



## Original 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 fractures (EADHF) impose 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. This study was carried to evaluate the clinico-radiological outcome of EADHF at Bheri Hospital.*

**Methods:** *It is a hospital based prospective study carried out in the department of Orthopedics at Bheri Hospital, Nepalgunj, Nepal from July 1, 2018 till June 30, 2020 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 30 patients were recruited and the mean age was  $40.12 \pm 7.5$  years. Majority of the patients were AO Type 13- A2 fracture and mean arc of motion was  $98.5 \pm 14.25^\circ$ . The average mean time for radiological union was  $18.2 \pm 3.6$  weeks (14 to 28) and there have been two cases of non union. The mean MEPS during the final up was  $85 \pm 13.8$  and 20 patients showed good results.*

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

**Keywords:** *Distal humerus, Extra articular fracture, Anatomical plates, 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<sup>1</sup>.

Distal region of the humerus elicits complex bone shape with irregular arrangements and has a complex bone shape with irregularities, and it is also troublesome 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 restricted 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<sup>2</sup>. 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, 000 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<sup>3</sup>. 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<sup>4,5</sup>. 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<sup>6</sup>. The plates are designed in such a way so that it can be positioned proximally along the central humeral diaphysis and distally at the lateral supracondylar ridge. Further, the increased option for locking screw placement in the distal fragment elicits high stability and early mobilization. Recently, paratricepetal approach using locking plate for extra-articular distal humeral fractures displayed stable fixation, early mobilization along with minimum soft tissue loss<sup>7</sup>. 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.

### Materials and Methods

This was a prospective, observational study conducted in the Department of Orthopedics, Bheri Hospital, Nepalganj situated in the mid western region of Nepal after taking ethical permission from the hospital authority on patients presenting with a history of trauma to distal humerus and diagnosed of having extra articular fracture distal humerus (only A2 and A3 type) on radiographic evaluation during the period from July 1, 2018 till June 30, 2020.

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.

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 not included in the study.

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 taken from the patients before the surgery.

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 and sterile bandaging was done.

Post operatively the patients were administered with intravenous antibiotics and continued for 48 hours. Routine analgesics were given as per the requirement. Radiographic evaluation was done. Sutures were removed on 10-12<sup>th</sup> 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. Final outcome was assessed using Mayo Elbow Performance Score<sup>8</sup>.

The collected data was entered and analyzed 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 significance.  $p < 0.05$  was considered as statistically significant.

**Results**

A total of 30 patients were included in this prospective study. Regarding the type of fracture, 25 (83.3%) patients elicited close distal humerus fracture and 5 (16.7%) patients had open grade 1 fracture. The mean age of the patients was  $40.12 \pm 7.5$  years ranging between 24 -58 years.

In our study, male preponderance was observed with 70% was males and 30% were females respectively. The major reason for trauma was due to road traffic accidents and fall which was

observed in 60% and 30% of patients respectively. Right upper limb involvement was observed 73.3% of the patients. AO Type 13- A2 was the most prevalent fracture type observed in 21 (70%) of the patients. The average duration between injury and surgery interval was  $4 \pm 1.6$  days and in majority of the cases (76.7%) the duration was 2- 5 days. The average duration of surgery was  $1.7 \pm 0.45$  hours and in 60 % of patients the duration was 2 hours. The average duration of hospital stay was  $9 \pm 3.5$  days and in 56.7% of patients the duration was 7-12 days. In this study, majority of patients, 70% had not developed any complications and the major complication was palpable implant which was observed in 16.7% of the patients. Mild pain was observed in 60% of the patients. The mean arc of motion was  $98.5 \pm 14.25^\circ$  and majority of the patients 56%, displayed the arc of motion between 50-100°. The results were shown in table 1.

**Table 1:** Demographics and clinical variables of the study population (n=45)

Variable	N (%)
Age, Mean(SD)	$40.12 \pm 7.5$
Gender	
Male	70%
Female	30%
Side of fracture	
Left	26.7%
Right	73.3%
Duration between injury and surgery interval (days)	$4 \pm 1.6$
Duration of surgery (hours)	$1.7 \pm 0.45$
Duration of hospital stay (Days)	$9 \pm 3.5$
Mean arc of motion in (°)	$98.5 \pm 14.25$

In this study, the mean overall union time was  $18.2 \pm 3.6$  weeks. Further, the union time was higher in Type 13-A3 fracture as compared to Type 13-A2 fracture ( $20.5 \pm 4.1$  vs  $16.2 \pm 3.4$  weeks). The results were shown in table 2.

**Table 2:** Average union time among the patients

Fracture (AO Type)	Average Union Time (in weeks) $\pm$ SD
Type 13-A2	$16.2 \pm 3.4$
Type 13-A3	$20.5 \pm 4.1$

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  $82 \pm 12.7$ . Further the function outcome based on the score was excellent in 8 patients (26.7%), good in 17 patients (56.7%), fair in 2 patient (6.7%) and poor in 3 patients (10%). The poor and fair results in 5 patients were due to non-union, superficial infection, exposed & palpable implants due to severe comminution (multi fragmentary fracture).The results were shown in table 3.

**Table 3:** Functional outcome based on the Mayo elbow performance score among the study participants

Results	No. of Patients	Percentage (%)
Excellent	8	26.6
Good	17	56.7
Fair	2	6.7
Poor	3	10
Total	25	100

In the present study, there was no significant difference in the Mayo elbow performance score and the type of fracture ( $p=0.42$ ). Out of the 21 patients who had A2 type of fracture, Mayo elbow performance score grade of 18(85.7%) patients was good & excellent while only 3(14.3%) patient showed poor grade. Meanwhile, in A3 type of fracture, majority 7 (77.7%) of patients showed good & excellent grade. The results were shown in table 4.

**Table 4:** Comparison of MEPS grade and type of fracture among the patients

MEPS Grade	Type of Fracture		P value
	13-A3 (%)	13-A2 (%)	
Good & Excellent	18 (85.7%)	7 (77.7%)	0.42
Fair & Poor	3 (14.3%)	2 (22.3%)	
Fair & Poor	3 (14.3%)	2 (22.3%)	

**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<sup>9</sup>. Meanwhile, surgical intervention is associated with the complications such as non-union, radial nerve palsy, surgical site infections and symptoms related to the implants<sup>10</sup>. 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.<sup>11</sup> modification of the lateral tibial head buttress locking plate of same side is carried out for fixation of fractures 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.<sup>12</sup> 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 as a result of small calibre screws used at bone fragments of shorter size. The outcome of 21 patients reveals that the healing of fractures 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<sup>5</sup>. 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 centre from the humerus long axis, however the plate obliquity hinders the effective fixation<sup>13</sup>. In addition the parallel and orthogonal dual plating have been used for the fixation of distal humerus fractures<sup>14</sup>. Meanwhile, dual plating elicits various complications such as dissection of soft tissue, infection and non-union. A saw bone model study done by Scolaro et al.<sup>15</sup> showed that the single precontoured posterolateral extra-articular LCP have marked bending, torsional and yield strength as compared to routine 3.5mm LCP for distal humerus fracture fixation. 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  $38.9 \pm 9.6$  years with male preponderance. In our study, the average time to fracture union was  $16.7 \pm 4.5$  (range 12-30 weeks) which is relatively lower when compared to Jain et al.<sup>16</sup> (22.4 weeks) and higher as compared to Trikha et al.<sup>17</sup> (12 weeks). Similar to our report in Ali et al.<sup>7</sup> 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 inter-observer variation in the analysis of reunion time is also a possible factor<sup>18</sup>.

Previous study shows that precontoured 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<sup>19</sup>. In our study, mean arc of elbow movement was  $98.5 \pm 14.25^\circ$ , mean MEPS score was  $85 \pm 13.8$  which are similar to the study conducted by Jain et al.<sup>16</sup> and Ali et al.<sup>7</sup> 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<sup>16</sup>.

### 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.

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