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## Clinical study on the management of extra-articular distal humerus fracture treated with extra-articular distal humeral locking compression plate

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### Abstract

**Background:** Extra-articular distal humerus fracture treatment is a controversial topic. One group of surgeons favor non-operative treatment with plaster cast immobilization and functional bracing, while the other favors operative fixation. Concern of radial nerve injury, mal aligned fracture ends and stiffness of the shoulder and elbow following non-operative treatment are the major reasons to opt for an operative fixation. Distal humerus fractures surgeries remain one of the most challenging orthopaedic surgeries. These fractures have a complex anatomy, occurs in osteoporotic bone and are commonly multi-fragmented. The Extra-articular Distal Humeral Locking Compression Plate is a useful treatment option for managing extra-articular distal humerus fractures. Due to the greater screw hole density of the plate distally and using 3.5-mm screws instead of 4.5 mm allows adequate number of screws to be placed to hold the small distal fragment.

**Materials and Methods:** A prospective clinical study was carried out for a total of 20 cases of extra-articular distal humeral fractures between 18 years and 65 years attending OPD and Emergency Department of Orthopaedics, Silchar Medical College and Hospital who meet inclusion and exclusion criteria from 1<sup>st</sup> June 2017 to 31<sup>st</sup> May 2018. All the cases were operated with EADHP. The time for union, range of motion at elbow and complications were recorded in followup. The elbow function was assessed using the Mayo Elbow Performance Score (MEPS) and pain by Visual Analogue Score (VAS).

**Results:** There were 20 patients (13 males and 7 females) with an average age of 38.85 years. 10 cases were 12B1; 3 cases were 12A1; 2 cases each were 12A2, 12B2 & 12C1 and 1 case was 12C2. The mean time of radiological union was 14.25 weeks. The average duration of follow-up was 9.25 months with a range of 6-12 months. The average range of motion in the study at the 6 months analysis was 0.50<sup>0</sup> – 125.5<sup>0</sup>. The mean Mayo Elbow Performance Score at the end of 6 months was 95.5, and ranged from 80 to 100. The average visual analogue score was 0.745 cm at the end of 6 months and ranged from 0 to 4cm. All the fractures showed union except one. There was one incidence of plate failure which was reoperated and it got united after 20 weeks of the revision surgery. There were 4(20%) patients who had complications. Two patients had post-operative neuropraxia, one patient had plate failure and in one patient there was loss of 10<sup>0</sup> extension.

**Conclusion:** Extra-articular Distal Humeral Locking Compression Plate fixation of distal humerus fractures using the paratricentral approach provides stable fracture fixation with adequate exposure of the radial nerve and 90% of posterior humeral shaft surface.

**Keywords:** Distal humeral, extra-articular, Postero-lateral, LCP

### 1. Introduction

Extra-articular distal humerus fracture comprises of about 16% of humerus fracture and 3% of all the fractures in adults [1]. The treatment of these fractures is controversial. There are two schools of thoughts. One group of surgeons favors non-operative treatment with plaster cast immobilization and functional bracing, while the other favors operative fixation [2]. Stewart *et al.* proposed that hanging cast is not ideal to treat distal humerus fracture, as the angulation is difficult to correct [3]. Sarmiento *et al.* reported that distal humerus fracture treated with functional bracing can achieve higher union rates with good functional outcome with added benefits of less complications [2].

Concern of radial nerve injury, mal-aligned fracture ends and stiffness of the shoulder and elbow following non-operative treatment are the major reasons to opt for an operative fixation [4].

Jawa *et al.* (2006) compared the results of functional bracing and plate fixation for extra-articular distal third diaphyseal fractures of the humerus and came to a conclusion that surgical treatment is better in terms of alignment, also the patients can return to their functions quicker. But carries a risk of iatrogenic nerve injury, infection and a need of second operation [4].

The peculiar anatomy of the distal humerus with transition from round to flat cross-section and narrow medullary canal makes locking intra-medullary nails a remote option for operative management. Also, radial nerve injury cannot be addressed [5].

Majority of the studies are in favor of using a 4.5 mm low-contoured dynamic compression plate. The plate should hold eight cortices in both the proximal and distal fragments. But for the fractures of the distal humerus this technique of plate fixation does not yield good results. Firstly, the small size of the distal fragment in humerus dia-metaphyseal fractures does not provide adequate area to hold eight cortices and secondly, the distal end of the plate may impinge on the olecranon fossa [5, 6].

Double plating techniques using two 3.5 mm plates in orthogonal (90°-90°) or parallel (180°) patterns can be used to deal with the problem of distal fixation. But, this method also has its own drawback of non-union, infection, extensive soft tissue destruction and longer operative time [4, 7].

To deal with all these problems Moran proposed to use an oblique posterior plate with an orientation of 5° to 8° angle of centre from the long axis of the humerus. This plate improved distal fixation but due to its obliquity, the proximal fixation was limited which caused a great deal of problems in complex fractures like comminuted or segmental fractures [8].

In the year 2005, Levy reported promising result by using a modified plate which has angular offset of 22° [9].

The extra-articular distal humeral locking compression plate is designed to tackle all the above problems. The shape is pre contoured to be placed in the centre of humeral diaphysis proximally and distally over the lateral supracondylar ridge [10]. This plate has the benefit that a purchase of eight cortices can be easily obtained distally and also due to the oblique design, there is no impingement on the olecranon fossa. Furthermore, as only a single plate is used, the operating time is relatively shorter. Also due to minimum soft tissue dissection, rehabilitation is faster [10].

## 2. Materials and Methods

This prospective study was conducted on 20 patients with age ranging from 21 to 62 years with closed extra-articular distal humeral fractures. They were treated with extra-articular distal humeral locking compression plate and followed up in the Department of Orthopaedics, Silchar Medical College and Hospital, Silchar from 1<sup>st</sup> June 2017 to 31<sup>st</sup> May 2018. Open fractures and patients with neuro-vascular injuries were excluded from the study. Maximum number of cases was in the age group of 31-40 years (8 cases, 40%) with an average age of 38.85 years. Male outnumbered female by a ratio of 1.86:1 (male-13, female-7). The commonest mode of injury was road traffic accident (10 cases, 50%), followed by fall (7 cases, 35%). Fracture of the left humerus was more common (12 cases, 60%) than the right humerus (8 cases, 40%). 10 cases were 12B1; 3 cases were 12A1; 2 cases each were 12A2, 12B2 & 12C1 and 1 case was 12C2. AO/OTA classification was used to classify the fractures (Fig. 1). 3 cases had associated injuries. One case had ipsilateral tibia fracture, one case had ipsilateral both bone leg fracture and the third case had contralateral radius fracture. All cases were operated within 7 days following injury.

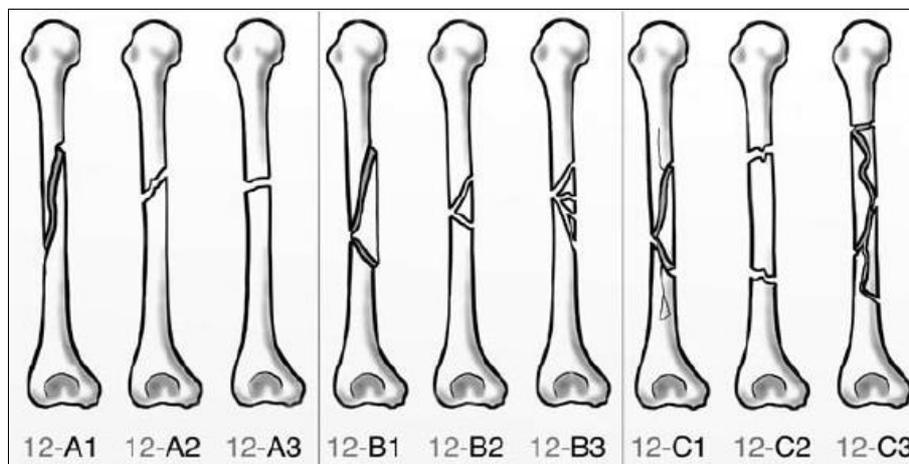


Fig 1: AO/OTA Classification of diaphyseal humerus fracture

**2.1 Extra-articular distal humeral locking compression plate:** We used the 3.5-mm LCP (Locking Compression Plate) extra-articular distal humerus plate. It is an anatomically shaped and angular stable fixation system for extra-articular fractures of the distal humerus. It is a “J” shaped plate. The plate is precontoured to be applied on the posterolateral surface of the distal humerus. It is separate for right and left sides. Proximally, the plate has elongated 3.5 mm combination hole system for the humeral shaft. Distally, to avoid the olecranon fossa it curves along the lateral supracondylar ridge of the humerus. There are five 3.5-mm

locking screws distally. The plate is tapered distally to minimize soft tissue irritation. To accommodate larger number of screws distally the screw hole density is greater. The two distal most screw holes are angled towards the capitellum and trochlea, which allows longer locking screws to be placed distally. A fixed-angle construct is created by the locking screws and also provide angular stability, whereas inter-fragmentary or dynamic axial compression is provided by using the combi-holes. It is available from 4 hole (122 mm) to 14 (302 mm) hole length.

**2.2 Surgical technique:** Tourniquet was not used as it hinders in the exposure of the radial nerve. All the surgeries were performed by the consultants of our department. Posterolateral paratriceps approach described by Gerwin *M et al* was used in all the cases. The advantage of this approach is that it gives complete access to the posterior surface of the humerus. Procedures like triceps splitting or additional procedure like Chevron osteotomy is not needed. A straight longitudinal incision in the midline of the posterior aspect of the arm, from 8cm below the acromion to the olecranon fossa extending distally between the lateral epicondyle of the humerus and the tip of the olecranon 4 cm distal to the elbow joint was made. After exposing the triceps and reflecting it medially, a branch of the radial nerve called the lower lateral brachial cutaneous nerve, was isolated at the level of lateral intermuscular septum. This nerve was traced proximally to reach the radial nerve. The septum over the nerve was incised. The lateral and medial head of the triceps were elevated subperiosteally from lateral to medial direction. Taking a loop the radial nerve was tagged and isolated. The fracture fragments were exposed and the reduction was temporarily held with the help of clamps and K wires. If needed one or two 3.5mm lag screws were used. 3.5mm pre-countoured extra articular distal humerus Locking Compression Plate (LCP) was used in all the cases. The plate was put beneath the radial nerve and profunda brachii artery and fixed with locking screws. In case of wedge or comminuted fractures lag screw fixation and/or encirclage were used. Then post-operative sterile dressing was done and arm was kept in a arm sling pouch.

**2.3 Post-operative protocol:** Passive mobilization of shoulder and elbow was started gently on the 1st postoperative day once the patient could tolerate pain. Within the first week active and assisted movements of the arm in the

sling were encouraged. Resistive and weight bearing exercises were allowed only after the radiological progress of bone union. Follow-up was carried out at 2,6,9,12,16 and 20 weeks and then at 2 monthly intervals. Union at the fracture site was defined as bridging callus in a minimum of three cortices on antero-posterior and lateral radiographs combined with a lack of tenderness at the fracture site or un-assisted weight bearing. The functional results were evaluated using Mayo Elbow Performance Score (MEPS) and Visual Analogue Scale for pain. The Mayo Elbow Performance Score (MEPS) assesses motion in terms of flexion and extension. Neither strength nor deformity is included in the content of the scale. Function and motion are weighted less heavily than pain. The maximum MEPS was 100 points. The VAS score is determined by measuring in millimeters and centimeters from the left hand end of the line to the point that the patient marks.

**3. Results**

The average duration of follow-up was 9.25 months with a range of 6-12 months. The mean time of radiological union was 14.25 weeks. All the fractures showed union except one. There was one incidence of plate failure which was reoperated and it got united after 20 weeks of the revision surgery. Two patients had post-operative neuropraxia (10%), one patient had plate failure and in one patient there was loss of 10° extension. The patients with post-operative neuropraxia recovered during follow up. At the end of 6months of follow up the mean Mayo Elbow Performance Score was 95.5, and ranged from 80 to 100. 19 out of 20 patients had excellent MEPS score and 1 patient had good score. The average visual analogue score was 0.745 cm at the end of 6 months and ranged from 0 to 4cm. The average range of motion in the study was 3.25° – 109.3° at 6 weeks. At the 6 months analysis the mean range of motion was 0.50° – 125.5°.



**Fig 2:** Pre-operative and immediate post-operative AP and Lateral view of distal humerus fracture fixed with extra-articular distal humeral locking compression plate.



**Fig 3:** Union noted in 12 post-operative weeks



**Fig 4:** Range of motion at 12 weeks post-operative



**Fig 5:** Plate failure, corrected by a secondary surgery

#### 4. Discussions

Extra-articular distal humerus fracture treatment is a controversial topic. One group of surgeons favor non-operative treatment with plaster cast immobilization and functional bracing, while the other favors operative fixation [2]. Keeping our aims of the study at high, we presented the clinical study of surgical treatment of 20 extra-articular distal humeral fractures. The analysis of the results were made in terms of age incidence, sex incidence, side of involvement, fracture characteristics, mode of injury, time interval between trauma and surgery, operative time, duration of hospital stay, period of radiological union, results in terms of union, elbow range of motion, functional results, complications and comparison with similar studies.

This study was conducted to examine the short term results, particularly early functional results and complications and healing rate of extra-articular distal humeral fractures fixed with extra-articular distal humeral locking compression plate.

As most of the time the size of the distal fragment is small and for a conventional plate it becomes difficult to hold the fragment. Double plating techniques using two 3.5 mm plates in orthogonal (90°-90°) or parallel (180°) patterns can be used to deal with the problem of distal fixation. But, this method also has its own drawback of non-union, infection, extensive soft tissue destruction and longer operative time [4, 7]. Moran used an oblique posterior plate with an orientation of 5° to 8° angle of centre from the long axis of the humerus. This plate improved distal fixation but due to its obliquity, the proximal fixation was limited which caused a great deal of problems in complex fractures like comminuted or segmental fractures [8].

The extra-articular distal humeral locking compression plate has the benefit that a purchase of eight cortices can be easily

obtained distally and also due to the oblique design, there is no impingement on the olecranon fossa. Furthermore, as only a single plate is used, the operating time is relatively shorter. Also due to minimum soft tissue dissection, rehabilitation is faster [10].

Zhiquan *et al.* (2007) [11] treated 13 distal third humeral shaft fractures with minimally invasive percutaneous osteosynthesis (MIPO). They reported that the fractures united with a mean healing time of 16.2 weeks.

Capo *et al.* [12] retrospectively studied 21 patients with distal humerus fractures who were treated with the EADHP to evaluate clinical and radiographic outcomes after open reduction and internal fixation. They concluded that for extra-articular distal humerus fractures, the anatomically shaped angular stable single-column plate provides satisfactory clinical and radiographic results.

Fawi *et al.* [13] came to a conclusion that with the usage of the Synthes plate for extra-articular fracture satisfactory results can be obtained and they have made it the technique of choice in their centre because it provides excellent results.

Kharbanda *et al.* [14] concluded that the EADHP system using the modified posterior approach to the humerus is a useful treatment option for extra-articular distal humerus fractures.

In our study the majority of the fractures involved the productive age group 30-60 years. Majority of the other studies like Jain *et al.*, Butala *et al.* and Capo *et al.* showed the third decade to be the most affected one, in our study too the third decade was the most affected one.

In our series majority of the patients were males 65%. This could be attributed to our Indian setup where the female population largely work indoor or in agricultural fields and do not travel much. Our findings for sex incidence were

comparable to the results in various studies done all over the world. Mostly it was the male sex which was predisposed to high velocity distal humeral fractures due to more active lifestyle.

RTA was the most prominent cause of injury followed by fall in our study. Most of the studies also depicted that the two major modes of injuries were RTA and fall. RTA was the most common cause of these types of extra-articular distal humeral fractures in all of the studies discussed.

All the cases included in our study group were fresh fractures. All the cases were operated within 7 days following injury. The mean interval between trauma and surgery was 3.05 days (range 2 -7 days). The delay was due to delay in arrival at the hospital, medical condition of the patients and associated injuries.

The duration of the surgery ranged from 40 to 66 minutes with a mean of 52.2 minutes. The mean time of radiological union was 14.25 weeks (12-20 weeks). All the fractures showed union except one. There was one incidence of plate failure which was reoperated and it got united after 20 weeks of the revision surgery. The average range of motion in the study was  $3.25^{\circ} - 109.3^{\circ}$  at 6 weeks. At the 6 months analysis the mean range of motion was  $0.50^{\circ} - 125.5^{\circ}$ . Range of movement of the elbow joint was good after operative treatment for extra-articular distal humeral fractures, when mobilization of the elbow joint was started immediately. Our results were comparable to the results shown by the previous

studies.

The mean Mayo Elbow Performance Score in our study was 95.5 which is comparable to the results showed by Jain *et al.* [15], Trikha *et al.* [16] and Butala *et al.* [17]. The mean Visual Analogue Scale was 0.745 cm which is comparable to the results of Sclaro *et al.* [18]. All the patients were regularly followed up and checked for early and late complications. There were 4(20%) patients who had complications. Following were the complications noted in the patients within the study period. Two patients had post-operative neurapraxia, one patient had plate failure and in one patient there was loss of  $10^{\circ}$  extension. 18 of the 20 patients were satisfied with the surgery, 2 patients were unsatisfied. Of the 2 unsatisfied patients 1 had post-operative neurapraxia and 1 had plate failure.

Every study has its limitations. Our study also was not any exception. We acknowledge that with more number of cases in this study the results and observations would have been more accurate and statistically significant. Although, we did not encounter any problems related to the quality of implants, but we could not use implants of international standard in the patients due to prohibitive cost and our patients could not afford them. Long term follow-up is also required to see the full functional outcome and long term complications. This was not possible in our study as the study duration was only for twelve months.

**Table 1:** Comparison between duration of radiological union

Study	Year of study	Duration of Radiological Union
Chavan <i>et al.</i> [19]	2017	13±0.6 weeks (13-19 weeks)
Jain <i>et al.</i> [15]	2017	22.4 weeks (16-28 weeks)
Fawi <i>et al.</i> [13]	2015	15.7 weeks (9-34 weeks)
Kharbanda <i>et al.</i> [14]	2017	12 weeks (10-18 weeks)
Butala <i>et al.</i> [17]	2017	23.5 weeks
Capo <i>et al.</i> [12]	2014	7.3 months (3-13 months)
Trikha <i>et al.</i> [16]	2017	3 months
Present Study	2017-2018	14.25 weeks (12-20 weeks)

**Table 2:** Comparison of complications

Study, Year	Complications	No. of cases	Total Complications/Total Cases (Percentage of Complications)
Jain <i>et al.</i> [15]	Brachial plexus injury	1	13/26(50%)
	Non-union	3	
	Screw failure	2	
	PIN injury	2	
	Post op radial nerve palsy	4	
Fawi <i>et al.</i> [13]	Wound infection	1	2/23(8.70%)
	Post op radial nerve palsy	1	
Chavan <i>et al.</i> [19]	Plate removal due to distal plate prominence	1	1/47(2.13%)
Butala <i>et al.</i> [17]	Post op radial nerve palsy	1	4/20(20%)
	+ $10^{\circ}$ loss of extension	3	
Present Study	Post op radial nerve palsy	2	4/20(20%)
	Plate failure	1	
	Loss of $10^{\circ}$ extension	1	

## 5. Conclusion

After the study we come to a conclusion that the Extra-articular Distal Humeral Locking Compression Plate is a useful treatment option for managing extra-articular distal humerus fractures. Due to the greater screw hole density of the plate distally and using 3.5-mm screws instead of 4.5 mm allows adequate number of screws to be placed to hold the distal fragment. Fixation of distal humerus fractures with this plate using the paratricentral approach provides stable fracture

fixation with adequate exposure of the radial nerve and 90% of posterior humeral shaft surface.

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