



International Journal of Orthopaedics Sciences

E-ISSN: 2395-1958
P-ISSN: 2706-6630
IJOS 2019; 5(4): 507-513
© 2019 IJOS
www.orthopaper.com
Received: 22-08-2019
Accepted: 24-09-2019

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Original Research Article

Assessment of olecranon fractures treated through open reduction and internal fixation surgery using pre-contoured locking compression plates

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DOI: <https://doi.org/10.22271/ortho.2019.v5.i4i.1724>

Abstract

Background: Fractures of the olecranon process constitute approximately 10% of fractures around the adult elbow and range from simple nondisplaced fractures to complex fracture–dislocations of the elbow [2]. The highest incidence is seen usually in middle aged adults with men sustaining the injury at a younger age than women. Ground-level falls are responsible for most of these fractures. Associated injuries include ipsilateral proximal radius fractures in 17% and open injuries in 6.4% [3].

Materials and Methods: A retrospective study was conducted in the Department of Orthopaedic Surgery, Grant Medical Foundation-Ruby Hall Clinic, Pune, India on 22 cases of closed olecranon fractures in patients between the age of 18-65 years who underwent surgical treatment through open reduction and internal fixation with pre-contoured olecranon locking compression plate between January 2014-March 2019. These patients were followed for 12 months (minimum for 6 months) and evaluated based on union rate through xray radiograph, any complications (infections, mal/nonunion, implant impingement, elbow stiffness) and functionally by Mayo Elbow Performance Score (MEPS).

Conclusion: Open reduction and internal fixation with pre contoured olecranon LCP should be the treatment of choice in majority of the olecranon fractures as it restores the anatomy, biomechanics and contact loading characteristics of the elbow joint and is associated with least complication rates due to static nature of fixation.

Keywords: Olecranon fracture, olecranon plating, mayo classification, elbow joint

Introduction

Fractures of the olecranon process constitute approximately 10% of fractures around the adult elbow and range from simple nondisplaced fractures to complex fracture–dislocations of the elbow [2]. The highest incidence is seen usually in middle aged adults with men sustaining the injury at a younger age than women. Ground-level falls are responsible for most of these fractures. Associated injuries include ipsilateral proximal radius fractures in 17% and open injuries in 6.4% [3]. The proximal ulnar articular surface is made by the olecranon and coronoid processes which comprise the semilunar or greater sigmoid notch of the ulna, articulating with the humeral trochlea. The ulnohumeral articulation is the essential factor for osseous stability and mobility in the flexion-extension plane. The olecranon blocks the anterior translation of the ulna with respect to the distal humerus, whereas an intact coronoid process resists posterior subluxation of the proximal ulna. The proximal ulna contributes to elbow stability in proportion to the amount of bone present and removal of proximal half of the articular surface reduces its stability by half [1]. Subcutaneous position of the olecranon on the posterior aspect of the elbow makes it vulnerable to fracture in adults in spite of its being a very heavy and strong process. Most fractures are intra-articular and can therefore compromise the stability of the elbow joint. Displacement in olecranon fractures is secondary to the pull of triceps muscle which pulls up the proximal fragment once the strong fibrous sheath coverage around olecranon is also ruptured. The injury is relatively less common in children because of its peculiar shape, it is shorter and thicker and much stronger than the distal humerus. The most

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Common mechanism is a fall on the outstretched hand with the elbow semi flexed and forearm supinated. During the fall, as the hand strikes the ground, the powerful and taut triceps muscle snaps the olecranon over the distal humerus which acts as a fulcrum [4]. In this study, we aim to evaluate the functional and radiological outcome of patients who underwent open reduction and internal fixation surgery through pre contoured olecranon LCP for closed olecranon fractures at our centre and to assess the factors associated with the functional outcome.

Applied Anatomy

The elbow is a complex hinge joint. The major stabilizers to valgus stress are the ulnar (medial) collateral ligament and the radial head. The major stabilizer to varus stress is the lateral collateral ligament complex. The coronoid process stabilizes the humerus against the distal ulna.

The olecranon prevents anterior translation of the ulna with respect to the distal humerus. The anterior surface of the olecranon is covered with articular cartilage. Therefore, all fractures (except the rare tip fractures) are intra-articular fractures. The carrying angle may be determined by noting the angle of intersection between a line connecting midpoints in the distal humerus and a line connecting midpoints in the proximal ulna. Studies report a valgus angle ranging from 11° to 14° in men and from 13° to 16° in women [7]. The olecranon articulates with the trochlea of the humerus. The triceps inserts into the posterior third of the olecranon and proximal ulna. The periosteum of the olecranon blends with

the triceps.

The ulnar nerve lies on the posterior aspect of the elbow, posterior to the medial collateral ligament. The ulnar nerve sweeps anteriorly to join the ulnar artery.

Fracture displacement is largely due to the pull of the triceps, which tends to pull a separated fragment upward but is resisted by the strong fibrous covering on the olecranon. This fibrous covering is formed by the blending of fibers in the lateral ligaments, the elbow capsule, and triceps fibers that blend with the periosteum. Usually, wide separation of fragments indicates an extensive tearing of the fibrous sheath in which the unopposed triceps is contracted, drawing the separated fragment upward. The lateral ulnar collateral ligament inserts onto the tubercle of the supinator crest, from which the supinator muscle also gains origin. The medial aspect of the coronoid process, the sublime tubercle, serves as an insertion site for the medial ulnar collateral ligament. The posterior capsule inserts proximally above the olecranon fossa, and distally at the annular ligament and the tip of the olecranon. Most of the olecranon is therefore an extra capsular structure. (Fig 1)

Muscles acting during Elbow and Forearm ROM [7]

Flexion (140°- 150°): Coracobrachialis, Biceps, Brachialis, Brachioradialis Extension (0° in males and upto 5° in females): Triceps, Anconius Pronation (0° to 85°): Pronator Teres, Pronator Quadratus, Flexor carpi radialis Supination (0° to 80°): Supinator, Biceps, Brachioradialis.

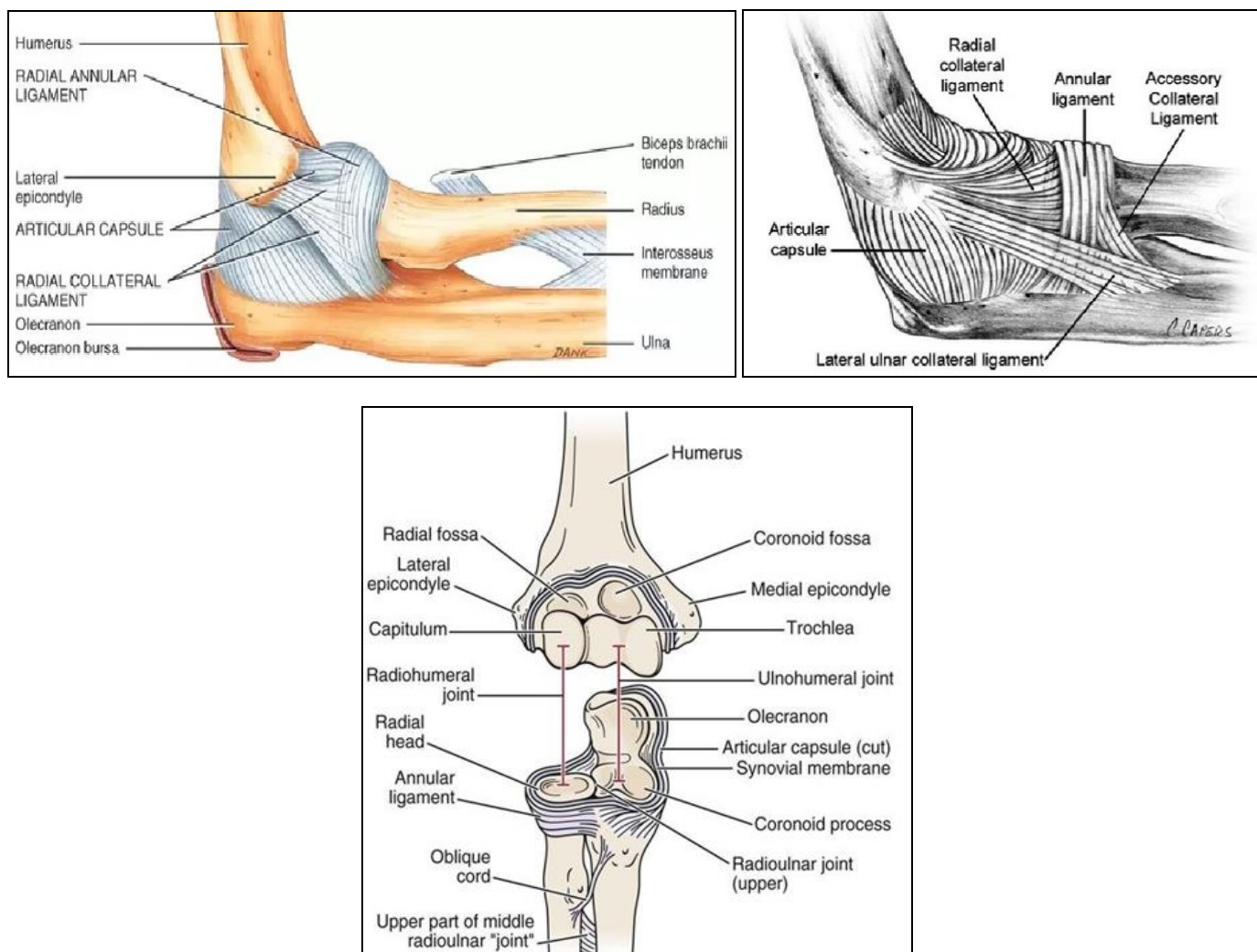
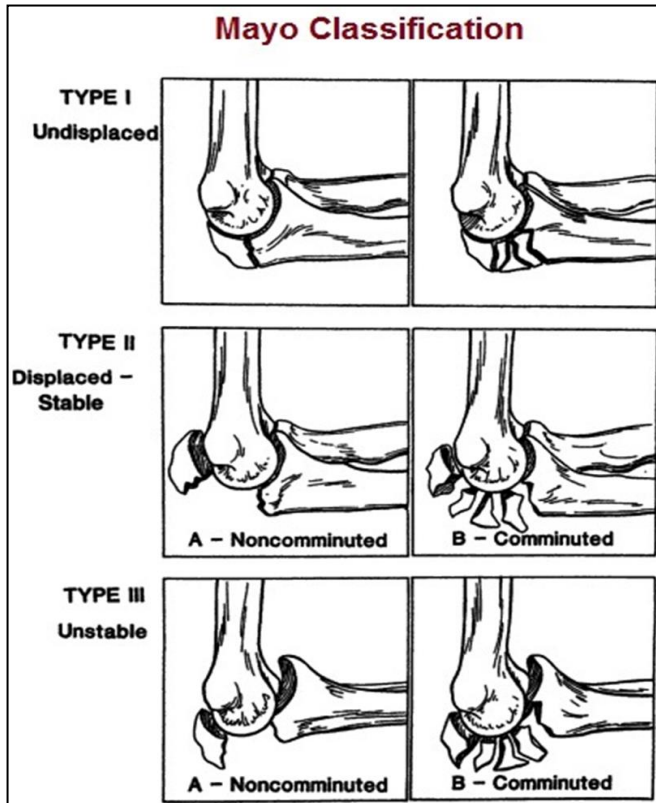


Fig 1: Applied Anatomy



Mayo Classification of olecranon fractures. Type I fractures are nondisplaced noncomminuted (IA) or comminuted (IB) fractures. Type II fractures are stable displaced fractures and may be noncomminuted (IIA) or comminuted (IIB). Type III fractures are unstable. Displaced fractures and may be noncomminuted (IIIA) or comminuted (IIIB).

Materials and Methods

A retrospective study was conducted in the Department of Orthopaedic Surgery, Grant Medical Foundation-Ruby Hall Clinic, Pune, India on 22 cases of closed olecranon fractures in patients between the age of 18-65 years who underwent surgical treatment through open reduction and internal fixation with pre-contoured olecranon locking compression plate between January 2014-March 2019. These patients were followed for 12 months (minimum for 6 months) and evaluated based on union rate through xray radiograph, any complications (infections, mal/nonunion, implant impingement, elbow stiffness) and functionally by Mayo Elbow Performance Score (MEPS).

Inclusion Criteria

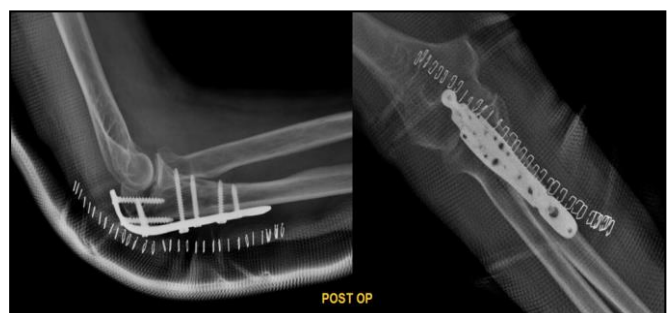
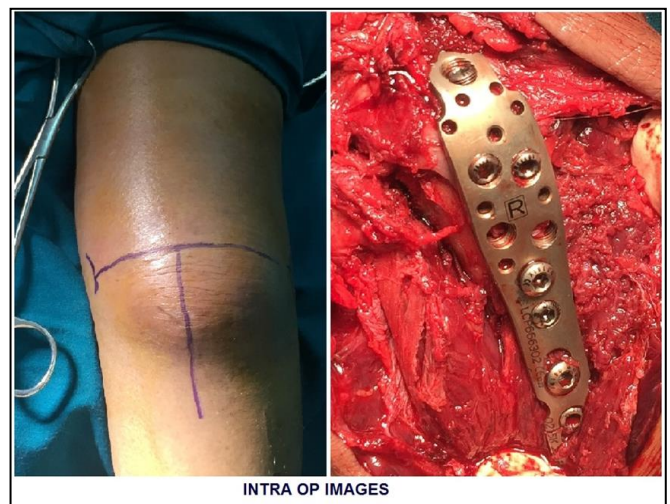
1. Age between 18-65 years.
2. Patients of either sex.
3. Patients with closed olecranon fractures without association of radial head or coronoid process fracture.
4. Fractures less than 1 week old.
5. Patients who comply with regular follow up for a period of at least 6 months.

Exclusion Criteria

1. Patients with history of previous fracture around elbow joint.
2. Open/Compound fracture.
3. Multiple Trauma / Neurovascular injuries.
4. Pathological Fractures.

Pre-operative protocol: Before the surgical intervention, all the patients were temporarily immobilized with above elbow posterior slab, underwent routine investigations, obtained anesthetic and medical clearance, analgesics and antibiotics.

Post-operative protocol: IV antibiotics for 3-4 days. Sterile dressing was done on second post op day. Suture removal was done after 13-15 days depending upon healing. The AE slab continued till 2 weeks following which the patients were advised elbow Rom exercises. Elbow loading was prevented for 6-8 weeks. Patients were permitted to return to normal daily activities, as tolerated, at 3 months. All the patients were assessed serially for 12 months (minimum period of six months) radiologically with xray of the elbow joint in true anteroposterior and true lateral views and functionally with Mayo Elbow Performance Score (MEPS).



Understanding the Mayo Elbow Performance Score for Functional Assessment

Explanation of Mayo Elbow Performance Score			
Function	Definition	Points	Score classification
Pain	None	45	Excellent > 90
	Mild	30	
	Moderate	15	
	Severe	0	
Motion	Arc > 100	20	Good, 75–89
	Arc 50–100	15	
	Arc < 50	5	
Stability	Stable	10	Fair, 60–74
	Moderate instability	5	
	Gross instability	0	
Function	Comb hair	5	Poor < 60
	Feed	5	
	Hygiene	5	
	Shirt	5	
	Shoe	5	
Total		100	

Observation and Results

In our study, majority of the patients were male (54.5%), most of the patients were in the age group of 21- 52 years with mean age of 36.5 years. Majority of the patients sustained these injuries following ground level falls (63.63%). According to Mayo classification system, most common type of fracture was type 2 non-comminuted fracture. Radiological union was seen at 8 weeks in 1 (4.54%) cases, 10 weeks in 2 (9.09%) cases, 12 weeks in 12 (54.54%) cases, 14 weeks in 5 (22.72%) cases and 16 weeks in 2 (9.09%) cases. One case had superficial infection which resolved completely with oral antibiotics and one case had elbow joint stiffness. There were no cases of implant impingement, nonunion or malunion in the present study. No patient had any implant related complication like implant failure, implant breakage or loosening. All 22 patients achieved fracture union in 6 months follow up period. As per Mayo Elbow Performance Score (MEPS), 54.54% cases had excellent results, 31.81% cases had well, 9.09% cases had fair and 4.54% of the cases had poor results respectively.

Range of motion

Analysis of range of motion (ROM) comprised flexion and extension of the elbow and pronation and supination of the forearm measured with a goniometer and evaluated with respect to the arc of movement of the uninjured arm.

Gender Distribution

Table 1: Gender

Gender	Frequency	Percent %
Male	12	54.5
Female	10	45.4
Total	22	100

Side Distribution

There was a predominance of right side in our study, accounting for 59.09% of the patients. (Table 2).

Table 2: Side

Side	Frequency	Percent %
Right	13	59
Left	9	41
Total	22	100

Mode of Injury

There was a predominance of Ground level fall as a mode of injury in our study, accounting for 63.63% of the patients. (Table 3)

Table 3: Mode

Mode of injury	Frequency	Percent %
Ground Level Fall	14	63.63
RTA	6	27.27
Sports Injury	2	9.09
Total	22	100

Patient Distribution According to Fracture

There was a predominance of Mayo Type 2A fracture in our study, accounting for 59.09% of the patients. (Table 4)

Table 4: Classification

Mayo Classification	Non Comminuted	Comminuted
Type 1 Undisplaced, Stable	1	3
Type 2 Displaced, Stable	13	4
Type 3 Displaced, Unstable	1	0

Radiological Union in Weeks

Radiological union was seen at 8 weeks in 1 (4.54%) cases, 10 weeks in 2 (9.09%) cases, 12 weeks in 12 (54.54%) cases, 14 weeks in 5 (22.72%) cases and 16 weeks in 2 (9.09%) cases. (Table 5.)

Table 5: Union

Union In Weeks	Number of Cases	Percentage %
8 Weeks	1	4.54
10 Weeks	2	9.09
12 Weeks	12	54.54
14 Weeks	5	22.72
16 Weeks	2	9.09
Total	22	100

Complications

Out of 22 cases, one (4.54%) cases had superficial infection which resolved completely with oral antibiotics and one (4.54%) case had elbow joint stiffness. There were no cases of implant impingement, nonunion or malunion in the present study. No patient had any implant related complication like implant failure, implant breakage or loosening. (Table 6)

Table 6: Post Op Complications

Post -Op Complications	Number of Cases
Superficial Infection	1
Deep Infection	0
Elbow Joint Stiffness	1
Implant Impingement	0
Non Union/ Mal union	0

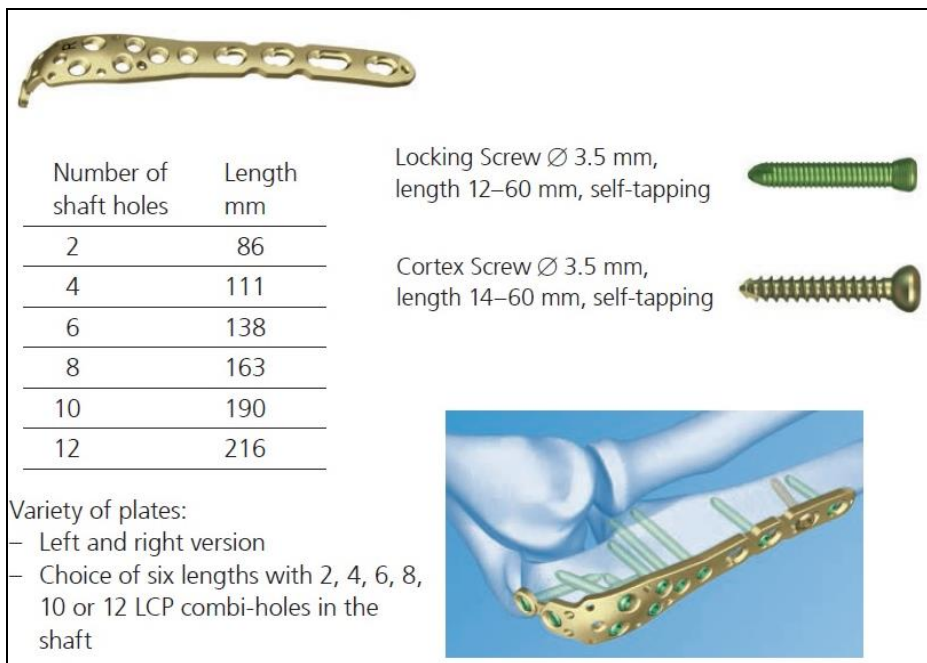
Functional Outcome

As per Mayo Elbow Performance Score (MEPS), 54.54% cases had excellent results, 31.81% cases had good, 9.09% cases had fair and 4.54% of the cases had poor results respectively (Table 7).

Table 7: Functional Outcome

Functional Outcome	Cases	Percent %
Excellent	12	54.54
Good	7	31.81
Fair	2	9.09
Poor	1	4.54
Total	22	100

Surgical Hardware



LCP Olecranon plate 3.5

Discussion

Fractures of the olecranon process constitute approximately 10% of fractures around the adult elbow and range from simple nondisplaced fractures to complex fracture-dislocations of the elbow [2]. The highest incidence is seen usually in middle aged adults with men sustaining the injury at a younger age than women. Ground-level falls are responsible for most of these fractures. In this study, the 22 cases of closed olecranon fractures were treated surgically by open reduction and internal fixation with pre contoured olecranon locking compression plate. Age groups between 21-52 years were most commonly injured. The mean age in the present study was 36.5 years and most common type of fracture was Mayo type 2 non-comminuted.. A study of K Tankshali [19] reported that olecranon plating was associated with least complication such as implant impingement or implant backout but was associated with more union time as compared to other techniques due to static nature of fixation unlike TBW or CCS fixation and maximum ROM was achieved with olecranon plating. Another study of Ren *et al.* [20] reported that due to the less complications, they recommend the plate fixation approach as the optical choice for olecranon fractures as compared to the other methods. In cases of comminuted fractures of proximal ulna has many pitfalls like loss of fixation, prominence of hardware, impingement and synostosis. Use of locking plate avoids these complications and can also be used in comminuted as well as non-comminuted fractures. It also provides structural stability, resists ulnar angulation, and restores ulna length [21]. In addition, plate fixation lowers the risk of fatigue failure caused by extreme bending stresses. Operative treatment by

plating has been shown to provide more predictable alignment and immediate fracture stability, allowing early elbow mobilization [21]. All fractures in our study had united by 6 months, both clinically and radiologically and the result is comparable to a study done by Wang YH *et al.* [22]. As per the Mayo elbow performance scoring, post-operative results were satisfactory in 86.35% cases, with good to excellent functional outcome and all patients returned to pre-injury daily activities. These results are comparable to studies done by Kloen *et al*, Niglis *et al*, Siebenlist *et al* and Li *et al.* [23-26] Maximum ROM of approximately 114° was achieved at 6 months of follow-up. Long term studies with larger database are required to further analyse olecranon plating as preferred method in majority of olecranon fractures.

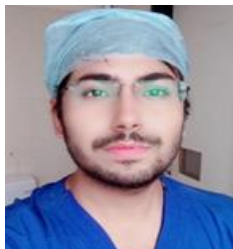
Conclusion

Comminuted fracture of olecranon are challenging, they functionally affect both elbow and the forearm. Fracture morphology and primary elbow instability are the most important prognostic factors for the elbow function. The stability of locking construct by providing extra purchase due to shape of plate as well as minimal periosteal compromise, provides high union rates even in osteopenic and comminuted fractures.

The goals of surgical treatment must include anatomic reduction of articular surfaces, restoring metaphyseal stability, realign the longitudinal axis of the proximal ulna, preserving blood supply are essential to allow early mobilization and prevention of stiffness and ulnohumeral arthritis. In our study the management of olecranon fracture with locking plate fixation along with early mobilisation, resulted in predictably

good union rates and excellent results in terms of patient outcome. Our results are comparable to those reported previously. Hence, as per our study, we conclude that open reduction and internal fixation with pre contoured olecranon LCP should be the treatment of choice in majority of the olecranon fractures as it restores the anatomy, biomechanics and contact loading characteristics of the elbow joint and is associated with least complication rates due to static nature of fixation.

About Authors and Contributions



Dr. Rohil Singh Kakkar was involved in manuscript preparation, data analysis and drawing relevant conclusions and the entire correspondence of this study. He had joined the Department of Orthopaedic Surgery as a Post Graduate Resident in 2017 at Grant Medical Foundation-Ruby Hall Clinic, Pune. His primary research interests include Arthroplasty, Complex Trauma and Orthopaedic Oncology. He is currently working at Ruby Hall Clinic as a Final Year PG Resident.



Dr. Deepak Mehta was involved in identifying the required cases, manuscript preparation, and data collection. He is currently working as a Final Year PG Resident in Department of Orthopaedics at Mhaishalkr Shinde Hospital and Research Centre, Sangli, Maharashtra, India. His primary research interests include Spine Disorders, Ilizarov Methodology and Complex Trauma.



Dr. Ankit Sisodia was involved in identifying the required cases, data collection and graphical analysis. He is currently working as a Final Year PG Resident in Department of Orthopaedics at Mhaishalkr Shinde Hospital and Research Centre, Sangli, Maharashtra, India. His primary research interests include Trauma, Paediatric Orthopaedics and Lower Limb Arthroscopy.



Dr. Varun M Rao was involved in identifying the graphical analysis. He is presently working as a consultant orthopaedic and spine Surgeon in Virat Hospital, Rewari, Haryana. His primary research interests include Spine Disorders and Complex Trauma.

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