A Biomechanical Comparison of Three Fixation Methods for Bennett Fractures

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INTRODUCTION: Bennett fractures are inherently unstable partial articular fractures of the first metacarpal base with several active deforming forces. Suboptimal treatment can lead to fracture displacement, malunion, and carpometacarpal (CMC) joint post traumatic arthritis, resulting in pain and dysfunction. Multiple options are available for surgical fixation of these fractures, each with their own associated drawbacks. The purpose of this study was to evaluate three different fixation methods for stabilization of Bennett fractures.

METHODS: Thirty match-paired fresh frozen cadaver hands were obtained with radiographs confirming the absence of any osseous lesions that would compromise bone quality. A Wagner approach was performed and Bennett fractures were created by an experienced orthopaedic surgeon halfway between the palmar beak ligament and the dome of the dorsopalmar convcavity of the metacarpal articular surface. Specimens were randomized and fractures were then fixated with one of three methods: two 1.2 millimeter (mm) Kirschner-wires (K-wires), two 1.2 mm cortical lag screws, or a single 1.7mm headless compression screw with a mini-suspensory cortical button construct (HCS/SB). The flexor carpi radialis and abductor pollicis longus were counterbalanced with 5N of force and a six degree-of-freedom materials testing system was used to apply compressive force on the 1st metacarpal at a rate of 1.5 mm/second until failure was reached. Load to failure was defined as a significant decrease in load when compared to the displacement. Radiographs were taken before and after testing to compare the final displacement and method of failure. Interfragmentary motion and applied load for each cycle were continuously measured throughout the duration of testing by motion tracking markers. The maximum force and relative motions of the first metacarpal and Bennett fragments were filtered and calculated by a custom MATLAB program. Univariate analysis was performed with t-test to calculate differences.

RESULTS:

Average load to failure for the K-wire, lag screw and HCS/SB were 255N, 205N and 214N, respectively. Pairwise comparisons between implants with contralateral specimens were performed and no significant difference were found between K-wires and HCS/SB (214 vs. 156N, p =.16), K-wires and lag screws (289 vs. 203N, p =.60) or HCS/SB and lag screws (254 vs. 228N, p =.83). Average displacement for the K-wire, lag screw and HCS/SB were 14.2mm, 7.4mm and 12.6mm, respectively. There were no significant differences in displacement for K- wires and HCS/SB (10.8mm vs. 14.5mm, p =.27), K-wires and lag screws (16.9mm vs. 5.6mm, p=.25), and HCS/SB and lag screws (10.7mm vs. 9.8mm, p =.80).

Average stiffness for the K-wire, lag screw and HCS/SB were 27.8 N/mm, 31.9N/mm and 20.4 N/mm, respectively. There were also no significant differences for K- wires and HCS/SB (21.9N/mm vs. 10.9N/mm, p =.06), K-wires and lag screws (32.4 N/mm vs. 35N/mm, p=.93), and HCS/SB and lag screws (29.9 N/mm vs. 27.7 N/mm, p=.90).

DISCUSSION AND CONCLUSION:

There were no statistically significant differences in biomechanical outcomes for surgical fixation of Bennett fractures with K-wires, lag screws or HCS/SB. All of these surgical stabilization methods appear be valid choices to effectively hold Bennett fractures. Surgeons may consider lag screws or a HCS/SB construct in appropriately selected patients to allow for early range of motion and avoidance of the downsides associated with K-wire use including pin migration, pin-site infection, increased postoperative immobilization, and the need for eventual pin removal.