

Original Research Article

Study on functional outcome of intra articular fractures of distal humerus managed by locking compression plate

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ABSTRACT

Background: The primary goal in management of intra articular fractures of distal humerus is to achieve stable and mobile elbow. Type C fracture of distal humerus is a relatively uncommon fracture. Internal fixation is difficult but anatomical reduction is needed to prevent poor functional outcome and degenerative changes.

Methods: Functional outcome of patients who underwent open reduction internal fixation with locking compression plates for intra articular fractures of distal humerus at the department of orthopedics, Government medical college Kottayam, from December 2017 to July 2019, were assessed using Mayo elbow performance index. A total of 30 patients were studied.

Results: Excellent and good results were found in 25 cases, 3 patients had fair outcome and 2 patients had poor result. Complications encountered in our study were, infection (superficial treated with antibiotics-3 cases), heterotopic ossification (3 cases), hard ware prominence (2 cases) and non-union (1 case).

Conclusions: Complications were minimal and outcomes were good in patients with type C distal humerus fractures who underwent bicolun locking compression plates fixation by posterior approach.

Keywords: Distal humerus intra articular fractures, Locking compression plates, Internal fixation

INTRODUCTION

The primary goal in management of intra articular fractures of distal humerus is to achieve stable and mobile elbow. AO Type C fracture of distal humerus is a relatively uncommon fracture. Internal fixation is difficult but anatomical reduction is needed to prevent poor functional outcome and degenerative changes. Fractures of the distal humerus accounts for 2-6% of all fractures and 1/3 of all humeral fractures. Intraarticular distal humerus fractures are very rare accounting for 0.5% of all fractures.¹

In this modern society with a growing elderly population and an extremely active young population, the incidence of distal humeral fractures is increasing and having a bimodal distribution. In young adults, most distal

humerus fractures occur from high-energy trauma like sideswipe injuries, motor vehicle accidents (MVA). In elderly persons with more osteoporotic bone, these injuries occur from simple falls.²

The chances of functional impairment and deformities are very high following conservative treatment of such distal intra-articular fractures of humerus. Malunion, stiffness, and osteoarthroses are very common following conservative management.

Since 1950s the trend has shifted to open reduction and stable fixation with early mobilization. Good anatomical alignment, stabilization and early mobilization can provide satisfactory results. The operative treatment poses certain difficulties due to the intricate anatomy of the elbow joint which is composed of three distinct

articulations, proximity of neurovascular structures, minimal soft tissues attached to the fragments and long operative period.³

The standard surgical techniques are used for fixation of both columns, using a combination of reconstruction plates, dynamic compression plates, locking compression plates and screws and k-wires. In rare situations, primary total elbow replacement may be considered. In current study we report the outcome of a series of intraarticular fractures of distal humerus, treated by open reduction and internal fixation using humeral LCP.

The guidelines proposed by the AO/ASIF group for fixation of distal humeral fractures has been a gold standard till now with 2 plates placed at a 90° angle to one another (orthogonal/perpendicular/90°/90° plating). Using these fixation techniques, different authors have reported unsatisfactory results in 20% to 25% of patients due to implant failure occurring, if mobilized early.^{4,9}

As a result of ongoing search for a more secure technique later evolved the concept of parallel plating (180°) which involves placing one plate along the medial column of the distal humerus and the other plate along the lateral column with the screws in the distal fragment interdigitating with each other in the distal fragment restoring the 'tie beam arch' of the distal humerus. The problems encountered during parallel plate technique is extensive soft tissue dissection and chances of neurovascular injuries.^{10,11}

Objectives

Objectives of current study were to analyze the outcome of intraarticular distal end humerus fractures (AO type C) managed by locking compression plate and to assess the time taken for radiological union. Current is a study of patients who presented with closed fractures of distal intra articular humerus and underwent internal fixation with bicolumn locking compression plates. Postoperatively patients were followed up for the functional outcome of distal intra articular humerus fractures and the results were analyzed.

METHODS

Study design and population

Current study is a prospective, observational study conducted on patients with AO type C fractures of distal Humerus treated with distal humeral locking compression plates in department of orthopaedics, Government medical college, Kottayam during the study period.

Sample size

In a study conducted by Ramesh Krishna et al, a study on functional outcome of surgical management of intra

articular fractures of distal humerus in adults, 80% of the patients had an excellent score according to MEPI criteria.¹² Using this data the sample size required for this study was calculated using the formula,

$$N = Z\alpha \times 2PQ \div d^2$$

Where, $Z\alpha=1.96$ at 95% CI, $P=80\%$, $Q=1-P$ and d -relative precision= 15% .

Minimum sample size required as per calculation for the study was 27. 1, so sample size was taken as 30. Type C fractures are uncommon and most of the previously done Indian studies related to this topic have an average sample size of 25-30, all the cases that meet the study criteria were taken into account.

Inclusion criteria

Inclusion criteria for current study were; patients with intra-articular fractures of the distal humerus—AO type C fractures and patient aged more than 18 years.

Exclusion criteria

Exclusion criteria for current study were; patients with co-morbid conditions and not fit for surgery, non-compliant patient, extreme osteoporosis, severe comminution or bone loss, open fractures and fractures with neurovascular injuries.

Statistical analysis

Data was coded and entered in Microsoft Excel and analyzed using IBM SPSS software. Association between various factors was assessed using chi square test for qualitative variables and t test/ANOVA for quantitative variables. Appropriate non parametric tests were applied wherever required. The level of statistical significance was $p<0.05$.

Study procedure

On admission, history was elicited from the patients and attendants to find out the mechanism of injury and associated injuries. A detailed clinical examination and radiological assessment was done to assess the fracture pattern, deformity, neurovascular status associated injuries. Then the injured limb was immobilized in an above elbow plaster slab until surgery.

Cases subjected to surgery were met during the follow up visits and analyzed for progress of treatment. Postoperative follow up was done at 1st month, 3rd month, and 6th month following surgery. Follow-up was stopped earlier if patient mobilized earlier or when patient is diagnosed as a case of nonunion or another surgery for the treatment of same fracture, later due to any reason.

X-ray were taken at 1 month, 3 month and 6 month were collected and assessed. Patients were clinically assessed using Mayo elbow performance index. Collected data was recorded on a performa and analyzed. During every phase of the study the personal details of the patients participating in the study were kept confidential & the patient had every right to withdraw at any phase of the study without affecting his/her future treatment. A written informed consent was taken from all the patients prior to the study.

RESULTS

Gender incidence and mode of fracture

Males dominated in our study, with a total of 19 males (63.3%) and 11 females (36.7%). Ratio of male:female was 19:11. Majority of the patients suffered motor vehicle accidents (MVA) (60%). The second most common mode of injury was accidental falls (26.7%). Other mode of injuries was fall from heights (FFH) and assault.

Table 1: Gender incidence and mode of fracture.

	Frequency	Percentage
Gender		
Male	19	63.3
Female	11	36.7
Mode of injury		
MVA	18	60.0
Simple fall	8	26.7
Fall from height	2	6.7
Assault	2	6.7

Gender and mode of injury

In both the gender groups majority of the patients had motor vehicle accidents as the mode of injury, with 12 male patients (63%) out of the total 19 males and 6 female patients out of the total 11 females (54.5%).

Table 2: Gender and mode of injury.

Mode of injury	Male		Female	
	Male	%	Female	%
MVA	12	63	6	54.5
Simple Fall	3	16	5	45.5
FFH	2	10.5	0	0
Assault	2	10.5	0	0

Fracture distribution

Out of all the intra articular fractures type C2 constituted the majority with 53.3%, type C1 (26.7%) and type C3 (20%).

Table 3: Distribution of fracture type.

AO type	Frequency	Percentage
C1	8	26.7
C2	16	53.3
C3	6	20.0

MEPI

The following observations were made in our study. Good to excellent outcomes were considered as successful. The mean age of the patients was 43 years ranging from 18 to 70 years. Among the 30 patients that were followed up 14 (46.67%) of them had excellent results, 11 (36.67%) had good results, 3 (10%) had fair ad 2 patients (6%) had poor results. Considering that MEPI Excellent and good scores to be successful results, in this study the overall success rate was 83.33%. The average MEPS was 80.8.

Table 4: Results MEPI.

N	Percentage	N	Percentage
Excellent		Fair	
14	46.67	3	10
Good		Poor	
11	36.67	2	6.66

Radiological union

On assessing the association between union and the type of fracture it was found that majority of the cases irrespective of the fracture type attained union by third month (90%), with one case each of C2 and C3 types attained union in the sixth month (6.7%). One case of C2 type had a non union (3.3%). Since the p>0.05 the association between fracture type and union is not significant.

Table 5: Radiological union in different fracture types.

Union in months	AO type					
	C1	%	C2	%	C3	%
3	8	100	14	87.4	5	83.3
6	0	0	1	6.3	1	16.7
Non union	0	0	1	6.3	0	0

Chi square value: 2.442, p=0.655, % values are within AO type.

Age group and bony union

On assessing the association between age group and the time taken for radiological union it was found that all the age groups majority of the patients had attained radiological union by third month (90%), but one case each in the age groups 18-30 and 61-70 years attained union at the sixthmonth follow up (6.7%). One case in the age group 61-70 years had a non union (3.3%). Since p>0.05, the association is not significant.

Table 6: Age group and bony union.

Union in months	Age (years)									
	18-30	%	31-40	%	41-50	%	51-60	%	61-70	%
3	7	87.5	6	100	5	100	4	100	5	71.4
6	1	12.5	0	0	0	0	0	0	1	14.3
Non union	0	0	0	0	0	0	0	0	1	14.3

Chi square value: 5.44, p=0.675, % values are within age group.

Gender and bony union

On assessing the association between radiological union and gender it was found that 18 out of 19 males (94.7%) had union by the third month, whereas 9 out of 11 (81.8%) females attained union by third month. One female patient had a non union. Since p>0.05, the association is not significant.

Table 7: Gender and bony union.

Union in months	Male	%	Female	%
3	18	94.7	9	81.8
6	1	5.3	1	9.1
Non union	0	0	1	9.1

Chi square value: 2.01, p=0.366.

Gender and MEPI

On assessment of association between the gender and the outcome it was noted that males had a better outcome overall compared to the females. 100% of the male patients had a successful result (excellent and good) compared to the females wherein 54.5% had successful results. Since p>0.05, the association is not significant.

Table 8: Gender and MEPI.

MEPI	Gender	
	Male N (%)	Female N (%)
Excellent	12 (63.1)	2 (18.1)
Good	7 (36.9)	4 (36.4)
Fair	0 (0)	3 (27.3)
Poor	0 (0)	2 (18.2)

Chi square value: 6.297, p=0.098

Age and MEPI

On assessment of association between age group of the patients and MEPI it was noted that age groups 18-30 years and 51 to 60 years had the most successful results of 100% (excellent and good). Poor results were found to be on the higher side in the older age groups above 60 years. Since p>0.05, the association is not significant.

Fixed flexion deformity, range of flexion and complications

On assessment for fixed flexion deformity during the sixth month post op follow up it was found that 6 patients (20%) had a minimum flexion deformity of 0-10 degrees, 14 patients (46.7%) had a flexion deformity in the range of 11-20 degrees, 7 patients (23.3%) had flexion deformity in the range of 21-30 degrees and 3 patients (10%) had a fixed flexion deformity of more than 30 degrees. On assessment of the range of flexion during the sixth month follow up, it was noticed that all the patients had a flexion over 90 degrees with 9 patients (30%) with range of flexion of 90-110 degrees, 15 patients (50%) with range of flexion of 111-130 degrees and 6 patients (20%) had a range of flexion of above 130 degrees. Out of the 30 patients in this study 70% (21 patients) had no complications in the 6 months of the follow up. 10% of the patients (3 patients) had superficial surgical site infection which subsided by taking antibiotics according to culture sensitivity reports. 10% patients (3 patients) had heterotrophic calcification at the elbow. 6.7% patients (2 patients) had hardware prominence and 3.3% (1 patient) had nonunion of the fracture fragments.



Figure 1: A) Pre operative and B) 6 month post operative X-ray (Case 1).



Figure 2: A) Pre operative and B) 6 month post operative X-ray (Case 2).

DISCUSSION

The treatment of distal humerus fractures with intraarticular extension-AO type C, by bicolumn locking compression plates applied orthogonally is studied in detail. The options for articular fractures are wide and are continuously refined over time. The treatment is difficult because of complex three dimensional geometry. Poor functional outcomes like stiffness, non-union and implant failure makes these fractures challenging to treat. In our study we focused on functional outcome of these patients strictly adhering to principles of good anatomical alignment, absolute stabilization and early mobilization. The mean age of patients in our study is 43 years. Our findings are comparable to the studies done by Kun

Chuang Wang et al, Liu D et al, Gabel et al and Shin et al.¹³⁻¹⁶ Kun Chuang Wang et al had an average of 47 years and Liu DIP et al in their study had average age of incidence of 39 years. Gabel et al in their study during 1987 had average age of incidence of 45 years. Shin et al in their study had mean age of incidence of 42 years. In current study we had 19 male patients (63.3%) and 11 female patients (36.7%). It is comparable to the studies done by Liu et al where in 57.4% were males and 42.86% females. Ozer et al in his study had 55.4% males and 45.46% females.¹⁷ The male patients had a better success rate than a female patient in our study which is comparable to the study proposed by Liu et al due to better bone quality and active postoperative mobilization exercises.

Table 9: Age and MEPI.

Age (years)	MEPI							
	Excellent	%	Good	%	Fair	%	Poor	%
18-30	6	75.0	2	25.0	0	0	0	0
31-40	2	33.3	3	50.0	0	0	1	16.7
41-50	1	20.0	3	60.0	1	20.0	0	0
51-60	4	100	0	0	0	0	0	0
61-70	1	14.3	3	42.9	2	28.5	1	14.3

Chi square value: 5.922, p=0.919, % values are within age group.

Table 10: Fixed flexion deformity, range of flexion and complications.

	Frequency	Percentage
Fixed flexion deformity of elbow (FFD)		
0-10°	6	20.0
11-20°	14	46.7
21-30°	7	23.3
>30°	3	10.0
Range of flexion		
90-110°	9	30.0
111-130°	15	50.0
131-150°	6	20.0
Complication		
No complication	21	70.0
Superficial infection	3	10.0
Heterotrophic ossification	3	10.0
Hardware prominence	2	6.7
Non union	1	3.3

In current study 60% of the cases, that is 18 cases out of the 30 had motor vehicular accidents as the mode of injury, followed by fall with 8 cases (26.7%). In the studies done by Henley et al 61 % sustained injury due to motor vehicular accidents and 39% had a fall.¹⁸ Kun et al had similar observations with 70% cases of MVA and 30% secondary to fall.¹³

In current study 16 cases (53.3%) had right side involvement and (46.7%) 4 cases had left side involvement. In the studies conducted by Henley et al 45 % were right sided and Kun et al had 70% right sided injury. In current study the functional outcome was assessed based on the Mayo elbow performance score and the results obtained were excellent in 14 cases (46.66%) good in 11 cases (36.66%), fair in 3 cases (10%) and poor in 2 cases (6%). Considering excellent and good as successful results, our study had a success rate of 83.33%. Results of the study are comparable to the studies conducted by Teng et al, Singh et al and Reising et al who reported good/excellent MEPS of 87.5%, 81.8% and 85% respectively.¹⁹⁻²¹ In a study by Ring et al, the complications of olecranon osteotomy reported were bursitis, hardware prominence, broken or migrated k wire.²² In our study we encountered 2 case of hardware prominence. In the study by Babhulkar et al 80 cases of intraarticular fracture were operated through orthogonal plating and had excellent outcome in 86% of cases.³ Kaiser et al study showed 22 patients treated with orthogonally applied LCP plates. The mean MEPS score was 84.7 compared to a mean score of 80.8 in this study.²³ In the study by Holubet al the outcomes of conventional reconstruction plates and LCP were compared, excellent results were achieved with the use of locking compression plates particularly in intraarticular distal humerus fractures.²⁴ The average operating time was 123 minutes using conventional plates. Current study had an average time of 100 minutes which may be attributed to the anatomically fit precontoured plates which does not need any contouring to fix with the bone.

Lee et al compared the outcomes of parallel and orthogonal plating technique using distal humerus LCP and no significant difference in outcomes of both techniques were noted.²⁵

CONCLUSION

Incidence of complex distal humerus fractures among younger population is on the rise due to increasing motor vehicle accidents. Absolute stability of the system allows early post-operative rehabilitation and thence a better functional outcome. Good to excellent functional outcome was achieved in >80% of the study group in terms of arc of motion and stability. A decrease in implant failure and non-union may be attributed to the highly stable construct system achieved by locking compression plates. It provides a greater stability in osteoporotic and comminuted bones. Locking compression plates applied can be a successful technique for internal fixation of these complicated fractures when its principles are strictly adhered to. We conclude that distal humerus fractures with intraarticular extension AO type C, can be successfully treated with locking compression plates with good outcomes. However a long term follows up and a larger sample study is needed to further validate our findings.

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Ethical approval: The study was approved by the institutional ethics committee

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