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TRAUMA SURGERY

Shoulder hemiarthroplasty for fracture with a conservative rehabilitation regime

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Abstract
Introduction Standard rehabilitation regime following hemiarthroplasty for trauma is early mobilisation to prevent the development of a stiff shoulder. However, an aggressive early rehabilitation may lead to non-union of the greater tuberosity. We hypothesise that a delayed rehabilitation will result in a good union rate without undue risk of shoulder stiffness.
Materials and methods Between December 1996 and June 2003, 40 patients with three or four part fracture of proximal humerus with or without dislocation, not amenable to open reduction and internal fixation underwent hemiarthroplasty with reconstruction of tuberosities and a conservative rehabilitation regime at our centre (age range of 39–92 with a mean of 68). Pathologic fractures and non-cooperative and/or demented patients were excluded. Patients were kept in a sling for 4 weeks before physiotherapy was commenced. They were reviewed at an average of 55 months (12–95) for assessment of pain, range of movement, activities of daily living and strength. Radiographs were taken to evaluate the union of the greater tuberosity.
Results One patient lost to follow up. In 12.8% of the patients (mainly elderly, with mean age of 78.8) the greater tuberosity failed to heal. In those with a healed greater tuberosity the average elevation was more than 130°, and the average external rotation was 40°. A total of 51.3% of the patients had excellent results, 33.3% had satisfactory and 15.4% had unsatisfactory results.
Conclusion Postoperative immobilisation did not result in excessive stiffness and excellent functional results were achieved, especially in those younger than 70 years of age. However, tuberosity union could not be guarantied in very old patients.

Keywords Proximal humerus fracture · Shoulder hemiarthroplasty · Neer reconstruction · Non-union of greater tuberosity · Shoulder physiotherapy

Introduction

The management of three and four part fractures of the proximal humerus with or without dislocation, presents a very challenging problem to the Orthopaedic Surgeon. There is still considerable controversy about the optimum management of these serious and severe injuries.

Hemiarthroplasty with reconstruction of the tuberosities around the prosthesis remains the gold standard of treatment when comminution precludes reconstruction or the blood supply to the head is completely disrupted [13].

The results following hemiarthroplasty of the shoulder, however, are somewhat variable. While there have been good reports in certain series [10], others have found a high incidence of failure [8] primarily from non-union of the greater tuberosity.

Standard rehabilitation following hemiarthroplasty reconstruction is early mobilisation to prevent the development of adhesions and secondary stiffness of the shoulder. However, failure of the greater tuberosity may result from an aggressive early rehabilitation program [2]. We

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hypothesise that a delayed rehabilitation program will result in a higher union rate with no increased rate of shoulder stiffness.

We report our experience of 40 consecutive fractures of the proximal humerus that were treated with hemiarthroplasty and reconstruction of the tuberosities and a conservative rehabilitation regimen, that is immobilisation in a sling for 4 weeks prior to commencement of physiotherapy.

Patients and methods

Between December 1996 and June 2003, out of all proximal humeral fractures referred to the senior author, 40 patients were selected for hemiarthroplasty. The inclusion criteria were acute three or four part fractures of the proximal humerus with or without dislocation, not salvageable via open reduction and internal fixation, with previous normal function in non-demented patients. Pathologic fractures were excluded as well.

Surgical technique

All the procedures were performed by or under direct supervision of the senior author. A deltopectoral approach was used. The tuberosities were isolated with minimal soft tissue dissection. The humeral head was carefully removed to preserve its anatomical shape. The excised humeral head was used as a template to select the appropriately sized modular head. Humeral head height and retroversion was determined interoperatively by applying the excised humeral head to the proximal humeral shaft and matching the fracture lines. A reasonable estimation of humeral height and retroversion was so obtained [12]. Acrylic bone cement was used for fixation of the humeral stem. Reconstruction of the tuberosities around the prosthesis and to the humeral shaft was undertaken with a standard technique [13].

Post operative rehabilitation

The limb was kept in a sling in the neutral position (shoulder internally rotated with the elbow in 90° of flexion) for 4 weeks. Free fingers and wrist but only limited elbow movements were allowed during this period. From the fifth to tenth week (6-week period) patients progressed from pendulum to active-assisted exercises. From 11th week onwards active exercises started progressing to rotator cuff strengthening exercises as tolerated.

Patients were followed up in the clinic and postoperative plain radiographs were taken at 3, 6, 12 months and yearly thereafter. The clinical outcomes of patients were broadly categorized into three groups according to the system of Cofield [4]. Excellent is where the patient is pain free or with mild pain with elevation of more than 130° and external rotation of 45°, satisfactory is defined if the patient has persistent moderate pain or the range of motion in elevation is 90°–130°, or external rotation is 20°–45°, and unsatisfactory is anything that will not fit into the above two categories. For the purpose of this study all the patients were recalled for a clinical and radiological examination by an independent observer. Their functional outcome was assessed by the use of Constant–Murley scoring system [5]. The score was adjusted in comparison to the unaffected side. The power was assessed with a myometer (which was checked and standardised weekly) with the shoulder in 90° of abduction.

Results

One patient (2.5%) was lost to follow-up. Three patients (8%) died of unrelated causes, however, all the three had their function assessed by the use of Constant–Murley scoring system 3 and 4 years after the index operation and had their latest radiographs available for review, therefore they were included in the study. This left a cohort of 39 patients. The patients' average age was 68 year-old (range 39–92). 29 of the patients were female (74%) and 10 male (26%). Table 1 shows the distribution of the fracture pattern in the study population. Average time to follow up was 55 months (12–95 months). The average time from the initial trauma to the surgery was 13 days (2–34). No correlation between the final outcome based on the adjusted Constant–Murley score and the delay of the surgical intervention was observed (correlation coefficient 0.29). Also no statistical significant difference in the outcome of the surgery was found between those who waited less than a week and those patients who waited more. This figure was still insignificant for the cut-off values of 2, 3 or 4 weeks.

In five of the patients (12.8%) the greater tuberosity failed to heal (Fig. 1). This was established after reviewing 1-year follow up radiographs. They were at the extreme of age with mean age of 78.8 year old (66–92), however the age difference of the two groups was not statistically significant.

A total of 20 (51.3%) of the patients had excellent outcome, 13 (33.3%) had satisfactory and 6 (15.4%) had unsatisfactory outcome. From patients with an unsatisfactory

Table 1 Distribution of the fracture pattern in the study population (the numbers in parenthesis are the percentages)

	Fracture	Fracture dislocation	Total
Three part	8 (20.5%)	6 (15.4%)	14 (35.9%)
Four part	18 (46.2%)	7 (17.9%)	25 (64.1%)
Total	26 (66.7%)	13 (33.3%)	39 (100%)

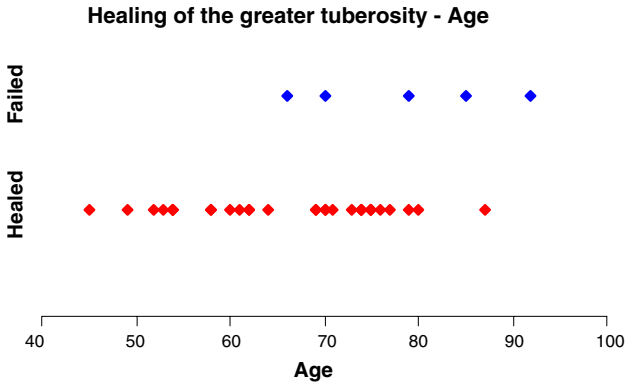

Fig. 1 Chart to compare the number of healed versus failed greater tuberosity

outcome five had a failure of the greater tuberosity, which resulted in poor function of the rotator cuff. The other one was a young patient who had a high-energy injury following road traffic accident and unfortunately developed complex regional pain syndrome.

From the group of patients with healed greater tuberosity one (2.9%) had severe pain (the young patient with complex regional pain syndrome), eight (23.5%) had mild pain and the rest (25 patients or 73.5%) had no pain. The average forward elevation of the affected shoulder was 132.5° and external rotation was 40.4°. The functional outcome of the study group is shown in Fig. 2. The average Constant–Murley score in united group was 73 (±16) and in failed tuberosity group 32 (±3). The difference between the two groups was significant ($P < 0.0001$).

No case of failure of the prosthesis was observed in the studied population. This gave a 100% prosthesis survival at the time of follow-up.

Discussion

The incidence of proximal humerus fracture is $63/10^5$ with women being affected more than twice as men [6]. Two

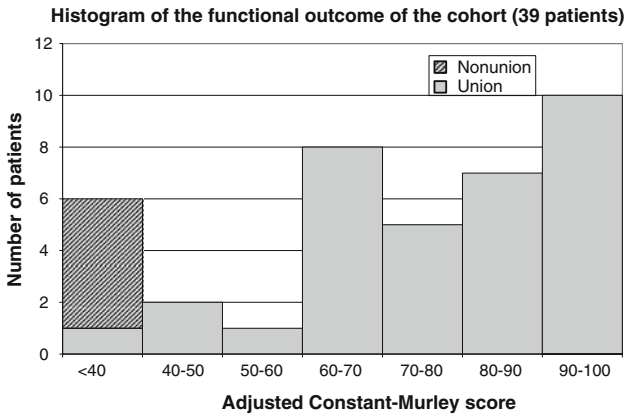

Fig. 2 Histogram of the functional outcome post operatively

different types exist: high-energy fractures in young patients, and insufficiency type in the elderly.

The blood supply to the head of the humerus is mainly derived from the anterolateral branch of the anterior circumflex artery [9]. This is usually disrupted in the case of a four-part fracture. Fracture line at the level of anatomical neck, lack of metaphyseal attachment to the head fragment and disruption of the postero-medial hinge (the only remaining blood supply) are the main predictors of avascular necrosis of the head [11]. Non-operative treatment of four-part fractures even in the low demand elderly patients is shown to have a poor outcome, with average Constant–Murley score of 47 and 40% being disabled due to the shoulder problem at ten year follow up [16]. When the humeral head is non-viable a primary hemiarthroplasty is the option of choice. Younger age, lack of pre-operative neurological deficit, absence of post-operative complications and a satisfactory radiographic appearance at 6 weeks follow-up are the predictors of a good outcome after hemiarthroplasty [14]. Early intervention after the trauma is shown to have a more satisfactory outcome [8].

The most common reason for early failure of the reconstruction, hence a poor outcome is the failure of the greater tuberosity [7]. One of the contributing factors to the non-union or absorption of the greater tuberosity is aggressive early rehabilitation [2]. On this basis a more conservative early post operative rehabilitation was advocated.

A recent randomized controlled study failed to show a statistically significant difference in between early (2 weeks) and late (6 weeks) mobilisation when the migration of the tuberosity used as the end point [1]. However, with the observed frequency of the failure in the two groups, the number of patients in each arm was not enough to show a statistically meaningful difference. Indeed the number of failures was reported to be higher in the early mobilisation group.

Despite close adherence to the described surgical techniques and postoperative mobilisation [13] our early experience with Neer reconstructions was disappointing. Patients would have almost anatomically reconstructed shoulders on the immediate postoperative radiographs only for the tuberosities to fail during rehabilitation leading to an unacceptably high number of poor clinical outcomes. We attempted to address the problem of tuberosity failure by allowing for time for the tuberosities to heal before starting formal rehabilitation exercises. We now immobilise our patients in a sling for 4 weeks before starting our rehabilitation regimen. Our concerns have been with excessive stiffness.

A comprehensive review of the literature shows a range of elevation between 11° and 120° following hemiarthroplasty for acute fractures [7]. In our study 12.8% had failure of the greater tuberosity (resorption or malunion combined). This group had a poor shoulder function. From those with a healed greater tuberosity, the average elevation was 130° and external rotation of 40°. This negates the increased risk of shoulder

stiffness due to a prolonged immobilisation and is more favourable than the previous series. The reported results in the literature following a conservative rehabilitation regime are also in agreement with our finding [1]. It is therefore important to separate the results of patients with functioning rotator cuff from those with a failed greater tuberosity.

The overall rate of pain relief in the literature is 88% [7]. As not all the papers mention the functional state of the rotator cuff tendons, it is difficult to differentiate in between those with failed greater tuberosity and those with a functioning rotator cuff. In the studied population all the five patients with failed greater tuberosity had persistent pain as their main complaint. Only one patient with a healed greater tuberosity complained of persistent pain on the latest follow-up secondary to chronic regional pain syndrome. Overall we encountered a 15% rate of unacceptable pain, which is similar to other researchers' findings. However, this once again proves the importance of the function of rotator cuff on the overall outcome.

A total of 31 cases of greater tuberosity non-union or superior migration were observed in total of 118 reported cases of hemiarthroplasty after trauma [7]. This gives an overall failure rate of 26%. The observed 12.8% greater tuberosity failure in our series is more favourable than other series [3], which further supports this rehabilitation regime.

The effect of the delay in intervention on the final outcome has been a matter of debate. In the studied population all of the patients were operated on during the first 5 weeks since injury. No statistically significant difference was observed in between the final outcome (as assessed by the Constant–Murley score) of the patients who were operated on during the first week and those who were operated on after the first week. This difference was again insignificant when the cut-off value was changed to 2, 3 or 4 weeks. Low number of patients in each arm might have contributed to this.

Prosthetic loosening is a rare occurrence. Three cases out of 360 were reported [7] in all the acute and chronic cases. In the studied population no case of clinical or radiographic loosening at the latest follow up was observed. This needs a long-term follow-up to ensure the good medium term survival rate is maintained over time.

Other reported complications in the literature are infection, nerve damage, instability, heterotopic ossification and erosion of the glenoid. We did not encounter any of these.

Wretenberg and Ekelund looked at the outcome of hemiarthroplasty in the over 70-year-old patients. They concluded that the procedure is good for pain relief but not to improve the range of movement [15]. No statistically significant difference was observed when the Constant–Murley scores of the above and below 70-year-old patients were compared. Also we did not see an increased risk of failure of the greater tuberosity in those above 70 years old. Small number of failure in each group (2 vs. 3) could have contributed to this finding.

Conclusion

Good functional outcome following hemiarthroplasty for trauma is achievable. A prolonged rehabilitation with an extended initial immobilisation period could reduce the rate of tuberosity failure. However, the healing cannot be guaranteed, specifically in the extreme of age.

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