

# Shoulder Hemiarthroplasty for Trauma: does a Tuberosity Friendly Prosthesis Improve Outcome?"

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## SUMMARY

**Background.** Reported outcomes of shoulder hemiarthroplasty for proximal humeral fractures have been poor due to tuberosity non-union or rotator cuff disruption. Newer designs provide features to allow secure tuberosity apposition and stabilisation. To evaluate the outcomes of a shoulder hemiarthroplasty system with “tuberosity friendly” features in the treatment of multi-fragmentary proximal humeral fractures.

**Material and methods.** An analysis of 12 patients undergoing Exactech Equinox hemiarthroplasty for proximal humeral fractures over a two year period. Radiological and clinical outcomes were assessed.

**Results.** Twelve patients, aged 55 to 84, were examined. Median follow up was 20 months (range 7 to 31). Although tuberosity reduction remained and the tuberosities united radiologically in all cases, 5 patients went on to develop superior migration of the humeral head. The median Oxford shoulder score was 25.7 out of 48 (range 11 to 43).

**Conclusions.** 1. A trauma hemiarthroplasty system combined with good surgical technique can ensure tuberosity fixation and subsequent union. 2. Superior migration of the prosthesis can still occur due to rotator cuff disruption. 3. The use of reverse shoulder arthroplasty may be more appropriate in elderly patients with multi-fragmentary proximal humeral fractures.

**Key words:** shoulder; hemiarthroplasty; proximal humerus; fracture

## BACKGROUND

Primary hemiarthroplasty has traditionally been the treatment of choice in proximal humeral fractures which are not considered suitable for internal fixation or where the humeral head is non-viable. Common indications include selected three-part fractures, four-part fractures with or without dislocation and head splitting fractures with significant involvement of the articular surface [5,10,12,19].

Outcome of shoulder hemiarthroplasty for fractures has been closely linked to adequate reduction and union of the tuberosities to allow restoration of rotator cuff function. Tuberosity non-union and superior migration is a concerning complication associated with poor outcome [1,2,5,13,15,22]. In the last decade, surgical technique and implant designs have become more refined to take this into account [11]. "Tuberosity friendly" hemiarthroplasty designs aim to facilitate tuberosity reduction and fixation, using design features such as low profile fins, suture holes and slots for bone grafting [8,20].

The aim of our study was to assess the role of a trauma hemiarthroplasty prosthesis, in the treatment of proximal humeral fractures, through the assessment of clinical and radiological parameters.

## MATERIAL AND METHODS

Over a two year period 12 patients with an acute proximal humeral fracture underwent primary hemiarthroplasty under the care of the senior author. One patient died before the beginning of this study, three weeks post-operatively following a myocardial infarction. Eleven patients were further assessed for this study.

The mean radiological follow-up was 13.3 months post-operatively (range 6-30 months) and mean clinical follow-up was 21.6 months (range 7 to 31 months). Demographic and clinical data are summarised in table one.

In all cases, the Equinoxe (Exactech, UK) hemiarthroplasty system was used. This shoulder system has features which aim to improve tuberosity fixation and subsequent tuberosity healing. The offset anterior-lateral fin features multiple holes with rounded edges to aid tuberosity suturing and a metaphyseal slot facilitates bone grafting between tuberosities. Asymmetric tuberosity beds allow easier tuberosity reduction and apposition [8].

## Surgical technique

Surgery was performed via a deltopectoral approach, by the most senior author in all cases. The humeral head was removed and sized. In cases where the head was between two sizes, the smaller size was used. Retroversion was guided by an alignment handle in relation to the forearm. Prosthesis height was adjusted so that the tuberosities were positioned firmly beneath the humeral head. In cases where there was no bone comminution medially and no metaphyseal bone on the head fragment, the calcar of the humeral stem was positioned directly on this medial bone to establish correct height. A cemented stem was used and cancellous bone graft from the native humeral head was placed in the graft slot of the prosthesis and between the two tuberosities. Tuberosity fixation was performed using two horizontal and two vertical cerclage orthocord (DePuy, UK) sutures. The rotator interval was closed with a continuous orthocord suture. Patients were immobilised in a sling for six weeks with only elbow, wrist and hand movement permitted. Passive movements were initiated for three weeks following this, with active movements beginning nine weeks post operatively.

## Radiological & Clinical Assessment

Fractures were classified using the Neer classification [18]. Radiological assessment was undertaken retrospectively through assessment of antero-posterior and lateral post operative films. Initial post-operative and most recent shoulder radiographs were reviewed to determine tuberosity positioning, fixation, rate of tuberosity healing and the occurrence of superior migration.

Clinical assessment was performed by measuring the active range of motion in the operated shoulder and through patient completion of the Oxford Shoulder Score questionnaire [6] (scoring 0 to 48, where 48 represents the best outcome).

Alongside clinical and radiographic assessment, clinical outcome was determined through a retrospective review of the patient records to identify any post-operative complications (both early and late); in particular infection, neurovascular injury, prosthesis displacement and loosening.

Tab. 1. Demographic & Clinical Data of Patient Population

Mean Age	69 (55-84)
Females: males	9:3
Fracture Type (Neer Classification) <sup>(18)</sup> :	
- 4 part fracture	8
- 4 part fracture dislocation	4

## RESULTS

### Radiological Outcome

All patients had radiographic evidence of maintenance of tuberosity positioning on initial post-operative films. All had recent shoulder radiographs available for assessment, which had been taken at least six-months post-operatively (mean 13 months, range 6 to 24 months since surgery). In all cases, the tuberosities had healed in a satisfactory position.

Five patients (45%) had evidence of superior migration of the prosthetic humeral head despite evidence of tuberosity union (figure II). The mean age of patients with superior migration was 70 (range 55 to 84), 4 of 5 cases were female and 4 out of 5 patients had multi-fragmented tuberosities on their initial radiographs. One patient, with a history of alcohol abuse, developed superior migration and infected loosening of the prosthesis requiring revision surgery.

Tab. 2. Summary of clinical outcomes of patients assessed in clinic

	Patient 1	Patient 2	Patient 3	Patient 4	Patient 5	Patient 6	Patient 7	Patient 8	Patient 9	Patient 10	Mean/ (range) of parameters	
Age (at operation)	62	80	80	60	83	84	65	73	73	57	71.7/ (57-84)	
Duration post-operatively when assessed (months)	18	12	18	12	24	31	24	30	17	30	21.6/ (12-31)	
Range of movement (degrees)	Forward Flexion	60	30	50	70	80	30	130	30	50	90	62/ (30-130)
	External rotation	60	Unkown	60	30	50	30	80	30	10	Unkown	43.8/ (10-80)
	Internal rotation (vertebral level to which thumb can reach)	to L2	L4	L1	L2	L3	L5	T10	Not assessed	L5	L1	
Superior Migration?	Yes	No	No	No	No	Yes	No	Yes	Yes	No		
Total oxford shoulder score (OSS)	36	30	17	33	17	13	28	29	11	43	25.7/ (11-43)	
From OSS:												
How much pain do you usually have from your shoulder?	Very Mild	None	Mild	None	Very mild	Very mild	Mild	None	Moderate	None		
How much has pain interfered with your usual work?	Moderate	Moderate	Moderate	Little bit	Totally	Greatly	Greatly	Moderately	Totally	Not at all		



Fig. 1. Shoulder radiographs of a 60 year old female – a) pre-operatively, a 4-part fracture; b) one month post-operatively demonstrating tuberosity stabilisation; c) one year post-operatively showing tuberosity union with no superior migration.

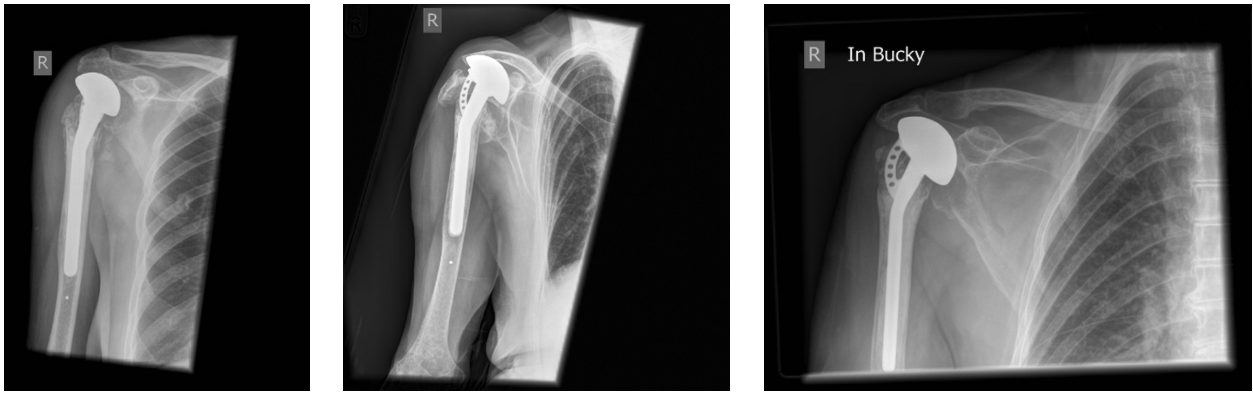


Fig. 2. Post-operative shoulder radiographs of three different patients demonstrating varying degrees of superior migration

### Clinical Outcome

The Oxford Shoulder Score questionnaire was completed at a minimum of 12 months post-operatively (mean 21.6, range 12-31). Excluding the patient that had revision surgery, the mean Oxford shoulder score in the remaining 10 patients was of 25.7 out of 48 (range 11 to 43). The results of the clinical examination and Oxford shoulder score are summarised in table two.

### DISCUSSION

Prosthetic replacement is a well-accepted and common treatment for three and four part proximal humeral fractures in elderly low demand patients, since the publication of Neer's results in 1970 [19]. However, results are variable and it has been shown that clinical results decline with increasing age, with those over 70 often having a poorer outcome [14,25].

Tuberosity migration or non-union is a major contributor to fracture hemiarthroplasty failure. Anatomic reconstruction and fixation of the tuberosities is vital in improving outcome; current hemiarthroplasty designs aim to facilitate this [1,2,5,13,15,22].

In our series, the combination of a trauma hemiarthroplasty design, a vertical and horizontal cerclage configuration suturing technique and a period of post-operative shoulder immobilisation allowed tuberosity consolidation in all cases. However, despite tuberosity healing, a substantial proportion of our cases went on to develop superior migration due to rotator cuff failure. This would suggest that other factors, such as pre-existing degeneration or injury to the rotator cuff is influential in patient outcome.

Disruption of the vascular supply to the rotator cuff as a result of the injury may also have an important role to play. This may be more relevant in those fractures where the tuberosities are osteoporotic, or in multiple small fragments rather than large pieces [15,16,21,23].

It has been shown in previous study that rotator cuff injury becomes increasingly common with age and is evident in 28% of patients between the age of 60 and 70, 50% of those between 70 and 80 and 80% in those aged 80 and older [17]. In keeping with this, the large number of elderly patients in our series and proportion of females may also account for cuff failure.

A recent systematic review examined the role of hemiarthroplasty in the early management of proximal humeral fractures [14]. This review analysed 16 articles; 808 patients with a fracture of the proximal humerus underwent primary hemiarthroplasty. It demonstrated that the majority of patients with early hemiarthroplasty had only mild or no pain, but that the level of function before the fracture was almost never regained, with a normally functioning shoulder after a hemiarthroplasty for fracture being described as generally unachievable. Range of movement was reduced with mean active anterior elevation reported as 105.7°, abduction 92.4° and external rotation 30.4°. Complications related to fixation of the tuberosities and healing were reported in 11.2% of cases. The incidence of proximal migration of the prosthesis was 6.8%. In 8 papers involving 560 patients the mean constant score was 56.6.

We demonstrate similar findings in our patient group. As shown in table 2, post-operative shoulder pain was mild or non-existent in nine out of ten cases. Despite good results in terms of pain control, it is clear that functionally the outcome is often sub-optimal, with the majority of patients describing at least moderate restriction their daily activities.

Reverse shoulder arthroplasty is increasingly becoming a popular option for elderly patients with multi-fragmentary proximal humeral fractures. These prostheses reverse the relationship between scapular and humeral components, resulting in the centre of rotation being moved towards the glenoid. This increases the lever arm of the deltoid, allowing com-

compensation for rotator cuff deficiency [7,24]. Several small studies have demonstrated positive midterm outcomes with improved range of movement in patients treated with primary reverse shoulder arthroplasty for three and four part fractures compared to hemiarthroplasty [4,9,24]. A study by Boyle et al comparing functional outcomes of patients treated with hemiarthroplasty versus reverse shoulder arthroplasty found patients in the latter group to achieve superior five year functional outcomes. These studies suggest that reverse shoulder arthroplasty provides excellent pain relief and may also offer improved functional recovery than conventional arthroplasty in patients over 75 [3].

Limitations of our study include the small number of cases examined and the inability to standardise post-operative radiographs given the retrospective nature of the study. Nevertheless, the fact that all patients were operated and managed by a single surgeon provides uniformity to the study. In addition, to our knowledge, this is the first study reporting results of the Exactech Equinox prosthesis.

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In conclusion, our results suggest that a fracture prosthesis, designed to be “tuberosity friendly” when used for proximal humeral fractures provides pain relief but does not restore range of motion or function. Even though features of the trauma haemiarthroplasty may allow secure tuberosity fixation and union, a substantial proportion of cases may still exhibit superior migration due to rotator cuff disruption. Reverse shoulder arthroplasty may be preferable as first line management in elderly patients with multi-fragmentary fractures and poor rotator cuff function.

## CONCLUSIONS

1. A trauma hemiarthroplasty system combined with good surgical technique can ensure tuberosity fixation and subsequent union.
2. Superior migration of the prosthesis can still occur due to rotator cuff disruption.
3. The use of reverse shoulder arthroplasty may be more appropriate in elderly patients with multi-fragmentary proximal humeral fractures.

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