Neurovascular Structures At Risk with a Modified Posteromedial Incision for Posterior Pilon Variant Fractures: A Cadaveric Study

Statement of Purpose

Posterior malleolar fractures with talar impaction and posteromedial extension through the medial malleolus are termed posterior pilon variant fractures. Despite the lack of consensus regarding the optimal surgical approach for this fracture pattern, a posteromedial incision is commonly implemented for posterior malleolar fractures. However, with posteromedial involvement, a modified posteromedial incision provides direct visualization of both the posteromedial and posterolateral fragments. The purpose of this study is to examine the proximity of neurovascular structures to the modified posteromedial incision for posterior pilon variant fractures.

Methodology

Ten fresh-frozen cadaver lower extremities (between ages 81-94 years old; 7 right-sided and 3 left-sided; 5 male and 5 female) were dissected to examine the neurovascular structures at risk with a modified posteromedial incision. A 12-centimeter (cm) incision was made 1-cm medial to the proximal insertion of the Achilles tendon on the calcaneus (Figure 1). The sural nerve was identified and explored along its course from midline to its distal lateral position along the Achilles tendon (Figure 2). The tibial nerve and posterior tibial artery are visible as they pass through the flexor retinaculum. A longitudinal measurement was recorded for the distance of the sural nerve from the posterior bony structures. A transverse measurement was recorded for the depth of the neurovascular bundle at the midly point of the incision.

In 2000, Sigvard Hansen termed posterolateral plan as a variant of posterior malleolar fractures, this was later modified by Rinderer, who further described this fracture pattern as an extension into the posterior collisicus, creating posteromedial and posterolateral fragments (1). In 2004, Sigvard Hansen postulated that a posteromedial incision was the most commonly employed surgical approach; however, damage to the sural nerve is a grave concern (1-2). In 2012, Sigvar et al. performed a cadaveric study in 12 legs to determine the proximity of the sural nerve to the incision (2). The authors reported that in ten out of 12 legs, these structures crossed over the incision at a mean distance of 50.7 mm and 61.0 mm, respectively. In four out of 12 legs, the sural nerve ran closely and parallel to the incision throughout its entire length. The exact location of where the sural nerve crosses the incision varies and the authors were unable to calculate an average measurement for this determination. Due to the variability and risk of injury to the sural nerve, it was suggested utilizing a different approach to access posterior pilon fractures.

In 2017, Assal et al. investigated three common approaches in 12 cadaveric legs for posterior malleolar fractures: posteromedial, posterolateral, and modified posteromedial (4). The posterolateral approach allowed direct visualization of the osseous anatomy but did not provide exposure of the lateral one-third. Alternatively, the posteromedial approach was described as a safer alternative as the neurovascular bundle is protected by flexor hallucis longus (FHL) however, the Achilles and FHL created a barrier to the medial plate. Assal et al. concluded that the modified posteromedial approach was superior to the posterolateral and posteromedial approaches not only for direct exposure of the osseous anatomy but also because it created the least amount of traction on the neurovascular bundle when using a straight-gauge.

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Results

The mean and median longitudinal distances from the sural nerve to the most proximal aspect lateral to the incision were 2.02 cm and 2.65 cm, respectively. These values range from 2.2 cm to 3.1 cm. The mean and median vertical distances from the neurovascular bundle to the proximal end of the incision were 1.5 cm and 1.3 cm, respectively. These values range from 0.7 cm to 2.9 cm. The range and average measurements are displayed in Table 1 and Figure 4, respectively.

References


Acknowledgments

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Analysis & Discussion

Posterior approaches for posterior malleolar fractures have gained popularity compared to indirect reduction through an anterior approach due to ample exposure of the fragments for proper anatomic reduction and fixation. While a posteromedial approach is commonly implemented to gain access to both the tibia and posterolateral malleolus, this limits the exposure to the medial malleolus in pilon variant fractures. Despite this, a traditional posterior incision may not provide enough visualization to the entirety of the bimalleolar plate, posterolateral, and medial malleolus. Therefore, Assal et al. developed the modified posteromedial incision to allow for greater exposure of the medial and lateral fragments (5). With incision placement, knowledge of neurovascular structures in the surrounding area is necessary to prevent iatrogenic nerve injuries.

The measurements obtained in our study, validate the hypothesis that the modified posteromedial incision not only provides excellent visualization but also is a safer surgical approach for pilon variant fractures. We found that the average distance of the sural nerve from the proximal aspect of the posterior part of the incision was 2.6 cm as it coursed midway over the Achilles tendon. This incision presents as a safer alternative: the posteromedial approach not only limits exposure to the posterior tibial plate but also poses as a risk to the sural nerve and lesser saphenous vein (3, 2). The mean depth of the neurovascular bundle was 1.5 cm deep to the course of the incision. Despite the bundle being directly deep to the incision, the measurements obtained in our study validate the hypothesis that the modified posteromedial incision is indicated not only for direct access to vital structures but also to prevent iatrogenic injury to neurovascular structures in the surrounding area.

Table 1. Patient characteristics and data

<table>
<thead>
<tr>
<th>Metric</th>
<th>Bone</th>
<th>Age</th>
<th>Females</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sural nerve</td>
<td>M</td>
<td>N</td>
<td>F</td>
</tr>
<tr>
<td>Length (cm)</td>
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<td>2.65</td>
<td>1.5</td>
</tr>
<tr>
<td>Width (cm)</td>
<td>0.7</td>
<td>2.9</td>
<td>1.5</td>
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Figure 1: Photograph of cadaveric specimen showing the modified posteromedial incision.

Figure 2: Photograph of cadaveric specimen showing the relationship between the modified posteromedial incision and the neurovascular bundle.

Figure 3: Photograph of cadaveric specimen showing the relationship between the modified posteromedial incision and the neurovascular bundle.

Figure 4: Photograph of cadaveric specimen showing the relationship between the modified posteromedial incision and the neurovascular bundle.