Reinsertion Mechanics of Sacroiliac Fusion Screws: Effects of Bone Density, Tapping, and Size

Cale J. Hendricks[1], David W. Polly Jr[1], Ashley M. Abbott[1], Yaqoub Y. Yusuf[1], Rafael A. Garcia[1], Matthew R. MacEwen[1], Arin M. Ellingson[1*]
[1]University of Minnesota, Minneapolis, MN
*Email of Presenting Author: ellin224@umn.edu

INTRODUCTION: Sacroiliac joint (SIJ) fusion is a common treatment for pain and dysfunction, but revision cases present unique biomechanical challenges. Threaded screw fusion devices have been developed to improve osseointegration, yet little is known about their reinsertion mechanics. We aimed to determine the influence of bone density, tapping, and implant size on reinsertional torque and pullout strength, hypothesizing that final insertional torque would correlate strongly with pullout strength.

METHODS: Mechanical testing followed ASTM F543 standards using 10 PCF (low-density) and 20 PCF (normal-density) polyurethane foams. A 10×35 mm screw fusion device was inserted as control, then removed and replaced with screws of varying diameters (10, 11.5, 13.5 mm) and lengths (35–45 mm), under tapped or untapped conditions. Maximum and final insertional torque and pullout strength were measured. Statistical analyses included three-way ANOVA and Pearson correlation (α=0.05).
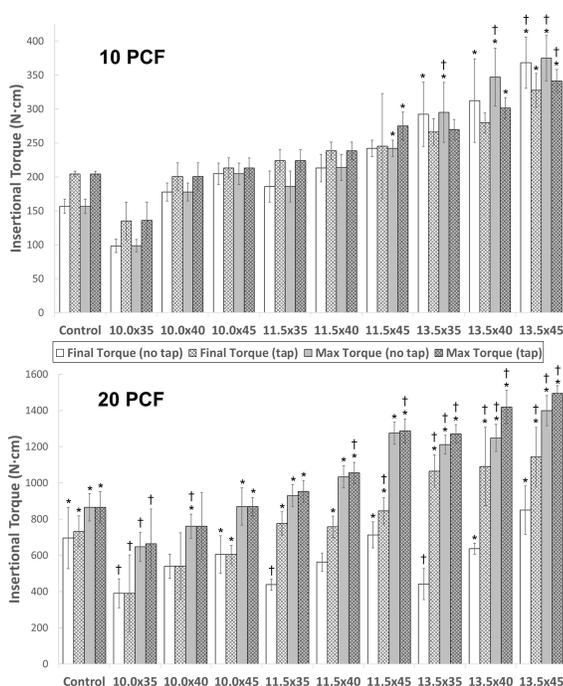
RESULTS: Normal-density bone showed significantly greater insertional torque (929.1±6.5 vs 235.0±6.5 N·cm) and pullout strength (1331.2±14.8 vs 457.3±14.6 N; p<0.001) compared to low-density bone. Tapping improved fixation in normal-density bone (+33.9% torque, +108.4% pullout; p<0.001) but reduced pullout strength in low-density bone (-22.4%; p<0.001). Larger screw diameter and length increased fixation strength, though oversized diameters yielded diminishing returns in normal-density bone. Final insertional torque strongly correlated with pullout strength (r=0.946, p<0.001).

DISCUSSION: Reinsertion stability depends on bone density, implant size, and tapping. While increasing screw dimensions generally improved fixation, diameter thresholds were observed. Tapping enhanced fixation in normal-density but not in low-density bone, underscoring the need for condition-specific strategies.
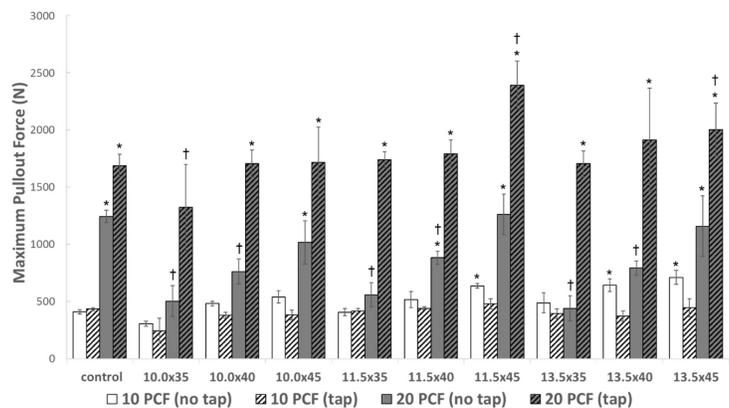
SIGNIFICANCE/CLINICAL RELEVANCE: This work addresses a critical knowledge gap in the biomechanics of revision sacroiliac fusion, demonstrating how implant geometry and surgical technique interact with bone quality to determine fixation strength. By identifying condition-specific strategies, these findings have the potential to directly inform surgical decision-making and improve patient outcomes in revision SIJ fusion.

REFERENCES: 1. Polly DW et al. Int J Spine Surg. 2016;10. 2. Varghese V et al. Comput Methods Programs Biomed. 2016;137:11-22. 3. Pfeiffer FM et al. Spine. 2006;31(23):E867-70.

Above (right) – Maximum Pullout Force for Reinserted Screws. Mean values were measured for the initial insertion of the control (10×35) and screw reinsertion for all conditions. Implant size (Diameter × Length; 10, 11.5, 13.5 × 35, 40, 45 mm), bone foam density (10, 20 PCF), and use/non-use of a tap were varied. Vertical error bars represent ±standard deviation. Significant differences from the control and reinserted 10×35 screw are indicated by symbols † and *, respectively.

Above (left) – Maximum and Final Insertional Torque for Reinserted Screws. Mean values for low-density bone (10 PCF) and normal-density bone (20 PCF) for initial insertion of the control (10×35) and reinsertion. Implant size (Diameter × Length; 10, 11.5, 13.5 mm × 35, 40, 45 mm) and use/non-use of a tap were varied. Vertical error bars represent ±standard deviation. Significant differences from the control and the reinserted 10×35 screw are indicated by symbols † and *, respectively.