

Midcarpal Load Redistribution Following Radioscapholunate Fusion with Incremental Scaphoid and Triquetrum Excision: A Finite Element Study

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INTRODUCTION: Radioscapholunate (RSL) fusion is a well-established surgical option for painful radiocarpal arthritis while still preserving the midcarpal joint. Although fusion provides pain relief, it may alter midcarpal biomechanics and predispose to secondary joint degeneration. Surgeons often add distal scaphoid excision (DSE) or triquetrum excision (TE) to improve motion, yet the effects of these resections on load distribution remain poorly quantified. This study aimed to evaluate the biomechanical consequences of incremental DSE, with or without TE, on midcarpal joint contact pressure and area using validated finite element analysis (FEA).

METHODS:

A previously validated finite element model of a human wrist was used to simulate RSL fusion combined with three levels of DSE ($\frac{1}{4}$, $\frac{1}{2}$, $\frac{3}{4}$) and with/without TE. Contact pressures and areas at the lunocapitate and lunohamate joints were assessed under physiologic grasping loads. Results were compared against the intact model and prior cadaveric studies.

RESULTS: RSL fusion alone produced minimal changes in lunocapitate contact mechanics. However, $\frac{1}{4}$ DSE increased peak pressure by 152% (to 8.32 MPa) and contact area by 60% (to 22.60 mm²) compared to intact. Greater resections ($\frac{1}{2}$ and $\frac{3}{4}$ DSE) showed diminished pressure elevations, indicating nonlinear load redistribution (Fig. 1). The addition of TE compounded mechanical disruption, with the $\frac{1}{2}$ DSE + TE scenario showing a peak pressure of 8.88 MPa and a contact area of 29.93 mm². Lunohamate pressures also increased in TE configurations, suggesting stress shifting toward adjacent articulations (Fig. 2).

DISCUSSION AND CONCLUSION: Incremental scaphoid and triquetrum excision following RSL fusion significantly alters midcarpal load sharing, with smaller resections producing greater peak pressures. Excessive excision may offload the lunocapitate joint but increase stress on the lunohamate articulation. These findings underscore the importance of preserving carpal bone integrity where possible to avoid joint overload and potential secondary arthritis.

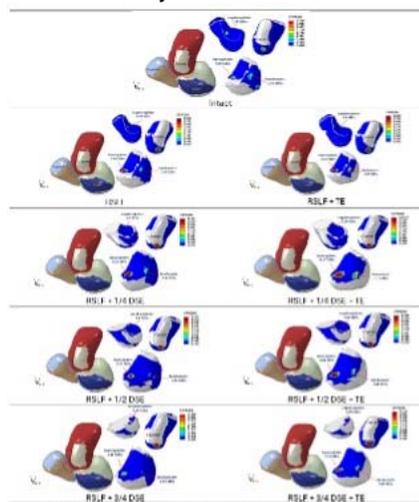
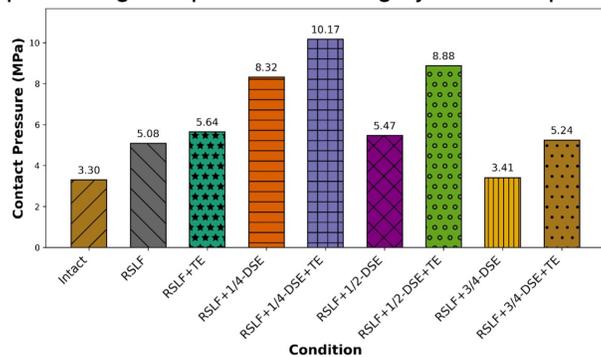


Figure 2. Peak contact pressures (units in MPa) for scaphocapitate, lunocapitate, and lunohamate articulations for the simulated conditions.