

Arthroscopic-Assisted Reduction of Depressed Lateral Tibial Plateau Fracture Using Precision Drill Guide and Fresh-Frozen Femoral Head Allograft



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Abstract: In the patient with osteoporosis, tibial plateau fractures can occur after high-energy trauma or low-energy trauma. Arthrosis will rapidly progress if the depressed articular surface is left untreated. Therefore, the depressed articular surface should be treated by anatomical reduction. This Technical Note describes an arthroscopic-assisted reduction depressed lateral tibial plateau fracture using a precision drill guide and fresh-frozen femoral head allograft.

In the patient with osteoporosis, tibial plateau fractures can occur after high-energy trauma or low-energy trauma. The injury-causing tibial plateau fracture mechanism is a valgus and axial load to the knee. Plain anteroposterior and lateral radiographs are the diagnostic tools used for assessment. Computed tomography scanning also is essential to assess the morphology of fractures and preoperative planning.¹ The most common classification used is the Schatzker classification.² A type III fracture is a depression of the lateral plateau. The soft-tissue injuries associated with lateral plateau fractures are anterior cruciate ligament (ACL), lateral meniscus, and medial collateral ligament injuries. The unacceptable alignments of type III tibial plateau fractures include articular step off of more than 3 mm and valgus of more than 5°. ¹⁻³ If it is left untreated, the arthrosis will rapidly progress.⁴ Therefore, depressed

lateral tibial plateau fractures should be treated by anatomical reduction to prevent secondary arthrosis and allow early mobilization. Several surgical techniques have been reported to fix the depressed lateral tibial plateau fractures, including open, fluoroscopic-assisted, and arthroscopic-assisted techniques.^{1,5-9} We propose an arthroscopic-assisted reduction of depressed lateral tibial plateau fractures using an ACL tibial drill guide and a fresh-frozen femoral head allograft.

Preoperative Evaluation

Plain radiographs and computed tomography scans are performed to evaluate the location, fracture configurations, and preoperative planning. The distance from the midway between the tibial tubercle and the posteromedial tibial cortex to the depressed fragment is measured to determine the depth of the drill tunnel. Examples of plain radiographs and computed tomography scans are shown in [Figure 1](#). The determined drilled tunnel is at a 5-cm depth.

Surgical Technique (With Video Illustration)

Patient Positioning

After spinal anesthesia is done, the patient is positioned supine with the surgeon sitting ipsilaterally. The examination under anesthesia is done to identify associated ligament instability. The operative leg is surrounded by a tourniquet and inflated.

Arthroscopic Portal Placement

First, the arthroscope is placed in the anterolateral portal located adjacent to the patellar tendon over the soft spot on the joint line. Then, a routine arthroscopic

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Fig 1. Plain radiograph (A) and computed tomography scan (B) of the right knee, depressed lateral tibial plateau fracture. The determined drilled tunnel is at a 5-cm depth.

examination is performed to evaluate the associated intra-articular injuries. The anteromedial portal is placed at the anteromedial adjacent to the patellar tendon using the out-side-in technique (Fig 2A). The arthroscope is switched to the anteromedial portal as the viewing portal. The operative leg is positioned in a figure-of-four position and applied varus force (Fig 2B, Video 1). The shaver (Smith & Nephew, Andover, MA) is introduced through the anterolateral portal to debride the hematoma (Fig 2C, Video 1).

Lateral Meniscus Traction

A polydioxanone suture (Ethicon) is passed through the joint and retrieved under the lateral meniscus using the outside-in technique with a spinal needle. The assistant pulls the polydioxanone suture to retract the lateral meniscus for fracture site visualization. The depressed lateral tibial plateau fracture is seen under the lateral meniscus (Fig 3, Video 1).

Drilling Tibial Tunnel and Reduction

The ACL tibial drill guide (Smith & Nephew, Andover, MA) is inserted via the anterolateral portal (Fig

4A, Video 1). The tip of the drill guide is placed at the depressed articular fragment (Fig 4B, Video 1). A 2-cm incision is made on the anteromedial border of the tibia (Fig 2A). The K-wire is marked at the measured distance from the pre-operative evaluation with a pen marker as preoperative planning of the drilled tunnel. The K-wire is drilled through the anteromedial border of the tibia until the marker sinks into the cortex, then the 6-mm cannulated reamer is used to open the anteromedial cortex of the tibia (Fig 4C, Video 1).

A 5.5-mm rod is introduced through the drilled tunnel and used to elevate the depressed fragment (Fig 5A, Video 1). The anatomic reduction is confirmed by arthroscopic visualization via the anteromedial portal (Fig 5B, Video 1).

Bone Grafting

A fresh-frozen femoral head allograft is obtained from our institution's bone bank. The femoral head is stored at -80°C and thawed in 1 L of room temperature normal saline for 30 minutes. The bone graft is immersed in the povidone-iodine solution for 5 minutes to sterilize it (Fig 6A). The cartilage is then removed with a handheld saw and bone rongeur. The cancellous bone graft is passed through a Bone Mill (Zimmer Biomet, Warsaw, IN) (Fig 6B). The cancellous bone graft is impacted into the drilled tunnel with a 5.5-mm rod until the tunnel is full. The arthroscopic examination is done to confirm the adequate reduction of the depressed lateral tibial plateau fracture. The operative leg is immobilized with a long leg anteroposterior plaster splint.

Postoperative Care

For 6 weeks, the patient is put in a long leg anteroposterior plaster splint. Afterward, static quadriceps exercises with passive range of motion of the knee are encouraged. The patient is ambulated with axillary crutches and non-weight bearing for a minimum of 8 weeks. Wound healing is assessed in the first 2 weeks. The patient can return to full activity after 3-4 months.

Discussion

Arthrosis will rapidly progress if the depressed articular surface is left untreated.⁴ Several surgical techniques have been reported to treat tibial plateau fractures, including open, fluoroscopic-assisted, and arthroscopic-assisted techniques.¹ Arthroscopic-assisted techniques have the advantages of direct visualization of the reduction, no meniscus detachment to visualize the articular surface, the ability to manage associated intra-articular pathology, and rapid recovery for the patient.^{10,11} Recent arthroscopic-assisted techniques for

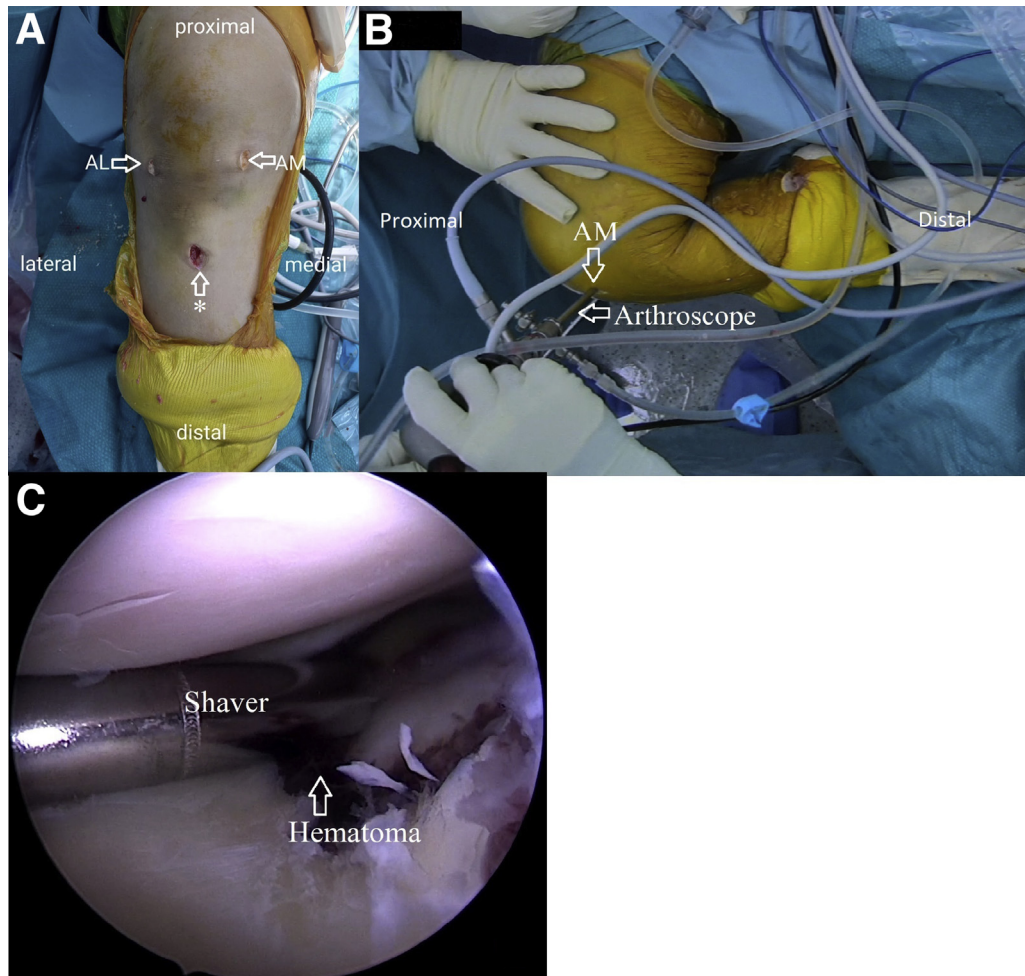


Fig 2. Images of a patient who had depressed lateral tibial plateau fracture of right knee underwent arthroscopic-assisted reduction in a supine position. (A) The incisions of the right knee are shown. (B) The right leg is positioned in a figure-of-four position and applied varus force. The arthroscope is switched to the anteromedial portal as the viewing portal. (C) The shaver (Smith & Nephew, Andover, MA) is introduced through the anterolateral portal to debride the hematoma. *A 2-cm incision on the anteromedial border of the tibia. (AL, The anterolateral portal; AM, The anteromedial portal.).

treating tibial plateau fractures have been described. Hermanowicz et al.^{7,8} described an all-arthroscopic treatment of posterolateral and lateral tibial plateau depressed fracture without fluoroscopy using a trans-septal portal and biocomposite screws. Ackermann et al.⁵ proposed an arthroscopic controlled reduction of the posterolateral tibial plateau depressed fracture using an ACL tibial drill guide and internal fixation with anterior-to-posterior screws. Alvarez et al.⁶ reported an arthroscopic reduction of split-depressed tibial plateau fracture with lateral incision and reduction by tamping through the fracture site. Later, Park et al.⁹ described an arthroscopic treatment of concomitant ACL injury and depressed posterolateral tibial plateau fracture. The reduced fracture is then fixed in situ using a press-fit fibular allograft to stabilize the depressed fracture.

Advantages of the presented technique include less soft tissue dissection, direct visualization of fracture

reduction, no donor site morbidity, no need for hardware implant fixation, no need for fluoroscopy, and reduction of operative time. This technique makes fracture reduction more precise by using the ACL tibial drill guide and less iatrogenic articular cartilage injury. Direct visualization through an arthroscope confirms an anatomic reduction of articular cartilage and an associated intraarticular lesion. Because of the minimally invasive technique, the risk of wound complications and infections is lower. In the present technique, no implants are used for fracture stabilization, and there is no donor-site morbidity from iliac crest graft harvest for bony defect fulfillment. During the operation, fluoroscopy involves radiation exposure and increases the operative time. This technique does not require fluoroscopy and may decrease the risk of infection along with the operative time. This technique is done in a supine position with standard knee

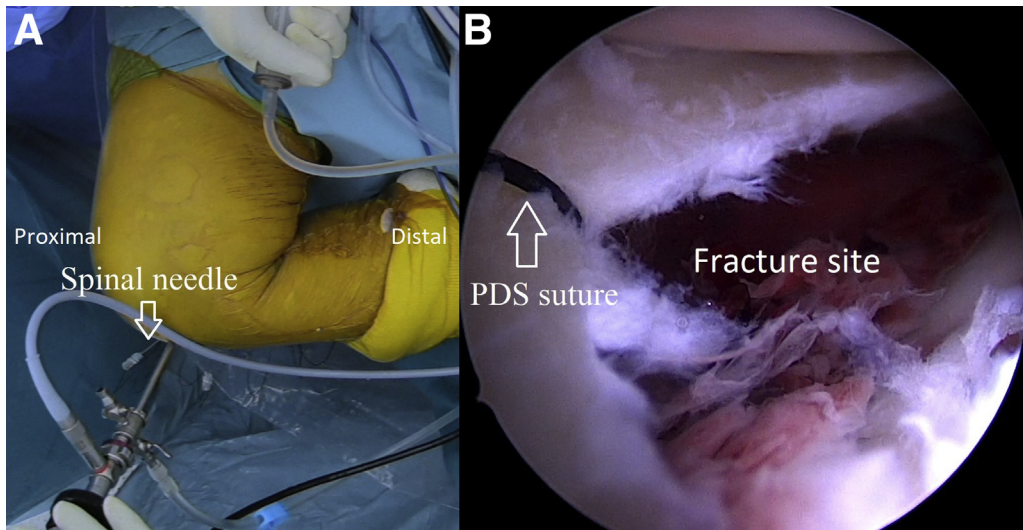


Fig 3. Images of a patient who had depressed lateral tibial plateau fracture of right knee underwent arthroscopic-assisted reduction in a supine position. (A) The right leg, the PDS suture is inserted to retract the lateral meniscus using the out-side-in technique with a spinal needle. (B) Arthroscopic view from the anteromedial portal of the right knee, the lateral meniscus is retracted. The depressed lateral tibial plateau fracture is seen under the lateral meniscus. (PDS, polydioxanone suture.).

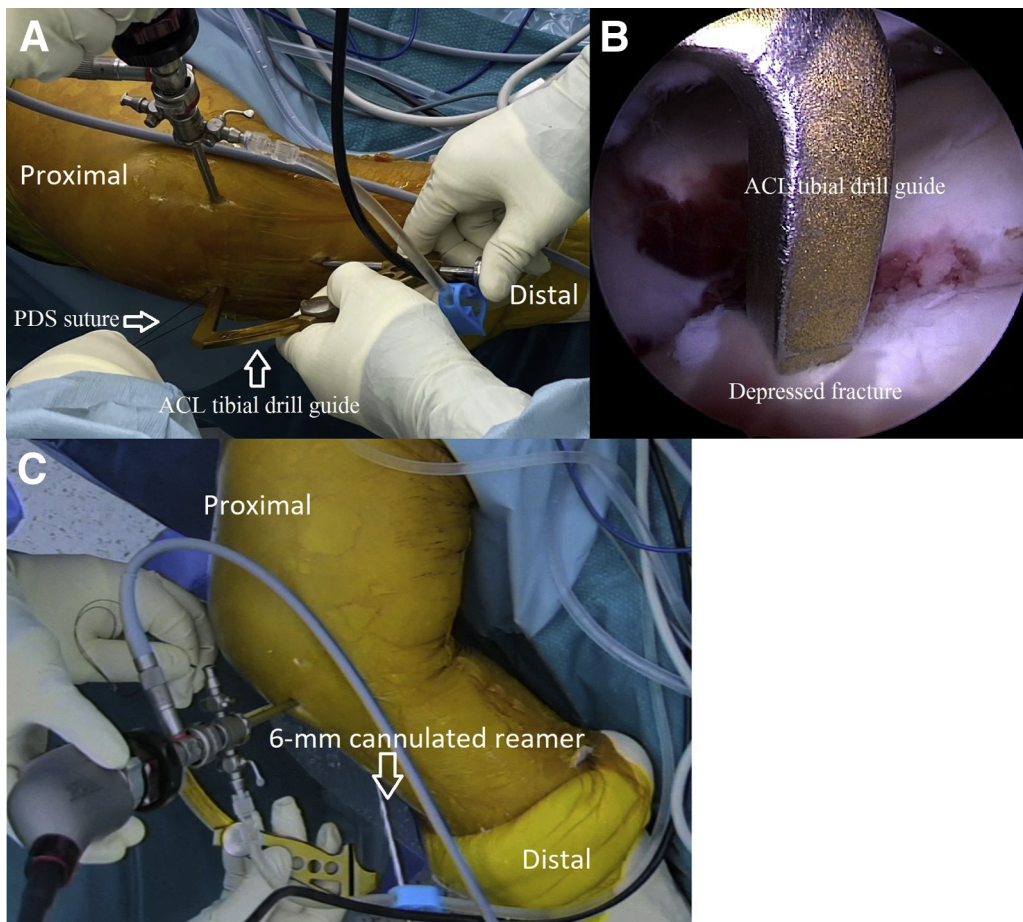


Fig 4. Images of a patient who had depressed lateral tibial plateau fracture of right knee underwent arthroscopic-assisted reduction in a supine position. (A) The anterior cruciate ligament tibial drill guide (Smith & Nephew, Andover, MA) is inserted via the anterolateral portal. (B) The tip of the drill guide is placed at the depressed articular fragment. (C) the 6-mm cannulated reamer is used to open the anteromedial cortex of the tibia.

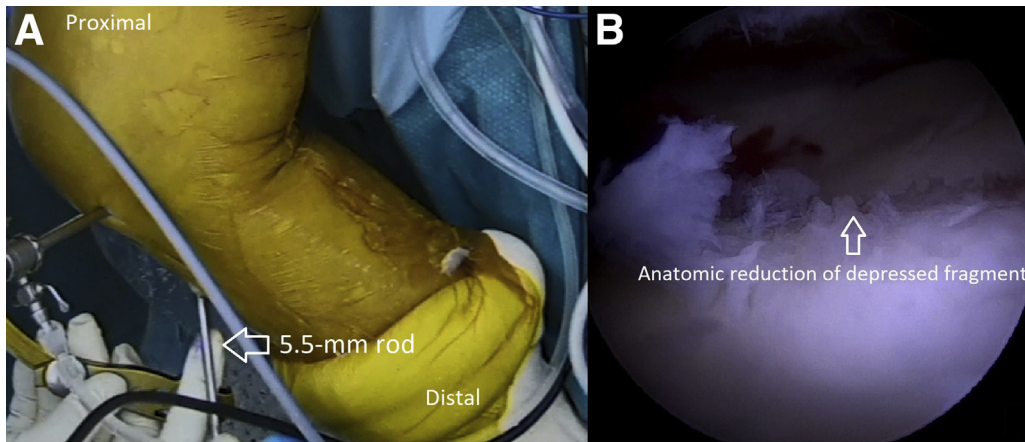


Fig 5. Images of a patient who had depressed lateral tibial plateau fracture of right knee underwent arthroscopic-assisted reduction in a supine position. (A) A 5.5-mm rod is introduced through the drilled tunnel and used to elevate the depressed fragment. (B) The anatomic reduction is confirmed by arthroscopic visualization via the anteromedial portal.

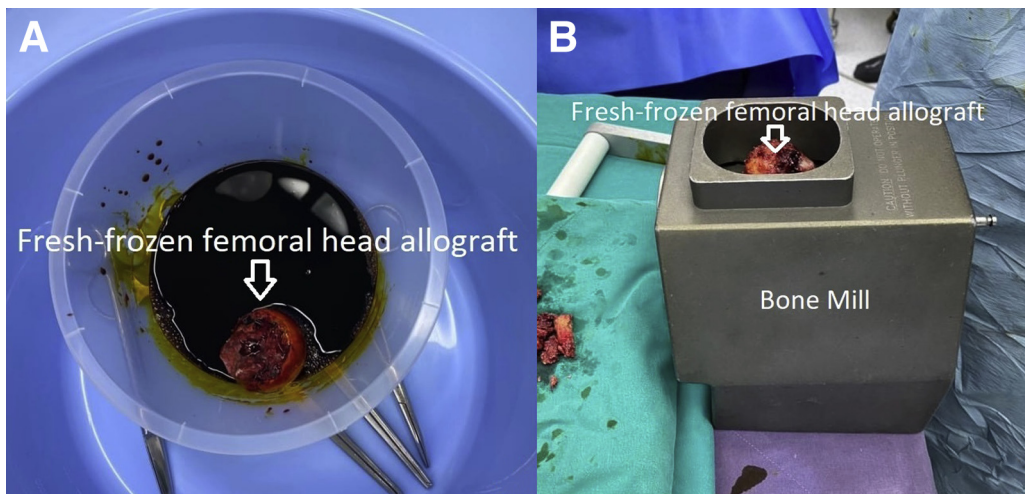


Fig 6. Preparing of femoral head allograft for reduction of depressed lateral tibial plateau fracture (A) Fresh-frozen femoral head allograft is immersed in povidone-iodine solution for 5 minutes for sterilization. (B) The cancellous bone graft is passed through a Bone Mill (Zimmer Biomet, Warsaw, IN).

arthroscopy equipment. Advantages/disadvantages and pearls/pitfalls of the procedure are further described in [Tables 1](#) and [2](#).

Table 1. Advantages/Disadvantages

Advantages	
Less soft-tissue dissection and time of recovery	
Direct visualization of fracture reduction through an arthroscope	
No donor-site morbidity	
No need for hardware implant fixation	
No need for fluoroscopy	
Less operative time	
Disadvantages	
Need arthroscopic experience	
Availability of fresh-frozen femoral head allograft	
Risk of disease transmission/infection	
Need further immobilization	
Risk of compartment syndrome from fluid extravasation	

In conclusion, this presented technique is a reproducible method and a safe surgical technique for the reduction of depressed lateral tibial plateau fractures.

Table 2. Pearls/Pitfalls

Pearls	
Preoperative planning	
Lateral meniscus traction by using PDS suture traction	
Using ACL tibial drill guide for precision of depressed fragment reduction	
Anatomic reduction confirms by arthroscopy	
Pitfalls	
Avoid penetrating the articular cartilage using pen marker and careful preoperative planning	

ACL, anterior cruciate ligament; PDS, polydioxanone suture.

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