Axial Length and Overstuffing Affects Radiocapitellar Pressures in Radial Head Arthroplasty, A Cadaveric Study

INTRODUCTION:
Successful results following radial head arthroplasty are dependent upon proper component position and size. Insertion of an implant that is incorrectly sized significantly alters stability, elbow kinematics and load transfer leading to unfavorable results and poor clinical outcomes. We examine the effects of alteration of axial length of the radial head prosthesis and force conveyed at the radiocapitellar joint.

METHODS:
Seven paired, fresh-frozen sided cadaveric arms were mounted on an MTS machine (MTS model 858 MiniBionix II, Eden Prairie, MN), with the elbow in 90° flexion, and the wrist neutral. Humeri were secured in a table vice attached to the MTS base, and the distal limb was secured in a self-centering vice attached to the actuator. A plumb-line was used to ensure the axis of rotation of each forearm was vertical in all planes. A 6900 Tekscan transducer (Boston, MA) was calibrated with a Tekscan calibration bladder and placed in the RC joint, and the soft tissues were closed with towel clamps. A compressive axial load cycle was then applied in load control between 13N and 130N at a rate of 0.25 Hz. The hand was then rotated while mounted on the MTS to 60° pronation (60P) and then 60° supination (60S) and the loading repeated for each new forearm position. The steady state was indicated by the point at which creep, or cyclic variance, was removed as seen on the load-displacement curve. Data was then recorded over the next ten cycles.

The radial head was then excised at 15 mm, and a medium Stryker (Mahwah, NJ) Cobalt Chromium Solar implant inserted. A steel washer was placed over the implant stem to increase implant sizing. The testing described above was repeated for all different implant sizing. Four different sizes compared to native were tested, -2 mm, 0 mm, +2 mm, and +4 mm. Multivariant ANOVA with tukey was used for statistical analysis.

RESULTS:
Radiocapitellar forces with the forearm in neutral in arms that were understuffed (-2), neutral (0), overstuffed (+2, +4) were 24.07 +/- 9.65 N, 30.21 +/- 9.63 N, 37.45 +/- 13.09 N, 46.47 +/- 9.25 N. There was a noticeable stepwise increase in force transmitted with progressive radiocapitellar head lengthening. Radiocapitellar forces were essentially 1.5 times greater with radial head overstuffing (+4) compared to neutral (0). Radiocapitellar forces were significantly elevated in forearms that were pronated in comparison to forearms in neutral and in supination for each adjusted radial head length. Strain measurements of the central band of the interosseous membrane correlated with forearm position; enhanced in forearms that were supinated and diminished in arms that were pronated.

DISCUSSION:
We demonstrate that correct sizing of the radial head implant plays a critical role in restoring native radiocapitellar loads and may effectively reduce wear at the radiocapitellar joint and prevent early arthritis and failure in radial head arthroplasty.

Successful results following radial head arthroplasty are dependent upon proper component position and size. In this cadaveric model progressive radial head lengthening was associated with a stepwise increase in radiocapitellar joint force. Radiocapitellar forces were 1.5 times greater with radial head overstuffing (+4) compared to neutral (0). Sizing of the radial head implant, forearm positioning and strain at the central band of the interosseous ligament each play a unique role in load transfer to the radiocapitellar joint.

SIGNIFICANCE
Restoring the native axial length may prevent accelerated kinematics, loss of motion and wear at the radiocapitellar joint after radial head arthroplasty.

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