

Significance of Radiological Quality of Surgical Reduction on the Clinical Outcome of Intra-articular Fractures of the Distal Humerus

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SUMMARY

Background. To study the effect of radiological quality of surgical reduction on the clinical outcome of the intra-articular fractures of the distal humerus.

Material and methods. Ninety seven intra-articular fractures of distal humerus were treated at our department by open reduction and internal fixation, using a trans-olecranon approach. Patients were assessed as per the scoring system of Caja and Moorani et al. At final follow-up, radiological and clinical parameters were evaluated to assess the effect of quality of surgical reduction on the clinical outcome of the patient.

Results. The mean radiological score was 15 points. Patients whose radiological score was 20 had excellent clinical result. Fractures which failed in one criteria, radiological score 15, had good to excellent clinical result. Fractures which failed in two criteria (score 10) failed to show any excellent clinical result. Correlation between radiological and clinical scores was statistically significant ($p = 0.0000$).

Conclusions. 1. Radiological quality of surgical reduction directly affects the clinical outcome of intra-articular fractures of the distal humerus. 2. The relative importance of each individual criterion is unknown at present. 3. Failure to meet two or more criteria decreases the result to fair or poor, with exceptions of a good result. 4. Further research is needed to evaluate the importance of each individual criterion on the ultimate clinical outcome.

Key words: fractures, distal humerus, clinical outcome

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BACKGROUND

Intra-articular fractures of the distal end of the humerus are relatively rare and constitute about 2% of all fractures [1]. These fractures are a treatment challenge to the point of being intimidating and frustrating to the operating surgeon [2,3]. When these fractures extend into the elbow joint, there is significant risk of residual pain and functional impairment [4,5]. The recommendations for the treatment range from essentially no treatment to open reduction and extensive internal fixation [6,7]. The conservative treatment has largely been given up because of unsatisfactory results [1,4,6,7]. With the improvement in surgical skills and implants, the outcome of these fractures continues to improve [7].

The lack of a widely accepted scoring system makes study of these difficult fractures even more difficult [8]. A large number of scoring systems have been proposed for the post-operative evaluation of these fractures mostly related to the post-operative range of motion [3,9], or to the post-operative clinical state and elbow range of motion [1,10,11]. Only few authors considered quality of surgical reduction [6,9]. However, there was no attempt to quantify it. A quantitative scoring system was devised by Caja and Morani et al [2]. It is a 100 point scoring system and considers clinical (70 points), radiological (20 points) and functional parameters (10 points).

The aim of the present study was to evaluate the effect of radiological quality of surgical reduction on the clinical outcome of intra-articular fractures of the distal end of humerus using the scoring system of Caja and Morani et al [2]

MATERIAL AND METHODS

From January 2002 to May 2007, 97 patients with intra-articular fractures of the distal humerus were

treated at our department, by open reduction and internal fixation, using a trans-olecranon approach. There were 41 (42%) male and 56 (58%) female patients; mean age was 53 years, ranging from 17 to 90 years. Mode of injury was falls in 53 (54%), road traffic accidents in 29 (30%) and direct hit in 15 (16%) patients. The fractures were classified as per AO classification into C1, C2 and C3 types. There were 40 type C1, 36 type C2 and 21 type C3 fractures. 62 (63.9%) fractures affected the right side and 35 (36.1%) affected the left side. 16 fractures were type 1 compound.

AP and lateral pre-operative radiographs including traction films to delineate fracture anatomy were taken (Fig 1A and B) and thoroughly analyzed and operative plan framed. All patients were operated within 5 days of admission using AO technique. Post-operatively elbow was immobilized in a crammer wire splint. Range of motion exercises were started from the first post-operative day. The splint was removed for the day and was re-applied at night, till wound healed and sutures were removed, when splintage was discarded.

Patients were followed weekly for one month, bi-weekly for 3 months, then monthly for a maximum period of 48 months (average 28 months). Postoperative radiographs were compared and assessed for adequacy and quality of surgical reduction (Fig 2A & B). The parameters noted included (Table 1) dimensions of any articular surface step, articular surface diastases, narrowing of distal humeral articular surface, malalignment of AP carrying angle and trochlea-capitellum angle, any para-articular calcification (Fig 3A & B), loosening of implant and progression of union. Range of motion, pain, functional status of patient and complications if any were noted. Final assessment was done at the end of 6 months



Fig. 1A, 1B. AP and Lateral Radiograph of type C2 fracture



Fig. 2A, 2B. Post-operative AP and lateral views showing adequate reduction no step, diastasis of articular surface and maintained anterior articular angulation and carrying angle



Fig. 3A, 3B. AP and lateral radiographs at 6 months post operatively showing united fracture . Fig 3B shows para-articular calcification

using scoring system of Caja and Morani et al. 1994 [2]. It is a 100 point scoring system and considers four parameters: pain (40 points), range of motion (30 points), level of activity compared to activity prior to injury (10 points) and radiological quality of surgical reduction (20 points). The quality of surgical reduction and clinical and functional outcome of each patient was compared to assess the effect of surgical reduction on the clinical and functional outcome of the patient.

STATISTICAL ANALYSIS

Data was described as mean \pm SD and percentages. All clinical and radiological parameters were

analyzed and the results were obtained by Mann-Whitney U test, chi-square test and odds ratio analysis. Statistical significance was met at 95% confidence interval.

RESULTS

Except for nonunion of one fracture at supra-condylar region, all the fractures united in the average of 12 weeks (range 8 to 20 weeks). The mean radiological score was 15 points (± 3.06 SD), range 0-20 points (Table 2). The most frequent criterion which was not met was an articular surface step less than 1 mm in 37 (38%) fractures. Second most difficult criterion to ascertain in our series was to maintain ante-

Tab. 1. Unaccomplished radiological criteria

Correlation between Total Score and Radiological Score						
C-Total Score	Radiological Score				Total	Result
	<= 5	10	15	20		
Poor <50	n	3	3	0	0	6
	%	50.0	50.0	0.0	0.0	6.2
Fair 50-65	n	0	8	10	0	18
	%	0.0	44.4	55.6	0.0	18.6
Good 70-85	n	0	7	34	0	41
	%	0.0	17.1	82.9	0.0	42.3
Excellent 90-100	n	0	0	4	28	32
	%	0.0	0.0	12.5	87.5	33.0
Total	n	3	18	48	28	97
	%	3.1	18.6	49.5	28.9	100.0

$\chi^2 = 139.24$ $p = 0.000$ (Sig)

Tab. 2. Comparison of total and radiological score

Radiological parameter	No. of patients
Articular surface step more than 1 mm	37
Articular surface diastases more than 1 mm	6
Articular surface reduction more than 1 mm	-
Anterior trochlea-capitellum angle malalignment more than 10°	34
AP carrying angle malalignment more than 10°	11
Non-union	1
Para-articular calcification more than 10mm	29

rior trochlea-capitellum angle; malalignment of more than 100 was seen in 34 (35%) cases. Para-articular calcification of more than 10mm developed in 29 (30%) cases, articular surface diastases of more than 1mm and malalignment of AP carrying angle of more than 100 was observed in 6 (6%) and 11 (11.5%) cases, respectively (Table 1). Pain was absent in 70 (72%) patients, mild and occasional in 16 (16.5%) patients, mostly weather related. Pain related to activities of daily living was observed in 11 (11.5%) patients. Rest pain was a symptom in 6 (6%) patients. Range of motion was full in 34 (35%) patients, more than functional range in 46 (47%) patients and less than functional range in 17 (18%) patients. (Morrey,s functional range of motion 30 to 130 of flexion and 50 of pronation and supination each)(14). 86 (88.5%)

patients had activity level as prior to injury; it was diminished in 8 (8.5%) and restricted in 3(3%).

All the three patients who had radiological score <= 5, had total score less than 50 and were graded as poor. Among the 18 patients with the radiological score of 10 points, 3 (16.7%) were graded as poor, 8 (44.4%) fair and 7 (38.9%) as good no one was excellent. In the 48 patients with the radiological score of 15 points, 20.8% were graded as fair, 70.8% as good and 8.3% as excellent and no one as poor. All the 28 patients with the radiological score of 20 points were graded as excellent.

Severity of the fracture affected the radiological, functional and total score. Patients with a higher radiological score had higher functional outcome.

DISCUSSION

Intra-articular fractures of the distal humerus are difficult to treat because of the nature of injury and intricate anatomy of the region [3,7,8]. The recommendations for treatment range widely from essentially no treatment to open reduction and extensive internal fixation [5,6,12]. The aim of operative treatment of intra-articular fractures of distal humerus is anatomic reduction, rigid fixation to allow early range of motion and finally to restore the pre-fracture function [6]. The anatomic reduction of articular fragments is made difficult by poor visualization because of the extensor mechanism and the intact olecranon process which is hooked over the trochlea. Direct visualization of the fracture is enhanced by mobilizing the extensor mechanism, which is further enhanced by osteotomising the olecranon process, as has been demonstrated in cadaveric experiments [11].

The quality of elbow function after the fracture of the distal humerus has been related to the degree to which the normal anatomic relations are restored [2, 3,7,10,12]. The elbow mobility is hindered by the loss of the normal anterior tilt of the distal humeral articular surface, narrowing or distraction of the distal articular surface or by obstruction of the coronoid and the olecranon fossae. Pain has been related to the failure of the fracture to unite, restricted motion, ulnohumeral arthrosis or instability and compression of the ulnar nerve [1,7,10].

Studies of the outcome of these difficult fractures are made even more difficult because of the relative rarity; substantial variability among different case series in terms of type of fracture included, operative techniques, type of the implants used and the method of rating the results. The lack of a universally accepted scoring system further compounds the problem [1, 2,10,13]. A large number of scoring systems have been proposed by the numerous authors based either on the post-operative range of motion of the elbow [1,2,4,5,10] or on the post-operative range of motion, pain and disability [1,3,4,8]. Few authors considered the quality of the surgical reduction as one of the criteria in evaluation of the results of these difficult fractures [6,9]; however, there was no attempt to quantify them. Caja and Morani developed a comprehensive 100 point scoring system with an attempt to quantitate the quality of the surgical reduction and the functional outcome of the patients. The aim of the present study was to assess the effect of the quality of the surgical reduction on the clinical outcome of these fractures using the evaluation criteria of Caja and Morani [2].

The radiological parameter which was most difficult to achieve, in our study, was to maintain an articular surface step less than 1mm, 37 fractures had an articular step more than 1mm. Out of these 37 fractures 11 had associated malalignment of anterior angulation of the distal humeral articular surface by more than 100, and six had para-articular calcification of more than 10mm. All these fractures which failed in more than one criterion were type C3 and all had limitation of range of motion, with 7 patients having range of motion less than functional range. 10 patients had pain with heavy activities. In 19 fractures with an isolated articular surface step more than 1mm, no patient had any range of motion loss, no one had pain and all had activity as prior to injury.

Among 9 patients with an isolated malalignment of anterior angulation of the distal humeral articular surface, none had full range of motion and 7 had pain with activity. Twenty-nine patients had para-articular calcification more than 10 mm. None of them had full range of motion. Out of the 20 patients who, in addition to para-articular calcification of more than 10mm, had either one or more of these radiological parameters associated viz. articular step more 1 mm, articular surface diastases more than 1 mm, anterior articular angulation malalignment more than 100 and or carrying angle malalignment more than 100, only 2 had range of motion more than functional range and all had pain. Seven patients who had more than two other unmet criteria (except for malalignment of anterior angulation and a para-articular calcification of more than 10mm), had pain even with activities of daily living, range of motion was less than functional range in all and 5 had restriction of activity.

In this study, all patients whose radiological score was 20 had an excellent result. All fractures which failed in one criteria, radiological score 15, had a good to excellent result (total score 75-100). Fractures which failed in two or more criteria, score 5-10, failed to show any excellent clinical result. Only 7 fractures with radiological score of 10 showed a good result. No patient with radiological score of less than 10 had a good result (Table 2). A similar observation was made by Caja and Morani et al [2] in their study two patients with a radiological score of 0 had a total score less than 50 and were graded as poor. Only two patients who had a radiological score of 10 had a good result. All patients whose radiological score was 20 had a good or excellent clinical result. However the observations are contrary to many authors who stated that the radiological score does not always parallel the clinical outcome [5,6].

CONCLUSIONS

1. Radiological quality of surgical reduction directly affects the clinical outcome of intra-articular fractures of the distal humerus.
2. The relative importance of each individual criterion is unknown at present.
3. Failure to meet two or more criteria decreases the result to fair or poor, with exceptions of a good result.
4. Further research is needed to evaluate the importance of each individual criterion on the ultimate clinical outcome.

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