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## Functional outcome of distal humerus fracture in adults treated with Bicolunar plating: A prospective study

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### Abstract

**Background:** Distal humerus fractures in adults are very difficult and challenging to treat due to intra articular and inter condylar involvement. It accounts for 2% to 6% of all fractures and one third of humerus fractures. The aim of this study was to evaluate the functional outcome of distal humerus fractures treated by bi columnar plating.

**Materials and Methods:** Our study consists of 30 post traumatic distal humerus fracture AO type C3 operated between December 2017 and December 2018. The functional outcome was assessed using The Mayo Elbow Performance Score. Patients were followed up at 6 weeks, 3months, 6months and 1 year post operatively.

**Results:** There were 21(70.0%) male patients, and 9(30%) female patients. Average age of the patients was 39.68 years with age ranging from 18 years to 80 years. 11(36.7%) cases were right humerus and 19(63.3%) were left sided humerus involved. All cases were operated through trans olecranon approach and chevron osteotomy technique, fracture stabilized with bi columnar locking compression plates. At the final follow up most of the patients had excellent postoperative elbow flexion with average arc of elbow flexion of 117.33 degrees, average extension deficit of 8.67 degrees, average pronation of 70.83 degrees, average supination of 70.83 degrees.

**Conclusions:** Bi columnar locking compression plates offer a good fixation for the distal humerus fractures with particular advantage in intra-articular type C3. The device helps in early mobilisation even in fractures with comminution due to its enhanced stability.

**Keywords:** Distal humerus fracture, Trans Olecranon, Chevron Osteotomy, Bi columnar locking compression plates, MEP Score.

### Introduction

Distal humerus fractures in adults are very difficult and challenging to treat due to intra - articular and inter - condylar involvement, high comminution, reconstruction difficulty of the articular surfaces, maintaining stability and morbidity, if not constructed anatomically. It accounts for 2% to 6% of all fractures and one third of humerus fractures<sup>[1]</sup>. Robinson reported that the incidence of distal humerus fractures in adults was 5.7/100000 per year in a 10 year follow up study<sup>[2]</sup>. In a study conducted by Palvanen elderly individuals aged (> 60 years) were predicted to have a three-fold rise in incidence by 2030. Hence its important to understand these fractures and their treatment protocol<sup>[3]</sup>. Non-surgical treatment can be justified in cases of hemiplegia sequelae involving the ipsilateral upper limb, advanced osteoporosis and fractures with extensive bone loss but to avoid fixation failure, stiffening is almost assured and arthrolysis will have to be performed later on. The main goal of surgical treatment is to obtain fixation that is stable enough to allow immediate post operative elbow mobilization to prevent it from stiffening, mal - union and non - union, hence open reduction and internal fixation allows early mobilization and good functional outcomes. Trans - olecranon approach and Chevron osteotomy technique exposes the articular surface of the distal humerus more than other approaches<sup>[4-7]</sup>. Patients who underwent Open reduction and internal fixation through an olecranon osteotomy showed good range of movement and good to excellent results than those who under went open reduction and internal fixation through other approaches<sup>[8, 10]</sup>.

Locking compression plates are more beneficial in distal humerus fractures than dynamic compression plates and k-wires. Single columnar plating, Recon plating and conventional plates have more fixation failures. Complete fixation with two pre contoured anatomical locking compression plates in 90 degree is the most suitable technique for distal humerus fractures [11]. Patients treated with bi columnar locking compression plates show a greater functional range of motion, better restoration of articular congruity, secure bony fixation, better bone healing, and early rehabilitation [12].

**Materials and Methods:** This was a prospective study consists of distal humerus fractures (AO type 13C) which presented to Sanjay Gandhi Institute Of Trauma and Orthopaedics, Bangalore between the period of December

2017 and December 2018, were included, after obtaining the permission from the Institutional Ethics Committee.

**Inclusion criteria:** Age more than 18 years belonging to both sexes with distal humerus fractures [AO type 31C], Closed and Early Gustilo-Anderson type 1 and 2 open fractures, Subjects with bilateral fractures were included.

**Exclusion criteria:** Age less than 18 years, Co-existing ipsilateral limb fractures, Gustilo-Anderson type 3 fractures, Closed fractures with neuro-vascular injuries, Pathological fractures, Revision surgeries or operated elsewhere, Upper limb congenital deformity, Established inflammatory or degenerative arthritis of the elbow and patients who refused to give informed written consent were excluded.



**Fig 1:** Pre op AP radiograph



**Fig 2:** Pre op Lateral radiographs

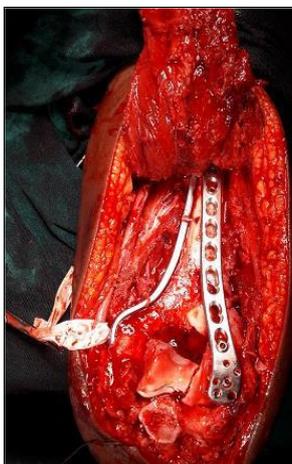


**Fig 3:** Pre op CT scan with 3D reconstruction.

**Surgical Technique:** All cases were operated by a senior trauma surgeon. Radiographs and CT images were reviewed for selection of plate size, plate position and for inter-fragmentary screws. Under all aseptic medications and under general anaesthesia or regional Brachial plexus block, patient was positioned in lateral position with arm on a side bar and a high pneumatic tourniquet was used. Entire upper limb was painted and draped with a strict sterile technique, Posterior, midline longitudinal incision was used. Ulnar nerve was identified, retracted in all cases, Chevron olecranon osteotomy was done to expose the articular surface (Fig 1). Articular surface was visualized fully and morphology of the fracture was re-assessed. Inter-condyles were fixed with cannulated cancellous screws. Fracture fixed with bi-columnar, orthogonal plating technique using AO Synthes® fixed angle locking compression plates (Fig 2). Osteotomy repaired by tension band wiring.



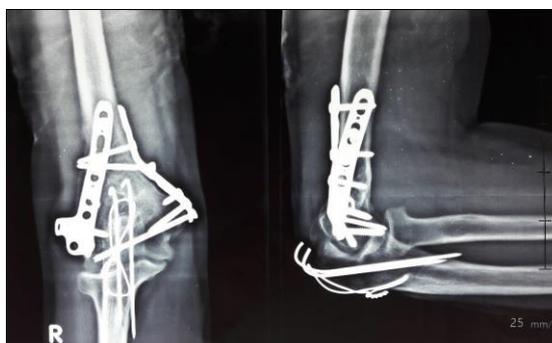
**Fig 4:** Chevron olecranon osteotomy



**Fig 5:** Bi columnar plating



**Fig 6:** 6months follow up



**Fig 7:** 1 year follow up



**Fig 8:** Flexion at 1 year



**Fig 9:** Extension at 1 year



**Fig 10:** Pronation at 1 year



**Fig 11:** Supination at 1 year

**Post operative management:** Post operatively the patient was immobilized with above elbow slab with elbow in 90° flexion and forearm in supine position for a period of two weeks. Third generation cephalosporins was administered parenteral for 48 hours post-operatively till the drain tubes were removed. Then oral antibiotic was started and continued till the suture removal. Oral indomethacin (75mg/day) was started on post-op day one and continued for three weeks. Active assisted mobilization was started after suture removal under the supervision of a senior physiotherapist. Patients were evaluated at 6 weeks, 3months, 6months and 1 year from December 2017. End point of follow up was 1 year. In the follow up wound related complications (Infection), range of movements at elbow joint and distal radio ulnar joint, return to professional / routine activities, ulnar neuropathy, fracture union, implant failure and heterotopic ossification were assessed. Functional outcome was assessed by Mayo elbow performance score.

**Results:** The mean age was 39.68, with the youngest being 21 years and oldest is 80 years (Table 1). 21 males and 9 females included in this study (Table 2). In 19 patients left side was involved and in 11 patients right side involved (Table 3). 15 cases were due to Road traffic accidents and 15 cases due to self fall (Table 4). 29 patients had a closed type and only one patient had an open type II fracture. Out of 30 patients only one patient did not return to his prior activities. 3 patients had superficial skin infection and they underwent early removal of protruding 'K' wires from TBW site after union at osteotomy site and parenteral antibiotics were started according to culture and sensitivity following which the infection subsided. Two patients had post operative ulnar neuritis in their early follow up (less than 3 months). The main complaint was paresthesia in the ulnar nerve distribution, they had no motor deficits and are treated symptomatically. However at the final follow up none of them had ulnar neuritis.

**Table 1:** age distribution

Age (in years)	No of patients	Percentage
18-38	18	60.00%
39-58	6	20.00%
59-78	4	13.33%
>78	2	6.67%
Total	30	100%

**Table 2:** Sex distribution.

Gender	No of cases	Percentage
Male	21	70.0%
Female	9	30.0%
Total	30	100%

**Table 3:** Side involvement.

Side	No of cases	Percentage
Left	19	63.3%
Right	11	36.7%
Total	30	100%

**Table 4:** Mode of injury.

Mode of Injury	Number of cases	Percentage
RTA	15	50%
Self-fall	15	50%
Total	30	100%

MEPS (Table 5) was excellent in 21 patients, good in 5 patients, fair in 3 patients and poor in 1 patient. The patient with poor score had severe stiffness and experienced difficulty in performing daily routine activities.

**Table 5:** Mayo elbow performance score.

MEPS	6 Weeks	3 Months	6 Months	1 Year
Excellent	0(0)	3 (10.0%)	11 (36.7%)	21 (70.0%)
Good	7(23.3%)	18 (60.0%)	15 (50.0%)	5 (16.7%)
Fair	16 (53.3%)	7 (23.3%)	2 (6.7%)	3 (10.0%)
Poor	7(23.3%)	2 (6.7%)	2 (6.7%)	1 (3.3%)

Paired 't' test was used to analyse the comparison of MEPS between different time intervals. A 'p' value of < 0.001 was obtained signifying that the comparison was statistically highly significant in every follow up (Table 6).

**Table 6:** Comparison of MEPS between different time intervals.

MEPS	N	Mean	Std. Deviation	Repeated Measures ANOVA	
				F	p-value
6 Weeks	30	63.00	10.22	176.18	<0.001*
3 Months	30	76.83	11.02		
6 Months	30	84.33	11.28		
1 Year	30	92.00	13.37		

**Discussion:** We studied 30 cases of distal humerus fractures AO type 13-C over a period of 1 year, all were intra articular fractures and we evaluated their functional outcome. Palvanen and Robinson observed in their respective studies, a bimodal age distribution<sup>[2, 3]</sup>. 18 patients aged 18- 38 years and rest of the 11 patients more than 40 years. In our study 15 patients had Road traffic accident and 15 had self fall, 11 had a trivial fall from standing height, indicating that osteoporosis may be a pre – disposing factor. Osteoporosis is the major risk factor leading to these type of fractures in the elderly<sup>[3]</sup>. Even though the elbow joint is superficial posteriorly, open fractures are not common, if present with open fracture it will be due to high velocity injury. Min *et al.* stated in their study that open distal humerus fractures are about 2.7% of all the open long bone fractures, 85.7% of these fractures are AO type C 3<sup>[22]</sup>. A single trans - olecranon approach and single technique was applied for all the fractures, chevron osteotomy was done in all the cases for good articular visualization and then the fracture was fixed with 3.5 mm bi columnar locking compression plates. Wilkinson and Stanley recommended in their studies that olecranon osteotomy exposes the articular surface fully than other approaches.<sup>5</sup> Jupiter stated in his study that chevron olecranon osteotomy is the workhorse for exposing the articular surface.<sup>9</sup> Gofton and Kundel used Chevron olecranon osteotomy and obtained good to excellent outcomes<sup>[10, 23]</sup>. We used trans olecranon approach with Chevron osteotomy which gave very good visualization of the articular surface and it gave sufficient working space to attain anatomic reduction and excellent result with respect to the ability to reconstruct the articular surface.

Open reduction and internal fixation with bi - columnar locking compression plates is the gold standard treatment for distal humerus AO type 3 C fractures. However, the position of the two plates with respect to each other has been a matter of discussion. The traditional concept was to place the plates in an orthogonal fashion (two perpendicular planes) and this has been challenged by the parallel plating technique. There are three studies in the literature which have compared the two techniques. While Jacobson and his colleague concluded that orthogonal plating provided better stability to the construct, Schemitsch and Self concluded the contrary, stating parallel plating technique was better<sup>[24-26]</sup>. Gofton, Kundel and Aslam all obtained excellent to good functional outcome with orthogonal plating technique<sup>[10, 24, 27]</sup>. Further, Korner compared fixation using locking compression plates (LCP) with conventional reconstruction plates and opined that LCP provides better stability, especially in areas where screw purchase is poor and also provides an increased resistance to bending, torsion and axial compression loading as compared to conventional plates<sup>[11]</sup>. The locking capability is important for a fixed angle construct in osteopenic bone or multi-fragmentary fractures where screw purchase is compromised.

We followed orthogonal plating using 3.5mm fixed angled AO Synthes® anatomic locking compression plates and obtained excellent to good outcome. This technique offered adequate stability of the construct to permit early mobilization. Gofton reported about loss of initial reduction and 40% of his patients required an additional plate to achieve stability. However, we did not come across such an event [10]. In our study, a mean arc of flexion of 117.33° with a mean

extension deficit of 8.67° was observed. This is comparable to that obtained by Gofton, Kundel and Aslam in their study on AO type 3 C fractures of the distal humerus.<sup>10,24,28</sup> 21 patients had excellent score, 5 had good score, 3 fair and 1 poor on MEPS. 29 patients had returned to their regular routine activities at the time of final follow up. This is also in comparison to those mentioned in the literature (Table 7).

**Table 7:** Comparison of our study with those in literature

Reference	No. of Patients Followed up	No. of Excellent to good results	Mean arc Of Flexion in deg	No. of Complications / type
Gofton	23	21	122	7HO, 2infection, 3 non union
Aslam	20	14	122	2 HO, 2 infection, 1 ulnar neuritis
Kundel	77	40	104	29 HO, 8 infection, 21 Ulnar neuritis
This study	30	26	117	3 Infection, 2 ulnar neuritis

Radio logically, all the fractures showed union at final follow-up. Helfet reported non-union rate of distal humerus fractures treated by ORIF at 2-10% [6]. We did not come across implant loosening or implant breakage leading to loss of fixation. In literature we came across authors observing non - union, implant failure and Heterotopic Ossification on post-operative radiographs. The common complications seen following surgical management of distal humerus AO type 3 C fractures as noted by Jupiter in a review article include elbow stiffness, infection, non-union, ulnar neuropathy and heterotopic ossification (HO) [9]. Although almost all patients in our study had certain degree of elbow of stiffness, 29 of them had a functional range of movement. This is comparable to studies in the literature. One patient had severe stiffness with only 10° movement in the flexion-extension arc with a fixed-flexion deformity of 40°. Helfet observed non-union in 2-10% of patients treated by ORIF, and it is common in patients with severe comminution, bone loss and inadequate fixation [6]. Jupiter and Green [2] reviewed the literature and reported that post-operative infection in these fractures range from 0 to 9% [9, 28]. We had 3 patients presenting with postoperative wound infection, which was superficial skin infection, K-wires and SS wires were removed and a thorough wound wash was given. With antibiotics sensitive to the aerobic culture report, the infection subsided in due course and required no further intervention. None of the other patients had any wound related complications. Transient ulnar neuritis is a common post-operative complication described in the literature. Kundel, Yilmaz and Aslam all have reported transient ulnar neuritis in the post-operative period. There has been a debate as to whether routine anterior transposition of the ulnar nerve during the exposure has any role in preventing postoperative ulnar neuritis [23, 27, 29]. Gofton, Eralp and Wang demonstrated less than 1% incidence of ulnar neuritis following routine transposition, as opposed to Helfet<sup>6</sup> who showed 7% incidence on not performing the transposition [6, 10, 30, 31]. This opinion was, however, challenged by Chen and Vazquez who advised against transposition [32, 33]. Chen, in his study, concluded that routine transposition is associated with higher incidence of post-operative ulnar neuritis [32]. There is, hence, a conflict as to perform the transposition or not. In all the cases, we identified the ulnar nerve by dissection along the muscle fibre and protected it during the surgery. Care was taken to avoid excessive devascularisation and forceful retraction. However, we did not perform anterior transposition in any of the cases. We had two patients presenting with symptoms of ulnar neuritis, mainly paraesthesia. All of them

developed the symptoms within 6 weeks postoperatively. None of them had motor deficits. All were managed symptomatically. At final follow-up, none of them had any residual symptoms.

**Conclusion:** In conclusion, this study shows that distal humerus fractures operated with bicolumnar locking compression plates using trans olecranon approach by chevron osteotomy has good functional outcome with particular advantage in the intra-Articular type C3 fractures, which allows early mobilisation of the patients even in fractures with comminution due to the enhanced stability of the construct.

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