Buttress Plating versus Anterior-to-Posterior Lag Screws for Fixation of the Posterior Malleolus: A Biomechanical Study

Chase Bennett MD, Anthony Behn MS, Adam Daoud BS, Sean Nork MD, Bruce Sangeorzan MD, Greg Dikos MD, Julius Bishop MD

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Introduction

• The reported incidence of posterior malleolus fractures varies widely
  • 7% to 44% of ankle fractures
• When compared to similar bimalleolar ankle fractures, outcomes of trimalleolar fractures are significantly worse\(^3,4,5\)
  • Lower post-treatment functional scores
  • Higher incidence of post traumatic arthritis
• The posterior malleolus plays a significant role in tibiotalar load transfer\(^7,8\)
  • Surface area of the plafond
  • Geometric restraint to posterior talar subluxation
  • Stabilizing the syndesmosis

▪ Despite recognized clinical and biomechanical importance, operative indications and preferred method of treatment remains unclear\(^1,2\)
Purpose

The purpose of this study is to compare the biomechanical performance of the two most common methods for fixation of the posterior malleolus: AP Lag Screws and Posterior Buttress Plating.

Hypothesis

Fractures treated with posterior buttress plating would show less axial displacement during cyclical loading than those treated with AP lag screws.

Fractures treated with posterior buttress plating would be able to sustain higher ultimate loads than those treated with AP lag screws.
Methods

• Preliminary test data showed that seven matched pairs were needed (alpha = 0.05, power = 0.8)
  • 0.5mm difference in displacement during cyclical load testing
• Seven matched pairs of cadaveric ankles were obtained
  • Age: 57±11; range: 43-70
• Specimen preparation
  • Disarticulated at the ankle.
  • Fibula and all soft tissues were removed
• A custom jig was fabricated to create reproducible posterior malleolar fractures (OTA type 43-B1)
  • Fracture plane internally rotated 6.5 degrees from the bimalleolar axis
  • Fracture plane exits posteriorly, 30 degrees from the long axis of the tibia
Methods

Each specimen was randomized to one of two fixation constructs:

- 2x 3.5mm AP lag screws at the level of the physeal scar
- 5-hole 1/3 tubular posterolateral buttress plate.
  - 3.5mm cortical screws in holes 1, 3, and 5.
Methods

• The proximal tibia was potted and secured in an angle vise oriented 15-degrees from vertical in the sagittal plane
  • The resulting ratio of axial-to-posterior load approximated that at 10% of the way through the gait cycle
  • The point at which maximum stress is placed on the posterior malleolus\textsuperscript{11,13}
• Cyclical loading from 0% to 50% BW at 1 Hz for 5,000 cycles
  • Displacement monitored with motion capture throughout cyclical loading
• Specimens were the loaded to failure at a rate of 10 mm/min and the following endpoints were recorded
  • Load at displacement of 1mm
  • Ultimate load
  • Displacement at ultimate load
Cyclical Loading Results

![Graph showing cyclical loading results for Buttress Plate and Lag Screws. The graph includes bars representing displacement (mm) against cycle numbers from 10 to 5000. Significant differences are indicated by asterisks.](image)
Ultimate Loading Results

- Load at 1 mm axial displacement
  - Buttress plate: 1211±570 N
  - Lag screws: 802±416 N
  - p=0.32
- Ultimate load
  - Buttress plate: 1585±683 N
  - Lag screws: 1617±422 N
  - p=0.90
- Axial displacement at ultimate load
  - Buttress plate: 2.51±0.41 mm
  - Lag screws: 3.67±1.56 mm
  - p=0.12
Significant & Discussion

• Posterior buttress plating is superior to AP lag screws at resisting displacement during cyclical loading
• It is unclear why posterior buttress plating failed to be more resistant to ultimate loading
  • Trend toward higher loads sustained at 1mm axial displacement in the posterior buttress plate group
    • $p=0.319$
  • Trend toward larger axial displacement at maximum load in the AP lag screw group
    • $p=0.122$
• Study may have been underpowered to detect differences in ultimate loading
Limitations

- All soft tissues were removed from the specimens and thus only the ability of the implants to resist displacement was examined.
- Our model may not replicate the forces seen in the early post-operative period.
- One potential advantage of a direct posterolateral approach to the posterior malleolus is improved reduction quality.
  - Direct visualization for confirmation of anatomic reduction and appropriate implant application was available in all cases.
  - As additional clinical research is performed, it will be important to distinguish the effects of reduction quality from fixation strategy on patient outcome.
References


