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Functional outcomes of surgical management of olecranon fractures with various modalities

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Abstract

Background: Olecranon fractures are one of the most commonly seen orthopaedic injuries in the emergency room. Fractures of the Olecranon process of the ulna typically occurs because of road traffic accident, a fall, or assault. The accepted line of management of Olecranon fractures depends on the degree of displacement of fragments. In non-displaced fractures, treatment is short period of immobilization followed by gradually increasing range of motion exercises. When displaced, being an intra-articular fracture, surgical management with various modalities of fixation is indicated for good functional outcomes.

Aims and objective: The present study is undertaken to evaluate the results of surgical management of these fractures, the merits and demerits of each fixation method and to assess elbow joint stability and mobility after the procedure.

Materials and Methods: It is a prospective, observational study which was carried out in the Department of Orthopaedics, Government General Hospital, attached to Guntur Medical College, Guntur, Andhra Pradesh, during the period January 2013 to December 2015. During this period, 25 cases of fracture olecranon which were treated by Tension band wiring with Kirschner wires (in Simple transverse fractures) and Olecranon hook plate (for Comminuted fractures), were subjected to clinical observation and the results analyzed. Functional outcomes were estimated using Mayo Elbow Performance score (MEPS). Follow up period of cases is for 2 years.

Results: In our series, majority of the patients were males, in middle age group, with road traffic accident being the commonest mode of injury. Most of the cases were Type II B fractures i.e., oblique and transverse fractures according to Colton's classification. Surgery was performed within an average period of 4 days (range from 1 to 8 days). Union was noted both clinically and radiologically and functional evaluation was done by Mayo Elbow Performance Score. Excellent results were found in 18 patients (72%), good in 4 (16%), fair in 3 (12%) and no poor results seen.

Conclusion: From the present study it is concluded that the technique of open reduction and internal fixation with Kirschner wires and figure of eight Tension band wire (for simple transverse and oblique fractures) is a gold standard technique. In comminuted fractures, TBW cannot provide a sufficient buttress for impacted articular fragments. Hence plate fixation which is based on good biomechanical principles is the method of choice and gives reliable results.

Keywords: K wire, olecranon fractures, olecranon hook plate, open reduction and internal fixation, Tension band wiring

1. Introduction

Olecranon fractures are one of the most commonly seen orthopaedic injuries (40 % of all fractures around the elbow joint) in the emergency room. In fractures of the olecranon process of the ulna, bimodal distribution is seen, in young individuals as a result of high energy trauma (Road Traffic Accidents, assaults) and old aged individuals as a result of simple falls. These fractures range from simple non displaced fractures to complex fractures—dislocation of the elbow and they are commonly intra-articular, except for avulsion fractures of brachial triceps. Non-displaced fractures or minimally displaced (< 2mm) can be treated with a short period of immobilization followed by gradually increasing range of motion exercises. Closed radiographic follow up is necessary (X-rays are obtained in 5 to 7 days) to monitor for any displacement.

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When primarily or secondarily displaced, open reduction and internal fixation are usually required to obtain anatomical realignment of the articular surface and also for restoration of disrupted elbow extensor mechanism. Consequently this leads to normal elbow function. The fixation should be stable, allow active elbow movements like flexion - extension, pronation-supination and promote union of the fracture ^[1].

In the past, closed reduction and plaster cast application was the treatment for many a fracture of olecranon. But, prolonged immobilization with its own complications, results in increased morbidity and mortality of patients ^[2]. Therefore, in order to avoid arthritis of elbow joint, open anatomical reduction and internal fixation of fracture is required.

Surgical treatment modalities available for treatment of acute olecranon fractures include tension band wiring, plating, Inter-fragmentary screw fixation, different intra medullary screws, suture anchor fixation or rarely resection of avulsed olecranon fragments with triceps advancement. The active mobilization of elbow after surgery will restore the patient's upper limb functional status as early as possible. There is no single technique which is suitable in management of all olecranon fractures because of variations in the fracture pattern and also associated injuries.

In our study, we used Tension Band Wiring technique (TBW) for simple transverse and oblique fractures, as it is a gold standard technique. But in case of comminuted fractures, as the tension band is tightened, fragments tend to telescope ^[3] and reduction might be lost. This causes incongruity of the articular surface and problems in initiating early movements of the elbow. In comminuted fractures, plate is consistent with the shape of proximal ulna, meets the design of olecranon anatomy and as it is applied closer to the bone surface, it makes fixation more stable and reliable. Hence we have used olecranon hook plate.

Objectives of present study

1. To clinically evaluate the result of various modalities of fixation like tension band wiring and olecranon hook plate.
2. To discuss the merits and demerits of each surgical fixation method.
3. To assess elbow stability and joint motion after the surgical procedure.

2. Methodology

The clinical material for this study consist of 25 cases of fracture of olecranon, meeting the exclusion and inclusion criteria, treated in the Department of orthopaedics, Government General Hospital affiliated to Guntur Medical college, Guntur, Andhra Pradesh, India between January 2013 to December 2015. All patients were informed about the study and their written consent for their inclusion in this study was obtained.

Ethical approval for the study was taken from Institutional ethics committee.

Inclusion criteria

- Adults
- Displaced fractures of olecranon (transverse, oblique, comminuted)
- Exclusive olecranon fractures
- Patients within 2 weeks of injury.

Exclusion criteria

- Extremes of age
- Infected & open fractures

- Complex fracture- dislocations of elbow
- Fractures with distal neurovascular deficits
- Poly-trauma patients.

Data recording (clinical and radiological)

As soon as the patient is admitted, a detailed history was taken and a meticulous physical examination both general and local was done. The information obtained was recorded in a standard proforma. The radiographs of the patient's affected elbow were taken both in Antero-Posterior and lateral views. CT scans may be required in some cases to assess the severity of injury and to plan fracture fixation. The diagnosis was thus established by both clinical and radiological examination.

In this study, olecranon fractures were classified according to Colton's classification ^[4] as given in Table (1)

Table 1: Colton's classification

Type	Description
I. Undisplaced and stable	Displacement < 2mm, displacement does not increase with elbow flexion.
II. Displaced	A) Avulsion fracture B) Oblique or transverse fracture C) Comminuted fracture D) Fracture with dislocation in the elbow joint.

Management protocol

In the meantime, the patient's injured elbow is immobilized in an Above-elbow POP slab and analgesics are given to alleviate pain. All the patients were taken for elective surgery as soon as possible after necessary preoperative work-up. Routine blood investigations like CBP, RBS, Blood urea, Serum Creatinine, Serum Electrolytes, Blood Grouping and typing, HIV, HbsAg were done. Also ECG and chest x-ray were obtained.

Patient's fitness for surgery was obtained after consulting the Physician and the anaesthetist was informed.

The patient and his attendants were explained about the nature of injury, its possible complications, the need for the surgery and the complications of surgery. Written and informed consent for surgery was obtained from the patient.

Proper preparation of the part to be operated was done and painted with Betadine solution. Aseptic draping of the part was done. Preoperative parenteral antibiotic (preferably cephalosporins) is administered one hour before surgery.

Surgical Procedure

In all patients (irrespective of mode of fixation), surgery was performed under General anaesthesia or Brachial block. A mid arm tourniquet was applied and with patient in supine or lateral position, the limb was placed on a well-padded elbow support. An image intensifier (C-arm) was used intraoperative to assess the reduction and congruency of the joint.

Operative technique of TBW

Exposure of the olecranon was done by posterior approach. A vertical incision was taken over the posterior aspect of the elbow about 2.5cms proximal to olecranon, curved to radial side, and then proceeding distally along the subcutaneous border of the ulna for about 7.5 cms distal to tip of olecranon (length of incision depends on type of fixation being used and complexity of the fracture). Fasciocutaneous flaps were raised to allow adequate exposure of the fracture site. Fracture hematoma was cleared off and the fracture ends are freshened with a curette. Anatomical hairline reduction was achieved and held with either reduction clamp or long towel clip.

Two K-wires (1.6 mm) were introduced parallel from the tip of

the olecranon i.e., into the proximal fragment, then across the fracture site to the distal fragment, with tip of k-wires lying in the intramedullary canal.

Approximately 3 to 5cms distal to fracture site, Periosteum was stripped from the shaft of ulna and a 2mm hole was drilled perpendicular to the long axis of the ulna. A 1.0 mm or 1.2 mm stainless steel malleable wire was passed through this transverse hole and crossed over the posterior surface of olecranon in a figure-of-eight manner. The wire was passed around the protruding K-wires deep to the triceps tendon [4] and tightened using AO tensioner and then secured with a twist. The proximal ends of 2 K-wires are bent 180° and impacted into the proximal fragment after splitting the triceps tendon fibers at this point. Accuracy of fracture reduction was checked and stability of fixation was tested by moving the elbow joint. Tourniquet is deflated and after ensuring hemostasis, the wound is closed in layers. Sterile dressing of the wound was done and a compression bandage applied.

Operative technique of Plate fixation

The fracture site was exposed in a similar way as described above. The ulnar nerve was protected throughout the procedure although not explored. After anatomical reduction, the fracture fragments are held with reduction clamps. Olecranon hook plate (Fig.1) was applied on the posterior surface (acts as Tension band plate), with hook seated into the proximal fragment. It is then fixed with cortical screws after drilling holes and tapping. Tourniquet was deflated and ensuring hemostasis, the surgical wound is thoroughly washed and is closed in layers over a suction drain. Wound is dressed and a compression bandage was applied.



Fig 1: Implants and instruments for fixation of olecranon fractures

Postoperative Management

- The Blood pressure, Pulse rate, Temperature were recorded. Soakage of dressin gif any, noted and changed if condition warrants.
- Once patient recovers from anesthesia, the wrist & finger

movements and sensations were examined for any iatrogenic nerve injury.

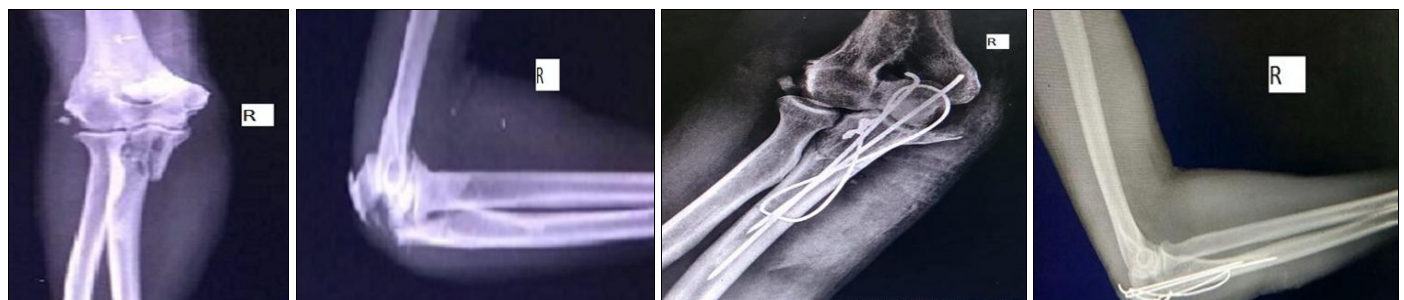
- Broad spectrum antibiotics IV and analgesics IM are administered.
- On the 2nd Post-operative day, drain was removed, the condition of the wound is noted and sterile dressing is done. The limb was kept in elevated position.
- Check X-ray of the operated elbow is taken both in antero-posterior and lateral views.
- From the 5th Post-operative day, oral antibiotics and analgesics were prescribed till the time of suture removal.
- Sutures are removed on the 10th postoperative day.
- The patient is discharged with the Above-elbow POP slab applied and the limb supported in an arm pouch. Patient is instructed to review after 3 weeks at OPD.

Follow up protocol

- Regular OPD follow-ups were done after 6 weeks, 12 weeks and thereafter every 3 months up to a period of 2 years.
- At each visit, clinical examination (Fig 4) (wound/scar, tenderness, movements at elbow joint, distal neurovascular status and any prominence of hardware are checked) and radiological evaluation (Fig 2 & 3) (for evidence of bony union and status of the implants) was done & post-operative complications if any, noted.
- Patients were instructed to carry out physiotherapy in the form of flexion-extension and pronation- supination movements at the elbow without loading.
- The functional results are graded as per MEPS / Mayo Elbow Performance Score [6] as shown in the table (2) given below.

Table 2: MEPS

Function	Definition	Points (max-100)	Score grading
Pain	None	45	Excellent ≥ 90
	Mild	30	
	Moderate	15	
	Severe	0	
Motion	Arc $> 100^\circ$	20	Good 75-89
	Arc $50^\circ - 100^\circ$	15	
	Arc $< 50^\circ$	5	
Stability	Stable	10	Fair 60 -74
	Moderate Instability	5	
	Gross Instability	0	
Function	Able to Comb Hair	5	Poor < 60
	Able to feed	5	
	Able to Perform hygiene	5	
	Able to wear shirt	5	
	Able to wear shoe	5	



Preopxray of TBW AP view

Preopxray of TBW Lateral view

postopxray of TBW AP VIEW

postop xray of TBW lateral view

Fig 2: Preoperative and postoperative x-rays of Tension Band Wire fixation

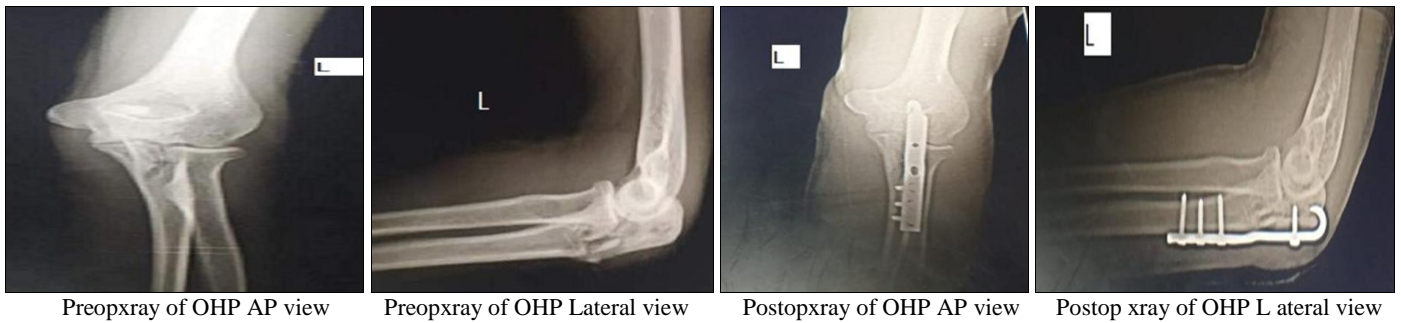


Fig 3: Preoperative and post operative x-rays of olecranon hook plate (OHP) fixation



Fig 4: Clinical pictures of patient showing elbow movements after fixation

3. Results

Study consist of 25 cases of fractures of the olecranon treated by Tension band wire and Kirschner wire (for Simple transverse fractures) and Olecranon hook plate (for comminuted fractures) during the period from January 2013 to December 2015. The following observations were made from the data collected during this study.

Table 3: Age Incidence

Age in years	21-30	31-40	41-50	51-60
No. of cases	6	8	4	7
Percentage	24%	32%	16%	28%

The age of the patients ranged from 21-60 years, with fractures seen most commonly in 3rd decade. Mean age was 40.5 years. In this series, 6(24%) patients were between 21-30 years, 8 (32%) patients were between 31-40 years, 4 (16%) patients between 41-50 years and 7 (28%) patients were between 51-60 years.

Table 4: Sex incidence

Sex	No. of cases	Percentage
Male	17	68%
Female	8	32%

In the present study, there were 17 males (68%) and 8 females (32%).The male to female ratio is 2.2: 1.

Table 5: Laterality

Side involved	No. of cases	Percentage
Right	16	64%
Left	9	36%

Table 6: Mode of Injury

Mode of injury	No. of cases	Percentage
Road traffic accidents	13	52%
Fall from height	11	44%
Assault	1	4%

In this study, 13 cases (52%) were due to road traffic accidents and 11 cases (44%) were due to falls and 1case (4%) was due to assault with a stick

Table 7: Type of Fracture (Based on Colton's classification)

Type of fracture	No. of cases	Percentage
Un-displaced and stable fractures	0	0%
II. Displaced fractures		
A) Avulsion fractures	1	4%
B) Oblique and transverse fractures	19	76%
C) Comminuted fracture	5	20%
D) Fracture dislocation	0	0%

Most common fracture pattern was Type II B (oblique and transverse fractures) and seen in 19 patients (76 %).

Table 8: Time interval between injury and surgery

1-8 days	25	100%
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No case was operated as a surgical emergency. All the cases were operated as elective cases (within 1-8 days) during our regular operation theatre days, as soon as the patient was fit for surgery. The average wait period for surgery was 4 days post-injury.

Table 9: Time for fracture union.

Time of union	No. of cases	Percentage
<4 months	17	68%
4-6 months	8	32%
6months - 1yr	0	0%
Non union	0	0%

In present study, 17 (68%) patients had solid union in period less than 4 months, 8 (32%) had union between 4 -6 months and no Non -union were noted.

Table 10: Record of Mayo Elbow Performance Score

Pain intensity	Score	Pain intensity	Number of cases	Percentage
	45	None	18	72%
30	Mild	7	28%	
15	Moderate	0	0%	
0	Severe	0	0%	
Range of motion	Score	Range of motion	Number of cases	Percentage
	20	Arc of motion >100°	22	88%
	15	Arc of motion between 50°- 100°	3	12%
5	Arc of motion < 50°	0	0%	
Stability	Score	Stability	Number of cases	Percentage
	10	Stable	23	92%
	5	Moderately instable	2	8%
	0	Grossly unstable	0	0%
Function	Score	Function	Number of cases	Percentage
	5	Able to comb hair	22	88%
	5	Able to eat	25	100%
	5	Able to perform hygiene	25	100%
	5	Able to put shirt	23	92%
5	Able to put shoe	25	100%	

Table 11: Results on interpretation of mayo elbow performance score

Grading	Number of cases	Percentage
Excellent (Score> 90)	18	72%
Good (Score 75-89)	4	16%
Fair (Score (60-74)	3	12%
Poor (Score< 60)	0	0%

Table 12: Complications of Surgery

Complications	Number of Cases	Percentage
Superficial infection	3	12%
Symptomatic metal prominence	4	16%

The complications noted in the present study are superficial infection in 3(12%) patients, which was treated with Broad spectrum antibiotics. The symptomatic hardware prominence was reported by 4(16%) patients.

4. Discussion

Early range of motion has been considered a critical aspect in management of olecranon fractures so as to prevent complication like joint stiffness and post traumatic arthritis. Therefore restoration of articular congruity and rigid internal fixation are essential in the treatment of intra articular fractures like olecranon fractures. Tension band wiring with 2 intramedullary Kirschner wires provides the strength of fixation i.e. by converting tensile forces of triceps into compressive force at the fracture site as proposed by weber &vasey [13]. In case of comminuted fractures Olecranonhook plate is used, as tension band wire will not provide reduction and stability.

In our study, 25 cases of fractures of the olecranon were treated with Tension band wiring and Kirschner wires (for simple transverse and oblique fractures) and Olecranon hook plate (for comminuted fractures). Our experience with this methods of fixation has given favorable results. The data obtained during our study is analysed and compared with similar studies available in the literature.

Table 13: Age Incidence

Study series	Average age
1) Jiang Xieyuan [7]	38 years
2) Macko Donald and Szabo [8]	35.5 years
3) Present study	40.05 years

The average age incidence in the present study was found to be 40.05 years. This is well in accordance with the author Jiang Xieyuan where the average age was 38 years and in Macko Donald and Szabo's study, the average age was 35.5 years.

Table 14: Sex Incidence

Study series	Male	Female
1) Jiang Xieyuan	10(66.66%)	5 (33.33%)
2) Hume &Wiss [9]	30(73.18%)	11(26.82%)
3) Wolfgang G. <i>et al.</i> [10]	27(60%)	18(40%)
4) Present study	17(68%)	8(32%)

In our study, there was greater incidence of fractures in males (68%). Similarly male preponderance was found in the study of Jiang Xieyuan, Hume &Wiss and also Garry Wolfgang *et al.* series.

Table 15: Incidence of laterality

Study series	Right	Left
1) Wolfgang G., <i>et al.</i>	25(55.55%)	20 (44.44%)
2) Hume and Wiss	16(39.2%)	25 (60.9%)
3) Present study	16(64%)	9(36%)

In this study, there was preponderance of right side 16(64%). According to author Wolfgang, the incidence on right side is more and according to author Hume &Wiss left is more.

Table 16: Incidence of different modes of injury

Study Series	No. of cases	Percentage
1. Jiang Xieyuan		
Traffic accident	9	60%
Fall from height	6	40%
2. Wolfgang G., et al.		
Fall	22	48.88%
Motor vehicle accident	20	44.44%
Direct blow	3	6.66%
3. Present study		
Road traffic accident	13	52%
Fall from height	11	44%
Assault	1	4%

In our study, majority of patients 13 (52%) sustained fractures due to Road traffic accident. According to Jiang Xieyuan series, the patients with traffic accidents were 9(60%) and patients with fall from height were 6 (40%). In Wolfgang *et al.*, series 22 (48.88%) patients were fall from height, 20(44.44%) were due to motor vehicle accidents, 3 (6.66%) were due to direct blow.

Table 17: Incidence of different type of Fracture

Study series	Number of cases	Percentage
1. Jiang xieyuan		
Oblique fracture	1	6.67%
Comminuted fracture	14	93.34%
2. Murphy <i>et al.</i> [11, 12]		
Transverse fracture	26	57.5%
Oblique fracture	12	26.7%
Comminuted fracture	7	15.6%
3. Present study		
Transverse fracture	14	56%
Oblique fracture	6	24%
Comminuted fracture	5	20%

In our study, 14 (56%) transverse fractures, 6 (24%) oblique fractures, 5 (20%) comminuted fractures were seen. In Jiang Xieyuan series, oblique fractures 1(6.67%) and 14 (93.34%) comminuted fractures were noted. In Murphy *et al.* study 26 (57.5%) transverse fractures, 12 (26.75%) oblique fractures and 7 (15.65%) comminuted fractures were reported.

Table 18: Incidence of Postoperative complications

Complications	Present study	Murphy <i>et al.</i>
Superficial infection	3 (12%)	0 (0%)
Symptomatic metal prominence	4 (16%)	3 (6.6%)

In our study, superficial infection was seen in 3 (12%) patients and was treated by broad spectrum antibiotics. The symptomatic metal prominence was reported by 4 (16%) patients and similar complication seen in 3 (6.66%) patients in murphy *et al.* series.

Table 19: Results in Percentage

Study series	Results in percentage			
	Excellent	Good	Fair	Poor
1. Murphy <i>et al.</i>	60%	10%	30%	0%
2. Jiang Xieyuan	53.33%	40%	6.66%	0%
3. Present study	72%	16%	12%	0%

The results were evaluated according to the Mayo elbow performance score. The results obtained in our study were excellent in 18 (72%) patients, good in 4(16%) patients, fair in 3(12%) patients and no poor results.

The results in our series is almost in accordance with other studies.

5. Conclusion

Based on our experience, it is concluded that the technique of open reduction and internal fixation with K-wires using the tension band wiring principle (for simple transverse and oblique fractures) is a gold standard technique in surgical management of olecranon fractures. 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. 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.

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