Does Calcaneus Fracture Gap without Step–off Alter Stress Distribution across the Subtalar joint?

Brett Barrick, M.D.
Donald A. Joyce, M.S.
Frederick W. Werner, M.M.E.
Maria Iannolo, M.D.

All authors are affiliated with:
Department of Orthopedic Surgery
SUNY Upstate Medical University
Syracuse, NY 13210 USA
Disclosures

- **Financial Disclosure:** Funded by the Department of Orthopedic Surgery, SUNY Upstate Medical University, Syracuse, New York, USA

- **Conflict of Interest:**
  - Brett Barrick, M.D.: “None Reported”
  - Donald A. Joyce, M.S.: “None Reported”
  - Frederick W. Werner, M.M.E.
  - Research support from: 1) Moximed, 2) Conventus
  - Own stock in Moximed
  - Maria Iannolo, M.D. “None Reported”
Abstract

- Subtalar arthritis is a common consequence following calcaneal fracture, and its development is related to the severity of the fracture at the posterior facet. Changes in posterior facet contact characteristics have not been previously characterized for calcaneal fracture gap without step-off.

- In this study, a primary calcaneal fracture line was created to simulate fracture gap displacement without a step-off of the articular surface, and to evaluate the resulting contact pressure changes across the posterior facet.

- The contact characteristics (peak pressure, area of contact, and centroid of pressure) of the posterior facet of the subtalar joint in 6 cadaveric specimens were determined at 5 foot positions. A fracture was created to simulate a Sanders Type II fracture. The contact characteristics were determined with the posterior facet anatomically reduced followed by an incremental increase in fracture gap displacement of 1, 2, and 4 mm without a step-off of the articular surface.

- Peak pressure on the medial fragment was significantly less with a 4 mm gap compared to a 1 or 2 mm gap, or reduced. On the lateral fragment, the peak pressure was significantly increased with a 4 mm gap compared to a 1 or 2 mm gap. Contact area significantly changed with increased gap. In this study there were no differences in contact characteristics between a 2 mm gap and an anatomically reduced fracture.
Pressure sensor packet position on posterior facet after completion of experiment and exposure of the calcaneus. The sensor was tethered to screw eyes laterally and buttons medially. The steel bars were placed through the calcaneus and used to hold the split calcaneus together by clamps on each bar.
Pressure sensor elevated off of the foot at the end of the experiment, showing the reduced fracture line.
Posterior view of foot showing dowels to reduce calcaneal fragments and shim between the fragments.
Foot loading frame allowing foot flexion-extension and inversion/eversion. The base of the frame was sequentially locked in five testing positions (neutral, 10 degrees flexion, 10 degrees extension, 10 degrees of inversion and 10 degrees of eversion).
RESULTS

Peak pressure significantly changed with increased fracture gap displacement on the medial and lateral fragments. On the medial fragment the test of within subject effects indicated there was a difference in pressure with gap distance ($P=.001$). Post hoc testing showed the peak pressure was significantly less with a 4 mm gap compared to a 1 mm gap ($P=.026$), a 2 mm gap ($P=.031$), and the fragments reduced ($P=.030$).

In regards to the lateral fragment the test of within subject effects indicated there was a difference in pressure with gap distance ($P=.007$). The post–hoc tests showed the peak pressure significantly increased with a 4 mm gap compared to a 1 mm gap ($P=.026$) or a 2 mm gap ($P=.011$). There was a trend with a 4 mm gap, that the pressure was greater than with the fracture reduced ($P=.12$). A post–hoc test showed that a sample size of 6 feet had 90% power at a 5% level of significance to show the above mentioned differences among the different gap comparisons.
Peak measured pressure on the medial fragment of the calcaneus as a function of foot position and amount of fracture gap. Based on 6 specimens.
Peak measured pressure on the lateral fragment of the calcaneus as a function of foot position and amount of fracture gap. Based on 6 specimens.
In this study, a primary calcaneal fracture line is created to simulate fracture gap displacement without a step-off, and to evaluate the resulting contact pressure changes across the posterior facet.

There was no significant difference in peak pressure on the medial or lateral fragments when 2 mm of gap displacement was compared to the anatomically reduced fracture. However, there was a significant difference in peak pressure of both fragments when comparing 4 mm of displacement with 2 mm of displacement.

We also showed that there was a significant decrease in contact area of the medial fragment with increasing gap displacement that occurred simultaneously with a significant increase in contact area of the lateral fragment with increasing fracture gap displacement.

This study suggests that a small amount of articular incongruity without a step-off can be tolerated by the subtalar joint, in contrast to articular incongruity with a step-off present.

Conclusions
References:


