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Original article

Comparative Study between Intramedullary Screw versus Tension Band wiring Fixation for Simple Displaced Olecranon Fractures

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Abstract

The goal of this study is to evaluate both functional and radiological outcomes in olecranon fractures management with both techniques; intramedullary screw and tension band wiring. 30 patients, with olecranon fracture mayo type IIA, were randomly grouped into two groups, 15 in each group. Group 1: fixed by intramedullary screw and group 2: fixed by tension band wiring. By comparison between types of fixation, regarding post-operative complication (loss of elbow motion, infection, loss of reduction, delayed or non-union and pain during movement) there was no statistically significant difference between types of fixation, but there was statistically significant increase hardware removal in K-wires method. Olecranon fracture fixation with intramedullary screw was as effective as K-wire with tension band in simple displaced olecranon fractures (Mayo type IIA) regarding functional and radiological outcomes. The complication rate was higher following K-wire fixation method due to a higher rate of implant removal in symptomatic patients.

1. Introduction:

The Olecranon fractures are common skeletal injuries, accounting for approximately 10% of upper extremity fractures in adults. Patients usually present after a fall on the affected arm. Swelling and tenderness is present at the fracture side. Olecranon avulsion fractures can occur by several mechanisms. In patients who have osteoporotic bone forceful eccentric contraction of triceps may result in olecranon avulsion fracture .additionally, a direct blow with the elbow slightly flexed can cause an olecranon fracture. With displaced fractures inability to move the forearm against gravity is noted. [1]

The Mayo classification is based on whether these fractures are stable or unstable, comminuted or non-comminuted, and displaced or undisplaced. Operative fixation is usually recommended for displaced fractures to restore the function of triceps muscle and allow for smooth movement of the trochlea in the trochlear groove of the olecranon. Type I (undisplaced) fractures with no displacement after 90 degrees of flexion can be treated by splinting and symptomatically. Type IIa (Non-comminuted displaced stable) fractures are treated surgically. Chevron olecranon osteotomies performed for access to the distal humerus are similar to type IIa fractures. [2]

Common techniques to treat simple olecranon fractures are tension-band wiring and plate fixation. As the skin is thin at the proximal ulna with relatively little subcutaneous tissue, these fixation methods often lead to implant-related soft-tissue irritation necessitating implant removal in 68–82% of the cases largely based on the fixation method that was used. Tension band wiring is a commonly used method for fixation of Type IIa olecranon fractures with no comminution at the articular surface. It was introduced with the aim of earlier post-operative mobilization. It is designed to transform the tensile forces produced by the triceps mechanism to compression forces at the fracture site. [3]

Complications are not uncommon with this technique. Prominent metal work, skin breakdown and loss of fixation due to pull out or breakage of the wires. In an attempt to avoid such complications we used this technique for the fixation of simple non-comminuted fractures mayo IIA with an intramedullary screw. It is a safe technique and has several advantages over tension band fixation. There is minimal tissue dissection and operating time is decreased. There is minimal risk of metalwork prominence. Good interfragmentary compression is achieved as screw is partially threaded and perpendicular to the fracture line. [4]

Aim of Study:

This comparative study aims to evaluate both functional and radiological outcomes of both techniques.

2. Patients and Methods:

This was a randomized comparative study performed in Beni-Suef university hospital within six months from January 2020 involving 30 patients, verbal consents were obtained.

Inclusion criteria:

1. The age group between 18 – 50 years old.
2. Olecranon fracture mayo type IIA.
3. Fractures with major soft tissue damage as in compartmental syndrome, skin ulceration or open fractures.

Exclusion criteria:

1. Pathological fractures.
2. Fractures with neurovascular injury.
3. Patient who is unfit for surgery.
4. Olecranon fractures mayo type IIb, IIIa and IIIb.

All patients were subjected to:

A. Preoperative:

Preoperative history and clinical examination: A detailed history was taken, including patient's complaint, time and mode of trauma, pain, and swelling or associated injuries, time passed after present fracture and history of any other associated injuries or underlying medical disease. Clinical examination aimed to measure the pre-operative range of motion for both sides, while post-operative range was reported for the affected side at end of follow up period. The soft tissue condition was classified according to Tscherne classification.

Inspection: Inspection of the soft tissue: skin integrity, swelling, abrasions, skin bullae, contusions, ecchymosis, palpable patellar defect, significant hem-arthrosis and any open wound was addressed according to its extent and size.

Neurovascular examination: This included assessment of the brachial and radial pulsations, wrist, fingers movements and sensation around the hand.

Motion: Palpable defect indicates displaced fracture or severe comminution, Inability to extend elbow indicates discontinuity of triceps (extensor) mechanism.

ER Management: After examination and resuscitation of the patient in the ER, the patient received primary management in the form of the lacerated skin was irrigated by saline, antiseptic solution and sterile dressing, the limb was splinted with a well-padded above elbow slab, patients with multiple trauma or chronic illness was assessed by different physicians then scheduled for operation according to their situation.

Radiological evaluation: Plain X- ray: each patient had the standard X-ray: AP and lateral views of the elbow. Each view was assessed for: morphology of the fracture, the degree of the bone comminution, the degree of bone fragments displacement.

Preoperative investigation: Laboratory investigations, ECG and chest X-ray were done for patients older than 40 years or when indicated.

Preoperative preparations: All patients were admitted with an elevated limb and in the inpatient ward received medical treatment in the form of strong pain killer on request, anti-edematous medications, the day before surgery (shaving of hair around the elbow and proximal forearm) and the duration between injury and operation was recorded for each patient.

B. Operative:

Timing of surgery: Each patient underwent the scheduled surgical procedure according to general condition and local skin condition, but all of them were done within the first week from the injury.

Surgical technique and implants: The patient was positioned in the lateral decubitus with the arm draped over a padded support. The limb was prepared and draped exposing the distal arm and proximal forearm.

Fig. (1): pre-operative x-rays.

In case of tension band wiring: Two K-wires is introduced parallel from the tip of the olecranon the proximal fragment across the fracture site to the distal fragment piercing the anterior cortex. Periosteum is stripped from the shaft of ulna distal to fracture site and a transverse hole is drilled approximately 3 to 5 cm distal to fracture site. A No 18 stainless steel malleable wire is passed through this transverse hole and crossed over the posterior surface of olecranon in a figure-of-eight manner and then passed around the protruding Kirschner wires and tightened and then secured with a twist. Bend the proximal ends of the Krishner wires 180O and tap the cut ends back into the proximal fragment. Accuracy of reduction is checked and stability is tested by moving the joint. Wound closed in layers and sterile dressing and Compression bandage given.

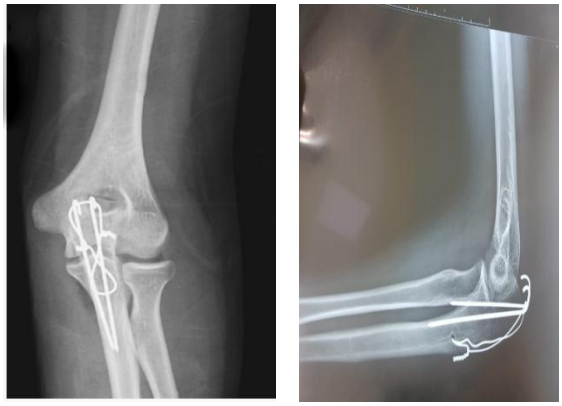

Fig. (2): 6 weeks follow up x-rays showing union.

Fig. (3): Clinical images showing ROM.

In case of intramedullary screw fixation: Using reduction forceps with points percutaneously and the adequacy of reduction was checked under image intensifier to ensure anatomical restoration of the articular surface.. A small longitudinal incision is made at the triceps insertion over the center point of the palpable olecranon tip to facilitate placement of the intramedullary screw .The Screw length is then measured by C-arm such that the distal threaded end of the screw will engage the

narrow marrow of the proximal ulnar diaphysis to provide stable fixation. The cortex is opened with the drill and the screw with washer is placed. The two anti-rotation k-wires are then removed.

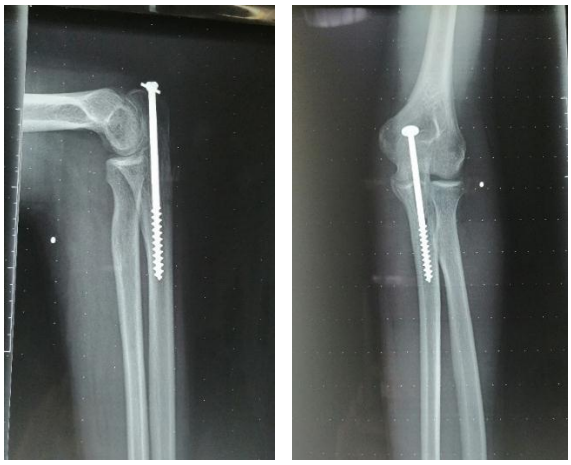

Fig (4): 6 weeks follow up x-rays showing union.

Fig (5): Clinical images showing ROM.

C. Postoperative Management:

Postoperative radiology: AP and lateral views X-rays were taken in the 1st postoperative day. Postoperative medications including: analgesics, anti-inflammatory, anti-edematous and anti-biotics.

D. Follow up: For 6 months.

Clinically: First 2 weeks the patient is examined for a full range of motion, if the wound is clean, stitches are removed after 2 weeks. Functional outcomes are determined using the Mayo elbow performance score (MEPS).

Radiologically: Plain X-rays - AP and Lateral views are done to make sure of healing. X-rays are done immediately post-operative, Patients are then seen at the outpatient clinic at regular intervals (2, 6 and 12 weeks) until radiographic healing is observed.

Statistical methodology

Data were collected, coded, revised and entered to the Statistical Package for Social Science (IBM SPSS) version 20. The data were presented as number and percentages for the qualitative data, mean, standard deviations and ranges for the quantitative data with parametric distribution and median with inter quartile range (IQR) for the quantitative data with non-parametric distribution. The p-value was considered significant as the following: P > 0.05: Non significant (NS), P < 0.05: Significant (S), P < 0.01: Highly significant (HS).

3. Results:

The current study was conducted at Beni-Suef university hospital within six months from January 2020. A total of 30 patients were randomly grouped into two groups, 15 in each group

Table (1): Demographic data

		No	%
Sex	Male	22	73.3%
	Female	8	26.7%
Age	Mean ± SD	32.83±9.84	
	Range	19-55	

This table shows that 22 patients (73.3%) were males but 8 (26.7%) were females. Mean of age was 32.83 with range from 19 to 55 years

Table (2): Comparison between type of fixation among MEPS

		K-wires		Screws		Chi square test	
		No	%	No	%	X^2	P value
MEPS	Excellent	5	33.3%	7	46.7%	2.410	0.492
	Good	7	46.7%	6	40.0%		
	Fair	0	0.0%	1	6.7%		
	Poor	3	20.0%	1	6.7%		

This table shows the difference in MEPS regarding type of fixation

Table (3): Mayo elbow performance score (MEPS)

		No	%
Mayo elbow performance score (MEPS)	Excellent	12	40.0%
	Good	13	43.3%
	Fair	1	3.3%
	Poor	4	13.3%
	Mean ± SD	83.47± 13.81	
	Range	50-98	

This table shows that 12 patients (40%) were excellent MEPS, 13 patients (43.3%) were good MEPS, 1 patient (3.3%) were fair and 4 patients (13.3%) were poor MEPS, mean of it were 83.47 with range from 50 to 98

Table (4): Comparison between Type of fixation among complication post operation (loss of elbow motion)

	K-wires		Screws		Chi square test	
	No	**%**	**No**	**%**	**X^2**	**P value**
Loss of elbow motion	3	20.0%	1	6.7%	1.154	0.283

This table shows that there was no statistically significant deference between type of fixation among complication post operation (loss of elbow motion)

Table (5): Comparison between Type of fixation among complication post operation (loss of reduction)

	K-wires		Screws		Chi square test	
	No	**%**	**No**	**%**	**X^2**	**P value**
Loss of reduction	3	20.0%	2	13.3%	0.240	0.624

This table shows that there was no statistically significant deference between type of fixation among complication post operation (loss of reduction)

Table (6): Comparison between Type of fixation among complication post operation (delayed or non union)

	K-wires		Screws		Chi square test	
	No	**%**	**No**	**%**	**X^2**	**P value**
Delayed or non-union	4	26.7%	1	6.7%	2.160	0.142

This table shows that there was no statistically significant deference between type of fixation among complication post operation (delayed or non union)

Table (7): Comparison between Type of fixation among complication post operation (pain during movement)

	K-wires		Screws		Chi square test	
	No	**%**	**No**	**%**	**X^2**	**P value**
Pain during movement	7	46.7%	4	26.7%	1.292	0.256

This table shows that there was no statistically significant deference between type of fixation among complication post operation (pain during movement)

Table (8): Comparison between Type of fixation among complication post operation (Hardware removal)

	K-wires		Screws		Chi square test	
	No	%	No	%	X^2	P value
Hardware removal	8	53.3%	1	6.7%	7.778	0.005

This table shows that there was statistically significant increase hardware removal in K-wires type

Table (9): Comparison between Type of fixation among complication post operation (infection)

	K-wires		Screws		Chi square test	
	No	%	No	%	X^2	P value
Infection	4	26.7%	2	13.3%	0.833	0.361

This table shows that there was no statistically significant deference between type of fixation among complication post operation (infection).

4. Discussion:

Olecranon fractures are considered as common injury that necessities anatomic reduction, restoration of the joint surface and contour of the trochlear notch contour for good outcome and to prevent post-traumatic arthritis through open reduction and internal fixation (ORIF), in addition fixation must be stable enough to allow early mobilization in order to avoid elbow stiffness [5].

Several methods of internal fixation are commonly utilized, including tension band wiring, plate fixation, interfragmentary screws, intramedullary screws, and fragment excision with triceps advancement, no single method of treatment is appropriate for all fractures because of the variability of fracture patterns and associated injuries [6].

Simple olecranon fractures are usually treated with tension-band wiring technique. However, as the skin is thin at the proximal ulna with relatively little subcutaneous tissue, the main complication relates to implant-related soft-tissue irritation and subsequent future removal of metalwork from the elbow [7, 8].

Recent studies show tension-band wiring hardware irritation rates of 30–90% and removal rates of 2–90% [9, 10]. Rare complications include anterior interosseous nerve palsy and impaired forearm rotations from prominent anterior cortex wires were observed [11].

Additionally, although bone healing and the functional results of tension-band wiring are excellent in most cases, the challenges associated with this operation are underestimated [12].

Intramedullary screw fixation is commonly used to fix olecranon osteotomies, however, fewer reports have been published on its use for simple olecranon fractures, and the results of such reports were controversial and unreliable because of their unclear inclusion criteria [13].

Therefore, the aim of our study was to compare between intramedullary screw versus tension band wiring fixation for simple displaced olecranon fractures regarding their functional and radiological outcomes.

This prospective comparative study included thirty patients with olecranon fracture mayo type IIA. They were recruited and assessed for eligibility from Orthopedics department, Beni-Suef University. They were divided into two groups according to the type of fixation; K-wires group and intramedullary group.

The mean age of the studied cases was 32.83±9.84 years old. 73.3% of cases were males and 26.7% of them were females. 56.7% of the fractures occurred in the right side while 43.3% were in the left side. Regarding the mode of trauma, 70.0% of the fractures resulted from direct impact while 30.0% of the fractures resulted from eccentric contraction.

A previous study by Duckworth et al. [4] regarding the epidemiology of olecranon fractures indicated that Olecranon fractures follow a bimodal distribution in which both young (due to violent high energy trauma) and osteoporotic elderly (simple falls) are included. While these fractures are common injuries at any age, the prevalence in adults are at its peak during the seventh decade of life, with males more likely to sustain an injury at a younger age.

Additionally, Baecher and Edward [14]indicated that simple displaced fractures of the olecranon (Mayo Type IIA fractures) represent the most common fracture type occurred clinically. Moreover, a prospective study by Rana et al. [15] indicated that the average age incidence of olecranon fractures was 40.05 years old, greater incidence was observed in males (68%) and in the right side.

Our results revealed no significant differences between K-wires group and intramedullary group regarding the mayo elbow performance score (MEPS) (P value=0.492).

A recent study by Fernández et al. [16] indicated that the functional outcomes of simple transverse olecranon fractures treated with an intramedullary cancellous screw are excellent, associated with a low rate of complications and material removal.

Many studies indicated that tension band wiring fixation showed good-to-excellent short- to long-term clinical outcomes, however, different complication could occur [17, 18].

A previous study by Terstappen et al. [19] indicated that 95.5% of simple and comminuted olecranon fracture patients treated with tension band wiring were rated excellent using the MEPI score.

On the other hand, our findings were in disagreement with Sleem et al. [20] study that indicated that MEPS was significantly higher at 4weeks, 3month and 6month in intramedullary group in comparison with K-wires group (P value= 0.032, 0.042 and 0.031 respectively) but with an insignificant difference at 2 weeks between both groups (P value =0.0501).

Our results indicated no statistically significant deference between K-wires group and intramedullary group regarding post operation complication (loss of elbow motion) (P value=0.283).

A previous study by Sleem et al. [20] indicated that the range of motion was significantly higher in group patients treated with intramedullary fixation method in comparison with wire method (P value= 0.004).

A study by Eglseder, [21] indicated that intramedullary screw placement can be used in conjunction with plate fixation for a wide variety of ulna fracture patterns. Additionally, a previous study by Buijze and Kloen, [22] indicated that in the treatment of comminuted olecranon fractures, a contoured locking compression plate combined with an intramedullary screw provides sufficient stability for early postoperative functional rehabilitation, with an excellent fracture union rate and very good clinical outcomes.

Additionally, Bosman et al. [13] indicated that patients treated with intramedullary screw showed an average flexion that was 145° (range 135–160) and average extension lag that was 11° (range 0–30) so fixation of simple olecranon fractures with an intramedullary screw is a safe and easy fixation method in young patients, leading to good functional and radiological results.

Our results indicated no statistically significant deference between K-wires group and intramedullary group regarding post operation complication (loss of reduction) (P value= 0.624).

Powell et al. [23] indicated that in patients undergoing tension band wiring procedures, radiographic loss of reduction and articular step-off were observed more frequently compared to locking plate fixation in Mayo 2A olecranon fractures.

A previous study by Sleem et al. [20] indicated that utilization of intramedullary screw fixation for olecranon fracture reduction has the advantage of decreasing irritation to surrounding tissues, while providing stability to facilitate early range of motion.

Additionally, a previous study by Potter et al. [24] indicated that avoiding a medially based starting point for the intramedullary screw is crucial for achieving its benefits of fixation and reduces the chance of mal-reduction after fixation.

Our results indicated no statistically significant deference between K-wires group and intramedullary group regarding post operation complication (delayed or non-union) (P value= 0.142).

Such finding was in agreement with a recent study by Sleem et al. [20] that indicated that the rate of union was 100% among olecranon fracture patients who were either treated with K-wires or intramedullary screw fixation.

A survey study by Wood et al. [25] indicated that tension-band wiring has shown excellent results with regard to union rates and remains considered the first choice of treatment for many due to the low complexity and costs.

Additionally, a recent study by Bosman et al. [13] indicated that patients who were treated with intramedullary screw showed complete union of their fracture leading to good functional and radiological results.

Our results indicated no statistically significant deference between K-wires group and intramedullary group regarding post operation complication (pain during movement) (P value= 0.256).

Such findings were in agreement with Sleem et al. [20] study that indicated no significant deference between K-wires group and intramedullary group regarding pain during movement.

A retrospective study by Tarallo et al. [6] indicated that both the use of TBW or plate fixation have excellent to good clinical outcomes with minimal loss of physical capacity, little pain and disability can be obtained in patients with Mayo type IIA and IIB olecranon fractures.

On the other hand, it was indicated that the prominence of hardware that lead to reoperation causing pain was noticed in 75% for tension band wire (8) and 0-33% in intramedullary screw fixation method (13).

Our results indicated statistically significant increase hardware removal among K-wires group in comparison with the intramedullary group (P value=0.005).

Such findings were in agreement with Duckworth et al. [5] that indicated that tension-band wiring implant removal is often necessary due to hardware irritation or k-wire migration in up to 82% of patients. Rommens et al [26] recommended routine tension band wire metal work removal after fracture union due to the incidence of patient dissatisfaction related to the implant.

A previous study by Chan and Donnelly [27] indicated no difference in complications or metalwork removal rate in the placement of K-wire (either intramedullary or transcortical) in tension band wiring for isolated olecranon fracture. However, Van der Linden et al [28] performed a retrospective review of 59 olecranon fractures treated with tension band wiring and showed that K-wire instability, evidenced by a fracture gap occurred in 78% of cases when the K-wires were intramedullary compared to in 36% of cases with bicortical K-wire positioning.

Moreover, Koh and Oh [29] recommended that in order to decrease the incidence of skin irritation and back-outs of K-wires, cutting K-wires in an oblique fashion and rotating them 180° before insertion would be beneficial.

Our results indicated no statistically significant deference between K-wires group and intramedullary group regarding post operation complication (infection) (P value=0.361).

A recent study by Bosman et al. [13] did not observe any superficial or deep infections among patients treated with intramedullary screw fixation that could be explained by the fact that, compared to tension-band wiring or plate fixation, a smaller incision could be used with minimal soft-tissue dissection or trauma.

5. Conclusion and Recommendations:

Olecranon fracture fixation with intramedullary screw was as effective as K-wire with tension band in simple displaced olecranon fractures (Mayo type IIA) regarding functional and radiological outcomes. The complication rate was higher following K-wire fixation method due to a higher rate of implant removal in symptomatic patients.

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