

# Comparison between the Usage of Tension band wiring versus hook plate in type II Mayo olecranon fractures in adults

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## Abstract

### Background

Olecranon fractures constitute a large proportion of injuries about the elbow. Several fracture patterns are recognized, with each pattern lending itself to a different treatment modality ranging from conservative treatment to fixation by different methods like tension band wiring, hook plate, intramedullary screw with or without tension and single Rush pin fixation. No single technique is suitable for the management of all olecranon fractures. In deciding how to treat this common trauma presentation, the surgeon needs a good understanding of the anatomy, different fracture morphologies, surgical options and potential complications. The goals of olecranon fracture management are to restore and maintain joint stability, articular congruity, strength, and a pain-free arc of functional elbow motion.

### Patients and methods

In the current study, thirty patients with olecranon fracture Mayo classification type II were surgically treated and followed up. The patients were selected by randomized closed envelop method and divided into two groups according to the method of surgical treatment: group I included fifteen patients treated by TBW and group II included fifteen patients treated by hook plate.

### Results

The age incidence ranged from 25 years to 58 years, the mean age of group I was  $42.8 \pm 10.60$  (range, 25-57) years. While in group II, the mean age was  $40.07 \pm 11.14$  (range, 27-58) years, 25 males were affected while 5 females were affected. No significant difference was found between the studied groups regarding the age, sex, side affected, occupation, mechanism of injury, associated injuries, time lapsed to surgery. All patients were followed up for six months and studied both clinically and radiologically according to the murphy scoring system as regards: pain, function, range of motion and radiological joint space. No significant difference was found regarding post-operative pain, function, ROM, radiological joint space and associated injuries in relation total score.

### Conclusion

A Significant difference was found between the age and total score in the two studied groups also between the studied groups regarding fracture classification in relation to total score and in group I the non-comminuted fractures in relation to total score and comminuted fractures in group II in relation to total score. The complications encountered in this study were superficial and deep infections, limited ROM, wire migration. Implant removal was done to 3 patients one plate for chronic infection and two TBW for limited ROM and hard metal prominence. Non-comminuted fractures showed better results in group I and comminuted fractures showed better results in group II.

### Keyword

Tension band, hook plate, Mayo olecranon fractures.

## Introduction

The elbow plays a critical role in the normal arm functioning. Complex fractures of the olecranon process of the ulna threaten the integrity of both the elbow and forearm joints. The treatment goals are to maintain a stable and anatomic reduction, realign the longitudinal axis of the olecranon process and enable immediate rehabilitation[1].

The olecranon process of the ulna enhances the stability and strength of the elbow. It is susceptible to direct injury, although indirect injury (caused by forces generated by the triceps while falling on a 90° flexed elbow) may be the most common cause of isolated olecranon fractures. They account for 7% of fractures in adult patients and 38% of all elbow fractures. When fractures are displaced, open reduction and internal

fixation is needed in order to realign the anatomic articular surface and restore normal elbow functioning [1].

The most popular classifications used to evaluate olecranon fracture are the Colton classification (1973) which depends on the displacement, Schatzker's classification (1987) considering mechanical issues related to the type of fixation required, AO classification (1987) which divides fractures according to articular involvement and superadded radial head fractures and the Mayo classification which is based on the degree of displacement, elbow joint stability and comminution [2-5].

Many methods have been used for fixation of olecranon fractures including non-operative methods and operative methods like tension band wiring, interfragmentary screws with or without wires, wires alone, plates, a single Rush pin and tension band, large intramedullary screws with or without tension bands, and bone fragment excision with reattachment of the triceps [6-10].

Mayo classification Type II can be treated by either tension band wiring or hook plate fixation techniques and can be applied effectively with good anatomical restoration of the bony fragments [11].

The most commonly used method of fixation of this type of fractures is the AO technique involving the use of a tension band and two intramedullary kirschner wires, the most common disadvantages are future need for hardware removal, wire migration, anterior interosseous nerve injury and impaired forearm rotation [11].

Plate and screws has been described for the treatment of olecranon fractures and recommended for comminuted fractures and oblique fractures. Advantages of hook plate fixation include favorable biomechanics as it acts as a tension band principle and as a buttress. In addition, hardware prominence is less problematic relative to tension band wiring fixation [12].

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## **Patients and methods:**

### **Patients:**

Thirty patients with type II mayo classification olecranon fracture were included in this study. They were divided into 2 groups:

**Group I:** Fifteen patients with type II mayo classification olecranon fracture fixed by tension band wiring.

**Group II:** Fifteen patients with type II mayo classification olecranon fracture fixed by hook plate.

All patients were operated upon at Menofia University Hospital and Kafr elDawar general hospital during the period from November 2016 to April 2017.

Patients were selected by randomized closed envelop method.

### **Inclusion criteria:**

Age between eighteen and sixty years, healthy patients with non-debilitating diseases, non-pathologic origin, closed fractures and type II Mayo classification (stable comminuted and non-comminuted fractures).

### **Exclusion criteria:**

Bleeding tendency, Other types of fractures than Type II Mayo classification, Vascular or neurological insults.

### **Methods:**

#### **1. Preoperative diagnosis and assessment:**

- History.
- Clinical examination.
- Radiological evaluation. For preoperative assessment of type of fracture and degree of displacement of the fragments, the anteroposterior and lateral views of the elbow were obtained.

#### **2. Methods of treatment:**

All patients were treated by open reduction and internal fixation by using tension band wiring or hook plate .

#### **First aid treatment:**

- The fractured limb was splinted in long posterior arm slab till time of surgery.
- Analgesic and anti-edematous drugs were given as required.
- Patients then were admitted and scheduled for surgery.

#### **Anaesthesia:**

General anesthesia was used for all the patients.

#### **3. Basic procedures in both technique:**

All patients were positioned in the lateral decubitus position, the arm was draped freely over a padded arm support attached to the operating table. Single dose of prophylactic antibiotic (Cefotaxime) was given to all

patients before the tourniquet. A tourniquet was applied and inflated (Fig 1).



**Figure 1:** Lateral decubitus position

Posterior approach to the elbow was performed in all patients, using a midline skin incision starting 2.5 cm above the olecranon. The incision curved radially to avoid placing the incision directly over tip of the olecranon process (Fig 2).



**Figure 2:** Posterior approach to the elbow

Fracture exposure with close inspection of the articular surface and elevation of the impacted fragments, aiming for joint surface realignment. The reduction was maintained using bone clamps (Fig 3).



**Figure 3:** Reduction maintained by bone clamp

#### **A) Tension band wiring:**

Basic requirements of this technique include a power drill, two 2mm Kirschner wires, 1mm stainless steel soft wire. Two small incisions were done in the triceps aponeurosis to facilitate wire introduction.

Two Kirschner wires were applied passing toward or the anterior cortex of ulna and distal to coronoid process (Fig 4).



**Figure 4:** Two Kirschner wires applied passing towards anterior cortex.

A 2.5mm transverse hole was drilled in the posterior cortex of the distal fragment about 2 cm from the fracture site.

Approximately 40 mm distal to the fracture line and 5 mm from the posterior cortex, a drill hole through the ulna with a 2.0 mm drill.

One mm stainless steel wire was passed through the transverse hole then crossed over the posterior surface of the olecranon in a figure of eight loop passing through the triceps aponeurosis adjacent to bone and posterior to the Kirschner wires (Fig 5).



**Figure 5:** Figure of eight loop TBW

The free ends of the stainless steel wire were tight-

ened together. The proximal ends of the Kirschner wires were bent 180 degrees and buried beneath the triceps fibers to avoid soft tissue irritation.

- After internal fixation, elbow motion was tested clinically and under fluoroscopic imaging if possible to ensure stable ulnohumeral and radio-ulnar articulation (Fig 6).
- Closure of the subcutaneous layer and skin was done.
- Sterile Dressing and above elbow back slab were applied.



**Figure 6:** Elbow motion is tested intra-operatively.

**B) Dorsal plating using pre-contoured hook plate:**

- Basic requirements of this technique include a small set, precontoured hook plate with variable length, full set of 3.5mm cancellous (fully threaded and partially threaded) and cortical screws.
- The insertion of the triceps tendon was incised to fit the hook of the plate for optimal positioning of the implant to the proximal part of the olecranon.
- The hook plate was applied over the tip of the olecranon with the hook to be inserted by gentle hammering (Fig 7).



**Figure 7:** Hook plate applied over the tip of the olecranon.

- For simple fractures, compression was applied, while for comminuted fracture only buttressing the fracture after restoring its length and alignment was done.
- Starting by the first hole proximally, a long cancellous fully threaded or partially threaded was applied, and then the remaining holes were inserted after proper drilling and tapping by cortical screws with variable length (Fig 8).



**Figure 8:** Fracture was reduced and plate was applied.

- Position of the plate has to be controlled in full elbow extension to avoid impingement of the olecranon fossa (Fig 9).



**Figure 9:** Position of the plate controlled in full elbow extension.

- After internal fixation, elbow motion was tested clinically and under fluoroscopic imaging if possible to ensure stable ulnohumeral and radio-ulnar articulation.
- Closure of the subcutaneous layer and skin was done (Fig 10).
- Dressing and above elbow back slab was applied.



**Figure 10:** Closure of the subcutaneous layer and skin.

#### 4. Postoperative care and assessment:

- All patients were examined for vascular and neurological status antibiotics, analgesics and anti edema medications were prescribed.
- Check X-ray were obtained to assess reduction and position of the implant.
- Patients were kept in hospital under observation for one or two days according to improvement of his medical status.

#### Follow up:

The stitches and the above elbow slab were removed after 2 weeks, After removal of stitches gentle active exercises were started gradually as long as the wound had healed, X-ray (anteroposterior and lateral) views were obtained after 4,8, 12 weeks, and then at the end of the follow up.

At the end of the 6 month follow up, patients were assessed as regards pain, function and range of motion graded on five point scale.

#### Statistical analysis:

Two types of statistical analysis were done:

- Descriptive statistics :e.g. percentage (%),mean and standard deviation(SD).
- Analytic statistics: e.g. Mann-Whitney test (Kruskal-wallis test, Fisher's Exact or Monte Carlo correction, marginal homogeneity test, Wilcoxon signed ranks test and chi-square Test.

P-value of <0.05 considered statistically significant.

## Results

The age of patients involved in this study from 25 to 58 years .The mean age of group I was  $42.8 \pm 10.60$  (range, 25-57) years. While in group II, the mean age was  $40.07 \pm 11.14$  (range, 27-58) years.

Among the 30 patients (25 males 80.3% ad 5 females 16.7%) involved in this study , 13 patients were males and 2 patients were females in group I, and 12 patients were males and 3 patients were females in group II.

Eleven fractures were in the right side and four in the left , in group I and ten fractures were in the right side and five fractures in the left in group II.

Light workers were five patients in both groups while hard workers in group I were three and in group II were four, moderate workers were five in group I and four in group II, there were two housewives in both groups.

Two patients with direct injury, seven patients with indirect injury and six patients with combined injury in group I. four patients with direct injury ,six patients with indirect injury and five patients with combined injury group II.

In group I eight patients had swelling and seven patients didn't develop swelling. In group II nine patients developed swelling and six patients didn't develop swelling.

In group I, five patients had no associated injuries and ten patients had associated injuries in the form of four patients had head injuries and post-concussion syndrome, one patient had shoulder dislocation and three patients had intra-abdominal mild collection and two patients with multiple contusions and abrasions . In group II, nine patients had no associated injuries and six patients had associated injuries in the form of two patients had head injuries developed post-concussion syndrome and one patient had contralateral calcaneus fracture and three patients of multiple abrasions and contusions and cutting wounds.

Fractures were classified according to mayo classification of olecranon fracture. In group I eight patients had comminuted fracture and seven patients had non comminuted fractures. In group II, nine patients had comminuted fractures and six patients had non comminuted fractures.

Patients who had loss of extensor mechanism in group I were six and patients who didn't loss were nine while in group II were five patients who had loss of extensor mechanism and ten who didn't have loss

extensor mechanism.

Time lapse less than 2 days in group I was 7(46.7%), time from 2-5 was 5(33.3%) and time more than 5 was 3(20%). While in group II was 8(53.3%), 5(33.3%) and 2(13.3%) respectively (table 10).

According to sex: there was no significant difference between the two studied groups regarding sex (P value 0.465).

There was non-significant difference between two studied groups regarding to side (P = 0.5).

A non-significant difference was found between the two groups regarding occupation (P value = 0.4342).

Regarding the mechanism of injury, there was a non-significant difference (P value =0.2364) between patients of both groups.

A non-significant difference was found between two groups regarding fracture classification (P value = 0.360).

Regarding the swelling, there was a non-significant difference (P value =0.362) between patients of both groups.

According to time lapse; there was a non-significant difference (P value =0.3192) between patients of both groups.

A non-significant difference was found between two groups regarding post-operative pain assessment (P value = 1); Patients without pain were higher in both groups with the same ratio 8(53.3%) followed by patients with pain with routine activity also in both group with the same ratio 4(26.7%).

Regarding to range of motion Flexion contracture Further flexion Loss of rotation; A non-significant difference was found between two groups (P value = 0.4035).

According to total Murphy et al. score; there was no significant difference between the two groups (P value = 0.4582). The mean score of group I was  $16.6 \pm 1.55$  (range, 213-19). While in group II, the mean score was  $16.5 \pm 1.88$  (range, 12-19).

Concerning total score according to Murphy et al. score ; there was significant difference between age and total score in the two studied groups (P value = 0.0465, 0.032). In group I, satisfactory patients ranged from 25-57 with mean value  $41.8 \pm 10.74$  and unsatisfactory ranged from 42-56 with mean value  $49.0 \pm 9.9$ . In group II, satisfactory patients ranged from 27-56 with mean value  $38.1 \pm 10.23$  and unsatisfactory ranged from 33-58 with mean value  $48.0 \pm 13.22$ .

There was non-significant difference in the two studied groups regarding sex in relation to total score (P = 0.743, 0.484).

There was non-significant difference in the two studied groups regarding Mechanism of injury in relation to total score (P = 0.831, 0.60).

Concerning fracture classification; there was significant difference in the two studied groups regarding fracture classification in relation to total score (P value = 0.05, 0.044).

The comparison between the net result of comminuted and non-comminuted fractures in group I and II, the comminuted fractures show better results in group II in comparison to group I, in group I the final score was  $15.88 \pm 1.64$  S.D, while in group II was  $17.33 \pm 1.00$  S.D, on comparing the two group regarding final score it was found that the comminuted fractures in group II had better results than group I. On the other hand in non-comminuted fractures group I show significant increase in final score than group II, in group I the final score was  $17.43 \pm 0.98$  S.D, while in group II was  $15.33 \pm 2.34$  S.D, there was a significant increase in group I than group II.

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## Discussion

The olecranon process of the ulna enhances the stability and strength of the elbow. It is susceptible to direct injury, although indirect injury may be the most common cause of isolated olecranon fractures. Non-displaced fractures may be treated either symptomatically with 7 to 10 days immobilization by arm sling in midflexion and neutral forearm rotation or with immobilization in a long arm cast 3 to 4 weeks, both followed by initiation of an active range of motion program and follow up 6 to 8 weeks[13].

Because all displaced olecranon fractures are intra-articular injuries, open reduction and internal fixation is needed and considered to be the gold standard treatment for olecranon fracture [1, 14].

The method of internal fixation is chosen based primarily on fracture type. The most commonly used classification between surgeons is the Mayo classification of olecranon fractures which is based on three variables: displacement, stability, and comminution [15].

Classically, the tension band wire has been used for only simple displaced fractures, whereas plates and screws have been employed for fixation of more comminuted fractures in order to prevent over com-

pression of the articular surface but yet an issue of controversy [16].

Mayo classification Type II (displaced comminuted and no comminuted) can be treated by either tension band wiring or hook plate fixation techniques and can be applied effectively with good anatomical restoration of the bony fragments[17].

This study is focused on type II Mayo's olecranon fractures. This method of classification is easier for decision making for the method of treatment and allows to categorized the patients according to the presence of comminution which allowed comparing the results of hook plate and tension band wiring . The Results of this study were assessed at the end of the follow up using the Murphy elbow score which Includes pain , function ,range of motion and radiological joint space [18].

In this study, twenty five patients were males (83.3%) and five females (16.7%) showed a non-significant difference between sex in both groups. In another study, males were more than females, as they are more active and more liable to trauma, though there was non significant difference between them as regard the final score [19].

**Sui and Fang** [20] compared the effects of olecranon plate and tension band in the treatment of olecranon fracture in 63 patients, mean age 49 years, 28 patient treated by plate and 35 patient by tension band, Results were excellent and good in 27 plate patients and in 33 tension band patients. So conclusion was that both olecranon plate and tension band are effective treatments for olecranon fractures and younger patients showed better results also the mean age in the study of Powell et al. in 2017 for proximal ulnar fractures the mean age was 57, (range 15–97) years. Male patients were significantly younger than their female counterparts and showed better results.

A significant difference between age and total score was seen in this study between the two groups as the satisfactory patients in group I mean 41.1 (range 25-57) years with unsatisfactory patients mean 49.0 (range 42-56) years while in group II satisfactory patients mean 38.1 ( range27-56) years with and unsatisfactory mean 48.0 (range 33-58) years.

**Hume el al.** [21] in a prospective study comparing between TBW and plate fixation showed that pain with movements was commonly seen with TBW (42%) than plates (5%) although they thought it was avoidable by good surgical techniques. In the contrary, **Schliemann et al.** [11] in the study of 26 patients with mayo type II olecranon fractures comparing the results of TBW and plate fixation, showed no

significant relation in pain within the two groups.

In this study, there was no significant difference between the two groups regarding pain and the no one of the patients did experience pain with routine activity going with **Schliemann et al.**[11] study.

**Finsen et al.** [22] in their study of 31 patients of olecranon fractures treated using AO tension band had 29 good (satisfactory) and 2 fair (unsatisfactory) clinical functional results in which the construct failed and needed replacement.

Regarding elbow function, this study revealed a non significant difference between the two groups in a 6 month follow up period and the unlimited elbow function was high in both groups (66.7%) in group I and (53.3%) while three patients from group I and five patients in group II had avoidance of heavy lifting and throwing and were satisfied.

**Schliemann et al.**[11] concluded that range of motion did not differ significantly between the two groups of TBW and plate fixation also same as the study of **DelSole et al.** [17] which stated that similar good-to excellent elbow range of motion are resulted in both methods of fixation.

In this study, the range of motion had a non-significant difference between the two groups agreeing with the previous two studies.

**Anderson et al.** [23] in 2007 using the same scoring system reported their experience with plate treatment of olecranon fractures and found no significant difference in comminuted and simple fractures and found that congruent anatomic plating is a safe, effective option for the treatment of olecranon fractures.

**Khann** [24] in his study comparing tension band wiring and reconstruction plating in olecranon fractures 13 patients (86%) showed excellent and good results while 2 patients (13.3%) had unsatisfactory outcome in group a with TBW was compare to 14 patients (93.3%) showed excellent and good results while only 1 patient (6.7%) had unsatisfactory outcome in with 3.5 mm reconstruction plate fixation.

In this study, according to **Murphy el al.**[8] score, there was a non-significant relation between the two groups satisfactory patients in group I 13 patients (86.7%) and in group II were 12 (80%) concluding the efficacy of both methods of elbow fixation with high rate of satisfactory patients.

**Schliemann et al.**[11] concluded that TBW is still a preferable surgical method to treat simple non-comminuted isolated olecranon fractures.

**Delsole et al.**[17] documented usage of TBW on several Mayo II fractures with no complication in clinical or functional outcomes. These results suggested that TBW could be used in selected comminuted fractures as long as anatomic reduction can be achieved and confirmation is obtained intra-operatively that over-compression of the articular surface does not occur.

In this study, in group I fixed by TBW non comminuted fractures showed a significant increase in final score ( $17.43\pm 0.98$ ) and in the comminuted fracture ( $15.88\pm 1.64$ ) agreeing with all previous studies recommending TBW in non-comminuted fractures.

**Erturer et al.** [25] in a retrospective study 18 patients recommended plate-and-screw osteosynthesis for comminuted fractures to ensure more stable fixation, to provide accurate joint restoration, and to prevent loss of elbow range of motion.

**Schliemann et al.** [11] concluded that fixation with plating does not provide better functional and radiographic outcome but is more expensive than TBW and preserved to comminuted fractures.

In this study, in group II fixed by hook plate comminuted fractures showed a significant increase in final score ( $17.43\pm 1.0$ ) while non-comminuted ( $15.33\pm 2.34$ ) agreeing with **DelSole et al.** [17] in recommending plate fixation in comminuted fractures. They stated that hardware removal was more common among those receiving TBW also acknowledged that some patients with symptomatic hardware did not report back for removal.

In this study, the follow up period was 6 months and removal was done for one patient treated with hook plate due to infection after 6 months also three patients with TBW each for a different reason one for limited ROM and another for wire migration and the third one was for cosmetic reasons.

The study limitations were Limited number of patients included and the follow up period did not cover all possible complications specially the rate of removal.

Future recommendations are increasing number of patents in future studies, Comparing other methods for olecranon fixation, retrospective study for patients done by different surgeon in different trauma centers and assessment of the elbow function by different scoring system.

## Conclusion

Age is strongly related to final total score younger patients showed better results.

Fracture classification is directly related to total score .

Non comminuted fractures showed better results in group I and comminuted fractures showed better results in group II.

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