THE DETRIMENTAL EFFECTS OF OVER OR UNDERSTUFFING A RADIAL HEAD REPLACEMENT

**van Glabbeek, F.; *van Riet, R.P.; *Baumfeld, J.A.; *Neale, P.G.; *Morrey, B.F.; +*An, K.-N.; *O’Driscoll, S.W.**

**Mayo Clinic, Rochester, MN**

**University of Antwerp, Antwerp, Belgium**

**Introduction**
Comminuted radial head fractures often occur in association with medial collateral ligament injuries. Positioning of a radial head prosthesis relies only on the judgement of the surgeon to reconstruct the exact length of the radial column. Nothing is known about the effects of slight lengthening or shortening of the radius on joint kinematics or force transmission through the radiocapitellar joint. One could assume that lengthening would increase load transmission forces over the radiocapitellar joint and therefore induce early intraarticular degenerative disease. However, it is also possible that the forearm possesses compensatory mechanisms to allow minor discrepancies in the length of the radial neck.

The goal of this study was to evaluate both the ulnohumeral kinematics and the force transmission through the radiocapitellar articulation after lengthening and shortening the radial neck in the medial collateral ligament deficient elbow.

**Material and methods**
Six fresh frozen cadaveric upper extremities were used. Sutures were attached to the biceps, brachialis and triceps tendons to simulate muscle loading. A custom device was inserted to maintain forearm rotation. The humerus was mounted in a testing apparatus. The medial collateral ligament was transected through a flexor pronator muscle split incision at the base of the medial epicondyly. An osteotomy of the lateral epicondyly was used to obtain access to the joint. The radial neck was cut using custom-made parallel saw blades. A custom-made fixture was cemented to both the radial neck and the radial head in the original orientation, permitting lengthening and shortening of the radial neck with the insertion or removal of acrylic spacers.

Three dimensional spatial orientation of the ulna and humerus were measured using an electromagnetic tracking device (3Space Fastrak, Polhemus, Colchester, VT). A motor applied to the biceps and brachialis pulled the forearm from extension to flexion at a controlled rate, with the elbow subjected to gravity valgus and varus stress sequentially and the forearm fixed in neutral rotation. Data were continuously collected at a sampling rate of 40 Hz using Motion Monitor software (Innovative Sports Training Inc., Chicago, IL). Data were analyzed in terms of ulnar axial rotation and varus/varus laxity at 4 discrete positions through the flexion arc (30, 60, 90, 120°).

Force at the radiocapitellar joint was measured with an I-scan sensor (model 6900, Tekscan Inc., Boston, MA) inserted into the joint through an anterior capsulotomy and secured via resuturing the soft tissues. The force was statically recorded at 5°, 30°, 60°, and 90° of flexion in a loaded condition with the forearm in neutral, pronation and supination, and the humerus in a gravity valgus position. Pilot studies showed that shortening of the radial neck eliminated force transmission, and that lengthening by 5 mm restricted joint motion, so these measurements were only made with 2.5 mm of lengthening.

The sequence was repeated with the radial neck lengthened and shortened in increments of 2.5 mm, to a maximum of 5 mm. These data from the 2.5mm lengthened radial neck is expressed as a proportional increase from the native condition.

**Results**
Clear trends were observed with lengthening and shortening conditions in all six specimens. When compared to the native length condition, total varus/varus laxity increased consistently with shortening and decreased with lengthening the radial neck (Figure 1).

A statistically significant difference was found between each of the shortened and lengthened conditions (p<0.05).

Shortening of the radial neck caused internal rotation of the ulna, whereas lengthening of the radial neck consistently caused an external rotation of the ulna (Figure 2) throughout the flexion arc. Again, a statistically significant difference was found between each of the conditions (p<0.05).

The axial force transmission across the radiocapitellar joint decreased with the flexion angle. In the normal elbow with native length, the force is highest in the forearm pronated position and lowest in the supinated position (Figure 3). With 2.5mm lengthening, the axial contact force increased significantly, in all forearm positions.

**Discussion**
Ulnohumeral arthritis is a common finding after radial head resections. Radiographic evidence of lengthening of the joint can sometimes be found through erosion of the capitellum and a varus asymmetry of the ulnohumeral joint. Stress on a malpositioned ulna during the flexion arc would cause changes in the load transfer through the proximal ulna, possibly causing point pressures on the articulating surface. Maltracking of the ulnohumeral joint could possibly induce degenerative disease.

The results of this study clearly show the importance of reproducing the original length of the radial neck when implanting a radial head prosthesis. Both shortening and lengthening of the radial neck, simulating under and overstuffing of the joint, caused consistent changes in the kinematics of the elbow. Although lengthening increased stability of the elbow, this was also coupled with increased forces in the radiocapitellar joint, which can lead to early degenerative changes.

Bipolar designs can compensate slightly for minimal lengthening of the radial column. However, this is at the cost of stability of the elbow. This results of this study emphasizes the need for intraoperative measurement and alignment jigs that can be used to ensure the optimal placement of the radial head prosthesis.

**References**

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