

Optimizing the Management of Moore Type I Postero-Medial Split Fracture Dislocations of the Tibial Head: Description of the Lobenhoffer Approach

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Summary: Moore type I tibial plateau fracture-dislocations pose a significant challenge to the treating surgeon. The displaced posteromedial fragment is difficult to reduce and adequately stabilize through traditional approaches. The Lobenhoffer approach provides the necessary access to the posterior surface of the proximal tibia but has only been described in the German-language literature. It involves a less extensive soft tissue dissection than that required by other posterior approaches. We provide the first English-language description of the technique, with 2 cases presented as illustrations of the approach.

Key Words: tibia plateau fracture, surgical approach, Moore type I, posterior approach, proximal tibia

(*J Orthop Trauma* 2007;21:330–336)

INTRODUCTION

Moore type I posteromedial split fracture-dislocations of the proximal tibia are relatively uncommon.^{1,2} It is a specific fracture pattern that is not well described by the AO (41-B2.2/B3.2) or Schatzker (IV) classification systems because these systems do not differentiate when the medial fragment is primarily posterior and associated with a dislocation as the Moore system does. They are mostly caused by high-energy trauma mechanisms and associated with significant ligament and soft tissue injuries.² This fracture pattern, however, is inherently unstable and difficult to adequately reduce and stabilize by conventional techniques and approaches.^{3,4} A reduction problem is created by the typical posteromedial displacement of the tibial fragment with knee flexion. Furthermore, biomechanical principles require placement of a posterior antiglide buttress plate. Both aforementioned

considerations imply that the Moore type I fractures cannot be optimally treated by conventional anterior, medial, or posteromedial approaches in the supine position.⁴ Conventional approaches for these fractures usually involve an extensive medial dissection, medial parapatellar arthrotomy, or both.⁵ Under standard conditions, an extension by vertical incision of the posteromedial collateral ligament and detachment of the medial capsule and the medial head of gastrocnemius from the medial femoral condyle are required for full exposure of the dorsomedial facet.⁴ Posterior approaches, such as described by Trickey in the 1960s, are more demanding and involve a dissection of the neurovascular bundle.^{6,7}

To overcome these problems, Galla and Lobenhoffer described a direct posteromedial approach for managing Moore type I tibial head fracture dislocations.⁸ This approach does not involve a dissection of the neurovascular bundle and allows excellent fracture visualization and appropriate placement of hardware, while minimizing soft tissue dissection. Furthermore, the prone positioning enables an easy reduction by axial traction and hyperextension of the knee. This direct posterior approach has been previously described exclusively in the German literature⁸ and is presented here in the English language for the first time to our knowledge.

DESCRIPTION OF PROCEDURE

The operation is performed with the patient in the prone position, with an exsanguinated leg and the use of a thigh tourniquet. The landmarks consist of the medial head of the gastrocnemius muscle and the hamstrings, which are easily palpated on the medial border of the popliteal fossa. The 6–8-cm long skin incision is performed straight along the border of the medial head of gastrocnemius and ends at the level of the medial joint line. The popliteal fossa is not crossed (Fig. 1A). The subcutaneous tissue and popliteal fascia are incised by sharp dissection (Fig. 1B). The small saphenous vein is identified in the sulcus between the two gastrocnemius heads (Fig. 2A). Lateral of the vein is the medial sural cutaneous nerve, which is a branch of the tibial nerve in the popliteal fossa (Fig. 2A). The nerve is not touched because the dissection stays on the medial border of the medial gastrocnemius head. There is no true internervous plane in the dissection. After blunt preparation of the medial gastrocnemius head, the muscle is retracted laterally with a Langenbeck retractor (Fig. 2B). The lateral retractors have to be placed carefully to avoid shearing injuries to the neurovascular structures (depicted in Fig. 2A).

Accepted for publication February 26, 2007.

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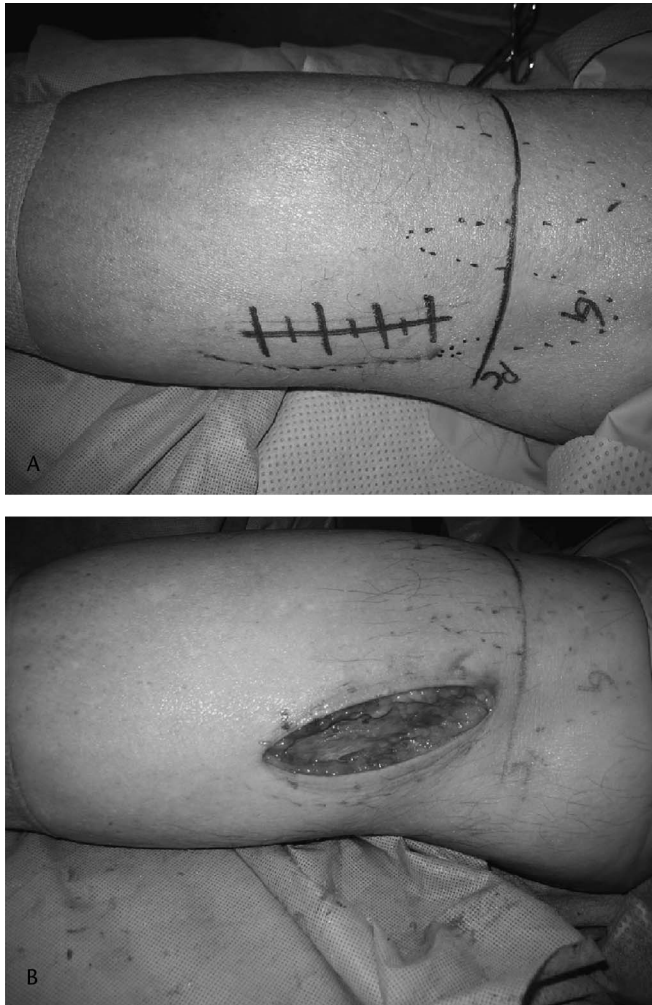


FIGURE 1. A, Skin incision along the medial head of the gastrocnemius, not crossing the popliteal fossa. B, Incision down to the fascia.

The semimembranosus-complex is also dissected by blunt preparation and retracted medially without detaching its insertion on the posteromedial tibial head (Fig. 2B). The upper border of the popliteus muscle is identified and the muscle is dissected and detached subperiostally until the posteromedial wedge of the fracture is fully exposed (Fig. 2B). If required for better exposure, the tibial insertion of the semimembranosus on the medial side can be carefully incised in a subperiosteal fashion. The soleus takes its origin off the posterior aspect of the fibula and tibia more distally than is generally required for adequate exposure. If further distal exposure is required for placement of a plate, the soleus origin may be partially elevated. Once the fracture is fully exposed, it can be reduced absolutely anatomically by hyperextension with axial traction and pushing the fragment with the help of a ballspike or periosteal elevator. The reduced fracture is fixed preliminarily with 2–3 Kirschner wires of 2.0-mm thickness, and the reduction is assessed by fluoroscopy in posterior–anterior (PA) and lateral views. In most cases, the Moore type I posteromedial dislocation fractures are best fixed with an angular stable

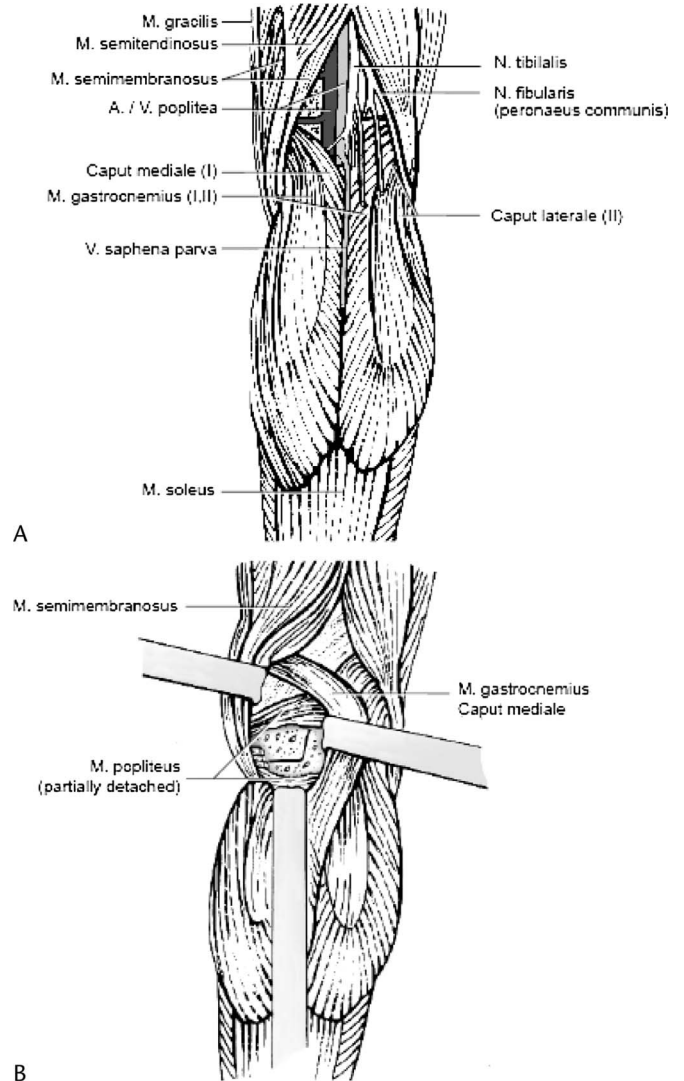


FIGURE 2. Anatomy of the popliteal fossa (A) and schematic drawing of the direct posterior approach (B), as described by Galla and Lobenhoffer (2003).⁸ See text for details and explanations.

dorsal antiglide plate (eg, a 3.5-mm T-plate; Fig. 3) The length of the plate should be selected so that at least 2–3 plate holes are fixed distal to the fracture.

The closure of the wound is simple because the plate is automatically covered by soft tissue after removal of the retractors. A deep drain is placed subfascially, and the popliteal fascia is closed by single sutures (eg, Vicryl 1) followed by closure of the subcutaneous layer and the skin. The concept of rehabilitation is by early postoperative functional aftercare, continuous passive motion, and partial weight bearing (10–15 kg) for 8–10 weeks.

There are instances in which it may be desirable to position the patient supine instead of prone. These include associated chest trauma or to avoid intraoperative repositioning in a patient undergoing multiple procedures. Supine positioning is made possible with external rotation of the affected leg,

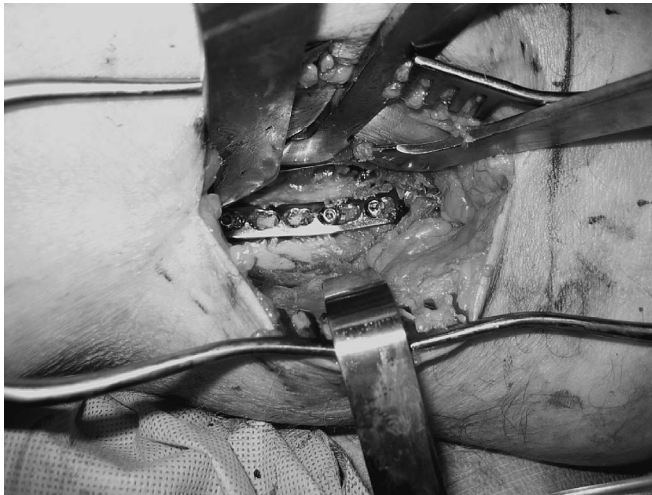


FIGURE 3. Intraoperative placement of the posterior antiglide plate.

with a bump underneath the contralateral hip. The surgeon stands on the opposite side of the table from the operative leg. When performing the approach with the patient in the supine position, knee flexion will improve visualization, although knee extension is still generally required for reduction. Although good results can be achieved performing a Lobenhoffer approach with supine positioning, we have found it more technically demanding. By placing an initial external fixator and awaiting improvement of soft tissue swelling, the patient's condition in terms of comorbid chest injury is generally improved enough to allow prone positioning.

Limitations of the approach include known limitations of prone positioning and the need for an additional incision in the case of bicondylar fractures. In the event of a need for a second, lateral incision, the surgeon will most likely be more familiar with performing the second approach in the supine position.

CASE PRESENTATIONS

Case 1

A 48-year-old male patient was involved in a motorcycle accident and sustained an indirect injury to the left knee with a combined mechanism of axial compression and rotation. He was evaluated at an outside hospital where a closed isolated left tibial plateau fracture was diagnosed (Moore type I, Schatzker 4, AO 41-B2.2). The left knee was placed in an immobilizer, and the patient was then transferred to our facility for further treatment. He presented approximately 24 hours after the injury, and on initial evaluation in the emergency department was neurovascularly intact to the left lower extremity and had no clinical signs of compartment syndrome. The knee was significantly swollen with a large effusion, but no open fracture or pending soft tissue compromise was appreciated. No other injuries were noted. Plain films and a computed tomography scan of the knee were obtained, which revealed a posteromedial fracture dislocation of the medial plateau (Fig. 4). The patient was taken to the operating room for a closed reduction and temporary fixation in a spanning external fixation of the knee given the fracture pattern and soft tissue appearance, with a plan for conversion to internal fixation once the soft tissue swelling subsided. The inherent instability of this Moore type I injury pattern is emphasized by the intraoperative views of the displaced (Fig. 5A) and reduced fracture (Fig. 5B).

The patient was admitted to the orthopaedic ward for monitoring of the soft tissue compartments, which remained soft throughout the observation period. He was evaluated in the physical therapy department and received mobility training with nonweight-bearing restrictions on the affected side. The external fixator remained in place for 9 days, until the soft tissue swelling resolved to the point where the overlying skin could be wrinkled with gentle finger traction. He was consequently taken for open reduction and internal fixation using a direct posterior approach. The fracture was anatomically reduced with a posteromedial 3.5-mm T-shaped locking compression plate used as an antiglide plate. The displaced condyle was temporarily fixed with a pelvic Matta clamp, and two 3.5-mm bicortical screws were applied percutaneously for additional stability (Fig. 6). There were no intraoperative or postoperative complications. The patient was placed in a hinged knee brace locked at full extension for the first 24 hours and kept at only touchdown weight bearing. He was discharged on postoperative day 1 after physical therapy



FIGURE 4. Preoperative x-rays of a 48-year-old patient with a Moore type I posteromedial split fracture dislocation. See text for details (Case 1).

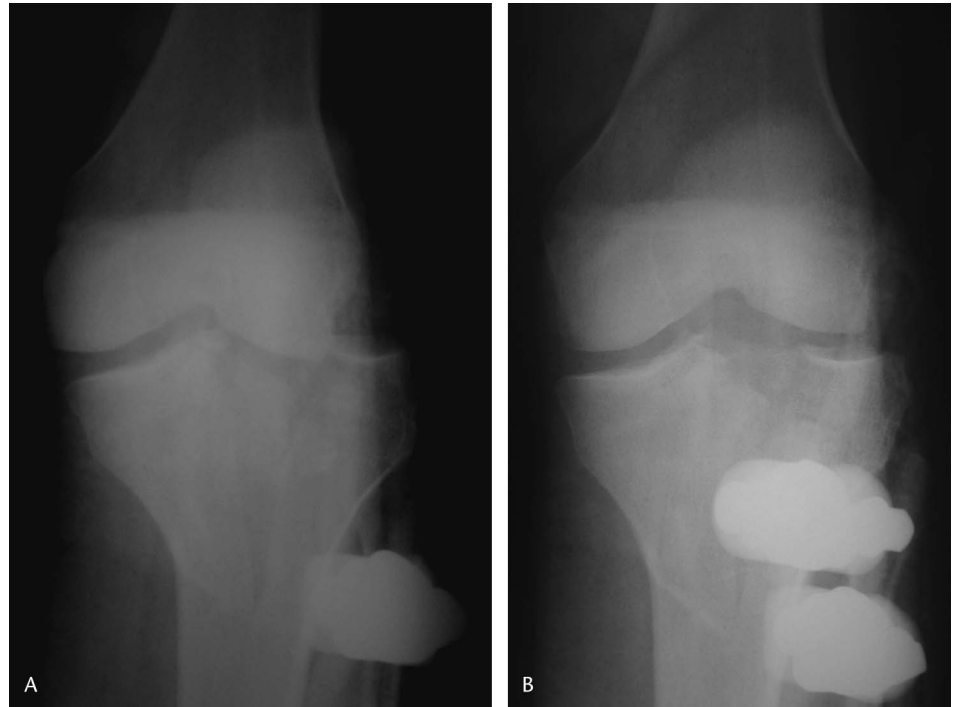


FIGURE 5. Intraoperative views of the highly unstable Moore type I fracture dislocation before (A) and after (B) closed reduction in a spanning external fixator (Case 1).

clearance with 0–60-degree range of motion in his hinged knee brace for the first 4 weeks.

Because the patient was from a distant location, we arranged for follow-up to occur with an orthopaedic physician in his hometown. Initial clinic follow-up occurred at 2 weeks. The posterior approach wound had healed without any complications and the sutures were removed. The patient was advised to increase his range of motion about 20 degrees per week until full range was regained. At 8 weeks postoperative he was noted to have

radiographic union, with no loss of reduction or fixation. He had regained flexion to 100 degrees and was advanced to weight bearing as tolerated. At the 3-month evaluation he had regained full range of motion (0 to 130 degrees). At his 6-month appointment, the patient had returned to full activity and had a functionally stable knee. Radiographic alignment was maintained on 1-year follow-up x-rays (Fig. 7). Although the proximal screws appeared prominent on the radiographs, they were not symptomatic to the patient.

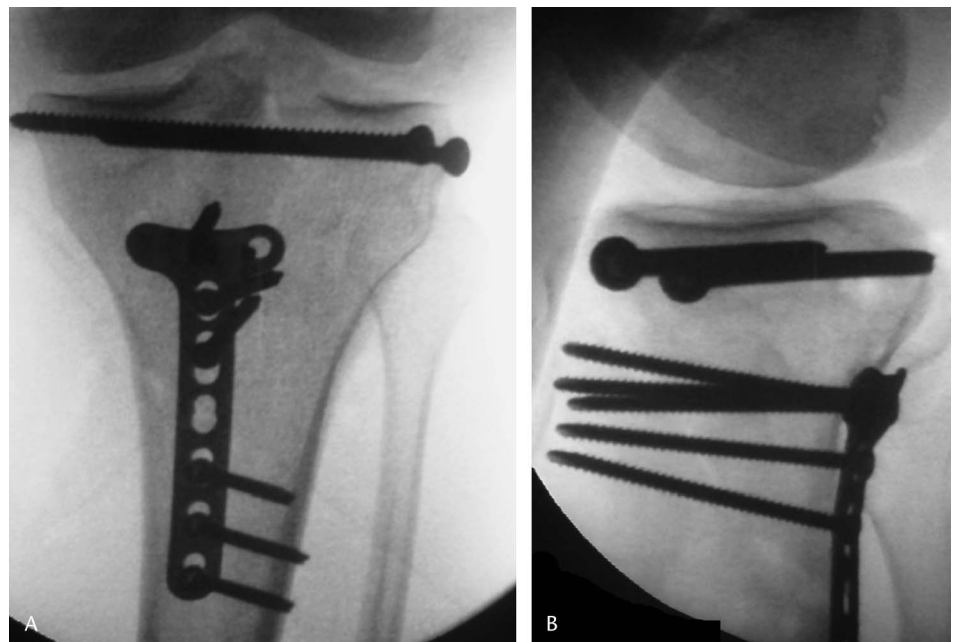


FIGURE 6. Postoperative x-rays after open anatomic reduction and fixation of the Moore type I fracture with a posterior 3.5-mm locking compression plate antiglide plate and two 3.5-mm percutaneous cortical screws (Case 1).

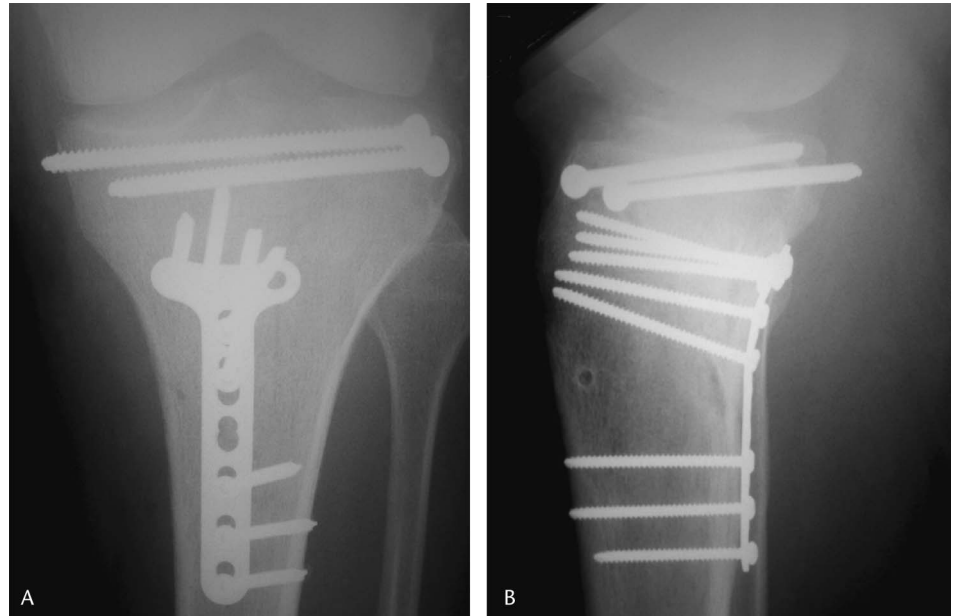


FIGURE 7. One-year follow-up radiographs AP (A) and lateral (B) showing maintenance of reduction and a healed fracture.

Case 2

A 43-year-old, obese male patient sustained an unstable fracture dislocation of the right proximal tibia after falling from a retaining wall onto his right leg (Moore type I, Schatzker IV, AO 41-B2.2). He was initially seen at a different institution and treated by open reduction and internal fixation using an anterolateral approach and stabilization with an L-shaped locking plate. The posteromedial split fracture was fixed with an anteroposterior cannulated cancellous bone lag screw. Five months later, the patient was referred to our clinic for a second opinion because of persisting pain in his right

knee. On lateral x-ray, a delayed union and malreduction of the posteromedial split fragment were evident. Inappropriate reduction and fixation of the posterior fragment may have been the result of a misjudgment of the fracture pattern that is consistent with a Moore type I posteromedial split injury (Fig. 8A). Direct anatomic reduction and proper placement of hardware had been impossible at his initial surgery because of the inability to access the posterior surface of the tibia from the chosen anterolateral approach.

Because of residual pain and deformity, we scheduled the patient for revision surgery with hardware removal and posterior

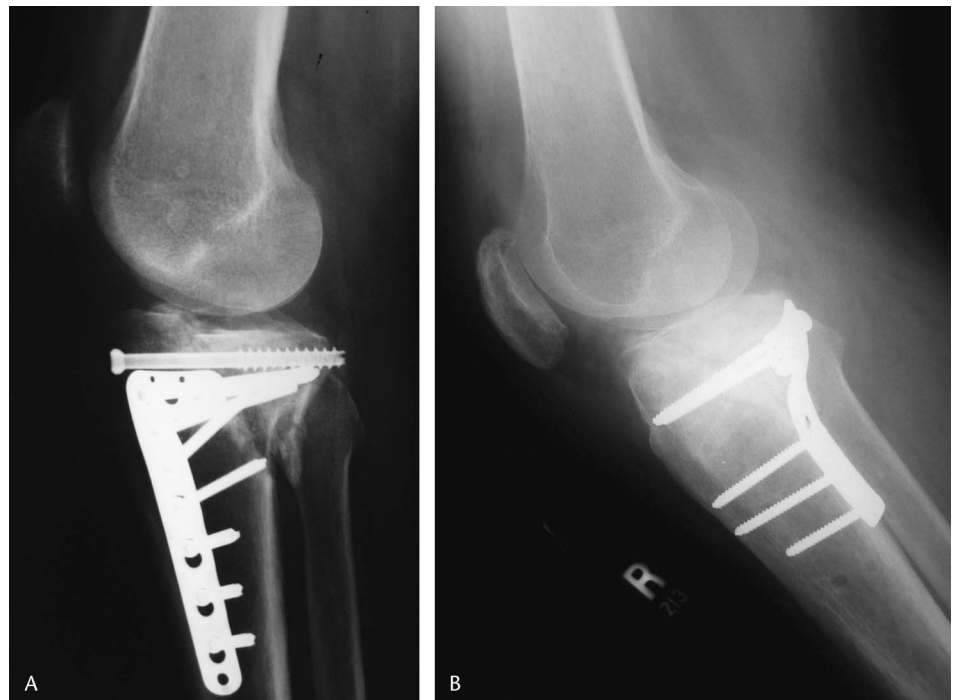


FIGURE 8. A 43-year-old male patient (Case 2) who sustained an unstable Moore type I fracture dislocation of the tibial head, which was treated by open reduction and internal fixation through a conventional, anterolateral approach. The posteromedial split fragment, which is held by an anteroposterior cannulated screw, was not reduced (A). The patient presented 5 months later at our institution for a second opinion as a result of pain and radiographic evidence of a delayed union. He was taken back to surgery for hardware removal and re-osteosynthesis through a direct posterior approach and fixation of the fracture with a dorsal 4.5-mm T-plate as antilide plate (B). A 3-month follow-up radiograph is shown.

buttress plating using the direct posterior Lobenhoffer approach. Intraoperatively, the delayed union of the posteromedial fragment was opened with a periosteal elevator and reduced anatomically by traction and extension of the knee in prone position. A posterior nonlocking 4.5-mm T-plate was applied as a posterior antiglide plate. This reduction was radiographically maintained at 3-month follow-up (Fig. 8B). The patient recovered well from surgery and no intraoperative or postoperative complications occurred. The rehabilitation plan consisted of touch-down weight bearing for 10 weeks, with consecutive increase to full weight bearing. At 3-month follow-up the fracture was anatomically healed on plain radiographs and the patient had full range of motion of his right knee (0–140 degrees). No further complications were identified at his 1-year follow-up, and the patient has been discharged from the clinic.

DISCUSSION

We present in this report for the first time in the English literature, to our knowledge, the technique of a direct posterior approach for optimized reduction and fixation of posteromedial split fracture dislocations of the proximal tibia. This approach was previously described by Galla and Lobenhoffer in 2003 in the German literature.⁸ It is a modification of the posterior approach described by Lobenhoffer in 1997.⁴ The operative treatment of Moore type I tibial plateau fracture dislocations¹ represents a persisting clinical challenge in spite of all the efforts for optimizing the approaches and the further development of implants.^{4,5,9,10}

Several approaches have been described in the literature for exposure of posteromedial split fractures, such as a median skin incision with medial parapatellar arthrotomy and detachment of the medial capsular ligament apparatus, an extension of the anteromedial arthrotomy by an additional posterior incision, or an osteotomy of the tibial tubercle for a better exposure of the posterior parts of the joint.^{11,12} All these standard techniques have the problem in common of an extensive approach with incision of the posteromedial lateral ligament, detachment of the medial capsule and the medial gastrocnemius muscle from the femoral condyle, and the potential requirement for detachment of the hamstrings insertion for achieving adequate exposure and reduction of the fracture.^{4,5,11,12}

Galla and Lobenhoffer have introduced a direct posterior approach that minimizes soft tissue injury while allowing excellent fracture visualization, reduction, and fixation.⁸ This technique protects the neurovascular bundle and requires only subperiosteal elevation of the popliteus to obtain full exposure. Furthermore, because of the protecting posterior soft tissues, skin closure and wound healing are reliable. An arthrotomy for fracture reduction is not necessary because the majority of the extraarticular fracture lines can be visualized directly for anatomic reduction, whereas intraarticular reduction is reliably assessed by fluoroscopy. Prone positioning of the patient also facilitates both fracture reduction and placement of lag screws and a buttress plate. The posteromedial split fracture can be easily reduced with hyperextension of the knee in the prone position.¹³

Numerous case series have advocated the use of 2 approaches for the treatment of complex tibial plateau fractures

involving both condyles.^{13–15} Likewise, the Lobenhoffer approach can also be combined with other approaches for complex fracture patterns, as illustrated in our cases. These 2 examples demonstrate situations where patients had excellent radiographic and clinical outcomes and are consistent with other similar cases treated at our institution. The frequency of these fracture types is relatively low, but the relative ease and usefulness of the direct posterior approach make it a valuable technique for adequate treatment of this rare but inherently unstable fracture pattern.

Other posterior approaches to the proximal tibia have been described. The technique reported by Trickey in 1968 requires extensive dissection of the neurovascular bundle.⁶ This is unnecessarily tedious and places important structures at risk.

Bendayan et al recognized the importance of direct visualization of the reduction. They described a posterior approach in which the fibers of the medial head of the gastrocnemius muscle were split to access the fracture.¹⁶ In their report fixation was achieved with an anterior-to-posterior lag screw. This approach is more damaging to the soft tissues than the Lobenhoffer technique, and the described fixation technique is suboptimal.

More recently, Bhattacharyya et al presented the results for 13 patients with tibial plateau fracture-dislocations with large posteromedial fragments (Moore type I) who were treated through a variation of the posterior approach that was initially described by DeBoeck and Opdecam.^{7,17} Although good results were documented, the Bhattacharyya approach involves a more extensive soft tissue dissection than the Lobenhoffer. Key differences are the Lobenhoffer approach utilizes an incision that does not cross the popliteal fossa, and the medial gastrocnemius tendon is not divided. Bhattacharyya et al suggested reducing the fracture with the knee in flexion to relax the posterior knee joint capsule. This maneuver may be useful in some instances, but our experience has been that the fragment reduces nicely with hyperextension of the knee and axial traction of the distal limb. In the original description Moore reported displacement of the fragment distally with knee flexion and reduction with knee extension.¹

If the surgeon intraoperatively determines that inadequate posterior exposure has been achieved with the Lobenhoffer approach, it can easily be converted to the more extensile version with proximal extension of the skin incision, using an “S”-type incision across the popliteal fossa, and division of the tendon of the medial head of the gastrocnemius. The muscle is then retracted laterally to maintain protection of the neurovascular bundle. The tendon will need to be repaired at the time of closure.

One could argue that the additional exposure may be necessary to “work through the fracture” for the elevation of a depressed joint line. However, this is generally unnecessary because the Moore type I fracture tends to be a pure split without significant comminution or depression.¹

The direct posterior approach described by Galla and Lobenhoffer and presented here for the first time in the English language should help to expand the surgical options for an optimal treatment of Moore type I posteromedial split fracture dislocations of the tibial head.

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