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ORIGINAL ARTICLE

Outcomes of reverse shoulder arthroplasty in small- and large-stature patients

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Background: As the worldwide use of reverse shoulder arthroplasty (RSA) increases, a range of implant sizes may be required to match regional and ethnic variation in patients' stature. Size-mismatched implants may possibly result in poorer surgical outcomes. The purpose of this study was to compare the outcomes of primary RSA in patients at the extreme ends of the growth curve with those in average-stature patients in the United States.

Methods: A multicenter shoulder arthroplasty database was retrospectively reviewed to identify all primary RSAs using a single implant system with a minimum 2-year follow-up. Small patients were defined as the height of <155 cm, tall as >183 cm, and average as 162-178 cm. Active range of motion (ROM), visual analog scale pain score, and patient-reported outcomes (PROs) were compared among the 3 groups.

Results: The study included 552 shoulders (130 small, 384 average, and 38 tall stature). Preoperatively, the average height group had significantly less ROM than the other groups, but there were no significant differences in postoperative ROM. This resulted in poorer improvements in postoperative ROM in the small and tall groups, with the small-stature patients having significantly less ROM improvement compared with average-stature patients. However, these differences did not result in poorer PROs between groups.

Discussion: Small- and large-stature patients showed inferior improvements in ROM after RSA compared with average-stature patients. Our results suggest that current implants optimize ROM gains for average-stature patients and improve PROs independently of patient stature at a minimum 2-year follow-up.

Level of evidence: Level III; Retrospective Cohort Design; Treatment Study

Keywords: Reverse shoulder arthroplasty; outcomes; stature; implant size; scapular notching; complications

Reverse shoulder arthroplasty (RSA) is currently the preferred surgical option for restoration of shoulder function in the setting of glenohumeral arthritis with concurrent rotator cuff disease.[5,18,24] As the worldwide use of RSA increases, a range of implant sizes may be required to match regional and ethnic variation in patients' height and bone size.[1] Outside of the United States, smaller implants may be required for proportionally smaller individuals in certain populations.[8,10] Ji et al reported difficulty in placing a standard 29-mm glenoid baseplate in the Korean population in their early experience with RSA because of smaller patient anatomy.[10] It remains unclear if today's RSA systems offer sufficient size variation to optimize outcomes for smaller stature patients. Similarly, patients with a larger stature may require larger

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implants; however, most systems currently offer larger implant options. Concern exists that size-mismatched implants may result in poorer surgical outcomes.[3,17]

One study has reported on outcomes of RSA in smaller stature patients with a mean height of 158 cm who underwent RSA with a small 25-mm baseplate and 36-mm glenosphere.[1] In this study, the outcomes in smaller patients were good, but the incidence of scapular notching was high (62%). However, the study did not include a control group with which to compare outcomes of average- or large-stature patients treated with a similar implant, thus making it difficult to evaluate the clinical outcomes of this population.

The purpose of this study was to compare the outcomes of primary RSA in patients at the extreme ends of the growth curve with those in average-stature patients in the United States. We hypothesized that clinical outcomes in smaller and larger patients would be inferior to those in average-stature patients because of size-mismatched implants relative to patients' native anatomy.

Materials and methods

Patients

A retrospective review of a multicenter, single-implant, shoulder arthroplasty database was used to identify all primary RSAs performed between 2007 and 2014 using the Equinoxe system (Exactech, Gainesville, FL, USA) with a minimum of 2-year follow-up. Fourteen surgeons from 10 institutions contributed to the study group. Patient demographic information, preoperative range of motion (ROM), patient-reported outcomes (PROs), surgical indications, implanted RSA components, intraoperative and postoperative complications, postoperative outcomes, and radiographic findings were collected from the database. Exclusion criteria included a preoperative diagnosis of acute fracture (78), post-traumatic arthritis (34), infection (1), revision surgery (173), and use of a constrained liner (11). Patients were stratified on the basis of height according to the US Centers for Disease Control and Prevention growth curves. Small patients were defined as the height of <155 cm (10th percentile of females), tall as >184 cm (85th percentile of males), and average as 162 cm (40th percentile of females) to 178 cm (60th percentile of males).[7] The tall patient subgroup was expanded beyond the 10th percentile to garner enough patients to perform a statistical analysis as only 8 patients were ≥186 cm (90th percentile of males).

Implant design

The Equinoxe RSA uses an onlay humeral tray with a functional neck-shaft angle of 145°. The glenosphere is available in 38-, 42-, and 46-mm diameters. The size of implanted glenosphere components is summarized in Table I. Glenosphere size was chosen on the basis of the surgeon's preference. There were significant differences in size selection for glenospheres based on the patient's height ($P < .001$).

Table I Glenosphere size

	Small	Average	Tall	*P* value
Glenosphere diameter				<.001
38 mm	110*	178*	6*	
42 mm	20	200	27	
46 mm	0	6	5	

* $P < .001$ compared with the other 2 groups.

Table II Internal rotation (IR) score

Active range of internal rotation	IR score
0°	0
15° of IR or motion to hip	1
30° of IR or motion to buttock, PSIS, or SI joint	2
45° of IR or motion to sacrum	3
60° of IR or motion to L4-L5	4
75° of IR or motion to L1-L3	5
90° of IR or motion to T8-T12	6
>90° of IR or motion to T7 or above	7

PSIS, posterior superior iliac spine; *SI*, sacroiliac; *L*, lumbar vertebra; *T*, thoracic vertebra.

Clinical assessment

Patients' demographic data including age at surgery, sex, height, weight, body mass index, and operative side (dominant or nondominant arm) were obtained from the database. The following clinical data before surgery and at final follow-up were collected: active shoulder ROM (abduction, forward elevation, external rotation at the side, and internal rotation), visual analog scale pain scores, and PROs (American Shoulder and Elbow Surgeons [ASES] score, University of California–Los Angeles score, Simple Shoulder Test, and Shoulder Pain and Disability Index). Active internal rotation was recorded using a standardized 8-point numeric score system according to previous reports (Table II).[6,17] Component size, postoperative complications, and reoperation rates were collected. Complications were entered individually by the treating surgeon, with standardized reporting of any event resulting in failure or potential impending failure of a component, hematoma, infection, fracture, and nerve injury.

Radiographic assessment

Each treating surgeon evaluated and recorded scapular notching with radiographs at the final follow-up using the Nerot-Sirveaux classification scale.[24] Humeral component lucencies were graded according to Sanchez-Sotelo et al.[21,22] Humeral loosening was defined as progressive radiolucent lines in >2 zones around the humeral component.[12] Glenoid loosening was defined as progressive radiolucent lines >2 mm around >1 screw or a shift in component position.

Statistical analysis

A Student *t*-test or 1-way analysis of variance and Tukey post hoc test were used to evaluate differences in continuous data. A χ^2 test