Arthroscopic Technique for Treatment of Schatzker Type III Tibia Plateau Fractures Without Fluoroscopy

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Abstract: Accurate reduction and maintenance of the stability with correct implant positioning is critical for surgical treatment of tibial plateau fractures. Our technique includes an arthroscopic reduction and fixation of Schatzker type III tibial plateau fractures with a bulls-eye screw placement without fluoroscopy control. With the arthroscopic guidance, an anterior cruciate ligament drill guide is placed and a K-wire sent to the midpoint of the depressed fragment through the guide at a 40° angle to the coronal axis of the tibia. A tunnel is created with the drill over the K-wire. The depressed fragment is further augmented with gentle impacts over the K-wire. After arthroscopic reduction control, an appropriate-sized iliac graft is pushed until it is below the depressed fragment. The targeting device is adjusted at 130° so that it is parallel to the joint line and a K-wire sent through the device so that it would pass just below the graft. The graft is then supported with cannulated screws sent over the K-wire. This technique provides an arthroscopic reduction of the chondral surface and precise placement of the rafting screws without fluoroscopy.

Long-term clinical results of tibial plate fractures are dependent on the quality of the intra-articular reduction of the articular surface.[1] Excessive dissection of the injured soft tissue envelope and devitalization of bone fragments are the primary concerns of the open techniques. To eliminate the problems related to the open techniques, many authors recommended minimally invasive reduction and stabilization techniques such as isolated lateral plating with medial external fixation, hybrid external fixation, tensioned-wire fixation, and percutaneous reduction.[2-4] In Schatzker type III tibia plateau fractures, exploration of the fracture site is challenging because the lateral plateau is not displaced. Arthroscopic reduction and internal fixation are recommended as a safe and reliable method for treatment of tibia plateau fractures.[4] With arthroscopic-assisted techniques, the reduction of the depressed fragment can be performed indirectly without excessive dissection.

Inherent advantages of arthroscopic-assisted techniques include less soft tissue stripping and lesser wound site complications. To avoid these complications, arthroscopic-assisted techniques that involve restoration of the depressed joint surface and grafting under the

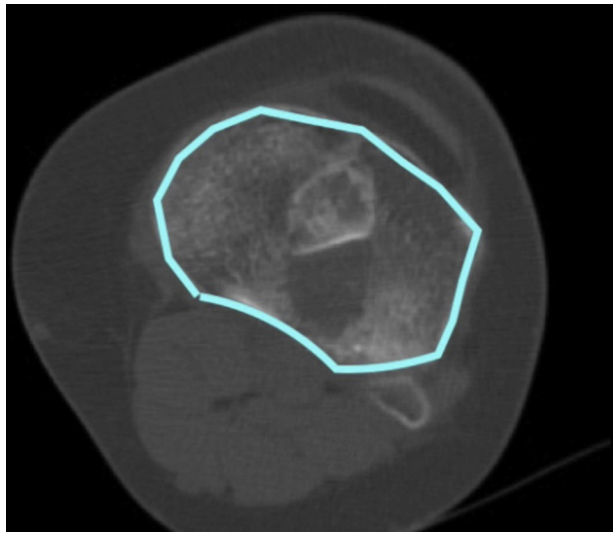

Fig 1. Axial computerized tomography image of a patient's right knee with Schatzker type III tibial plate fracture. The blue line represents the continuity of the bony envelope.

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Fig 2. Photograph of the operation representing the patient's position. The patient is positioned supine on the operating table. The injured right knee is bent to 90° and is freely movable during the procedure; the other extremity is secured in a leg holder.

fragment have become more prevalent.[1,3,5] However, the most of these procedures require fluoroscopy. The aim of this technical note is to describe an arthroscopic technique for treatment of Schatzker type III tibia plateau fractures without any fluoroscopy usage.

Surgical Technique

Video 1 presents a clear demonstration of our technique.

Objective Diagnosis

To determine the exact expansion of the fracture, in addition to the standard anteroposterior and lateral knee radiographies, computerized tomography assessment is needed. Especially in axial computerized tomography images, the continuity of the bony envelope should be assessed (Fig 1).

Table 1. Advantages and Disadvantages

Advantages:
Minimizes risk of radiation exposure
Without fluoroscopy usage
Precise placement of screws and reduction
Allows articular reduction without arthrotomy
Avoids long incision and soft-tissue disruption
Allows diagnosis and treatment of additional intra-articular injuries
Decreases blood loss
Excellent intra-articular visualization
Disadvantages:
Special instruments and adjustments needed
Requires good assistance of the operation team
Graft site morbidity

Patient Positioning

The procedure is performed with the patient under general anesthesia. The patient is positioned supine on the operating table. The injured right knee is bent to 90° and freely movable during the procedure; the other uninjured extremity is secured in a leg holder (Fig 2, Table 1).

Surgical Approach

Standard anterolateral and anteromedial portals should be used for knee arthroscopy. The arthroscopic procedure is performed as the fluid inflow through the portal is provided without applying pressure but solely with the aid of gravity to minimize the compartment

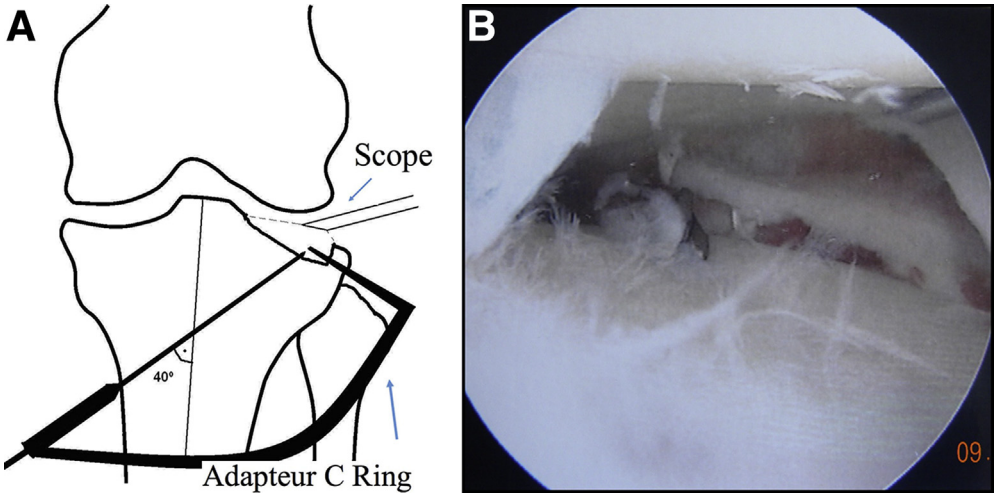

Fig 3. (A) Drawing of a type III tibial plateau fracture. The anterior cruciate ligament Drill Guide, Adapteur C-Ring with an arc of 130° is placed; the tip of the guide is at the center of the depressed fragment. A K-wire is sent through the guide until it is 1 mm past the joint. (B) Arthroscopic view of a type III tibial plateau fracture; the meniscus is elevated with a probe from the anteriolateral portal and the anteriomedial portal is used for visualization of the fracture. The K-wire tip is at the middle of the depressed fracture.

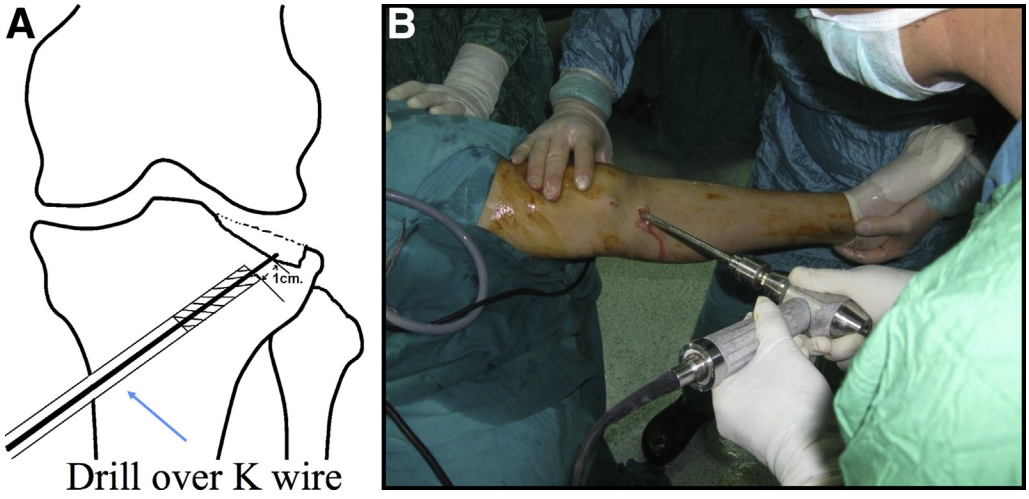

Fig 4. (A) Drawing of a type III tibial plateau fracture. Cannulated headed drill is sent through a K-wire until it is 1 cm below the cartilage. (B) Photograph of the surgical step; the surgeon is drilling over the K-wire while the assistant is holding the injured extremity still.

syndrome risk. First irrigation of the joint with open outflow eases the visualization of the joint. Additional intra-articular injuries can be determined and treated at this point. The fracture site is examined and loose articular fragments are removed.

With arthroscopic visualization, the anterior cruciate ligament (ACL) guide is adjusted so that the target pop marking hook (AR-1866; Arthrex, Naples, FL) is set in the middle of the deepest part of the fracture. The ACL Drill Guide, Adapteur C-Ring with an arc of 130° (AR-1875-L; Arthrex) is placed. A K-wire is sent through the guide with an angle of 40° to the tibia axis. Then the K-wire is sent through the guide until 1 mm past the joint (Fig 3).

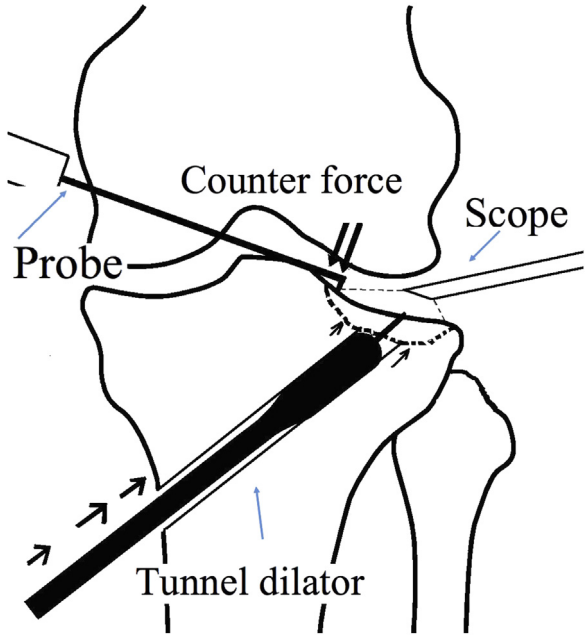

Fig 5. Drawing of a type III tibial plateau fracture representing the reduction of the fracture. The arthroscope is at the anteriolateral portal and a probe is used from the anteriomedial portal to apply counter force during augmentation of the depressed fracture with a tunnel dilator.

Reduction of the Fracture

After the length of the K-wire is determined, a tunnel is created with cannulated headed drill 8 or 9 mm (AR-1409 or -1410; Arthrex) over the K-wire until 1 cm below the cartilage (Fig 4). The depressed fracture is elevated using a tunnel dilator (AR-1854; Arthrex) with gentle impacts over the K-wire. Creating the tunnel 1 cm below the cartilage level provides safe impacts without the risk of damaging the cartilage surface. Gentle counter force with a probe helps to maintain the reduced position of the fracture (Fig 5, Table 2).

An approximately 1- to 2-cm-long bone graft is harvested from iliac bone with the same size of the tunnel. Little trimming of the graft may be necessary to approach the created tunnel size.

The graft is placed in the tunnel and with a tunnel dilator is gently driven to the point where it is just below the depressed fracture.

The Drill Guide, Adapteur C-Ring is adjusted so that the 2 arms are at 130° to each other. The mobile arm with the adjustable knob is pushed in the tunnel until it contacts

Table 2. Pearls and Pitfalls

Pearls:
Supine position and free movement of the injured extremity is recommended
First perform joint irrigation and debridement for adequate visualization
Use a medially based metaphyseal window for better graft support
Confirm anatomic articular reduction with direct arthroscopic visualization before screw placement
Pitfalls:
Careful impaction of the graft is necessary
Gentle counter force should be applied with a probe to the least displaced area of the fracture

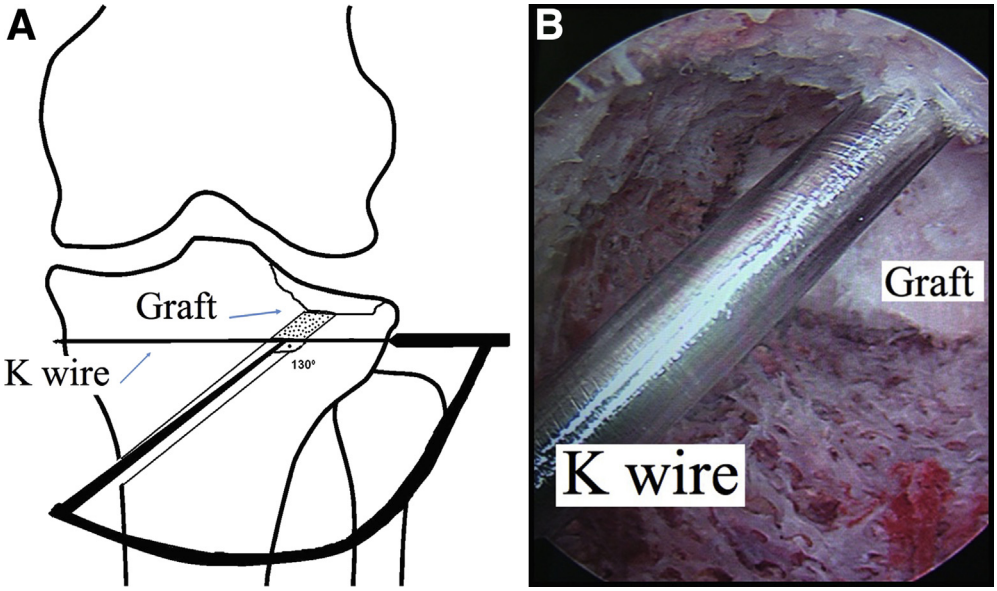

Fig 6. (A) Drawing representing maintaining the reduction with the graft. The graft is driven gently until it is below the depressed fragment. The Drill Guide, Adapteur C-Ring is adjusted so that the 2 arms are at 130° to each other. The mobile arm with the adjustable knob is pushed in the tunnel until it touches the graft. A K-wire is placed through the graduated guide pin sleeve just under the graft. (B) Arthroscopic view of the graft and K-wire. The arthroscope is in the tunnel and confirms the correct position of the K-wire.

the graft. The Adapteur C-Ring has an arc of 130°; one arm is at 40° inside the tunnel, and the other arm is nearly parallel to the joint line. A K-wire is placed through the graduated 2.4-mm guide pin sleeve (AR-1876; Arthrex), whereas the other arm of the Adapteur C-Ring is in the tunnel just below the graft (Fig 6).

Fixation of the Fracture

The graft is supported from below with a cannulated cancellous screw (with or without a washer) that is sent over the K-wire (Fig 7). Because the K-wire is taken as a reference point, additional screws are placed easily (Table 3).

Postoperative Course

No complications were observed during the procedure that we performed in 3 patients. Postoperatively the patients were mobilized with crutches and/or walker. Passive and active assisted range of motion exercises were started to achieve 90° knee flexion at 3 weeks and full range of motion at 6 weeks. Patients who had radiologic union were allowed to full weight bear at a mean time of 13 weeks.

Discussion

Plateau fractures are always challenging for orthopaedic surgeons because of their intra-articular origin.

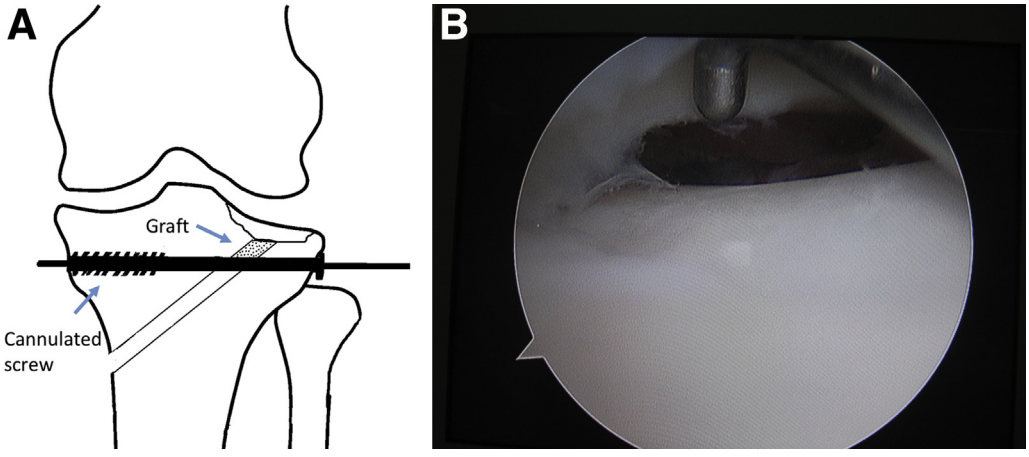

Fig 7. (A) Drawing representing the position of the cannulated screw and graft after fixation. The graft is supported from below with a cannulated cancellous screw that is positioned over the K-wire. (B) Arthroscopic view of the fracture after reduction and fixation of the fracture. The arthroscope is at the anteriomedial portal and the lateral meniscus is elevated with a probe from the anteriolateral portal.

Table 3. Risks and Limitations

Risks:
Adequate exposure of the fracture site is needed
Care must be taken during placement of the drill guide and guidewire to avoid improper placement of the screws
Use appropriate size of bony graft, and trim if necessary
Limitations:
Careful patient selection and preoperative planning is needed
Good arthroscopy skills are needed

Treatment goals that will lead to favorable results have been outlined as reestablishing the joint stability, alignment, and articular congruity that preserve full range of motion.[6] Open reduction and internal fixation have major risks such as wound dehiscence or infection. Direct visualization of the depressed articular surface is difficult in Schatzker type III fractures, even with a long anterior midline incision. Arthroscopy-assisted fixation techniques provide a perfect visualization of the fracture site and have the advantages of the minimal invasive approach. Additional intra-articular injuries such as meniscal tears, chondral lesions, or ACL injuries can be diagnosed and treated as usual, with these arthroscopic techniques.[7] It has been recommended that grafting of the depressed area should be an essential part of the treatment.[8] We prefer a medially based metaphyseal window for lateral tibial plateau fracture because of the advantage of the longer tunnel for better subchondral support as stated in previous studies.[9]

Risk of compartment syndrome during the arthroscopic approach to tibia plateau fractures has been reported.[10] To minimize the risk of compartment syndrome, fluid inflow must be performed with the aid of gravity (i.e., without applying pressure) and outflow through another cannula must be maintained. Biomechanical and clinical studies of rafting K-wires or screws have been reported.[11,12] Screws are advised to be sent parallel to the joint line with the rafting technique. Our technique involves grafting of the depressed area and rafting with cancellous screws. There is a report on a similar technique where a K-wire may be placed through a cannulated K-wire guide but the guide has a fixed angle.[5] The previously reported techniques all involve the use of fluoroscopy for screw placement. The technique described in this study involves screw placement under the core graft instead of the K-wire and the screw may be placed parallel to the joint line with the help of the guide adjusted at 130°. Image-guided interventional procedures may lead to occupational radiation exposure.[13] There are established guidelines for the protection of the staff. The limitation of dose seems to be the most important precaution that can be taken against the hazard of radiation exposure.[13]

The main advantage of this technique is that it provides a safe fluoroscopy independent technique where the accurate screw placement is achieved without fluoroscopy usage.

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