

Comparative Study of the Mechanical Performance of 2-Tine and 4-Tine Stainless Steel Staples

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Introduction. Fractures are common orthopedic injuries affecting all ages. The efficacy of 2-tine staples in surgical fracture fixation is well documented, especially in the foot, but the efficacy of 4-tine staples is not well discussed. This study compares the mechanical performances of 4-tine and 2-tine staples in bending.

Methods. Two 4-tine staples (A and B) and one 2-tine staple were designed and fabricated from 316 stainless steel. 4-tine A represents staples with two tines placed closely together on opposite ends, creating a large central gap. 4-tine B represents staples with evenly distributed tines and a smaller gap. The differing 4-tine designs intend to investigate the effect of inner tine proximity on fracture stabilization. Fractures were simulated using two polyurethane foam blocks held together by one staple. Dorsal and lateral 4-point bending tests were conducted with an MTS-858 Mini Bionix II System (n = 10). Fixation stability was determined by the moment produced at the center of each staple with 2mm of actuator displacement.

Results. Wilcoxon rank sum tests revealed a significant difference between the moments produced by both 4-tine staples compared to 2-tine staples in dorsal and lateral bending (p<0.001). There was also a significant difference between 4-tine B and 4-tine A staples (p<0.001). 4-tine B staples produced the greatest average moment.

Conclusions. The results suggest that 4-tine staples, especially those with evenly spaced tines, offer superior resistance to bending than 2-tine staples. Greater stability offered by 4-tine staples may promote wound healing and should be considered in novel surgical staple design.

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