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## Functional outcome of distal humerus fracture in adults followed with bicolunar fixation: A prospective study

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### Abstract

**Background:** Distal humerus Fractures account for about 0.5 - 2% of all adult fractures, out of which a significant percentage (50 - 70%) of patients present with intraarticular and intercondylar involvement; thereby posing operative challenges to the surgeon. An attempt has been made in this study to evaluate the radiological and functional outcome of distal humerus fractures treated with bi columnar fixation.

**Materials and Methods:** Our study consists of 20 posts traumatic distal humerus fracture AO type C operated at Rajah Muthiah Medical College and Hospital, Annamalai University, Chidambaram between May 2019 and December 2021. The Mayo Elbow Performance Score was employed for the assessment of Functional Outcome. Patients were regularly followed up at the intervals of 6 weeks, 3 months, 6months and 1 year postoperatively.

**Results:** There were 13 (65.0%) female patients, and 7 (35%) male patients over a wide age range of 18 years to 75 years. The mean age of these patients being 44.6 years. The majority had an involvement of the nondominant limb; left humerus 15 (75%) and the rest of the cases were right humerus 5 (25%). The fractures were stabilized with bicolunar locking compression plates with Lag Screws depending on the fracture pattern. The final follow-up majority showed good to excellent outcomes with the mean arc of elbow flexion of 116 degrees, average extension deficit of 7 degrees, average supination of 70 degrees, and average pronation of 70 degrees.

**Conclusions:** Olecranon Osteotomy approach gave a better visualization of the fracture site and an easier articular reconstruction opportunity. Bicolunar fixation showed good outcomes and achieved satisfactory union rates.

**Keywords:** distal humerus fracture AO type C, olecranon osteotomy, bicolunar fixation, locking compression plates

### Introduction

Distal humeral fractures show a bimodal age distribution, with women over the age of 65 being most commonly affected due to their increased elbow carrying angle and osteoporosis, while younger patients who sustain intra-articular fractures generally are involved in high-energy trauma [1]. Even today, in spite of improved implant designs and advanced techniques, treatment of distal humerus fractures continues to pose a considerable challenge. This could be attributed to the complex regional anatomy, high degree of communication and reconstruction difficulty of the articular surfaces [2].

It is imperative that the Type C intra-articular distal humeral fractures in adults be treated surgically for good functional outcomes. The goals of surgical management is aimed at restoring satisfactory articular congruity and anatomy with stable internal fixation allowing for early mobilization. Imaging studies such as a computed tomography (CT) with three-dimensional (3D) reconstruction of fracture pattern aids in the easier location of fracture fragments intraoperatively, thereby decreasing operative time and leading to better results [3].

Of all the approaches, discussed in the literature, it's observed that the Trans-olecranon approach and Chevron osteotomy technique gives excellent exposure to the articular surface of the distal humerus [4-7]. Good to excellent outcomes were seen in distal humerus fractures managed with Open reduction and internal fixation through an olecranon osteotomy [8-10].

Single columnar plating, Recon plating and conventional plates are less stable to loads have more fixation failures. Locking Compression plates give good results than Dynamic compression plates and are more beneficial. Distal Humeral Fractures are most amenable to bi columnar fixation with 2 pre contoured anatomical locking compression plates in 90 degrees <sup>[11]</sup>. Better results with respect to good functional range of motion, the early union of fracture fragments, secure fixation and stability, satisfactory restoration of articular congruity and early mobilization were seen in patients fixed with bi columnar locking compression plates <sup>[12]</sup>.

### Materials and Methods

The study is a clinical, prospective and observational study conducted at Rajah Muthaiah Medical College and Hospital, Annamalai University, Chidambaram between May 2019 and December 2021.

Inclusion criteria were skeletally mature patients with Closed Distal Humerus Fractures who were medically fit and willing for Surgery. Exclusion criteria were Open Fractures, skeletally immature patients, pathological fractures, medically unfit and unwilling patients.

On admission, hemodynamic stabilization was first done. Then a detailed examination for other coexisting fractures and screening for abdominal, pelvic and head injuries were done. Next, primary immobilization with the above elbow slab was done. Routine investigations were done. Anteroposterior and Lateral views of X-ray of the elbow with distal humerus were taken along with CT imaging.

### Surgical Technique

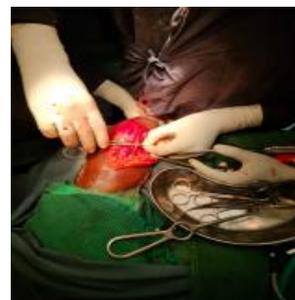
Under regional anesthesia, and under sterile, aseptic precautions, the patient in a lateral position with an arm on a sidebar, Posterior Approach to the elbow was followed (Fig-1), A Midline longitudinal incision was made (Fig- 2). The ulnar nerve was identified and isolated in all cases (Fig – 3). Chevron Osteotomy (Fig -4) and Campbell's posterior approaches were followed depending upon the surgeon's discretion. Intercondylar fractures were fixed with 4 mm cannulated cancellous screws. Bi Columnar fixation of the fracture was done; with pre-contoured Anatomical Locking Compression plates (Fig – 5). Osteotomy fixed with modified tension band wiring (Fig – 6). The wound was closed in layers with a drain in situ (Fig – 7).



**Fig 1:** Posterior Approach



**Fig 2:** Midline Longitudinal Incision



**Fig 3:** Isolation of Ulnar nerve



**Fig 4:** Olecranon Osteotomy



**Fig 5:** Bicolumnar Plating



**Fig 6:** Modified TBW for Olecranon



**Fig 7:** Wound Closure

**Post Operative Management**

Postoperative immobilization with above elbow slab with 90-degree elbow flexion and forerarm in supination was followed for the next 2 weeks. The dressing was done on Postoperative days 2,5,8 and 13<sup>th</sup> days. The drain was removed on 2<sup>nd</sup> day and the drain tip culture was sent. Sutures were removed on the 13<sup>th</sup> day. IV antibiotics were given until the 5th day and changed to Oral antibiotics until suture removal. Oral Indomethacin (75mg/day) given for 3 weeks. Mobilization started after suture removal. Patients were followed up at 6 weeks, 3months, 6months and 1 year with the end of 1 year being the endpoint of follow-up. Return to routine activities, range of movements at the elbow joint and distal radioulnar joint, complications like infection, union at the fracture sites and Heterotropic Ossification were evaluated during follow-ups. Functional Outcome was assessed by The Mayo Elbow Performance Score.

**Results**

In our study, we observed that majority of the patients were females 13 (65%), with a high percentage of involvement of the Non-Dominant Upper limb, 15 (75%) patients. It was also noted that RTA contributed a significant portion; in 14 (70%) patients, to the etiology and with at least 6 cases (30%) attributing a history of self fall to be the cause, it could be safely ascertained that Osteoporosis in elderly can also cause these fractures following trivial falls. A significant proportion (50%) of individuals were within the age group 18 - 38 years. The patients had an average of 44.6 years. Based on the Mayo Elbow performance Score, all AO C1 fractures (35%) & AO C2 (40%) had an Excellent to Good Outcomes and 4 patients with AO C3 (20%) showed Excellent to Fair results at the end of the study period. However, we had 1 (5%) individual within the purview of AO C3 faring poor. Chevron Osteotomy gave an excellent visualization of the articular surface, thereby aiding in faster reconstruction and lesser operating time; in turn, facilitating better outcomes with lesser complications. Also, it was easier to perform and easier to repair with modified tension band wiring. We had employed Chevron Osteotomy in 10 (50%) of our cases and Campbell's posterior approach in the rest of the 10 (50%) cases. Most of our cases had a fracture union by the end of 4 months (85%). None had a nonunion. No routine anterior transposition of the ulnar nerve was done for any of our cases. The mean arc of elbow flexion in our study is 116 degrees. 1 (5%) patients had superficial infection (Fig -8), 1 patient (5%) had ulnar neuropraxia (Fig - 10), 1 had Metal prominence; olecranon K wires (Fig- 10) and 3 (15%) patients had Elbow stiffness (Fig - 11).

**Table 1: Sex Distribution**

Gender	No. of Cases	Percentage
Female	13	65%
Male	7	35%

**Table 2: Side Involvement**

Side	No. of Cases	Percentage
Left	15	75%
Right	5	25%

**Table 3: Age Distribution**

Age (in years)	No. of Cases	Percentage
18-38	10	50%
39-58	5	25%
>58	5	25%

**Table 4: Mode of Injury**

Mode of Injury	No. of Cases	Percentage
RTA	14	70%
Self -Fall	6	30%

**Table 5: Fracture Type (according to AO classification) And Distribution**

Fracture Type (AO)	No. of Cases	Percentage
C1	7	35%
C2	8	40%
C3	5	25%

**Table 6: Mean Elbow Range of Motion**

Range of Motion	No. of Cases	Percentage
> 100 Degrees	17	85%
50 -100 Degrees	2	10%
>50 Degrees	1	5%

**Table 7: MEPS based on fracture pattern (at the end of 1 year)**

Outcomes	C1	C2	C3	Total
Excellent	6	7	1	14 (70%)
Good	1	1	1	3(15%)
Fair			2	2 (10%)
Poor			1	1 (5%)

**Table 8: Distribution of Surgical Approaches**

Surgical Approaches	No. of Cases	Percentage
Chevron Osteotomy	10	50%
Campbell's Posterior Approach	10	50%

**Table 9: Time for Fracture Union**

Time Interval	No. of Cases	Percentage
> 12 weeks	3	15%
12 -16 weeks	14	70%
> 16 weeks	3	15%

**Table 10: Post Operative Complications**

Complications	No. of Cases	Percentage
Superficial Infection	1	5%
Elbow Stiffness	3	15%
Ulnar Neuropraxia	1	5%
Metal Prominence (Olecranon K Wires)	1	5%

**Case 1**



Pre-Operative AP & Lateral radiographs of a 34-year-old right-hand-dominant man



Follow up at 6 months



Implant exit at 1 Year



Photographs of the patient demonstrating flexion, extension, pronation and supination 1 year after surgery.

**Case 2**



Pre Operative AP & Lateral radiographs & Coronal CT Scan showing Intra Articular Distal Humerus Fracture of a 24 year Old Right-hand dominant male



Follow up at 6 months



Follow up at 1 year



Photographs of the patient demonstrating flexion, extension, pronation and supination 1 year after surgery.

**Complications**



**Fig 8:** Infection



**Fig 11:** Elbow Stiffness



**Fig 9:** Transient Ulnar Neuritis



**Fig 10:** Metal Prominence (Olecranon K Wires)

**Discussion**

Bimodal age distribution was shown in our study, which was in agreement with the studies by Palvanen and Robinson. [2, 3] In our study average age was 44.6 years. This is comparable to studies done by Kamrani *et al.* [13] who had observed an average age of 46 years in their study. Singh V *et al.* [14], Schmidt-Horlohé KH *et al.* [15] and Kamrani *et al.* [13]; all noticed predominant left side involvement in their studies. We noted similar observations. Studies conducted by Riyaz sheik *et al.* [16] and Ata Can Atalar *et al.* [17] concluded that males were more commonly involved than females; contrary to our observations wherein we noted a female predominance. Riyaz sheik *et al.* [16], Shao-hua Li *et al.* (2011) [18] and Imran mang *et al.* (2014) [19] in their studies found that fractures occurred more likely due to high-velocity RTA, which is in accordance with our study. Kiran GU *et al.* (2017) [20] in their study found that the average time of fracture union was achieved in 16.4 weeks in 20 patients, Muzaffar N *et al* (2014) [21] in their study found that fracture united in 25 patients by 10-16 weeks with an average time of 12.56 weeks. These are consistent with our findings; wherein fracture union was achieved in an average time of 15 weeks. Helfet [6] reported non-union rate of distal humerus fractures treated by ORIF at 2-10%. No case of non union or delayed union was

found in our study. Radiologically, all the fractures showed union at final follow.

Jupiter<sup>[9]</sup>, Holdsworth BJ<sup>[22]</sup> and Wilkinson & Stanley<sup>[5]</sup> recommended olecranon osteotomy in their studies as it provided a very good visualization of the articular surface compared to other approaches. Gofton<sup>[10]</sup> and Kundel<sup>[23]</sup> used Chevron olecranon osteotomy and obtained good to excellent outcomes. We concur with their studies. In 10 of our patients, we had used *Trans olecranon* approach with Chevron osteotomy which gave better exposure of the articular surface aiding an easier articular reconstruction, shorter operating time with better outcomes eventually. The resultant mean range of elbow motion was 116 degrees at the final follow up, which nearly identical with the study by Imran mang *et al* (2014)<sup>[18]</sup> where they achieved mean elbow range of motion of 110.

Abilhek Mishra<sup>[24]</sup> *et al* in their study complication rate was 15% with 2 (10%) cases of transient ulnar neuropraxia and 1(5%) case of superficial infection. Muzaffar N *et al* (2014)<sup>[21]</sup> in their study encountered 4(16%) cases of superficial infection; 1(4%) case of Ulnar neuropraxia 2(8%) had metal prominence (olecranon K-wires). Imran Mang *et al* (2014)<sup>[19]</sup> in their study encountered 1(4%) case of elbow stiffness, 1(4%) case of Ulnar neuropraxia which recovered spontaneously. 3 of our patients owing to poor compliance during postoperative rehabilitation had elbow stiffness and 1 patient had Olecranon K Wire Prominence. Kundel<sup>[23]</sup>, Yilmaz<sup>[25]</sup> and Aslam<sup>[26]</sup> all have reported transient ulnar neuritis in the post-operative period. A less than 1% incidence of ulnar neuritis following routine transposition was observed by Gofton<sup>[10]</sup>, Eralp<sup>[27]</sup> and Wang<sup>[28]</sup> whereas Helfet<sup>[6]</sup> observed a 7% incidence on not performing the transposition. Contrasting conclusions were made by Chen<sup>[29]</sup> & Vizquez<sup>[30]</sup> from his study that indicated an higher incidence of post-operative ulnar neuritis following routine Ulnar Transposition and advised against the same. In all the cases, we identified the ulnar nerve by dissection along its course and protected it during the surgery. Care was taken to avoid excessive devascularisation and forceful retraction. Nevertheless, we did not perform anterior transposition in any of the cases. Only one of our patient presented postoperatively with mild affliction of ulnar nerve; sporadic paraesthesias and transient numbness in the ring and little fingers and recovered completely by 4 months.

Jupiter<sup>[29]</sup> and Green<sup>[31]</sup> reviewed the literature and reported that post-operative infection in these fractures range from 0 to 9%. We had 1 patient presenting with postoperative wound infection who were managed with antibiotics sensitive to the aerobic culture report, the infection subsided in due course and required no further intervention.

## Conclusion

We conclude that Olecranon Osteotomy approach gives a better visualization of the Fracture site. And also, Bicolumnar fixation appears to be an effective modality of treatment for distal humerus fractures.

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