

# FUNCTIONAL OUTCOME OF INTERCONDYLAR DISTAL HUMERUS FRACTURES SURGICALLY TREATED WITH OPEN REDUCTION AND INTERNAL FIXATION WITH A PRINCIPLE BASED ON ORTHOGONAL PLATING TECHNIQUE

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## ABSTRACT

### Introduction

Owing to the complex articular structure, paucity of metaphyseal bone and thin soft tissue covering, treatment of intra-articular distal humerus fractures still pose challenge to surgeons. Although it comprises 2% of all fractures the massive complication rate to the treatment is worrisome. This study aims to evaluate the outcome of surgical treatment of these fractures by open reduction and internal fixation by dual orthogonal plates.

### Objectives

The objective of the study is to evaluate the functional outcome of intercondylar humerus fractures managed with open reduction and internal fixation with orthogonal dual plating technique.

### Methodology

Eighteen patients (19 – 68 years old) with AO/OTA type 13C fractures were evaluated after surgery for one year with MEPS and range of motion. Complications were categorized as major or minor complications. Functional comparisons were made between simple articular type C1/C2 and complex articular type C3 fractures at one year.

### Result

There were 2 (11.11%) type C1 fracture and 8 (44.44%) each in type C2 and C3 fractures. Eight (44.44%) patients obtained excellent, 7 (38.89%) obtained good and 3 (16.7%) obtained fair results. There was no poor outcome. Average MEPS score was 83.33 and there was no significant between the subgroups ( $p = 0.07$ ). The average flexion was  $118.06^\circ$  and it was significantly impaired in type C3 fractures ( $p = 0.03$ ). Three patients obtained full extension, and remaining patients had mean extension deficit of  $12^\circ$ . Average arch of motion was  $108.06^\circ$  with significant difference between two subgroups ( $p = 0.008$ ). The mean arc of motion for supination-pronation was  $154.44^\circ$ . There was 5 minor and 2 major complications (total - 38.9%).

### Conclusion

The surgical management with open reduction and internal fixation by dual plates in orthogonal configuration for the intercondylar distal humeral AO type C fractures has good or excellent functional outcome in majority of the patients.

## KEY WORDS

Elbow, intra-articular fractures, open reduction, internal fixation



## INTRODUCTION

Distal humerus fractures comprise 2 % of all fractures and almost one-third fractures of humerus in adult.<sup>1</sup> Intra-articular fractures at the distal end of humerus pose constant difficulty to the surgeons owing to its complex articular structure, paucity of metaphyseal bone, thin soft tissue covering and their frequent comminution.<sup>2</sup> Many of the surgeons agree on surgical management of these articular fractures as anatomical reduction, stable fixation and early mobilization are the optimal treatment goals.<sup>3-6</sup> Also operative treatment has far better outcomes than conservative treatment which leaves patient with significant stiffness, deformity and pain.<sup>7-10</sup> Last few decades has seen constant growth in surgical techniques and methods of fixations for these fractures but controversies still exist on various approaches, implant choices, their mode of fixation and occurrence of complications.

As knowledge expands, bicolumnar fixation of AO/OTA 13C fractures of distal humerus is being considered standard technique.<sup>11-12</sup> 90-90 orthogonal fixation as well as parallel fixation with dual plates are the methods of bicolumnar fixation, where some consider orthogonal fixation to be superior than later while some consider the vice versa.<sup>13-16</sup> But many recent studies have now recognized both methods have their own merits and none of these techniques seems to be superior to each other.<sup>17-19</sup> Moreover, total elbow replacement is the treatment of choice for unreconstructable fractures of distal humerus.

This research was aimed to evaluate the outcome of open reduction and 90-90 orthogonal bicolumnar fixation of distal humerus fractures.

## METHODOLOGY

A prospective study of the cases who were operate for intercondylar fractures of distal humerus from February, 2017 to February, 2019 was made. Criteria for inclusion was maintained with single distal humeral fractures, open grade I fractures and AO/OTA type 13C fractures. Cases without previous history of elbow surgeries, elbow arthritis or tumors were included in the study. Open fractures of grade II and III, fractures associated with elbow dislocations, fractures with neurovascular complications and the fractures along with the fractures of ipsilateral radius or ulna were not included in the study. Pathological fractures and fractures with previous congenital or acquired deformities were also excluded. The age limit for inclusion was set as above 16 and below 80 years. Therefore, a total of eighteen cases, eleven men and seven women were studied with mean age of  $45.94 \pm 12.6$  years (range, 19 – 68 years). Age distribution among them were five patients of 19 to 40 years, seven patients being 41 to 50 years, four patients being 51 to 60 years and two patients being 61 to 70 years. Number of fractures in the right elbow was 12 (66.67%).

Detailed history was obtained and thorough clinical examination was performed taking regards to soft tissue and neurovascular status. There were two cases of grade I open

fractures and one case of preoperative ulnar nerve sensory deficit. For both the open fractures, debridement and fixation was done in same sitting. X-rays in anteroposterior and lateral views were obtained. CT scans was obtained as far as possible. Classification of the fracture was made under AO/OTA classification system. Type C1 simple articular fracture was present in two (11.11%) patients, type C2 in eight (44.4%) patients and type C3 in eight (44.4%) patients. Mean duration of trauma to surgery was  $2.78 \pm 1.83$  days (range, 1 – 8 days). All the patients were operated under general anesthesia or regional brachial plexus block in lateral decubitus under tourniquet control. Transolecranon osteotomy approach for distal humerus was applied for all the cases. Posterior midline incision was made 8 to 10 cm proximal to the olecranon tip and extended distally. Slight lateral curve was made at the level of olecranon prominence. At medial edge of triceps ulnar nerve was isolated and released from cubital tunnel and secured with a loop. Osteotomy was performed about 2 cm distal from tip of olecranon process with drill bit and osteotome. Triceps was retracted upwards along with olecranon process that provided good exposure to the posterior surface of distal end of humerus. Due care was taken not to strip excessive soft tissue from bone fragments. Step by step reconstruction of fracture fragments were performed. First, condylar fragments were assembled as a single articular unit. They were provisionally held together by k-wire. If epicondylar ridge fragment was present, it was reduced to humeral metaphysis. Then the condylar unit was reduced to the humeral metaphysis and fixed provisionally with k-wires. The condyles were fixed together with 4mm cannulated screw then bicolumnar fixation was performed with precountoured anatomical locking compression plates and/or recon-plates/tubular plates and screws in 90-90 orthogonal fashion. Medial column plate was applied medially to the distal humerus and lateral column plate was applied posterolaterally (Figure 1). Intraoperatively stability was tested by checking range of motion of the elbow. Then the olecranon osteotomy was fixed with tension band wiring with 2 mm k-wires and stainless-steel wires. During closure, transposition of ulnar nerve was not performed except for 1 patient where irritation of the nerve due to the implant was of concern. In all other cases ulnar nerve was rather secured properly so entrapment and irritation would not occur. Postoperatively, intravenous antibiotics were continued for 3 days. Naproxen was administered for 28 days as prophylaxis for heterotrophic ossification. Physiotherapy with passive range of motion was started as soon as pain allowed and active motion was initiated gradually. In all cases, physiotherapy was initiated before 10 post-operative days. Posterior slab was continued for 2 weeks then arm-sling was applied for next 2 weeks. Patients were evaluated clinically and with postoperative x-rays regularly for at least 12 months. Functional outcomes were evaluated individually with Mayo Elbow Performance Score (MEPS) and range of motion (ROM) not at least before 12 months (average, 14.83 months, range, 12 – 20 months) postoperatively.

SPSS 17.0 was used for statistical analysis. For descriptive



data analysis percentage, mean, SD, minimum and maximum were calculated. The outcome measures were compared between the AO subgroups (simple articular C1/C2 vs. complex articular C3). For inferential data analysis, student's t-test was applied for continuous data to find the significant differences. Fischer exact test was used to find out the significant difference between nominal variables at 95% CI where p-value corresponds to <0.05.

## RESULT

Among eighteen patients, eight (44.44%) patients obtained excellent, seven (38.89%) obtained good and three (16.7%) obtained fair results according to MEPS (Table 1). The mean overall MEPS was 83.33 (range 60 – 100). The average flexion was 118.06° (range 100° – 130°). MEPS didn't differ significantly between the AO subgroups ( $p = 0.07$ ), however, the flexion was significantly impaired in C3 fractures ( $p = 0.03$ ). Three patients obtained full extension, whereas mean extension deficit of 12° (range 5° – 25°) was noted in rest of the patients. The arch of flexion-extension motion also had significant difference between the subgroups ( $p = 0.008$ ) where overall average arch of motion was 108.06° (range 80°–130°). The mean arc of motion for supination-pronation was 154.44° (range 130° – 170°) (Table 2) (Figure 2).

**Table 1: MEPS results based on AO/OTA subgroups**

AO/OTA subgroups		MEPS				Total
		Poor	Fair	Good	Excellent	
AO/OTA subgroups	Articular simple (C1 & C2)	-	-	4	6	10
	Articular Complex (C3)	-	3	3	2	8
Total		-	3	7	8	18

**Table 2. Functional outcome of elbow based on MEPS and range of motion of elbow joint.**

Parameters	Overall fractures	AO/OTA subgroups		p
		Type C1/C2	Type C3	
MEPS	83.33 (60-100)	87.5	78.1	0.07
Flexion	118.06° (100°-130°)	123° (110°-130°)	111.89° (100°-120°)	0.03
Arc of Motion	108.06° (80°-130°)	114.5° (100°-130°)	110° (80°-120°)	0.008
Extensor lag	12° (5°-25°)	10.63° (0°-25°)	13.57° (0°-20°)	0.35
Supination - pronation	154.44° (130°-170°)	158.5° (145°-170°)	149.38° (130°-170°)	0.09

**Table 3: Major and minor complications**

Complications	Number of patients
<b>Major</b>	
Deep infection	1(5.5%)
Nonunion	1(5.5%)
<b>Minor</b>	
Superficial infection	1(5.5%)
Incomplete ulnar nerve palsy	1(5.5%)
Hardware prominence	2(11%)
Screw loosening	1(5.5%)
<b>Total</b>	<b>7(38.9%)</b>

In this study, seven (38.9%) cases had complications (Table 3). There was one superficial infection, one deep infection, one case of pre-operative incomplete ulnar nerve palsy, one case of nonunion, two case of hardware prominence and one

case of screw loosening. There were altogether five minor and two major complications. Superficial infection required prolonged antibiotics for 4 weeks. Deep infection required repeated debridement before healing. The case of ulnar nerve injury recovered spontaneously during the follow-ups. The case of nonunion required autogenous bone graft at 7 months. Rest of the fractures united at expected time (average, 16.29 weeks, range, 12 – 22 weeks). The case with loosening of screws didn't require second surgery since there was evidence of proper healing. All olecranon osteotomies united uneventfully.



**Figure 1: a)** AO/OTA Type C distal humerus fracture in 60-year-old lady, **b)** Immediate post-op X-rays after fixation with orthogonal dual plating in same patient, **c)** One-month Post-op X-rays of same patient, **d)** one year follow up x-ray of the patient where fracture has united.



**Figure 2:** Range of movement of elbow joint after 12 months of surgery

## DISCUSSION

Intra-articular fractures of distal humerus are considered as difficult to treat fractures owing to its high rate of complications. The nonunion, implant breakage or loosening, elbow stiffness, loss of reduction of fragments, heterogeneous ossification and ulnar nerve palsy can cause trouble to both patients and surgeons. Nonunion occurs almost invariably at the supracondylar region most probably because this is the region of watershed.<sup>20-22</sup> In this study also the single case of nonunion had nonunion in this region. So, care must be taken to the soft tissue and not to damage the arterial supply during the surgery. Fracture gap at this region should be avoided because significant stiffness provided by the locking plates may not produce callus in the gap.<sup>23</sup> Bone grafting should be considered if there is significant gap between the

fragments.<sup>11</sup> However, stability of the fixation is of utmost importance since there was 32% cases of nonunion among which 78% had unstable fixation in a study by Proust.<sup>24</sup> Nonunion is also a well-known cause of plate breakage due to fatigue.<sup>23</sup> Implant failure also occurs due to pre-bending.<sup>25</sup> Bending at the long holes should be avoided. There was 27% case of implant failure in a study by Korner.<sup>4</sup> Similarly 29.5% failure of implant in the form of plate breakage or screw loosening occurred in a study by Makela.<sup>26</sup>

In this study, 83.33% of patients had excellent or good MEPS, 16.7% patients had fair MEPS and there were no poor outcomes. All the cases of AO C1/C2 fractures had excellent or good outcomes however C3 had only 75% cases of excellent or good outcome. The average MEPS in AO C1/C2 group was 87.5 whereas it was 78.1 in C3 group. Although MEPS in C1/C2 was better than C3 group, it was not statistically significant. In a study by Griener et al and Schmidt-Horlohe et al, there as excellent to good outcome in 83% and 92% of patients.<sup>27,28</sup> Schmidt also found that 90% of AO C3 group had excellent to good result. In the similar study, Rubberdt found 73% of C3 fractures had excellent to good result.<sup>25</sup> The mean flexion was 129° and extension deficit was 16° in the study by Korner. The mean ROM, flexion motion and extension deficit were 110°, 127.5° and 10° in the study by Schmidt. He found out that there was statistically significant extension deficit in the AO subgroups. In our study, means of flexion, flexion-extension arc of motion, supination-pronation range of motion and extension lag were 118.06°, 108.06°, 154.44° and 12° respectively. There was no significant difference in extension deficit between the subgroups. However, there were significant differences between flexion and flexion-extension arc of motion between the subgroups. The average flexion in C1/C2 group was 123° (range, 110°–130°) and it was 111.89° (range 100° - 120°) in C2 group. Similarly, average arc of motion was 114.5° (range, 100°-130°) and 110° (range, 80° - 120°) respectively (Table 2). Reported by KN An, the golden arc of flexion-extension motion is 100° (0° - 30° - 130°).<sup>29</sup> Raiss also reported that arc of flexion-extension motion and arc of supination-pronation needed for ten Activity of Daily Living (ADL) are 0° - 36° - 146° (total 110°) and 55°-0°-72° (total 127°) respectively.<sup>30</sup> So

majority of the patients in both subgroups in this study had gained satisfactory mobility required for the ADL. Administration of proper physiotherapy from the beginning of postoperative period for gaining good motion cannot be less emphasized. Charissoux found poor or fair result in 87% in those of the patients who couldn't initiate early physiotherapy.<sup>3</sup> Korner also found that there is significant decrease in range of motion who were immobilized for more than 15 days.<sup>4</sup>

## CONCLUSION

It can be concluded that the surgical management with open reduction and internal fixation by dual plates in 90-90 orthogonal configuration for the intercondylar distal humeral AO type C fractures has good or excellent results in majority of the patients. But the maximum complication rate and dissatisfaction of the patients mandate further studies about the biological behavior of the distal humerus and biomechanical properties of the implants.

## LIMITATION OF THE STUDY

The severe limitation of this study is the small size of the sample. Although the average follow-up is 14.83 months, the complications that could arise after longer duration like osteoarthritis and implant related problems could not be addressed through this study. As well as not all the patients with distal humerus fractures treated in this center undergone ORIF, leaving the space for selection bias. Also, the high rate of complications mandate for further studies.

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## CONFLICT OF INTEREST

None.

## FINANCIAL DISCLOSURE

None.

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