



## Reverse shoulder arthroplasty for the treatment of three and four part fractures of the proximal humerus in patients older than 75 years old

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Reverse shoulder arthroplasty is an attractive alternative option in treating three- or four-part fractures of the proximal humerus. The main goal of the current study was to evaluate the functional and radiographic results after primary reverse shoulder arthroplasty of three- or four-part fractures of the proximal humerus in patients older than 75 years old. Between 2008 and 2010, 29 consecutive patients with a three- or four-part fracture of the proximal humerus undergoing a reversed shoulder prosthesis were included. There were 16 women and 13 men, with a mean age of 81 years (range 78 to 85). The dominant arm was involved in 18 patients (62%). All of the operations were carried out within 10 days of the injury.

The patients were followed up for a mean of 26 months (range 10 to 36).

The mean postoperative Constant-Murley score at the end of the follow-up period for each patient (age- and gender-matched) was 73.3% (range 58 to 92%). The mean Constant score was 75% in the group of patients with fixation of the tuberosities and 72.3% in the patients with no fixation of the tuberosities ( $p = 0.06$ ). There was no significant difference in Constant score between patients who were operated by the fifth day after the fracture and patients who had an operation between the sixth and tenth day after the injury (Constant score of 74% and 71%, respectively,  $p = 0.07$ ). Complications occurred in 12 patients. One patient sustained a fracture of the acromion intraoperatively. Four patients (13.8%) developed heterotopic ossification. One had a non-traumatic anterior dislocation due to wrong retroversion of the glenoid component. Scapular notching was observed in six shoulders (20.6%).

**Key words :** proximal humerus fractures, reverse arthroplasty, elderly patients

### INTRODUCTION

Proximal humerus fractures account for 4% to 5% of all fractures in adults (13). The management of these complex fractures is still a challenging and unresolved problem. Avascular necrosis is a frequent complication in four-part fractures and may also be provoked by extensive osteosynthesis (6). Hence, replacement of the head of the humerus appears to be justified in three- or four-part fractures, particularly if they are associated with a dislocation of the glenohumeral joint (5,11). However, the results are often compromised by displacement or malposition of the tuberosities (1). Reverse

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shoulder arthroplasty is an attractive alternative option because of the ability of the prosthesis to compensate for tuberosity complications.

Especially in elderly patients, reversed shoulder arthroplasty (TSA) is a valid alternative for complex humeral fractures due to the good pain relief and the good restoration of function (6). Encouraging mid-term results using this prosthesis have been described in degenerative or inflammatory shoulder disease with massive deficiencies of the rotator cuff (16,17). The use of similar implants in fracture cases has been described only in a small series and has had a short follow-up period (3). The main purpose of the current study was to evaluate the functional and radiographic results after primary reverse shoulder arthroplasty of three- or four-part fractures of the proximal humerus in patients older than 75 years old.

## PATIENTS AND METHODS

Between 2008 and 2010, we treated 29 consecutive patients with a recent fracture of the proximal humerus, using a Zimmer reversed-shoulder prosthesis. All were over 75 years of age.

Five had sustained a displaced three-part fracture and 24 had a four-part fracture of the proximal humerus. (Fig. 1) Twelve of the 24 patients had a dislocation. (Fig. 2) There were no cases with an active infection, axillary nerve palsy, a deficient deltoid muscle, or a bone tumour.

There were 16 women and 13 men with a mean age of 81 years (range 78 to 85). The dominant arm was involved in 18 patients (62%). All of the operations were carried out within 10 days of the injury. In 21 patients, the operation was performed within 5 days of the injury and in the other eight patients, the operation was performed between the fifth and tenth day after the injury. All patients were provided with an illustrated information sheet describing all of the possible complications.

### Operative technique.

The operations were performed by one surgeon (A.K.). The patients were placed in the beach-chair position and operated on under general anaesthesia with associated local anaesthesia. A deltopectoral approach was used in all patients. The greater and lesser tuberosities were retracted, allowing removal of the head of



**Fig. 1.** – The typical radiographic appearance of 3-part fracture of the proximal humerus.



**Fig. 2.** – Acute 4-part fracture dislocation of the proximal humerus.

the humerus and wide exposure of the glenoid. The supraspinatus tendon and the long head of the biceps, if present, were divided.

The glenoid base plate was implanted to cover the glenoid surface. The version of the component was adjusted

in order to reproduce the physiological orientation of the glenoid. The base plate is available in one size for both 36 mm and 40 mm glenospheres and was applied without cement.

Adjustment of the version and of the length of the humerus was carried out after a trial reduction to test the laxity and stability of the joint. The humeral component was positioned in retroversion. The definitive humeral stem was implanted with gentamicin-impregnated bone cement in all of the shoulders (Figs. 3, 4).

In 11 cases, the tuberosities were sutured to each other and around the neck of the prosthesis in their anatomical position. In the other 18 patients, there was no fixation of the tuberosities.

After the operation, the shoulder was immobilised for 2 days before active but gentle physiotherapy was begun. Patients continued with physiotherapy in a rehabilitation centre and then at home for an overall mean duration of 7 months.

The patients were reviewed every 6 months by an independent observer (P.P.) and assessed by the Constant-Murley score (10). The modified Constant score was calculated as a percentage of the normal value relative to gender and age. The results were available for 29 patients, with a mean follow-up of 26 months (range 10 to 36).

Preoperatively, patients were evaluated with anteroposterior radiographs, scapular lateral radiographs, and computed tomography. Postoperatively, fluoroscope-guided anteroposterior radiographs, scapular lateral radiographs, and Velpeau views were obtained at each visit. Inferior scapular notching was recorded and classified according to Sirveaux *et al* (17).

### Statistical analysis.

The independent t-test was performed to evaluate differences in Constant-Murley score between groups in relation to tuberosity fixation and the time of operation. Statistical analysis was performed using SPSS software (version 17, Chicago, Illinois) and a value of  $p < 0.05$  was considered statistically significant.

## RESULTS

The patients were followed up for a mean time of 26 months (range 10 to 36). The mean postoperative Constant-Murley score at the end of follow-up period for each patient (age- and gender-matched) was 73.3% (range 58-92%).



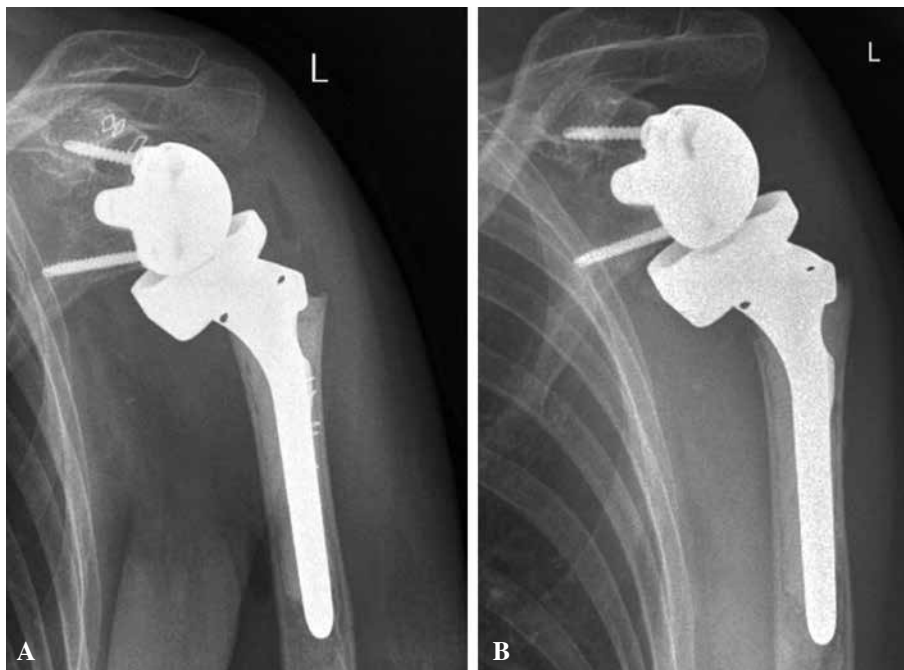
**Fig. 3.** – A postoperative radiograph of a fracture repaired with an inverse prothese. (Zimmer).

Pain had a value of 12 points (range 9-13). The mean active anterior elevation was 95° (range 82°-150°), the mean abduction was 85° (range 60°-160°), and the mean active external rotation in abduction was 30° (range 23°-38°) (Table I).

Moreover, based on the modified Constant score, the percentage of patients with good, satisfactory, and excellent results was 76.6% and only 11.1% of the patients had a bad result.

Table I. — Postoperative Constant-Murley score (age and gender matched)

Constant-Murley score postoperatively	73.3% (59-92%)
Pain	12 (9-13)
Anterior elevation	95 (82-150)
Abduction	85 (60-160)
External rotation	30 (23-38)



**Fig. 4.** – A : Immediate postoperative radiograph showing scapular notching. B : 17 months later, no signs of loosening.

The clinical results were not influenced by fixation of the tuberosities. The mean Constant score was 75% in the group of patients with fixation of the tuberosities and 72.3% in the patients with no fixation of the tuberosities ( $p = 0.06$ ) (Table II).

According to the time of the operation after the injury, the patients were divided into two groups : those who had an operation on the first to fifth day after the fracture (21 patients) and those who were operated between the sixth and tenth day after the injury (eight patients). There was no significant difference in Constant score between the two groups (Constant score 74% and 71%, respectively,  $p = 0.07$ ) (Table III).

Complications occurred in 12 patients. One patient sustained a fracture of the acromion intraoperatively ; it healed with no other consequences. Four patients (13.8%) developed heterotopic ossification with no consequences in range of motion of the shoulder. One had a non-traumatic anterior dislocation due to wrong retroversion of the glenoid component and we performed a revision in the component. Scapular notching was observed in six shoulders (20.6%). Notching was generally noted during the first year and did not widen in those patients followed up for more than 2 years. Scapular notching had no negative effect on the survival of the shoulder prosthesis. No patient had neu-

Table II. — Constant-Murley score according to the fixation of the tuberosities

	Fixation of tuberosities	No fixation of tuberosities	P
Constant-Murley score	75%	72.3%	0.06

Table III. — Constant-Murley score according to the time of the operation after the injury

	0-5 day (21 patients)	6-10 day (8 patients)	P
Constant-Murley score	74%	71%	0.07

Table IV. — Complications

Complications	No of Patients
Scapular notching	6 (20.6)
Heterotopic ossification	4 (13.8%)
Acromion fracture	1 (3.4%)
Wrong retroversion and dislocation	1 (3.4%)

rological complications. There was no evidence of loosening of either component (Table IV).

## DISCUSSION

The main finding of the current study was that reverse shoulder arthroplasty in patients older than 75 years with a three- or four-part fracture of the proximal humerus offers a reasonable treatment option without severe complications. Only 11.1% of patients had a bad result based on the modified Constant score. The length of follow-up was not very long but appeared to be sufficient to allow the assessment of functional recovery.

The main difficulty encountered with reverse arthroplasty was fixation of the tuberosities in an anatomical position. This has been described as the main prognostic factor influencing the functional recovery after arthroplasty of the shoulder (1,11,12). In our study, anatomical reconstruction was achieved in 11 patients (37.9%) and 18 patients had no fixation of the tuberosities. There was no difference in Constant score between the two groups. A number of other studies have shown that the main benefit of the reversed shoulder prosthesis is that shoulder function is not affected by the anatomical positioning of the tuberosities. Bufquin *et al* showed that correct reconstruction of the tuberosities was achieved in only 17 patients (41.5%), but the effect on the Constant score appeared to be moderate. The external rotation score decreased slightly although this was not significant, but the other ranges of movement remained satisfactory (2).

On the contrary, conventional hemiarthroplasty is associated with major problems in healing of the

tuberosities. Displacement of the greater tuberosity has been identified as the most common complication after shoulder replacement for a fracture, and tuberosity malposition and migration are thought to be reasons for disappointing results (8,9). Grönhagen *et al* posed that most patients treated with a primary hemiarthroplasty had little pain but did have reduced range of motion and strength (18). Poor function appeared to be related to a lack of rotator cuff integrity. Kralinger *et al* performed a large retrospective study and showed that anatomic healing of the tuberosities was the most important factor influencing the Constant score (9).

All of the patients in this study were more than 75 years old. This may have affected the clinical results because age has been shown to significantly reduce the mobility score (9). Nevertheless, in our study, the percentage of patients with satisfactory, good, and excellent results was 76.6% based on the modified Constant score.

In a similar way, Cazeneuve *et al* showed that using reverse arthroplasty in acute trauma achieved good anterior elevation, which in all cases was more than 120° (3). Their 16 patients represented a heterogeneous population with a mean age of 75 years (range 55 to 90).

The mean anterior elevation in our study was 95°, as was the case with conventional replacement of the humeral head in the series of Goldman *et al*, who reported a mean anterior elevation of 93° in patients older than 70 years (7). Wretenberg and Ekelund, in a series of patients aged more than 75 years, treated with hemiarthroplasty, measured a mean active anterior elevation of 55°, which was worse than that obtained in our study (19).

Another important finding of our study was that we observed only four patients (13.8%) with heterotopic ossifications, with no effect on functional recovery. Neer showed a similar percentage of heterotopic bone formation – 14 of 117 patients (12%) – after both open and closed reduction and prosthetic replacement (14). Predisposing factors were fracture-dislocations and repeated manipulation, as well as delayed reduction (more than 1 week). Likewise, Goldman *et al* found ectopic bone in only three of 22 patients (14%), without any clinical complication (7).

By contrast, Mansat *et al* discovered ectopic bone in 39% of the patients after shoulder arthroplasty but they did not find any correlation between this and the final clinical result (10). The other complications in our study were less common than with conventional arthroplasty. We had no neurological complications, and no evidence of early loosening of the components or prosthetic joint infection. Neer and McIlveen noted transient neurological complications in 27% of a series of 44 four-part fractures treated by hemiarthroplasty (15).

Notching of the scapula has also been reported in cuff tear arthropathy treated by the same implant and also after acute trauma (16,12). Further follow-up is required in order to draw definite conclusions, but it is likely to have less consequence. Another advantage of the reversed shoulder prosthesis is that it does not require participation in an extensive postoperative rehabilitation programme, which is sometimes very difficult for older patients to follow.

There are some limitations to the present study. Although our data were prospectively collected and the evaluator was blinded, we had no control group treated with hemiarthroplasty or plate fixation. Another limitation is that we used only a single outcome score, the modified Constant score.

However, our study has some potential strengths. We focused only on three- and four-part proximal humerus fractures. All patients were treated by the same surgeon using the same treatment method. They were evaluated by an independent observer using a standard evaluation score (modified Constant score, adapted to age and sex), and no patient was lost to follow up in the study period.

Our conclusion is that reverse shoulder arthroplasty is a valid treatment option in complex fractures of the proximal humerus in patients older than 75 years old. It provides sufficient pain relief and offers better functional recovery than conventional arthroplasty.

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