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Original Article

Comparative Study on Outcome between Orthogonal and Parallel Plating in the Treatment of Distal Humeral Intra-Articular Fractures

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Abstract

Background: *Intra articular distal humerus fractures are complex injuries that can comsiderably limit elbow function if not treated properly. In the treatment of distal humerus intra articular fractures double plate osteosynthesis is the standard treatment method. However, controversy still exists concerning the plate positions in terms of providing optimal stability of these kind of fractures. This study is aimed at finding any significant difference in outcome of these orthogonal and parallel plating methods of fracture fixation.*

Materials and methods: *This quasi experimental study was undertaken to compare the differences between these two dual plating methods. It was conducted in Department of Orthopedics and Traumatology of Chittagong Medical College Hospital, Chattogram, for a period of fifteen months. 36 patients were enrolled conveniently according to inclusion and exclusion criteria. Patients were followed up for 6 months and overall outcomes were measured by MEPS. Depending on the overall functional outcome patients were grouped as having excellent to good outcome and fair to poor outcome.*

Results: *At 6th month follow up, mean MEPS in the parallel plating group was 87.89±6.50 (Mean ± SD) and in the orthogonal group it was 83.72±7.45. There was no significant (p=0.785) difference between two groups in functional outcome but in parallel plating group MEPS was better. The mean union time was 6.17±0.383 weeks in parallel plating group and 6.22±0.548 weeks in orthogonal plating group. p value was 0.549. Regarding complications, elbow stiffness developed in 3(13.89%) in parallel and 4(19.44%) in orthogonal group, superficial infection developed 1 in parallel and 3 in orthogonal group.*

Conclusion: *This study shows that, parallel plating group was superior to the orthogonal group, as of better functional outcome, less union time and less complications.*

Key words: Fracture; Orthogoanal plating; Parallel plating.

INTRODUCTION

Intra-articular distal humerus fractures remain one of the most difficult injuries to manage. These fractures comprise 2-6% of all fractures and have bimodal age distribution. The majority of these fractures occur either of two ways, low energy falls or high energy trauma. Most fractures in elderly patients are intra-articular with bi column involvement[1]. They are commonly multifragmental and occur in osteopenic bone. Straight forward fall in forward direction is the most common cause. Usually, 70% of patients that sustain an elbow fracture fall directly on to the elbow because they are unable to break their fall with an out stretched arm. High energy injuries like motor vehicle collisions, sports, and fall from height and industrial accidents are the causes of most intra-articular distal humerus fractures in young adults.[1,2]

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AO/OTA used classification is the most widely used. Extra articular (AO type A) Partial articular (AO type B) Complete articular (AO type C). A TYPE: fracture is non-articular. B TYPE: Partially articular, A part of the articulating segment remains in the continuity with the shaft. C TYPE: Fractures are articular, but have no articular fragments remaining in the continuity with the shaft. C1: T or Y fractures, C2: articular fractures are simple, but the non-articular supracondylar area is segmental or comminuted. C3: articular segment is segmental or comminuted.[3]

Earlier consensus favoured non operative management due to poor operative outcomes. Modern orthopaedic implants and surgical techniques permitting rigid fixation and early motion, achieves painless functional range of motion at elbow overcame this problem. Any treatment that needs extended immobilization of elbow leads to a stiff joint. Closed methods like cast immobilization, traction, bag of bones technique is recommended for elderly patients and for those whose medical conditions don't allow surgery.

The management of distal humeral fractures pertained to controversies. Few are correct approach, fixation techniques, management of ulnar nerve, the role of total elbow arthroplasty etc.[4] Restoration of diaphyseal metaphyseal contact and reconstruction of olecranon fossa was essential to provide more stability and allow best healing.[5]

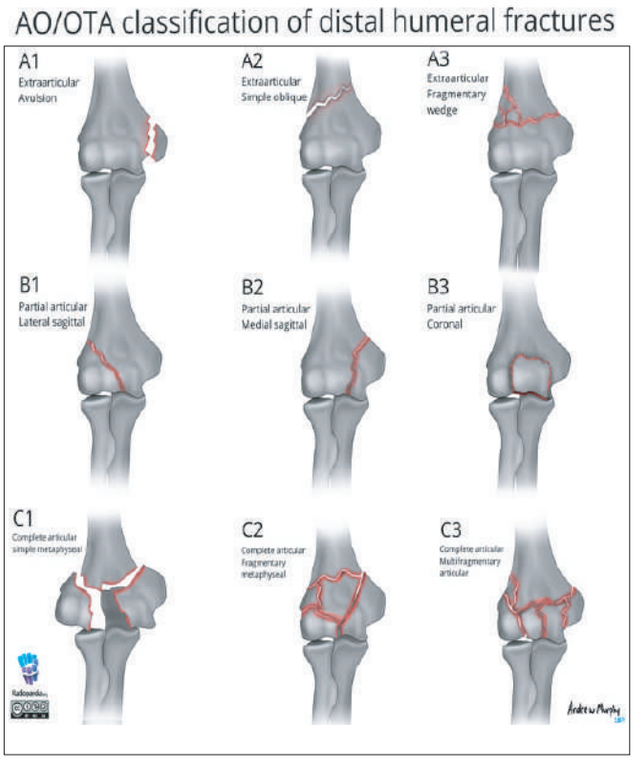
Though relatively uncommon, intraarticular fractures of the distal humerus continue to provide operative challenges to the surgeons attempting to address this problem as it is complicated by the anatomy of the elbow, its small area for fixation and otherwise compounded by comminution and osteopenia of articulating surfaces.

The main principle of managing these fractures is reconstruction of the articular block and stable internal fixation of this reconstructed block with the shaft by plating on both pillars. Without this dual plate arrangement, the stability of xation can be inadequate.

In complex fractures of the distal humerus, single column plating systems, which are proven to be less stable to loads compared to double column plating methods is not recommended. Based on clinical and biomechanical studies, fixation with double plating is currently recommended.

However, controversy still exists concerning the plate positions in terms of providing optimal stability for these kinds of fractures.Among the placement, the main debate is between the perpendicular plating proposed by, the AO/ASIF group where plates are placed perpendicular to each other one over the medial supracondylar ridge and the other one over the flat posterior surface of the lateral column also called as orthogonal plating and, the principle stated by, O' Driscoll, two plates placed parallel to each other, one over each supracondylar ridge, termed parallel plating.Various plate designs have been developed for the fixation of these fractures, some are like Y plates, reconstruction plates, and pre contoured anatomical plates, compression plates[3,4,5].

This quasi experimental study was conducted to compare the clinical and radiological outcomes in terms of elbow function, bone union and complications following the management of intra-articular distal humeral fractures by parallel or orthogonal plating techniques.



MATERIALS AND METHODS

This present quasi experimental study was conducted between the periods of September 2022 to November 2023 for duration of fifteen months in the Department of Orthopaedics and Traumatology, Chittagong Medical College Hospital, Chattogram, Bangladesh. In this study, adult patients with intra-articular fracture of the distal humerus underwent Parallel plating (Group P) or Orthogonal plating (Group O) were the study sample. Total 36 samples were included in the study. In this study, total four follow up were done at 4th week, 6th week, 3rd month and 6th month. The overall functional outcome was categorized according to Mayo Elbow Performance Score and analyzed. The union time and complications were also compared.

The protocol was approved by the Ethical Review Committee (ERC) of Chittagong Medical College Hospital, Chattogram, Bangladesh.Memo no: 59.27.0000.013.19. PG.009.2022/ 906 dated: 12.11.2022.

Inclusion criteria

Age 18 years and above who have consented, Closed type B and C (According to AO/OTA classification).

Exclusion criteria

- Age <18years.
- AO/OTA type A fractures.
- Pathological fractures.
- Open fractures
- Fractures with neurovascular complications.

RESULTS

Table I Side of injuryand mechanism of injury of the patients (n=36)

Injury details	Types of plating						p value
	P		O		Total		
	No	% age	No	% age	No	% age	
Side of injury							
Right side	7	38.89	8	44.44	15	41.67	0.735^{ns}
Left side	11	61.11	10	55.56	21	58.33	
Total	18	100	18	100	36	100	
Mechanism of injury							
Road traffic accident	5	27.78	7	38.89	12	33.33	0.468^{ns}
Physical assault	5	27.78	6	33.33	11	30.6	
Fall from height	3	16.67	1	5.55	4	11.11	
Fall from standing height	3	16.67	4	22.22	7	19.4	
Sports injury	2	11.11	0	0.00	2	5.56	
Total	18	100	18	100	36	100	

Mayo Elbow Performance Score (MEPS): Function of elbow at 6 months.

- Statistical analysis was done by Chi square test.
- p value > 0.05 indicaters non significant
- ns= non significant.

Table I represents that, among 36 patients, according to side of injury, 58.33% patients had injury on left side and 41.67% patients had injury on right side. Most of the patients had fracture on their left humerus, with the left to right ratio 21:15. According to mechanism of injury, maximum patients (33.33%) had history of road traffic accident. No significant statistical difference between parallel and orthogonal group according to side of injury (p=0.735ns) and mechanism of injury (p=0.468ns).

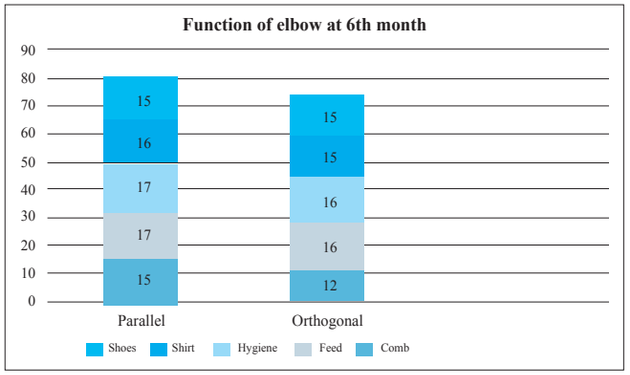


Figure 1 Function of elbow at 6th month (n= 36)

Figure 1 representing elbow function shows that, at the end of the 6 months, 15(41.67%) in parallel group were able to comb by himself and 12(33.33%) in orthogonal group. No significant difference (p=0.248) was observed. 17(47.2%) patient were able to feed by himself in parallel group and 16(44.44%) in the orthogonal group. Difference between these two groups was not significant (p=0.546). 17(44.44%) in parallel group were able to maintain personal hygiene and 16 (44.44%) in orthogonal group. There was no significant (p=0.546) difference between these two groups. 16(44.44%) patients in the parallel group were able to put on shirt and 15 (41.67%) in orthogonal group. Difference between these two groups was not significant (p=0.630). In both groups 15(41.67%) patients (p=1.000) were able to put on shoes.

Table II Mayo Elbow Performance Score (MEPS): Range of Movement

ROM	Type of fixation				Total		p value
	P		O				
	No	%	No	%	No	%	
>100	9	50	7	39	16	44	0.502^{ns}
50-100	9	50	11	61	20	56	
<50	0	0.00	0	0.00	0	0.00	
Total	18	100	18	100	36	100	

Chi square= 0.450, df=1.p value = 0.502.

- Statistical analysis was done by Chi square test.
- p value > 0.05 indicates non significant
- ns= non significant.

In the parallel plating group nine patients had flexion of more than nine patients had flexion of more than 100^{o}, nine had 50-100^{o} and none below 50. The mean range of motion in parallel plating was 107^{o}. In the orthogonal plating group seven patients had flexion of more than 100^{o} and eleven had 50-100^{o} and none below 50^{o}. The mean range of motion in orthogonal plating was 104^{o}. No significant statistical difference was observed (p=0.502ns) between the groups.

Table III Various findings in follow up period

Categories in follow up	Parallel		Orthogonal		Total		p value
	No	% age	No	% age	No	% age	
Time for union							
6 weeks	8	44.44	6	33.33	14	38.89	0.377^{ns}
7 weeks	6	33.33	10	55.56	16	44.44	
8 weeks	4	22.22	2	11.11	6	16.67	
Mean Union Time	6.17		6.22		6.19		
Total	18	100	18	100	36	100	
MEPS							
Excellent	10	55.56	5	27.88	15	41.67	
Good	7	38.89	9	50.00	16	44.44	0.156^{ns}
Fair	1	5.56	4	22.22	5	13.89	
Poor	0	0.00	0	0.00	0	0.00	
Mean	87.89			83.72		85.81	0.785 ^{ns}
Total	18	100	18	100	36	100	
Complications							
Present	7	38.89	10	55.56	17	47.22	
Absent	11	61.11	8	44.44	19	52.78	0.317^{ns}
Total	18	100	18	100	36	100	

- Statistical analysis was done by Chi square test.
- p value > 0.05 indicates non-=significant.
- ns=non-significant.

Table III showd that, the mean union time for parallel group was 6.17 weeks and for orthogonal group it was 6.22 weeks. Most of the patients in parallel group united in 6 weeks (44.44%) and in orthogonal group (55.56%) united in 7 weeks. According to time of union, difference between two groups is not significant (p=0.377ns). In Mayo Elbow Performance Score, for the parallel plating groups the functional outcome was excellent in 10 cases, good in 7 cases and fair in 1 cases. For the orthogonal plating group MEPS was excellent in 5 cases, good in 9 cases and fair in 4 cases. Mena MEPS in parallel group is 87.89 and in orthogonal group it was 83.72. Difference between these two groups was not significant (p=0.785ns). In parallel group the notable complication were 38.89% and in orthogonal group it was 55.56% which was not significant (p=0.317ns).

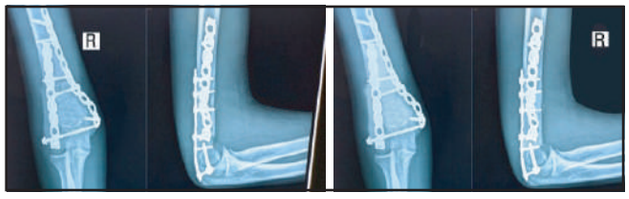


Image I Follow up X ray at 3 months

Image II Follow up X ray at 6 months

DISCUSSION

According to side of injury, 58.33% patients had injury on left side and 41.67% patients had injury on right side. Most of the patients had fracture on their left humerus, with the left to right ratio 21:15. Our study result was comparable toan study where majority of the patients had fracture on their left humerus, with the left to right ratio 26:12.[8] According to mechanism of injury, maximum patients (33.33%) had history of road traffic accident. No significant statistical difference between parallel and orthogonal group according to side of injury ($p=0.735^{ns}$) and mechanism of injury ($p=0.468^{ns}$) was observed. Our study result was comparable to a study which showed that according to mechanism of injury, 66.67% had history of road traffic accident among parallel group and 53.33% in orthogonal group.[7] Increasing number of motor vehicles and the lack of driving skill and with very few people following traffic rules, RTA was the major mode of injury sustained by our patients with respect to fall and assault.

Among 36 patients, according to AO/ OTA type of fracture, 38.89% patients had 13C2, 13C1 had 33.33%, and 13C3 had 22.22% and 5.56% had 13B3 type of fracture. No significant statistical difference between parallel and orthogonal group according to side of injury ($p=0.853^{ns}$) was observed. This study result was comparable to singh et al. according to AO/OTA type of fracture, 43.33% patients had 13C2, 13C1 had 33.33% and 13C3 had 20.00% and 3.33% had 13B1 type of fracture.[8]

According to Mayo Elbow Performance Score, for the Parallel Plating group the functional outcome was excellent in 10 cases, good in 7 cases, fair in 1 and poor in 0 cases. For the Orthogonal Plating group the functional outcome was excellent in 5 cases, good in 9 cases, fair in 4 and poor in 0 cases. Mean MEPS in parallel group is 87.89 and in orthogonal group it was 83.72. According to p value (0.785), there was no significant difference found between the groups. This study result was comparable to studies who found the mean MEPS was 85.6 points in parallel group, which corresponded to an excellent result in 5 elbows, a good result in 8, and a fair result in orthogonal group.[9]

In the parallel plating group nine patients had flexion of more than 100°, nine had 50- 100° and none below 50°. The mean range of motion in parallel plating was 107°. In the orthogonal plating group seven patients had flexion of more than 100° and eleven had 50-100° and none below 50°. The mean range of motion in orthogonal plating was 104°. This study result was comparable to who found it 121.66° in parallel group and 99.66° in orthogonal group.[10]

Out of 36 patients at 6 months follow up, 15(41.67%) in parallel group were able to comb by himself and 12(33.33%) in orthogonal group. No significant difference (P=0.248) was observed.17 (47.2 %) patient were able to feed by himself in parallel group and 16(44.44%) in the orthogonal group.

Difference between these two groups was not significant (p=0.546). 17(44.44%) in parallel group were able to maintain personal hygiene and 16 (44.44%) in orthogonal group. There was no significant (p=0.546) difference between these two groups. 16(44.44%) patients in the parallel group were able to put on shirt and 15 (41.67%) in orthogonal group. Difference between these two groups was not significant (P=0.630). In both groups 15(41.67%) patients (p=1.000) were able to put on shoes. The present study result was comparable to that who found that13(43.33%) in parallel group were able to comb by himself and 11(36.67%) in orthogonal group.[11] 15(50%) patient were able to feed by himself in parallel group and 15(50%) in the orthogonal group. 15(50%) in parallel group were able to maintain personal hygiene and 15 (50%) in orthogonal group. 15(50%) patients in the parallel group were able to put on shirt and 14 (46.67%) in orthogonal group. In both groups 13(43.33%) were able to put on shoes.

Among 36 patients, according fracture union was assessed radiologically. The mean union time for parallel group was 6.17 weeks and for orthogonal group it was 6.22 weeks. Most of the patients in parallel group united in 6 weeks (44.44%) and most of the orthogonal group united in 7 weeks (55.56%). No significant statistical difference between parallel and orthogonal group according to time of union ($p=0.377^{ns}$). The present study was comparable to a study the mean union time for Orthogonal plating was 9.53 weeks, which was higher than for that of the parallel plating (8.93 weeks).[12]

Over the last 1 year, after evaluation of 36 patients with intra-articular fracture of lower end of Humerus treated with parallel plating and orthogonal plating, the average Mayo Elbow Performance Score for parallel plating group was 87.89 which was good and for orthogonal group was 83.72 which was also good. The difference in the mean MEPS of the two plating technique was statistically non-significant in this study (p=0.785).

In the present study, 48% of patients had complications. Complications were elbow stiffness, prominent hardware, superficial infection and transient ulnar nerve palsy. Post operatively, 7 patients developed elbow stiffness (p value=.480) who achieved improvement in functional range of motion with physiotherapy. 4 patients had prominent hardware (p value=1.000) which was removed after the bony union. 4 patients had superficial infection (p value=.289) which was treated with antibiotics and dressings and 2 patients had transient ulnar nerve neuropraxia (p value=1.000) which recovered spontaneously. 19 patients were free of complications. The results were comparable to 44% patients had complications. The notable complications were painful hardware, superficial infection and transient ulnar nerve palsy. Post-operatively, 8 patients had painful hardware for which was removed after the bony union. 7 patients had superficial infection which got treated with antibiotics and dressings and 3 patients had transient ulnar nerve neuropraxia which recovered subsequently. 17 patients had no complications.[13]

LIMITATIONS

- No randomization and blinding were done.
- Small sample size.
- Single centered study.
- Sample was taken conveniently. So, there may be chance of bias which can influence the interpretation.

CONCLUSION

Present study showed that, from a clinical perspective, a parallel plating method appears to provide better rigid fixation that is adequate for obtaining bone union. However, no statistical significant differences were observed between the orthogonal and parallel double plating methods in terms of clinical outcomes and complication rates. If appropriately applied with suitable plates, both parallel and orthogonal positioning can provide adequate stability and anatomic reconstruction of the distal humerus fractures. The goal is to get functional elbow which can be achieved by stable fixation and early mobilization and proper postoperative rehabilitation protocol.

RECOMMENDATIONS

- For more reliable result a multi-center study could be conducted.
- Longer duration of prospective study and longer follow up of patients with respect to their functional status will be helpful.
- Randomization and blinding are needed for reducing bias in future.
- As present study was done on a relatively small sample, a large scale study to be conducted to make the findings of the study generalized to reference population.

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DISCLOSER

All the authors declared no competing interest.

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