated screw is inserted.

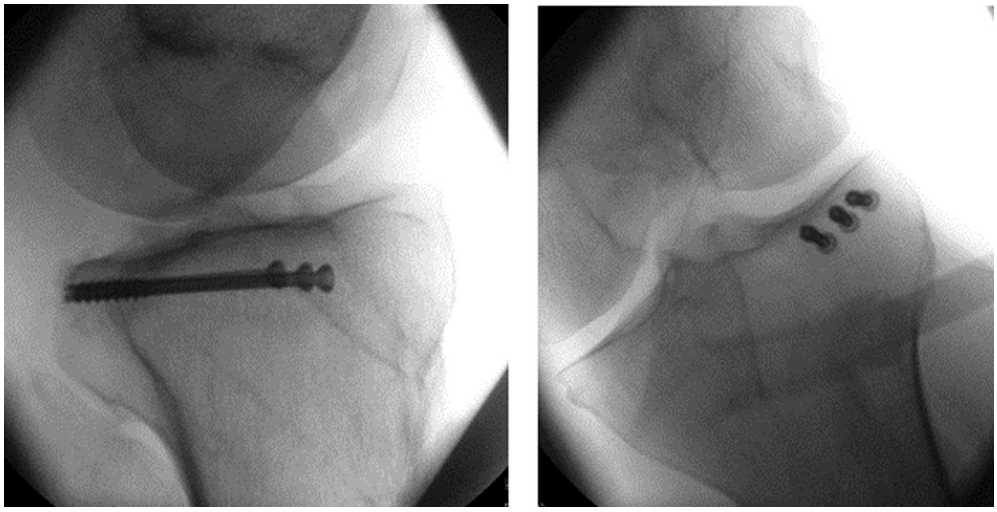

Fig 17. Intraoperative fluoroscopy of the left knee. The posterolateral tibia plateau is anatomically reduced and fixed by 3 cannulated screws directly under the subcortical bone.

Table 2. Advantages and Disadvantages

Advantages	Disadvantages
Exclusively nonopen techniques of fracture reduction.	Requires advanced arthroscopic skills.
No osteotomy of femoral epicondyle or of the fibula head.	The use of special instruments is strongly recommended (i.e., anterior cruciate ligament drill guide).
More aesthetic incisions.	This arthroscopic technique is indicated for simple fractures and fewer dislocated fractures.
Small incisions lead to lower risks of bone and soft tissue infections.	
Lower risk of damaging nerves and less postoperative pain.	
Proper visualization of the posterolateral tibial fracture.	
Arthroscopic control improves anatomical reduction of the articular surface.	
Short operation time.	

The described procedure provides an arthroscopic reduction technique of posterolateral depression fractures with percutaneous screw fixation. The performance of this technique requires advanced arthroscopic skills to avoid risks like injury of the neurovascular structures, perforation with the ram, and intra-articular or malposition of the screws. This technique is limited to simple fractures of the tibia plateau. This Technical Note clarifies the challenge in achieving a better visualization for the specific posterolateral depressed tibia plateau fractures. We stress the need for posteromedial and (transseptal) posterolateral portals with posterolateral capsular incision to achieve an anatomic reduction and proper fixation of the fracture.

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