Technique Report

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Percutaneous posterior to anterior screw fixation through achilles tendon for posterior malleolus fractures: technique description and case series

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Abstract Posterior malleolus fractures (PMFs) (OTA 43B1.1) are frequently seen in combination with fractures of the fibula, medial malleolus, and distal tibia; they can rarely be seen in isolation. PMFs affect the alignment of the ankle mortise and the stability of syndesmosis. Techniques described for fixation of PMFs include open reduction internal fixation through a posterolateral or posteromedial approach or anterior-to-posterior screw fixation. For selected minimally displaced or nondisplaced fractures of the posterior malleolus, we developed a percutaneous technique through the Achilles tendon for the insertion of a posterior-to-anterior cannulated screw. The technique is described, and a clinical series is reviewed.

Keywords: ankle, fracture, posterior, malleolus, percutaneous, cannulated, screw

1. Introduction

Posterior malleolus fractures (PMFs) (OTA 43B1.1) are often associated with fractures of the fibula, medial malleolus, and distal tibia; they can rarely be seen in isolation. After recognition of the importance of the posterior malleolus to syndesmosis stability, the indications for fixation of PMFs have expanded; they now account for the biomechanical importance of the posterior malleolus rather than the absolute size of the fragment.[1] In addition, given that there is an approximately 50% incidence of PMFs in association with spiral distal tibia fractures, most surgeons recommend prophylactic fixation to prevent displacement during tibial nailing.[2]

Techniques for fixation of PMFs include open reduction internal fixation (ORIF) through a posterolateral ankle approach using a buttress plate and/or lag screws or insertion of anterior-to-posterior (AP) lag screws. Both techniques are limited in that they require dissection for safe insertion either posteriorly in the case of an ORIF or anteriorly in the case of an AP lag screw; moreover, the AP screw is not biomechanically strong as it relies on the distal aspect of the screw to capture the posterior malleolar fracture fragment and there is not reliable targeting of the center of the PMF fragment.[3]

The aim of the article was to describe a percutaneous technique through the Achilles tendon for safe insertion of posterior-to-anterior (PA) screw for fixation of a posterior malleolar fracture.

2. Technique

This technique is amenable for nondisplaced or minimally displaced PMFs. If there is >2-mm displacement or articular impaction, we perform a formal ORIF through a posterolateral approach. It is critical to review the axial and sagittal computed tomography (CT) scan imaging at the level of the tibial plafond preoperatively to ensure that both the fracture is non or only minimally displaced and that the guide wire going through the Achilles tendon will effectively capture the PMF (Fig. 1).

In the case where the PMF is part of a trimalleolar fracture (Fig. 2), we first fix the medial and lateral malleolus fractures with the patient in a supine position; the stability and ligamentotaxis offered after fixation of medial and lateral malleolus fractures

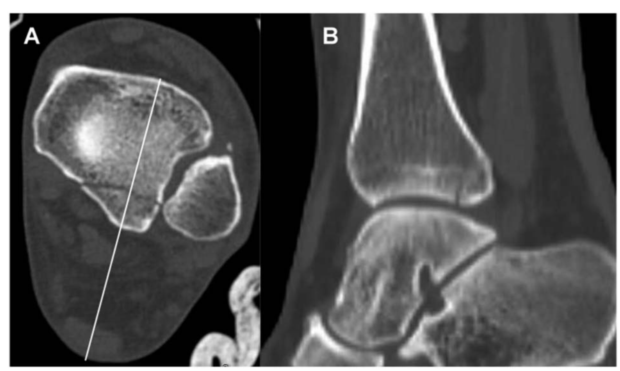

Figure 1. A and B, Axial and sagittal CT scans of the ankle are used to ensure that the posterior malleolar fracture is nondisplaced and that the planned trajectory of the screw is appropriate (white line).

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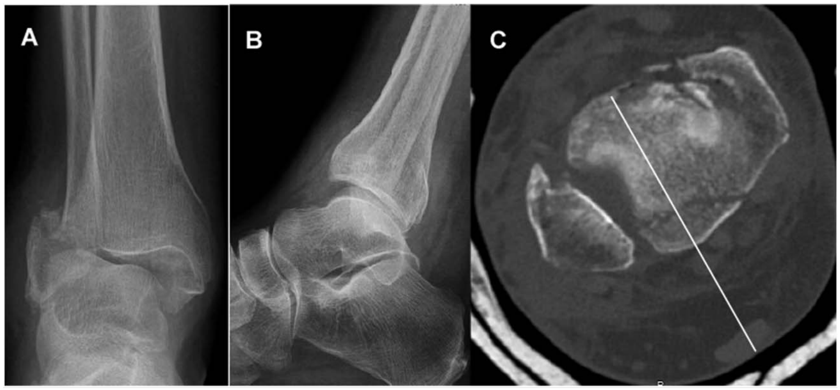

Figure 2. A and B, An 89-year-old woman with trimalleolar ankle fracture subluxation. Owing to the poor soft tissue envelope, a percutaneous reduction and fixation was chosen. C, Axial CT demonstrates that a wire inserted through the middle of Achilles tendon will capture the posterior malleolar fracture (white line).

ensures alignment of the PMF. The leg is then elevated and the foot dorsiflexed by an assistant; foot dorsiflexion helps further with appropriate reduction of the PMF and tensioning of the posterior–inferior tibiofibular ligament. Next, a trocar tip guide wire from the 4.0-mm cannulated screw set is percutaneously inserted through the middle part of the Achilles tendon and advanced to the posterior tibia. In that area, sural nerve and lesser saphenous vein are lateral to the lateral edge of Achilles tendon. In a prior study, it has been found that the mean distance between Achilles tendon and sural nerve is 11.4 mm at 4 cm proximal to the insertion of the tendon.[4] A lateral fluoroscopic view is used to position the wire just proximal to the plafond. The wire is advanced 2 to 3 mm in the bone (Fig. 3A). The starting point for the wire is then assessed using an AP and mortise view of the ankle; with only the tip of the wire inserted in the bone, it is easy to assess if the starting point is at the center of the fractured posterior malleolus (Fig. 3B). If needed, adjustments to the starting point can be made, remembering that the screw will be placed in the syndesmosis if started lateral to the posteromedial vertical syndesmotic line,[5] and the screw may not capture the PMF or may damage flexor hallucis longus tendon if started too medial. Once satisfied with the starting point on all 3 fluoroscopy views, the wire is advanced to the anterior cortex (Fig. 3C). Ideally, the trajectory of the lag screw should be perpendicular to the fracture plane on the axial CT scan; however, in clinical practice, we accept minor deviations from that the trajectory of the wire is largely predetermined by the center of Achilles tendon and the center of PM fragment. After insertion of the guide wire, a small longitudinal skin incision is made next to the wire and deepened to the paratenon and Achilles tendon in line with its fibers. The soft tissues are spread, the screw length is measured, the pathway is reamed with the cannulated drill, and then the cannulated

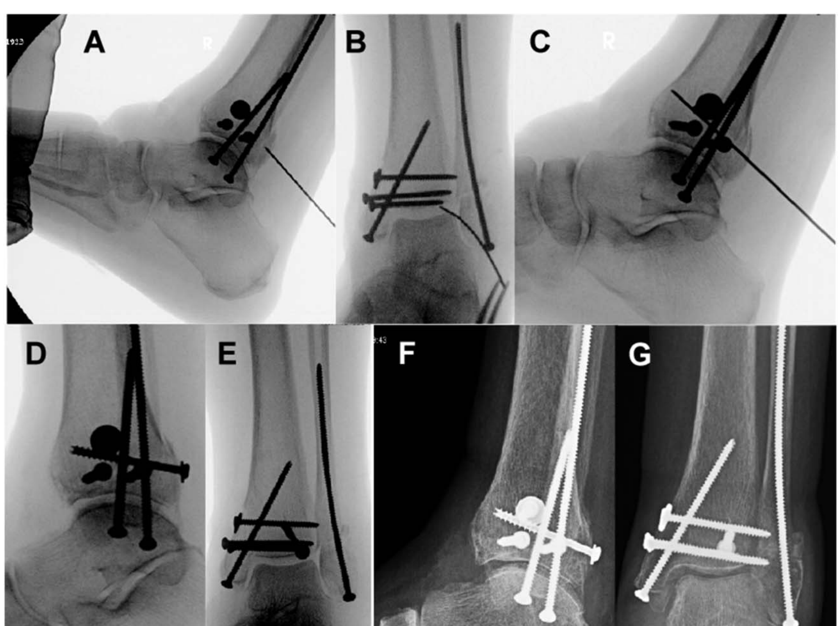

Figure 3. A, After fixation of medial and lateral malleolus and with the foot dorsiflexed, a guide wire is inserted through Achilles tendon and inserted for 2 to 3 mm in the PMF using the lateral view of the ankle. B, Ankle mortise view confirms appropriate starting position of the wire. C, The wire is advanced to the anterior cortex of distal tibia. D and E, Lateral and mortise fluoroscopic images after insertion of the posterior malleolus screw. F and G, Three months of postoperative follow-up AP and lateral radiographs revealing healed fractures.

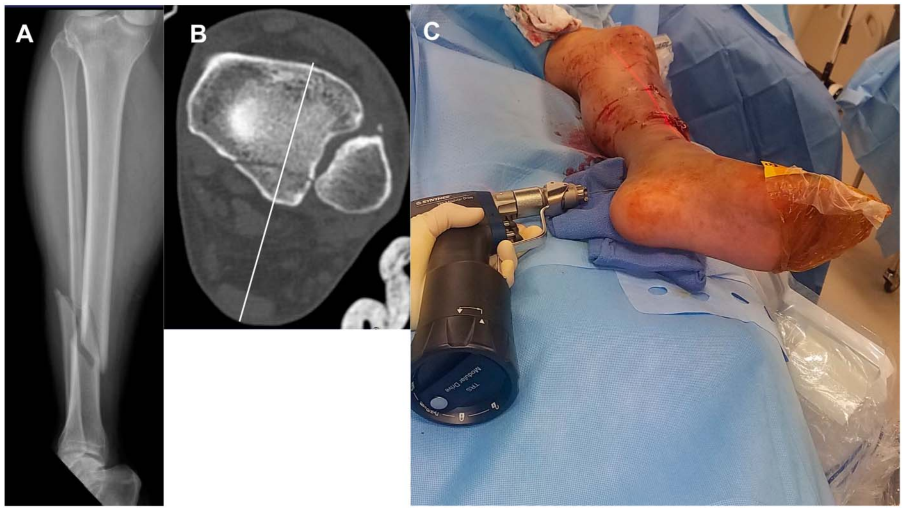

Figure 4. A, A 44-year-old man sustained a type 1 GA open fracture of distal tibia and fibula. B, Axial CT reveals a noncontiguous PMF (same patient as Fig. 1). C, The external rotation of the extremity offered by the fractured tibia and fibula allows for easy insertion of the guide wire through Achilles tendon using the lateral ankle view without any manipulation of the extremity.

partially threaded screw (with or without a washer) is inserted from posterior to anterior (Fig. 3D). Given the small size of the incision, the paratenon and Achilles tendon incisions are not closed, and the skin is approximated with a nylon suture.

In the case where the PMF is part of a spiral distal tibia fracture, the PMF is addressed before the reduction and fixation of the tibia fracture to prevent further fragment displacement. With the patient supine, the leg elevated on a "ramp" type of positioner or folded blankets with the knee in the semiextended position. The external rotation of the extremity offered by the fractured tibia allows for easy access to the Achilles tendon and facilitates biplanar fluoroscopy without any manipulation of the extremity (Fig. 4C). The remaining steps are as described above: the wire is advanced a few millimeters in the posterior malleolus on the lateral view, the starting point is confirmed with AP and mortise views, and the wire is then advanced anteriorly followed by a small longitudinal skin and Achilles tendon incision. The screw length is measured, and the cannulated screw is inserted in a standard technique (Fig. 5A–E).

Figures 6 and 7 show a case of a patient with a distal tibia fracture and a nondisplaced posterior malleolus fracture that was not fixed. The PMF displaced during distal most locking screw insertion and was subsequently fixed with the described technique.

3. Case Series

The use of patient data was approved by the committee on research ethics of our hospital and informed consent was obtained as required. Between August 2017 and February 2022, 13 patients with PMF have been treated with this technique (5 with distal tibia fractures and 8 with ankle fractures) with at least 6 months of follow-up. The patients were on average 41.3 years (range 16–89 years, SD 21.9 years) at the time of surgery with average follow-up of 14.1 months.

No patients in the cohort had postoperative wound complications related to the PA screw incision. All patients returned to their baseline ambulatory status after an initial period of 6 weeks of non–weight-bearing. No patients had residual limitations in dorsiflexion related to Achilles tightness. There were no patients with neurovascular damage postoperatively.

There were no incidences of posterior malleolus malunion or nonunion. There were no cases of screw loosening or fixation

Figure 5. A, The starting position on the PMF is checked on the AP X-ray. B and C, AP and lateral images after screw fixation of PMF. D and E, AP and lateral ankle radiographs after percutaneous fixation of the PMF and intramedullary nailing of the tibia.

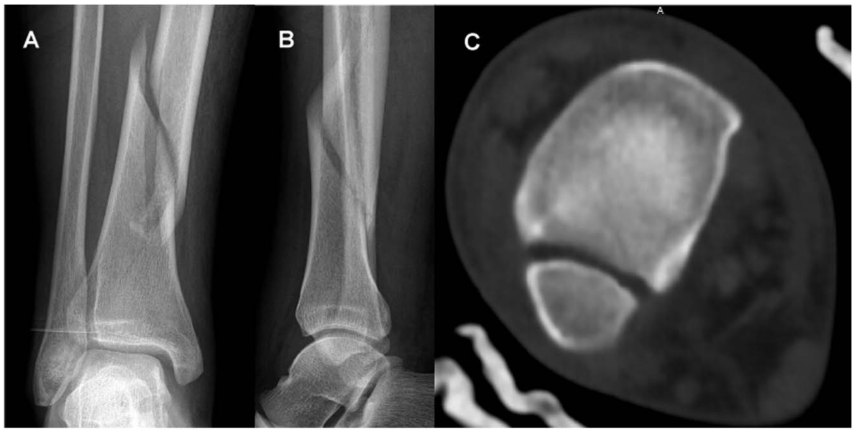

Figure 6. A and B, A 42-year-old man sustained a closed distal tibia fracture. C, CT scan revealed a nondisplaced PMF. It was decided not to fix the PMF.

failure at most recent follow-up visit. There were no cases with symptomatic or prominent implants related to the PA screw. Two patients underwent removal of syndesmotic screws at 7 and 10 months postoperatively.

4. Discussion

Minimally invasive techniques for fixation of PMFs have been described in the past. For anterior-to-posterior fixation, careful dissection of the anterior aspect of distal tibia is required to avoid any neurovascular damage. Strenge et al described a technique where the guide wire is inserted just medial to tibialis anterior tendon, thus obviating the need for dissection over the anterior distal tibia, and the wire is driven posteriorly aiming toward the lateral edge of the Achilles tendon.[6] The wire is then advanced through the skin, and a cannulated screw is inserted from posterior to anterior. All the techniques that involve targeting of the PMF from anterior suffer from imperfections in the accuracy of positioning the screw in the center of the fragment, especially with smaller sized fragments. Moreover, this technique risks damage of the sural nerve.[7,8] The technique described here is simple and avoids neurovascular structures using a safe pathway between the center of the Achilles tendon and the posterior malleolus. Studies have shown that posterior to anterior screw fixation of PMF is biomechanically better than anterior to posterior screw, although there has been no difference in clinical outcomes.[3]

A disadvantage of the technique is that there is limited ability to place the screw perfectly perpendicular to the fracture as seen on the axial CT scan. In clinical practice, this has not been found to be a problem and slight imperfections of this trajectory have not resulted in fracture displacement.

In addition, the technique is not amenable for all PMFs. The indications are narrow as evident by the small number of cases presented. If there is more than 2 mm of fracture displacement, we recommend formal ORIF through a posterolateral approach. If the screw trajectory, as predicted on the axial CT scan, is such that the fragment cannot be fixed effectively, the technique is not used. Small and comminuted fractures are not amenable for this technique. The technique is more suitable for nondisplaced or minimally displaced Haraguchi type 1 fractures for selected type 3 fractures where the fragment is large enough to be captured by a screw and for the posterolateral part of Haraguchi type 2 fractures. Finally, the extra cost associated with the use of cannulated drill and cannulated screw has to be considered.

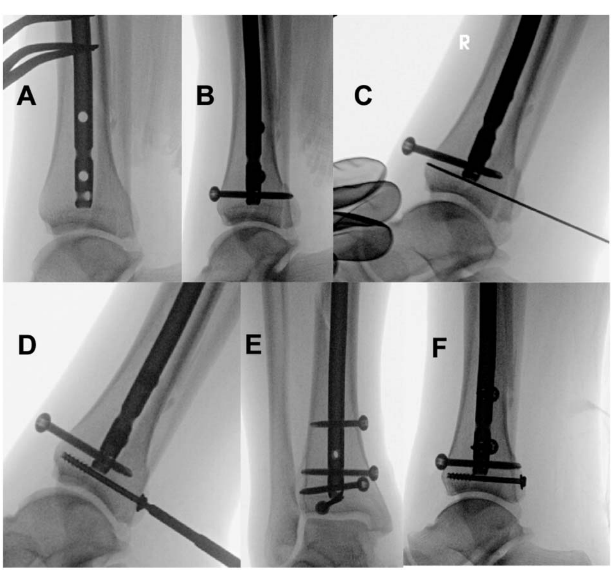

Figure 7. A, After insertion of the intramedullary tibia nail, the PMF remained nondisplaced. B, The PMF displaced during insertion of the distal most locking screw. C, The screw was partially removed, and the guide wire was inserted through the Achilles tendon. D, A cannulated screw was inserted from posterior to anterior to compress the fracture. E and F, Final fluoroscopic images after fixation of the PMF and reinsertion of the distal locking screw.

5. Conclusion

In conclusion, we describe a technique for percutaneous fixation of selected PMF's that uses a safe pathway through the Achilles tendon. It avoids neurovascular structures and is biomechanically sound.

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