



## A STUDY ON SURGICAL MANAGEMENT OF OLECRANON FRACTURE BY ANATOMICAL LOCKING PLATE FIXATION

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**ABSTRACT** **Objective:** To evaluate the functional outcome of displaced olecranon fracture, both comminuted and simple, managed by plate fixation.

**Design:** Prospective study

**Setting:** Academic teaching hospital

**Background:** Olecranon fractures are one of the common fractures presenting to an orthopaedician. All olecranon fractures are intraarticular injuries and they occur because of RTA, assault or a fall typically. While non comminuted fracture of olecranon can be managed by TBW, it is associated with high rate of hardware removal. Plate fixation is devoid of these complications and gives a stable fixation allowing early physiotherapy.

**Patients:** It is a prospective study which was carried out from September 2017 to September 2019 in Karnataka Institute of Medical Sciences. In this study period of 32 cases of fracture olecranon treated by open reduction and internal fixation with olecranon plate, with 2 patients lost to follow up.

**Outcome measurements:** Functional outcome assessed by Mayo Elbow Performance Score, radiologically patients were evaluated preoperatively, post operatively and at the time of final review.

**Results:** In our study most of the patients were middle aged male (86.6%) patients with average age being 39 years. Right side (66.6%) was involved more commonly and road traffic accident (66.6%) was the most common mode of injury. Most common fracture type was Mayo's type 2B (43.3%). The olecranon fractures were fixed with anatomical olecranon plate. Union was noted clinically and radiologically and functional evaluation was done by Mayo elbow performance score. Excellent results were noted in 23 (76.66%) of patients, 5 (16.6%) patients had good results and fair results were noted in 2 cases (6.6%)

**Conclusion:** Anatomical plate fixation for displaced olecranon fracture is an acceptable modality of treatment with good functional outcome and low rate of complications.

### KEYWORDS : Olecranon, Fracture, Plate fixation

#### INTRODUCTION

Olecranon fractures are common and comprise of 10% of all the upper extremity fractures and 40% of all the fractures around the elbow joint. All olecranon fractures are intra articular fractures and require anatomical reduction. It can be caused by direct or indirect trauma particularly forced hyperextension of the elbow joint.

Undisplaced olecranon fractures can be managed conservatively. Displaced olecranon fractures are managed tension band wiring, screw fixation or by plating. The fixation should be strong enough to allow early range of motion of the elbow joint. Post traumatic elbow stiffness is a common complication after olecranon fracture which can be avoided by early mobilisation. Early mobilisation can be done only if the fixation is stable enough.

While tension band wiring is a popular technique for management of olecranon fractures it is reserved for fractures which are non comminuted. It is also associated with high rate of hardware removal. Schneider et al (2014) described 10 possible imperfections that can occur with TBW for olecranon fractures and found on an average 4.24 imperfections per intervention in their study.

TBW is associated with complication rate of upto 80%, the most common ones being pain and need for implant removal due to migration of K wires and symptomatic prominence of the implant. Screw fixation alone of olecranon fractures is associated with failure due to loss of reduction. (1, 9).

Plating of olecranon fractures is associated with lower rates of hardware removal and less incidence of loss of reduction. While plate fixation is done for comminuted olecranon fractures, oblique fracture, fracture involving coronoid process, it is also recommended for simple olecranon fractures (2).

The operative treatment should restore the extensor mechanism, achieve exact anatomical reduction, and give enough stable fixation to permit early mobilization. In undisplaced fractures these can be

achieved without difficulty. A fracture at the olecranon base with dislocation of the radial head constitutes a Monteggia variant illustrates the problem associated with olecranon fractures. (3)

The purpose of this prospective study was to evaluate the functional outcome after locking plate fixation for olecranon fracture both simple and comminuted.

#### Aim

To evaluate the functional outcome of anatomical plate fixation for olecranon fractures.

#### MATERIALS AND METHODS

Between September 2017 and September 2019, thirty two patients were studied with olecranon fractures in the institute of KIMS, hubli, India after obtaining ethical committee approval for the study protocol and fixed with anatomical locking plate. The inclusion and exclusion criteria were as follows -

#### Inclusion Criteria

- Age  $\geq$  16 and  $<$  75 years of age
- Displaced fracture of olecranon
- Presentation within 3 weeks of olecranon fracture.
- Patients fit for surgery

#### Exclusion Criteria

- Patient medically unfit for surgery.
- Paediatric population
- Pregnant women with predetermined treatment
- type 3 open elbow fractures
- Associated vascular injuries
- Patients unable to give informed consent or unable to comply with follow up

Two patients did not come back for follow up, we therefore studied 30 patients, 26 male and 4 female patients with mean age of 40 years (age range 21 to 60 years).

### Immediate Management

On arrival of the patient in the emergency immediately the viatls were noted. Any other associated injuries were managed accordingly. X-Ray of the part was taken and the elbow was immobilized in a above elbow posterior slab. The fractured limb was kept elevated. Analgesics were given and antibiotics were added if necessary. Patient was then prepared for surgery and anaesthesia after the pre-anaesthetic examination.

### History & General Examination

A detailed history was taken from patients including mode of injury, duration whther due to direct or indirect trauma was noted. History was noted regarding pre trauma status of the joint and severity of pain. History was followed by a through clinical examination regarding the general condition of the patient and associated systemic diseases. Appropriate references were taken when necessary and managed accordingly.

### Local Examination

General examination was followed by local examination. Local examination was done in the following order – inspection, palpation, movements and measurements.

Upon inspection we noted the attitude of the limb, whether there was swelling of the elbow if so the size and extent of the swelling. Any abrasions or open wounds were noted.

In palpation we noted the signs of the fracture – tenderness, loss of continuity of the bone and crepitus, movements of the elbow and restrictions in it were noted and measured and compared with contra lateral side. Any neurovascular deficit was noted.

### Investigations

Apart from standard antero posterior and lateral radiographs of the elbow and routine preoperative investigations, additional investigations were carried out as necessary. Patients satisfying the inclusion criteria were chosen for the study.

The fracture was classified as per Mayo classification for olecranon fractures. Mayo's classification provides a simplified classification system that is also clinically useful through plain radiographs. The Mayo's classification divides olecranon into type I to III based on stability and displacement. Type I injuries are undisplaced and form only 5% of the injuries. Type II injuries constitute 80 – 85%, these are displaced olecranon fracture with stable ulnohumeral joint. The stable ulnohumeral joint indicates intact ligamentous structures of which the anterior portion of medial collateral ligament is most important. The type III injuries have a displaced olecranon fracture with unstable ulnohumeral joint. Each type is further subdivided into A, noncomminuted, and B, comminuted. (4)

The numbers are as follows: type IIa, n = 9; type IIb, n = 13; type IIIa, n = 3; type IIIb, n = 5.

### Operative Technique

The operation was performed under general anaesthesia or brachial plexus block. Pre-operative antibiotics were administered. Mid arm tourniquet was applied with patient in supine or lateral position. Site of the surgery was thoroughly painted with and draped.

A midline posterior approach was used with a lateral curve to avoid placing the incision directly over the olecranon process. Reduction was performed under fluoroscopic imaging guidance using bone clamps or K-wires. Congruent locking elbow plates were used to maintain reduction and achieve fixation. The plate was initially secured to the bone with a 2-mm Kirschner wire placed down the ulna into the coronoid. Next, a 3.5-mm bicortical screw was placed distally in the slotted hole to secure initial fixation. Two 3.5-mm screws usually are placed proximally into the hard cortical bone of the posterior olecranon.

These screws, if placed properly, should be aimed at the olecranon tip. Finally, in the most proximal hole, the 2-mm K- Wire was removed, and a long 3.5-mm screw was inserted from proximal to distal into the coronoid, used as the 'home run' screw. This typically secured excellent fixation in the strong bone of the coronoid region. In fracture patterns with substantial proximal comminution, the long proximal plate was preferred. Ulnar nerve was not dissected during exposure as it was not

necessary. There was not much difficulty in closure of the wound even with the implant insitu.

### Post Operative Management

Postoperatively, patients were placed in a compressive dressing and a posterior splint in extension and elevated overnight and patient was asked to perform finger movements on day 1. No patient complained of features of ulnar nerve injury.

For comminuted fractures and unstable fixations, the limb was immobilized in above elbow posterior slab with elbow in 90° flexion for 2 weeks. For other fractures the limb was mobilized by about 3rd postoperative day.

Postoperatively appropriate antibiotics and analgesics were given to patient.

### Follow Up



Figure 1: range of motion post surgery at final follow up

Patients were followed up regularly – at the time of suture removal and thereafter at 6 weeks, 12 weeks and after that every 3 months. The patient was evaluated as per MEPS. In addition to that presence of swelling, range of motion at elbow, supination and pronation of forearm, prominence of the hardware were noted. Intense physiotherapy was given to patients.

### Assessment Methods

The functional recovery was assessed by Mayo Elbow Assessment Score. The MEPS evaluates pain, motion, stability, and function. The total score ranges from 5 to 100, with higher scores indicating better function. Score values are categorised as follows: excellent, >90; good, 75–89; fair, 60–74; and poor, <60. The Mayo elbow performance score which is a modification of Broberg and Morrey scale is a reliable instrument to assess outcome at elbow joint. The score has strong test – retest agreement (5) (6) Any discomfort caused the hardware was also recorded.

At the time of follow up antero-posterior and lateral radiographs were obtained. The quality of reduction was assessed by looking at the intra articular step off with 2mm taken as the cut off value. The radiographs at re-evaluation were compared to those obtained during the immediate post-operative period to observe for evidence of secondary displacement. The time to healing was recorded. Complete healing defined as complete absence of a visible fracture line.



Figure 2a

Figure 2b

Figure 2c

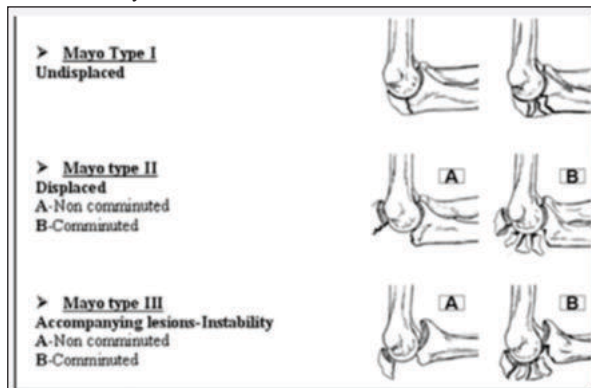
Figure 2A, B & C Showing Intra Operative Photographs



**Figure 3a** **Figure 3b** **Figure 3c**  
**Figure 3 a, b & c** Showing Preoperative, Immediate Postoperative Radiograph And Radiograph After Union Respectively



**Fig 4 :** Image Showing Prominence Of Hardware Placed Subcutaneously



**Fig 5 :** Image Showing Mayo Classification Of Olecranon Fracture (10)

**Table 1: Mayo Elbow Performance Score**

Function	Points	Definition (points)
Pain	45	None (45) Mild (30) Moderate (15) Severe (0)
Motion	20	Arc > 100 degrees (20) Arc 50 – 100 degrees (15) Arc < 50 degrees (5)
Stability	10	Stable (10) Moderate instability (5) Gross instability (0)
Function	25	Comb hair (5) Feed (5) Perform hygiene (5) Don shirt (5) Don shoe (5)
<b>Total</b>	<b>100</b>	
<b>Classification</b>	Excellent > 90, good 75-89, fair 60-74, poor <60	

**RESULTS**

All 30 patients were evaluated with regular follow up (range 12 to 24 months). At the time of follow up the range of motion of the elbow, varus and valgus instability, nerve injury were assessed, the outcome was measured by Mayo Elbow Performance Index (MEPI). Further Antero-posterior and Lateral radiographs were obtained to evaluate

the union of the fracture.

The age of the patients ranged from 21-60 years, with fracture association being most common in 5<sup>th</sup> decade i.e. 11 cases (36.6%) and mean age of 39 years. There were 6(20%) patients between 21-30 years, 9 (30%) patients between 31-40 years, 11 (36.6%) patients between 41-50 years and patients between 51-60 years were 4(13%).

**Table 2: Age Incidence**

Age in Years	21-30	31-40	41-50	51-60
No. Of Cases	6	9	11	4
Percentage (%)	20	30	36.6	13

The study group consisted of 26 (86.6%) males and 4 (13.3%) females with M:F ratio of 6.5:1.

The fracture was on the dominant side in 20 patients (66.6%).

**Table 3: Side Involved**

Side	Cases	Percentage
Right	20	66.6
Left	10	33.3

In our study 20 cases (66.6%) were due to road traffic accidents, 3 cases (10%) were due to fall and 2(6.6%) patient due to assault

**Table 4: Mechanism Of Injury**

Mechanism of injury	Cases	Percentage
Road traffic accidents	20	66.6
Fall from height	3	10
Assault	5	16.6
Self fall	2	6.6

In the present series, 9 (30%) olecranon fractures were Mayo's type 2a, 3(43.3%) olecranon fractures were Mayo2b and 3(10%) Mayo's type 3a and 5 (16.6%) were Mayo's type 3b.

**Table 6: Type Of Fracture**

Mayo's type	Number of cases	Percentage
Type 1	--	--
Type 2a	9	30%
Type 2b	13	43.3%
Type 3a	3	10%
Type 3b	5	16.6%

No case was operated as a surgical emergency. All the cases were operated on regular operation theatre days, at the earliest possible time after evaluating patients and obtaining medical fitness for surgery. The patients were operated upon with an average period of 4.63 days after the injury.

There was one type 2 open fracture which was managed with thorough wound debridement and plating. There was no reported case of post operative infection. There was no neurovascular injury, compartment syndrome. There was 2 patients with associated tibia shaft fracture, one patient had associated injury of acetabular fracture, 6 patients had radial head dislocation and one of them had femur shaft fracture as well. 1 patient had ipsilateral proximal humeru fracture and 3 were having associated head injuries all of which was managed appropriately.

The fracture was defined as united when clinically there was no tenderness and no subjective complaints and radiologically when the fracture line was not visible.

In this study 11(36.6%) patients had sound union in less than 4months, 13(43.3%) had union between 4-6 months and no patient developed non union.

In the present series 23(76.66%) patients were pain free and 7(23.33%) Patients had mild aching pain. No patients had moderate or severe pain.

**Table 7: Time To Union Of Fractures**

Time of union	No. of cases	Percentage
< 4 months	11	36.6%
4-6 months	13	43.3%
6months- 1year	5	16.6%

Non union	0	--
Total	30	--

**Table 8: Table Showing Pain Intensity Score**

Score	Pain Intensity	No. of cases	Percentage
45	None	23	76.66%
30	Mild	7	23.33%
15	Moderate	-	-
-	Severe	-	-

In the present series 23(76.66%) patients were having Arc of motion greater than 100 degrees, 7(23.33%) patients were having Arc of motion between 50 and 100 degrees and no patients with Arc of motion less than 50 degrees.

Mean flexion range was 122.17° (range 110° TO 140°) mean loss of extension was 20.17° (S30°), producing a mean motion arc of 110° (range 75° to 130°), mean pronation was 75.16° (range 10° to 80°), mean supination was 75.16° (range 20° to 80°) resulting in mean motion arc of 102° (range of 75° to 130°).

**Table 9: Scoring For Arc Of Motion**

Score	Arc of motion	Cases	Percentage
20	Greater than 100°	23	76.66%
15	Between 50° & 100°	7	23.33%
5	Less than 50°	-	-

We found that 28(93.33%) patients were having stable elbow, 2(6.67%) had moderate instability and no patient had gross instability.

**Table 10: Scoring For Elbow Stability**

Score	Stability	No. of cases	Percentage
10	Stable	28	93.33%
5	Moderate instability	2	6.67%
	Grossly unstable		

In the present study 19(63.33%) patients had functional score of 25. 11(36.66%) patients had score of 20.

**Table 11: Functional Evaluation.**

Functional Score	No. of patients	Percentage
25	19	63.33%
20	11	36.66%
<20	-	

In our study the patients with excellent results were 23(76.6%). 5 cases (16.6%) with good results, fair results were noticed in 2 cases (6.6%). No cases seen in poor results. The mean MEPS was 91.83 (range 70 to 100)

**Table 12: Results According To MEPS**

Grading	No. of Cases	Percentage
Excellent (Score greater than 90)	23	76.6%
Good (Score 75-89)	5	16.6%
Fair (Score 60-74)	2	6.6%
Poor (Score below 60)	-	-

In our series 6 patients had radial head dislocation, 3 patients had head injury, 3 patients had tibia shaft fracture, 1 patient each had proximal humerus fracture, acetabular floor fracture and femur shaft fracture. Radial head dislocation was reduced intra operatively at the time of fixation of olecranon fracture, femur shaft fracture, tibia shaft fracture and proximal humerus were managed with fixation. Conservative management was done for a case of undisplaced acetabular floor fracture and head injury.

The complications of the present study, superficial infection was in 1 (3.33%) patient, which was treated with broad spectrum antibiotics and implant removal. The symptomatic metal prominence was noticed in 8 (26.66%) patients; however there was no case with exposure of implant.

**DISCUSSION**

The main aim of surgical management of olecranon fracture is realignment of the bone axis, restoration of articular congruity, restoration of stability of the joint, normal strength, and a pain free arc of motion of the elbow. Elbow joint is known for stiffness even with short period of immobilization of 3 weeks and hence affecting the functional outcome. Therefore early mobilization of the joint is of utmost importance (7). The proximal part of the ulna is exposed to

extreme bending stresses which can lead to fatigue failure of the internal fixation device. Hence a stable fixation if of utmost importance. All the above goals and a stable fixation that resists the high bending stresses of proximal ulna can be achieved with anatomical locking plate fixation. Our experience with this method of fixation has given favourable results.

Not many studies of olecranon fractures managed with anatomical locking plate fixation is available in Indian population, and very few in the population group from the state of Karnataka.

The average age incidence; in the present study was found to be 39 Years. In the study by authors Bailey et al(2) in his study average age was 54 years and Geert Buijze et al (8) average age was 56 years.

**Table 13: Average Age Of Incidence**

Series	Average age
Bailey et al (2001)	54 years
Geert Buijze et al (2009)	56 years
Present study	39 years

We found that there was a greater incidence in males (86.6%). Similarly male predominance was found in the study of Bailey et al. But in study by Geert Buijze et al there was female predominance.

**Table 14: Sex Incidence**

Series	Male	Female
Bailey et al (2001)	14(56%)	11 (44%)
Geert Buijze et al (2009)	8(42.10%)	11 (57.89%)
Present study	26(86.6%)	4(13.3%)

In this study the involvement of right side [20 patients (66.6%)] was seen more frequent than left side. This is in accordance with the study by Bailey et al where right side was involved in 16 (64%) of the patients, however in the study by Geert Buijze et al there was near equal distribution of the side of involvement.

**Table 15: Side Involved**

Series	Right	Left
1) Bailey et al (2001)	16(64%)	9 (36%)
2) Geert Buijze et al (2009)	9(47.36%)	10(52.63%)
3) Present study	20(66.6%)	10(33.3%)

In this study, the patients with Road traffic accident were 20 (66.6%) patients, with Fall from height were 3 (10%) patients, 5(16.6%) patient as Assault and 2(6.6%) sustained injury due to slip and fall. Where as according to Geert Buijze et al series, the patients with traffic accidents were 5(26.31%) and patients with fall from height were 14 (73.68%) and according to Bailey et al, 20 (80%) patients were slip and fall 5 (20%) were due to motor vehicle accident.

In the present series 9 (30%) type 2A, 13 (43.3%) type 2B and 3 (10%) 3A and 5 (16.6%) type 3B fractures were noted. In Anani A et al there were 4 (6.4%) type IB, 29 (46%) type IIA, 7 (11.1%) type IIB, 19 (30.1%) type IIIA, and 4 (6.4%) type IIIB. In Bialek et al series there were 5(20%) type 2A, 9(36%) type 2B, 4(16%) type 3A, 7(28%) type 3B olecranon fractures.

**Table 16: Mode Of Injury**

Series	No. of Cases	Percentage
Bailey et al (2001)		
Slip and fall	20	80%
Traffic accident	05	20%
Geert Buijze et al (2009)		
Fall from Height	14	73.68%
Motor Vehicle Accident	05	26.31%
Present study		
Road Traffic Accident	20	66.6%
Fall from height	03	10%
Assault	05	16.6%
Slip and fall	02	6.6%

**Table 17: Type Of Fracture**

Series	Cases	Percentage
Anani A et al (2011) <sup>10</sup>		
2A	4	6.4%
2B	29	46%
3A	7	11.1%
3B	19	30.1%

Bailey et al (2001)		
2A	5	20%
2B	9	36%
3A	4	16%
3B	7	28%
Present study		
2A	9	30%
2B	13	43.3%
3A	3	10%
3B	5	16.6%

In the present series superficial infection in 1(3.33%) patients which was managed with plate removal and intravenous antibiotics The symptomatic metal prominence in 8(26.66) where as complications in Bailey et al is symptomatic metal prominence in 5 (20%), transient ulnar neuropathy was seen in 1 patient (4%).

The results were assessed as per the Mayo elbow performance score. The results obtained in our series were excellent in 23 (76.6%) patients, good in 5(16.6%) patients, fair in 2(6.6%) patients and no poor results.

**Table 18: Complications**

Complications	Present Study	Bailey Et al.
Superficial Infection	1 (3.33%)	0
Symptomatic Metal Prominence	8(26.66%)	5 (20%)
Transient Ulnar neuropathy	0	1 (4%)

**Table 19: Results**

Study	Results in Percentage			
	Excellent	Good	Fair	Poor
Geert Buize et al (2009)	63.15	15.78	5.26	-

**Table 20: Patient Data**

SI No	SIDE	TYPE BY MAYOS CLASSIFICATION	EXTN	FLXN	ARC OF MOTION	SUPINATION	PRONATION	MEPI
1	L	2A	-10	130	120	80	80	100
2	L	2A	-20	130	110	70	80	100
3	R	2A	-10	130	120	80	65	100
4	L	2B	-25	120	95	70	70	95
5	R	2A	-30	120	90	70	80	95
6	R	3B	-30	105	75	20	10	70
7	L	3B	-25	120	95	80	80	80
8	R	2A	-20	115	95	80	80	95
9	R	2B	-20	110	90	80	80	95
10	L	3B	-30	110	80	80	70	70
11	R	3A	-10	120	110	75	80	80
12	L	2B	-15	110	95	70	80	95
13	R	2B	-20	140	120	80	80	100
14	R	2B	-20	130	110	80	80	85
15	L	2A	-10	130	120	80	80	100
16	R	3A	-20	110	90	80	70	90
17	R	2A	-30	120	90	80	80	95
18	R	2B	-25	120	95	80	80	95
19	R	3B	-20	120	100	70	80	80
20	R	2B	-30	125	95	70	70	95
21	R	2A	-10	140	130	80	80	100
22	L	2B	-10	130	120	80	80	100
23	R	2B	-10	130	120	80	80	100
24	R	3A	-25	120	95	70	70	95
25	R	3B	-20	130	110	70	70	80
26	L	2B	-15	110	95	80	80	95
27	R	2B	-20	110	90	80	80	90
28	R	2A	-25	120	95	80	80	90
29	R	2B	-20	130	110	80	80	100
30	L	2B	-30	130	100	80	80	90

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Bailey et al (2001)	52	40	4	4
Present study	76.6	16.6	6.6	-

The result in our study is almost accordance with the studies of Geert Buijze et al and Bailey et al.

We found intra operatively that even though a plate was applied subcutaneously there was no difficulty in closure of the surgical incision.

All patients had an extension deficit ranging from 10° to 30° with average extension deficit of 20.167°. However the patients did not find any difficulty in carrying out daily activities because of this loss of extension. extension deficit in study by Geert Buijze was 9° to 14°. The extension deficit may be occurring because of the proximal position of the plate, this can be avoided by careful positioning of the plate to avoid impingement in olecranon fossa in elbow extension. In fact severe limitation in extension and hardware prominence are two most commonly reported complications following fixation of olecranon fractures with plate(8). We did not have to remove any plate because of hardware prominence but patients reported inconvenience because of it.

While the study did have a relatively larger study group the limitations of the present study include lack of evaluation by scores other than MEPI and a relatively shorter duration of follow up as arthritis takes many years to develop, therefore we cannot draw any conclusion with the present study regarding onset and severity of ulnohumeral arthritis. In conclusion the anatomical locking plate fixation for olecranon fractures provides a stable construct to start early rehabilitation and has a high rate of fracture healing with high outcome score as calculated by MEPI.

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