LOAD-SHARING AT THE WRIST FOLLOWING RADIAL HEAD REPLACEMENT WITH A TITANIUM IMPLANT: A CADAVERIC STUDY

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INTRODUCTION:
Surgical excision of the radial head is frequently required after a comminuted radial head fracture. The outcome of this procedure is often unpredictable, with some patients experiencing ulnar-sided wrist pain secondary to proximal migration of the radius. Insertion of a radial head prosthesis could theoretically prevent proximal radial migration and restore normal load sharing at the wrist. The thickness of the radial head implant is an important variable in restoring anatomical radial length; the effects of varying the length of the reconstructed radius upon load sharing at the wrist have not been studied biomechanically.

METHODS:
Fifteen fresh frozen cadaveric forearms had a miniature load cell installed to record force in the distal ulna as the wrist was axially loaded to 134N of compression force in neutral rotation; proximal displacement of the radius relative to the capitellum was also recorded. Loading tests on intact forearms were performed with the elbow in valgus alignment (radial head contacting the capitellum) and varus alignment (gap between radial head and capitellum). Loading tests were repeated at the varus and valgus alignments of the intact forearm after radial head excision and subsequent insertion of a titanium radial head implant that restored anatomical length (0mm implant). Testing was also performed with reconstructed radial lengths longer than anatomical (+2mm and +4mm implants) and shorter than anatomical (-2mm and -4mm implants). Testing with all five implant thicknesses was repeated after section of the interosseous membrane (IOM). A one-way repeated measures analysis of variance model was used to determine the significance of differences between mean distal ulnar forces and mean radial displacements for the various test conditions. Multiple pairwise comparisons between means were made using the Student Neuman Keuls procedure. The level of significance was p < 0.05.

RESULTS:
Mean distal ulnar forces and mean proximal radial displacements following insertion of a 0mm implant (IOM intact) were not significantly different from corresponding values for the intact forearm (Figures 1 & 2).
Replacing a 0mm implant with a +4mm implant (IOM sectioned) decreased mean distal ulnar force from 13.4% to 3.3% (valgus alignment) and from 29.1% to 8.6% (varus alignment) (Figure 1). In contrast, replacing a 0mm implant with a -4mm implant (IOM sectioned) significantly increased mean distal ulnar force from 13.4% of applied wrist load to 33.3% (valgus alignment), and from 29.1% to 51.6% (varus alignment) (Figure 1).
With varus alignment, mean proximal radial displacements with +2mm and +4mm implants were significantly less than corresponding values for a 0mm implant; mean displacements with -2mm and -4mm implants were significantly greater than corresponding values for a 0mm implant (Figure 2). With valgus alignment, mean proximal radial displacements with a +4mm implant were significantly less than corresponding values for a 0mm implant; mean displacements with a -4mm implant were significantly greater than corresponding values for a 0mm implant (Figure 2). Mean proximal radial displacements with the IOM sectioned were significantly greater than corresponding levels with the IOM intact for -2mm, and -4mm implants (varus alignment).

DISCUSSION:
Radial head implants are utilized to prevent proximal migration of the radius as the wrist is loaded; this is especially important in cases where the IOM has been ruptured and is unavailable to help limit radial displacement. In this cadaveric model, insertion of a titanium implant maintained distal ulnar forces at normal levels when the radius was restored to its original anatomical length. Distal ulnar force and proximal radial displacement were significantly affected by the reconstructed length of the radius.

At the time of surgery, comminution and displacement of a radial head fracture may make estimation of the original radial length difficult. Our results demonstrated that in terms of distal ulnar loading, it was preferable to insert an implant, which was too thick rather than too thin. When the implant was too thin, a space between the implant head and capitellum was created. The radius displaced proximally into this space as the forearm was loaded; an intact IOM helped to limit this radial displacement. When the IOM was absent, unopposed proximal migration of the radius made the wrist more ulnar positive, which in turn produced markedly higher distal ulnar forces. A thicker-than-normal implant made the wrist more ulnar negative, which reduced distal ulnar loading.