Intra-operative Interpretation and Templating of Plain Radiographs to Prevent Overstuffing in Radial Head Implant Arthroplasty, A Cadaveric Study
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BACKGROUND
Radial head implant arthroplasty has received considerable interest as a treatment option for irreparable radial head fractures. Reliably good results can be expected when used for the correct indications. However, problems do arise when incorrectly sized implants are chosen. Failure to restore orientation and proper length can adversely affect stability, kinematics and load transfer across the elbow. A standardized geometry from a perfect lateral plain radiograph of an elbow joint with its native radial head can be compared to the geometry of an elbow joint with a radial head implant. This novel templating technique using plain radiographs can overcome the challenge of restoring axial anatomy intra-operatively in radial head arthroplasty, and subsequently can predict if the radial head is over stuffed, understuffed, or neutral.

METHODS
Eight fresh-frozen sided cadaveric arms were utilized. All limbs were demonstrated to have no evidence of macroscopic pathologic changes or radiographic abnormalities. Arms had normal range of motion and stability. A standard postero-lateral approach the elbow was used to access the radial head. Radial heads were resected 2mm distal to ideal cut length. A telescoping radial head prosthesis with adjustable radial head length was used. In situ adjustments of radial head length were made in 2mm increments to create and understuffed (-2), neutral (0), and overstuffed (+2, +4) effect. Plain lateral radiographic films were acquired with radial head length set at -2mm, 0, +2mm, and +4mm and comparisons were made with native radial heads.

A perfect lateral plain radiograph was taken of each arm with its native radial head, as well as with the radial head implant at its different lengths. A triangle was then drawn by using landmarks within the radiograph, namely the center of the capitellum, the midpoint of the radial tuberosity, and the tip of the olecranon. To test that the triangles formed from these landmarks were all proportionally equal, the triangle lengths from the native head radiographs were compared and the quotient was taken from corresponding lengths (e.g. \(A_1/A_2\), \(B_1/B_2\), \(C_1/C_2\)). This was then done for each series of radiographs corresponding to the different radial head implant sizes. Length quotients were formed from every possible combination of two radiograph triangles within the same data series. These quotients were then compared to each other, finding the percentage difference between two quotients within one triangle comparison.

RESULTS
The average percentage difference between triangle quotients in the plain radiographs with native radial heads was 0.59%, with a standard deviation of 11.0%. The mean values for the radial head implant plain radiographs were 0.36%, 0.39%, 0.64%, and 0.42%, with standard deviations of 8.5%, 8.9%, 11.4%, and 9.3%, for understuffed (-2mm), neutral (0mm), and overstuffed (+2mm, +4mm) respectively.

REFERENCES


DISCUSSION
Radiographic distances between radial tuberosity-center of capitellum, center of capitellum-tip of olecranon, tip of olecranon-radial tuberosity were proportionally related between arms. The length between the center of the capitellum-tip of the olecranon appear to change minimally regardless of radial head implant size. The quotient from this measurement and that of the baseline triangle will, as a result, be constant. This can then be compared to the quotients from the other two lengths. If the radial head is understuffed, these quotients are reduced; whereas, if the radial head is overstuffed these quotients are enhanced compared to the baseline quotient from the center of capitellum-tip of olecranon. Measurements appear to be reproducible with minimal inter- and intra-observer variability. When the radial head lengths are incorrectly sized, quotients tend to deviate from those of native radial heads. This novel technique may provide a useful way to evaluate intra-operative fluoroscopic imaging to determining appropriate lengths of radial head prosthesis.