J Shoulder Elbow Surg (2016) ■■, ■■–■■

ELSEVIER

Journal of Shoulder and Elbow Surgery

www.elsevier.com/locate/ymse

ORIGINAL ARTICLE

Reverse total shoulder arthroplasty for failed open reduction and internal fixation of fractures of the proximal humerus

Florian Grubhofer, MD, Karl Wieser, MD, Dominik C. Meyer, MD, Sabrina Catanzaro, RRN, Katharina Schürholz, MS, Christian Gerber, MD, FRCSEd (Hon)*

Department of Orthopaedics, Balgrist University Hospital, University of Zurich, Switzerland

Background: Open reduction and internal fixation (ORIF) of complex fractures of the proximal humerus may yield unsatisfactory results. This study analyzed the results obtained after revision of failed ORIF of proximal humeral fractures using reverse total shoulder arthroplasty (RTSA).

Methods: Fifty-four shoulders of 53 patients with a subjectively unacceptable outcome after ORIF of a complex fracture of the proximal humerus were revised with RTSA. At a minimum follow-up of 2 years (mean follow-up, 46 months; range, 24-108 months), 44 shoulders were clinically and radiographically reviewed for the purpose of this study. Six patients had been lost to follow-up, and 4 patients (7%) were excluded from functional analysis because of revision surgeries.

Results: The mean absolute Constant score improved from 26 (range, 4-54) to 55 (range, 19-80) points; the mean relative Constant score improved from 32% (range, 4%-85%) to 67% (range, 27%-94%) of an age- and gender-matched, normal shoulder. The mean subjective shoulder value improved from 29% (range, 0%-90%) preoperatively to 67% (range, 5%-95%) at final follow-up. Nineteen patients rated their outcome excellent, 16 good, and 7 fair; 2 patients were dissatisfied.

Conclusion: RTSA is a valuable salvage procedure after failed ORIF of a proximal humeral fracture with relatively low revision rates. Shoulder function, patient satisfaction, and pain levels can be reliably improved.

Level of evidence: Level IV; Case Series; Treatment Study

Keywords: RTSA; failed ORIF; salvage therapy; screw cutout; intracapsular fracture sequelae; extracapsular fracture sequelae

About 80% to 85% of proximal humeral fractures can be treated conservatively.[19] Operative treatment of displaced fractures often involves open reduction and internal fixation (ORIF). This is, however, associated with complication and reoperation rates of up to 35%.[12,18,20,27]

Revision of an unsatisfactory ORIF of proximal humeral fractures is not always satisfactory. Joint-preserving treatment, including reosteosynthesis, shoulder arthroscopy, and partial or total hardware removal, has not consistently been

The study was approved by the Cantonal Ethical Committee Zurich: No. 2015-0146.

*Reprint requests: Christian Gerber, MD, FRCSEd (Hon), Department of Orthopaedics, Balgrist University Hospital, University of Zurich, Forchstrasse 340, CH-8008 Zürich, Switzerland.

E-mail address: christian.gerber@balgrist.ch (C. Gerber).

1058-2746/$ - see front matter © 2016
http://dx.doi.org/10.1016/j.jse.2016.05.020

successful in addressing pain or restoring shoulder function,[17] especially if glenoid destruction due to screw cutout[20] and avascular necrosis of the humeral head are present.

Therefore, secondary shoulder arthroplasty is often considered. Because of concomitant rotator cuff destruction, malposition, or nonunion of the tuberosities, hemiarthroplasty or anatomic total shoulder arthroplasty is associated with unpredictable outcome and a high complication and revision rate.[11,15,25] Reverse total shoulder arthroplasty (RTSA) can address glenoid bone destruction and at least partially compensate for muscle imbalance. It has therefore been considered for salvage of failed ORIF of proximal humeral fractures and yielded promising results in preliminary studies.[16]

We conducted this study to retrospectively analyze the radiologic and clinical outcome as well as the complication and revision rates of 53 patients in whom an RTSA was implanted at our institution after failed ORIF of a proximal humeral fracture.

Materials and methods

Study population

We retrospectively reviewed all patients identified in our database who had undergone revision RTSA after failed ORIF of a fracture of the proximal humerus between April 2006 and June 2013. There were 53 patients with 54 RTSAs after ORIF identified (Table I).

Table I Patients demographics (RTSA after failed ORIF, April 2006–June 2013, Balgrist University Hospital)

Variable	No. or mean (range)
Patients (total)	53 with 54 RTSAs
Patients included	43 with 44 RTSAs
Follow-up from RTSA (months)	46 (24-108)
Delay from ORIF to RTSA (months)	20 (1-92)
Male	32
Female	12
Age at RTSA (years)	68 (30-86)
Surgical site right	30
Surgical site left	14
Reasons for revision	
Screw cutout	43
Humeral head necrosis	35
Glenoid destruction	37
Patients excluded	10
Lost to personal follow-up	6
RTSA revision surgery with removal of the prosthesis	4
Reason for revision surgery	
Infection	2
Instability	1
Periprosthetic distal humeral fracture	1

RTSA, reverse total shoulder arthroplasty; *ORIF*, open reduction and internal fixation.

Six patients were not available for follow-up. Five of them (aged 77-96 years) refused further follow-up appointments because of poor general health status and no complaints of the surgical shoulder. One 62-year-old computer scientist had moved to another country. On the phone, all six patients valued the treatment outcome excellent (n = 4) or good (n = 2) with a subjective shoulder value (SSV) between 50% and 90%.

Four patients (aged 49-70 years) needed revision surgery (see Results section, complications) and were excluded from clinical results and satisfaction outcome analysis.

The remaining 43 patients (12 women and 31 men, one bilateral; 30 right and 14 left, 36 dominant and 8 nondominant shoulders) with a mean age of 68 years (range, 30-85) had a minimum follow-up of 24 months (mean, 46 months; range, 24-108 months). All 43 patients with the involved 44 shoulders were reviewed for the purpose of this study. In addition to a structured interview assessing disability, physical examination including scoring according to Constant and Murley[5] and imaging using conventional radiographs were performed.

The mean duration from ORIF to RTSA was 20 months (range, 1-92). Fifty patients had ORIF using plates (Philos Plate [Synthes Inc, West Chester, PA, USA], n = 45; 1/3 tube plates, n = 4; blade plate, n = 1); 3 patients were primarily treated with a nail and 1 patient with transcutaneous K-wire fixation.

The most common cause for revision was painful subjective impairment of shoulder function. The painful dysfunction was associated with screw cutout (n = 43, 79%), humeral head necrosis (n = 35, 65%), or glenoid destruction (n = 37, 69%; Fig. 1).

A thorough preoperative workup, including radiographs and computed tomography (CT) scans, laboratory (C-reactive protein and erythrocyte sedimentation rate) studies, and joint aspiration for microbiology and cell count and cell differentiation, was performed in every patient to exclude a pre-existing (low-grade) infection of the shoulder joint.

Surgical technique

All 54 procedures were revised using the Zimmer Reverse Anatomical Shoulder System (Zimmer, Warsaw, IN, USA). A deltopectoral approach was used, leaving the cephalic vein laterally. The humerus was exposed; the subscapularis muscle was mobilized, detached, and grasped with No. 2 FiberWire (Arthrex, Naples, FL, USA) sutures. If present, the tendon of the long head of the biceps was tenotomized at the level of the groove. After removal of the hardware, the humeral head was resected. In 6 patients, hardware had been removed in a previous operation without relieving pain and dysfunction. The glenoid was then evaluated for glenoid destruction, especially in cases with screws penetrating the humeral head surface. The glenoid was then minimally reamed to conserve as much subchondral bone as possible. Care was taken to have a low position, slight inferior tilt, and neutral version of the baseplate.

The height of the prosthetic stem was determined using the contralateral humerus as a template as it was the goal to obtain an overall lengthening of the humerus of 2 to 2.5 cm compared with the healthy side. The decision for cementation of the stem was made intraoperatively, depending on bone quality and quality of press-fit with the largest possible stem; 31 stems were cemented and 13 were press-fitted. A fracture or a standard stem was used, depending on the rotatory stability of the implant and the need for osteotomy and re-repair of the tuberosities. The stem was implanted in between 0°