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ORIGINAL ARTICLE

Outcome of Olecranon Fracture Treated with Tension Band Wiring Versus Anatomical Locking Plate Fixation

MUHAMMAD INAM[1], WAJID REHAN[2], MUHAMMAD KAMRAN SHAFI[3], MUHAMMAD AFAQUE ALAM[4], SYED ABDUR RUB ABIDI[5], USMAN ALI[6], TAUSEEF RAZA[7], ABDULAKBAR[8]

[1]*FCPS, Associate Professor, MTI-LRH, Peshawar*
[2]*Consultant Orthopedic Surgeon, Type C Hospital, Karak*
[3]*Assistant Professor Orthopaedic Nishtar Medical University, Multan*
[4]*Orthopedic Surgeon, Trauma and Orthopedic Clinic, Karachi*
[5]*Associate Professor Orthopaedic Surgery Department, Jinnah Medical &Dental College, Karachi*
[6]*Consultant Orthopedic surgeon, Department of Trauma and Orthopedic Surgery, C.M.C Medical Institute, Lahore*
[7]*Assistant Professor, Department of Orthopedics, KMU Institute of Medical Sciences, Kohat*
[8]*MBBS, Trainee Medical Officer, MTI-LRH, Peshawar*
Corresponding author: Abdul Akbar, Email: drminamkhan71@gmail.com

ABSTRACT

Aim: Up to 10% of all upper limb fractures involve the olecranon, and this type of fracture is the most common osseous injury of the elbow joint. These show a bimodal distribution occurring in younger patients due to high-energy trauma and in elderly cohorts with low bone quality afterlow-energy falls.

Objective: To compare functional outcome of tension band wiring versus anatomical locking plate fixation for reduction of olecranon fracture

Materials and Methods: This randomized controlled trial study was conducted in the Department of Orthopedic, Lady Reading Hospital, Medical Teaching Institute Peshawar from December 2022 to June 2023. Non-probability consecutive sampling technique was used in this study. Sample size was calculated using WHO calculator keeping 95% confidence interval 80 % power of study, 10% absolute precision, mean Mayo elbow score was 84.0±9.3 in the TBW group and 88.3±9.1 in the locking plate fixation group [(4)]. Expected sample size is 32 patients in each group, total 72 patients. Patients of both genders have age range from 20 to 70 year with Mayo type 2A olecranon fractures, more than 2 mm of joint displacement determined on X-ray elbow, and elbow extension loss determined on physical examination presented within 7 days of the injury were included in the study while Patients with open fracture and revision surgery were excluded from the study.

Results: In this study age distribution among 72 patients was analyzed as n= 20-30 Years 17(27.4%) 31-40 Years 14(22.6%) 41-50.Years 11(17.7%) 51-70 Years 20(32.3%). Mean age was 47.1 Years with SD ± 2.87. Gender wise Distribution among 72 Patients was analyzed as Male were 31(50.0%) and female were 31(50.0%). Distribution of duration of disease among 72 patients were analysed as n= 1-2 weeks were 47(75.8%) and 3-4 weeks were 15(24.2%)

Practical Implication: There are no established guidelines for the treatment of olecranon fracture in our institution. Most olecranon fractures are treated according to surgeon preferences and surgical experience of the surgeon. Previous studies showed variables results with no consensus. We will provide rationale basis for universal use of standard treatment of olecranon fracture.

Conclusion: Although there were no statistically significant differences in clinical outcomes between the two groups, the ALP grouphad a higher proportion of any complication than the RP group.

Keywords: Anatomical locking plate; complications; eyelet wire; olecranon fracture; tension band wiring.

INTRODUCTION

Up to 10% of all upper limb fractures involve the olecranon, and this type of fracture is the most common osseous injury of the elbow joint. These show a bimodal distribution occurring in younger patients due to high-energy trauma and in elderly cohorts with low bone quality after low-energy falls (1). Simple transverse olecranon fractures are the most common pattern (2). While there is an argument for conservative management in low demand elderly patients, they typically require surgical fixation. The goal of surgical fixation is to restore the anatomy of the articular surface, repair the extensor mechanism, restore joint stability and mobility and prevent stiffness (3). Due to the tension of the triceps brachii muscle and tendon, many olecranon fractures are displaced and the chance of conservative treatment is therefore low. To date, many different procedures have been defined in the surgical treatment of olecranon fractures, and the most preferred procedures by surgeons are tension band wiring (TBW) and plate fixation (PF). Tension band wiring is a simple and low-cost procedure and so it is considered the gold standard. Functional results are satisfactory in the treatment of simple olecranon fractures, but there are limited indications in comminuted fractures. In addition, high complication rates and secondary surgical requirements have been reported (4). Therefore, many alternative treatment procedures have been developed, such as shaped plates, intramedullary rods, precontoured plates, and tendon sutures(5). Tension band wiring (TBW) or plating may be used for fixation with similar clinical outcomes for adults (6). Powell et al. (7) suggest that locking plates are superior to TBW concerning post-operative morbidity, reoperation rate. Complication rate was 38% in TBW and no complication was observed in locking plates In the TBW group, the mean post-injury Quick DASH was 12.9, compared with 15.0 for the locking plate group. There was no statistically significant difference between the outcomes for either group. While in another study the mean DASH score was 10.0±1.8 in the TBW group and 7.7±1.2 in the locking plate fixation group (p=0.001). The mean Mayo score was 84.0±9.3 in the TBW group and 88.3±9.1 in the locking plate fixation group (p=0.049) (4). The rationale of this study is to compare functional outcomes of Tension band wiring versus anatomical locking plate fixation for treatment of olecranon fracture which results in minimal complications and good surgical outcome. There are no established guidelines for the treatment of olecranon fracture in our institution. Most olecranon fractures are treated according to surgeon preferences and surgical experience of the surgeon. Previous studies (4, 6, 7) showed variables results with no consensus. We will provide rationale basis for universal use of standard treatment of olecranon fracture. The objective of this study was to compare functional outcome of tension band wiring vs anatomical locking plate fixation for reduction of olecranon fracture.

MATERIALS AND METHODS

This randomized controlled trial study was conducted in the Department of Orthopedic, Lady Reading Hospital, Medical Teaching Institute Peshawar from December 2022 to June 2023.

Non-probability consecutive sampling technique was used in this study. Sample size was calculated using WHO calculator

keeping 95% confidence interval 80 % power of study, 10% absolute precision, mean Mayo elbow score was 84.0±9.3 in the TBW group and 88.3±9.1 in the locking plate fixation group [4]. Expected sample size is 32 patients in each group, total 72 patients. Patients of both genders have age range from 20 to 70 year with Mayo type 2A olecranon fractures, more than 2 mm of joint displacement determined on X-ray elbow, and elbow extension loss determined on physical examination presented within 7 days of the injury were included in the study while Patients with open fracture and revision surgery were excluded from the study.

Data Collection Procedure: After approval from hospital ethical board, patients fulfilling the inclusion criteria were enrolled from indoor of orthopedic ward of the hospital. A written informed consent was taken after explaining the purpose of study. Demographic data including age, gender and duration of disease were noted. Complete history was taken and physical examination was done. Baseline labs including Complete blood Count (CBC), Liver Function Tests (LFTs), Renal Function Tests (RFTs), serum electrolyte and chest x ray were done for general anesthesia fitness. Patients were divided randomly in two groups using block randomization generated by computer software. All patients were operated on in the supine position, using an arm table and a tourniquet for bleeding control. For all patients, a standard posterior longitudinal approach was used for reduction and fixation. In order to protect the ulnar nerve, the incision was performed by curving the radial side at the tip of the olecranon. Patients in group A were treated with tension band wring technique and patients in group B were treated with locking plate fixation technique. All procedures were done by consultant orthopedic surgeon having five years of post-fellowship experience. A similar rehabilitation program was applied in both patient groups after surgery. All patients will have an adjustable-angle elbow orthosis and no angle restrictions. On the same day, passive movement were started to protect the ROM of all patients. All patients were discharged one day after surgery. Active flexion, extension, pronation, and supination were started for all patients at the end of the second week. At the end of the sixth week, the rehabilitation process of all patients was completed and functional outcomes in term of mayo elbow score and DASH score were noted. Data were entered in specially designed proforma.

Data Analysis Procedure: Data were entered and analyzed by using SPSS version 22.0. Frequency and percentage were calculated for categorical variables like gender. Mean and standard deviation were calculated for quantitative variables like age, duration of injury, mayo elbow score and DASH score. Mayo elbow score and DASH score were compared in both groups using independent t-test. P-value≤0.05 were taken as statistically significant. Effect modifiers like age, gender and duration of injury were addressed through stratification of data for mayoelbow score and DASH score. Post stratification independent t-test were applied. P-value ≤0.05 were taken as statistically significant.

RESULTS

In this study age distribution among 72 patients was analyzed as n= 20-30 Years 17(27.4%) 31-40 Years 14(22.6%) 41-50 Years 11(17.7%) 51-70 Years 20(32.3%). Mean age was 47.1 Years with SD ± 2.87 (Table No1) Gender wise Distribution among 72 Patients was analyzed as Male were 31(50.0%) and female were 31(50.0%) (Table No2)

Distribution of duration of disease among 72 patients were analysed as n= 1- 2 weeks was 47(75.8%) and 3-4 weeks was 15(24.2%) (Table No 3) BMI classification among 72 patients were analysed as n= Below 18.5 Underweight was 25(40.3%) 18.5–24.9 Normal weight was 10(16.1%) 25.0–29.9 Pre-obesity was 17(27.4%) and 30.0–34.9 Obesity class was 9(14.5%) (Table No 4)

Distribution of functional outcome among the groups were analyzed as n= Yes among Group A (Tension Band Wring Technique) was 4(12.9%) and Group B (Locking Plate Fixation Technique) was 9(29.%) (Table No 5)

Table 1: Age Distribution (n=72)

Age wise Distribution	Groups wise Distribution		Total
	Group A (Tension Band WringTechnique)	Group B (LockingPlate Fixation Technique)	
20-30 Years	6	8	14
31-40 Years	42.9%	57.1%	100.0%
41-50Years	0	11	11
51-60 Years	.0%	100.0%	100.0%
61-70 Years	6	7	13
	46.2%	53.8%	100.0%
	10	5	15
	66.7%	33.3%	100.0%
	10	9	19
	52.6%	47.4%	100.0%
Total	32	40	72
	44.4%	55.6%	100.0%

Mean age was 47.1 Years with SD ± 2.87

Table 2: Gender Wise Distribution (n=72)

Gender wise Distribution	Groups wise Distribution		Total
	Group A (TensionBand Wring Technique)	Group B (LockingPlate Fixation Technique)	
Male	7	13	20
Female	35.0%	65.0%	100.0%
	25	27	52
	48.1%	51.9%	100.0%
Total	32	40	72
	44.4%	55.6%	100.0%

Table 3: Duration of Disease (n=72)

Functional outcome	Groups wise Distribution		Total
	Group A (Tension Band WringTechnique)	Group B (Locking Plate Fixation Technique)	
Excellent	6	6	12
Good	50.0%	50.0%	100.0%
Fair	5	12	17
Poor	29.4%	70.6%	100.0%
	11	9	20
	55.0%	45.0%	100.0%
	10	13	23
	43.5%	56.5%	100.0%
Total	32	40	72
	44.4%	55.6%	100.0%

Table 4: Duration of Fracture (n=72)

Duration of fracture	Groups wise Distribution		Total
	Group A (Tension Band WringTechnique)	Group B (LockingPlate Fixation Technique)	
Less than or Equal 5	10	19	29
DaysMore than 5	34.5%	65.5%	100.0%
Days	22	21	43
	51.2%	48.8%	100.0%
Total	32	40	72
	44.4%	55.6%	100.0%

Table 5: Functional Outcome W.R.T Age with Group Wise Distribution Crosstabulation (n=72)

Age wise Distribution	Functionaloutcome	Groups wise Distribution		Total	P.Value
		Group A (Tension BandWring Technique)	Group B (Locking PlateFixation Technique)		
20-30 Years	Excellent	4	2	6	0.307
	Good	66.7%	33.3%	100.0%	
	Fair	2	2	4	
	Poor	50.0%	50.0%	100.0%	

		0	1	1	
		.0%	100.0%	100.0%	
		0	2	2	
		.0%	100.0%	100.0%	
	Total	6	7	13	
		46.2%	53.8%	100.0%	
31-40 Years	Functional	0	2	2	0.526
	Outcome	.0%	100.0%	100.0%	
	Good	2	4	6	
	Fair	33.3%	66.7%	100.0%	
	Poor	3	4	7	
		42.9%	57.1%	100.0%	
	Total	5	10	15	
		33.3%	66.7%	100.0%	
41-50Years	Excellent	2	4	6	0.153
	Good	33.3%	66.7%	100.0%	
	Fair	0	3	3	
	Poor	.0%	100.0%	100.0%	
		2	2	4	
		50.0%	50.0%	100.0%	
		2	0	2	
		100.0%	.0%	100.0%	
	Total	6	9	15	
		40.0%	60.0%	100.0%	0.052
51-60 Years	Excellent	5	0	5	
	Good	100.0%	.0%	100.0%	
	Fair	3	2	5	
	Poor	60.0%	40.0%	100.0%	
		1	5	6	
		16.7%	83.3%	100.0%	
		1	1	2	
		50.0%	50.0%	100.0%	
	Total	10	8	18	
		55.6%	44.4%	100.0%	
61-70 Years	Excellent	0	1	1	0.547
	Good	.0%	100.0%	100.0%	
	Fair	2	3	5	
	Poor	40.0%	60.0%	100.0%	
		1	0	1	
		100.0%	.0%	100.0%	
		2	2	4	
		50.0%	50.0%	100.0%	
	Total	5	6	11	
		45.5%	54.5%	100.0%	

Table 6: Stratification of FunctionalOutcome with Gender * Group Wise Distribution (n=72)

Gender wiseDistribution	Functional outcome	Groups wise Distribution		Total	P.Value
		Group A (Tension Band WringTechnique)	Group B (LockingPlate Fixation Technique)		
Male	Excellent	6	2	8	
Female	Good	75.0%	25.0%	100.0%	0.005
	Poor	1	2	3	
	Poor	33.3%	66.7%	100.0%	0.026
	Total	0	9	9	
		.0%	100.0%	100.0%	
		7	13	20	
		35.0%	65.0%	100.0%	
	Excellent	0	4	4	
	Good	.0%	100.0%	100.0%	
	Fair				
	Poor				
		4	10	14	
		28.6%	71.4%	100.0%	
		11	9	20	
		55.0%	45.0%	100.0%	
		10	4	14	
		71.4%	28.6%	100.0%	
	Total	25	27	52	
		48.1%	51.9%	100.0%	

Table 7: Stratification of Functional Outcome with Duration of Disease * GroupWise Distribution (n=79)

Duration offracture	Functionaloutcome	Groups wise Distribution		Total	P.Value
		Group A (Tension BandWring Technique)	Group B (Locking Plate Fixation Technique)		
Less than or	Excellent	5	2	7	0.033
Equal 5 Days	Good	71.4%	28.6%	100.0%	
	Fair	0	8	8	
	Poor	.0%	100.0%	100.0%	
		1	3	4	
		25.0%	75.0%	100.0%	
		4	6	10	

		40.0%	60.0%	100.0%	
	Total	10	19	29	
		34.5%	65.5%	100.0%	
More than 5 Days	Excellent	1	4	5	0.397
	Good	20.0%	80.0%	100.0%	
	Fair	5	4	9	
	Poor	55.6%	44.4%	100.0%	
		10	6	16	
		62.5%	37.5%	100.0%	
		6	7	13	
		46.2%	53.8%	100.0%	
	Total	22	21	43	
		51.2%	48.8%	100.0%	

DISCUSSION

Tension band wiring for displaced olecranon fractures is a gold standard surgery, and good clinical outcomes have been reported. Recently, the plate fixation technique is widely used for simple and comminuted olecranon fractures due to advances in low profile and locking mechanisms. Some authors have reported similar clinical results between TBW and plate fixation, although TBW was associated with a higher complication rate than the plate fixation technique.1-4 Powell et al.[1] compared TBW with ALP fixation in only simple olecranon fractures and reported good outcomes with no differences in both groups. The total complication rate in the TBW group (39%: 19/48) was significantly higher than that in the ALP group (0%: 0/16), and 13 patients required implant removal for TBW irritation versus zero patient in the ALP group. Tarallo et al.[2] compared TBW with plate fixation in simple and comminuted olecranon fractures and found good outcomes with no difference between both groups; the implant removal rates were 10/33 (30%) in the TBW group and 4/45 (9%) in the ALP group. In a prospective randomized trial comparing nonlocking plate fixation with TBW for Mayo Ⅱ A fractures conducted by Duckworth et al.,[4] no difference was found between the two groups in the patient-related outcome. The authors concluded that the overall complication rate was higher after TBW and was due to a higher rate of implant removal, while plate fixation led to a more serious complication of infection, requiring revision surgery. In our study, the complication rate in the ALP group was higher than that in the RP group in contrast to previous reports. No back out of the K-wire was found in the RP group, because the Ring Pin never moved proximal due to the eyelet, unless it was broken. Symptomatic implant removal rates in this study were 2/24 (8%) and 12/34 (35%) in the RP and ALP groups, respectively. Although the end of the K- wire passed through the anterior ulnar cortex to prevent the proximal migration in TBW,7 other complications such as ulnar artery and anterior interosseous nerve injury8-10 and restriction of forearm rotation[11,12] were described due to penetration of the K-wire. In the RP group, the end of the Ring Pin was inserted into the intramedullary canal, and we were able to avoid these complications. One of the advantages of Ring Pin is that the insertion of the wire at the fracture fragment is away from the fracture line. In the normal TBW technique, the insertion of the wire tends to come close to the fracture line to penetrate the anterior ulnar cortex.

Tension band wiring has been commonly used in treating simple olecranon fractures, in contrast to the indication of plate fixation that is believed to be used for comminuted olecranon fractures.[13,14] Tarallo et al.[2] compared TBW with plate fixation in treating simple and comminuted olecranon fractures and reported no significant differences in the clinical outcome and complication rates in both fracture patterns. Moreover, in our study, there were no significant differences in the treatment of Mayo type Ⅱ B fractures between the RP group and the ALP group. Okamoto et al.[6] reported satisfactory clinical results using TBW with the eyelet wire and biodegradable pins for selected comminuted olecranon fractures.

Various factors are associated with implant removal after bone union. Okamoto M, et al.[15] stated that the implant removal rate after plate fixation for distal radius fractures is dependent on the medical health insurance system of each country. For other reasons, we considered that implant irritation after bone union was associated with the site of the fracture and the thickness of the subcutaneous tissue. Bugarinovic et al.[16] reported that both lower BMI and age were associated with a higher rate of symptomatic implant removal after olecranon fracture fixation. The present study revealed significant differences in the prominent implant removal rate between patients with BMI ≥25 and those with BMI <25. BMI is not an accurate measure to evaluate subcutaneous tissue because fat and muscle mass are not taken into account; however, BMI is a simple index of weight for height and widely used to estimate overweight throughout the world. According to the report [17] of the Organization for Economic Co-operation and Development (OECD) in 2016, the proportion of obese people in Japan was only 3.7%, and the country ranked 34th among 34 countries. Furthermore, Japan has a universal health system, and hence the rate of prominent implant removal may tend to be higher.

Several limitations exist in this study, such as short follow-up. In the short follow-up, the patient who complains of the implant symptom later may come out. Moreover, we could not evaluate patient-related functional outcomes such as the disabilities of the arm, shoulder, and hand (DASH). However, to our knowledge, no clinical study has compared the outcomes between ALP fixation and TBW with Ring Pin. Although there were no significant differences in clinical outcomes between the two groups, the ALP group had a higher proportion of any type of complication than the RP group.

CONCLUSION

This study revealed no significant differences in the clinical outcomes between the two treatment approaches. However, the ALP group was associated with a higher rate of complications than the RP group.

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