ORIGINAL RESEARCH PAPER
Volume - 12 | Issue - 02 | February - 2023 | PRINT ISSN No. 2277 - 8179 | DOI : 10.36106/ijsr
INTERNATIONAL JOURNAL OF SCIENTIFIC RESEARCH

A PROSPECTIVE STUDY OF OPERATIVE MANAGEMENT AND FUNCTIONAL OUTCOME IN OLECRANON FRACTURES.

Orthopaedics

Dr. Lavakumar S Loya M.S(ORTHO) Professor Dept of Orthopedics Mahadevappa Rampure Medical College Kalaburagi.

Dr. Vivek O Karanagi* Post graduate. *Corresponding Author

ABSTRACT

BACKGROUND AND OBJECTIVE: Olecranon fractures account for 5–7% of elbow fractures in adults but are much rarer in children. The Mayo classification is based on displacement, comminution, and elbow stability. Type II and III are treated operatively with various techniques, including TBW, locked plate fixation, intramedullary fixation, and fragment excision with triceps advancement. Most patients can expect a good outcome, there are some complications, including loss of motion, hardware irritation, and wound healing problems. This study reviews the evidence and current understanding of olecranon fractures. **MATERIALS AND METHODS:** 30 Confirmed cases of olecranon fractures treated operatively by above techniques were studied and assessed radiologically and clinically using MAYO Elbow Performance Score up to 6 months post-operatively. **CONCLUSION:** From this study we concluded that the technique of open reduction and internal fixation with Kirschner wires with tension band wiring or CC screws with tension band wiring for simple transverse and oblique fractures and olecranon plate fixation for comminuted fractures, and unstable fractures are effective and gold standard technique for the treatment of olecranon fracture.

KEYWORDS

INTRODUCTION

Olecranon fracture is a fairly common injury. Olecranon fractures account for 5–7% of elbow fractures in adults but are much rarer in children.[1] The common mechanism is either a direct fall onto the elbow, or in rare cases an indirect pull of the triceps tendon while the forearm is in pronation, causing the olecranon to break[2] It can be as simple as non-displaced fractures or complex fractures with dislocation of the elbow joint.[3] The Mayo classification was described by Morrey and is based on several factors, including displacement, comminution, and elbow stability. Type I is nondisplaced, type II is displaced but the elbow is stable, and type III is displaced with elbow instability. Type I is treated conservatively. Type II and III are treated operatively and these can be accomplished with various techniques, including TBW, standard plate fixation, locked plate fixation, intramedullary fixation, and fragment excision with triceps advancement[4] Fixation with Plate and screws is the gold standard treatment for comminuted fractures, fractures of Monteggia, fractures associated with dislocations and oblique fractures with distal extension affecting the coronoid.[5-6]

The surgical goals are to restore articular congruity, provide stable reliable fixation, and allow early mobilization to minimize joint stiffness.[7] Although most patients can expect a good outcome, there are some well-known complications, including loss of motion, hardware irritation, and wound healing problems. This study reviews the evidence and current understanding of olecranon fractures.[8]

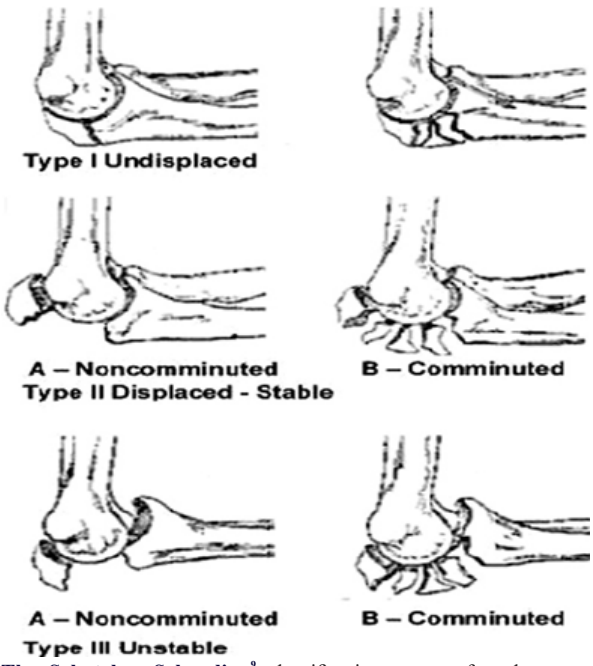
MATERIALS AND METHODS

This is a prospective study of 30 cases of olecranon fractures diagnosed with history taking, examination and investigations: Elbow Xray-AP and Lateral view. The study was conducted between February 2021 to August 2022 at Basaweshwara Teaching and General Hospital, Kalaburagi. The need of operative intervention is assessed based on the Mayo classification, Schatzker classification and Colton's classification and intervention done by techniques like K wire with tension band wiring, CC screw with tension band wiring and Olecranon hook plates. Patients were reviewed at 6 weeks, 3 months and 6 months interval and their assessment done by Mayo Elbow Performance Score.

CLASSIFICATION:

Mayo Classification Of Olecranon Fractures

The Mayo classification was described by Morrey[4] and is based on several factors, including displacement, comminution, and elbow stability. Type I is nondisplaced, type II is displaced but the elbow is stable, and type III is displaced with elbow instability. Groups are further subclassified into groups A and B based on the presence of comminution.[4]



The Schatzker–Schmeling[9] classification system for olecranon fractures focuses specifically on fracture morphology and the biomechanical concerns related to each type of internal fixation.[8]

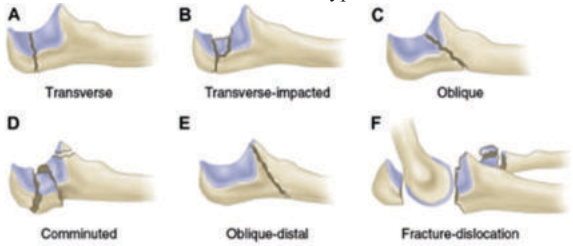


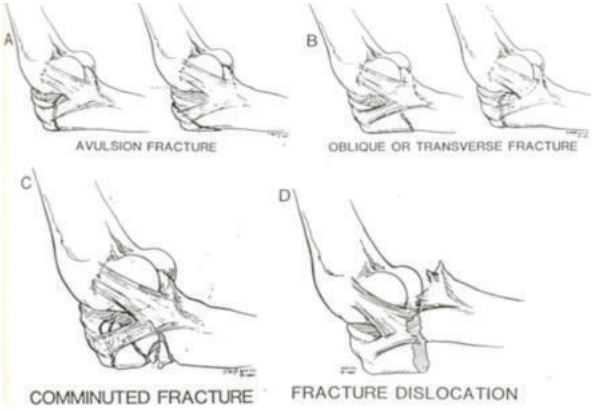
Fig. 2. Schatzker classification of olecranon fractures. (From Perez EA. Fractures of the shoulder, arm, and forearm. In: Canale ST, Beaty JH, editors. Campbell's operative orthopaedics. 12th edition. Philadelphia: Mosby Elsevier; 2013. Fig. 57-70. p. 2879; with permission.)

1. Type A fractures describe a transverse fracture extending through the articular surface of the ulnohumeral joint.
2. Type B fractures describe a type A fracture with some associated comminution or impaction at the articular surface.
3. Type C fractures are oblique fractures (proximal to the midpoint of the trochlear notch)

4. Type D fractures are comminuted fractures.
5. Type E fractures comprise an oblique fracture that begins and ends distal to the midpoint of the trochlear notch of the ulna.
6. Type F fractures include olecranon fracture dislocations that involve a fracture of the radial head and likely soft-tissue disruption of the medial collateral ligament.

MECHANISM OF INJURY:

- Fractures of the olecranon are usually caused by three main types of injuries: -
- Direct violence, such as falling on the tip of the elbow.
- Indirect violence, such as falling on a partially flexed elbow with indirect forces generated by the strong contraction of the triceps muscle.
- Combination of direct and indirect violence.



Colton Classification

TREATMENT

The vast majority of olecranon fractures require open reduction and internal fixation[10]. The exception is the rare undisplaced fractures with displacement of less than 2 mm when the elbow is flexed at 90 degrees with an intact extensor mechanism where conservative treatment is recommended. An initial 4 weeks of splint immobilisation followed by active-assisted mobilisation will ultimately lead to union and good function[11].

Displaced fractures require fixation. The type of procedure will depend on whether the fracture is defined as stable or unstable. Comminuted fractures, fracture dislocations/ subluxations and displaced fractures distal to the midpoint of the sigmoid notch are defined as unstable[12]. Stable fractures are transverse, two-part and at or proximal to the midpoint of the sigmoid notch. The aim of fixation is to achieve anatomical reduction of the joint surface and stable fixation construct that allows early mobilisation and rehabilitation[10].

Multiple methods of internal fixation have been proposed for olecranon fractures and the commonly used are-

1. Open reduction and fixation with K-wire and tension band wiring (figure of 8 wire loop).
2. Intramedullary fixation with CC screws and tension band wiring.
3. AO plate fixation.

The advantages of open reduction and internal fixation include-

1. This method provides an anatomical reduction of the fracture and a congruous articular surface.
2. Rigid fixation allows for an early range of motion.
3. Elbow stability is preserved.
4. The extensor power of the triceps muscle is maintained.
5. Pain free range of motion.

1. Open reduction and internal fixation with K wire and tension band wiring:

It is indicated for stable oblique and transverse fractures types (Mayo IA-IIA). A vertical incision was taken over the posterior aspect of the elbow about 2.5cms proximal to olecranon, curving distally along the lateral aspect of olecranon reaching the subcutaneous border of the ulna and extending distally for about 7.5cms distal to olecranon. Fascia was incised along the line of skin incision and fracture site was exposed. Fracture hematoma was cleared off and the fracture site was gently curettage. Accurate anatomical hairline reduction was achieved and held with either reduction clamp or long towel clip. Two parallel Kirschner wires are inserted in a longitudinal direction from the proximal fragment of the olecranon, into the ulna more distally just the tip of the wire crossing the anterior cortex. A drill hole is placed 3-5cms distal to the perpendicular to the axis of the ulna on the dorsal side. An 18/20-gauge wire is passed in a figure-of-eight pattern through a predrilled hole in the dorsal cortex of the ulna distal to fracture line and around the proximal end of K-wires deep to the triceps. The wire is tensioned in unison to create compression across the fracture. The wires are cut proximally and buried deep to the triceps tendon. The elbow is then moved through full range of motion to ensure the fixation is stable Thorough wash given with normal saline. Skin closed in layers. Dressing done and compression bandage applied. Above elbow slab applied with elbow in 90 degrees flexion.

K wire and tension band wiring

Pre-op Xray

Immediate Post-op Xray

6 Months Follow Up Xray

Extension

Flexion

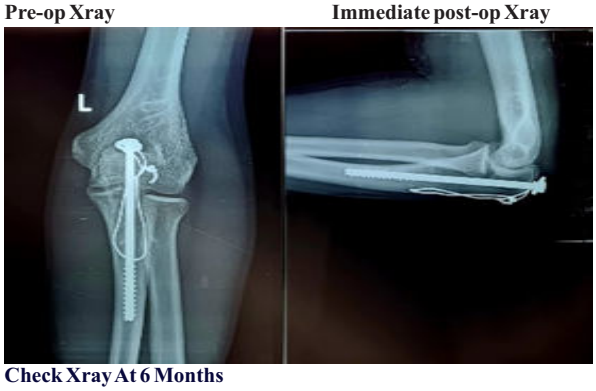
Pronation Extension

2. Intramedullary Fixation With CC Screw And Tension Band Wiring:

It is indicated in avulsion fractures, transverse, oblique superior, or oblique inferior fracture configurations were included. Usually, medullary 6.5mm AO cancellous screws are used which are long enough to obtain purchase in the medullary canal of the distal ulna providing rigid fixation.[13,14]A drill hole is placed 3-5cms distal to the perpendicular to the axis of the ulna on the dorsal side. A 18/20-gauge wire is passed in a figure of 8 pattern through the predrilled hole of the ulna distal to the fracture line and around the proximal end of the CC screw below the washer. Now the wire is tensioned in unison to create compression across the fracture. Now the CC screw is tightened completely over the wire to achieve hairline reduction. The wires are cut proximally and buried deep to the triceps tendon.

Cancellous Screw With Tension Band Wiring

Pre-op Xray Immediate post-op Xray



Check Xray At 6 Months

Flexion Extension

Supination Pronation

AO Plate Fixation:

Precontoured locking plate fixation is also used in the treatment of olecranon fractures. It allows for significantly more compression at fracture site than does TBW as well as the ability to manage more complex and comminuted fracture patterns[15](Mayo IIB-III), unstable fractures associated with elbow dislocation or fracture extending down along the shaft of the ulna. The fracture is reduced and a pre-contoured dorsal proximal ulnar hook plate is applied.

ORIF with olecranon hook plate

POSTOPERATIVE COURSE:

The postoperative course depends on several variables, including soft tissue status, the stability of fixation, and the type of implant used. Elbow was immobilised in above elbow slab for 2 weeks until suture removal. In our study, patients were advised to report for follow up after 2 weeks for suture removal, at 6 weeks, 12 weeks and thereafter at 6 months post-operatively. At follow up, a detailed radiological and clinical examination was done and result was assessed at 6 months. At 2 weeks follow up, patients were instructed to carry out physiotherapy in the form of active flexion-extension of elbow joint and pronation-supination without loading and with partial loading was initiated at 6 weeks.

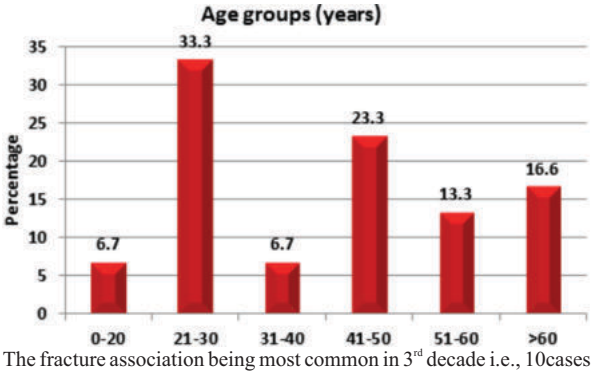
Early active range of movements were encouraged to prevent elbow stiffness. This can be applied to both TBW and plate fixation[16].

RESULTS

This study consists of 30 cases of olecranon fractures treated by K wire with tension band wiring or CC screw with tension band wiring for simple transverse fractures, oblique fractures (type IA, IIA) and Olecranon hook plate for communited fractures, fractures extending into diaphysis in Basaweshwara Teaching and General hospital attached to Mahdaveppa Rampure Medical College, Kalaburagi between February 2021 to August 2022. All cases were followed up periodically during the period 2021-2022. The following are the observations made and the available data are analysed as follows.

1) Age Incidence

Mean (SD) age was 40.4 (14.3) years with the minimum of 19 and maximum of 67 years.



The fracture association being most common in 3rd decade i.e., 10cases (33.3%).

In this series, 2(6.7%) patients between 0-20years, 10(33.3%) patients between 21-30 years, 2 (6.7%) patients between 31-40 years, 7 (23.3%) patients between 41-50 years, 4(13.3%) patients between 51-60 years and patients above >60 years were 5(16.6%).

2) Gender Incidence:

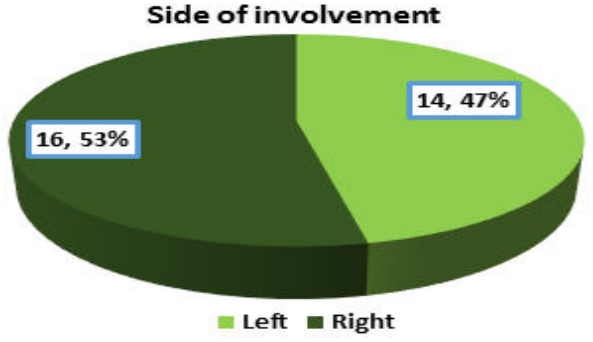
Table –i: Gender Incidence

Gender	Number	Percentage
Female	11	36.7
Male	19	63.3
Total	30	100.0

In the present series, males were 19 (63.3%) and females were 11 (36.7%) with M:F ratio of 1.72:1.

3) Side Of Involvement:

In this series, fracture of the olecranon on right side were 16 (53.3%) and on the left side were 14 (46.7%).



4) Mode Of Injury:

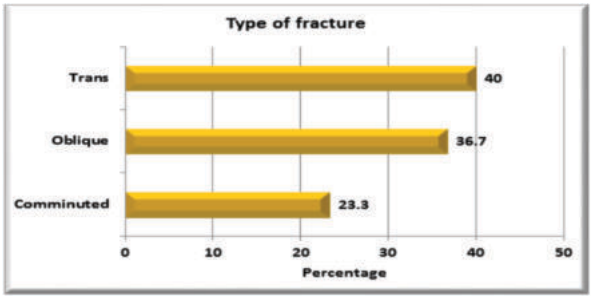
Table – II: Mode Of Injury

Mode Of Injury	Number	Percentage
Assault	5	16.7
Fall From Height	13	43.3
Road Traffic Accidents	12	40.0
Total	30	100.0

In this series, 12 cases (40%) were due to road traffic accidents, 13 cases (43.3%) were due to fall and 5(16.7 %) cases sustained olecranon fracture due to assault.

5) Type Of Fractures:

In this series, 11 (36.7%) patients sustained oblique fractures, 12 (405) patients had transverse fractures and 7 (23.3%) patients had comminuted fractures.



6) Type Of Fracture Fixation:

Table –iii: Showing The Type Of Fracture Fixation

Type of fixation	Number	Percentage
CC screw with TBW	9	30.1
K wire with TBW	14	46.7
OHP	7	23.2
Total	30	100.0

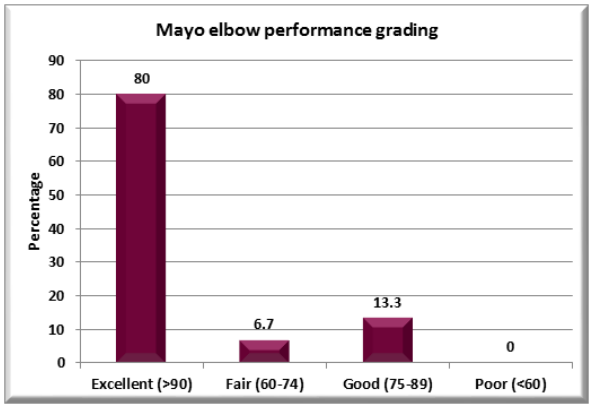
In this series, 9 (30.1%) underwent fixation with CC screw with tension band wiring, 14 (46.7%) patients treated with K wire and tension band wiring and 7 (23.2%) patients underwent plate fixation.

7) Interpreting The Mayo Elbow Performance Score:

Table – Iv: Results

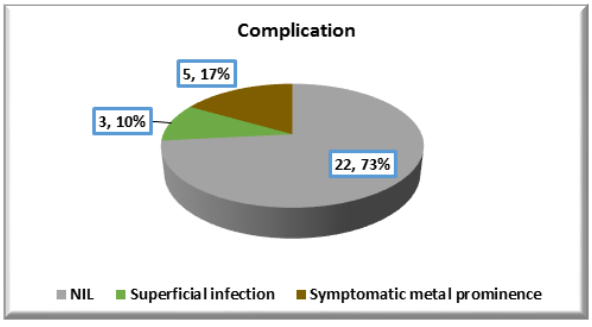
Grading	Number	Percentage
Excellent (>90)	24	80.0
Good (75-89)	4	13.3
Fair (60-74)	2	6.7
Poor (<60)	0	-
Total	30	100.0

In this series, patients were graded according to MAYO Elbow performance score and 24 (80%) patients had excellent results, 4 (13.3%) had good results and 2(6.7%) patients with fair results.



COMPLICATIONS:

The complications of the present study, superficial infection was in 3(10%) patients, which was treated with broad spectrum antibiotics. The symptomatic metal prominence was noticed in 5 (16.6%) patients. Due to thin skin and soft tissue coverage over the olecranon, most common complications were superficial infection and hardware prominence.



DISCUSSION

Methods of fixation for the olecranon fractures are a matter of debate with many implant choices and configurations being studied.

The outcome of the surgical treatment always depends directly on the precision of the joint reduction, restoration of mechanical stability that permits prompt mobilisation, respect for the soft tissues, and maintaining an intact extensor mechanism.[17,18]

The aim of surgery is to achieve an adequate stability to the fracture and to reconstruct the joint surface to enable range-of motion exercises in the early post-operative period.[19]

In the management of intra articular fractures like fractures of the olecranon, a perfect anatomical reduction of the fragments to obtain articular congruity and rigid fixation of the fragments is of utmost importance, if early movements are to be instituted to prevent

complications like traumatic arthritis and joint stiffness. Tension band wiring provides the strength of fixation i.e., by converting tensile force to compressive force at the fracture site and for comminuted fractures Olecranon hook plate is used.

In our study 30 cases of fractures of the olecranon were treated with K wire and Tension band wiring or CC screw with tension band wiring for simple transverse and oblique olecranon fractures and Olecranon hook plate for comminuted fractures and unstable fractures (type IIB and III). Our experience with these methods of fixation has given favorable results. The findings, the end results and various other data will be analysed and compared in the following discussion.

1) AGE INCIDENCE:

Table showing average age incidence in various study groups

Series	Average age
1) Jiang Xieyuan (2000)[20]	38 years
2) Macko Donald and Szabo (1985)[21]	35.5 years
3) Present study	40.4 years

The average age incidence; in the present study was found to be 40.4 years. This is well in accordance with the authors Jiang Xieyuan (2000) is his study average age was 38 years and Macko Donald and Szabo California (1985) average age was 35.5 years.

2) SEX INCIDENCE:

Series	Male	Female
1) Jiang Xieyuan (2000)[20]	10(66.66%)	5 (33.33%)
2) Hume &Wiss (1992)[22]	30(73.17%)	11(26.82%)
3) Wolfgang G. et al (1987)[23]	27(60%)	18(40%)
4) Sinha S et al (2020) [24]	39(65%)	21(35%)
5) Present study	19(63.7%)	11(36.7%)

The present study of fracture olecranon revealed greater incidence in males (63.7%). Similar male predominance was found in the study conducted by Jiang Xieyuan, Hume and Wiss, Garry Wolfgang et al series and Sinha S et al series.

3) SIDE INCIDENCE:

Series	Right	Left
1) Wolfgang G., et al (1987)[23]	25(55.55%)	20 (44.44%)
2) Hume and Wiss (1992)[22]	16(39.2%)	25 (60.9%)
3) Sinha S et al (2020) [24]	37(61.7%)	23(38.3%)
4) Present study	16(53.3%)	14(46.7%)

In this study, 16(53.3%) out of 30 patients had right side fractures implying right side fractures were more than the left side. In the study by Wolfgang G. et al and Sinha S et al, they found that right side involvement is more frequent and according to Hume and Wiss, left side involvement is more frequent.

4) MECHANISM OF INJURY:

Series	No.Of Cases	Percentage
1) Jiang Xieyuan (2000)[20]		
Traffic Accident	9	60%
Fall From Height	6	40%
2) Wolfgang G., Et Al (1987)[23]		
Fall	22	48.88%
Motor Vehicle Accident	20	44.44%
Direct Blow	3	6.66%
3) Sinha S Et Al (2020)[24]		
RTA	22	36.7
Fall	27	35
Physical Assault	11	18.3
1) Present Study		
Road Traffic Accident	12	40%
Fall From Height	13	43.3%
Assault	5	16.7%

In this study, the patients who had road traffic accidents were 12(40%) patients, with fall from height were 13 (43.3%) patients and patients of assault were 5(16.7%). Whereas according to Jiang Xieyuan series, the patients with traffic accidents were 9(60%) and patients with fall from height were 6 (40%) and according to Sinha Smet al, 22 patients had RTA, 27 patients sustained fracture due to fall and 11 patients had physical assault. Wolfgang et al, 22 (48.88%) patients were fall from height 20(44.44%) were due to motor vehicle accident 3 (6.66%) were due to direct blow.

5) TYPE OF FRACTURE:

Series	No.Of Cases	Percentage
1) Jiang Xieyuan (2000)[20]		
Oblique Fracture	1	6.67
Comminuted Fracture	14	93.34
2) Murphy Et Al (1987)[25,26]		
Transverse Fracture	26	57.5%
Oblique Fracture	12	26.7%
Comminuted Fracture	7	15.6%
3) Present Study		
Transverse Fracture	12	40%
Oblique Fracture	11	36.7%
Comminuted Fracture	7	23.3%

In the present series ,12(40%) patients had transverse fractures, 11(36.7%) patients had oblique fractures and 7(23.3%) sustained comminuted fractures. In Jiang Xieyuan study, 1 (6.67%) patient had oblique fractures and 14 (93.34%) patients had comminuted fractures. In Murphy et al series, 26 (57.5%) patients had transverse fracture, 12 (26.7%) patients had oblique fractures and 7 (15.6%) patients sustained comminuted fractures.

6) POSTOPERATIVE COMPLICATIONSTHIS PROCEDURE:

Complications	Present Study	Murphy Et Al[25]	Sinha S Et Al [24]
1. Superficial Infection	3 (10%)	-	-
2. Symptomatic Metal Prominence	5 (16.6%)	3 (6.6%)	5 (8.3%)

In the present series, superficial infection was seen in 3(10%) patients, which were treated with broad spectrum antibiotics but 1 patient also underwent wound exploration and thorough wash and the implant was left in situ. The symptomatic metal prominence in 5 (16.6%) whereas complications in the study by Murphy et al[31] is only symptomatic metal prominence 3 (6.66%).

7) RESULTS:

Study	Results in percentage			
	Excellent	Good	Fair	Poor
1) Murphy et al[25,26]	60	10	30	-
2) Jiang Xieyuan[20]	53.33	40	6.66	-
3) Karlsson et al [27]	80	13.3	6.7	-
4) Sinha S et al [24]	83.3	16.7	-	
5) Present study	80	13.3	6.7	

The results were evaluated according to the Mayo elbow performance score. The results obtained in our series were excellent in 24 (80%) patients, good in 4(13.3%) patients, fair in 2(6.7%) patients and no poor results.

CONCLUSION

From the present study it is concluded that the technique of open reduction and internal fixation with Kirschner wires with tension band wiring or CC screws with tension band wiring for simple transverse and oblique fractures (Type IIA). But in case of comminuted fractures, as TBW cannot provide a sufficient buttress for impacted articular fragments and also with risk of migrating K-wires, delayed union and non-union, plate fixation should be considered as a method of choice. Olecranon hook plate fixation used for comminuted fractures, fractures extending into diaphysis and unstable fractures (Type IIB, III) The plate acts as a posterior buttress, supporting the articular fragments till the fracture consolidates. Plate fixation (olecranon hook plate) is an effective and reliable way of treatment with very low risk of nonunion.

REFERENCES

1. S.D. -Newman, C. Mauffrey, S. Krikler, Olecranon fractures, Injury volume 40 , issue(6) (Jun1,2009),575–581.
2. Niéto H, Billaud A, Rochet S, Lavoinne N, Loubignac F, Pietu G, Baroan C, Espie A, Bonnevialle P, Fabre T. Proximal ulnar fractures in adults: a review of 163 cases. Injury. 2015 Jan;46 Suppl 1: S18-23. doi: 10.1016/S0020-1383(15)70006-9. Epub 2015 Jan 19. PMID: 26528935.
3. Veillette CJ, Steinmann SP. Olecranon fractures. Orthop Clin North Am. 2008 Apr;39(2):229-36, vii. doi: 10.1016/j.ocl.2008.01.002. PMID: 18374813.
4. 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. PMID: 7797857.
5. M.L. Anderson, A.N. Larson, S.M. Merten, S.P. Steinmann, Congruent elbowplate fixation of olecranon fractures, J. Orthop. Trauma 21 (6) (2007) 386–393.
6. H. Niéto, A. Billaud, S. Rochet, et al., Proximal ulnar fractures in adults: areview of 163 cases, Injury 46 (Suppl. 1) (2015) S18–S23.
7. Duckworth AD, Clement ND, White TO, Court-Brown CM, McQueen MM. Plate versus tension-band wire fixation for olecranon fractures: a prospective randomized trial. J Bone Joint Surg Am. 2017 Aug 2;99(15):1261-73.
8. Brolin TJ, Throckmorton T. Olecranon Fractures. Hand Clin. 2015 Nov;31(4):581-90. doi: 10.1016/j.hcl.2015.07.003. Epub 2015 Sep 3. PMID: 26498547.

9. Hak DJ, Golladay GJ. Olecranon fractures: treatment options. J Am Acad Orthop Surg 2000;8: 266–75.
10. Quintero J, Varecka T (2013) Olecranon, radial head and complex elbow injuries, Chap 6.3.1. In: Ruedi TP, Buckley RE, Moran CG (eds) AO principles of fracture management. Specific fractures, vol 2, pp 628–633.
11. Ring D (2011) Open reduction and internal fixation of olecranon fractures, chap 30. In: Tornetta III et al Operative techniques in orthopaedic trauma surgery. Lippincott Williams & Wilkins, Philadelphia, pp 252–258.
12. Baecher N, Edwards S (2013) Olecranon fractures. J Hand Surg Am 38(3):593–604
13. David Ring "Elbow fractures and dislocations in 'Rockwood and Green Fractures in Adults' Chapter 32 Vol I 7th, Bucholz RW, Heckman JD, Lippincott Williams& Wilkins.2010, 936-942.
14. Netz P, and Stromberg L, "Non-sliding pins in traction absorbing wire of fractures: A modified technique". ActaOrthop Sand,1982 53: 355-360.
15. Wilson J, Bajwa A, Kamath V, et al. Biomechanical comparison of interfragmentary compression in transverse fractures of the olecranon. J Bone Joint Surg Br 2011; 93:245–50.
16. S. Akman, R.E. Ertürer, M. Tezer, et al., Long-term results of olecranon fractures treated with tension-band wiring technique, Acta Orthop.Traumatol. Turc. 36 (5) (2002) 401–407.
17. C.J. Veillette, S.P. Steinmann, Olecranon fractures, Orthop. Clin. North Am. 39(2) (2008) 229–236.
18. H. Niéto, A. Billaud, S. Rochet, et al., Proximal ulnar fractures in adults: are view of 163 cases, Injury 46 (Suppl. 1) (2015) S18–S23.
19. J. Dawson, H. Doll, I. Boller, et al., The development and validation of a patient-reported questionnaire to assess outcomes of elbow surgery, J. BoneJoint Surg. Br. 90-B (2008) 466–473.
20. Jiang Xieyuan et al. "Operative treatment of olecranon fracture associated with anterior dislocation of the elbow". Chinese J of Orthop, 2000;20(3): 154- 156.
21. Macko D, and Szabo RM: "Complications of tension band wiring of olecranon fractures". J Bone Joint Surg,1985, 57B: 399.
22. Hume, Mary C, and Wiss, Donald A: "Olecranon fractures". 1992, Clin Orthop, 285: 229-235.
23. Wolfgang G., et al: "Surgical treatment of displaced olecranon fractures by tension band wiring technique". Clin Orthop,1987, 224: 192-204.
24. Sinha S, Maharjan R, Khanal GP, Pokharel B, Drolia N, Gupta S, Kanojia RK, Chaudhary P. Comparison of Functional and Radiological Outcomes of Olecranon Fractures Treated with Tension Band Wiring with Kirschner Wires to Transcortical Screw Fixation-A Randomised Controlled Study. Strategies Trauma Limb Reconstr. 2020 Sep-Dec;15(3):131-137. doi: 10.5005/jp-journals-10080-1510. PMID: 34025792; PMCID: PMC8121108.
25. Murphy D.F., et al: "Displaced olecranon fractures in adults. Biomechanical analysis of fixation methods". Clin Orthop,1987, 224: 210-4.
26. Murphy D.F., Greene W.B. and Damerson T.B.: "Displaced olecranon fractures in adults. Clinical evaluation". Clin Orthop,1987, 224: 215-23.
27. KarlssonMK, Hasserius R, KarlssonC, et al. Fractures of the olecranon: a 15- to 25-year followup of 73 patients.Clin Orthop Relat Res 2002;(403):205–12.