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Research Article

Radiological and Functional Outcome of Open Reduction and Internal Fixation of Extra Articular Distal Humerus Fracture Using Anatomical Plate

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Abstract

Introduction: Reliable techniques for the fixation of Extra-Articular Distal Humerus Factures (EADHF) impose a significant challenge among the surgeons. Albeit there has been mounting proposed plate configurations, anatomic plates is an optimal solution for the management of these difficult fractures. The present study was carried to assess the clinico-radiologic outcome of EADHF in our hospital setting. Hypothesis We hypothesized that the use of anatomical plate by triceps splitting posterior approach might result in early union with minimal complications.

Methods: This was a prospective study carried out from November 2016 to November 2018 and patients affected with EADHF were included and managed using anatomical plates. The fractures were approached using triceps splitting posterior methods. The fracture fixation was done using anatomical distal humerus plate. Radiological union and final functional outcome using Mayo Elbow Performance score (MEPS) was evaluated.

Results: A total of 25 patients were recruited and the man age was 38.9 ± 9.6 years. Majority of the patients were AO Type 13-A2 fracture and mean arc of motion was 97.2 ± 21.79°. The mean time to radiological union was 16.7 ± 4.5 weeks (12 to 30) and included one cases of non-union. The average MEPS at final follow up was 82 ± 12.7 and 17 patients' displayed good results.

Discussion: Using anatomical locking plates with triceps splitting approach provides best visualisation of extra-articular fracture of distal femurs. This method displays stable fixation and early reunion with minimal soft tissue loss and complications.

Keywords: Anatomical plates; Distal humerus; Extra articular fracture; Mayo Elbow Performance score

Introduction

Distal humerus fractures in adults and its treatment is a challenging task for Orthopedic surgeons as a result of precise anatomy of distal humerus and limited site for surgical procedures [1]. Distal region of the humerus elicits complex bone shape with irregular arrangements and has a complex bone shape with irregularities, and it is also problematic to decide implants' position based on the type of fracture. The anatomical structures such as olecranon and coronoid fossa, the trochlea of distal humerus elicits a narrow space for the locking screw insertion. In the case where the combination of plates is used, the different direction of screws may lead to poor fixation of distal fragments [2]. The main aim of the treatment in these fractures is regain the complex geometry for early mobilization. The annual incidence of distal humerus fractures in adults ranges from 5.7 per 100, 0001 and displays a bimodal distribution. The first peak occurs specifically in males between the age 12-19 years as a result of high energy trauma and the second peak is particularly in elderly women with osteoporotic disease due to low energy trauma and falls. Extraarticular fractures of distal humerus

occur between the shaft of humerus and the intercondylar region. Most these fractures are displaced and the fracture pattern is more complex with marked comminution. Albeit, functional bracing is the primary mode of management it may not elicit effective stability and alignment due to the fracture at distal site [3]. Surgical modalities include intramedullary nailing along with locking techniques but displays improper as a result of short distal fragment. Various plating methods such as dual plating, lambda plate, and metaphyseal plate fixation have been recommended but the results are not satisfactory [4,5].

The precisely designed anatomical plates for extraarticular distal humerus are introduced to meet the demands of this complex fracture plate has been specifically designed to address these complex fractures [6]. It is designed in such a way so that it can be positioned proximally along the central humeral diaphysis and distally at the lateral supracondylar ridge distally. Further, the increased option for locking screw placement in the distal fragment elicits high stability and early mobilization. Recently, para-tricepetal approach using locking plate for extra-articular distal humeral fractures displayed stable fixation, early mobilization along with minimum soft tissue loss [7]. In this backdrop, the present study was done to evaluate the radiological and functional outcome of open reduction and internal fixation of extra articular distal humerus (only A2 and A3 type of fractures) using anatomical plate in adults.

Patients and Methods

Study Design

This was a prospective, observational study conducted on patients presenting to the OPD and casual of Sushrut Hospital Research Centre and Post Graduate Institute of Orthopedics with history of trauma to distal humerus and diagnosed of having extra articular fracture distal humerus (only A2 and A3 type) on radiographic evaluation. The study was conducted during the period between the November 2016 to November 2018.

Inclusion Criteria

Patients above 18 years during admission presenting with close and open grade 1 (according to Gustilo-anderson classification) fractures of the distal humerus were included in the study. Further, patients with extra-articular distal humerus fracture (A2 and A3 Type) were also included in the study.

Exclusion Criteria

Patients with poly-trauma and multiple fracture, open grade 2 and open grade 3 fractures, repeat trauma to same limb after the initial surgery and patients with age less than 18 years of age were excluded from the study.

Preoperative Planning

A brief history of the patient and clinical examination was done to evaluate the patient stability. Plain radiographs of distal humerus including an anteroposterior view and lateral view were obtained for diagnosis & preoperative planning. The limb was immobilized in above elbow plaster splint up-to shoulder joint. Informed consent was obtained from the patients before the initiation of surgery.

Surgical Technique

Under brachial block patient was taken on operation table in lateral position with arm hanging over a side block. Pneumatic tourniquet was used in all cases. Painting and draping of the part was done. Triceps splitting posterior approach was used in all the cases. A longitudinal incision in the midline of the posterior aspect of the arm 8 cm below the acromion to the olecranon fossa was taken. Followed by dissection involving skin, subcutaneous tissue and separation of both the heads of triceps was done. Care was taken to prevent injury to radial nerve by isolating it. Meticulous soft tissue dissection was done to preserve blood supply to the zone of injury. Fracture site was approached, reduced into anatomical alignment followed by fixation using anatomical distal humerus plate. Sutures were taken into two layers. The surgical procedure were shown in Figure 1.

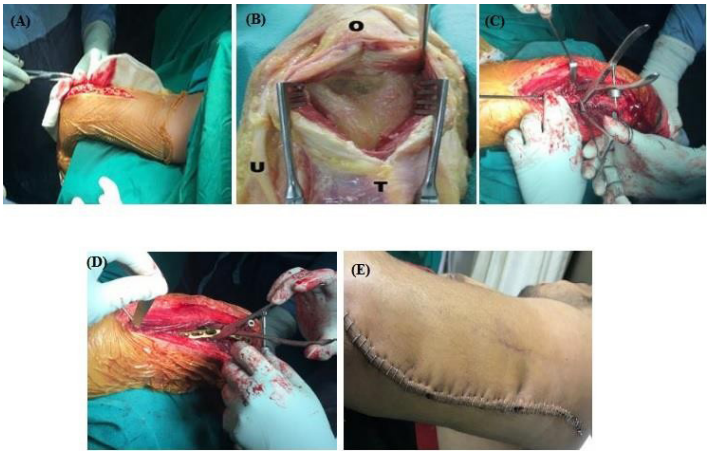

Figure 1: Intra operative photographs. **(A)** Longitudinal incision in the midline of the posterior aspect of the arm 8 cm below the acromion to the olecranon fossa; **(B)** Triceps splitting incision; **(C)** Stabilization of fracture fragments by bone holding clamps; **(D)** Plate placement on posterolateral aspect of distal humerus; **(E)** Surgical wound closure.

Post-Operative Protocol and Follow-Up

Post operatively the patients were administered with intravenous antibiotics and continued for 48 hours. Limb was immobilized in above elbow plaster splint. Routine analgesics were given as per the requirement. Radiographic evaluation was done. Sutures were removed on 10-12th postoperative day. At 6 weeks clinical assessment of pain, range of motion of elbow and radiological assessment was done. At 12 weeks assessment of radiological and clinical union was done. At 24 weeks radiological and clinical union and functional ability of the elbow was evaluated. Outcome was assessed using Mayo Elbow Performance Score [8].

Statistical Analysis

The collected data was entered and analysed in Microsoft excel. Means and standard deviations were calculated for normally distributed quantitative data. Frequency distribution tables and cross tables were created for ordinal and nominal data. Percentages and proportions were calculated for various variables. Fisher's Exact Test was used as test of significances. $p < 0.05$ was considered as statistically significant.

Results

A total of 25 patients were included in this prospective study. Regarding the type of fracture, 22 (88%) patients elicited close distal humerus fracture and 3 (12%) patients had open grade 1 fracture. The mean age of the patients was 38.9 ± 9.6 years ranging between 22 -56 years. In this study, majority of the patients (40%) were in the age range between 31-40 years. In our study, male preponderance was observed with 72% was males and 28% were females respectively. The major reason for trauma was due to road traffic accidents and fall which was observed in 48% and 44% of patients respectively. Right upper limb involvement was observed 60% of the patients. AO Type 13- A2 was the most prevalent fracture type observed in 68% of the patients. The average duration between injury and surgery interval was 3 ± 1.3 days and in majority of the cases (72%) the duration was 2- 4 days. The average duration of surgery was 1.9 ± 0.38 hours and in 52% of patients the duration was 2 hours. The average duration of hospital stay was 8±3 days and in 52% of patients the duration was 8-11 days. In this study, majority of patients, 72% had not developed any complications and the major complication was palpable implant which was observed in 16% of the patients. Severe patients were not observed in none of the patients and majority of the patients, 60% had developed mild pain. The mean arc of motion was 97.2 ± 21.79° and majority of the patients 56%, displayed the arc of motion between 50-100°. The results were shown in Table 1. In this study, the mean overall union time was 16.7 ± 4.5 weeks. Further, the union time was higher in Type 13-A3 fracture as compared to Type 13-A3 fracture (19.5 ± 5.5 vs 15.4 ± 3.4 weeks). The results were shown in Table 2.

ARC of Motion	No. of Patients	Percentage (%)
< 50 degrees	2	8
50-100 degrees	14	56
> 100 degrees	9	36
Total	**25**	**100**

Table 1: Distribution of patients according to Arc of Motion.

Fracture (AO Type)	Average Union Time (in weeks) ± SD	Range (in weeks)	No. of Patients	Percentage (%)
Type 13-A2	15.4 ± 3.4	12 to 24	17	68
Type 13-A3	19.5 ± 5.5	12 to 30	8	32

Table 2: Distribution of patients and union time according to the fracture type.

We observed good stability in 96% of patients and only one patient was moderately unstable. At the final follow up based on the Mayo Elbow Performance Score five functions were taken in account, out of which 21 (84%) patients could comb their hair by themselves, all 25(100%) patients could feed by their own, 24 (96%) patients could do daily hygiene work by themselves, 22(88%) patients could put on their shirts by their own and 23 (92%) patients could put on their shoes by their own. In our study, the mean Mayo elbow performance score was 82 ± 12.7. Further the function outcomes based on the score was excellent in 5 patients (20%), good in 17 patients (68%), fair in 1 patient (4%) and poor in 2 patients (8%). The poor and fair results in 3 patients were due to non-union, superficial infection, exposed & palpable implants due to severe comminution (multifragmentary fracture). The results were shown in Table 3. In the present study, there was no significant difference in the Mayo elbow performance score and the type of fracture (p=0.231). Out of the 17 patients who had A2 type of fracture, Mayo elbow performance score grade of 16(94%) patients was good & excellent while only 1(5.9%) patient showed poor grade. Likewise, in A3 type of fracture, majority (75%) of patients showed good & excellent grade. The results were shown in Table 4. The radiographic evidence of preoperative, post-operative and follow up were shown in Figure 2.

Results	No. of Patients	Percentage (%)
Excellent (>90)	5	20
Good (75-89)	17	68
Fair (60-74)	1	4
Poor (<60)	2	8
Total	25	100

Table 3: Functional outcome of patients based on the Mayo elbow performance score.

MEPS Grade	Type of Fracture		Total	P value
	13-A2 (%)	13-A3 (%)		
Good & Excellent	16 (94.1)	6 (75.0)	22 (88.0)	0.231
Fair & Poor	1 (5.9)	2 (25.0)	3 (12.0)	
Total	17 (100.0)	8 (100.0)	25 (100.0)	

Table 4: Comparison of Mayo Elbow Performance Score and fracture type.

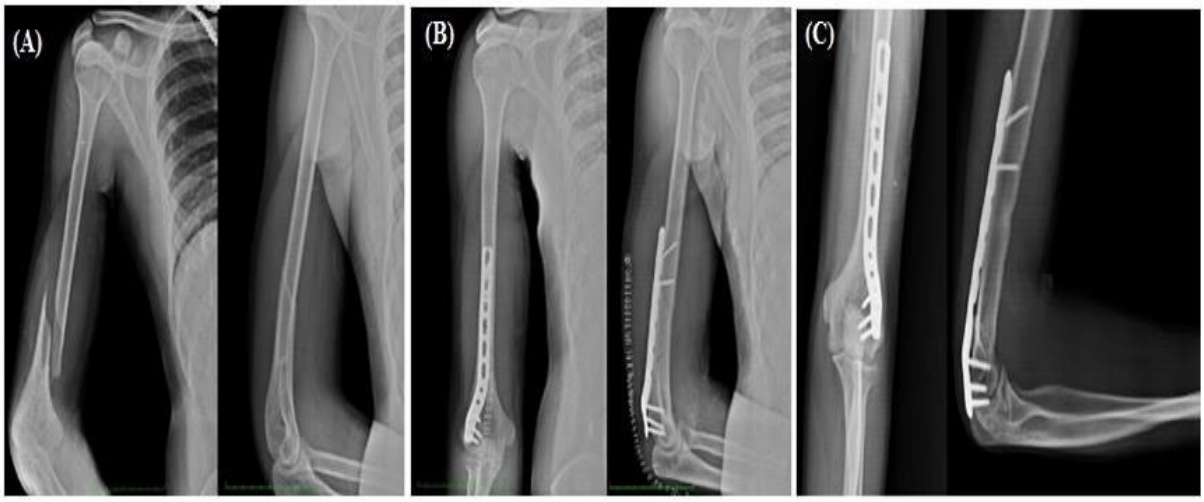

Figure 2: Surgical management of extra articular fracture distal humerus AO/OTA type 13-A2. **(A)** Preoperative x-ray anteroposterior and lateral views showing the extra articular fracture distal humerus AO/OTA type 13 A2; **(B)** Immediate Postoperative anteroposterior and lateral views showing good reduction and fixation of fracture by extra-articular distal humerus Locking Compression Plate; **(C)** One year postoperative anteroposterior and lateral views showing full union at fracture site.

Discussion

Extra-articular distal humerus fractures are the most complicated injuries with significant morbidity and also affect the quality of life. The management is difficult and imposes marked challenge among the surgeons as a result of periarticular location, comminution with distal fragments of small size and till date there is no definite consensus statement has been reported for the optimal implant choice for the management. The main aim of the treatment is to acquire proper alignment with stable reconstruction for the commencement of early ROM. So the surgical management is favored as compared to the conservative treatment [9]. Meanwhile, surgical intervention is associated with the complications such as non-union, radial nerve palsy, surgical site infections and symptoms related to the implants [10].

Due to the limited size of the distal fragment and the existence of torsional forces at this junction hinders the effective stable fixation of standard plates. So diverse these difficulties, various changes in the plate designs have been proposed. Further, based on the fractures site various plates have been recommended. In a study done by Levy et al. [11], modification of the lateral tibial head buttress locking plate of same side is carried out for fixation of factures so that there is no impinge on the olecranon fossa. The radiological outcome reported on 15 patients showed complete alignment and the callus bridging also achieved. In another report done by Spitzer et al. [12], showed effective outcome by using a 'hybrid' metaphyseal LCP for the fixation of proximal or distal metaphyseal humerus fractures. The implant encompasses 4.5 mm and 3.5mm locking holes at one end and the other end respectively. These arrangements elicit high strength because of small caliber screws used at bone fragments of shorter sizes. The outcome of 21 patients reveals that the healing of factures occurs with a mean time of 4.5 months with

no evidence of infection or implant failure. A previous study reported the specially designed Lambda plates with Y-shaped arrangements which can be easily placed according to fracture type in distal humerus [5]. However, this compression plate lacks locking holes and hence there is a risk of inadequate fixation in cases of comminution and osteoporosis. As stated by Moran, the enhancement of distal fixation is achieved by placing the conventional plate at an angle 5° -8°at the center from the humerus long axis, however the plate obliquity hinders the effective fixation [13]. In addition, the parallel and orthogonal dual plating have been used for the fixation of distal humerus fractures [14]. Meanwhile, dual plating elicits various complications such as dissection of soft tissues, infection and non-union. A saw bone model study done by Scolaro et al. [15], showed that the single pre contoured posterolateral extra-articular LCP have marked bending, torsional and yield strengths as compared to routine 3.5mm LCP for distal humerus fracture fixations. Meanwhile, the authors conclude that the replication of this method must be done with high precaution since the study was done on cadavers without considering the surrounding soft tissues and in routine clinical practice it may stabilize or destabilize fracture fragments.

Mounting techniques has been used to fix the fractures and the posterior approach is the most commonly used. In our study we have used triceps splitting posterior approach in all the cases. The main advantage of this technique are it aids good visualization, provides extensor mechanism for early mobilization. In this study, the predominant of injuries are due to road traffic accidents and fall Majority of the injuries in our study are high energy roadside accidents, with type 13-A2 accounting for 68% of the cases . The mean age of the patients was 38.9 ± 9.6 years with male preponderance. In our study, the average time to fracture union was 16.7 ± 4.5 (range 12-30 weeks) which is relatively lower when compared to Jain et al. [16], (22.4 weeks) and higher as compared to Trikha et al.[17], (12 weeks). Similar to our report in Ali et al. [7], study the average time for reunion was 17.6 weeks. Thus these variations might be due to the bone healing mechanism of the different study population and these fractures elicit direct bone healing with minimal callus bridging. Fracture union is not clearly visible in the initial postoperative days and interobserver variation in the analysis of reunion time is also a possible factor [18].

Previous study shows that pre contoured posterolateral locking plate displayed high union rate and alignment, minimal complications and effective elbow ROM as compared dual column plating in the management of for extra-articular distal humerus fracture [19]. In our study, mean arc of elbow movement was 97.2 ± 21.79, mean MEPS score was 82 ± 12.7 which are similar to the study conducted by Jain et al.[16] and Ali et al. [7]. In our study, one patient experienced non-union and similarly in Jain et al. study 4 patients showed non-union as a result of proximal screw failure [16].

Conclusion

Stable fixation of extra-articular distal humerus fracture using anatomical plate tends to provide complete union in majority of the cases with early recovery. Triceps splitting approach provides effective outcome with less complications.

References

1. Ul Islam S, Glover AW, Waseem M (2017) Challenges and Solutions in Management of Distal Humerus Fractures. Open Orthop J 11: 1292-307.
2. Yoshii Y, Teramura S, Oyama K, Ogawa T, Hara Y, et al. (2020) Development of three- dimensional preoperative planning system for the osteosynthesis of distal humerus fractures. Biomed Eng Online 19: 56.
3. Ali E, Griffiths D, Obi N, Tytherleigh-Strong G, Van Rensburg L (2015) Nonoperative treatment of humeral shaft fractures revisited. J Shoulder Elb Surg 24: 210-214.
4. Yang Q, Wang F, Wang Q, Gao W, Huang J, et al. (2015) Surgical treatment of adult extra-articular distal humeral diaphyseal fractures using an oblique metaphyseal locking compression plate via a posterior approach. Med Princ Pract 21: 40-45.
5. Saragaglia D, Rouchy R-C, Mercier N (2013) Fractures of the distal humerus operated on using the Lambda® plate: report of 75 cases at 9.5 years follow-up. Orthop Traumatol Surg Res 99: 707-712.
6. Supe AC, Palange ND, Pawar ED, Mahajan NP (2019) Functional outcome of locking anatomical plate in extra articular fractures of the distal humerus. Int J Res Orthop 5: 443.
7. Ali N, Ahamd Mir N, Ahmad Dar T, Nawaz Rather M, Ahmad Mir W, et al. (2018) Outcome of Extra-Articular Distal Humerus Fractures Fixed by Single Column Extra- Articular Distal Humerus Locking Compression Plate Using Triceps Sparing Postero- Lateral Approach. Bull Emerg Trauma 6: 306-312.
8. Mayo Elbow Performance Score. J Orthop Trauma 20: S127.
9. Goel DP, Pike JM, Athwal GS (2010) Open Reduction and Internal Fixation of Distal Humerus Fractures. Oper Tech Orthop 20: 24-33.
10. Jawa A, McCarty P, Doornberg J, Harris M, Ring D (2006) Extra-Articular Distal-Third Diaphyseal Fractures of the Humerus. J Bone Jt Surg 88: 2343-2347.
11. Levy JC, Kalandiak SP, Hutson JJ, Zych G (2005) An Alternative Method of Osteosynthesis for Distal Humeral Shaft Fractures. J Orthop Trauma 19: 43-47.
12. Spitzer AB, Davidovitch RI, Egol KA (2009) Use of a "hybrid" locking plate for complex metaphyseal fractures and nonunions about the humerus. Injury 40: 240-244.
13. Moran MC (1997) Modified lateral approach to the distal humerus for internal fixation. Clin 1997: 190-197.
14. Moon J-G, Lee J-H (2015) Orthogonal versus Parallel Plating for Distal Humeral Fractures. Clin Shoulder Elb 18: 105-112.
15. Scolaro JA, Hsu JE, Svach DJ, Mehta S (2014) Plate selection for fixation of extra-articular distal humerus fractures: a biomechanical comparison of three different implants. Injury 45: 2040-2044.
16. Jain D, Goyal G, Garg R, Mahindra P, Yamin M, et al. (2017) Outcome of anatomic locking plate in extraarticular distal humeral shaft fractures. Indian J Orthop 51: 86.

17. Trikha V, Agrawal P, Das S, Gaba S, Kumar A (2017) Functional outcome of extra-articular distal humerus fracture fixation using a single locking plate: A retrospective study. J Orthop Surg 2017.

18. Kini A, Kumar Ma, Shetty Ms, Sujay K, Kanthi K (2011) Minimally invasive plate osteosynthesis for humerus diaphyseal fractures. Indian J Orthop 45: 520.

19. Meloy GM, Mormino MA, Siska PA, Tarkin IS (2013) A paradigm shift in the surgical reconstruction of extra-articular distal humeral fractures: single-column plating. Injury 44: 1620-1624.