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Magnetic resonance imaging study of glenohumeral relationships between genders

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Background: During glenohumeral arthroplasty, not only should the dimensions of the prosthesis match the normal anatomy but also the relationship of the humeral head-greater tuberosity and humeral head inclination should be replicated to avoid muscular dysfunction. To date there is no evidence whether fit could be optimized with gender-specific prostheses.

Materials and methods: Magnetic resonance (MR) arthrography imaging was used to evaluate 81 proximal humeral scans for 5 different anatomic parameters. The study group included 41 men and 40 women, aged 20 to 62 years. Anatomic parameters, including the humeral head height, humeral head width, humeral head-greater tuberosity distance, humeral head inclination, and glenoid version were measured using Horizon Rad Station 11.0 to evaluate the MR imaging.

Results: The humeral head height, width, and distance to the greater tuberosity were significantly different in size between genders. However, none of the anatomic relationships were different. The humeral head—greater tuberosity distance significantly correlated with the humeral head inclination in both men ($r = 0.338$; $P < .05$) and women ($r = 0.448$; $P < .005$).

Conclusion: We conclude that there are no significant differences in glenohumeral relationships between genders.

Level of evidence: Basic Science Study, Anatomic Study, Imaging.

Keywords: Shoulder; arthroplasty; glenohumeral; MRI; MRA; anatomy; gender

Humeral head prosthetic reconstruction has been practiced widely as a treatment for arthritis and certain fractures of the proximal humerus. An important goal of surgery is to replicate normal anatomic relationships as closely as possible. It is not known whether prosthetics should be modified to better fit the population. Previous studies have used computed tomography (CT) and magnetic resonance imaging (MRI) to begin to evaluate humeral anatomy, including size, offset, head neck angle, and the height of the greater tuberosity relative to the articular surface.[1-4,7-9] The effects of size and positioning of humeral prosthesis on pain, function, and range of motion, as well as overall fit, have also been evaluated.[1,5-7,9]

We wanted to use improved measurement techniques to determine if men and women have significantly different humeral head anatomic relationships. We measured 5

The study was performed with an exemption from the Institutional Review Board.

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geometric parameters, including humeral head height, humeral head width, humeral head inclination, humeral head−greater tuberosity distance, and glenoid version. The purpose of this study was to evaluate the relationships and determine if further exploration of gender specific prosthetics is appropriate.

Materials and methods

The study was performed in compliance with Health Insurance Portability and Accountability Act regulations.

The study participants consisted of 250 patients who visited University of Wisconsin Hospitals and Clinics for shoulder discomfort and had an MR arthrography (MRA) examination. After exclusion of those patients with relevant pathologic abnormalities, including fractures and degenerative joint diseases, and those who were not adults or were skeletally immature (patient age < 20), 81 patients were evaluated. There were 41 men, with an average (standard deviation [SD]) age of 37 $\pm$ 13 (range, 20-60), and 40 women, with an average age of 39 $\pm$ 12 (range, 20-62) when the MRA examination occurred.

To ensure accuracy and reproducibility, MRA was taken with patients supine, with their arms gently against their sides and palms facing inward. All tests were performed using identical technique. A 22-guage spinal needle was inserted into the glenohumeral joint under fluoroscopic guidance. After proper needle positioning was confirmed with a small amount of iodinated contrast material, a dilute gadolinium solution containing a mixture of 1 part gadolinium and 250 parts normal saline was injected into the joint. All shoulders were imaged on the same 1.5T General Electric Sigma HDx 1.5T scanner (General Electric Medical Systems, Waukesha, WI, USA) using phased-array extremity coils. All MR examinations consisted of axial, sagittal, and coronal frequency selective fat-suppressed T1-weighted fast spin-echo sequences (TR/TE = 575/30 ms) and a coronal frequency selective fat-suppressed T2-weighted fast spin-echo sequence (TR/TE = 3150/111 ms). All sequences were performed using a 12-cm field of view, 256 $\times$ 224 matrix, 3-mm slice thickness with a 1.5-mm gap, 20-kHz bandwidth, and 2 excitations.

We used an ALI 11.0 workstation (Horizon Medical Imaging Systems, McKesson Corp, San Francisco, CA, USA) to evaluate the T2-weighted coronal slices and straight axial slices of the shoulder. The proximal humeral anatomy was first evaluated by coronal slice, displaying the largest view of the humeral head (Fig. 1). A line was passed through the humeral head at its widest arc of curvature to measure humeral head width (line A). A second line bisecting the first and extending toward the glenoid up to the cartilage on the articular head determined the humeral head height (line B). The distance between 2 parallel lines extending from the humeral head−greater tuberosity junction and the humeral head articular surface gave the humeral head−greater tuberosity distance (C). The supplement of the angle between the shaft of the humerus and the humeral head height (line B) determined the humeral head inclination (D). Using straight axial slices of the glenohumeral joint at the largest view of the humeral head, we repeated the measurements of humeral head height and width (Fig. 2). Lastly, the supplement of the angle between the plane of the scapula and the glenoid face determined glenoid version (E).

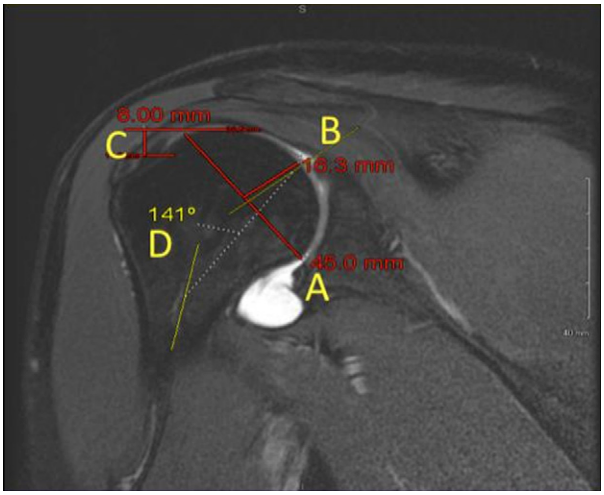

Figure 1 This diagram of the head of the humerus demonstrates how the anatomic measurements were obtained in the coronal plane.

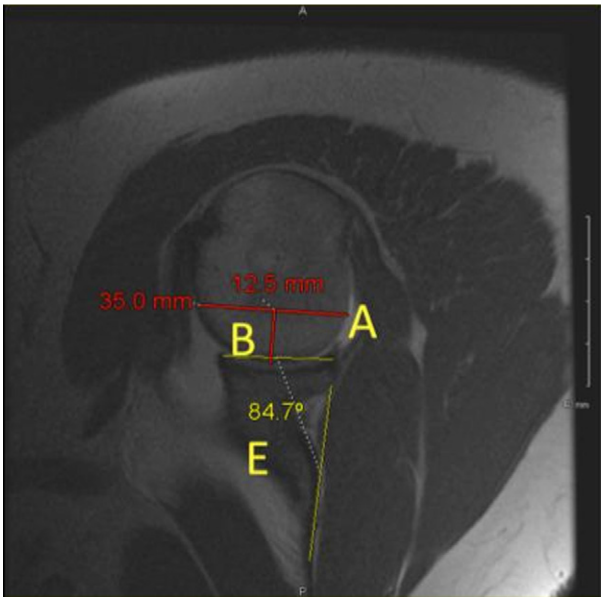

Figure 2 This diagram of the head of the humerus diagram demonstrates how the anatomic measurements were obtained in the axial plane.

The effects of gender and MRA view of the above 5 parameters and correlations among these parameters were evaluated.

The mean and SD of all the parameters are presented. The Student *t* test, Wilcoxon test of the median, and paired *t* test were used to detect statistical differences between genders or views for any given parameter or relationship. Additional relationships were measured by Pearson correlation coefficients calculated by linear regression analysis.

Results

The measured values of the 5 parameters are reported in Table I.