

FUNCTIONAL OUTCOME OF ORTHOGONAL DUAL COLUMN PLATING IN TREATMENT OF DISTAL HUMERUS FRACTURE

Orthopaedics

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ABSTRACT

Background: The study was conducted to evaluate the functional outcome of orthogonal dual column plating system in distal humerus fracture. **Material and Methods:** 47 patients above 18 years of age with fracture distal end of humerus with or without intraarticular extension were evaluated, with the mean age group of 43 years to find the functional outcome of Orthogonal plating using various approaches. **Results:** The mean union time was 11.3 weeks. The average arc of motion was 97°. Average mayo elbow performance score (MEPS) was 81.4. We had superficial infection in immediate post-operative period in 7(15%) patients, deep infection in 1(2%) patients, stiffness in 5(10%) patients, 3(6%) patients with hardware prominence and 1 patient had exposed implant, 1(2%) patient developed ulnar nerve neuropraxia and 1(2%) patient developed non-union. **Discussion and Conclusion:** The following results were assessed: operating time, hospital stay, arc of motion, time to fracture union, functional recovery, and complications. We conclude that dual plate technique provides good fixation for closed intercondylar distal humerus fractures if proper preoperative planning, good reduction and surgical technique are followed, leading to high rate of bone union and minimal soft tissue damage. Orthogonal dual column plating can be a successful technique for internal fixation of these complicated fractures when its principles are strictly adhered to.

KEYWORDS

Functional outcome, orthogonal plating, treatment, distal humerus fracture

INTRODUCTION

Fractures of the distal humerus accounts for 2-6% of all fractures and 1/3 of all humeral fractures. Intra-articular distal humerus fractures are very rare accounting for 0.5% of all fractures¹. In this modern society with a growing elderly population and extremely active young population, the incidence of distal humeral fractures is increasing and having a bimodal distribution.² As a result of ongoing search for a more secure technique, orthogonal dual column plating technique evolved, which involves placing one plate along the medial column of the distal humerus and the other plate along the posterolateral lateral column³. The aim of the present study is to evaluate the functional outcome of surgical management of distal humerus fractures with orthogonal dual column plating.

AIMS AND OBJECTIVE:

- To assess the clinical outcome associated with orthogonal dual column plating in treatment of distal humerus fracture.
- To assess the elbow range of motion.
- To assess the rate of different complication associated with this technique

MATERIALS AND METHODOLOGY

STUDY DESIGN:

A prospective study was done to evaluate the functional outcome of orthogonal bicolumnar plating technique in treatment of distal humeral fractures and to analyse the results.

STUDY GROUP:

A study group of 47 patients having Distal humerus fractures were admitted to SSG Hospital attached to Baroda Medical College and were taken up for study from June 2019 to December 2020. The study was done with clearance from Hospital ethical committee. Those who fulfilled the inclusion criteria given below were invited to participate in the study. Informed consent was obtained from all the patients willing to take part in the study.

INCLUSION CRITERIA:

- Patients of or above the age of 18 years with displaced distal humerus fractures with or without intra-articular extension. (AO classification type A (A2, A3) and type C)
- Patients with close and open grade 1 (according to Gustilo-Anderson classification) fractures of the distal humerus.

EXCLUSION CRITERIA:

- Patients with multiple procedures previously performed on same limb.
- Patients with open grade 2 and open grade 3 fractures.
- Patients with repeat trauma to same limb after the initial surgery under study.
- Patients less than 18 years of age.
- Patients unfit for major surgery.
- Severe unreconstructable intra-articular comminuted fractures in elderly.
- With vascular injury
- With pathological fractures

SURGICAL TECHNIQUE:

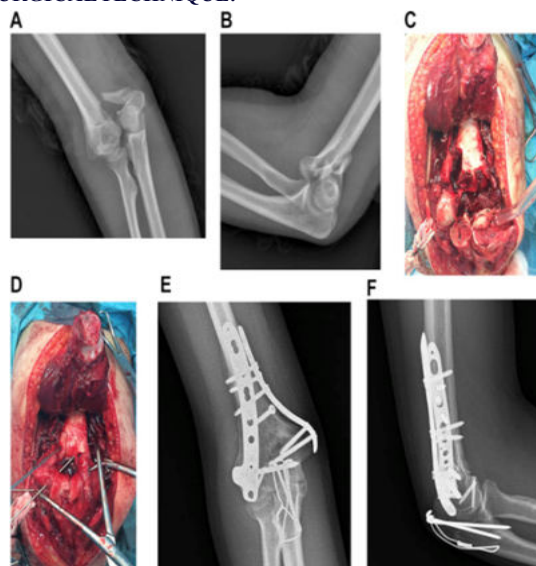


Figure 7.4 showing technique of orthogonal plating

Type of anaesthesia: General anaesthesia was used in 15 cases and brachial block in 32 cases.

Patient in lateral position with arm supported and forearm hanging. We used pneumatic tourniquet in all our patients with inflation pressure of 100+mean arterial pressure (mm of Hg) for duration of maximum 90 minutes. In majority of the patients (36 patients) a posterior trans-olecranon approach was used to give better exposure of the articular surface. In remaining 11 patients, para-tricipital approach were taken. A midline posterior skin incision made, 5cm distal to tip of olecranon process and 8 cm proximal to tip of olecranon process. Deep fascia incised and before proceeding further, the ulnar nerve is identified, dissected out and retracted gently with an umbilical cotton tape. Triceps muscle identified and released on either side from the intermuscular septum. Fracture site exposed further with chevron V shaped olecranon osteotomy^{3,5,6} incompletely with saw and completed with an osteotome in complex articular fractures. as it provides adequate exposure of the articular fragments⁷. In other types we utilized para-tricipital approach.

TECHNIQUE OF ORTHOGONAL PLATING⁵:

Fragments of the humerus were assembled in 2 steps -

- Reduction and fixation of condyle together in type C distal humerus fractures
- Reassembled condyles are fixed to the humeral metaphysis.

Reduction and fixation of the condyles:

- Condyles were reduced and held with a bone holding clamp.
- Reduced condyle was provisionally fixed with Kirschner wire.
- Lag screw (a partially threaded screw, or a fully threaded cancellous screw with over drilling the near cortex) was used to obtain compression. Try to use two screws to avoid rotational instability.
- Reduction and fixation of the reconstituted articular condyles to metaphysis with help of K-wire.
- Reduction and temporary stabilization of the medial and lateral column was done by using crossed Kirschner wire.
- Medial and lateral pillars were reconstructed using pe-countered 3.5mm distal humerus medial and posterolateral column anatomical plates.
- To enhance the mechanical strength, the plates were placed as closed to 90° to each other as possible.
- First place a 3.5 mm lateral column plate posterolaterally. It should curve around the capitellum which has no cartilage cover posteriorly. A slightly longer plate is used to provide additional stability.
- In a more distal fracture, the lateral column plate can be extended all the way to the edge of the capitellar articular surface. It will not interfere with the radial head during the extension of the joint. The more bone, is covered by the plate, the greater is the stability achieved. Place a K-wire through the distal plate hole. Now insert the proximal screw without load. As the plate is pulled gently proximally, stable contact with the bone is obtained. Complete the plate fixation to the bone by inserting the remaining screws.
- Another plate medially on the crest of the medial supracondylar ridge was placed, its plane at a right angle to the lateral plate, in order to increase stability. It is recommended to insert the distal screws into the trochlea below the medial epicondyle.
- The fixation should ideally have at least three screws proximal and three screws distal to the fracture site through each plate and thus through each column.
- The stability of the internal fixation was tested by putting the elbow through a range of motion.
- The olecranon osteotomy was reduced under direct vision and held with reduction clamp. Two 2 mm k wires were introduced from the tip of the olecranon. Periosteum was stripped from the shaft of the ulna distal to the osteotomy site and transverse hole was drilled approximately 3-5cm distal to osteotomy site. A No.18 stainless steel malleable wire passed through thin transverse hole and crossed over the posterior surface of the olecranon in a figure of eight manner and then passed around the k-wires and tightened.
- At the completion of the fixation the elbow was again put through a range of motion to test the security of the internal fixation.
- The tourniquet was let down and haemostasis carefully secured. The wound was closed in layers over a 12-number suction drain. Pressure bandage was applied and limb immobilized with above elbow splint.

POST OP PROTOCOL:

Patients were placed in a well-padded plaster extension splint applied posteriorly and the limb elevated for first 3 days. Active finger

movements started from day 1. Intravenous antibiotics were given for 3 days. Oral antibiotics were given for 7 days. Drain removal at 48 hours. Suture removal done between 9th to 16th post-op day. Elbow range of motion was started between days 3 and 7 postoperatively, as tolerated by the patient. Generally, active-assisted and active range of motion were encouraged (flexion, pronation, and supination) of elbow. Passive supported (gravity assisted) extension was reserved for patients that underwent an extensor mechanism disrupting approach. Patients were advised to remove posterior slab and do intermittent elbow flexion and extension movements and also not to lift weight or exert the affected upper limb. Monthly follow up for first 3 months and thereafter every 3 months.

POST OPERATIVE ASSESSMENT: Post operatively the patients were assessed radiographically and clinically. Radiographic and clinical assessment was done by the Mayo Elbow Performance Score⁸. The clinical outcome was assessed according to the Mayo Elbow Performance Score⁸. The Overall clinical outcome was graded as follows.

- Excellent : >90
- Good (satisfactory) : 75-89
- Fair : 60-74
- Poor : <60

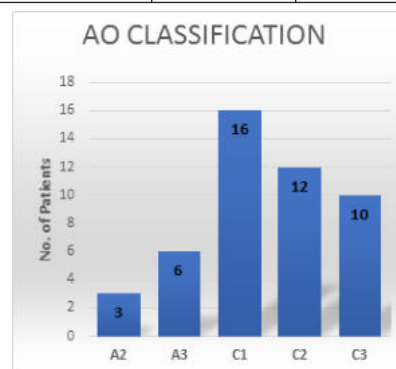
OBSERVATION:

The study consists of 47 Adult patients having distal humerus fractures who were admitted to SSG Hospital, Vadodara attached to Baroda Medical College after obtaining their informed written consent. This is a prospective study from June 2019 to December 2020.

1) AO classification of fracture:

Table 1:

AO CLASSIFICATION		Patients	Percentage (%)
A	A2	3	6.38%
	A3	6	12.76%
C	C1	16	34.04%
	C2	12	25.53%
	C3	10	21.27%
Total		47	100%



In our series, we accounted 81% fractures of type C and 19% fractures of type A according to OTA classification.

2) Union Status:

Table 2:

Months	Patients	Percentage (%)
0-12 weeks	37	78.72%
>12 weeks	10	21.27%
Total	47	100%

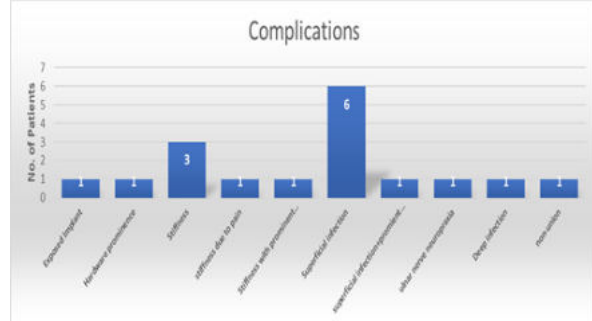
In our study majority of patients operated with orthogonal dual column plating showed signs of union. Average time of Union - 11.3 weeks. We had one case AO type C3 fracture showing no signs of radiological union at final follow-up in elderly female.

3) Complication:

Table 3:

Complications	No. of Patients	Percentage
Exposed Implant	1	2%
Hardware prominence	1	2%
Stiffness	3	6%

stiffness due to pain	1	2%
Stiffness with prominent hardware	1	2%
Superficial infection	6	13%
superficial infection+prominent hardware	1	2%
Ulnar nerve neuropraxia	1	2%
Deep infection	1	2%
Non-union	1	2%

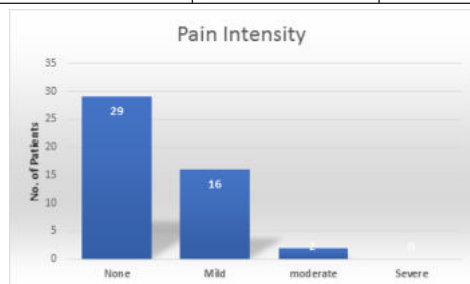


In our study, we had superficial infection in immediate post-operative period in 7(15%) patients, stiffness in 5(10%) patients, 3(6%) patients with hardware prominence and 1 patient had exposed implant in which exposed herbert screw was removed at 3 months, olecranon TBW at 6 months and exposed plate was removed at 11 months after confirming signs of fracture union on x-ray. Out of 7 patients with superficial infection, 4 patients were having diabetes, 1 patient was having open grade 1 injury. 1(2%) patient developed ulnar nerve neuropraxia which spontaneously recovered by 5 weeks. 1 patient developed deep infection on 15th day post-op follow-up which was resolved by debridement and antibiotic according to culture and sensitivity. 1(2%) patient developed non-union which was associated with fracture AO type C and old age with poor bone quality.

4) Pain Intensity:

Table 4:

Pain Intensity	No. of Patients	Percentage
None	29	62%
Mild	16	34%
Moderate	2	4%

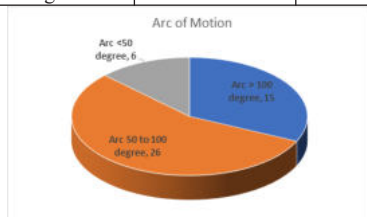


In our study, 29 patients did not complain of any pain and 16(34%) patients complained of mild pain, while 2(4%) patients complained of moderate pain at final follow-up.

5) Arc of Motion:

Table 5:

ARC of Motion	No. of Patients	Percentage
Arc >100 degree	15	32%
Arc 50 to 100 degree	26	55%
Arc <50 degree	6	13%

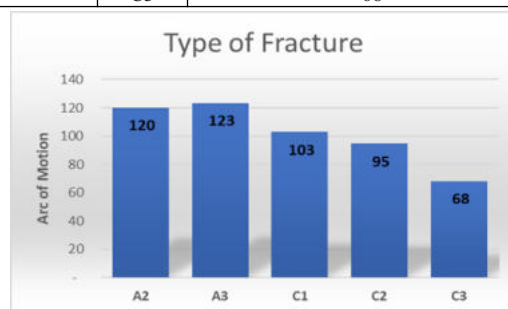


Mean arc of motion is 97 degrees. Required functional range of motion is 30-130 degree which could be achieved in majority of patients in our study.

6) Arc of motion according to fracture type:

Table 6:

Fracture pattern		Average of Arc of Motion (degrees)
A	A2	120
	A3	123
C	C1	103
	C2	95
	C3	68



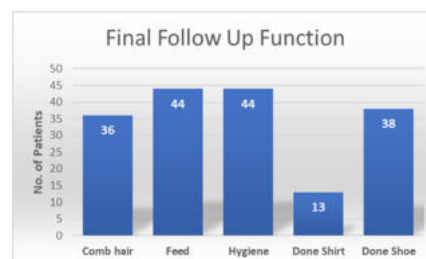
Type of fracture	Average of Arc of Motion
A	122
C	91

In our study, we found that average arc of motion in AO subgroup type A is 122 and type C is 91. This demonstrates that as the complexity of fracture pattern and intra-articular extension increases, there is decrease in final arc of motion and increase in incidence of stiffness.

7) Function at Final Follow Up:

Table 7:

Functions	No. of Patients	Percentage
Comb hair	36	80%
Feed	44	98%
Hygiene	44	98%
Done Shirt	13	29%
Done Shoe	38	84%



In our study as per Mayo Functional Assessment score 72, five function were taken in account out of which 44(98%) patients could feed by themselves, 44(98%) patients could do daily hygiene work by themselves, 38(84%) could do wear shoes by their own, 36(80%) could comb hair by themselves and only 13(29%) could wear shirts by their own.

8) Grading of Results:

Table 8:

Results	No. of Patients	Percentage
Excellent	20	42.55%
Good	20	42.55%
Fair	5	10.63%
poor	2	4.25%



In our study, Functional outcome based on Mayo Elbow Performance Score⁷² is excellent in 20(43%) patients, good in 20(43%) patients, fair in 5(11%) and poor in 2(4%) patients. Average MEPS is 81.4.

9) Grading of Results according to fracture type:

Type	Excellent	Good	Fair	Poor
A	A2 100%	0	0%	0%
	A3 83.33%	16.67%	0%	0%
C	C1 56.25%	37.5%	6.25%	0%
	C2 25%	50%	16.67%	8.33%
	C3 0%	70%	20%	10%

Table 9:

Fracture Type	Excellent	Good	Fair	Poor
A	88.88%	11.1%	0%	0%
C	31.57%	50%	13.15%	5.2%

In our study, we found difference in MEPS with respect to AO subgroups. Type A fractures were having excellent results in 89% of patients with no outcome of poor result in A subgroup. Type C fractures achieved good outcome (50%) in majority of patients, excellent result in 32%, fair in 13% and poor result in 5% of patients. Here, we observed that as the complexity of fracture pattern, intra-articular extension and comminution at fracture site increases, there is decrease in MEPS score.

DISCUSSION

In our study 47 cases of fractures of distal humerus including extra and intra articular were treated with two anatomical orthogonal plates. Our experience with these methods of fixation has given favourable results. The findings, the end results and various other data have been analyzed and compared in the following discussion.

In our study, 15(32%) patients could move their elbow with an arc of more than 100 degrees, 26(55%) patients with an arc of 50-100 degrees and 6(13%) patients with an arc of less than 50. Mean arc of motion is 97 degrees. Required functional arc of motion for daily activity is 30-130 degree. In our study majority of patients were able to achieve the functional arc of motion required for day to day activities.

We found that fracture subtype A has greatest arc of motion and type C has least, which demonstrates that as the extension of fracture into articular surface increases, there is increase in incidence of stiffness and decrease in elbow arc of motion.

From above table there is very high union rate found in patients treated with orthogonal dual column plating technique. In our study there is union rate of 97.8% where as in Iqbal MJ study there is 94.7% union rate

Table 10:

Study	Union Rate
Our Study	97.87%
Iqbal MJ study ⁹	94.7 %

• High union rate can be achieved due to:

- 1) Anatomical reduction
- 2) Rigid Fixation in two perpendicular planes
- 3) Use of anatomically pre-contoured plate
- 4) Use of locking screw
- 5) Less soft tissue dissection

In our study, Functional outcome based on Mayo Elbow Performance Score⁷² is excellent in 20(42.5%) patients, good in 20(42.5%) patients, fair in 5(11%) and poor in 2(4%) patients. Our study is comparable to the studies conducted by Teng-Le Huang.et.al³⁰ and K.Reising.et.al³⁶

Table 11:

STUDY	GOOD/EXCELLENT SCORES (based on MEPS)
Teng-Le Huang-et-a ¹⁰	87.5%
Kun-Chung wan. Et.al ¹¹	75%
K. Reising.et.al ¹²	85%
Our Study	85%

Also, comparison of functional outcome between fracture subtype suggest 100% excellent/good results (based on MEPS) Type A, while type C has 82% of excellent/good results with 13% fair and 5% poor

outcome. This shows better functional outcome in extra-articular and simple intra-articular fractures as compared to complex comminuted intra-articular fractures treated with orthogonal plating technique.

Regarding complications in our study, we had superficial infection in immediate post-operative period in 7(15%) patients which were resolved with appropriate antibiotics after culture and sensitivity. Out of 7 patients with superficial infection, 4 patients were having diabetes mellitus showing a direct co-relation with suture site superficial wound infection. In our study we had stiffness in 5(10%) patients mainly associated with type C fracture, 3(6%) patients with hardware prominence and 1(2%) patient had exposed implant due to persistent infection in which plate was removed at 11 months after confirming signs of union on x-ray. 1 patient developed ulnar nerve neuropathy which spontaneously recovered in 5 weeks. 1(2%) patient developed deep infection at follow-up on 15th post-operative day which was resolved by debridement and IV antibiotic based on culture and sensitivity.

In the study Soon JL et.al¹³ reported 6.66% superficial infection, 13.33% of ulnar nerve neuropraxia and zero incidence of heterotopic ossification

Table 12

Study	Superficial Infection	Radial Nerve Palsy	Ulnar Nerve Palsy	Prominent Hardware	Deep infection	Heterotopic Ossification
Soon JL.et.al ⁷⁰	6.66%	NIL	13.33%	NIL	NIL	NIL
Our Study	14.89%	NIL	2.12%	6%	2.12%	NIL

Our results are comparable to the work reported in the literature

CONCLUSION

In this study carried out in 47 cases of distal humerus fractures, we came to the following conclusions:

Intercondylar fractures demand careful evaluation, classification of fracture type and pre-operative planning. Trans-olecranon approach provides best visualization of articular surface. For a successful internal fixation of closed distal humeral fracture, it is necessary to maintain anatomic and angular stable reconstruction of the articular surface and both humeral columns using two anatomically precontoured distal humerus plates. Operative treatment with rigid anatomical internal fixation should be the line of treatment for all grades of extra and intercondylar fractures, as it gives best chance to achieve good elbow function. During open reduction internal fixation, anatomic nature of articular surface should be given prime importance. Early Vigorous, active physiotherapy is a must for good results. Absolute stability of the system allows early post-operative rehabilitation and hence a better functional outcome. Good to excellent functional outcome was achieved in about 85% of the study group in terms of arc of motion and stability. Low rate of implant failure may be attributed to the highly stable construct system achieved by orthogonal perpendicular dual column plating. Failures by pull-out or cut-out of the implant are less likely to occur if implants with angular stability are used for osteosynthesis. Thus, the biomechanical behavior of the osteosynthesis depends more on plate configuration than plate type. Orthogonal dual column plating technique has significantly greater torque to failure load compared to other plating technique. We conclude that orthogonal dual column plating can be a successful technique for internal fixation of these complicated fractures when its principles are strictly adhered to.

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