



Functional Outcomes of Olecranon Fracture Treated with Anatomical Locking Compression Plate

¹Dr. Parth Macwan,²Dr. RaghavSuthar,³Dr. Rasik B Dabhi,⁴Dr. PathikVala,⁵Dr. Jasmin Bhalodiya,
⁶Dr. Harshil Shah,⁷Dr. ShreyRaiyani,⁸Dr. Aishwarya Desai

^{1,5,6}Third Year Resident, Department of Orthopaedics, NMMC & Seth L.G. Hospital, Ahmedabad, Gujarat, India

²Assistant Professor, Department of Orthopaedics, NMMC & Seth L.G. Hospital, Ahmedabad, Gujarat, India

³Associate Professor, Department of Orthopaedics, GMERS Medical College, Himmatnagar, Gujarat, India

⁴Associate Professor, Department of Orthopaedics, Dr. N.D. Desai Medial College & Hospital, Nadiad, Gujarat, India

⁷First Year Resident, Department of Orthopaedics, NMMC & Seth L.G. Hospital, Ahmedabad, Ahmedabad, Gujarat, India

⁸Senior Resident, Department of Orthopaedics, NMMC & Seth L.G. Hospital, Ahmedabad, Ahmedabad, Gujarat, India

Abstract:

Introduction: Olecranon fractures represent 8-10% of all elbow fractures. The treatment goals for the olecranon fractures are restoration of elbow motion and prevention of stiffness and prevention of complications. Treatment of comminuted olecranon fractures with TBW and K-wires gives no stability to the construct and causes failure. So, plate fixation is commonly employed for comminuted fractures.

Material and Method: In this retrospective study, we reviewed 12 patients who presented to our institute between July 2020 and March 2022, having olecranon fracture treated with open reduction and internal fixation with anatomical locking plate osteosynthesis. A 3.5 mm locking olecranon anatomical plate was used for definitive fracture fixation. On follow up visit at six weeks, three months, and six months (final follow up) after surgery, radiological and clinical evaluation was done.

Results: Our study included 12 patients. Majority of patients were male (66.66%). According to Mayo classification system, maximum number of patients (50%) were Mayo type IIB. 3 patients (25%) were type IIIA and 2 patients were type IIIB. Mean interval period from injury to surgery was 18 hours. According to BrobergMorrey scale, out of total 12, 8 patients (66.66%) had excellent outcome, 3 patients (25%) had good outcome and 1 patient (8.33%) had fair outcome at 6 months.

Conclusion: Displaced and comminuted olecranon fractures when treated with locking anatomical plate gives good to excellent functional outcome with less complications.

Keywords: Olecranon fracture, Anatomical locking compression plate

DOI Number: 10.48047/nq.2023.21.6.NQ23077

NeuroQuantology2023;21(6): 736-742

1. Introduction

The Proximal end of the ulna fractures are common injuries in adults around the elbow, which mainly involves injuries including olecranon fractures and Monteggia fractures. The olecranon process of ulna gives stability and strength to the elbow joint. The subcutaneous location of the olecranon process

makes it prone to direct injury.

Olecranon fractures represent 8-10% of all elbow fractures [1] and Monteggia fracture comprise 5-10% of all forearm fractures [2]. Olecranon fracture has bimodal distribution with younger individuals sustaining a fracture due to high energy trauma, while older individuals as a result of a simple fall. The



mechanisms for injury include the indirect injury to olecranon being the most common mode, which is due to sudden and a strong eccentric triceps contraction or triceps overloading on a flexed elbow typically producing a transverse or oblique fracture pattern and represents loss of active elbow extension mechanism and direct injury to olecranon which is less common, results in a comminuted fracture[3].

Fractures with displacement of less than 2 mm, and with no further separation when the elbow is in flexion up to 90 degrees, they are usually considered stable and can be treated with a conservative approach. Surgical treatment should be considered in more severe fractures[4, 5].

The treatment goals for the olecranon fractures are restoration of the articular surface, restoration and preservation of the elbow extensor mechanism, restoration of elbow motion and prevention of stiffness and prevention of complications[3].

Tension band wiring (TBW) with Kirshner Wires(K-wires) is well considered standard for most simple non-comminuted transverse fractures [6, 7]. Treatment of comminuted olecranon fractures with TBW and K-wires gives no stability to the construct and causes failure in compression in subchondral bony comminution. So, plate fixation is commonly employed for comminuted fractures [8, 9, 10, 11]. For better stability and early rehabilitation, plate fixation is used for the management of simple olecranon fractures.

This was a retrospective study and the purpose of this study was to determine the functional outcome of plate fixation for displaced olecranon fractures.

Material and Methods

In this retrospective study, we reviewed 12 patients who presented to our institute between July 2020 and March 2022, having olecranon fracture treated with open reduction and internal fixation with anatomical locking plate osteosynthesis. Patients with age between 18-65 years, with displaced olecranon fractures of Mayo grade IIB, IIIA and IIIB (with or without concomitant radial head and coronoid process fracture) treated with olecranon locking anatomical compression plate were included in the study with their informed written consent after approval from ethical committee. Those with pathological fractures of olecranon, neurovascular deficit, olecranon fracture treated with Tension band wiring, with other fractures in the same limb (excluding radial head and coronoid process fracture) or other limbs, those with pre-existing deformity in the same or other limbs, who were medically unfit for surgery, lost to follow up, were

excluded.

All the patients presented to emergency room were managed according to standard ATLS protocol. Necessary X-rays and CT scan done for the better evaluation of the fracture pattern in the elbow and they were classified according to the Mayo Classification[12] as types I (un-displaced), II (displaced and stable), III (displaced and unstable), and subtypes A (non-comminuted) and B (comminuted). All patients had some degree of soft-tissue injury. Definitive management in the form of open reduction and internal fixation with locking anatomical plate was done as soon as possible.

Before surgery, antibiotic prophylaxis was given within one hour. Patients were given general or regional anesthesia according to the requirement. They were kept in Lateral decubitus position with elbow resting on a padded support in 90-degree flexion. We used pneumatic tourniquet in all patients. In a surgical technique, a posterior midline incision was given over elbow aiming olecranon extending distally to expose the fracture. Kirschner wires were used for provisional fracture fixation. A 3.5 mm locking olecranon anatomical plate was used for definitive fracture fixation and was put in neutralizing position using both locking and cortical screws. Cortical screws were used for plate-shaft alignment. Sometimes for interfragmentary compression in fracture, we used 2.7 mm cortical screws.

In patients with concomitant radial head fracture and/or coronoid process fracture, we used Boyd's/Kocher's approach to reach the fracture. Coronoid process fracture fixed using a long 3.5 mm cortical screw in a proximal to distal direction or using suture pull out method. In patients with residual instability, we also repaired medial collateral ligament.

Elbow stability and range of motion assessed at the end. Wound closed in layers. Sterile gauze dressing applied and Arm supporting pouch given in all patients.

Post operatively intra venous antibiotics were given for 48 hours. Analgesics and other supportive management were given according to the patient's needs. Post-operative X-rays were taken to check the implant position and assessment of fracture fixation.

During subsequent follow up visit at six weeks, three months, and six months (final follow up) after surgery, radiological and clinical evaluation was done. During final follow up visit, the Broberg and Morrey scale[13] was calculated.



Table 1

Variable	No. of points
Motion (total for each plane) (degrees)	
Flexion ($0.2 \times \text{arc}$)	27
Pronation ($0.1 \times \text{arc}$)	06
Supination ($0.1 \times \text{arc}$)	07
Strength	
Normal	20
Mild loss (appreciable but not limiting; strength 80% that of contralateral side)	13
Moderate loss (limits some activity; strength 50% that of contralateral side)	05
Severe loss (limits everyday tasks, disabling)	00
Stability	
Normal	05
Mild loss (perceived by patient, no limitation)	04
Moderate loss (limits some activity)	02
Severe loss (limits everyday tasks)	00
Pain	
None	35
Mild (with activity, no medication)	28
Moderate (with or after activity)	15
Severe (at rest, constant medication, disabling)	00

CLINICAL CASE

35 years old male, h/o RTA, right side.



PRE-OP

3 MONTHS FOLLOW UP

6 MONTHS FOLLOW UP

IMMEDIATE POST-OP



RANGE OF MOTION AT 6 MONTHS

Results

Our study included 12 patients. Majority of patients were male (66.66%). The youngest patient was of 19 years of age and the oldest patient was of 62 years of age. Maximum number of patients (total 4) were in the age group of 31-40 years (33.33%) with Mean age of 37.08 years. 7 patients (58.33%) had right side limb involvement and 5 patients (41.66%) had left limb involvement. The side involvement of the limb had no any significance on the causation or outcome of the fracture. Road traffic accident (RTA) was the most common mode of injury involving 6 out of 12 patients (50%). Other modes of injury were fall on a ground with flexed elbow at around 90 degrees involving 4 patients (33.33%) and assault being the least common mode involving 2 patients (16.66%). According to Mayo classification system, maximum number of patients (50%) were Mayo type IIB. 3 patients (25%) were type IIIA and 2 patients were type IIIB.

Mean interval period from injury to surgery was 18 hours. All patients in the study were operated using locking olecranon anatomical plate. The usual site for plate placement is on the dorsal surface of the ulna because of the creation of a tension-band effect and to get high biomechanical stability [14]. Dorsal surface plating is considered to be biomechanically superior to dual plating applied from the medial and lateral aspects. In our study, we applied plates from the posterior aspect in all patients. We achieved anatomical reduction in 10 patients. In other 2 patients, gap of 2 mm or more or articular step was noted on a post-operative radiograph. We used 5-hole locking plate in majority of patients (50%). 3-hole plate and 7-hole plate were used in 33.33% and

16.66% patients respectively. Inter-fragmentary fracture compression using additional 2.7 mm cortical screw was achieved in 41.66% patients. Medial collateral ligament was repaired in 25% patients. Associated injuries like, radial head fractures were managed using plate or prosthesis in 25% patients and coronoid process fractures were fixed in 33.33% patients.

Mean tourniquet time was 50 minutes. Range of motion exercises started as early as possible.

Bone union was achieved in all patients which could be seen on plain radiograph taken at final follow up. Average time of radiological fracture union was 15.16 weeks. No patients reported delayed union or nonunion in the study.

In the study, the mean flexion was 134.5 degrees, mean extension lag was 20.16 degrees. Mean extension-flexion arc was 114.33 degrees, mean supination was 79.66 degrees and mean pronation was 73.08 degrees.

According to BrobergMorrey scale, out of total 12, 8 patients (66.66%) had excellent outcome, 3 patients (25%) had good outcome and 1 patient (8.33%) had fair outcome at 6 months.

In our study we reported few complications. Out of 12, 2 patients (16.66%) had symptomatic hardware, 2 patients (16.66%) had superficial infection and no patient reported delayed union or non-union. Schliemann B et al. study, implant irritation (with subsequent removal) was the most common complication[15].The rate of symptomatic hardware and its removal is probably higher than the orthopedic surgeon perception as demonstrated by the study by Edwards, et al.[16]

739

Table 2

Variable	Frequency
Sex	
Male	8 (66.66%)
Female	4 (33.33%)
Age Group	
18-20	1 (8.33%)
21-30	3 (25%)
31-40	4 (33.33%)
41-50	2 (16.66%)
51-60	1 (8.33%)
>60	1 (8.33%)
Side	
Right	7 (58.33%)
Left	5 (41.66%)
Mode of Injury	
Fall	4 (33.33%)
RTA	6 (50%)



Assault	2 (16.66%)
Type of Fracture (Mayo Classification)	
IIB	6 (50%)
IIIA	3 (25%)
IIIB	2 (16.66%)
Complications	
Infection	2 (16.66%)
Wound Dehiscence	0
Symptomatic Hardware	2 (16.66%)
Non-Union	0
Delayed Union	0
Heterotopic Ossification	0

Table 3

Variables	No. of Patients	Percentage
Plate Size (No. of Holes)		
3	4	33.33%
5	6	50%
7	2	16.66%
9	0	0
MCL Repaired	3	25%
Use of 2.7 Mm Lag Screw	5	41.66
Coronoid Fixation	4	33.33%
Radial Head Fixation/Replacement	3	25%

740

Table 4

Elbow Range of Motion	
Mean extension-flexion arc	114.3 degrees
Mean extension lag	20.16 degrees
Mean flexion	134.5 degrees
Mean supination	73.08 degrees
Mean pronation	79.67 degrees

Table 5

Outcome Based on Broberg and Morrey Scale		Frequency
Excellent	>95	8 (66.66%)
Good	80-94	3 (25%)
Fair	60-79	1 (8.33%)
Poor	<60	0

Discussion

The elbow joint has a critical role in the normal arm functions. The integrity of the joints around the elbow is compromised by complex and comminuted fractures of proximal ulna. The main treatment goals for olecranon fractures are to achieve and maintain a stable and anatomic reduction, to realign the longitudinal axis of the proximal ulna, and to allow patient for early mobilization and range of motion exercises.

Open reduction and fixation using Tension-band wiring (TBW) with Kirschner wires is currently accepted for transverse olecranon fracture. And this construct provides excellent stability and allows us for early rehabilitation[17,18,19]. Tension-band wiring when used in cases where fractures are comminuted, problems may arise like compression failure, sigmoid notch contraction and hardware prominence[20,21,22].

By using Locking plate, these complications can be



overcome. It gives stability to the construct, prevents bony angulation hence providing angular stability, and resist bending stresses. Patients are also allowed to start early elbow mobilization because of proper alignment and construct stability. In this way, they provide superior mechanical stability at the fracture line. Friction force at bone-implant interface for stability is not needed and thereby allowing tensioning through the plate via fixed angle locking screws. Also, considering the normal proximal olecranon process anatomy, only unicortical screw purchase can be accommodated due to presence of sigmoid notch, the locking screws have shown

excellent stability in this scenario [23,24,25].

Locking plates can be used in both comminuted and non-comminuted fractures. Other indications for their use include oblique fractures around the middle part of the trochlear notch, concurrent coronoid fractures, and joint subluxation with an associated Monteggia fracture.

Final results were made from the data collected at 6 months follow up. The results of our study can be compared to other similar studies showing near similar outcomes as can be seen in the table given below.

Table 6

Studies	Outcome (Excellent and Good)
Our study	91.66%
Buijze and Kloen[23]2009	93.75%
Siebenlist et al.[26] 2010	93.33%
Ring et al. [27] 2002	88%

The range of motions at elbow were recorded using goniometer. The results of our study can be

comparable with other similar studies as shown below in the table.

Table 7

Studies	Mean Range of Motion (Degrees)			
	Mean Flexion	Mean Extension-Flexion ARC	Mean Supination	Mean Pronation
Our study	134.5	114.33	79.66	73.08
Ring et al.[27] 2002	123	92	60	66
Buijze and Kloen[23] 2009	136	123	71	74
Siebenlist et al. [26] 2010	141	129	87	84

741

Various complications are reported following olecranon fracture like infection, symptomatic hardware, delayed union, nonunion, wound dehiscence, ulnar neuritis, post traumatic arthritis, heterotopic ossification, etc. The most frequent complication reported after open reduction and internal fixation of olecranon fractures is hardware irritation [4]. These symptoms are developed due to subcutaneous placement of the plates. However, painful hardware is more frequent in tension-band wiring than plate fixation.

Limitations of the study

We had very limited number of patients in our study so it was not possible to compare with other major studies. All the patients in our study were not operated by a same/single surgeon. All the fractures were not fixed with same company implant design. So, it was not possible to control these confounding factors in the study.

Conclusion

Fractures of the olecranon process and especially comminuted and complex fractures are challenging to the surgeon as they can hamper elbow stability and function. Primary objective in treating such olecranon fracture is to achieve stable construct, restore articular surface and elbow extensor mechanism, prevention of complications and early mobilization of elbow which can be achieved by locking anatomical plate. It gives better stability to construct so helps in early functioning of elbow. Hence, from this study we conclude that displaced and comminuted olecranon fractures when treated with locking anatomical plate gives good to excellent functional outcome with less complications.

References

- [1] Court-Brown CM, Heckman JD, McQueen (2015) Rockwood and green's fractures in adults. Wolters Kluwer Health.
- [2] Konrad GG, Kundel K, Kreuz PC, Oberst M,



- Sudkamp NP. Monteggia fractures in adults. *J Bone Joint Surg Br.* 2007;89(3):354-60.
- [3] Egol KA, Koval KJ, Zuckerman JD, 2010, *Handbook of fractures*, Wolters Kluwer Health.
- [4] Cabanella ME, Morrey BF. Fractures of the proximal ulna and olecranon. In: Morrey BF, editor. *The elbow and its disorders*. Philadelphia: WB Saunders; 1993. p. 407-8.
- [5] Veillette CJ, Steinmann SP. Olecranon fractures. *OrthopClin North Am* 2008;39:229-36. doi:10.1016/j.ocl.2008.01.002
- [6] Holdsworth BJ, Mossad M. Elbow function following tension band fixation of displaced fractures of the olecranon. *Injury* 1984;16:182-87.
- [7] Molloy S, Jasper Le, Elliott DS, Brumback RJ, Belkoff Sm. Biomechanical evaluation of intramedullary nail versus tension band fixation for transverse olecranon fractures. *J Orthop Trauma* 2004;18:170-174.
- [8] Fyfe IS, Mossad MM, Holdsworth BJ. Methods of fixation of olecranon fractures. *J Bone Joint Surg Br* 1985;67:367–372.
- [9] Horne JG, Tanzer TL. Olecranon fractures: a review of 100 cases. *J Trauma* 1981;21:469–472.
- [10] Horner SR, Kalia SK, Lipka JM, et al. Analysis of mechanical factors affecting fixation of olecranon fractures. *Orthopedics* 1989; 12:1469–1472.
- [11] Kozin SH, Berglund LJ, Cooney WP, et al. Biomechanical analysis of tension band fixation for olecranon fracture treatment. *J Shoulder Elbow Surg* 1996;4:442–447.
- [12] Morrey BF. Current concepts in the treatment of fractures of the radial head, the olecranon, and the coronoid. *Instr Course Lect* 1995;44:175–85.
- [13] Broberg MA, Morrey BF. Results of treatment of fracture-dislocations of the elbow. *ClinOrthopRelat Res* 1987;216:109-119.
- [14] Newman SD, Mauffrey C, Krikler S. Olecranon fractures. *Injury* 2009; 40:575-81. Doi:10.1016/j.injury.2008.12.013
- [15] Schliemann B, Raschke MJ, Groene P, Weimann A, Wähnert D, Lenschow S et al. Comparison of tension band wiring and pre-contoured locking compression plate fixation in mayo type IIA olecranon fractures. *Acta OrthopBelg* 2014;80(1):106-11.
- [16] Edwards SG, Cohen MS, Lattanza LL, Iorio ML, Daniels C, et al. (2012) Surgeon perceptions and patient outcomes regarding proximal ulna fixation: A multicenter experience. *J Shoulder Elbow Surg* 21: 1637-1643.
- [17] Gordon MJ, Budoff JE, Yeh ML, Luo ZP, Noble PC. Comminuted olecranon fractures: a comparison of plating methods. *J Shoulder Elbow Surg* 2006;15:94-9. doi:10.1016/j.jse.2005.06.003
- [18] Veillette CJ, Steinmann SP. Olecranon fractures. *OrthopClin North Am* 2008;39:229-36. Doi:10.1016/j.ocl.2008.01.002
- [19] Wolfgang G, Burke F, Bush D, Parenti J, Perry J, LaFollette B, et al. Surgical treatment of displaced olecranon fractures by tension band wiring technique. *ClinOrthopRelat Res* 1987:192-204
- [20] Bailey CS, MacDermid J, Patterson SD, King GJ. Outcome of plate fixation of olecranon fractures. *J Orthop Trauma* 2001;15:542-8.
- [21] Boyer MI, Galatz LM, Borrelli J Jr., Axelrod TS, Ricci WM. Intra-articular fractures of the upper extremity: new concepts in surgical treatment. *Instr Course Lect* 2003;52:591-605.
- [22] Hak DJ, Golladay GJ. Olecranon fractures: treatment options. *J Am AcadOrthopSurg* 2000;8:266-75.
- [23] Buijze G, Kloen P. Clinical evaluation of locking compression plate fixation for comminuted olecranon fractures. *J Bone Joint Surg Am* 2009;91:2416-20. doi:10.2106/JBJS.H.01419
- [24] Gardner MJ, Helfet DL, Lorich DG. Has locked plating completely replaced conventional plating? *Am J Orthop* 2004;33:439-46.
- [25] Haidukewych GJ. Innovations in locking plate technology. *J Am AcadOrthopSurg* 2004;12:205-12.
- [26] Siebenlist S, Torsiglieri T, Kraus T, Burghardt RD, Stöckle U, Lucke M. Comminuted fractures of the proximal ulna: preliminary results with an anatomically preshaped locking compression plate (LCP) system. *Injury* 2010;41:1306-11. doi:10.1016/j.injury.2010.08.008
- [27] Ring D, Jupiter JB, Sanders RW et al. Transolecranon fracture-dislocation of the elbow. *J Orthop Trauma* 1997;11:545-550.

