Original Article

Functional Assessment of Olecranon Fracture Management Using Tension Band Wiring and Locking Plate Osteosynthesis

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Abstract

Background: Olecranon fractures are frequently reported intra-articular fractures following elbow injuries. It requires stable fixation to restore joint congruity and mobilization. Traditionally, tension band wiring (TBW) was used for simple fractures. Locking plates are used for unstable fractures. The present study was done to determine the functional radiological and complication outcomes of olecranon fractures treated with tension band wiring versus locking plate osteosynthesis. **Material and Methods:** This prospective study was done on n=25 cases with displaced olecranon fractures of category (Mayo type IIA and IIB). N=13 cases were allotted to group A, treated with tension band wiring, and N=12 patients were allotted to Group B, and they were treated with locking plates. Patients were followed for six months. Outcome assessment was done by comparison of operative parameters, radiological union, range of motion, Mayo Elbow performance scores (MEPS), and complications. **Results:** The overall results of this study showed that the two groups were well-matched in terms of age, sex, injury mechanism, and fracture classification (Mayo IIA/IIB). Tension Band Wiring (TBW) had a significantly shorter operative time compared to Locking Plate fixation. Both techniques achieved a 100% union rate by 6 months. TBW showed a trend towards more complications like implant back-out (23.1%) and loss of reduction (15.4%). **Conclusion:** Both fixation methods provide satisfactory outcomes at 6 months follow-up. However, locking plate osteosynthesis may reduce implant-related complications and offer more consistent functional results.

Keywords: Olecranon fracture, Tension band wiring, Locking plate osteosynthesis, Mayo Elbow Performance Score.

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Introduction

Olecranon fractures are the most frequent fractures following an elbow injury. It is estimated that approximately 10% of all upper extremity fractures are olecranon fractures. Its reconstruction is challenging because of the unique anatomy, functions of the proximal ulna, and articular surface of the elbow joint.[1-3] The olecranon, which is the proximal part of the ulna, is the point of insertion of the triceps mechanism and is a very important part in the extension of the elbow and stability. Dislocated intra-articular fractures of this area interfere with the congruity of the joint and the extensor mechanism and, in many cases, may require surgical repair to reestablish anatomic position, secure stable fixation, and early mobilization.[4] Traditionally, the tension band wiring (TBW) technique has been used as a treatment standard in cases of simple, non-comminuted olecranon fractures. It offers a biomechanical advantage of converting tensile forces into compressive forces across the fracture site during elbow motion.[5] The technique was initially described by Weber and Vasey and has since been widely used because of its comparative simplicity, low implant cost, and satisfactory functional outcomes in large patient groups.[6,7] Studies examining functional outcome after TBW report a high rate of excellent and good outcomes based on Mayo Elbow Performance Score (MEPS) and patients' satisfaction indices.[8-10] The disadvantages of TBW are hardware prominence, irritation, k-wire migration, and higher rates of reoperation for implant removal in active individuals and cases with comminated fractures.[10] Locking plate osteosynthesis (LP) or pre-contoured plates are now increasingly being used, particularly in cases with complex comminuted or unstable fracture patterns that cannot be managed by tension band wiring.[11] Since plates offer rigid fixation, they can tolerate a wide range of motion without the likelihood of displacement or loss of reduction. Studies have found that LP offers biomechanical advantages such as enhanced stability under cyclic loading as compared to TBW, with the ability to support a wide range of postoperative rehabilitation protocols and improved functional outcomes in selected fracture cases.[11,12] Despite the advantages offered by plating, assessing literature for comparison of LP versus TBW showed mixed opinions on superiority in functional outcomes. Comparative studies and meta-analysis have shown almost similar postoperative range of motion, functional scores and return to activity between two

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methods.[12,13] Although few studies showed that plate fixation produced lower rate of complications and reoperations and reduced hardware removal and loos of reduction however, the cost of implant and time to surgery was higher in plate fixation.[11,12,14] Therefore, individualized treatment planning must be done based on fracture pattern (Mayo classification), bone quality and patient activity level. Based on this background, we aimed to analyze the two treatment methods with objective evaluation measures such as MEPS, the Disabilities of the Arm, Shoulder, and Hand (DASH) score, range of motion (ROM), and radiographic union rates. The data from this study can provide evidence-based surgical decision-making and optimize patient recovery following olecranon fracture fixation.

Materials and Methods

This was a prospective observational comparative study conducted in the Department of Orthopaedics, Rajiv Gandhi Institute of Medical Sciences (RIMS), Adilabad, Telangana. Institutional Ethical Committee approval was obtained for the study after following the protocol for human research based on the Helsinki Declaration. Written informed consent was obtained from all participants before inclusion in the study after explaining the nature of the study and possible outcomes in the vernacular language.

Inclusion Criteria

1. Displaced intra-articular fractures (Mayo Type IIA and IIB)
2. Closed Fractures of the olecranon, less than 2 weeks
3. Patients aged above 18 years
4. Males and Females
5. Patients fit to undergo surgery
6. Available for follow-up

Exclusion Criteria

1. Pathological fractures
2. Open fractures
3. Polytrauma patients with ipsilateral upper limb injuries
4. Fractures involving neurovascular structures
5. Previous elbow surgeries

Based on the inclusion and exclusion criteria, a total of n=25 cases of displaced olecranon fractures were included in the study. An initial evaluation of all the patients was done, after which they were allotted to two groups based on fracture pattern, bone quality, and the surgeon's discretion. Group A was the patients treated with Tension Band Wiring (TBW); a total of n=13 patients were included in this group. Group B were patients treated with Locking Plate Osteosynthesis. They were treated with a pre-contoured olecranon locking plate; a total of n=12 cases were allotted in this group.

Preoperative evaluation of all the cases was done using a pre-designed and validated questionnaire, which included a history of trauma, mechanism of injury, and a complete physical examination. Radiological evaluation was done by taking anteroposterior and lateral radiographs of the elbow, and fractures were classified based on Mayo classification. All routine surgical investigations were performed in the cases as per institutional protocol.

Surgical Technique in brief for Tension Band Wiring (TBW) was done in general anesthesia; fractures were exposed through a posterior midline incision. After anatomical reduction, fixation was achieved using two parallel Kirschner wires and a figure-of-eight stainless steel tension band wire, converting tensile forces into compressive forces across the fracture site.

Locking Plate Osteosynthesis: In this group, fracture reduction was achieved under direct visualization and fixed using a pre-contoured olecranon locking plate with locking and non-locking screws as required. Care was taken to restore articular congruity and triceps mechanism alignment.

Postoperative Management protocol: All patients received standard postoperative care, including antibiotics and analgesia. Elbow immobilization in an above-elbow slab was maintained for a short duration, followed by early active range-of-motion exercises as tolerated. Sutures were removed on postoperative day 12–14.

Functional Assessment and follow-up: Patients were followed up at 2 weeks, 6 weeks, 3 months, and 6 months postoperatively. Functional outcomes were assessed using:

1. Mayo Elbow Performance Score (MEPS)
2. Range of motion (Flexion–Extension arc)
3. Radiological assessment for fracture union, implant position, and complications

The fracture union was defined as radiological evidence of bridging trabeculae with the absence of tenderness at the fracture site.

Statistical Analysis: All the available data were refined, segregated, and uploaded to an MS Excel spreadsheet and analyzed by SPSS version 26 in Windows format. The continuous variables were represented as mean, standard deviation, and percentage, and the categorical variables were calculated by the chi-squared test for differences between two groups. Values of p (<0.05) were considered significant.

Results

The baseline demographic profile and clinical characteristics of the cohort are presented in [Table 1]. The mean age of both groups was comparable, with Group A having a mean age of 45.2 ± 16.8 years and Group B having a mean age of 48.7 ± 14.3 years. Predominance of males was present in both groups; however, the intergroup distribution pattern remained similar. There were similarities in both groups as far as the laterality of injury, mechanism of trauma, and fracture patterns. This showed that groups were well matched for comparison. The time of surgery did not differ significantly between the groups, indicating that the groups were clinically comparable, and differences in outcomes will be because of the fixation method.

Table 1: Baseline Demographic and Clinical Characteristics

Characteristic	Group A Tension Band Wiring (1=13)	Group B Locking Plate (n=12)	p -value
Age (Years)	45.2 ± 16.8	48.7 ± 14.3	0.551
Sex (Male: Female)	9:4	8:4	0.876
Side (Right: Left)	8:5	7:5	0.829

Mechanism of Injury			
Simple Fall	8 (61.5%)	7 (58.3%)	0.874
Road Traffic Accident	4 (30.8%)	4 (33.3%)	0.889
Sports Injury	1 (7.7%)	1 (8.3%)	1.000
Mayo Classification			
Type IIA	9 (69.2%)	8 (66.7%)	0.889
Type IIB	4 (30.8%)	4 (33.3%)	0.889
Time to Surgery (Days)	4.2 ± 2.1	3.8 ± 1.9	0.605

Operative and Early Post-operative Parameters are presented in [Table 2]. A critical analysis of the table shows that the mean operative time was significantly shorter in the TBW groups, 68.5 ± 15.2 minutes, compared to the locking plate group, 94.3 ± 18.7 minutes. The differences were found to be statistically significant. The mean duration of hospital stays, time to suture removal, and time to initiation of active range of motion were comparable between the groups. Although patients treated with locking plates tended to begin active motion earlier, this difference did not reach statistical significance (p = 0.098).

Table 2: Operative and Early Post-operative Parameters

Parameter	Group A Tension Band Wiring (N=13)	Group B Locking Plate (N=12)	p -value
Operative Time (Minutes)	68.5 ± 15.2	94.3 ± 18.7	<0.001*
Hospital Stay (Days)	3.1 ± 1.2	3.5 ± 1.4	0.412
Time to Initiate Active ROM (Days)	7.2 ± 2.4	5.8 ± 1.9	0.098
Suture Removal (Days)	13.5 ± 1.8	13.2 ± 1.5	0.651
*Significant			

[Table 3] presents the time to Radiological and other outcomes. The overall time to radiological union was similar in the two groups, with 10.8 ± 2.2 versus 11.5 ± 2.6 weeks, respectively. The union rate assessment at different intervals showed that the rate at 3 months and 6 months was comparable, and almost 100% union was achieved in both groups at the end of 6 months. Loss of reduction was observed in the TBW group, and no such case was found in the LP group. This showed that both the fixation methods provided reliable fracture union rates; however, the TBW group may have a chance of mechanical failures.

Table 3: Radiological and Time-to-Union Outcomes

Outcome	Group A Tension Band Wiring (N=13)	Group B Locking Plate (N=12)	p-value
Time to Radiological Union (Weeks)	10.8 ± 2.2	11.5 ± 2.6	0.462
Union at 3 Months n (%)	10 (76.9%)	9 (75.0%)	0.909
Union at 6 Months, n (%)	13 (100%)	12 (100%)	0.982
Loss of Reduction, n (%)	2 (15.4%)	0 (0%)	0.169
Implant Back-out/Migration, n (%)	3 (23.1%)	0 (0%)	0.079

Functional Outcomes and Range of Motion at follow-up are given in [Table 4]. A critical analysis of the table showed that both groups of patients showed progressive improvement in elbow range of motion over time, from 6 weeks, 3 months, and 6 months. Flexion-extension arch was slightly better in the LP group, but the differences between the two groups were not statistically significant. At the final follow-up, a greater proportion of patients in the LP group were able to achieve an excellent range of motion (≥130°), although the differences were not statistically significant.

Table 4: Functional Outcomes - Range of Motion (Degrees)

Time of Follow-up	Flexion-Extension Arc (°)		p-value
	Group A (TBW)	Group B (Plate)	
6 Weeks	78.5 ± 20.4	85.2 ± 18.7	0.401
3 Months	112.3 ± 15.6	118.8 ±12.9	0.247
6 Months	128.7 ± 10.5	132.4 ± 8.8	0.327
Final ROM (6 Months)			
Excellent (≥130°)	8 (61.5%)	9 (75.0%)	0.474
Good (100-129°)	4 (30.8%)	3 (25.0%)	0.745
Fair/Poor (<100°)	1 (7.7%)	0 (0%)	0.334

Mayo Elbow Performance Scores (MEPS) to assess functional outcomes are presented in [Table 5]. Analysis of the table showed a steady, gradual improvement in both groups. Mean MEPS at 3 months was Group A 78.6 ± 12.4 and Group B 82.5 ± 10.8. Similarly, at 6 months, the locking plate group demonstrated a slightly higher mean MEPS (93.7 ± 6.5) compared to the TBW group (90.8 ± 8.2), but the difference was not statistically significant (p = 0.324). A higher proportion of patients in the locking plate group achieved excellent MEPS outcomes with no significant difference in elbow performance at final follow-up.

Table 5: Functional Outcomes- Mayo Elbow Performance Score (MEPS)

Time Point 1 MEPS Category	Group A Tension Band Wiring (n=13)	Group B Locking Plate (11=12)	p-value
MEPS at 3 Months	78.6 ± 12.4	82.5 ± 10.8	0.392
MEPS at 6 Months	90.8 ± 8.2	93.7 ± 6.5	0.324
Final MEPS (6 Months) Category			
Excellent (90-100)	9 (69.2%)	10 (83.3%)	0.408
Good (75-89)	3 (23.1%)	2 (16.7%)	0.671
Fair (60-74)	1 (7.7%)	0 (0%)	0.334
Poor (<60)	0 (0%)	0 (0%)	-
Mean Final MEPS	90.8 ± 8.2	93.7 ± 6.5	0.324

The rate of Complications and Re-operations is depicted in [Table 6]. The overall complication rate was higher in the TBW group (46.2%) compared to the locking plate group (16.7%), though this difference did not reach statistical significance. Hardware-related complications and symptomatic implant prominence requiring removal were notably more frequent in the TBW group. Re-operation rates followed a similar trend. The results showed that TBW is associated with a higher incidence of implant-related complications and secondary procedures, whereas locking plate fixation appears to offer improved implant tolerance.

Table 6: Complications and Re-operations Complication

	Group A: Tension Band Wiring (n=13)	Group B: Locking Plate (n=12)	p-value
Overall Complication Rate	6 (46.2%)	2 (16.7%)	0.105
Specific Complications			
Superficial Infection	2 (15.4%)	1 (8.3%)	0.577
Prominent Hardware / Irritation	4 (30.8%)	1 (8.3%)	0.141
Ulnar Neuropathy (transient)	1 (7.7%)	0 (0%)	0.334
Non-union	0 (0%)	0 (0%)	-
Symptomatic Hardware Requiring Removal	5 (38.5%)	1 (8.3%)	0.072
Re-operation Rate (Hardware Removal)	5 (38.5%)	1 (8.3%)	0.072

Discussion

Displaced Olecranon fractures require stable fixation for the restoration of articular congruity of the elbow joint and allow early mobilization, which is a critical factor for optimal functional recovery. The current study was done to compare the radiological and functional outcomes of displaced olecranon fractures managed with tension band wiring and locking plate osteosynthesis. The objective was to compare the union rates, elbow functions, and complication rates in the two groups of patients. The results of this study showed that the patients allocated to both groups were comparable demographically and clinically, without any confounding variables [Table 1]. This ensures a valid outcome comparison of both techniques. The nature of injury, as determined by Mayo classification, showed Mayo type IIA was common fractures in both groups, which result from simple falls or road traffic accidents. The results of our study agree with a similar pattern reported by other studies. [15,16] The fact that the time to surgery is similar in groups also contributes to the homogeneity of management guidelines. The operative time was shorter in the TBW group, which is consistent with previous literature on TBW studies, because TBW is a simpler and faster method. [17,18] However, despite the increased time of surgery, the locking plate fixation did not lead to an increase in the length of hospital stay or delay in rehabilitation. Interestingly, we found that the patients treated with locking plates had an early onset of active range of motion, which could be attributed to greater construct stability offered by plate fixation.[19]

Assessment of patients in follow-up showed that at the end of six months, radiological union was achieved by 100% of cases in both groups, which confirms that these techniques were successful in achieving fracture healing. Studies by Duckworth et al,[20] and Buijze et al,[21] have also reported no differences in fracture union rates between TBW and LP groups. However, loss of reduction and implant migration occurred only in the TBW group of cases in this study, although the values were not found to be significant. This showed that TBW has biomechanical limitations and is particularly evident in comminuted fractures and osteoporotic bones. Assessment of functional outcomes using range of motion and MEPS scores showed progressive improvement in both groups with no statistically significant difference at the end of the follow-up. These results are similar to various comparative studies done in this field that indicate the same long-term functional outcomes in both TBW and plate fixation. [22,23] However, more patients in the locking plate group attained excellent functional scores and greater arcs of flexion and extension, which indicates the potential functional benefit of locking plates. The complication rates were different in the two groups in the study; we found that TBW has a slightly higher rate of complications in the form of hardware prominence, implant irritation, and reoperation for implant removal. Other studies with TBW have also reported similar rates of complications, ranging from 30% to 80% most of which were due to symptomatic failure of hardware. [24,25] Although LP is not without complications, these locking plates were providing superior implant tolerance and hence a lower need for secondary procedures. These observations showed that locking plate fixation is particularly beneficial in active individuals and those with comminuted fracture patterns. The results and observations of this study must be applied with an understanding of its limitations, which included a smaller sample size and short duration of follow-up due to time constraints. Therefore, larger randomized controlled trials are required to

evaluate the best fixation strategy for different olecranon fracture subtypes.

Conclusion

Within the limitations of the present study, we found that tension band wiring and locking plate osteosynthesis are effective surgical methods for the management of displaced olecranon fractures. Both procedures were able to achieve satisfactory radiological union and functional recovery. The functional recovery, as assessed by Mayo Elbow Performance Score, was found to be similar in both groups. However, lower rates of implant-related complications and lower reoperation rates were observed in locking plate osteosynthesis groups. Therefore, TBW remains a simple and cost-effective technique for selected fracture patterns, whereas locking plate osteosynthesis may be more suitable for comminuted fractures and patients with higher functional demands.

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Conflicts of interest

There are no conflicts of interest.

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