



## Outcome of cemented Neer II hemiarthroplasty in displaced humeral head fractures

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The functional and radiological outcome of cemented Neer II hemiarthroplasty performed within six weeks after a fracture-dislocation or a three/four-part humeral head fracture was evaluated in 48 patients with an average age of 73 years (range : 45 to 89), with an average follow-up period of 44 months (range : 6 to 106).

Thirty-two (67%) patients were satisfied or very satisfied. Twenty-nine (61%) patients had no or mild pain, 17 (35%) had moderate pain and two (4%) had severe pain. Constant Score averaged 49 (range : 8 to 71) compared to 78 (range : 40 to 100) for the non-operated shoulder ( $p < 0.001$ ). The 26 (57%) patients with abnormal radiographs (malpositioning or loosening of the prosthesis, non-union of tuberosities, heterotopic ossification, and/or glenoid erosion) had a significantly lower Constant Score (45 [range : 8 to 69] versus 55 [range : 31 to 71],  $p = 0.013$ ).

The functional outcome is disappointing and related to the radiographic status. The patients however seem to be satisfied despite a rather stiff shoulder and in our opinion a non-acceptable pain relief.

**Keywords :** proximal humerus ; fracture ; fracture-dislocation ; hemiarthroplasty ; Constant score.

### INTRODUCTION

Humeral head fractures remain a therapeutic challenge. Since Neer (14) reported his excellent results with prosthetic replacement, this treatment has gained wide acceptance for severely displaced three- and four-part fractures. While several later

studies have reported satisfactory results (5,7-9,16,17), more recent studies have reported disappointing results using cemented hemiarthroplasties (1,2,10-12,15,18,22).

The purpose of this follow-up study was to evaluate the functional and radiographic outcome as well as satisfaction in patients undergoing surgery with a cemented Neer II hemiarthroplasty for treatment of a fracture-dislocation or a three- or four-part fracture of the proximal humerus. As this has been the guideline treatment in our department since 1994, we had hypothesised that the patients were satisfied, although the radiographs and functional outcome appeared to be disappointing.

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## MATERIALS AND METHODS

Between January 1994 and December 2004 a total of 2255 patients with proximal humeral fractures were treated in our department either conservatively or operatively. The inclusion criteria for this follow-up study were patients treated within 6 weeks after trauma with a cemented Neer II hemiarthroplasty for displaced three- or four-part fractures, fracture-dislocations or head-splitting fractures according to Neer's classification (13). During this period 98 patients were treated (82 females and 16 males, median age 76 years [range : 45 to 89]). Time from fracture to surgery was a median of 8 days (range : 0 to 41).

As 32 patients died during the observation period, 11 declined to participate in the follow-up examination and 7 were lost to follow-up, 48 patients (41 females and 7 males, average age 73 years [range : 45 to 89]) were available for clinical and radiological evaluation.

The average follow-up period was 44 months (range : 6 to 106). The dominant side was affected in 27 (56%) patients. No patients had surgery performed on their shoulder prior to insertion of the prosthesis. According to Neer's classification 20 (42%) had a four part-fracture, 17 (35%) had a three-part fracture and 11 (23%) had a fracture-dislocation. Time from fracture to surgery was a median of 10 days (range : 0 to 37) with 4 patients having more than 28 days to surgery.

### Surgical technique

All patients were operated on under general anaesthesia. Antibiotics were administered routinely as a single dose cefuroxim 1, 5 g i.v pre-operatively. Senior surgeons performed all operations.

The operation was performed through an anterior deltopectoral approach with mobilisation of the tuberosities, removal of the humeral head, insertion of a cemented monoblock Neer II humeral prosthesis and reattachment of the tuberosities to the prosthesis with heavy 5-0 non-absorbable sutures. The prosthesis was secured with methylmethacrylate bone cement in 20-30° retroversion at the correct anatomical height with the intention of restoring appropriate tension of the rotator cuff and deltoid muscles.

Postoperatively the patients wore a shoulder sling for one week. Pendulum and passive range-of-motion exercises of the shoulder were initiated on day one. Active assisted range-of-motion exercises were initiated after two weeks, with restriction of abduction and external rotation for the first 6 weeks, based on range of motion

measured intra-operatively. All patients followed a rehabilitation programme instructed by a physiotherapist for two to six months.

### Clinical evaluation

At follow-up, clinical evaluation was performed using the Constant Score (6) evaluating pain (15 points), activities of daily living (ADL) (20 points), range of motion (ROM) (40 points) and power (25 points). Pain was measured using a visual analogue score (0-15), ADLs were assessed by a combination of questions and specific movements of the shoulder. ROM was measured with a goniometer with the patients standing and performing maximal forward flexion, abduction, external and internal rotation ; strength was measured with a spring balance dynamometer.

At follow-up patients were also asked about their personal overall satisfaction with the result after shoulder surgery according to a five level grading. The pain during motion was measured using the visual analogue scale (VAS) (0-100 mm). All patients were interviewed concerning their social level before surgery and the first year after surgery (level 1 : employment, 2 : unemployment, 3 : sick-leave due to the fracture, 4 : retired, 5 : need for additional help from public or private health care services in ADLs, and 6 : resident in a rest home).

### Radiographic evaluation

Radiographic evaluation was based on anterior-posterior (AP) and lateral radiographs taken at follow-up. Two patients were excluded from the radiographic evaluation as one refused to have radiographs performed, and the other had had a re-operation with a different type of shoulder prosthesis. Three orthopaedic senior registrars evaluated the radiological status of the remaining 46 patients in a blinded fashion, without knowledge of the patients' Constant Score.

The radiological evaluation focused on 1) loosening of the prosthesis, graded as mild (involving less than 25% of the bone-cement interface), moderate (25 to 50%), severe (more than 50%) and gross instability with a radiolucent line of 2 mm or more over the whole interface, 2) non-union of the tuberosities, 3) heterotopic ossification, 4) glenoid erosion and 5) prosthetic height in relation to acromion.

Radiographs were defined as abnormal if one or more signs were present : radiographic loosening, non-union of the tuberosities, heterotopic ossification, glenoid erosion, the centre of the prosthetic head not located in the



**Fig. 1.** — An acceptable radiograph of the prosthesis at follow-up.



**Fig. 2.** — Abnormal radiograph showing periarticular ossification.

middle third of the glenoid cavity, or/and an acromion-prosthesis distance of 5 mm or less (figs 1 to 3).

### Statistical Analysis

Mann Whitney test and paired t-test were used for analysis. The level of significance was set at  $p < 0.05$ . All calculations were performed with use of SPSS 13.0 statistical software (Chicago, Illinois).

### RESULTS

As seen in table I, the clinical outcomes, based on Constant's Score, forward flexion, abduction and external rotation – are significantly lower for the operated shoulder compared to the non-affected shoulder. The pain measurement, which is part of the Constant Score (pain 0 to 15), showed that 8 (17%) patients had no pain (score = 15), 21 (44%) had mild pain (score from 10 to 14), 17 (35%) had moderate pain (score from 5 to 9), and 2 (4%) had

severe pain (score from 0 to 4). The patients scored a mean of 31 (range : 0 to 100) on the VAS-scale for pain in motion and a mean of 46 (range : 0-100) for pain when performing maximum range of motion of the operated shoulder.

Postoperatively, 29 patients (60%) returned to their pre-hospitalisation social level. The remaining 19 patients (40%) were postoperatively at a lower social level, as two were still not able to return to work after one year and 17 patients that were preoperatively retired needed additional help from public or private health care services for ADLs.

At follow-up patients were asked about their personal satisfaction with the result after shoulder surgery. Thirteen (27%) were very satisfied, 19 (40%) satisfied, 11 (23%) neither satisfied nor dissatisfied, 3 (6%) dissatisfied, 2 (4%) very dissatisfied. The 32 very satisfied or satisfied patients (67%) had a significantly higher Constant Score with an average of 53 (range : 29 to 71) versus 42



**Fig. 3.** — Abnormal radiograph showing non-union and migration of the tuberosities.

for the non-satisfied patients (range : 8 to 57),  $p = 0.003$ . No correlation was found between time from fracture to surgery and Constant Score.

### Radiographic evaluation

Six prostheses (13%) showed radiographic loosening, three patients with moderate and three patients

with severe radiographic loosening. Non-union of the tuberosities was found in six (13%) patients, heterotopic ossification in nine (20%) patients and glenoid erosion in three (7%) patients. The average distance from the acromion to the prosthesis was 10 mm (range : 0 to 23) with seven (15%) patients having a distance of 5 mm or less. Thirty-two prostheses (70%) were found having the centre of the prosthetic head located in the middle third of the glenoid cavity in AP radiographs. The others were all placed higher than the middle third except for one which was placed lower than the middle third of the glenoid cavity. A total of 26 (57%) patients had abnormal radiographs. These patients were found having a significantly lower Constant Score compared to patients having non-abnormal radiographs (average : 45 [range : 8 to 69] versus average 55 [range : 31 to 71]  $p = 0.013$ ).

### Complications

Complications were noted in five patients, an overall complication rate of 10%. Two patients had minor neurological complications (one had neurapraxia of the ulnar nerve and one neurapraxia of the axillary nerve) and fully recovered without any changes in the post-operative treatment. One patient had a superficial wound infection successfully treated with antibiotics. Two patients underwent re-operations. One patient had persistent pain and impaired movement of the shoulder and had a surgical removal of a loose greater tuberosity, which was necrotic, and re-insertion of a loose minor tuberosity five weeks after primary surgery. One patient had a replacement of the prosthesis due to clinical and radiological signs of loosening 13 months after primary surgery.

Table I. — Clinical outcome at follow-up for the 48 patients treated with a cemented Neer II hemiarthroplasty

	Operated shoulder	Non-operated shoulder	
Constant Score	49 (range : 8 to 71)	78 (range : 40 to 100)	$p < 0.001$
Forward flexion	78° (range : 28 to 155)	163° (range : 70 to 180)	$p < 0.001$
Abduction	68° (range : 25 to 130)	158° (range : 50 to 180)	$p < 0.001$
External rotation	19° (range : -25 to 60)	55° (range : 0 to 90)	$p < 0.001$

Numbers are presented as average (range).

## DISCUSSION

Pain relief and acceptable range of motion are mandatory for the successful outcome following shoulder arthroplasty for displaced three- and four-part fractures. We found a significantly lower ROM on the operated side ; 39% of patients had moderate to severe pain, especially in motion, resulting in a significantly lower Constant Score on the operated side. Other studies have suggested a correlation between a low Constant Score and radiographic findings ; in our study this correlation was also found despite the relatively small number of patients.

Several studies have shown satisfactory relief of pain (3,9-11,14,15,17,18). We found that 39% of our patients at follow-up had moderate to severe pain according to the Constant Score, which is more than reported in other studies. This could be due to the fact that pain has been defined and measured in various ways in the different studies. As the Constant score does not explicit pain, we also evaluated pain in motion and in maximum range of motion. Not surprisingly, the pain was even worse under such conditions. In our opinion, pain should be measured at rest, during motion and at the maximum range of motion when describing these patients.

Several studies have also shown better ROM and therefore also a better Constant Score than we have been able to document (1,2,4,7,22). As higher age has been related to a lower Constant Score, the poor results could be explained by our patients having a higher average age compared to other studies (2,3,7,15). Although many of the patients are elderly, we found that those 17 patients that were preoperatively retired, now needed additional help for ADLs. In spite of this and despite the low average Constant Score, 67% of the patients were satisfied or very satisfied with the result. Not surprisingly, the satisfied patients had a significantly higher Constant Score than the others. Contrary to other studies (3,8,17), we found no correlation between time to surgery and a low Constant Score. As in other studies we also noted a 10% complication rate, with two patients (4%) needing re-operation due to serious complications.

In contrast to other studies, abnormal radiographs significantly influenced the clinical results negatively in our study. This observation emphasises the importance of appropriate operating technique. This includes secure fixation of the tuberosities to the prosthesis and the metaphysis of the humerus. Particularly in older patients with osteoporosis, healing of the soft bone in the shoulder is unpredictable and consequently poor outcome of prosthetic replacement may be expected. The prosthesis should also be secured at the correct anatomical height to restore appropriate tension of the rotator cuff and deltoid muscle, so that the prosthesis in time ends in the correct position relative to the glenoid cavity. As hemiarthroplasty is a technically demanding procedure, one could also consider conservative treatment. Recent reports with a low number of patients have suggested that this is an acceptable alternative in elderly individuals (19-21). However no randomised studies are available so far.

The functional outcome after a cemented Neer II prosthesis for a humeral head fracture is all in all disappointing and is related to the radiographic status. The patients however seemed to be satisfied with the results even though many had a rather stiff shoulder and in our opinion a non-acceptable pain relief.

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