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ORIGINAL ARTICLE

Impact of scapular notching on clinical outcomes after reverse total shoulder arthroplasty: an analysis of 476 shoulders

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Background: Scapular notching is a complication unique to reverse total shoulder arthroplasty (rTSA), although its clinical implications are unclear and remains controversial.

Methods: We retrospectively reviewed rTSA patients of a single implant design in 476 shoulders with a minimum 2-year clinical and radiographic follow-up. Clinical measures included active range of motion and American Shoulder and Elbow Surgeons scores, in addition to one or more of the Constant score, Shoulder Pain and Disability Index, Simple Shoulder Test (SST), and University of California, Los Angeles Shoulder Rating Scale. Complications and rates of humeral radiolucencies were also recorded.

Results: Scapular notching was observed in 10.1% (48 of 476) of rTSAs and was associated with a longer clinical follow-up, lower body weight, lower body mass index, and when the operative side was the nondominant extremity. Patients with scapular notching had significantly lower postoperative scores on the Shoulder Pain and Disability Index, Constant, Simple Shoulder Test, and University of California, Los Angeles, Shoulder Rating Scale compared with patients without scapular notching. Patients with scapular notching also had significantly lower active abduction, significantly less strength, and trended toward significantly less active forward flexion ($P = .0527$). Finally, patients with scapular notching had a significantly higher complication rate and trended toward a significantly higher rate of humeral radiolucent lines ($P = .0896$) than patients without scapular notching.

Conclusions: This large-scale outcome study demonstrates that patients with scapular notching have significantly poorer clinical outcomes, significantly less strength and active range of motion, and a significantly higher complication rate than patients without scapular notching. Longer-term follow-up is necessary to confirm that these statistical observations in the short-term will result in greater clinically meaningful differences over time.

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

Keywords: Scapular notching; rTSA; clinical outcomes; arthroplasty; complications; retrospective

Data acquisition and analysis was performed with approval from the Western Institutional Review Board (protocol # WIRB 20091701).

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Reverse total shoulder arthroplasty (rTSA) has been shown to alleviate pain and improve function at midterm follow-up in patients with rotator cuff arthropathy and glenohumeral arthritis with rotator cuff tears.[11,23] Indications have expanded to include complex proximal humeral fractures and

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revision shoulder arthroplasty.[1,7,8,38] Despite improved surgeon experience and implant design, complication rates still range from 3% to 22% in recent series.[11,13,18]

Scapular notching is a complication unique to rTSA. Notching occurs when the humeral polyethylene liner contacts the inferior scapular neck, resulting in bone loss beneath the glenoid baseplate and component failure in severe cases.[24,27-29,32-34] Rates of scapular notching have ranged from 10% to 96% in recent series,[7,8,17,19,20,28,29,32-34,36,39] with notching progressive with follow-up duration. The magnitude of scapular notching is defined by the Nerot-Sirveaux grading scale,[34] where grade 1 or 2 notches represent the mechanical limit of impingement (up to the inferior screw) and grade 3 and 4 notches involve a biologic response as the notch progresses past the inferior screw.[19,20,34,39] Numerous patient and surgical technique factors (ie, glenosphere position, body mass index [BMI], scapular neck angle, scapular neck length, and humeral or glenoid retroversion),[12,17,19,20,22-29] as well as prosthesis design parameters (ie, glenosphere inferior overhang, glenosphere thickness, center of rotation location, humeral neck angle, and humeral liner constraint)[15,16,26,27,29] have been demonstrated to affect range of motion (ROM) and prosthesis impingement, thereby contributing to scapular notching. Substantial effort has attempted to reduce the rate of occurrence, with the most recent prosthesis designs and implantation techniques associated with substantially less scapular notching.[17,22,27-29]

Biomechanical studies suggest scapular notching may increase baseplate micromotion and reduce fixation, potentially leading to implant failure.[30] However, the clinical effect of scapular notching remains unclear. Some clinical studies have reported poorer outcomes in patients with scapular notching,[20,32-34,37] but others have found no difference compared with those without notching.[7,8,19,36,39] Such conflicting reports regarding the clinical effect of scapular notching likely reflect issues in study design/power arising from the relatively high rate of notching associated with many rTSA prosthesis designs coupled with the inherent error in radiographic identification of the scapular notch. For example, Werner et al[39] reported that scapular notching did not correlate with any negative outcome, despite only 4% (2 of 48) of patients without scapular notching.

The rate of scapular notching has been demonstrated to be affected by BMI, with scapular notching less likely to occur in patients with a greater BMI.[19,20,22] Therefore, clinical outcome studies using a prosthesis associated with very high scapular notching rates may not be comparing equivalent populations because greater BMI has been demonstrated to negatively affect patient outcomes with shoulder arthroplasty.[5,14,21] We retrospectively reviewed a prospectively collected database of outcomes of an rTSA shoulder prosthesis associated with a well-defined and relatively low scapular notching rate[17,22,27-29] to determine whether the presence of a scapular notch negatively affects clinical outcomes and the rate of complications.

Materials and methods

Patient selection

We retrospectively reviewed a prospectively collected database to identify patients who received primary rTSA with the Equinoxe rTSA platform shoulder arthroplasty system (Exactech, Inc., Gainesville, FL, USA) between 2007 and 2014. The database recorded information on demographics, preoperative functional scores, surgical indications, implanted rTSA component sizes, intraoperative and postoperative complications, postoperative outcomes, and radiographic findings. Exactech, Inc. funds and maintains this database but is not involved in any of the data input; all data input occurs at each of the clinical sites.

All patients were monitored for a minimum of 2 years and had complete preoperative and postoperative active ROM (AROM) values and American Shoulder and Elbow (ASES) scores. All data were recorded by a fellowship-trained shoulder surgeon who also performed the surgical procedure. The study excluded patients with a history of a previous arthroplasty procedure or a diagnosis of infection or acute proximal humeral fracture. Given the association between constrained polyethylene liners and scapular notching, patients receiving constrained implants were also excluded. Other nonarthroplasty surgical interventions were noted, but were not part of the exclusion criteria.

These criteria resulted in 464 patients who received 476 rTSAs by 1 of 9 fellowship-trained surgeons with mean follow-up of 38 months (range, 22-93 months; Fig. 1). Case distribution was not uniform because 3 of the 9 surgeons performed 69% of the operations. Twelve patients underwent bilateral procedures separated in time; thus, the final sample consisted of 476 shoulders with a mean age at surgery of 72.5 years (range, 53-90 years). Of the 476 rTSAs, 312 (66%) were performed in women, and 313 (67%) performed in the dominant shoulder. Additional demographic, preoperative, and operative information are reported in Table I.

Prosthetic design selection

The 38-, 42-, and 46-mm Equinoxe reverse shoulder prosthesis has a 145° neck angle, a humeral liner constraint of 0.260, 0.250, 0.240, and a standard glenosphere geometry of 38×21, 42×23, and 46×25 mm, respectively. The center of rotation of each size standard glenosphere averages 2.3 mm lateral to the spherically reamed glenoid surface to minimize torque on the glenoid fixation surface while also maximizing the length of the deltoid abductor moment arm. Because of the 4 mm superiorly shifted glenoid plate cage peg, when the inferior rim of the glenoid plate is aligned with the glenoid inferior rim, the 38-, 42-, and 46-mm Equinoxe is designed to provide 2.25, 4.25, and 6.25 mm of glenosphere overhang, respectively. Because of this inherent prosthesis inferior offset, inferior tilt is not recommended and was not performed in this study.

Expanded (≥4-mm thick) glenospheres are also provided in 38-mm and 42-mm sizes to help the surgeon lateralize the humerus and gain stability in instances of medial glenoid wear. In this study, 256 patients (227 women and 29 men) received a standard 38-mm × 21-mm glenosphere, 10 patients (7 women and 3 men) received a 38-mm × 25-mm expanded glenosphere, 189 patients (73 women and 116 men) received a standard 42-mm × 23-mm glenosphere, 11 patients (3 women and 8 men) received a 42-mm × 27-mm expanded glenosphere, and 10 patients (2 women and 8 men) received a standard 46-mm × 25-mm glenosphere.