International Journal of Orthopaedics Sciences

ISSN: 2395-1958
IJOS 2017; 3(3): 757-764

www.orthopaper.com
Received: 06-05-2017
Accepted: 07-06-2017

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Outcome of management of distal humerus fractures by locking compression plate

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DOI: https://doi.org/10.22271/ortho.2017.v3.i3k.114

Abstract
Background: Distal humerus fracture is one of the commonest fractures among young adults and which accounts for about 30% of all elbow fractures. The treatment of these fractures continues to the challenges for orthopedics despite of many advances in technique and implants. Different modalities like 1/3rd tubular plate, reconstruction plate, K wires, double tension band wiring, etc, have been tried. The new distal humerus locking compression plate (LCP) system allows angular stable fixation of these complex fractures with anatomically pre-shaped plates.
Aims: Aim of this study is to assess the benefits of using locking compression plate (LCP) in the management of distal humerus fractures clinically and as well as functionally.
Materials and Methods: A prospective study of 30 adult patients with closed distal humerus fractures were treated by locking compression plate in the department of Orthopaedics, RIMS, Ranchi, between June 2014 to Sep 2015. Variables of each patient were recorded and analysed with respect to age, sex, fracture type, mode of injury, limb involvement, associated injuries, timing and duration of operation, duration of hospital stay, follow up, complications and final outcomes. These patients were followed up at different intervals i.e. at 3 weeks for first 3 months, then at 6-weeks interval for next 6 months and then at 3-month interval.
Results: The average age was 38.5 years and majority patients were men (60%). The right humerus was involved in majority (70%) of patients. The complete union was achieved in all patients which was confirmed by radiographically. Average time interval between admission of patients and surgery was 7.8 days (range 4-13 days). The average operative time was 82 minutes (range 70-100 min). All the fractures as well as the olecranon osteotomies united at 12-18 weeks (average 13.80 weeks). There were no any case of primary malposition or secondary dislocation was observed. Using the Mayo elbow performance score, the majority (53.33%) of patients were graded as excellent. There was no any patient reported with deep infection, implant failure, non-union of fracture site or olecranon osteotomy site. There were only three patients those reported superficial wound infection, which was treated with antiseptic dressing and antibiotics. Transient ulnar nerve palsy developed in only 2 (6.66%) cases and both were recovered with conservative treatment.
Conclusion: Findings can be concluding that the treatment of distal humerus fractures is a challenging task. Anatomically pre- shaped distal humeral locking compression plate system facilitates operative reduction and stabilization of the fracture and may allow with good range of motion, and flexion and extension force.

Keywords: Distal humerus fracture; Locking compression plate; Functional outcome; Olecranon osteotomy; anterior transposition; Orthogonal plating

Introduction
Distal humerus fractures remains one of the most challenging injuries for orthopedics to manage. They are commonly multi-fragmented, occurs in osteoporotic bone and have complex anatomy with limited options for internal fixation. The treatment of these fractures continues to present challenges despite advances in technique and implants. Joint function is often compromised because of stiffness, pain and weakness. To conduct the normal activities of daily living/pursuits, personal hygiene and feeding etc. a normal painless, stable and mobile elbow joint is most desired and essential components of body [1].
The majority of distal humerus fractures occur in one of two ways, low energy falls or high energy trauma.

The most common cause for distal humerus fractures is a simple fall in the forward direction and high energy injuries in young adults. The predominating modes for distal humerus fractures are motor vehicle collisions, sports, falls from height and industrial accidents [1].

Intercondylar fractures of the distal humerus are uncommon injuries which present the most difficult challenge of fracture of lower end of Humerus. According to Robinson et al. (2003) the distal humeral fractures account for 2 to 6% of all fractures and about 30% of all elbow fractures [2]. The Charnley J (1961) has reported that the closed reduction with immobilization, traction and limited internal fixation has caused significant functional impairment with loss of range of movement.[3] Therefore, the consensus has shifted towards treating these fractures with open reduction and stable internal fixation. Depending upon the comminution and displacement, different methods of open reduction and internal fixation like 1/3rd tubular plate, reconstruction plate, K wires, double tension band wiring either individually or in combination have been tried by different authors. Conventional implants have not been able to completely address the problem of implant failure and substantial stability in small distal osteoporotic fragments [4, 5]. The high failure rates in management of these fractures are due to insufficient area for insertion of many screws in a small sized distal fragment, resulting in poor stability at bone-plate interface [6, 7]. Two column plates at 90° is an another method in complicated elbow fracture have become a standard treatment against which all other treatment methods are measured [8].

The lower compression plate (LCP) distal humerus system characterizes a new angular stable fixation system which consist two anatomically pre-shaped angular stable orthogonal plates purporting for treatment of fractures of distal humerus. It provides higher stability by permitting multiple screws in small distal fragment, thereby addressing some of the limitations of conventional implants [9, 10].

There are two crucial factors those influencing prognosis. The first one is delay in surgical fixation following injury and the second is difficulty in obtaining adequate surgical exposure. Therefore, a proper surgical approach and timing are important factors for obtaining good functional results. In case of a complex fracture with fragmentation of the articular surface in the sagittal & coronal planes and poor bone quality, which render the fracture unamenable to internal fixation. Total elbow arthroplasty (TEA) can be performed by keeping in mind that the functional limitations and eventual failure with arthroplasty.

Therefore, this study was planned to evaluate the rate of union, functional outcome and complications of these fractures treated with open reduction and internal fixation with a locking compression plate.

Materials and Methods

This study was conducted in the Department of Orthopaedics, RIMS, Ranchi, between June 2014 to Sep 2015. This is a prospective study of 30 distal humerus fractures in adult patients, aged 23- 66 years, and irrespective of sex was subjected to locking compression plate fixation after obtaining written informed consent. The fractures were classified according to Mehne and Matta classification. [11]

The clinical diagnosis was confirmed by routine antero-posterior and lateral radiographs of elbow with arm and forearm (Fig-1, Fig-2, Fig-3, Fig-4). X-rays were used to assess for comminution, involvement of joint, displacement and extension of fracture to the shaft. CT scan was done in selected cases to conform the nature of fracture and comminution. After getting all pre-operative evaluation and fitness for surgery, patients were operated with locking compression plate (LCP). Patients were treated with appropriate antibiotics, analgesics and anti-inflammatory medications pre and post operatively.

Fig 1: Case-1 - Preoperative X- ray left elbow AP & Lateral view

Operative and Surgical Technique

Regional brachial block was used in all patients. All cases were operated in the lateral decubitus position with the elbow 90° flexion and forearm hanging on the side over an arm support. Tourniquet was used routinely in all patients. Skin was disinfected by using Povidone iodine (10% v/v) solution and spirit, and the operating field from mid arm to mid forearm was draped. We used a posterior midline longitudinal incision. Olecranon osteotomy was performed in all cases to improve the exposure so as to ensure anatomical reduction and approximation of articular fragments (Fig-5). All osteotomies were later stabilized at the last step by tension band wiring with two 2 mm K-wires (Fig-8). The ulnar nerve was isolated, protected. The anterior transposition was performed in all cases after fixation of fracture to prevent iatrogenic damage.

The first step in the osteosynthesis was reduction of the condyles and reconstruction of the joint surface. Medial and lateral condyles were fixed together with a cannulated lag screw. After reconstruction of the articular surface, the medial and lateral columns were reduced and provisionally fixed to the metaphysis with crossed 2 mm K-wires. Then both the columns were reconstructed using 3.5mm precontoured distal humerus locking compression plate (LCP) and screws (Fig- 6, Fig-7). Plates were applied at 90º to each other (Orthogonal plating). In some cases, the plate needed to be bent slightly to fit the individual anatomy of the distal humerus. At the end of the procedure, reconstruction of the soft tissues was performed. Wound was closed in layers over a negative suction drain, antiseptic dressing done and limb immobilized in plaster of Paris above elbow slab with elbow in 90 degree flexion and mid-prone position. Operated limb was elevated and patient was advised to keep moving the fingers and shoulder joint. Hand grip strength exercises were also begun. The arms were assessed clinically with respect to pain relief,

instability, range of motion and functional improvement. Radiological assessment was done by antero-posterior and lateral views (Fig-9). Drain was removed after 48 hrs. and skin sutures were removed on twelfth post-operative day and patients were discharged. After one week, controlled assisted active mobilization of elbow was started and, after 2 weeks, active mobilization was performed.

Post-operatively, patients were evaluated both clinically as well as radiologically at different intervals which were started from 3rd week for a period of three months (Fig- 10, Fig- 11, Fig-12, Fig-13, Fig-14, Fig-15, and Fig-16). Follow up of another next three months at interval of 6 weeks up to six months (Fig- 17, Fig-18, Fig-19).

After 6 months patients were followed at interval of 3 months up to 15 months. In each visit, radiological assessment of union and fracture callus quality was done in addition to functional limb assessment by Mayo Elbow Performance Scoring System (MEPSS).

Fig 2: case-2 preoperative x ray AP & Lateral view

Fig 3: Case-3 Preoperative x-ray Right Elbow joint lateral view

Fig 4: case-3 preoperative x ray right elbow AP view

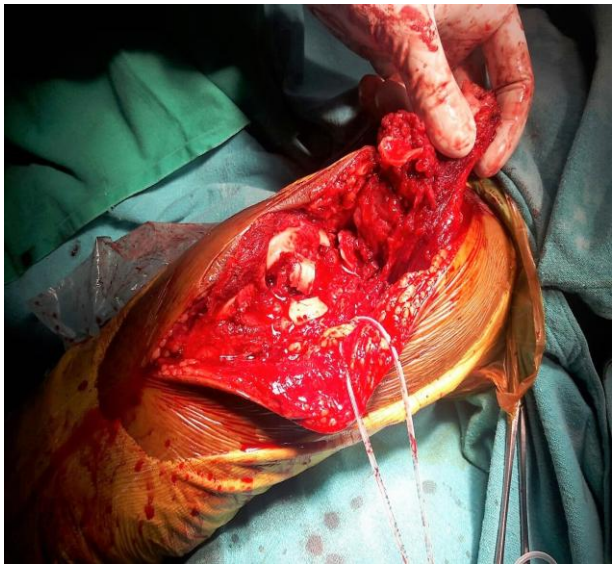

Fig 5: Case-1 Per-operative, showing Fracture fragments after Transolecranon Approach

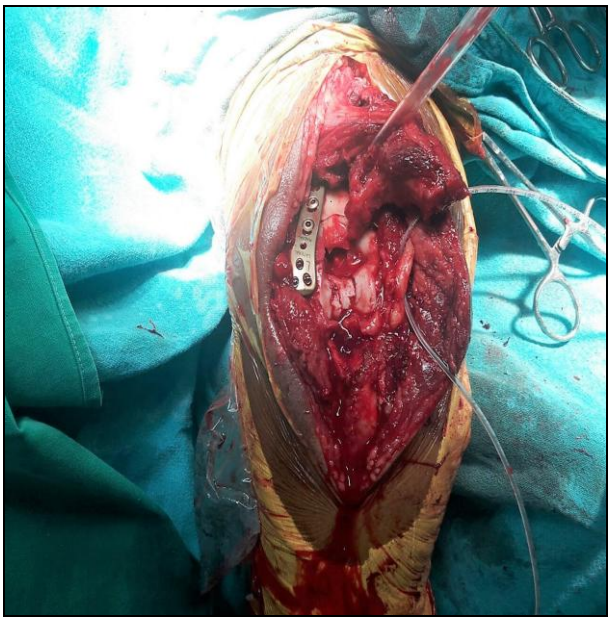

Fig 6: Case -1 Per-operative, showing Fracture reduction & fixation

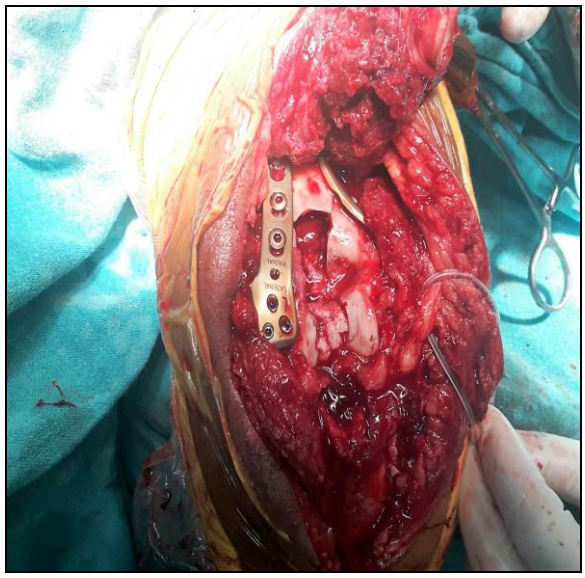

Fig 7: Case-1 Per-operative, showing fracture reduction & fixation with anatomical LCP

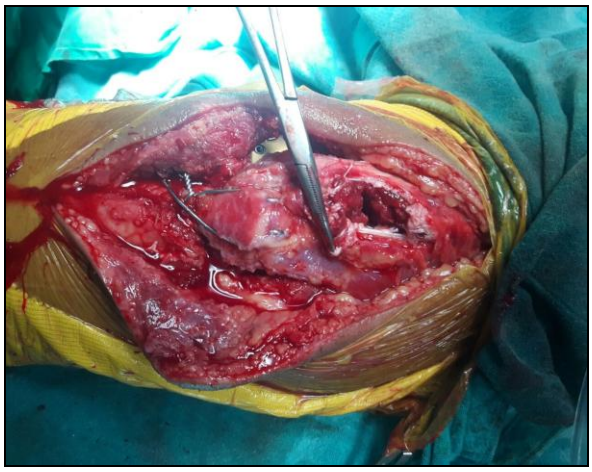

Fig 8: Case-1 Per- operative, showing Olecranon Fixed with TBW & Rent in Triceps due to Fracture fragments

Fig 9: Case-1 Postoperative x- ray AP & Lateral view

Fig 10: Case-1 Follow up X- ray after 3 months post-operative

Fig 11: case-1 follow up 3 months full extension left elbow

Fig 12: Case 1 Follow-up 3 Months post-operative showing almost Full Flexon of Left Elbow joint

Fig 13: case-3 follow-3months post-operative AP lateral view

Fig 14: Case-3 follow-3months post-operative lateral view

Fig 15: Case-3 Follow up -3months months post-operative showing full extension of Right elbow joint

Fig 16: Case-3 Follow up 3 months Post-Operative showing full flexon of Right elbow joint.

Fig 17: Case-2 Follow up 6 months s Post-Operative showing good union & alignment

Fig 18: Case-2 Follow up 6 months Post-Operative showing full extension

Fig 19: Case-2 Follow 6 Months Post-Operative showing almost full flexon of Left Elbow

Exclusion criteria for Patients

Patients those were less than 18 years of age and had sustained compound fractures of Distal humerus, pathological fractures other than those due to senile osteoporosis, pregnant patients, previously operated or non-functional elbow, patients who were unfit for surgery and who didn't gave consent for surgery were excluded from the study.

Results

Overall 30 cases of closed distal end of humeras fractures were studied, out of which 10 (33.33%) were high T- type, 4 (13.33%) low T- type, 12 (40.0%) Y- type, 2 (6.66%) H- type, 1 (3.33%) medial lamda type and 1 (3.33%) was lateral lamda type fracture (Table- 1). Y- type fracture was most common followed by high T- type. Out of 30 patients, 18 (60%) were men and 12 (40%) were women. The maximum age of the patient in this study was 66 years and minimum being 23 years, with mean age of 38.50 years. The majority cases were from age group of 20 years to 40 years (50%) followed by above 60 years (20%) (Table-2). The table -3 depicting the cause of fracture where the majority of patients were due to fall (53.33%) followed by RTA (43.33%) and only one was sports injury (3.33%).

Right humerus was involved in 21 (70%) cases and left humerus in 9 (30%). Whereas six patients had other associated fractures which included 2 femoral shaft fracture, 1 radial and ulna shaft fracture, 1 clavicular fracture and 2 patients with rib fracture.

Radiographically, complete union was achieved in all patients. The average time interval between admission and surgery was 7.8 days (ranged 4-13 days). The average operative time was 82 minutes (70-100 min). All the fractures as well as the olecranon osteotomies were united by 12-18 weeks (Average 13.80 weeks). There were no cases of primary malposition or secondary dislocation. 18 (60%) patients had >100° while 12 (40%) patients had 60-100° range of motion at elbow.

In present study it was observed that no any patient had reported about deep infection, implant failure, non-union of fracture site or olecranon osteotomy site. Only three patients were reported for a superficial wound infection, which was treated with antiseptic dressing and antibiotics. It was also observed that two patients were developed transient ulnar nerve palsy, which recovered with conservative treatment. Loosening of the cancellous intercondylar screw was noticed in 1 (3.33%) patient; however, the fracture in this patient united uneventfully and 2 (6.66%) patients had metal prominence (olecranon K-wire and lateral column plate) (Fig-20). The Mayo elbow performance score was used to evaluate the outcome obtained was graded as excellent, good, fair and poor. The majority patients had achieved excellent outcome (53.33%), followed by good (36.33%), fair (6.6%) and only one poor (3.33%) (Table- 4).

Table 1: Showing Types of Fracture (Mehne and Matta Classification)

Type of fracture	No. of cases (N = 30)	Percentage
High T- type	10	33.33
Low T- type	4	13.33
Y- type	12	40
H- type	2	6.66
Medial lamda type	1	3.33
Lateral lamda type	1	3.33

Table 2: Showing Age and Sex Distribution of the Patients

Age Groups (Yrs.)	No. of Patient (N= 30)		Percentage
	Male	Female	
20-30	8	1	30
31-40	3	3	20
41-50	2	2	13.33
51-60	2	3	16.66
>60	3	3	20
Total	18	12	100

Table 3: Showing Cause of Injury

Cause of Injury	No. of Patient (N=30)	Percentage
Fall	16	53.33
RTA	13	43.33
Sports injury	1	3.33

Table 4: Showing Final Outcome (Mayo Elbow Performance Score)

Outcome	No. of Patient (N= 30)	Percentage
Excellent	16	53.33
Good	11	36.33
Fair	2	6.66
Poor	1	3.33

Fig 20: Case-1 Follow-up showing implant prominence – a complication

Discussion

Fractures of distal humerus are challenging to treat because of complex anatomy of the elbow, small sized fracture fragments, limited amount of subchondral bone and the fact that most of the orthopedics do not have a great deal of experience with them [12]. As the elbow joint tolerates immobilization poorly hence the functional outcome after surgical treatment is manifestly deteriorated by prolonged immobilization elbow joints. Surgical expertise is of utmost importance in handling cases of Distal Humerus fractures. Good functional outcomes are expected with quick surgical approach and early rehabilitation. The early restoration of articular surface and reconstruction of elbow joint is compulsory to restore maximum joint function. This can be safely achieved by proper stabilization of fracture fragments with plate osteosynthesis based on restoration of joint congruity. Earlier treatment methods of closed reduction with immobilization, traction and limited internal fixation have caused significant functional impairment with loss of range of movement.

Hence, it is now generally accepted that the most favourable outcome of displaced intraarticular fractures is provided by surgical reconstruction. Different approaches have been described for distal humerus fracture repair. The posterior approach has been used by many surgeons because it provides excellent visualisation, particularly of the distal articular fragments and the plate fixation [13].

In present study, a posterior approach with olecranon osteotomy was done in all cases. We used Locking

Compression Plates to reconstruct both the medial and lateral columns as the locking plates to provide a fixed plate screw construct with multiple screw options for easy application in distal complex fractures thereby providing angular stability. There is no consensus that whether the orthogonal or parallel plating is superior for fixation [14]. We used orthogonal plating because it provides better mechanical stability [15-16] although it requires more extensive soft tissue dissection.

In this present case series of study, we treated 30 adult patients with distal humeras fractures, age ranging from 23-66 years. We observed that out of total cases the majorities (53.33%) were achieved excellent results, remained 36.33% achieved good, 6.66% fair and 3.33% achieved poor results. Similar results have been recently reported with the use of precontoured LCP by other authors [17- 18].

In our study, average time interval between admission of patients and surgery was 7.8 days (Ranged 4 -13 days) which is slightly higher than in the studies reported by Atalar et al. (2009) 6 days [19]. The average time to union in our study was 13.8 weeks (Ranged 12-18 weeks) which was slightly greater than as reported by Pankaj et al. (2007) 12.8 weeks [20] but was less than in study reported by Georgiades *et al.* (2010) 16 weeks [9].

The complications encountered in the operative management of Distal humerus fractures as reported by various authors are: superficial wound infection, deep wound infection, nerve injuries, delayed union, non-union of fractures and osteotomy, heterotopic ossification, joint stiffness, pain and implant failure. The present study showed that 3 (10%) patients had superficial wound infection, 2 (6.66%) patient had transient ulnar nerve palsy, 1 (3.33%) had screw loosening (intercondylar cancellous screw), 2 (6.66%) had metal prominence (olecranon K-wire and lateral column plate), and 3(10%) patients had occasional mild post-operative pain. There was no any patient had observed with deep infection, implant failure, non-union of fracture site or olecranon osteotomy site. The rate of ulnar neuropathy (6.66%) encountered in our study was nearly same as reported by Helfet *et al*. (1993) 7% [21] but less than the rate reported by Reising et al. (2008) 12.5%. [22]. Furthermore, we observed that this fixation was reasonably stable in osteopenic weak bones as majority of patients were more than 40 years of age with complain of osteoporosis. The osteoporosis is not a common problem in population of Jharkhand but it is a common problem in India. According to Benu Gopal Das etal (2016) [23] about more than 61 million Indians have osteoporosis; of these, 80% patients are females and majority between ages 30 years to 45 years.

As we know the major limitations of our study which include the small sample size and relatively short duration of follow-up. This follow-up is too short to address long term development of osteoarthritis. In addition, in present study, most of the patients had relatively low-energy trauma as compared with other clinical trials [12].

Furthermore, since we had used only one type of plating and technique therefore we cannot made a direct comparison with other plating systems or techniques.

Conclusion

An anatomically pre-shaped distal humerus locking compression plate system was useful in providing stable fixation of intercondylar humerus fractures, thereby facilitating early postoperative rehabilitation. In contrast to conventional plating, we did not observe any case of secondary fracture displacement, non-union or implant failure even in elderly patients with potentially reduced bone mass. The results of present series are comparable with other series, although larger control studies with long term follow-up will be required before advocating it for wider application.

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