J Shoulder Elbow Surg (2015) 24, 1698-1706

ELSEVIER

Journal of Shoulder and Elbow Surgery

www.elsevier.com/locate/ymse

Reverse shoulder arthroplasty for massive rotator cuff tear: risk factors for poor functional improvement

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Background: Some patients unexpectedly have poor functional improvement after reverse shoulder arthroplasty (RSA) for massive rotator cuff tear without glenohumeral arthritis. Our aim was to identify risk factors for this outcome. We also assessed the value of RSA for cases with poor functional improvement vs. controls.
Methods: The study was a retrospective case-control analysis for primary RSA performed for massive rotator cuff tear without glenohumeral arthritis with minimum 2-year follow-up. Cases were defined as Simple Shoulder Test (SST) score improvement of ≤ 1, whereas controls improved SST score ≥ 2. Risk factors were chosen on the basis of previous association with poor outcomes after shoulder arthroplasty. Latissimus dorsi tendon transfer results were analyzed as a subgroup. Value was defined as improvement in American Shoulder and Elbow Surgeons (ASES) score per $10,000 hospital cost.
Results: In a multivariate binomial logistic regression analysis, neurologic dysfunction ($P = .006$), age <60 years ($P = .02$), and high preoperative SST score ($P = .03$) were independently associated with poor functional improvement. Latissimus dorsi tendon transfer patients significantly improved in active external rotation (−0.3° to 38.7°; $P < .01$). The value of RSA (ΔASES/$10,000 cost) for cases was 0.8 compared with 17.5 for controls ($P < .0001$).
Conclusions: Young age, high preoperative function, and neurologic dysfunction were associated with poor functional improvement. Surgeons should consider these associations in counseling and selection of patients. Concurrent latissimus dorsi transfer was successful in restoring active external rotation in a subgroup of patients. The critical economic importance of improved patient selection is emphasized by the very low value of the procedure in the case group.
Level of evidence: Level III, Retrospective Case-Control Design, Treatment Study.

Keywords: Massive rotator cuff tear; reverse shoulder arthroplasty; irreparable rotator cuff tear; latissimus dorsi transfer; value; economics; patient selection

This study was determined to be exempt by the Western Institutional Review Board.

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1058-2746/$ - see front matter © 2015 Journal of Shoulder and Elbow Surgery Board of Trustees.
http://dx.doi.org/10.1016/j.jse.2015.04.015

Patients with a rotator cuff–deficient shoulder present with variable combinations of pain and dysfunction, and multiple options are available for treatment. Joint-preserving techniques for massive rotator cuff tears have been reported with varying results and include physical therapy,[29] tuberoplasty,[17] débridement or biceps tenotomy or tenodesis,[4,27,30] tendon transfer,[21] and rotator cuff repair.[3,12,13,19,33] Reverse shoulder arthroplasty (RSA) has been reported to have success in treating massive rotator cuff tears without glenohumeral arthritis.[6,32,48] However, controversy exits as to whether RSA should be used as a primary surgical treatment for this condition.[33]

Poor outcomes after RSA for massive rotator cuff tear have been noted with certain groups of patients: revision surgery,[6,51] no pseudoparalysis,[32] and presence of comorbid conditions (e.g., cervical radiculopathy).[23] In our practice, we have observed that some patients have had unexpectedly poor functional improvements after this operation. This can be especially frustrating for both the patient and the surgeon because the majority of patients with a massive rotator cuff tear that we indicate for RSA have pseudoparalysis and wish to regain overhead use of the arm.

Our primary objective was to identify risk factors for poor functional improvement in patients undergoing reverse arthroplasty for a massive rotator tear. This may help guide selection and counseling of patients because alternative options are available for these patients. We also aimed to carry out an economic analysis of patients with poor functional improvement to determine the value of reverse arthroplasty for these patients compared with those who did achieve clinically relevant functional improvement.

Materials and methods

Study design

We used a retrospective case-control study design to achieve our primary objective of identifying risk factors for poor functional improvement after RSA for massive rotator cuff tear without arthritis. Patients in the poor improvement group (cases) were identified as those who failed to improve the Simple Shoulder Test (SST) score equal to or above the minimal clinically important difference of 2 points at minimum 2-year clinical follow-up.[43] Control patients had improvement of 2 or more points at minimum 2-year follow-up.

The primary indication for reverse arthroplasty was intolerable pain that failed to respond to a minimum of 6 months of nonoperative treatment. Rotator cuff tears were judged to be irreparable on the basis of commonly accepted preoperative imaging and patient characteristics, such as chronic pseudoparalysis, clinical anterosuperior escape, narrowed acromiohumeral distance, and severe fatty infiltration of rotator cuff muscles.[23,49] In addition, shoulder dysfunction presumed to be secondary to humeral escape from rotator cuff deficiency was considered in deciding the indication for RSA. Both cases and controls were also subject to the following inclusion and exclusion criteria: date of surgery from February 2007 to January 2011; massive rotator cuff tear diagnosed with advanced imaging study; minimum of 2 tendon tears, 5 cm in greatest dimension, found at the time of operation; no preoperative glenohumeral arthritis, defined by radiographic changes (Hamada stage 1-3)[4,32,46,47]; no preoperative infection; no prior fracture; and no prior surgery except for rotator cuff repair or diagnostic arthroscopy.

The decision to define the case group by poor improvement in SST score was based on several factors. First, SST has been used to describe unsatisfactory shoulder arthroplasties in prior studies.[18,24] Second, we were most interested in lack of functional improvement, and the SST asks almost exclusively for patient self-reported function. Finally, we performed a pilot study with various methods for control group selection using patient outcome data that the senior author (M.A.F.) has previously reported for this operation.[32] The analysis showed that for the previous cohort, selection of a group of patients based on low improvement in SST score maximized the number of patients who also did poorly by other outcome measures (American Shoulder and Elbow Surgeons [ASES] total and function scores, self-rated satisfaction, and self-rated function) and minimized the number of patients in the case group who had satisfactory outcomes by the other outcome measures.

During the study design phase, we identified risk factors that have previously been suggested in the literature to be associated with poor outcomes after arthroplasty in general or RSA in particular. These preoperative, intraoperative , and postoperative risk factors were as follows:

Preoperative: prior rotator cuff repair,[6,51] elevation $>90°$,[32] age <60 years,[8,14,16,41] workers compensation,[8] low mental health component of the 36-Item Short Form Health Survey (<50),[1] high preoperative SST score (8-12),[16] upper extremity neurologic dysfunction.[23]

Intraoperative: intraoperative elevation $<90°$,[39] latissimus dorsi tendon transfer.[20]

Postoperative: major complication.[53]

We defined a major complication as one resulting in further surgery (revision or reoperation), readmission, or extensive evaluation and treatment lasting >1 month, as has been previously done in the literature.[44-53] We noted any patients with a history of a neurologic condition or injury that might affect shoulder girdle strength, especially axillary neuropathy, upper cervical radiculopathy, or spinal cord injury. Deltoid strength rating is collected prospectively for all shoulder arthroplasty patients in the senior author's practice.

Our surgical technique and postoperative protocol have not deviated substantially from what has been previously reported.[32] The technique of latissimus dorsi tendon transfer was performed as has been described previously in the fashion of L'Episcopo through a single deltopectoral approach.[5] The indication for transfer was presence of Hornblower's sign or lack of active external rotation to $\geq 0°$ with maintained passive external rotation. Postoperatively, patients who underwent tendon transfer were placed into an abduction–external rotation shoulder sling for the first 6 weeks.

Data collection

The senior author (M.A.F.) collects preoperative, intraoperative, and postoperative data prospectively for all shoulder arthroplasty