Reference Points for Radial Head Prosthesis Size

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Purpose: Metallic radial head implants are useful when the radial head cannot be repaired reliably and when either the elbow or the forearm is unstable. Problems arise when the radial head prosthesis is too thick, causing erosions of the capitellum and incongruity of the ulnohumeral joint. We used quantitative 3-dimensional computed tomography analysis to investigate the relative height of the radial head relative to the lateral edge and central ridge of the coronoid process as reference points for optimal insertion of a radial head prosthesis.

Methods: Seventeen computed tomography scans of the elbow were analyzed. The anatomic coronal plane of the forearm was determined using 3-dimensional images and a 2-dimensional image bisecting the articular surface of the radial head was created in this plane. The distance between the plane of the articular surface of the radial head and parallel planes at the most proximal aspect of the coronoid (the central ridge) and the lateral edge of the coronoid articular surface were measured. Negative values indicate the radial head is proximal to the coronoid.

Results: The average distance between the planes defined by the radial head articular surface and the coronoid central ridge was -0.8 mm. The average distance between the planes defined by the radial head articular surface and the lateral edge of the coronoid articular surface was -0.9 mm.

Conclusions: Because the radial head was on average only 0.9 mm more proximal than the lateral edge of the coronoid process and because the key is to not overstuff the joint a useful general guideline would be to place the plane of the articular surface of the radial head even with or just slightly more proximal than the lateral edge of the coronoid articular surface. Considering the substantial variability of the normal height of the articular surface of the radial head with respect to that of the coronoid, preoperative radiographs of the opposite elbow may be useful to avoid overstuffing the elbow. (J Hand Surg 2006;31A:53–57.

Key words: Coronoid, elbow, fracture, injury patterns.

The radial head has been recognized as an important stabilizer of the elbow.[1] Replacement of the fractured radial head with a prosthesis is a useful treatment option when the forearm or elbow are unstable and when internal fixation is tenuous or impossible.[2–4] Silicone rubber implants were popular for a while but now it is well recognized that a metal implant provides greater stability.[5,6]

Selection of the appropriate radial head implant size can be difficult. No guidelines have been suggested other than attempting to match the size of the resected radial head; the appropriate size is disputed. One biomechanical study suggested using the thickest radial head implant possible.[7] This is in stark contrast to the realization by many elbow surgeons that the major drawback of metal radial head prostheses is the placement of an implant that is too large and causes widening of the lateral side of the ulnotrochear joint space and radiocapitellar wear.[8] A prosthesis that is too large also may contribute to persistent elbow instability after surgical repair.

The purpose of this study was to quantify the anatomic relationship between the coronoid process and the radial head to determine useful landmarks for

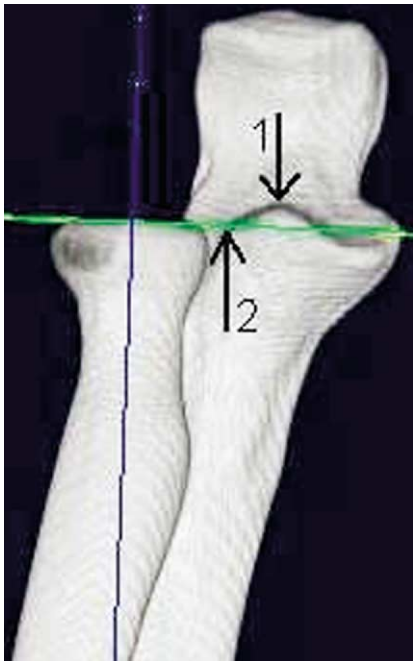

Figure 1. Three-dimensional computed tomography images were used to determine a plane defined by the distal margins of the articular surface of the radial head. Arrow 1, the central ridge of the coronoid process; arrow 2, the lateral edge of the coronoid process.

insertion of an appropriately sized radial head prosthesis.

Materials and Methods

Seventeen computed tomography scans of the elbow were analyzed. This represents a single year's consecutive set of scans obtained for the routine patient care of an isolated fracture of the distal humerus in a skeletally mature patient. There were 8 females and 9 males with an average age of 44 years (range, 15–84 y). A protocol for the use of these scans was approved by the Human Research Committee.

Image manipulation was performed (Vitrea 2 software; Vital Images, Inc., Plymouth, MN). For each patient 3-dimensional computed tomography images were used to determine a plane defined by the margins of the articular surface of the radial head (Fig. 1). A 2-dimensional image was created in a plane orthogonal to the articular surface of the radial head. The rotation of the plane was selected so that it connected 2 points: (1) a point at the center of the radial head (where lines representing the major and minor diameters of the somewhat elliptical radial head cross) and (2) a point on the central ridge of the coronoid at a point representing 50% of the total height of the coronoid process (Fig. 2). By using this image the distance between the plane of the articular surface of the radial head and parallel planes at the most proximal aspect of the coronoid (the central ridge) (Fig. 1) and the lateral edge of the coronoid articular surface (the most proximal aspect of the proximal radial ulnar joint) (Fig. 1) were measured with imaging software (OSIRIS Imaging Software; Digital Imaging Unit, University Hospital of Geneva, Switzerland). Negative values indicate the radial head is proximal to the central ridge and lateral edge of the coronoid; positive values indicate the radial head is distal.

Although the software is accurate to 0.1 mm the selection of planes and measurement points is somewhat subjective; therefore, 2 observers performed all of the measurements to evaluate the interobserver reliability of the technique. Each observer repeated the measurements 3 times at 2-week intervals to evaluate the intraobserver reliability. With 80% power the sample size of 17 elbows allowed a degree of accuracy of detecting a difference of 1 mm in coronoid height and lateral edge measurements based on assuming an SD of 1 mm across the trials (effect size = 1) using the F-test in repeated-measures analysis of variance (ANOVA) (version 5.0, nQuery Advisor; Statistical Solutions, Boston, MA).

Statistical Methods

The Pearson product-moment correlation coefficient (r) was used to measure the level of intraobserver and interobserver reliability. Correlations between 0.70

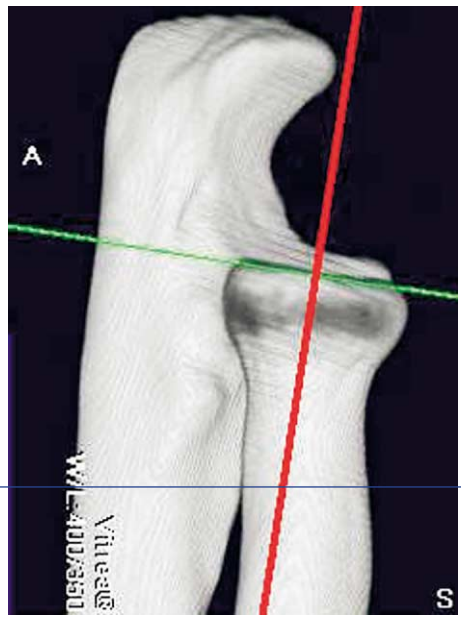

Figure 2. A 2-dimensional image was created in a plane orthogonal to the articular surface of the radial head. The rotation of the plane was selected so that it connected 2 points: (1) a point at the center of the radial head (where lines representing the major and minor diameters of the somewhat elliptical radial head cross) and (2) a point on the central ridge of the coronoid at a point representing 50% of the total height of the coronoid process.