The Effect of Coronal Shear Fractures of the Distal Humerus on Elbow Kinematics and Stability
+Sabo MT; Fay K; Ferreira LM; McDonald CP; Johnson JA; King GJW
+ The University of Western Ontario, London, Ontario, Canada

Senior Author gking@uwo.ca

INTRODUCTION: Coronal shear fractures of the humerus include a spectrum of injury from osteochondral fragments to loss of the entire articular surface. The Kocher-Lorenz fracture is an osteochondral fracture of much of the capitellar articular surface, while the Hahn-Steinthal fracture is defined by a more substantial shear fragment with greater underlying bone. Extension into the trochlea, and combined capitellar and trochlear fractures are also described. Traditional treatment focused on excision, but more recently authors have recommended internal fixation if technically possible. The amount of capitellum that is safe to resect has not been clarified in the literature. The purpose of this study was to examine the effect of sequential loss of the capitellum and trochlea on elbow stability with ligamentous structures intact. We hypothesize that excision of the capitellum will alter elbow kinematics and decrease stability despite intact collateral ligaments, coronoid, and radial head.

METHODS: Eight fresh-frozen cadaveric arms (mean age 71 ± 11 years, 7 male) were mounted in an upper extremity joint testing system. Cables were sutured to the major muscles around the elbow (biceps, triceps, brachialis, brachioradialis, pronator teres, and supinator) and attached to motors and pneumatic actuators to simulate joint motion and loading. An electromagnetic receiver was fixed to the ulna and joint kinematics were quantified with respect to the humerus. After testing the intact elbow and removal of the anterior capsule to permit access to the articulation, sequential excision of the capitellum was performed (the Kocher-Lorenz and Hahn-Steinthal fractures, extension to the trochlear groove, and then a combined capitellar-trochlear fracture). The collateral ligaments were undisturbed. Simulated active elbow flexion was performed in the joint testing system in the dependent and valgus-loaded positions with the forearm in pronation and supination. Valgus angulation of the ulna relative to the humerus was quantified. Repeated-measures two-way ANOVA testing was applied with subsequent pairwise comparisons and Bonferroni correction.

RESULTS: Because the anterior capsule contributes a small amount of stability to the elbow, the post-capsulotomy tests were regarded as the true control group. However, no significant difference was found between the intact capsule tests and the post-capsulotomy states (p = 1.00). For active supination in the dependent position, lesions involving the trochlea were associated with greater valgus at 60, 90, and 120°; but this difference was not significant (p = 0.4) (Figure 2).

Excision of the capitellum had no effect on the motion pathways of the elbow in either the dependent or valgus positions for either pronation or supination (p = 1.0) (Figures 2 & 3). With pronated flexion in the dependent position, loss of the entire trochlea was associated with variable kinematics – increased varus angulation was observed as often as increased valgus angulation. The lesions involving the trochlea tended towards increasing coronal instability, but this difference was not significant either (p = 0.3). At higher flexion angles, the lesions involving the whole trochlea led to significant increases in valgus angulation (p = 0.01) compared to the post-capsulotomy control. Resection of the lateral trochlea tended to increase valgus angulation but did not reach statistical significance (p = 0.09).

DISCUSSION: This study demonstrates that the capitellum has a minimal role in preventing valgus instability of the elbow in the setting of intact collateral ligaments. Significant changes in valgus angulation were not noted until the entire trochlea was violated, although a strong trend towards significance was noted for the lateral trochlear lesions. Kinematics were altered in the valgus-loaded position for lesions involving the trochlea, but not in the dependent position. This was likely caused by the more provocative effect of gravity with the arm oriented in the valgus position.

Only one previous study has reported the effect of capitellum excision on valgus instability. Dushuttle et al examined valgus angulation with passive stressing of the elbow at 10-15° of flexion. They found minimal impact on coronal stability with loss of the capitellum in the setting of intact collateral ligaments, similar to the results of the current study, which evaluated the kinematics and stability throughout elbow flexion.

Loss of the lateral and whole trochlea leads to an increase in valgus angulation of the elbow suggesting that while isolated capitellar excision may be considered in the setting of comminuted unconstructable fractures, excision should be avoided if these fractures extend into the trochlea. Careful evaluation for concomitant collateral ligament injuries should be performed prior to considering capitellar excision. Since many capitellar fractures extend into the lateral trochlea, preoperative imaging and intraoperative examination of the trochlea to confirm its integrity is mandatory before considering excision of the capitellum. Clinical studies are needed to confirm these in-vitro findings. Furthermore, the effect of capitellar excision on load transfer across the elbow requires further evaluation.

REFERENCES: