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Study of surgical fixation of extra-articular distal third humerus fractures with a posterolateral locking compression plate

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ABSTRACT

Background: Fractures of the adult distal humerus account for approximately 2% of all fractures and represent a third of all humerus fractures. Fractures of the distal third of the humerus are challenging injuries due to their peri-articular location, small size of the distal bone fragments, and the osteopenic quality of the bone in older adults. Aim of our study was to evaluate the clinical, radiographic and functional outcomes of posterolateral locking compression plate for extra-articular distal third humerus fractures through posterior triceps splitting approach.
Methods: This is a prospective study done at All India Institute of Medical Sciences, Patna in which 30 consecutive skeletally mature, closed extra-articular distal humerus fractures underwent fixation with posterolateral locking compression plate and outcome evaluated in terms of radiological evidence of healing, functional outcome and complications if any.
Results: Use of posterolateral plate results in predictably good union rates and excellent results terms of patient outcome without any implant related complications.
Conclusions: We recommend using this posterolateral plate for these humerus fractures, because of its consistent results with respect to fracture union, stability across the fracture site and early mobilization for better functional results.

Keywords: Humerus fracture, Fracture fixation, Posterolateral locking plate

INTRODUCTION

Fractures of the adult distal humerus account for approximately 2% of all fractures and represent a third of all humeral fractures.[1,2] There is good evidence that the overall incidence of distal humerus fractures is increasing worldwide.[3,4] There is a bimodal distribution with respect to age and gender, with peaks of incidence in males aged 12 to 19 years and females aged 80 years and over. In males the incidence of fractures declines with age until 7th decade. In females, incidence falls slightly between 2nd and 3rd decades and then increases with age.[5] High energy trauma, mainly during road side accidents and sports injuries, is responsible for the majority of injuries in young patients. The fractures are caused primarily by simple falls in middle aged and elderly females in which the elbow is struck directly or axially loaded if fall is on outstretched hand.[5,6]

Fractures of the distal third of the humerus are challenging injuries due to their peri-articular location, small size of the distal bone fragments, and the osteopenic quality of the bone in older adults.[7]

Methods of management of distal humerus fractures include conservative management using plaster cast immobilization or functional bracing, plate osteosynthesis and intra-medullary nailing.[8-10]

Although these fractures can be treated conservatively with satisfactory union but the operative treatment is preferred due to risks of radial nerve injury (during either closed reduction or movement of the fracture ends), difficulty controlling fracture alignment and elbow stiffness after conservative treatment.[11-14]

Operative treatment provides more predictable alignment as well as immediate stability allowing early mobilization.

Distal third humerus fractures can be exposed better through posterior approach which offers good exposure of radial nerve.

Meticulous reduction and absolute stable fixation comes at a price. Literature has evidence to show the supremacy of biological fixation over a stable mechanical fixation as a result of which various new techniques were developed for biological fixation for fractures.

Fixation of acute distal humeral shaft fractures and fracture non-unions is often challenging, as it is difficult to adequately stabilize these fractures without compromising elbow motion. Most authors have recommended managing these fractures using a 4.5 mm low-contact dynamic compression plate (LC-DCP) with 4.5 mm diameter screws and obtaining 6 to 8 cortices of purchase on either side of the fracture.[14-16]

Several authors have recommended managing distal humerus fractures by centring the plate on the shaft.[17-20] However, distal humeral shaft fractures that occur at the junction of the metaphysis are more difficult to manage, as a plate of adequate length often impinges on the olecranon fossa.

Moran recognized this problem and proposed using an anterolateral approach to the distal humerus to place the narrow 4.5 mm DC plate posteriorly at a 5° to 8° angle off-centre from the long axis of the humerus along the lateral column with the most distal screw angled proximally.[21]

This technique, however, presents an additional problem with proximal fixation, especially in the face of proximal segmental extension or comminution, as the oblique nature of the plate prevents the placement of additional necessary proximal fixation.

The posterolateral plate modification allows for direct central placement of the 3.5 mm LCP extra-articular distal humerus plate on the shaft, with the head portion providing a low profile built-in plate angulation extending farther distally and providing 3 or 4 additional holes for screw purchase distal to the meta-diaphyseal junction, without impingement into the olecranon fossa.

Aim of our study was to evaluate the clinical, radiographic and functional outcomes of posterolateral locking compression plate for extra-articular distal third humerus fractures through posterior triceps splitting approach.

METHODS

This prospective study was hospital based, and was conducted at All India Institute of Medical Sciences, Patna from July 2016 to March 2018. Patients were selected from those who had attended the emergency and outpatient department. A clearance from ethical committee of institute was obtained. Written informed consent was obtained from all the patients or their family for participation in the study.

Thirty skeletally mature (with fused physis around elbow) consecutive patients who presented to the department of orthopaedics with fresh extra-articular distal 3rd humerus fracture not more than 1 month old were included in the study. Inclusion criteria were Patients with extra-articular distal one third humerus fracture, age more than 20 years and those who were fit for surgery and gave consent to participate in the study.

Exclusion criteria were patients below the age of 20 years, those who were unfit for surgery due to the associated comorbidities and those not willing to participate in the study or rehabilitation protocol. On admission demographic data was recorded and thorough history and clinical examination was done. Neurovascular status and radiological assessment of the fractured limb was done. Patients were investigated further depending on the general condition and co-morbidity of the patient and the routine pre-operative protocol was followed as per our hospital guidelines.

We used AO Synthes posterolateral locking compression plate 3.5 mm LCP extra-articular distal humerus plate in all 30 patients and the approach was posterior triceps splitting approach in all cases (Figure 1).

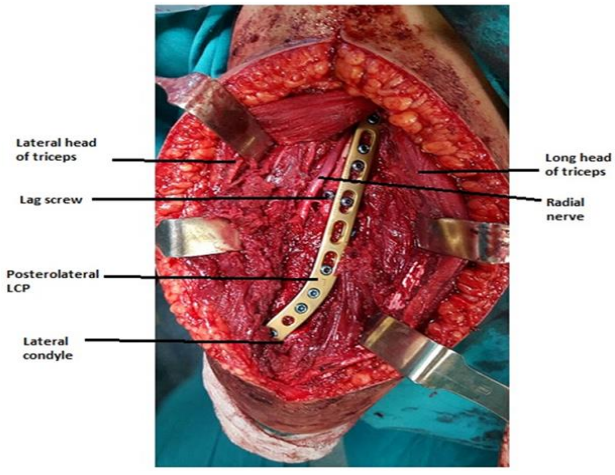

Figure 1: AO Synthes extra-articular distal humerus plate.

Position of the patient was lateral decubitus with arm over padded bar allowing elbow flexion.

General condition and fluid balance of the patient were monitored closely in the immediate post-operative period. Anti-biotics were given as per hospital protocol. Analgesics and other supportive management was given according to the patient need. The patients were discharged according to the overall well-being of the patient, preferably on third or fourth day, with medications convenient to be taken at home. Postoperatively, range of motion of the shoulder and elbow is begun within the two weeks.

Patients were evaluated both clinically and radiologically at 2 weeks, 6 weeks, 3 months and 6 months postoperatively.

Follow up

1. The course of fracture healing was documented radiologically (with minimum of 6 weeks between successive radiographs).
2. Evaluation of any possible loss of reduction that might have occurred, compared to immediate post of radiographs.
3. Assessment of functional status using mayo elbow performance score at 6 months post-operatively.
4. Assessment and analysis of any complications observed in terms of loss of reduction, infection, problems of union and implant failure.

No patient was lost in our follow up period of 6 months.

Statistical analysis

It was done by using MS excel to calculate mean and percentage. The graphical study method from MS Excel was used.

RESULTS

Patient age in our study varied from 21 years to 66 years. Most of the patients (26.67%) belonged to either between 31 to 40 years or between 51-60 years indicating the need for use of LCP in an adult (Table 1). More than two-third of the patients in our study were male (n=21) out of total thirty patients, reflecting the general population visiting the hospital (Table 2). Sixty percentage of our patients (n=18) suffered injury of the left side and the remaining (n=12) of the right side, with no bilateral involvement (Figure 2).

Road traffic accident (RTA) was the major cause of injury in our study group, contributing 70% (n=21) of mode of injury. Injury to the rest (n=9) was due to fall either from stairs or by slip on the floor. Of RTA patients, 15 were males and 6 were females. While of patients with injury due fall, 6 were males and 3 were females. Six patients out of nine, with injury due to fall, belonged to age group of more than 50 years. In the younger patients, main mode of trauma was RTA **(**Figure 3).

Table 1: Age distribution.

Age group (years)	Number of patients	%
21-30	7	23.33
31-40	8	26.67
41-50	4	13.33
51-60	8	26.67
>60	3	10

Table 2: Sex distribution.

Gender	Number of patients	%
Male	21	70
Female	9	30

Table 3: Fracture union time.

Duration (weeks)	Number of patients
12-16	22
17-20	6
21-24	2
>24	0

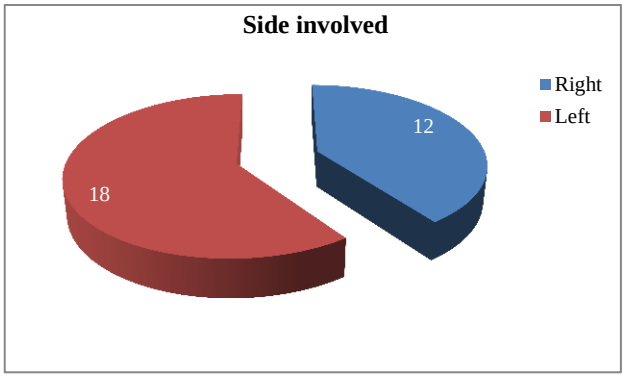

Figure 2: Side involvement.

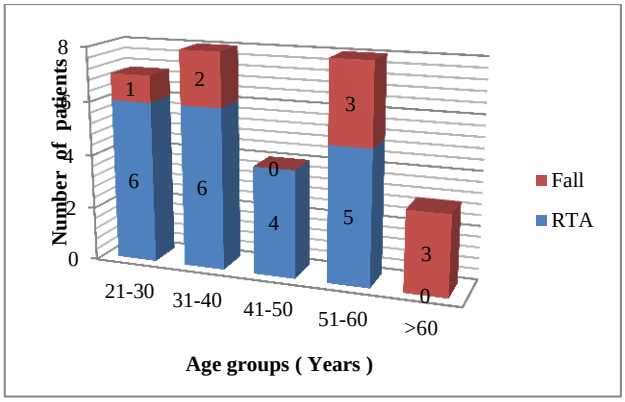

Figure 3: Mode of injury in various age groups.

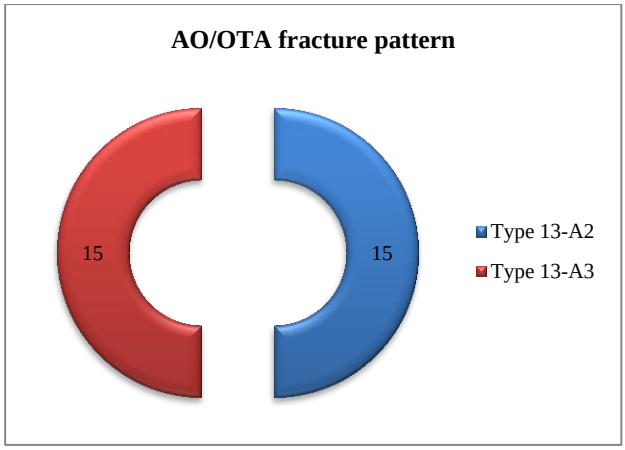

Figure 4: Fracture pattern.

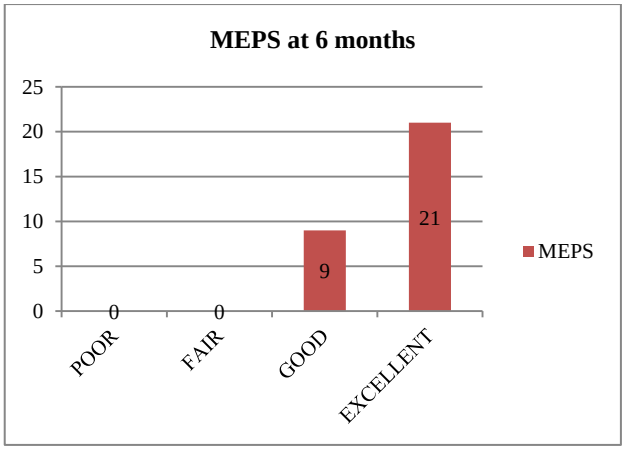

Figure 5: Mayo elbow performance score at 6 months.

None of the patients in our study group had compound injury. Our study included distal extra-articular fracture of humerus AO/OTA type 13-A2 and 13-A3. Out of 30 patients, 15 patients were belonged to type A2 and 15 to type A3 (Figure 4).

All of our thirty patients achieved fracture union in 6 month follow up period. Out of 30, 22 patients (73.33%) had fracture union by 16 weeks. Six patients (20%) achieved fracture union by 20 weeks while the rest two (6.67%) by 24 weeks. Eight patients had delayed union but no case of non-union was seen (Table 3). No other complication was noted.

Assessment of range of motion at elbow joint yielded following results:

At 6 weeks: The mean arc of motion was 79.83^{o}, the mean range of motion was from 16^{o} to 95.83^{o}.

At 3 months: The mean arc of motion was 93.67^{o}, the mean range of motion was from 11.33^{o} to 105.33^{o}.

At 6 months: The mean arc of motion was 103.67^{o}, the mean range of motion was from 9^{o} to 112.67^{o}. Mean MEPS at six months follow up was 93.17.

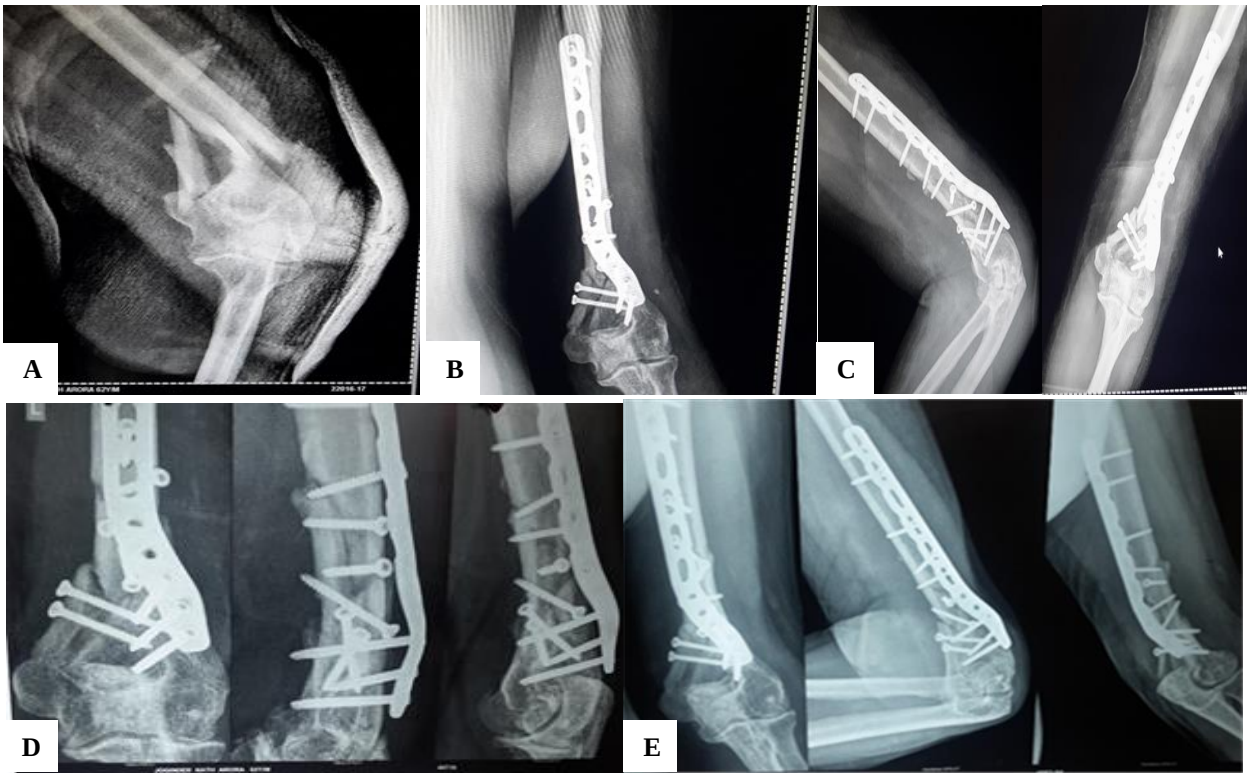

Figure 6: (A) Preoperative radiograph; (B) immediate postoperative; (C) at 6 weeks post op; (D) at 3 months; (E) at 6 months.

Figure 7: (A) Preoperative radiograph; (B) immediate postoperative; (C) at 6 weeks postop; (D): at 3 months postop; (E): at 6 months postop.

DISCUSSION

Fractures of the adult distal humerus account for approximately 2% of all fractures and represent a third of all humeral fractures. The most common fracture pattern is an extra-articular fracture (OA/OTA type A) accounting for just under 40% of all distal humerus fractures.

Distal humerus are very challenging to treat. They are commonly comminuted with long butterfly fragment, occur in osteoporosis and have complex anatomy with limited options for internal fixation. Extra-articular humerus fractures can potentially be treated non-operatively in functional brace. It is however, cumbersome and difficult for patients initially and has been associated with skin problems, mal-alignment, joint stiffness and risk of nerve injury during reduction or fracture mobility.

Operative treatment has been shown to provide more predictable alignment and immediate fracture stability, allowing early elbow mobilization.

We treated thirty patients with extra-articular distal humerus fractures using anatomically pre-contoured 3.5 mm LCP extra-articular distal humerus plate. The results obtained in our study were favourable.

Our study included patients with AO/OTA fracture type A2 and A3; and represented equal incidence of both types. All fractures in our study had united by 24 weeks, both clinically and radiologically. Mean duration of fracture union was 15.67 weeks.

Study done by Fawi et al in 2014 had mean duration of fracture union as 15.7 weeks while another study done by chowdary et al in 2015 had mean duration of fracture union as 12 weeks.[22,23]

Mean arc of elbow flexion–extension at six month follow up was 103.67^{o} with mean range of motion from 9^{o} to 112.67^{o}.

27 patients (90%) had range of motion 90 degrees or more and only 3 patients (10%) had range of motion less than 90 degrees. Study done by Levy et al in 2005 found mean flexion as 112°, arc of motion 101° and mean extension as 11°.[24] Similarly another study done by Capo et al in 2014 found out mean flexion as 126°, arc of motion as 119° and mean extension as 7°.[25]

In our study the problem of extensor lag of more than 10 degrees was seen in 5 patients, while the extensor lag of more than 5 degrees was seen in 13 patients.

Tarkin et al, however, has shown that the triceps sparing approaches positively affects the extensor lag as opposed to triceps splitting approach.[26]

The problem of extensor lag should have been addressed with more aggressive rehabilitation by elbow mobilisation during within postoperative week.

Our case series resulted mean MEPS of 93.17 with 70% excellent results and 30% good results, and all patients returning to pre-injury daily activities (Figure 5).

As per earlier studies and literature, distal third humerus plating has potential risks of non-union, iatrogenic radial nerve palsy, infection, implant irritation, implant failure and ulnar neuritis. Our study group had reported the complication of delayed union in 26.67% (n=8) cases, but no case of non-union. Our study had no case of iatrogenic radial nerve palsy.

No case reported the complication of hardware failure, loss of reduction, infection or ulnar neuritis.

In our study the management of extra-articular distal third humerus fracture with anatomically pre-contoured 3.5 mm LCP Extra-articular distal humerus plate, along with early mobilisation, results in predictably good union rates and excellent results terms of patient outcome. The stability of locking construct by providing extra purchase due to shape of plate as well as minimal periosteal compromise, provides high union rates even in osteopenic and communited fractures.

The advantage of this plate is that its distal contour obviates the risk of olecranon fossa impingement, it has low profile to minimise soft tissue irritation and it has high density of distal locking screws to maximize the fixation. Its shape makes it useful in long oblique fractures with proximal extension allowing central placement of plate on the humeral shaft. These features make it an ideal implant for such fractures.

The more aggressive approach of rehabilitation with elbow mobilisation during first week should further improve the range of motion and overcome the problem of extensor lag.

Limited study series on this technique and lack of uniform evaluation criteria, paralyses the benefit of comparative evaluation.

There is increasing evidence of use of 3.5 mm LCP extra-articular distal humerus plate for distal third humerus fractures with satisfactory results but the literature as of now is deficient in this regard.

CONCLUSION

Our study has yielded excellent results without any implant related complications in internal fixation of extra-articular distal third humerus fractures with single posterolateral locking compression plate.

We recommend using this 3.5 mm LCP extra-articular distal humerus plate for these humerus fractures, because of its consistent results with respect to fracture union, stability across the fracture site and early mobilization for better functional results.

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

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