Effect of a Calcaneal Osteotomy in a Novel Asymmetric Ankle Arthritis Model

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Disclosures

- Jack Anavian, MD – none
- Heather E. Gotha, MD – none
- Todd A. Fellars, MD – none
- Sarath C. Koruprolu, MS – none
- Ryan R. Rich – none
- David J. Paller, MS, MBA – none

Ours disclosures are in the Final AOFAS Mobile App, we have no potential conflicts with this presentation
Background

- In patients with asymmetric ankle arthritis, ankle realignment surgery with a calcaneal displacement osteotomy has shown promising but variable clinic results.

- The effects of a calcaneal osteotomy remain poorly understood from a biomechanical standpoint.
  - Prior studies have failed to adequately recreate an in-vitro model of asymmetric ankle arthritis.
  - Biomechanical explanations for the effects of realignment surgery have yet to be elucidated.
Purpose

- In this study, we employ a novel cadaveric asymmetric ankle arthritis model in order to better elucidate the effect of a calcaneal displacement osteotomy, with and without a fibular osteotomy, on ankle joint contact pressures.

- We hypothesize that this asymmetric ankle arthritis model will result in a shift in the center of pressure (COP) and that a corrective calcaneal osteotomy will reduce this shift.
Methods

- 12 paired cadaveric leg specimens were axially loaded to simulate a single leg stance up to 700N

- Baseline intra-articular pressure (COP) and contact area measurements were obtained via pressure sensors (Tekscan) in the native specimens
Methods

- A varus (6 right-sided specimens) or valgus (6 left-sided specimens) deformity model simulating stage IV asymmetric ankle arthritis was designed for all specimens
  - Partial ligamentous release
  - Eccentric removal of cartilage (50%) from both the tibial plafond and the talus
- Specimens were then reloaded to 700N and intra-articular pressure (COP) and contact area measurements were reassessed
Methods

- Realignment was, thereafter, created with a lateral (right-sided specimens) or medial (left-sided specimens) calcaneal displacement osteotomy (1 cm)
- The specimens were then reloaded and pressure (COP) and contact areas reassessed
- The above protocol was repeated after a fibular osteotomy to assess the effect of an intact fibula
- A paired $t$-test was performed to determine the effect of a concomitant fibular osteotomy
Results

- **Varus Arthritis Model**
  - After creation of the arthritis model there was a mean COP of 4.4 ± 1.9mm in a posterior and medial direction
  - A lateral displacement calcaneal osteotomy caused a mean COP shift of 5.6 ± 2.8mm in an anterior and lateral direction
  - A lateral displacement calcaneal osteotomy + fibular osteotomy caused a mean COP shift of 5.2 ± 2.8mm in an anterior and lateral direction

- **Valgus Arthritis Model**
  - After creation of the arthritis model there was a mean COP of 5.4 ± 2.0mm in an anterior & lateral direction
  - A medial displacement calcaneal osteotomy caused a mean COP shift of 5.7 ± 2.1mm in an anterior and lateral direction
  - A medial displacement calcaneal osteotomy + fibular osteotomy caused a mean COP shift of 5.1 ± 0.8mm in an anterior and lateral direction

<table>
<thead>
<tr>
<th>Mean Center of Pressure Shift</th>
<th>Varus Model</th>
<th>Valgus Model</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Magnitude (mm)</td>
<td>Direction</td>
</tr>
<tr>
<td>Arthritis Model</td>
<td>4.4 ± 1.9</td>
<td>Posteromedial</td>
</tr>
<tr>
<td>After Calcaneal Osteotomy</td>
<td>5.6 ± 2.8</td>
<td>Anterolateral</td>
</tr>
<tr>
<td>After Calcaneal + Fibular Osteotomy</td>
<td>5.2 ± 2.8</td>
<td>Anterolateral</td>
</tr>
<tr>
<td>t-test (effect of fibular osteotomy of COP shift)</td>
<td>p=0.063</td>
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Results

- According to the paired t-test, presence of concomitant fibular osteotomy did not have a significant effect on the COP shift for both the varus ($p=0.063$) and valgus ($p=1.000$) arthritis models.

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Conclusions

- The creation of asymmetric arthritis in cadaveric ankle specimens caused a shift in the intra-articular COP
- In a varus model, the COP shifted in a posteromedial direction; in a valgus model, the COP shifted in an anterolateral direction
- Corrective displacement calcaneal osteotomy appeared to reduce this COP shift in the varus arthritis model, but resulted in a paradoxical shift in an anterior and lateral direction in the valgus model
- Concomitant fibular osteotomy exhibited no significant effect on COP position in either model
- A larger sample size is needed to determine the significance of these findings


