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*ORIGINAL STUDY*

# Shoulder hemiarthroplasty in the management of humeral head fractures

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**The results of hemiarthroplasty for shoulder fracture were evaluated in 26 patients, 20 women and 6 men with a mean age of 64.7 ± 8.2 years. The follow-up period was 2 to 7 years. Cofield prostheses were used for the first 10 patients and subsequently 9 Global and 7 Aequalis prostheses were implanted, all cemented. The clinical outcome was assessed using the Constant-Murley scale. The mean score, at the last follow-up, was 70.4 ± 16.4 (39-96). Mean forward elevation of the arm was 150° (30°-175°), mean abduction was 145° (30°-170°), and mean external rotation was 30° (10°-45°). In most of the cases internal rotation corresponded with a position of the dorsum of the hand at the L3 vertebrae. The patients in our series achieved their optimal clinical result within the first 6 months after operation. Shoulder hemiarthroplasty is a worthwhile procedure, giving predictable results provided the patients have been carefully selected, the individual anatomy of the shoulder is restored and an aggressive rehabilitation program is implemented during the first six months after surgery.**

## INTRODUCTION

Most undisplaced or minimally displaced fractures of the proximal part of the humerus are managed successfully by conservative means *(1,8).* The type of the fracture as well as factors related with the specific characteristics of each patient, usually determine the selection of treatment. Osteosynthesis of these fractures is feasible using various methods such as transcutaneous pins, strong non-absorbable sutures or plates and screws. A prerequisite for a stable osteosynthesis is an efficient bone stock. Shoulder hemiarthroplasty is mainly used for the treatment of 4-part fractures and fracture-dislocations as well as for the treatment of 3-part fractures in patients with diminished bone stock *(5,14).*

After the introduction of hemiarthroplasty for fractures around the shoulder by Neer, some authors reported beneficial results with excellent pain relief and good function *(5,12,14).* Other studies reported poor results considering the range of motion and physical activity *(8,10).* Those poor and unpredictable results even lead some surgeons to reconsider non-operative treatment for the management of those complex fractures of the proximal humerus *(17,18,20).* The objective of this study was to assess the results of hemiarthroplasty for shoulder fractures in 26 patients with a follow-up period from two to seven years.

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Table I. – Data of the twenty six patients

| | Patients | Sex | Age | Type | Days until surgery | Type of prosthesis | Constant score (%) Last F.U. | Follow-up months |
|---|---|---|---|---|---|---|---|---|
| 1. | M.E. | F | 63 | 4-part fracture/ant. dislocation | 3 | Cofield | 60 | 80 |
| 2. | M.A. | F | 70 | 4-part fracture | 2 | Cofield | 44 | 72 |
| 3. | K.E. | F | 54 | 4-part fracture | 6 | Cofield | 72 | 68 |
| 4. | T.G. | M | 60 | 4-part fracture | 4 | Cofield | 81 | 68 |
| 5. | K.E. | F | 70 | 4-part fracture | 5 | Cofield | 83 | 64 |
| 6. | T.E. | F | 67 | 3-part fracture/ head split | 5 | Cofield | 87 | 63 |
| 7. | P.M. | F | 65 | 4-part fracture/ant. dislocation | 4 | Cofield | 91 | 62 |
| 8. | K.M. | M | 42 | post.dislocation/head impaction | 0 | Cofield | 85 | 62 |
| 9. | L.R. | F | 67 | 3-part fracture/ head split | 1 | Cofield | 56 | 61 |
| 10. | P.G. | M | 50 | 4-part fracture/ant. dislocation | 1 | Cofield | 39 | 59 |
| 11. | D.M. | F | 71 | 3-part fracture | 2 | Global | 92 | 58 |
| 12. | B.T. | F | 63 | 4-part fracture | 2 | Global | 84 | 54 |
| 13. | T.Z. | M | 62 | 4-part fracture/ant. dislocation | 17 | Global | 59 | 49 |
| 14. | M.M. | F | 78 | 4-part fracture/ant. dislocation | 2 | Global | 66 | 4 |
| 15. | B.S. | M | 60 | 4-part fracture/post. dislocation | 1 | Global | 70 | 47 |
| 16. | A.E. | F | 58 | 4-part fracture | 15 | Aequalis | 50 | 45 |
| 17. | M.E. | F | 65 | 4-part fracture | 3 | Aequalis | 88 | 45 |
| 18. | S.A. | F | 65 | 4-part fracture | 2 | Aequalis | 54 | 43 |
| 19. | H.E | F | 70 | 4-part fracture | 1 | Aequalis | 46 | 37 |
| 20. | K.M | F | 75 | 4-part fracture | 3 | Aequalis | 71 | 37 |
| 21. | M.K | F | 70 | 4-part fracture | 10 | Aequalis | 88 | 34 |
| 22. | P.N | M | 74 | 4-part fracture | 9 | Aequalis | 71 | 32 |
| 23. | S.M | F | 59 | 4-part fracture | 17 | Global | 56 | 28 |
| 24. | G.M | F | 67 | 4-part fracture | 12 | Global | 96 | 26 |
| 25. | A.M | F | 69 | 3-part fracture | 10 | Global | 74 | 25 |
| 26 | S.E | F | 70 | 3-part fracture | 7 | Global | 68 | 24 |
| Mean | | | 64.7 | | 5.5 | | 70.4 | 49.6 |

## MATERIAL AND METHODS

Twenty six patients (20 women and 6 men, mean age 64.7 ± 8.2 years, range 41 to 78 years) with a follow-up 2 to 7 years (mean 49.6 ± 10.1 months) after humeral head replacement for displaced fracture or fracture-dislocation of the humeral head were included in this study. The patients' data are summarised in table I. In the first 10 cases we implanted Cofield prostheses, and subsequently we implanted 9 Global and 7 Aequalis prostheses. All the procedures were performed 0-17 days after the injury (mean 5.5 ± 4.6 days).

Under general anaesthesia, with the patient in a beach chair position, and the arm draped free beyond the edge of the table, the fracture was exposed using a deltopectoral approach. The deltoid was carefully kept intact, without damaging its origin or its fibers. The long biceps tendon was used as a guide for the separation of the tuberosities. The fracture line between the tuberosities was usually lateral to the bicipital groove. The fractured head was removed and the size of the prosthetic head was selected accordingly. Our aim was to achieve anatomic restoration of the tuberosities around the humeral prosthesis. We used cement for implant fixation in all the cases. With the prosthesis implanted, mobility of the shoulder was cheked : a full range of shoulder motion was achieved without any impingement.

Regarding the retroversion of the humeral prosthesis, we used three different techniques. The aim was to improve our technique and to achieve anatomical orientation of the prosthesis. For the first 10 patients, we implanted the prosthesis with its lateral fin just behind the posterior edge of the bicipital groove. For the next 8 patients, we implanted the lateral fin of the prosthesis 5mm behind the posterior edge of the bicipital groove. For the last 8 patients an individualised approach was used in order to estimate the desired retroversion, using the upper part of the contralateral humerus for the measurements.

All patients started passive shoulder flexion and external rotation the day after the surgery. The goal was to achieve 140° passive flexion and 30° passive external

rotation by the end of the 3rd postoperative week. All patients followed the same postoperative rehabilitation program at this period. When the tuberosities were healed, at 6 weeks, active shoulder motion was permitted. Thereafter it was not possible for them to follow the same rehabilitation program, owing to the organisation of the rehabilitation centers in our region. Eleven patients did not follow any rehabilitation program, only trying to achieve by themselves the functional demands of daily living.

In one patient there was a definitive lesion of the axillary nerve which led to significant impairment of shoulder function. This lesion occurred at the time of injury, in a four-part fracture dislocation. Temporary nerve lesions, related to the injury, occurred in two patients. These resolved completely during the first three months after operation.

One patient had an infection during the immediate postoperative period. This infection was controlled with surgical debridement and antibiotics (i.v. for 6 weeks and orally for another 6 weeks). One further patient developed late infection and a discharging sinus, three years after his operation. This was also controlled with antibiotics.

The postoperative follow-up was done at 6 weeks, 3 months, 6 months, 1 year and then yearly. After the first 3 months, all patients were assessed using the Constant-Murley grade scale at each follow-up, in order to evaluate pain, strength and active range of motion of the shoulder. At the time of the last follow-up anteroposterior, Y, and axillary roentgenographs were taken of all patients. Radiographic assessment focussed on both radiolucency with possible loosening of the implant, and healing of the tuberosities. No patient has required revision arthroplasty during the follow-up period.

*Statistical analysis*

Repeated measures analysis of variance and Frydman non parametric test was used for the statistical analysis. All tests were two-tailed with a confidence level of 95% ($p<0.05$). Values are expressed as mean±standard error, unless otherwise stated.

## RESULTS

The mean Constant-Murley score, at the last follow-up of the patients, was 70.4 ± 16.4 (39-96). Mean forward elevation of the arm was 150° (30°-175°), mean abduction was 145° (30°-170°), mean external rotation was 30° (10°-45°). In the vast majority of cases, internal rotation corresponded with a position of the dorsum of the hand at the L3 vertebrae.

Table II. – Mean Constant score (%) at different time intervals postoperatively

| Time Post-operatively | Mean Constant score | 95% Confidence Interval | |
|---|---|---|---|
| | | Lower | Upper |
| **3 months** | 46.92 | 43.79 | 50.05 |
| **6 months** | 69.38 | 64.14 | 74.62 |
| **1 year** | 70.92 | 64.50 | 77.33 |
| **2 years** | 70.35 | 63.75 | 76.93 |
| **Last examination** | 70.42 | 63.77 | 77.06 |

At 3 months after surgery, the mean Constant-Murley score was 46.9 ± 7.7 (30-67). At six months after surgery the mean score, for the same patients, was 69.3 ± 12.9 (39-92). The difference between 3-month and 6-month examinations was significant ($p < 0.001$) (table II). One year after surgery the mean score was 70.9 ± 15.8. Two years after surgery the mean score was 70.3 ± 16.3 (39-96). The differences between 6-month, 1-year and 2-years examinations were not significant (fig 1).

For the first 10 patients in which the prosthesis was implanted with its lateral fin just behind the

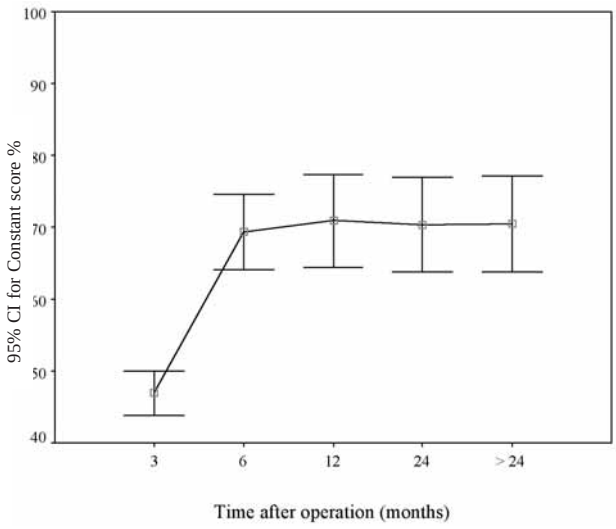


***Fig. 1.*** — Progress of the Constant score % postoperatively (CI : Confidence Interval)

posterior edge of the bicipital groove the mean Constant-Murley score was 70. For the next 8 patients with the lateral fin of the prosthesis implanted 5mm behind the posterior edge of the bicipital groove, the mean score was 70.6 and for the last 8 patients in which we used an individualised approach in order to estimate the proper retroversion the mean score was 71.2 (table III). No significant differences were noted between these three groups regarding the Constant scores.

The patient with permanent axillary nerve injury had a score of 39. The patient with the early postoperative infection had a Constant score of 56 at the last follow-up, 2 years postoperatively, with impaired shoulder mobility, but a pain free and strong shoulder. The patient with delayed infection had a Constant score of 59, also with reduced range of movements for his shoulder.

At their last follow-up 18 patients (69.2%) had no pain and 7 (27%) had some mild pain at the end of their daily activities ; one patient (3.8%) had pain even with mild activities. Six months after the injury 20 out of the 26 patients (76.9%) had the same activity level as they had prior to the fracture. The patient with permanent axillary nerve lesion had the lowest values regarding the range of motion, but he was pain free, with a stable shoulder.

Radiographic assessment demonstrated radiolucency with possible loosening of the implant for the patient with delayed infection, but at that time the patient was pain free and could perform strenuous activities. Radiolucency was not observed in any other patient. With respect to healing of the tuberosities, there was in one patient obvious moderate displacement and malunion of the greater tuberosity. For this patient the shoulder was painful with daily activities and there was some restriction of the active range of motion, as well.

Table III. – Mean Constant-Murley score in 3 patient groups, according to the technique used to achieve proper posterior version of the prosthesis

| Technique | No of patients | Mean Constant score % |
|---|---|---|
| 1. lateral fin of the prosthesis just behind the posterior edge of the bicipital groove | 10 | 70 |
| 2. lateral fin of the prosthesis 5 mm behind the posterior edge of the bicipital groove | 8 | 70.6 |
| 3. Individualised approach | 8 | 71.2 |

## DISCUSSION

The rate of avascular necrosis of the humeral head after 3- or 4- part fractures ranges between 12-25% and 41-59% respectively *(10)*. This results in loss of the rounded shape of the humeral head and inevitable arthritis of the shoulder with associated pain and limitation of function *(4,11,14)*. Failure of conservative treatment, resection arthroplasty or ORIF to relieve the patients' symptoms and to improve function, made prosthetic replacement of the upper humerus a good alternative *(2,14)*.

The results of shoulder hemiarthroplasty for fractures are very good according to several authors *(6,12,14)*. The Neer II humeral prosthesis has been used in the majority of cases but the use of other prostheses has resulted in similar outcomes *(6,7, 12)*. However, several authors reported less predictable results after shoulder hemiarthroplasty for fractures or better results after conservative treatment *(19,20)*. Despite the fact that there is satisfactory pain relief, the range of motion is unpredictable after hemiarthroplasty, particularly in elderly patients *(17)*. In our series the pain relief as well as the range of motion after this treatment was very satisfactory.

Special consideration was given to the surgical technique. The aim was anatomical implantation of the prosthesis and the use of an anatomical prosthesis, as well. For this reason, we changed the first generation prosthesis (Cofield) that was used, to a second generation (Global) and finally to a third generation prosthesis (Aequalis), trying to reproduce the individual bony anatomy. In an effort to implant the prosthesis with the optimal retroversion, three different techniques were used, based on advances reported in the literature *(3,9,14)*. Even though our sample was small, and we could not have powerful statistics for these three groups of patients, no significant difference could be observed between the three groups (table III). This

observation possibly reflects the fact that the shoulder joint can tolerate small deviations from the optimal retroversion and only major deviations could affect the clinical outcome.

A very important factor, which influences the functional results of patients with shoulder hemiarthroplasty, is the rehabilitation program. Passive mobilisation of the shoulder during the first 6 weeks post-operatively is very important for the outcome, and crucial for the achievement of a good range of movements. A proper long-term rehabilitation program, after this period, is also very important in order to restore the range of active motion and the strength of the shoulder. The patients in our series achieved their maximum clinical result during the first 6 months after the operation. We believe that the duration of the rehabilitation program should be at least 6 months, because these first 6 months are very important for the final outcome.

In our series, the cinical outcome as measured using the Constant-Murley scale was very satisfactory. We attribute this to the appropriate surgical technique that was used. Our final results could be improved with a better rehabilitation program. We believe that shoulder hemiarthroplasty is a predictable, established and worthwhile procedure.

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