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Original Article

A Study of Surgical Management of Distal Humerus Fractures

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Abstract

Introduction: Distal humeral fractures are uncommon injuries that account for fewer than 2% of all adult fractures. The complex shape of the elbow joint, the adjacent neurovascular architecture, and the sparse soft tissue envelope combine to make these fractures difficult to treat. The quality of elbow function following intercondylar fractures of humerus is related to the degree to which normal anatomical relationship are restored.

Purpose: The purpose of this study was to determine the functional outcome of various surgical methods of distal humeral fractures in adults.

Materials and Methods: This study consists of 36 patients with fracture of distal humerus treated by open reduction/close reduction and internal fixation with K-wires, reconstruction plate, and cannulated cancellous screws. Postoperatively, patients were reviewed every 2 weeks for the first 2 months and monthly for the next 2 months, then every 2 months until fracture healing or full range of motion was regained. Postoperatively elbow function was evaluated using physician-based elbow scoring systems using Mayo Elbow Performance Index (MEPI).

Results: In this study, significant difference was found between gender and mode of injury, including road traffic accident (RTA) and falls (P = 0.003) with most cases occurring because of RTA. A significant difference existed in the mean duration of union for implants used (P = 0.048). K wire + recon plate + cancellous screw gave the highest MEPI mean score of 94.86 ± 33.39. However, the K wire group showed the least mean MEPI score of 61.36 ± 22.03. A significant association was observed between implants used and the outcome (P = 0.038).

Conclusion: Reconstruction plate alone or a combination of reconstruction plates and cannulated cancellous screws offers excellent results in the distal humeral fracture in adults and can be considered as the first-line of management.

Key words: Fracture, Humerus, Mayo elbow performance index, Open reduction

INTRODUCTION

We live in a society with a growing elderly population and a young population in which extreme sports and high-speed motor transportation are popular; therefore, the incidence of distal humeral fractures is likely to increase. In young adults, most distal humerus fractures occur from high-energy trauma, sideswipe injuries, motor vehicle accidents, falls from height, and gunshot wounds. In elderly persons with more osteoporotic bone, most of these injuries occur from falls.

Distal humeral fractures are uncommon injuries that account for fewer than 2% of all adult fractures. The complex shape of the elbow joint, the adjacent neurovascular architecture, and the sparse soft tissue envelope combine to make these fractures difficult to treat. So the complex nature of the unstable distal humeral fracture has promoted a global interest in more precise treatment for this diverse group of injuries. Acceptable results have been reported in most patients treated by open reduction and internal fixation.[1] The only reliable method for restoring the normal alignment and contour of distal humerus is operative exposure and direct manipulation of fractures and fragments. Surgical treatment for these fractures has evolved significantly in the last 30 years. In the 1960's and 1970's, most surgeons

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condemned surgical treatment due to high failure rates with loss of fixation, non-union, and elbow stiffness.[2] In the 1970s, treatment began to shift from casting and the "bag of bones" technique to surgical intervention with limited internal fixation. Again, results generally were poor due to a lack of adequate stabilization for early motion.

In the early 1980s, the AO-ASIF group reported good and excellent results in 27 of 39 patients with communited fractures of the distal humerus.[3] These were the best results reported in the treatment of these difficult fractures at that time. This led to increased enthusiasm for surgical reduction and fixation. A surgeon treating a healthy active patient with a fracture distal humerus should make every attempt to reconstruct and preserve the distal humerus. The quality of elbow function following intercondylar fractures of humerus is related to the degree to which normal anatomical relationship are restored. Residual elbow stiffness remains the worst complication of intercondylar fractures as it is poorly tolerated because of a lack of compensatory motions in adjacent joints.

Hence, improved understanding of the complex pathoanatomy of unstable distal humerus fractures in adults has prompted a global interest in more precise treatment for this diverse group of injuries. Surgeons who treat fracture of the distal humerus frequently have realized the challenges that arise relate to poor bony quality, distal separation of the articular fragment from the columns of the distal humerus, and fragmentation of the articular surface in one or more planes. Varying patterns of distal humeral fractures are common in adults. Malunion is also common. Even minor irregularities of the joint surface of the elbow usually cause some loss of function. The purpose of this study was to determine the functional outcome of various surgical methods of distal humeral fractures in adults.

MATERIALS AND METHODS

This study was conducted among 36 patients with fracture of distal humerus, treated by open reduction/close reduction and internal fixation with K-wires, reconstruction plate, and cannulated cancellous screws between April 2015 and August 2016 after obtaining the clearance from ethical committee at Vinayaka Missions Kirupananda Variyar Medical College Hospital, Salem. Out of all the above, 21 treated by open reduction and internal fixation with reconstruction plates (3.5 mm), cancellous screws, K-wires, and 9 patients were treated by closed reduction and internal fixation with K wires.

Most of the patients presented to hospital within 24 h of injury of distal humerus. Only 7 patients presented within a week after sustaining the injury. About 90% of the patients presented with injured forearm supported with hand, while 10% patients came with their injured limb immobilized with plaster of Paris slab. On admission of the patient, careful history was elicited from the patient or attendants to reveal the mechanism of injury. The patients were examined clinically for signs of fracture displacements, deformity, neurovascular status associated injuries, and for vital signs.

According to the AO classification, 14 patients belong to Type A, 7 patients Type B, and 14 patients Type C (5 Type C1, 6 Type C2, and 3 Type C3).[4] After thorough clinical evaluation X-ray of the affected forearm was taken in both anteroposterior and lateral view, including shoulder and elbow joints. The limb was immobilized in the above elbow slab with positioning the forearm in supination or mid prone according to the site of fracture with sling. The surgery was done and post-operative care given.

The patient comes for follow-up on 14th post-operative day. The sutures were removed. In patients with rigid fixation, active gentle motion of involved limb several times a day in concurrence with the pain was advised. All patients had to demonstrate >40° of range of motions within a month. He can be subjected for active physiotherapy after 1 month and full activity after 3 months. Full activity was allowed at 3–4 months as fracture consolidation occurred. Postoperatively, patients were reviewed every 2 weeks for the first 2 months and monthly for the next 2 months, then every 2 months until fracture healing or full range of motion was regained.

Postoperatively, elbow function was evaluated using physician-based elbow scoring systems using Mayo Elbow Performance Index (MEPI).[5]

The data were collected in Microsoft Excel and analyzed using SPSS version 16. All study variables were analyzed using descriptive statistical methods such as frequencies and percentages for categorical variables and mean with standard deviation for continuous variables. The various factors and their relation were studied using Chi-square tests and Fischer's exact test to find associations. Analysis of variance (ANOVA) was used to find the significant difference between mean values of multiple variables under study. P <0.05 was considered significant.

RESULTS

The distribution of age of the study population is from 18 to 70 years. Out of the 36 patients, 16 patients (44.0%)

were between the age group of 18–30 years, eleven patients (31.0%) between 30 and 50 years, and 9 patients (25.0%) between 50 and 70 years. A significant difference existed between the mean age of males and females (t = 4.09; P = 0.001). Female patients were found to have significantly higher age (mean =51.91 years) compared to males (mean =31.40 years). Maximum cases were recorded in the age group of below 30 years (44%) and least was in the age group below 70 years.

The pattern of distribution of cases of male and female patients in different modes of injury was statistically different, where male patients had more of road traffic accidents (RTA) while female patients had more of falls. When gender and mode of injury were considered, a significant Chi-square (Chi-square =8.96; P = 0.003) value was observed, revealing that frequencies of mode of injury differed significantly with gender. Maximum cases were reported in RTA, followed by fall.

Equal number of injuries was reported in both right (18) and left side (18). A non-significant association was observed between age group and mode of injury (P = 0.301), indicating that the pattern of injury in different age groups is statistically the same. Table 1 shows the distribution of the samples by type of fracture.

A non-significant association was observed between sex and type of fractures (Chi-square =5.88; P = 0.208), as well as between type of fracture and associated injuries (Chi-square =13; P = 0.369). There was no significant association between type of implant used and age groups (Chi-square =12.64; P = 0.396) and between type of implant used and gender (Chi-square =2.80; P = 0.834). Table 2 shows the distribution of the sample by the side of injury and the implant used.

A significant difference existed in the mean duration of union for implants used (Chi-square=2.41, P = 0.048) [Table 3]. K-wire + Recon plate with cancellous screws and Recon plate (10 weeks) alone had taken least duration for union while Recon plate + cancellous screw + Tension Band Wiring (TBW) had maximum duration (30 weeks).

Table 4 shows mean flexion-extension, flexion contracture, supination and pronation, and MEPI. The flexion-extension arc had a mean value of 94.86 ± 33.39. The MEPI had a mean value of 72.64 ± 21.46.

A non-significant difference was found in the mean flexion extension values of different implants used as ANOVA value revealed a non-significant value of 1.498 with P = 0.214. Flexion contracture showed a non-significant result in different implants used as ANOVA revealed a non-significant value (ANOVA =0.901; P = 0.508). Similarly, pronation (ANOVA =0.764; P = 0.604) and

Table 1: Distribution of sample by type of fracture

Fracture type	Frequency	Percent
Supracondylar	13	36.1
Supracondylar with intercondylar	10	27.8
Lateral condyle	4	11.1
Intercondylar	7	19.4
Medial condyle	2	5.6
Total	36	100.0

Table 2: Distribution of the sample by the side of injury with implant used

Implants used	Left (%)	Right (%)	Fischer's Exact value	*P*-value
K-wire+recon plate+cancellous screw	0 (0.0)	1 (100.0)	11.02	0.888
K-wire+cancellous screw fixation	2 (20.0)	8 (80.0)		
K-wire	7 (64.0)	4 (36.0)		
Recon plate	1 (50.0)	1 (50.0)		
Recon plate+cancellous screw	8 (80.0)	2 (20.0)		
Recon plate+cancellous screw+TBW	0 (0.0)	1 (100.0)		
Recon plate+K-wire	0 (0.0)	1 (100.0)		
Total	18 (50.0)	18 (50.0)		

TBW: Tension band wiring

Table 3: Mean duration of union with different implants

Implants used	*n*	Union in weeks			ANOVA	*P*-value
		Mean	SD	Std. Error		
K-wire+recon plate+cancellous screw	1	10.00	–	–	2.41	0.048*
K-wire+cancellous screw fixation	10	14.50	8.29	2.62		
K-wire	11	11.82	2.99	0.90		
Recon plate	2	10.00	0.00	0.00		
Recon plate+cancellous screw	10	12.10	1.52	0.48		
Recon plate+cancellous screw+TBW	1	30.00	–	–		
Recon plate+K wire	1	12.00	–	–		

TBW: Tension band wiring

Table 4: Descriptive statistics for the flexion-extension, flexion contracture, supination, pronation, and MEPI

Parameters	Minimum	Maximum	Mean	SD
Flexion extension arc	35	140	94.86	33.39
Flexion contracture	5	60	26.39	16.93
Supination	5	71	56.69	20.02
Pronation	5	84	66.53	23.96
MEPI	35	95	72.64	21.46

MEPI: Mayo elbow performance index

supination (ANOVA =0.780; $P = 0.592$) showed a non-significant result in different implants used.

MEPI values of different implants used showed a non-significant result (ANOVA =1.119; $P = 0.376$). Comparatively, K-wire + recon plate + cancellous screw gave the highest MEPI mean score of 95. However, the K-wire group showed the least mean MEPI score of 61.36 ± 22.03. K-wire had maximum stiffness of 55% and patients treated with recon plate alone did not show any complications. Furthermore, combinations with recon plates had the least complications.

A significant association was observed between implants used and the outcome (Fisher's Exact value =29.95; $P = 0.038$) [Table 5]. K-wire + recon plate + cancellous screw implant, Recon plate + cancellous screw, and Recon plate implant had the better results in treatment compared to K-wire implant.

DISCUSSION

Functional elbow is very essential for an individual for social and economic well-being. Fractures of the distal humerus may affect the functional movement of elbow, especially intercondylar (intra-articular) fracture. The relationship of the radiohumeral joint and ulnohumeral joints must be perfect for functional outcome.

The restoration of elbow function is dependent on three salient features: Exposure, fixation, and post-operative rehabilitation, with later two are of primary consideration. Adequate exposure is necessary for visualization of the bone injury and fixation of the fracture fragments. The optimal exposure is provided by posterior approach with extra-articular osteotomy of the olecranon. This allows complete examination of the articular surfaces of trochlea, capitellum, olecranon, and radial head. It also gives access to the medial and lateral supracondylar ridges. Full evaluation of the fragments of the fracture and reduction can then be performed. Although non-union of the extra-articular osteotomy may be regarded as a potential complication of this exposure, TBW of the osteotomy has provided sufficient stability of the olecranon for immediate use of the elbow through a secure range of motion without the occurrence of non-union.

The distal humeral fractures were observed to be more common between 18 and 70 years and number of cases decreased linearly as age increases. The minimum age was 18 years and maximum age was 70 years (mean age of 31.40 for males and 51.91 for females). The age distribution could be compared to earlier studies done by Holdsworth and Mossad[6] in which the mean age for males was 33.4 years and for females was 42.4 years. Majority of our patients were males attributable to their activity and exposure to vehicular and other accidents.

In our study, the incidence of right- and left-sided fracture was equal. Among the distal humeral fractures, the most common was supracondylar fracture with 13 cases (36.1%). The study reported equal number of injuries in both right (18) and left (18) sides. In this study, commonly encountered complications were elbow stiffness in 8 cases (22%), delayed union in 2 cases (6%) and delayed union with pin tract infection in 1 case (3%) and non-union in 1 case (3%). Pin tract infections were treated by regular dressing and oral antibiotics. Physiotherapy was given for elbow stiffness.

In our study, 11 patients were treated with K-wire, out of which 5 sustained injury by RTA and 6 by fall. In the 11 cases, 6 patients had a fracture left distal humerus and 5 patients had right side. The fracture type was supracondylar in 5 patients, intercondylar in 2 patients, supracondylar with intercondylar in 1 patient, lateral condyle in 2 patients, and medial condyle in 1 patient. Union of fractures in 11 patients was between 8 and 16 weeks with mean of 11.82 weeks. The flexion and extension range of movements in 11 patients is 50°–140° with a mean of 75.91°. By MEPI scoring system, 1 had excellent result, 4 had good result, 1 had fair result, and 5 had poor results.

In our study, 10 patients were treated with K-wire and cannulated cancellous screws, out of which 5 sustained injury

Table 5: Distribution of sample by implants used and the outcome

Implant used	Results				Fischer's exact value	*P*-value
	Poor (%)	Fair (%)	Good (%)	Excellent (%)		
K-wire+recon plate+cancellous screw	0 (0.0)	0 (0.0)	0 (0.0)	1 (100.0)	29.95	0.038
K-wire+cancellous screw fixation	2 (20.0)	3 (30.0)	2 (20.0)	3 (30.0)		
K-wire	5 (45.5)	1 (9.1)	4 (36.3)	1 (9.1)		
Recon plate	0 (0.0)	0 (0.0)	0 (0.0)	2 (100.0)		
Recon plate+cancellous screw	1 (10.0)	0 (0.0)	0 (0.0)	9 (90.0)		
Recon plate+cancellous screw+TBW	0 (0.0)	0 (0.0)	1 (100.0)	0 (0.0)		
Recon plate+K-wire	0 (0.0)	0 (0.0)	1 (100.0)	0 (0.0)		

TBW: Tension band wiring

by RTA and 5 by fall. The fracture type was supracondylar in 4 patients, supracondylar with intercondylar in 3 patients, lateral condyle in 2 patient, and intercondylar fracture in 1 patient. Union of fractures in 10 patients was between 10 and 30 weeks with mean of 14.50 weeks. The flexion and extension range of movements in 10 patients was 50°–140° with mean of 92.50°. By MEPI scoring system, 3 had excellent result, 2 had good result, and 3 had fair result and 2 had poor results.

In our study, 10 patients were treated with reconstruction plate and cannulated cancellous screw. The fracture type was supracondylar with intercondylar in 5 patients, intercondylar in 3 patients, medial condyle in 1 patient, and supracondylar in 1 patient. Union of fractures in 9 patients was between 10 and 15 weeks with mean of 12.10 weeks. The flexion and extension range of movements in 10 patients were 35°–140° with mean of 111°. By MEPI scoring system, 9 had excellent result and one had poor result.

One patient treated with a reconstruction plate and K-wire had supracondylar fracture following RTA with right elbow involvement. Fracture united in 12 weeks with mean flexion of 100°. MEPI scoring system patient had given good result.

In our study, the correlation we found between the functional results and the type of fracture confirms the prognostic value of AO classification. The elderly patients regained less movement, but none of them had instability. In one case, olecranon osteotomy was used for reduction of fracture but we had no complication regarding the union by olecranon osteotomy and been fixed by a cancellous screw and TBW. We found tingling in ulnar nerve distribution even after prophylactic anterior transposition. However, the nerve was returned to its normal course at the end of the operation.

In our study, the lateral or radial plate (reconstruction plate) was posterior and, therefore, at right angles to the medial or ulnar plate which enhanced stability. This was possible because the articular surface of the capitellum was entirely anterior and distal. The posterolateral plate required little contouring; the medial plate needed to be very heavily contoured in two planes. Hence, the "pelvic reconstruction" plate, though slightly less strong, was often useful. We have not removed implants as a routine unless their prominence in thin patients caused issues. K-wire with cancellous screws showed an excellent result when compared to K-wire alone.

In the case of reconstruction plate and cannulated cancellous screws, the value of compression while obtaining union was noted. The union occurred between 12 and 15 weeks with mean of 12.10 weeks. One patient who had elbow stiffness was corrected by physiotherapy.

By compression, the fracture united by primary bone healing if the fragments were rigidly fixed with their blood supply disturbed as little as possible. Under these conditions, resorption and bone formation occurred simultaneously in fracture treated with rigid fixation. When the fracture gap was obliterated or greatly diminished by a compression plate, the capillaries were able to grow into the medullary callus at an early stage in the healing process.

Functional results were of more importance than anatomical results, functional recovery was rapid and complete in relatively fresh cases in our series is by absolute stability[7,8] and contact healing.[9] Plate removal was not done in the study since none of the patients had symptoms associated with plate. Although the long-term effects of these retained plates are not known and there is no need to remove plates as such.[8]

CONCLUSION

Reconstruction plate and reconstruction plate with cannulated cancellous screws showed stable fixation and allowed immediate mobilization than K-wires when used exclusively. Excellent results were achieved in terms of mobility and union without deformity. Reconstruction plate alone and reconstruction plates and cannulated cancellous screws offer excellent results in distal humeral fracture in adults.

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