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ORIF with orthogonal plating in the management of complex distal humerus fractures - A prospective study of 30 patients

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ABSTRACT

Fractures of the distal humerus are quite challenging to treat due to the intraarticular nature of the fracture. They are compounded by factors such as gross comminution and osteoporosis, especially in the elderly age group. This study was performed to evaluate the functional outcome following ORIF (Open reduction and internal fixation) of these fractures with orthogonal plating. Thirty patients with complex intraarticular fractures of the distal humerus who presented between April 2011 to April 2014 were managed with ORIF with orthogonal plating. They were followed up for three years. Functional evaluation was performed using the MEPS (Mayo elbow performance score) and the DASH score (Disabilities of arm, shoulder and hand). The right elbow was more commonly affected, as seen in 16 patients, and the most common mode of injury was road traffic accidents. The average time to fracture union was 11.6 weeks. The mean MEPS score was 88.5±11.6 with 85.6% of patients having a good or excellent outcome, and the mean DASH score was 23.2 points. ORIF with orthogonal plating of complex intraarticular distal humerus fractures provides a stable fixation construct and gives good functional outcomes to the patient.

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INTRODUCTION

Fractures of the distal humerus are relatively uncommon injuries and account for 2% of all fractures but the incidence of these injuries have been increasing gradually over the years (Robinson *et al.*, 2003). They are difficult to fix due to the intraarticular and complex nature of the fractures. They are often compounded by factors such as gross comminution and osteoporosis, especially in the elderly age group (Gabel *et al.*, 1987). Fractures around the elbow are prone to develop stiffness with loss of movement which can be quite disabling and can also be associated with complications such as nonunion, malunion, posttraumatic arthritis, heterotrophic ossification as well as iatrogenic injury to the ulnar nerve (Helfet and Hotchkiss, 1990). Conservative management has no role in the management of these fractures and is usually reserved in patients who are medically unfit to undergo a surgical procedure. The mainstay of treatment would be ORIF with plate osteosynthesis.

The aim of treatment for these fractures would be an excellent anatomical reduction to restore the integrity of the two columns of the distal humerus and the articular surface, provide a stable internal fixation with preservation of the blood supply to the bone, active early mobilization to promote adequate bone healing and prevent cartilage degenera-

tion and to give an excellent functional outcome to the patient (Henley, 1987; Holdsworth and Mossad, 1990). The aim is to achieve an arc of movement of 100^0 to facilitate activities of work and daily living to the best possible extent. A good stable fixation construct would need to address both columns of the distal humerus. Hence a single column fixation would not be an ideal procedure. The fixation of choice would be a dual column plating with the plates being placed either in a parallel of orthogonal fashion (Johannson and Olerud, 1971; Lee *et al.*, 2014). The implants should be rigid and should provide excellent stability, especially in fractures with comminution and in the osteoporotic bone along with the preservation of the blood supply to the bone. Current distal humerus locking plates are anatomically pre-contoured with a low profile and are biomechanically stable and provide a good fixation construct. In orthogonal plating, the medial plate is placed on the ulnar side, and the lateral plate is placed in a posterolateral position (Jacobson *et al.*, 1997; Schwartz *et al.*, 2006). This study was performed to evaluate the functional outcome following ORIF of complex intraarticular distal humerus fractures with orthogonal plating.

MATERIALS AND METHODS

This was a prospective study of 30 patients with complex intraarticular distal humerus fractures who presented between April 2011 to April 2014 managed with ORIF with orthogonal plating with a follow-up period of 3 years. This study was approved by the ethical committee of our institution. All patients with AO type C fractures of the distal humerus willing for the procedure and follow up were included. While, AO type A and B fractures, compound injuries, floating elbow and patients with active infection or inflammation in the affected limb were excluded. The patients were admitted, and the affected limb was immobilized with a broad arm sling and analgesics were prescribed for pain relief. A thorough neurovascular examination was performed, and the findings were documented in the case records. The patients were evaluated radiologically, and radiographs of the affected elbow were taken in AP, lateral and oblique projections. CT scans Were also done in cases with gross comminution to assess the fracture geometry and to aid in planning for surgery. All fractures were classified according to the AO classification [Figure 1].

Routine blood investigations were done, and the patients were worked up for the surgical procedure. Proper informed and written consent was obtained from the patients before the surgical procedure. All surgeries were performed by a single orthopaedic surgeon who was well versed with the procedure. The procedures were performed either under regional or general anaesthesia with antibiotic cover. Injection cefazolin 1 gm was given at the time of starting the surgical procedure. The patients were placed in the lateral position with the elbow supported with a post and the forearm hanging free. A 10 to 15 cm posterior skin incision was made which was curved laterally over the olecranon, and subcutaneous tissue and fascia were dissected. The ulnar nerve was then isolated and protected to avoid iatrogenic injury to the nerve. A V-shaped osteotomy of the olecranon was then performed 3 to 4 cm from the tip initially using a power saw and then completed with an osteotomy to get a good approximation at the end of the procedure while performing the tension band wiring. The osteotomized olecranon was then reflected proximally along with the triceps to provide good exposure of the distal humerus. The first step in the fixation would be to restore the articular surface, followed by reduction of the metaphyseal region. The fracture reduction was performed and provisionally fixed with K wires. Then two pre-contoured locking plates were applied in an orthogonal fashion with the medial column plate placed medially, and the lateral column plate set posterolaterally at 90^0 to each other using locking screws to provide optimum fixation especially in osteoporotic bone. Fluoroscopic images were taken to assess the quality of reduction as well as fixation, and the elbow was put through its range of movement to check for stability. The osteotomy was then fixed with tension band wiring. The ulnar nerve was then checked for mobility and possible friction or impingement by the hardware. We did not routinely transpose the ulnar nerve in our series. Thorough wound irrigation was then given, and after ensuring haemostasis and placing a drain in situ, wound closure was done in layers. A sterile dressing and a compression bandage were then applied. The elbow was placed in a broad arm sling following the procedure. The patient's elbow and wrist were mobilized on the same evening of surgery, and active finger movements were promoted.

The shoulder was also actively mobilized. Injection cefazolin 1 gm was given for three days postoperatively. Wound inspections were done on the 3^{rd} and 5^{th} postoperative days and the drain tube was removed at the time of the first wound inspection. Suture removal was done on the 12^{th} postop day. Radiographs were taken to assess the quality of reduction and fixation. The patients were discharged after suture removal and were asked

Figure 1: AO classification

to review at periods of 1,3,6 months and then at yearly intervals. Serial radiographs were taken to assess for signs of fracture union, and functional assessment was performed with the MEPS score and the findings were documented in the case records. Data analysis was performed using IBM SPSS Version 22.0. Armonk, NY: IBM Corp software. The Chi-square test compared categorical variables. A P value of <0.05 was considered to be statistically significant.

RESULTS AND DISCUSSION

The average age of the patients was 44.73 years which ranged from 22 to 62 years. There were an equal number of males and females in our study, and the most common mode of injury was road traffic accidents, as seen in 20 patients Followed by fall from height and slip and fall. The fractures were classified according to the AO classification, and C2 was the most common fracture type followed by C3 [Figure 2].

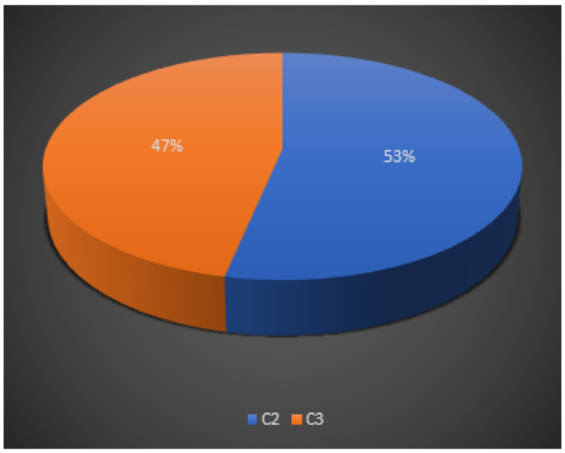

Figure 2: AO fracture type

The mean time from injury to presentation to the hospital was four days, ranging from 1 to 6 days, and the meantime from presentation to the surgical procedure was five days ranging from 2 to 8 days. The average surgical time was 96.56 minutes ranging from 80 to 100 minutes, and the mean blood loss was 214.51 ml ranging from 180 to 270 ml. We were able to achieve a 100% union rate in our series [Figure 3]. The average time to fracture union was 11.16 weeks ranging from 9 to 14 weeks [Table 1]. The average MEPS score was 88.5±11.6 with a range of 75 to 100. According to the MEPS score, 85.6% of patients had good or excellent scores, while 14.4% had a fair score. The mean DASH score was 23.2 points. The mean range of movement achieved was Flexion: 110^0(86^0-122^0), Pronation: 80^0(65^0-86^0) and Supination: 80^0(60^0-84^0). The mean grip strength measured was 54kgf (25-95). Three of our patients developed superficial infections which settled with a course of antibiotics. Two patients had an extensor lag of 15^0, which was well tolerated. We had no complications such as nonunion, malunion, loss of fixation, implant failure or iatrogenic ulnar nerve injury seen in our study. We did not lose any patients to follow up.

Figure 3: Illustrative case

Table 1: Patient demographics and data

S.Nc	Age	Sex	Side	Mode of injury	AO type	Surgical time (mins)	Blood loss (ml)	Fracture union (weeks)	MEPS score
1	35	M	L	RTA	C2	90	200	9	90
2	41	M	R	FFH	C2	84	250	11	94
3	42	F	R	RTA	C2	110	180	10	75
4	54	F	R	RTA	C3	100	210	13	88
5	22	F	L	RTA	C2	95	220	11	100
6	38	M	R	RTA	C2	120	270	9	94
7	49	M	R	FFH	C3	110	210	12	86
8	48	M	R	RTA	C3	100	180	11	78
9	51	M	L	SAF	C3	95	250	11	80
10	54	F	R	SAF	C3	86	190	12	94
11	46	F	R	RTA	C3	110	200	13	98
12	62	M	L	RTA	C2	100	220	12	100
13	58	F	L	SAF	C2	95	270	10	100
14	41	F	L	FFH	C3	90	260	14	90
15	39	M	R	RTA	C2	95	200	11	86
16	36	M	R	RTA	C2	90	250	12	88
17	52	F	R	SAF	C2	100	190	10	84
18	49	M	L	RTA	C3	110	210	10	75
19	31	F	R	FFH	C3	104	180	11	80
20	36	F	R	FFH	C2	100	220	12	86
21	43	M	L	RTA	C3	108	240	10	76
22	44	M	L	RTA	C3	94	250	12	100
23	41	F	R	RTA	C3	80	260	11	80
24	45	F	L	RTA	C2	92	270	10	96
25	42	M	L	FFH	C3	86	210	10	100
26	46	F	L	RTA	C2	94	200	10	78
27	54	F	L	RTA	C2	100	210	11	94
28	51	F	R	RTA	C3	80	220	12	90
29	48	M	R	FFH	C2	85	210	12	96
30	44	M	R	FFH	C2	94	220	13	78

RTA-Road traffic accident. FFH-Fall from height. SAF- Slip and fall

AO type C fractures are quite difficult to treat since they are intra articular fractures often associated with comminution and osteoporosis especially in the elderly age group and they can be associated with complications leading to a poor functional outcome. Fractures around the elbow are prone to develop stiffness with loss of movement which can be quite disabling and can also be associated with complications such as nonunion, malunion, post-traumatic arthritis, heterotrophic ossification as well as iatrogenic injury to the ulnar nerve. Conservative management has no role in the management of these fractures and is usually reserved in patients who are medically unfit to undergo a surgical procedure. Fixation options such as K wire and screw fixation alone do not provide a good fixation, and single-column plating is not biomechanically stable since the two-column theory proposes that the distal humerus coronal section is in the shape of a triangle with medial and lateral columns. A good fixation construct should restore the capito-trochlear joint as well as the medial and lateral columns. Total elbow arthroplasty is a viable option in fractures with extensive comminution where reconstruction is not possible, especially in the elderly age group with poor bone stock or pre-existing arthritis. The aim of treatment for these fractures would be a good anatomical reduction to restore the integrity of the two columns of the distal humerus and the articular surface, provide a stable internal fixation with preservation of the blood supply to the bone, active early mobilization to promote adequate bone healing and prevent cartilage degeneration and to give a good functional outcome to the patient (Stoffel *et al.*, 2008). The main causes for mechanical failure following an internal fixation would be complex fracture patterns, gross osteoporosis, extensive comminution, bone loss, inadequate fixation with poor biomechanical properties of the implant used and poor surgical technique. So, a dual column plating would be the ideal fixation construct to address all the issues and to provide a biomechanically stable construct along with a proper surgical technique and preservation of the blood supply to the bone to promote the union of the fracture. While employing this technique, the plates can be placed parallel to each other or in an orthogonal fashion where the plates are placed at 90^0 to each other. Various studies have shown that both plating techniques have acceptable outcomes, and there is no significant difference between them (Schuster *et al.*, 2008). Different approaches have also been advocated such as trans olecranon, transtricipital and posterior approach with an olecranon osteotomy. In our study, we used the posterior approach with an olecranon osteotomy which we feel gives excellent visualization of the fracture site, especially in C2 and C3 fracture patterns. We were comfortable placing the plates in an orthogonal fashion, and we used anatomically pre-contoured locking plates. Complications such as iatrogenic ulnar nerve injury and heterotrophic ossification have been reported in certain studies. The rate of ulnar nerve injury had been reported as 0 -50% of cases happening either during dissection or in the postoperative period during mobilization or due to hardware irritation. There have been conflicting reports as to whether transposition of the nerve would be beneficial or not (Gofton *et al.*, 2003). In our study, we took care to isolate and protect the nerve initially and always performed a check after metal implantation to make sure that there is no irritation of the nerve due to the hardware. We did not have any cases of ulnar nerve injury in our study. We generally performed the procedures with 3 to 5 days of presentation and were quite gentle in the handling of the soft tissues and bone and avoided excessive manipulation hence we did not encounter any cases of heterotrophic ossification in our study. Our postoperative mobilization was quite early and aggressive, and we were able to achieve a good range of movement of the affected elbow and ware able to provide a good functional outcome. Minos tyllianakis et al. studied 26 patients with AO type C fractures with a 70 month follow up. They reported excellent results in 23.1% of patients and very good results in 15%. They had complications such as ulnar nerve injury, heterotrophic ossification and metal failure in their series (Tyllianakis *et al.*, 2004). In Asfuroglu ZM at al study of 39 patients, the MEPS score was excellent in 7 patients, good in 12, fair in 13 and poor in 7 patients. They had complications such as superficial infection in 3 and ulnar nerve palsy in 3 patients (Asfuroğlu, 2017). Schmidt at al studied 34 patients, and they reported 92% excellent and good results. The mean DASH score was 22.5 points, and the range of movement was $0\text{-}105^0$. They had complications such as nonunion, implant failure and elbow stiffness (Schmidt-Horlohé *et al.*, 2013). In our study, we were able to achieve a 100% union rate with the meantime to fracture union being 11.6 weeks. The mean DASH score was 23.2 points, and the MEPS was 88.5 ± 11.6 with 85.6% of patients having an excellent or good score, while 14.4% of patients had fair results. Three of our patients developed superficial skin infections which settled down with a course of antibiotics while two patients had an extensor lag which was well tolerated. We had no complications such as nonunion, malunion, loss of fixation, implant failure or iatrogenic ulnar nerve

injury seen in our study. We did not lose any of our patients to follow up. We, with this, conclude by stating that the management of complex intraarticular fractures of the distal humerus with ORIF and orthogonal plating gives good union rates and functional results. Early fixation of the fracture with a good anatomical reduction and restoration of the integrity of the articular surface with a biomechanically stable construct and early active mobilization are the key factors to be followed to provide a good functional outcome to the patient.

ORIF with orthogonal plating in the management of complex intraarticular fractures of the distal humerus gives reasonable union rates and functional results to the patients. Good anatomical reduction with a stable internal fixation while preserving the blood supply to the bone along with protection of the ulnar nerve and early elbow mobilization ensure the good functional outcome to the patient to enable them to return to activities of work and daily living at the earliest.

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The authors declare that they have no funding support for this study.

Conflict of Interest

The authors declare that they have no conflict of interest for this study.

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