Anatomic Structures at Risk during Posterior to Anterior Percutaneous Screw Fixation of Posterior Malleolar Fractures: A Cadaveric Study

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Category: Ankle; Trauma

Keywords: Posterior Malleolus Fracture; ORIF With Mini-Open / Percutaneous; Screws

Introduction/Purpose: Posterior malleolus fractures (PMFs) are typically associated with trimalleolar ankle fractures and have been reported to occur in 10-40% of ankle fractures. The PM may be fixed by direct ORIF or indirect percutaneous reduction. Direct reduction via a posterolateral approach is required for larger fragments, which requires prone or lateral decubitus positioning. Indirect reduction and fixation with anterior to posterior (AP) screws remains the most common method, in which screw threads are not entirely across the fracture site to allow interfragmentary compression. Objective: Determine the risk to anatomic structures utilizing a percutaneous technique for posterior to anterior (PA) screw fixation. It is advantageous as it places all the threads across the fracture site even for small fragments and can be performed in the supine position.

Methods: 10 fresh-frozen, morphologically normal cadaver lower leg. Under fluoroscopic guidance, 1.35 mm Kirschner wire was inserted percutaneously from anteromedial to posterolateral. Guidewire was inserted from a starting point just medial to the tibialis anterior tendon and aimed at a point just lateral to the Achilles tendon. Small skin incision was made over the wire posteriorly, displacing the Achilles tendon medially as required. The wire was then over-drilled in posterior to anterior direction and replaced with a 4.0 mm partially threaded cannulated screw directed posterior to anterior. Each specimen was dissected, and adjacent soft tissue and neurovascular structures were identified. The distance from the guidewire to each anatomic structure of interest was measured. Descriptive analysis and the correlation between the mean distances from the guidewire to each structure was calculated using SPSS version 26.

Results: The sural nerve was directly transected in 1/10 specimens (10%) and in contact with the wire in a second specimen (10%). There was a significant correlation between the proximity of the guidewire to the apex of Volkmann’s tubercle and its proximity to the sural nerve. (r= 0.705, p = 0.034) The flexor hallucis longus (FHL) muscle belly was perforated by the guidewire 40% of the time but was not tethered or entrapped by the screw. The neurovascular bundles were safely away from the wire in all cases. The lateral 1-2 mm of the Achilles tendon was pierced by the guidewire 20% of the time. Although suboptimal, these injuries may be of little clinical consequence, and the screw passed without tethering the tendon in all cadaveric specimens.

Conclusion: Percutaneous PA screw placement is a safe technique which can be improved with several modifications. A mini-open technique is recommended to protect the sural nerve. The surgeon may consider aiming slightly more medial and closer to the Achilles tendon in order to avoid injury to the sural nerve. It is also advisable to use a soft tissue guide when over-drilling the guidewire. There may be potential for tethering of the FHL with use of a washer or large screw head. Risk to the anterior and posterior neurovascular bundles is minimal.

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Figure 1. A) Cross sectional anatomy with proposed screw trajectory. B)Posterolateral surface anatomy with K-wire. Illustration by Nicole Wolf, MS, ©2019. Printed with permission.