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COMPARISON OF FUNCTIONAL OUTCOMES OF TENSION BAND WIRING VERSUS PLATE FIXATION IN OLECRANON FRACTURES: A RANDOMIZED CLINICAL TRIAL

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ABSTRACT

Background: Displaced olecranon fractures may impair elbow extension and joint alignment. Tension band wiring (TBW) and plate fixation (PF) are commonly used, but their functional outcomes during early recovery remain uncertain.

Objective: To compare the mean Mayo Elbow Performance Score (MEPS) at three months after TBW and PF in adults with Mayo type II olecranon fractures.

Materials and Methods: An open-label, parallel-group randomized clinical trial was conducted at the Department of Orthopaedics, RYK Medical and Dental College and Hospital, Rahim Yar Khan. A total of 106 adults aged 18–65 years with closed, displaced, stable Mayo IIA or IIB fractures were allocated to TBW (n = 53) or PF (n = 53). The primary outcome was the three-month MEPS. Welch's t-test was used for continuous outcomes and Fisher's exact test for categorical outcomes.

Results: Mean three-month MEPS was 84.62 ± 9.50 in the TBW group and 90.28 ± 9.27 in the PF group. The mean difference (PF minus TBW) was 5.66 points (95% confidence interval [CI], 2.04–9.28; p = 0.002). Excellent MEPS (90–100) was recorded in 24/53 (45.3%) and 36/53 (67.9%) patients, respectively (p = 0.031). Implant-site irritation was reported in 8/53 (15.1%) after TBW and 5/53 (9.4%) after PF (p = 0.555). Radiographic signs consistent with healing were present in 53/53 (100%) and 51/53 (96.2%), respectively (p = 0.495).

Conclusion: Plate fixation was associated with a higher mean MEPS at three months. The short follow-up and low number of complications do not allow conclusions about long-term outcomes or comparative safety.

KEYWORDS: Olecranon fracture; Tension band wiring; Plate fixation; Mayo Elbow Performance Score; Elbow function.

INTRODUCTION

Olecranon fractures involve the articular surface of the proximal ulna. Displacement may disrupt the trochlear notch, triceps insertion and active elbow extension. These fractures occur after direct trauma or indirect loading through the triceps. Their causes and patterns vary with age, and falls are particularly common among older adults [1,2]. Displaced fractures in medically fit adults are generally treated surgically to restore articular alignment and the extensor mechanism and allow early elbow movement. Inadequate reduction or fixation may lead to pain, restricted motion, weakness and post-traumatic arthritis. Anteroposterior and lateral radiographs are used to assess displacement, comminution and joint stability and to classify the fracture according to the Mayo system [3,4].

Tension band wiring converts tensile forces across a suitable transverse fracture into compression and remains widely used because of its relatively low cost. Dorsal plate fixation provides an alternative, particularly for comminuted fractures or poor bone quality [5]. Previous studies have not consistently shown better functional outcomes with either technique. Giardina et al. reported mean MEPS values of 80.5 ± 14.7 after TBW and 75.6 ± 15.3 after PF in 72 patients with Mayo IIA fractures (p = 0.17) [6]. A meta-analysis of 2,164 patients found similar MEPS values for TBW and PF (92.0 ± 5.4 versus 92.3 ± 3.7; p = 0.65), but implant removal and reoperation were more frequent after TBW [7]. Duckworth et al. found no significant difference in functional outcome at one year in a randomized trial of 67 patients [8]. In a later multicentre randomized trial of 200 patients, TBW was noninferior to PF for the primary QuickDASH outcome at 12 months, although further procedures were more frequent after TBW [9].

These results need to be interpreted in relation to fracture pattern, follow-up duration and rehabilitation. Similar functional scores at one year do not exclude a difference during early recovery. A trial with extended follow-up also found differences in implant-related procedures despite similar disability scores [10]. Implant availability, cost and fracture configuration can influence the choice of treatment. Evidence on early function remains relevant to clinical practice. This study compared mean MEPS at three months after TBW and PF in adults with displaced, stable Mayo type II olecranon fractures.

MATERIALS AND METHODS

An open-label randomized clinical trial was conducted in the Department of Orthopaedics, RYK Medical and Dental College and Hospital, Rahim Yar Khan, from January to December 2025. Patients meeting the eligibility criteria were enrolled consecutively and assigned to one of two treatment groups by random allocation. The reported sample comprised 106 patients, with 53 in each group.

The sample size was calculated for a comparison of two independent means using previously published MEPS values of 90.0 ± 14.0 for TBW and 96.0 ± 6.8 for PF [8]. A two-sided significance level of 0.05, 80% power and equal allocation were used in the standard formula [11]:

$$n = \frac{\left(Z_{1-\alpha/2} + Z_{1-\beta}\right)^2 (\sigma_1^2 + \sigma_2^2)}{(\mu_1 - \mu_2)^2} = \frac{(1.96 + 0.84)^2 (14.0^2 + 6.8^2)}{(90.0 - 96.0)^2} \approx 52.81 \text{ per group.}$$

Here, n denotes the required number per treatment group; $Z_{1-\alpha/2}$ and $Z_{1-\beta}$ are the standard normal quantiles corresponding to the two-sided type I error and power; σ_1 and σ_2 are the anticipated standard deviations; and $\mu_1 - \mu_2$ is the expected between-group mean difference. Rounding upward gave 53 patients per group and 106 in total.

Patients aged 18–65 years with a closed, radiographically confirmed Mayo IIA or IIB olecranon fracture, a stable ulnohumeral joint, presentation within 14 days of injury and American Society of Anesthesiologists (ASA) physical status I–III were eligible. Patients with open or pathological fractures; additional ipsilateral periarticular fractures or ligamentous instability requiring reconstruction; polytrauma or head injury that prevented rehabilitation; metabolic bone disease other than age-related osteopenia; previous surgery, arthritis or deformity of the affected elbow; relevant neurological deficit or vascular injury requiring repair; or active local or systemic infection were excluded. Fractures were classified on anteroposterior and lateral elbow radiographs. Age, sex, affected side, mechanism of injury, injury-to-surgery interval, Mayo subtype, ASA class and comorbidities were recorded on a structured proforma.

A computer-generated randomization sequence was used for 1:1 allocation. Treatment assignments were placed in sequentially numbered, opaque, sealed envelopes opened immediately before fixation. Both groups underwent a posterior surgical approach, fracture reduction and intraoperative assessment of fixation stability. In the TBW group, two parallel Kirschner wires were advanced from the olecranon tip across the fracture. A stainless-steel wire was passed through a transverse drill hole in the distal ulna, tightened in a figure-of-eight configuration and secured. In the PF group, a precontoured dorsal olecranon plate or a comparable plate was applied after reduction. Screw placement was determined by fracture configuration and bone quality, and interfragmentary compression was permitted where appropriate. Tourniquet use was based on clinical suitability. Preoperative assessment, laboratory investigations, prophylactic antibiotics, anaesthesia and wound care followed institutional practice; no uniform antibiotic regimen was specified.

Postoperative care was similar in both groups and included limb elevation, short-term splinting for comfort, analgesia, wound care and supervised elbow movement as pain permitted. Wound review and suture removal were performed approximately 10 days after surgery. Clinical and radiographic assessments were performed at three months. The primary outcome was the three-month MEPS, a 100-point score comprising pain (45 points), motion (20 points), stability (10 points) and daily activities (25 points), with higher scores indicating better function [12]. Scores of 90–100, 75–89, 60–74 and below 60 were categorized as excellent, good, fair and poor, respectively. Radiographic signs consistent with healing, loss of reduction, implant-site irritation and local infection were also recorded. The reporting was reviewed with reference to the CONSORT 2025 recommendations [13].

Data were analysed using SPSS version 26. Quantitative variables were reported as mean ± standard deviation (SD), and categorical variables as frequencies and percentages. The Shapiro–Wilk test was specified to assess normality. Mean MEPS values between the two groups were compared using Welch's independent-samples t-test, with the mean difference and 95% CI reported. Fisher's exact test was used for categorical outcomes with small cell counts. Additional comparisons were made according to Mayo subtype, age, sex and ASA class. These subgroup analyses were not adjusted for multiple testing, and no treatment-by-subgroup interaction test was reported. All p-values were two-sided, and $p < 0.05$ was taken as statistically significant.

RESULTS

A total of 106 patients were included, with 53 allocated to TBW and 53 to PF. A three-month MEPS result was reported for all 106 patients. The mean age was 40.13 ± 12.23 years in the TBW group and 40.74 ± 12.27 years

in the PF group. Mayo IIA fractures were present in 41 (77.4%) and 33 (62.3%) patients, respectively; Mayo IIB fractures were present in 12 (22.6%) and 20 (37.7%) patients. Baseline characteristics are presented in Table 1.

Table 1. Baseline demographic and clinical characteristics of the study groups

Characteristic	TBW (n = 53)	PF (n = 53)
Age, years, mean ± SD	40.13 ± 12.23	40.74 ± 12.27
Male sex	35 (66.0%)	42 (79.2%)
Female sex	18 (34.0%)	11 (20.8%)
Right-sided fracture	29 (54.7%)	31 (58.5%)
Left-sided fracture	24 (45.3%)	22 (41.5%)
Fall	27 (50.9%)	28 (52.8%)
Road traffic accident	20 (37.7%)	18 (34.0%)
Assault/other mechanism	6 (11.3%)	7 (13.2%)
Injury-to-surgery interval, days, mean ± SD	6.42 ± 3.60	7.66 ± 3.70
Mayo type IIA	41 (77.4%)	33 (62.3%)
Mayo type IIB	12 (22.6%)	20 (37.7%)
ASA I	36 (67.9%)	31 (58.5%)
ASA II	16 (30.2%)	19 (35.8%)
ASA III	1 (1.9%)	3 (5.7%)
Diabetes mellitus	9 (17.0%)	7 (13.2%)
Hypertension	9 (17.0%)	13 (24.5%)

Note. Values are number (%) unless otherwise stated. TBW, tension band wiring; PF, plate fixation; SD, standard deviation; ASA, American Society of Anesthesiologists.

At three months, mean MEPS was 84.62 ± 9.50 in the TBW group and 90.28 ± 9.27 in the PF group. The mean difference (PF minus TBW) was 5.66 points (95% CI, 2.04–9.28; p = 0.002). The main differences were in the pain and daily-activity components, whereas motion and stability scores were similar. An excellent MEPS (90–100) was recorded in 24 patients (45.3%) after TBW and 36 (67.9%) after PF (p = 0.031). Component scores and MEPS categories were additional outcomes, not separate primary endpoints (Table 2).

Table 2. Mayo Elbow Performance Score and component scores at three months

Outcome	TBW (n = 53)	PF (n = 53)	Mean difference: PF − TBW (95% CI)	p-value
Total MEPS, mean ± SD	84.62 ± 9.50	90.28 ± 9.27	5.66 (2.04–9.28)	**0.002**
Pain component (0–45)	37.08 ± 8.63	40.47 ± 7.55	—	0.033
Motion component (0–20)	18.30 ± 2.93	18.58 ± 2.84	—	0.615
Stability component (0–10)	9.72 ± 1.17	9.81 ± 0.96	—	0.651
Function component (0–25)	19.53 ± 3.43	21.42 ± 3.59	—	0.007
Excellent MEPS (90–100), n (%)	24 (45.3%)	36 (67.9%)	—	0.031
Good MEPS (75–89), n (%)	25 (47.2%)	15 (28.3%)	—	—
Fair MEPS (60–74), n (%)	4 (7.5%)	2 (3.8%)	—	—
Poor MEPS (<60), n (%)	0 (0%)	0 (0%)	—	—

Note. Values are mean ± SD or number (%). Higher MEPS indicates better function. Component and category comparisons were additional analyses.

At three months, symptomatic implant-site irritation was reported in 8 patients (15.1%) after TBW and 5 (9.4%) after PF (p = 0.555). Loss of reduction occurred in 2 patients (3.8%) and 1 patient (1.9%), respectively (p > 0.999). Local postoperative infection was recorded in 2 patients (3.8%) after TBW and none after PF (p = 0.495). Radiographic findings consistent with healing were reported in 53 (100%) and 51 (96.2%) patients, respectively (p = 0.495). The low event counts limit interpretation of these comparisons (Table 3).

Table 3. Radiographic and postoperative findings at three months

Finding	TBW (n = 53)	PF (n = 53)	Fisher exact p-value
Radiographic signs consistent with healing	53 (100%)	51 (96.2%)	0.495
Loss of fracture reduction	2 (3.8%)	1 (1.9%)	>0.999
Symptomatic implant-site irritation	8 (15.1%)	5 (9.4%)	0.555
Postoperative local infection	2 (3.8%)	0 (0%)	0.495

Note. P-values are from Fisher's exact test. Radiographic findings were recorded at three months and should not be taken as confirmation of complete union.

Mean MEPS was higher after PF in both Mayo IIA and IIB fractures. Among patients with Mayo IIA fractures, mean MEPS was 86.59 after TBW and 90.76 after PF (p = 0.057). Among those with Mayo IIB fractures, mean MEPS was 77.92 and 89.50, respectively (p = 0.004). Results by age, sex and ASA class are shown in Table 4. These are descriptive subgroup comparisons; no interaction analysis was reported to establish whether the effect of fixation differed between subgroups.

Table 4. Subgroup comparisons of three-month Mayo Elbow Performance Score

Stratum	TBW n	TBW MEPS, mean	PF n	PF MEPS, mean	Mean difference (PF − TBW)	p-value
Mayo IIA	41	86.59	33	90.76	4.17	0.057
Mayo IIB	12	77.92	20	89.50	11.58	0.004
Age 18–40 years	26	83.85	25	88.60	4.75	0.092
Age 41–65 years	27	85.37	28	91.79	6.42	0.010
Male sex	35	84.29	42	90.71	6.43	0.004
Female sex	18	85.28	11	88.64	3.36	0.324
ASA I	36	84.03	31	90.32	6.29	0.008
ASA II–III	17	85.88	22	90.23	4.34	0.181

Note. Subgroup p-values are unadjusted. No treatment-by-subgroup interaction was assessed; these comparisons should be interpreted cautiously.

DISCUSSION

At three months, patients treated with PF had a higher mean MEPS than those treated with TBW. The between-group difference was 5.66 points (95% CI, 2.04–9.28). Pain and daily activities accounted for most of the difference, while motion and stability scores were similar. Few complications were recorded in either group, and their rates could not be compared reliably. Although statistically significant, the clinical importance of the 5.66-point difference is uncertain. Because follow-up was limited to three months, the findings describe early recovery and do not establish a long-term functional advantage for PF.

Other studies have generally reported similar functional scores after TBW and PF at longer follow-up. Giardina et al. studied 38 patients treated with TBW and 34 treated with PF and found mean MEPS values of 80.5 ± 14.7 and 75.6 ± 15.3, respectively (p = 0.17) [6]. Their findings differed in direction from the present results, possibly because of differences in fracture characteristics, follow-up and patient selection. Bethell et al. analysed 20 studies involving 2,164 patients and found similar MEPS values after TBW and PF (92.0 ± 5.4 versus 92.3 ± 3.7; p = 0.65) [7]. The pooled results included different surgical methods and follow-up periods. An earlier meta-analysis of 13 studies also found no significant difference in DASH scores (standardized mean difference 0.07; 95% CI, −0.32 to 0.46; p = 0.73), but complications were more frequent after TBW (odds ratio 2.61; 95% CI, 1.65–4.14) [14].

Randomized trials are particularly useful because fracture complexity can influence implant selection in observational studies. Duckworth et al. randomized 67 patients (34 TBW and 33 PF) and found no significant difference in the primary DASH score at one year (12.8 versus 8.5; p = 0.315) [8]. Midtgaard et al. randomized 200 patients with two-part or multifragmentary fractures and reported that TBW was noninferior to PF on the 12-month QuickDASH score [9]. Avisar et al. randomized 50 patients with simple displaced fractures and found no difference in DASH at one year (p = 0.73), although subsequent implant removal differed between groups [10]. These findings do not exclude a difference at three months, but they do not support a lasting functional advantage for either technique. As the present trial was open-label and assessor blinding was not documented, pain and function scores may have been affected by measurement bias.

Earlier studies provide further information on clinical outcomes. Hume and Wiss reported good clinical results in 19 of 22 patients treated with plates and 9 of 19 treated with TBW [15]. Their assessment did not use MEPS and therefore cannot be compared directly with the present scores. Chalidis et al. followed 62 patients treated with TBW and reported satisfactory long-term elbow function, although symptomatic hardware remained a concern [16]. Scrivano et al. described eyelet-pin tension band fixation in 15 patients with Mayo type II fractures, reflecting continued efforts to reduce complications related to conventional Kirschner wires [17]. The fixation devices and outcome measures differed across these reports.

Complications should be considered separately from functional scores. Duckworth et al. reported complications in 63% of patients treated with TBW and 38% treated with plates (p = 0.042), mainly related to symptomatic implant removal (50% versus 22%; p = 0.021). Serious infection and revision surgery were more common in the plate group in that trial [8]. Bethell et al. reported implant removal rates of 31.4% after TBW and 14.3% after PF, and overall reoperation rates of 35.3% and 17.7%, respectively (both p < 0.01) [7]. During longer-term follow-up, Avisar et al. reported symptomatic implant removal in 8 of 23 patients after TBW and 1 of 19 after PF (p = 0.02) [10]. These outcomes cannot be compared directly with implant-site irritation assessed after only

three months. A 2026 meta-analysis of randomized trials also reported higher risks of overall complications (risk ratio 1.53; 95% CI, 1.10–2.11) and reoperation (risk ratio 1.47; 95% CI, 1.10–1.95) after TBW, without a significant difference in pooled functional scores [18].

Fracture pattern influences the choice and stability of fixation. Mayo IIB fractures are comminuted and may require control of several fragments during elbow movement. Chapleau et al. described a fragment-specific classification for complex olecranon fractures [19]. Ingwersen et al. reported a median MEPS of 90 (interquartile range, 80–100) after orthogonal plating in 23 patients, but their study did not include a comparison group [20]. In the present study, the between-group difference in MEPS was numerically greater for Mayo IIB than Mayo IIA fractures. However, the small and unequal subgroup sizes and absence of an interaction test prevent any conclusion that fracture subtype altered the relative effect of treatment. Further trials should assess this question with prespecified subgroup analyses. Fixation should also take account of comminution and patient requirements [5,21].

Joshi et al. examined operative and nonoperative treatment of olecranon fractures in older adults and showed that the benefits of surgery must be weighed against treatment burden and functional requirements [22]. A Cochrane review of six trials involving 244 adults found that evidence comparing fixation methods was limited and generally of low quality [23]. Strengths of the present study included randomized allocation, a defined three-month outcome, similar postoperative care and classification by Mayo subtype. Limitations included the open-label design, short follow-up, absence of documented assessor blinding, limited information on the assessment of radiographic healing and few postoperative events. Subgroup results were based on small numbers and were not supported by interaction tests. Longer follow-up is needed to examine maintenance of function, nonunion, hardware-related symptoms and implant removal.

CONCLUSION

Plate fixation was associated with a higher mean Mayo Elbow Performance Score than tension band wiring at three months in adults with Mayo type II olecranon fractures. The findings concern early functional recovery. Longer follow-up and more patients are needed to assess whether the difference persists and to compare complications.

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