



Comparison of Single-Row and Double-Row Metacarpal Fracture Plating Constructs Under Cyclic Loading

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Introduction

- Metacarpal fractures are commonly treated with a variety of means including closed reduction, pinning, intramedullary nailing, and plating. Dorsal plating with either single-row 2-dimensional (2D) or double-row 3-dimensional (3D) plates has been proposed.
- 3D plates provide the ability to place an equal or increased number of screws in a shorter potentially lower profile plate due to the staggered screw design potentially offering advantages of a smaller incision, less soft tissue stripping, and a subsequent decrease in tendon irritation by the plate.
- The shorter 3D plates have demonstrated a higher load to failure potentially allowing patients to more safely begin early active range of motion sooner than with 2D plates.¹



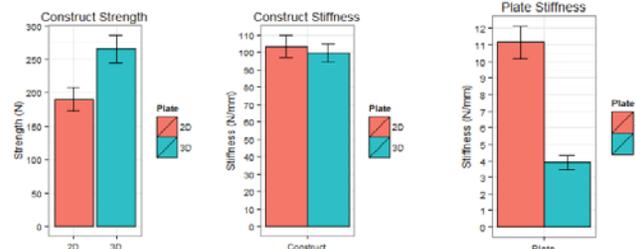
Research Objectives

- To determine if the 1.5-mm Synthes locking 3D plates will demonstrate equal or greater stability under cyclic loading in comparison to the larger 2.0-mm Synthes locking 2D plates in a sawbone model simulating an aggressive range of motion post-operative protocol.
- To determine if the 3D plates will demonstrate a higher tensile strength when loaded to failure.

Results

- All double-row constructs survived both cyclic loading conditions. Ten of the fifteen (67%) single-row constructs survived both cyclic loading conditions, while five constructs failed during the 120N loading at 1377 +/- 363 cycles.
- When loaded to failure, the double-row constructs failed at 265 N +/- 21 N, whereas the single-row constructs surviving cyclic loading failed at 190 N +/- 17 N ($p < 0.001$).
- The double-row plates exhibited significantly lower stiffness ($p < 0.001$), however, the construct stiffness was not significantly different.

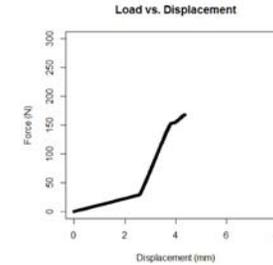
Construct	Strength	Plate Stiffness	Construct Stiffness
2D Plate	190 ± 17 N	11.2 ± 1.0 N/mm	103.3 ± 6.5 N/mm
3D Plate	265 ± 21 N	3.9 ± 0.4 N/mm	99.5 ± 5.0 N/mm
P-value	< 0.001	< 0.001	0.134



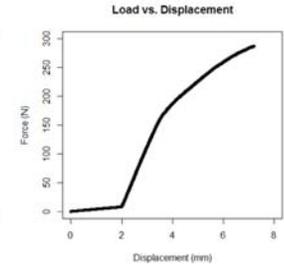
Methods

- Thirty metacarpal sawbones were cut with a 1.5mm gap in between the two pieces simulating a comminuted fracture pattern. Half of the bones were plated with single-row (2D) plates and half with double-row (3D) plates.
- The plated bones were then mounted into a Materials Testing System (MTS) Mini Bionix testing apparatus where they were cyclically loaded under cantilever bending for 2,000 cycles at 70N, 2,000 cycles at 120N, and then monotonically loaded to failure.
- Throughout the testing sequence, fracture gap sizes were measured, failure modes were recorded, and construct strengths and stiffnesses were calculated for comparison.

2D Plate Load to Failure Plot



3D Plate Load to Failure Plot



Discussion

- Demonstration of the 3D plates equivalence in strength is justification for use of the 3D plates in addition to the benefits of decreased tendon irritation due to a lower profile and a staggered screw design.
- This decreased tendon irritation may limit the number of patients requiring a return to the operating room for hardware removal.
- The stability allowed for early rehab should help reduce the common post-operative complication of finger stiffness by reducing scarring and adhesions from forming.

Conclusions

- Double-row metacarpal plates offer a lower profile metacarpal fixation option that provides the stability necessary for an early post-operative range of motion protocol.
- Double-row plates demonstrated increased resistance to failure in a cyclic loading model and increased load to failure compared to higher profile single-row metacarpal plates.
- Double-row plate fixation demonstrated greater stability while allowing for less soft tissue stripping and a lower risk of tendon irritation.

Clinical Significance

- Demonstrating the ability of both plates to sustain superphysiologic cyclic loading is justification for early and aggressive post-operative range of motion protocols following metacarpal ORIF using either plate.

References

[1] Gajendran VK, Szabo RM, Myo GK, Curtiss SB. Biomechanical comparison of double-row locking plates versus single- and double-row non-locking plates in a comminuted metacarpal fracture model. J Hand Surg Am 34(10): 1851, 2009