CROSSING SCREWS VERSUS TENSION BAND WIRING FOR TREATMENT OF ISOLATED NON-COMMINUTED OLECRANON FRACTURE

[1]Eslam Saeed El-Sayed, [2]Abd-Elsalam Mohammed Hefny,[3] Ashraf Abd-Eldayem,[4] Ahmed Mashhour Gaber

[1]Orthopaedic Surgery Department, Faculty of Medicine, Zagazig University, Egypt.

Corresponding author: Eslam Saeed El-Sayed, Email: Eslam.orthopedic@gmail.com

ABSTRACT

Background: Olecranon fractures are one of the most common and severe upper- extremity injuries. Many methods have been described for fixation of olecranon fractures including the tension band wiring (TBW) and Crossing Screws. The aim of the present study was to comparing crossing screws fixation to the gold standard, TBW in treating isolated non-comminuted olecranon fractures by assessing clinical, radiological and functional results. **Patients and Methods:** This study included 18 patients with displaced olecranon fracture Mayo's type IIA were incorporated in an interventional prospective comparative study.Patients included in this study were divided into two groups according to the method of treatment. Each of which comprised 9 patients, we kept using the crossing screws technique for the first 9 patients presented to us before moving to the traditional TBW technique for the next 9 patients. A detailed history, clinical and radiological assessment were performed. The functional evaluation of the surgically treated elbow was determined based on the Mayo Elbow Performance Score (MEPS). **Results:** Time between time between injury and surgery; Group A was significantly longer as it was distributed as 83.22±24.76 and11.11±3.48 respectively. Operation time was significantly longer among Group A and length of surgical incision also was significantly longer in Group A. Time of union was significantly shorter among group. No significant difference between groups detected. At the end of follow-up, no loss of reduction was observed. Stable fixation permitted early exercises and excellent and good functional recovery in all patients. **Conclusion:** PC or mini-open transcortical crossing screws for simple olecranon fractures provide a mini-invasive, safe fastening that enables early healing with excellent outcomes.

Keywords: Tension Band Wiring ; Olecranon Fracture; MEPS; Crossing Screws

INTRODUCTION

Olecranon fractures are one of the most common and severe upper- extremity injuries,these fractures account for approximately 10% of upper extremity fractures,and resulting from trauma, whether direct or indirect **(1).** Direct injuries typically result from a fall that affects the proximal forearm's dorsal aspect, while on the other hand indirect trauma may lead to impaction of distal aspect of the olecranon into the trochlea during fall on out-stretched hand **(2)**. Displaced olecranon fractures require open reduction and internal fixation since they are intra-articular fractures that require anatomical reduction and early mobilization **(3)**.

Many methods have been described for fixation of olecranon fractures including thetension band wiring (TBW) which is the standard treatment for fixation of minimally displaced non comminuted olecranon fracture, while the other modalities are available asplates,inter-fragmentary screws with or without wires, wires alone,large intramedullary screws with or without tension bands, and bone fragment excision with triceps reattachment **(4)**. It has been stated that an ideal system should avoid discomfort or migration of metalwork problems, avoid the risk of damaging anterior structures, have a low complication rate, be easily reproducible by various surgeons, have equal, if not superior, union and function rates and be cost-efficient **(1)**.

TBW will turn the tensile forces in the joint line at the side of the system into compressive forces. This is a simple and inexpensive method.however, there are reports of wire-related pain or wiring migration off the ulna resulting in inflammation or deterioration of the skin **(5)**.

A mini-invasive way of stable fixation, which respects the biological factor, has been defined to enable compression at the fracture site with counteraction to the tension forces generated at the fracture site and functionally allow direct union without excessive callus formation to allow early and complete return of function with low risk of post-traumatic elbow arthritis. Ali, Mohamed theory was that the transcortical cannulated partly threaded screws mounted cross-sectionally in the view of the anteroposterior (AP) and almost perpendicular to the lateral view of the fracture site would give these benefits **(6,7)**.

The current study aimed to comparing crossing screws fixation to the gold standard, TBW in treating isolated non-comminuted olecranon fractures by assessing clinical, radiological and functional results.

PATIENTS AND METHODS

This study included 18 patients with displaced olecranon fracture Mayo's type IIA were incorporated in an interventional prospective comparative study. Patients included in this study were divided into two groups according to the method of treatment. Each of which comprised 9 patients, we kept using the crossing screws technique for the first 9 patients presented to us before moving to the traditional TBW technique for the next 9 patients. All patients were consented and asked to volunteer for the study and the ethical committee of the hospital was asked for the approval for this study.

Inclusion criteria:

All patients diagnosed as isolated non-comminuted type II-A fractures as per Mayo clinic classification, closed or types I &II open fractures as per Gustillo and Anderson classification, and in the age group between 20-60 years.

Exclusion criteria:

Patients with types I and III olecranon fracturesas per Mayo clinic classification, type III open fracturesas per Gustillo and Anderson classification, pathological fractures, previous proximal ulna fracture with malunion or elbow stiffness.

Patients' demographic data were collected using case notes There were 12 males and 6 females with 18 involved elbows (10 left & 8 right). The mean age at presentation was 30.61 years (20 – 50 years). The mean follows up period was 6.72 months (3- 10 months).

Clinical assessment:

A detailed history, clinical and radiological assessment were performed. Pre-operative, immediate post-operative and serial follow-up of traditional radiographs of affected elbows was performed. All patients had standard antero posterior and lateral elbow radiographies.

Surgical techniques:

I.Tension band wiring technique: (8)

All surgeries were performed under general anesthesia and with pneumatic tourniquet are applied after the limb has been exsanguinated. The incision is curvilinear to minimize the painful scar over the tip of the olecranon. Full thickness flaps are formed and retracted on both sides of the olecranon. A direct reduction is performed with a reduction clamp. The first 1.6 mm K-wire was medially introduced through the head of the olecranon using the drill guide. For the second K-wire, we must leave enough space on the lateral side. The K-wire was then cut 2 cm from the bone obliquely. In the same way as the first one, the second K-wire was cut. A 1.0 mm wire was prepared along its length by making a loop of approximately one third. By further twisting, the slack was then taken up and the process was repeated until the desired tension was achieved. The two fragments are

ISSN: 0975-3583, 0976-2833 VOL 12, ISSUE 03, 2021

drawn together by tightening the twist and the loop with two wires simultaneously, so that the fracture is put under compression **(Figure 1)**.

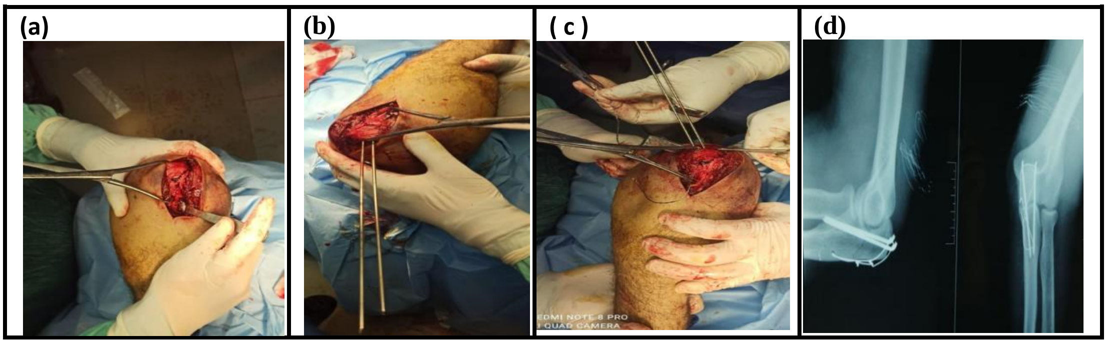

Figure (1): Surgical Tension band wiring technique; (a) reduction of the transverse olecranon fracture was hold with a small point reduction clamp ; (b) wire insertion; (c)1 mm wire was inserted through holemade 4mm distal to the fracture line; (d) the wire was twisted around K-wire in figure of eight.

II. Crossing screws technique: **(9)**

All surgeries were performed under general anesthesia. Patients were in lateralposition with the arm draped over a bolster attached to the operating table. We typically aim to achieve closed fracture reduction and the reduction is maintained using small point reduction forceps. A reference K-wire was inserted into the olecranon central in the AP view and in the lateral view after the reduction was achieved. in the AP view, they tend to cross so that the one that began near the medial cortex is aimed at the lateral cortex and vice versa to be parallel to the reference wire or have slight crossing in the lateral view. The reference wire will be removed after assurance of their position, and then the other wires was replaced by two partially threaded 4.0 -mm cannulated screws with washers **(Figure 2)**.

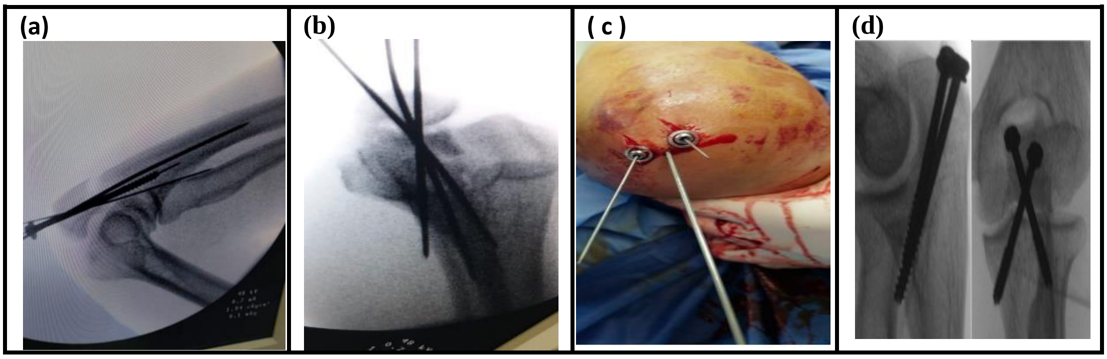

Figure (2): Surgical **crossing screws** technique; (a) C-arm image showing the A reference K-wire was inserted into the olecranon central in the AP view and

in the lateral view; (b) C-arm image showing the position of the two wires in AP; (c &d) other wires was replaced by two partially threaded 4.0 -mm cannulated screws with washers.

Postoperative follow up:

The elbow will be secured in a removable splint flexed to 90 ° to rest the injured zone and aid in the healing of soft tissue. An x-ray will be performed at 4 weeks postoperative and if the fixation remains stable without fracture gap, the rehabilitation phase was started based on passive stretching and reinforcement under the supervision of occupational therapist.

Elbow outcome measures:

The operating time and intra-operative blood loss, and all parameters were reported at the end of the operation. AP and lateral elbow radiographs were taken directly after surgery and at 4, 8, 12 weeks, 6 and 12 months postoperatively, and finally at the end of the follow-up operation. The quality of the reduction, union and position of the implant will be measured. The elbow's range of motion (ROM)

ISSN: 0975-3583, 0976-2833 VOL 12, ISSUE 03, 2021

was measured using the universal goniometer (ShanghaiXinman Scientific Equipmenti, China). Clinical outcomes of all patients after one-year post-operative. The functional evaluation of the surgically treated elbow based on the Mayo Elbow Performance Score (MEPS) , which total score was graded as excellent (≥ 90 points), good (75 –89 points), fair (60 – 74 points), or poor (< 60 points) **(8)**.

Statistical analysis:

Data analyzed using Microsoft Excel softwar and imported into Statistical Package for the Social Sciences (SPSS version 20.0) software for analysis. According to the type of data qualitative represent as number and percentage, quantitative continues group represent by mean ± SD, the following tests were used to test differences for significance; difference and association of qualitative variable by Chi square test (X2). Differences between quantitative independent groups by t test. P value was set at <0.05 for significant results & <0.001 for high significant result.

RESULTS

We studied 18 cases of Isolated Non-Comminuted Olecranon Fracture with mean age 30.61±9.85 with minimum 20 and maximum 50 years, majority were male with 66.7% and female 33.3%, right side 44.4% and left side 55.6% and we followed them up for 8.72±1.36 with minimum 6 and maximum 11 months allocated in two groups: Group A: Tension Band Wiring; Group B: Crossing Screws. Regarding time between time between injury and surgery; Group A was significantly longer as it was distributed as 83.22±24.76 and11.11±3.48 respectively **(Table 1)**. Operation time was significantly longer among Group A and length of surgical incision also was significantly longer in Group A **(Figure 3,4)**. Time of union was significantly shorter among group **(Table 2)**. No significant difference between groups detected **(Table 3)**.

Table 1: Time between injury and operative distribution between studied groups

	Group A	Group B	t	P
Time between injury operative interference/hours	83.22±24.76	11.11±3.48	8.528	0.00**

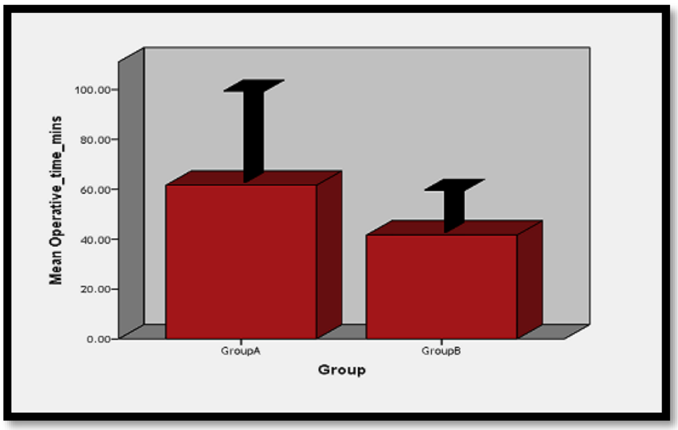

Figure (3): Mean operation time between studied groups

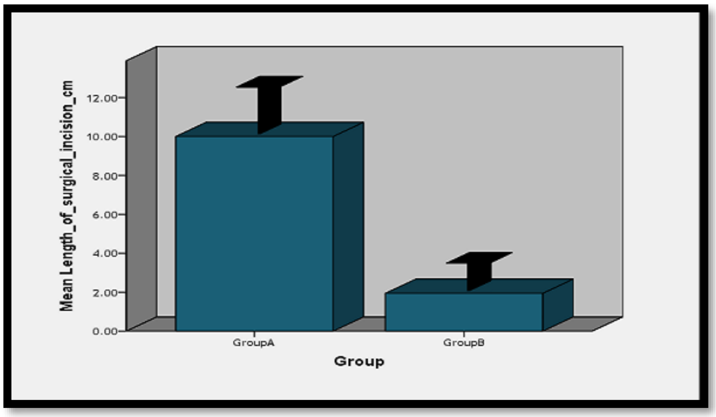

Figure (4): Mean length of surgical incision between studied groups

Table 2: Union time distribution between studied groups

	Group A	Group B	t	P
Time union/weeks	15.44±3.12	10.33±2.06	4.094	0.001**

Table3: overall outcome distribution between studied groups

			Group		X^2	P
			Group A	Group B		
Results	Excellent	N	4	7	2.48	0.28
		%	44.4%	77.8%		
	Fair	N	1	0		
		%	11.1%	0.0%		
	Good	N	4	2		
		%	44.4%	22.2%		
Total		N	9	9		
		%	100.0%	100.0%		

DISCUSSION

This study had some limitations including the limited numberof patients, the patients were not matched neatly, the used techniques are not suitable to treat all types of olecranon fractures, and the follow-up was not long enough to investigate for the development of post-traumatic osteoarthritis.

Being an intra-articularfracture, anatomical restoration of the articular surface is mandatory in olecranon fractures. If obtained, the mode of fixation that maintains the reduction is controversial. This controversy arises from the need for stable fixation to allow for early ROM exercises and rapid functional improvement **(11)**.

This study has addressed a specific non-comminuted fracture type. However, other fracture configurations and combinations do exist and these types of fixation may not be applicable for which. This may not weaken the validity of this study, because itcovers a big category of patients with non-comminuted olecranon fractures for which the claimed gold standard, TBW, was only used. With the introduction of the new option, crossing screws, better overall results were obtained.

Minimally invasive surgery gained growing field in the orthopaedic surgery as it minimizes the surgical trauma, carries minimal disturbance to the fracture hematoma, and preserves the soft tissue envelope and the blood supply of the fracture fragments, as proved by vascular injection studies **(12)**. This correlates with this study, where the mean length of surgical incisions was significantly shorter with screws 1.94±0.65 versus 10.0±1.22 cm (P< 0.001*) and may explain the less incidence wound problems in the patients treated with PC or mini-invasive screw fixation.

Although TBW was considered as the gold standard in the treatment of transverse olecranon fractures **(13)**, its principle of converting the tension into compressiveforces **(14,15)** has no data to support it, and was recently reported to be questionable **(16-18)**.

Fyfe et al **(19)** concluded that TBW provided more stable fixation than intramedullary or plate fixation in transverse olecranon fractures. But this may be questionable as they used the weak one-third tubular plates and they defined stability as resistance to fracture displacement when a fixed force was applied to the fixation construct, which is not equivalent to measuring the compression between the fragments **(20)**.

On the contrary, **Wilson et al. (16)** reported that plate fixation provides significantly greater compression of transverse olecranon fractures than does TBW, both over the whole surface of the fracture (approximately 2 to 24 times) and also over the anterior half adjacent to the articular surface. Their study has shown that TBW produces negligible compression of the fracture at the articular side, where primary cortical healing is especially desirable.

With crossing screws direct fracture compression was noticed intra-operatively in open cases and with C-arm in PC ones. Also, Theoretical imagination of the effect of triceps contraction will lead to dynamic compression of the fracture, not distraction, as each screw will pull in a nearly perpendicular line to the other. But this necessitates good cortical engagement of the screws and need to be proved biomechanically. This suspected dynamic compression may also help in faster direct fracture healing. In this study, the mean time to radiographic union was shorter with screws 10.33±2.06weeks versus 15.44±3.12weeks with TBW which was statistically significant (P < 0.001*).

The subcutaneous nature of the proximal ulna demonstrated a problem in relation to hardware prominence, skin-related complications, migration, and the high rate of secondary surgeries for implant removal **(14)** that reached up to 20 % with plates **(6)** and 87 % with TBW **(1,8)**. This correlates with our study, as the screw fixation has a low profile and was not prominent. Only 1/8 (11.1 %) hardware removal in the screws group versus 3/9 (33.3 %) in the TBW group was required in our patients. Penetration of the anterior cortex of the ulna by K-wires used with TBW was thought to reduce the risk of K-wire migration, but this was associated with many risks such as ulnar artery or anterior interosseous nerve injuries and impaired forearm rotation **(21)**.

At the end of follow-up, no loss of reduction was observed. Stable fixation permitted early exercises and excellent and good functional recovery in all patients. All the patients could keep the original job and the preoperative level of activity and sports. In addition to being cheap and available all over the world, transcortical crossing screws allow biomechanical, biological, and functional advantages over the TBW.

CONCLUSION:

PC or mini-open transcortical crossing screws for simple olecranon fractures provide a mini-invasive, safe fastening that enables early healing with excellent outcomes.

We recommend a comparative biomechanical study, and a bigger randomized multicenter prospective study before standardization of the crossing screws technique.

No conflict of interest.

References:

1- von Keudell, Arvind, et al. "Biomechanical properties of an intramedullary suture anchor fixation compared to tension band wiring in osteoporotic olecranon fractures-A cadaveric study." Journal of orthopaedics 17 (2020): 144-149.

2- Lavigne, Gregory, and Mark Baratz. 2004. “Fractures of the Olecranon.” Journal of the American Society for Surgery of the Hand 4(2):94–102.

3- Bosman, Willem Maarten P. F., Benjamin L. Emmink, et al., 2020. “Intramedullary Screw Fixation for Simple Displaced Olecranon Fractures.” European Journal of Trauma and Emergency Surgery 46(1):83–89.

4- Rana, Dr. Haresh, Dr. Kerul Ninama, et al ., 2020. “A Clinical Study of Surgical Management of Olecranon Fractures.” National Journal of Clinical Orthopaedics 4(1):33–38.

5- Gruszka, Dominik, Charlotte Arand, et al., 2015. “Olecranon Tension Plating or Olecranon Tension Band Wiring? A Comparative Biomechanical Study.” International Orthopaedics 39(5):955–60.

6- Ali, Mohamed. 2015. “The Role of Crossing Screws as a Mini-Invasive Treatment for Isolated Non-Comminuted Olecranon Fractures.” European Orthopaedics and Traumatology 6(3):211–18.

7- Hachem, Bahe. 2016. “Scoliosis and Assessment of a New Dual-Epiphyseal Growth.”

8- Jockheck, Michael, DankwartHöntzsch, and Klaus Brettschneider. "Tension band wiring for olecranon fractures." Orthopedics and Traumatology 4.3 (1995): 150-157.

9- Ali, Mohamed. "The role of crossing screws as a mini-invasive treatment for isolated non-comminuted olecranon fractures." European Orthopaedics and Traumatology 6.3 (2015): 211-218.

10- Wiegand, Laura, Joseph Bernstein, and Jaimo Ahn. "Fractures in brief: olecranon fractures." Clinical Orthopaedics and Related Research® 470.12 (2012): 3637-3641.

11- Hume MC, Wiss DA. Olecranon fractures. A clinical and radiographic comparison of tension band wiring and plate fixation. Clin OrthopRelat Res 1992;285:229–35.

12- Farouk O, Krettek C, Miclau T, Schandelmaier P, Guy P, Tscherne H (1999) Minimally invasive plate osteosynthesis and vascularity: preliminary results of a cadaveric injection study. Injury 28:A7–A12.

13- Chalidis BE, Sachinis NC, Samoladas EP, Dimitriou CG, Pournaras JD (2008) Is tension band wiring technique the “gold standard” for the treatment of olecranon fractures? A long-term functional outcome study. J OrthopSurg Res 3:9.

14- Wu CC, Tai CL, Shih CH (2000) Biomechanical comparison for different configurations of tension band wiring techniques in treating an olecranon fracture. J Trauma 48:1063–1067.

15- Hutchinson DT, Horwitz DS, Ha G, Thomas CW, Bachus KN (2003) Cyclic loading of olecranon fracture fixation constructs. J Bone Joint Surg Am 85-A:831–837.

16- Wilson J, Bajwa A, Kamath V, Rangan A (2011) Biomechanical comparison of interfragmentary compression in transverse fractures of the olecranon. JBJS 93-B:245–250.

17- Veillette CJH, Steinmann SP (2008) Olecranon fractures. Orthop Clin N Am39:229–236.

18- Jones TB, Karenz AR, Weinhold PS, Dahners LE (2014) Transcortical screw fixation of the olecranon shows equivalent strength and improved stability compared with tension band fixation. J Orthop Trauma 28(3):137–142.

19- Fyfe IS, Mossad MM, Holdsworth BJ (1985) Methods of fixation of olecranon fractures: an experimental mechanical study. J Bone Joint Surg (Br) 67-B:367–372

20- Anderson ML, Larson AL, Merton SM, Steinmann SP (2007) Congruent elbow plate fixation of olecranon fractures. J Orthop Trauma 21(6):386–393.

ISSN: 0975-3583, 0976-2833 VOL 12, ISSUE 03, 2021

21- Parker JR, Conroy J, Campbell DA (2005) Anterior interosseous nerve injury following tension band wiring of the olecranon. Injury 36:1252–1253.