Posterior Ankle Arthroscopic Reduction With Internal Fixation

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Abstract: Current surgical techniques in ankle fracture management now include arthroscopic-assisted reduction and internal fixation. The need for minimally invasive fracture reduction techniques, which preserve soft tissue envelops and assists in overall anatomic reduction, can be refined and improved. The ankle is an ideal anatomic location for arthroscopic-assisted reduction and internal fixation due to the high incidence of intra-articular pathology and the poor long-term sequela of nonanatomic reduction. Thus, we propose using prone posterior ankle arthroscopic reduction internal fixation for posterior ankle fracture variants.

Ankle fractures are among the most commonly treated fractures, but surgeons have been slow to accept arthroscopic assistance in treating these fractures. The thin rigid articular surfaces of the tibiotalar joint and the high incidence of traumatic osteochondral lesions produce small fragments and often loose bodies that are difficult to assess with standard open techniques. Standard anterior ankle arthroscopy is ideal for anterior pathology and syndesmosis reduction, but puts posterior pathology out of reach.[1] Posterior ankle arthroscopy puts the posterior malleolus and pilon variants and their associated pathology within reach, making loose body removal and direct visualization of fracture reduction possible, while avoiding extensive posterior lateral dissection. Thus, we purpose using prone posterior arthroscopic reduction and internal fixation for posterior ankle fracture variants.

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Surgical Technique

Preoperative Setup

The patient is positioned prone taking care to prevent hyperextension of the cervical spine and padding all bony prominences. We also recommend placing a thigh tourniquet before rolling the patient into the prone position ensuring that the feet are off the end of the bed. An external positioning arm (Trimano; Arthrex, Naples, FL) is applied to the ipsilateral side on the most distal end of the operating table rail. The operative leg is then prepped and draped in the standard fashion. We then apply a standard padded ankle distraction strap positioned around the end of the external position arm with gentle traction applied. The gentle traction serves 2 purposes: helps with reduction and holds the ankle in place as we operate. The anatomic landmarks (medial/lateral malleolus, Achilles tendon, and sural nerve) are marked and identified.

Portal Placement

We use the tip of the lateral malleolus to gauge the location of the posterior portals, which are established tangential to the Achilles tendon. The posteromedial portal is initially established using the nick-and-spread technique. Then a Stryker (Kalamazoo, MI) 4.0-mm 30° arthroscope is introduced. The posterolateral portal is then established in the same manner using a straight hemostat to create a working space and help with triangulation.

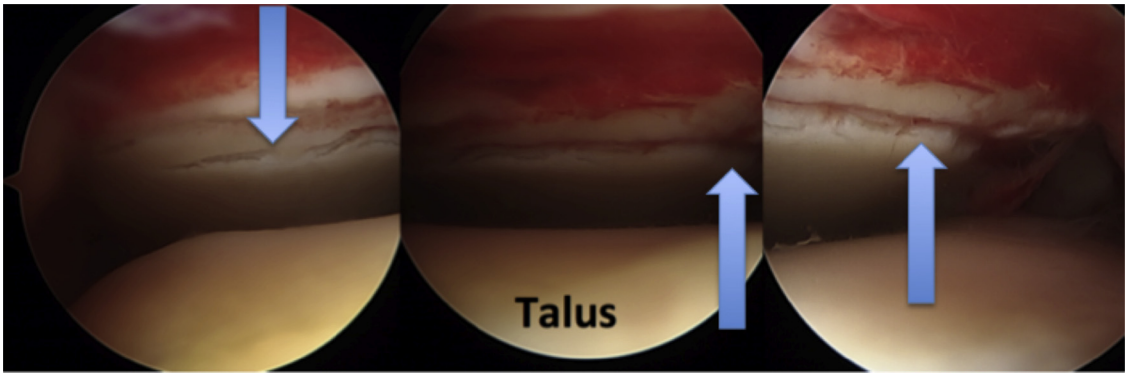

Fig 1. Images obtained from the posterior medial portal using a Stryker 4-mm 30° arthroscope. They were taken after the fracture hematoma has been evacuated so that the fracture line can adequately be identified (which is shown by the blue arrows) before the reduction. In the images a fracture step off can be noted. The fracture is on the tibial plafond; the images show that the start, end, and amount of disruption can all be accurately identified. The most inferior bone (talus) can be seen and no injury is identified.

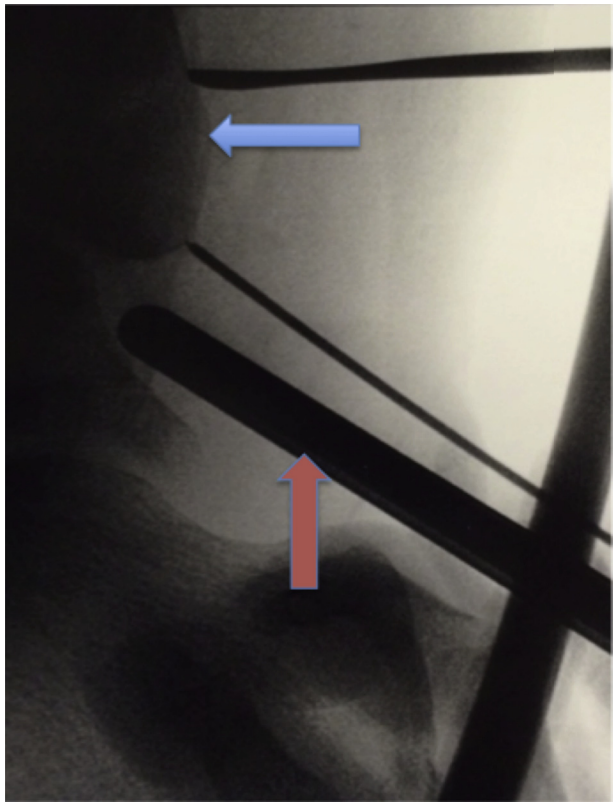

Fig 2. After the fracture is identified, it must be reduced. A third portal is created approximately 2-3 cm proximal to that of the posterior lateral portal; the portal must be established using the nick-and-spread technique to prevent injury to the sural nerve. A bone pusher or elevator may be used for the reduction (which is just superior to the blue arrow). Then a 1.25-mm cannulated guidewire is introduced through the posterior lateral portal; the position and angle are checked arthroscopically (indicated by the red arrow) and with fluoroscopy as seen above. This also shows the positioning of the arthroscope in the posteriormedial portal and guidewires through the posterior lateral portal before reduction. Blue arrow = posterior malleolus of tibia. Red arrow = arthroscope in joint space from posterior arthroscopy.

Hematoma Evacuation and Loose Body Removal

A Stryker 4.0-mm Tomcat shaver is then introduced. Before addressing pathology, it is paramount to visualize and stay lateral to the flexor hallucis longus (FHL), which helps prevent injury to the medial neurovascular bundle. After the FHL is identified, the posterior capsule is taken down and the tibiotalar joint is identified. A small c-arm fluoroscopy is useful to help identify landmarks and with the aforementioned patient positioning access should be

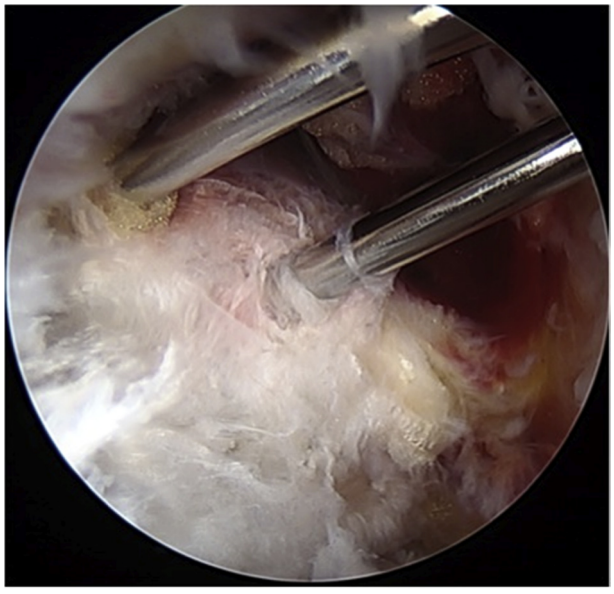

Fig 3. Arthroscopic image from the posterior medical portal using a Stryker 4-mm 30° arthroscope showing direct visualization of the 2 cannulated guidewires after inserting into the posterior fragment before screw fixation. During this step, spacing is checked along with fracture alignment using fluoroscopy. The screws are then placed on the guidewires and direct visualization of insertion is observed.

Table 1. Recommended Equipment and Procedural Tips

Positioning	• Ensure that ulnar nerves, chest, knees, and anterior ankle are well padded (we prefer gel pads) • Foot is off the end of the bed, neutral • External positioning arm that provides distraction and position
Fluoroscopy	• Mini c-arm reduces exposure
Portals	• Level of the lateral malleolus • Adjacent to Achilles
Arthroscopy	• Stryker 4.0 mm 30° • Fluid gravity up to 30 mm Hg • Stryker 4.0-mm Tomcat shaver • Smith & Nephew small joint arthroscopic instruments
Reduction	• Proximal posterior lateral portal allows bone pusher or elevator reduction
Wire fixation	• Preliminary reduction with 1.25-mm cannulated guidewires • Number of wires depends on the size of the fragment • Larger fragments need a perpendicular pin to create an axilla, stopping proximal migration
Screws	• Synthes 3.5-mm cannulated titanium screws, washers depending on bone quality
Postoperative protocol	• Splint for 2 wk • Boot with range of motion for 4 wk • Progressive weight bearing starting at 6 wk

unimpeded and easily accessible. Evacuate the hematoma and begin identifying the fracture characteristics (Fig 1). If a loose body is identified, we turn off the inflow before grasping the fragment to prevent propulsion of the fragment into the anterior ankle.

Reduction and Fixation

We then begin our reduction by establishing an accessory posterior lateral portal approximately 2 to 3 cm proximal to the standard posterolateral portal using the previously mentioned nick-and-spread technique. This technique mitigates iatrogenic damage to the sural nerve. A bone pusher or elevator is introduced into the newly created portal to reduce the posterior fragment. C-arm and direct arthroscopic visualization are used concomitantly. After anatomic reduction, which can be seen and confirmed both arthroscopically and via the use of fluoroscopy, a cannulated guidewire is introduced through the standard posterior lateral portal (Fig 2). We then place our arthroscope into the standard posterolateral portal, and place a second guidewire through the posterior medial portal. A third guidewire is placed in the accessory portal at an oblique angle creating an axilla preventing proximal migration of the fragment (Fig 3). Depending on the fragment size 1-3, Synthes (Trimano; Arthrex) 3.5-mm cannulated titanium screws are placed using standard techniques (see Table 1). Screws are tightened sequentially, whereas visualization of the maintained reduction is achieved arthroscopically to ensure that the fragment does not migrate proximal (Fig 4).

Discussion

Prone posterior ankle arthroscopic reduction and internal fixation is ideal for posterior hindfoot pathology. It provides access to loose bodies and allows direct visualization of the fracture reduction. Our technique described above also allows for safe placement of internal fixation by using established portals within anatomic safe locations[2] with a low rate of major complications.[3]

This technique provides several advantages over standard open reduction internal fixation. The primary advantage is the limited soft tissue disruption. The standard posterolateral approach requires the FHL to be stripped from the syndesmosis and retracted allowing for care to protect the posterior inferior tibiofibular ligament. The posterolateral approach requires extensive dissection and retraction while only providing a limited view of the reduction and articular surface. Preserving the posterior inferior tibiofibular

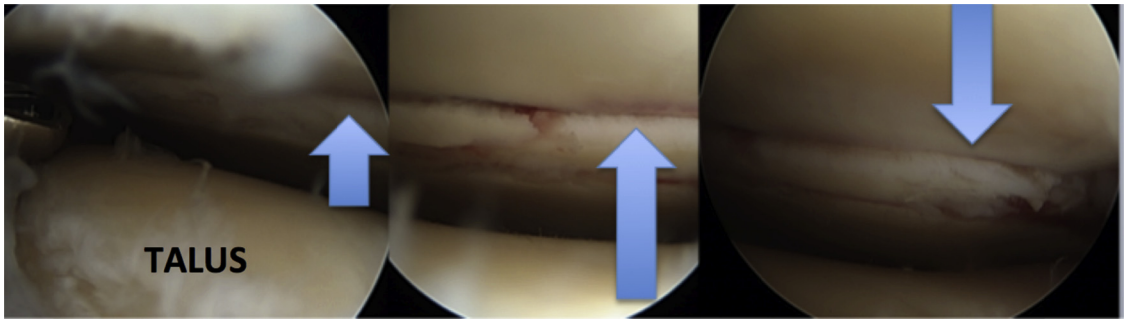

Fig 4. Arthroscopic images from the posterior medical portal using a Stryker 4-mm 30° arthroscope showing the postreduction fracture line. Moving inferiorly in the images, it can been seen that the tibial plafond only has slight plastic deformation after the reduction (this is indicated by the blue arrows). Joint space preservations remain and the talus remains uninjured.

Table 2. Tips, Advantages, and Pitfalls

Tips	Advantages	Pitfalls
Pad all boney prominences in the prone position	Limited soft tissue capsule disruption	Increases surgical time because of patient setup in the prone position
Use a low pump pressure <30 mm Hg	Direct visualization of fracture or injury	Fracture hematoma decreases visualization and makes landmarks more difficult to find
Find your landmarks before starting surgery—locate the flexor hallucis longus (FHL) and stay inside (lateral)	Direct visualization of reduction during and after fixation	Fracture reduction time may be increased
Have mini c-arm draped and ready to help locate and confirm position	FHL remains intact and not disrupted from syndesmosis	
	Plates and screws no longer have to be used	
	Preservation of the posterior inferior tibiofibular ligament	

ligament with posterior malleolus fixation restores 70% of syndesmotic stiffness compared with 40% with syndesmotic screw fixation in a cadaveric model.[4]

Our approach also maximizes the biomechanical advantage of partially threaded cannulated screws, compared with anterior-to-posterior directed screws. Our technique also avoids plates and screws that can lead to impingement with the FHL tendon. Posterior arthroscopic-assisted reduction and internal fixation (ARIF) provides a clear advantage due to direct visualization of the reduction and removal of loose bodies with no retraction and minimal dissection. The arthroscopic lavage also evacuates the hematoma and helps reduce inflammatory cytokines and matrix metalloproteinase that contribute to cartilage damage and synovitis[5] (see Table 2).

Limitations

The most notable risk or limitation of this technique is surgeon experience and comfort with posterior ankle arthroscopy. The surgeon should be comfortable with posterior ankle arthroscopy before attempting ARIF, because the fracture hematoma and fracture fragments can make visualization difficult. Prone arthroscopy is a difficult surgical setup that requires the anesthesia provider to be familiar and comfortable with prone positioning. This positioning increases surgical times because of the difficulty of setup and the need to flip and maneuver the patient from a supine to prone position from the transport bed to the operating table. Ensuring that all bony prominences are well padded is also paramount to prevent nerve compression in the prone position. Soft tissue fluid extravasation is an additional risk that the surgeon should continually monitor and mitigate with low pump pressure and short arthroscopy times (see Table 3).

Conclusions

Prone posterior ankle arthroscopic reduction and internal fixation allows for direct visualization of fracture reduction and allows the surgeon to simultaneously address intra-articular pathology. Posterior ankle ARIF uses safe proven portals for fixation, while avoiding large extensive soft tissue disruption from a standard posterolateral approach (see Video 1).

Table 3. Key Points, Indications, Contraindication, and Risks

Key Points	Indications	Contraindications	Risks
Surgeon must be comfortable with posterior ankle arthroscopy	Posterior hindfoot pathologies	Severe soft tissue swelling caused by fracture	Soft tissue extravasation
Find your landmarks before starting reduction to decrease iatrogenic damage	Pilon fractures/Pilon-variant-type fractures	Infection where portal sites need to be placed	Unable to locate fracture because of surgeons' ability
Partially threaded cannulated screws can be used giving biomechanical advantage	Posterior malleolus fracture		
	Loose body removal		

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