# Comparing Fixation Stability of Rotationally Unstable Proximal Phalanx Fractures: A Biomechanical Study

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INTRODUCTION: Proximal phalanx fractures are common upper extremity injuries; many are treated nonoperatively, but surgical fixation is often recommended for unstable patterns or malrotation. Intramedullary screw (IMS) fixation has emerged as a minimally invasive technique with potential benefits of earlier range of motion and reduction of soft tissue disruption compared to traditional methods. However, its relative resistance to fracture displacement in rotationally unstable fracture patterns requires further investigation. This study compares the biomechanical stability of single IMS, dual crossing IMS, and dual interfragmentary cortical screw constructs in long oblique proximal phalanx fractures, hypothesizing that dual crossing IMS will provide superior stability.

METHODS: Eleven cadaveric hands (33 fingers) were used in the study. Sixty-degree oblique extra-articular proximal phalanx fractures were created in middle, index and ring fingers, then randomly assigned to one of the three constructs: single 3.5-mm IMS, dual crossing 2.5-mm IMS, two 1.5-mm cortical screws perpendicular to the fracture. The hands then underwent a flexion-extension protocol of 2000 cycles at 0.25 Hz, simulating postoperative movement and rehabilitation. The fractures' angular rotation (degrees) and displacement in coronal and sagittal planes (millimeters) were subsequently measured. Statistical analysis was conducted using ANOVA with p-value $< 0.05$ defined as statistically significant.

RESULTS SECTION: There was no significant difference in average angular rotation, or sagittal and coronal displacement across the three constructs before and after simulated motion. Mean angular rotation in the single IMS group was $7.12 \pm 3.41°$, dual IMS group $6.20 \pm 5.91°$, and interfragmentary screws $7.10 \pm 4.84°$. Mean absolute coronal displacement was similar across groups (single IMS: $0.280 \pm 0.216$ mm, dual IMS: $0.388 \pm 0.381$ mm; interfragmentary screws $0.378 \pm 0.315$ mm; $p = 0.827$), as was sagittal displacement (single IMS: $0.362 \pm 0.307$ mm, dual IMS: $0.374 \pm 0.364$ mm, interfragmentary screws: $0.531 \pm 0.469$ mm; $p = 0.587$).

DISCUSSION: The biomechanical stability of single IMS, dual IMS and interfragmentary screws does not differ when considering angular rotation or displacement during simulated early post-operative range of motion in long oblique proximal phalanx fractures. Surgeons should consider using IMS fixation over interfragmentary screws in oblique fractures to minimize soft tissue dissection and subsequent scar formation. The addition of another IMS may be unnecessary in long oblique fracture patterns if canal fill with a single IMS is maximized. Study limitations include small sample size and lack of rotational stress during range of motion testing which was limited to flexion and extension.

SIGNIFICANCE/CLINICAL RELEVANCE: (1-2 sentences): Intramedullary screw fixation has emerged as a minimally invasive way to stabilize proximal phalanx fractures and allow earlier post-operative range of motion compared to prior techniques, but its role in rotationally unstable fracture patterns remains controversial. Our study findings support its application to rotationally unstable proximal phalanx fractures without sacrificing fracture stability in early post-operative range of motion.

REFERENCES: None.

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IMAGES AND TABLES:

**Figure 1.** Three fracture fixation constructs in oblique proximal phalanx fractures.