

Posterior Malleolar Fracture Fixation with Posterior Plating versus a Modified Anterior-Posterior Four Screw Construct: A Cadaveric Biomechanical Study

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INTRODUCTION: There continues to be controversy regarding the optimal fixation strategy of large posterior malleolar fractures while treating trimalleolar ankle fractures. This study compared the biomechanical stability in a cadaveric model of a modified anterior-posterior (AP) 4-screw construct versus posterior plate fixation of posterior malleolar fractures.

METHODS: Twenty fresh-frozen human cadaveric below-knee specimens were prepared with an oblique osteotomy of the posterior malleolus, resection of medial and lateral ankle ligaments, and posterior dislocation of the tibiotalar joint to produce unstable Mason 2A posterior malleolar fractures. Specimens were fixed with either a modified AP 4-screw construct or with a 5-hole one-third tubular plate with 4 cortical screws. The specimens were axially loaded in neutral ankle position for 50,000 cycles to simulate protected weightbearing, then loaded to failure in 20 degrees of plantarflexion. Fracture displacement and load to failure were recorded. Statistical significance was set at $p < 0.05$.

RESULTS: There was no difference in displacement between the two constructs after axial cyclic loading (screws, 1.32 ± 0.26 mm vs plate, 1.26 ± 0.48 mm, $p = 0.82$). Additionally, there was no difference in the load-to-failure (screws, 3856 ± 617 N vs plate, 3939 ± 569 N, $p = 0.81$). Maximum load-to-failure was statistically equivocal between the two constructs (screws, 4867 ± 718 N vs plate, 4862 ± 1020 N, $p = 0.99$). On average, posterior malleolar fractures in the study had sagittal height of 47.25 mm, sagittal angle of 7.35 mm, axial angle of 29.70°, with 50% involvement of the tibial plafond and no differences between groups ($p > 0.34$).

DISCUSSION: For the fixation of large, unstable Mason 2A posterior malleolar fractures involving roughly 50% of the articular surface, our modified AP 4-screw construct may offer similar biomechanical stability while avoiding prone positioning and additional posterior surgical exposures associated with posterior plating.

SIGNIFICANCE/CLINICAL RELEVANCE: This cadaveric study demonstrates that a modified anterior-posterior 4-screw construct provides biomechanical stability equivalent to posterior plating for large posterior malleolar fractures.

Outcome	Plate	Screws	P-value
	Mean (95% CI)	Mean (95% CI)	
Max load catastrophic (N)	4861.89 (3841.72 – 5883.06)	4867.40 (4149.27 – 5585.53)	0.99
Max displacement (mm)	1.26 (0.78-1.74)	1.32 (1.06-1.58)	0.82
Max load @ 2mm (N)	3939.14 (3369.77-4508.52)	3856.10 (3239.48-4472.72)	0.81

Table 1: Estimated marginal means for the study outcomes and their associated 95% confidence intervals by study group. Catastrophic max load, max displacement during cyclic testing, and max load at 2 mm did not significantly differ between experimental conditions (all $p > 0.05$)



Figure 1: Posterior plating of posterior malleolus fracture on (A) AP, (B) Mortise, and (C) Lateral fluoroscopic views. Screws are labeled 1-4 based on order of placement.



Figure 2: AP 4-screw fixation of posterior malleolus fracture on (A) AP, (B) Lateral, and (C) Secondary lateral fluoroscopic views. Screws are labeled 1-4 based on order of placement.