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Operative Management of Displaced Mayo Type II Olecranon Fractures: A Retrospective Comparison of Tension Band Wiring and Dorsal Plate Fixation

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Abstract:

- ***Background:***

Displaced fractures of the olecranon compromise the elbow extensor mechanism and generally require internal fixation to restore joint surface alignment and allow early movement. While tension band wiring (TBW) and dorsal plate fixation (PF) are the two standard operative techniques, debate persists regarding which construct offers superior clinical results.

- ***Objective:***

To evaluate and compare bone healing timelines, functional recovery, and postoperative adverse events between TBW and dorsal PF in adult patients with displaced Mayo Type II olecranon fractures followed for 6 months.

- ***Methods:***

We performed a retrospective comparative review of hospital records at the Department of Orthopaedics, RKDF Medical College Hospital and Research Centre, Bhopal, Madhya Pradesh, India. Sixty adult patients presenting with closed, displaced Mayo Type II fractures were divided equally into two cohorts based on the fixation received: 30 underwent TBW and 30 underwent dorsal PF. Patient demographics, surgical duration, time to radiological union, Visual Analog Scale (VAS) pain scores, Mayo Elbow Performance Score (MEPS), active elbow arc of motion, and clinical complications over a 6-month follow-up were extracted from medical charts and radiographs. Continuous data were evaluated using the independent-samples t test or Mann–Whitney U test, whereas categorical variables were analysed via the Chi-square or Fisher's exact test.

- ***Results:***

Every patient across both cohorts demonstrated complete bony union on radiographs by the 6-month mark. Mean surgical time was notably brief in the TBW cohort (48.5 ± 8.4 minutes) compared with the PF cohort (64.2 ± 11.6 minutes; $p < 0.001$). Average healing time was similar between TBW (10.4 ± 1.6 weeks) and PF (10.8 ± 1.8 weeks; $p = 0.370$). At final follow-up, 90.0% (27/30) of patients treated with TBW and 96.7% (29/30) of those treated with PF achieved good or excellent MEPS ratings ($p = 0.612$), alongside comparable pain relief and elbow mobility. Postoperative issues were infrequent (3/60, 5.0%), comprising two reports of mild palpable hardware beneath the skin in the TBW group and one case of mild joint stiffness in the PF group.

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➢ ***Conclusion:***

Both TBW and dorsal plating deliver reliable bone healing, low complication rates, and satisfactory 6-month elbow function for displaced Mayo Type II olecranon fractures. Surgeons should tailor implant choice to the specific fracture geometry, bone density, and condition of the overlying soft tissues.

Keywords: *Elbow Trauma; Functional Recovery; Mayo Elbow Performance Score; Olecranon Osteosynthesis; Plating; Tension Band Construct.*

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I. INTRODUCTION

Fractures involving the olecranon represent roughly 10% of all upper-extremity injuries, 18% of forearm fractures, and close to 37% of bony injuries around the elbow.[1-3] Their incidence peaks in two distinct age groups: younger individuals sustaining high-energy trauma and older adults experiencing low-energy falls onto a bent elbow against osteoporotic bone.[1,4] Because this bony prominence forms the posterior buttress of the trochlear notch and serves as the insertion site for the triceps brachii, displaced injuries disrupt the articular surface and require open reduction and internal fixation (ORIF) to re-establish joint congruity and active elbow extension.[2,5,6] Simple, non-comminuted transverse fractures (Mayo Type IIA) account for nearly 85% of adult presentations.[2,6]

Tension band wiring (TBW) operates by redirecting posterior tensile forces generated by the triceps into dynamic compression across the joint surface using two parallel Kirschner wires (K-wires) and a dorsal figure-of-eight stainless steel wire.[2,6] Across Indian orthopaedic centres, TBW remains a staple technique because it is familiar to most surgeons, requires minimal periosteal stripping, shortens anaesthesia time, and keeps implant expenses low—though prominence of the K-wires under thin posterior skin can cause local discomfort.[2,3,6,7] On the other hand, dorsal plate fixation (PF) acts as a rigid neutralization buttress that provides superior screw hold in osteoporotic or comminuted fractures (Mayo Type IIB), though it demands broader soft-tissue dissection, longer theatre time, and greater implant expenditure.[5,6,8]

Given that recent clinical trials and meta-analyses have yet to establish a clear consensus on which technique is superior,[2,6,8,9] we reviewed our institutional experience to compare healing rates, functional recovery, and complications between TBW and dorsal PF in displaced Mayo Type II olecranon fractures over 6 months.

II. MATERIALS AND METHODS

➢ *Study Design, Setting, and Participants*

We carried out a single-centre retrospective comparative review within the Department of Orthopaedics at RKDF Medical College Hospital and Research Centre, Bhopal, Madhya Pradesh, India, after obtaining formal clearance from the Institutional Ethics Committee. Inpatient files, operative notes, and serial radiographs of adults who underwent ORIF for displaced olecranon fractures were examined across a 6-month postoperative window.

Eligible subjects were adults aged 18 years or older presenting with acute, closed, isolated displaced olecranon fractures (Mayo Type II / AO-OTA 2U1B1, defined by an articular step-off exceeding 2 mm) managed with either standard TBW or single dorsal PF and possessing complete 6-month follow-up records. We excluded paediatric patients with open physes, open or pathological injuries, Mayo Type III fracture-dislocations, associated fractures in the same upper limb, alternative fixation constructs, and cases lost to follow-up. Sixty consecutive patients met these criteria, forming two equal groups of 30 patients each.

➢ *Surgical Technique and Postoperative Protocol*

All procedures were carried out under regional brachial plexus blockade or general anaesthesia with the patient positioned either lateral decubitus or prone. Following inflation of an upper-arm tourniquet, the fracture was exposed through a midline posterior incision curved slightly radially around the olecranon tip:

- Tension Band Wiring (TBW, n = 30): Once the articular surface was reduced anatomically, two 1.6-mm K-wires were driven parallel and antegrade across the fracture site to purchase the anterior cortex of the distal ulna. A transverse 2.0-mm drill hole was created 3.5–4 cm distal to the fracture line, through which an 18-gauge stainless steel wire was routed in a figure-of-eight configuration and tightened evenly. The proximal ends of the K-wires were bent and buried beneath the split triceps tendon fibres.
- Plate Fixation (PF, n = 30): Either an anatomical pre-contoured proximal ulnar locking compression plate (LCP) or a one-third tubular plate was positioned over the dorsal surface of the ulna and fixed using proximal cancellous/locking screws and distal bicortical shaft screws under C-arm guidance.

Postoperatively, all limbs were rested in a posterior above-elbow plaster slab at 90° of elbow flexion for 10 to 14 days. After skin sutures were removed, patients began supervised active-assisted and gentle passive range-of-motion exercises, advancing to progressive strengthening at 6 weeks.

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➢ *Outcome Assessment and Statistical Analysis*

Routine clinical and radiological evaluations took place at 2 weeks, 6 weeks, 3 months, and 6 months post-surgery. Bone union was confirmed when bridging trabeculae were visible across a minimum of three cortices on anteroposterior and lateral radiographs. At the 6-month visit, functional recovery was quantified via goniometric measurement of elbow motion, pain intensity on a 0–10 Visual Analog Scale (VAS), and the Mayo Elbow Performance Score (MEPS), categorized as Excellent (90–100), Good (75–89), Fair (60–74), or Poor (< 60). All clinical adverse events noted during outpatient visits were recorded.

Statistical processing was performed in IBM SPSS Statistics. Continuous measurements are expressed as mean ± standard deviation (SD) and analysed via the independent-samples t test or Mann–Whitney U test depending on distribution normality. Categorical counts are summarized as percentages and compared using the Chi-square or Fisher's exact test, taking $p < 0.05$ as the threshold for statistical significance.

III. RESULTS

➢ *Baseline Characteristics and Operative Duration*

All 60 patients (30 per group) completed their scheduled 6-month evaluation. The overall cohort had a mean age of 42.6 ± 14.8 years (41.2 ± 14.3 years in TBW vs. 44.0 ± 15.4 years in PF; p = 0.471) and a male predominance of 63.3% (38/60; 20 males [66.7%] and 10 females [33.3%] in TBW vs. 18 males [60.0%] and 12 females [40.0%] in PF; p = 0.592). Simple domestic falls accounted for 58.3% (35/60) of the fractures, followed by road traffic collisions at 31.7% (19/60) and falls from height at 10.0% (6/60). Fracture morphology was similarly distributed between groups, with Mayo Type IIA comprising 73.3% (44/60; 23 [76.7%] in TBW vs. 21 [70.0%] in PF) and Type IIB comprising 26.7% (16/60; 7 [23.3%] in TBW vs. 9 [30.0%] in PF; p = 0.559), alongside comparable mean preoperative displacement (5.2 ± 1.6 mm vs. 5.6 ± 1.9 mm; overall 5.4 ± 1.8 mm; p = 0.382). However, mean theatre time was substantially shorter for TBW than for dorsal plating (48.5 ± 8.4 min vs. 64.2 ± 11.6 min; overall 56.4 ± 12.8 min; p < 0.001).

➢ *Radiological, Functional, and Complication Outcomes*

Bony union was achieved in every single patient (60/60, 100%) within the 6-month study window. Average time to radiographic healing was virtually identical between the TBW group (10.4 ± 1.6 weeks) and the PF group (10.8 ± 1.8 weeks; p = 0.370) (Table 1, Figure 1A). At 6 months, active flexion arc, terminal extension lag, steady decline in VAS pain scores, and MEPS grades showed no statistically meaningful differences between the two surgical methods, with 90.0% (27/30) of TBW patients and 96.7% (29/30) of PF patients attaining good-to-excellent functional outcomes (Table 1).

Overall morbidity was low, with only three minor complications observed across the entire study population (3/60, 5.0%) (Table 1, Figure 1B). Two individuals in the TBW cohort (6.7%) noticed mild subcutaneous prominence of the hardware over the back of the elbow, though neither experienced functional restriction or requested implant extraction. In the PF cohort, one patient (3.3%) developed mild residual stiffness (a 15° extension deficit) that responded satisfactorily to targeted physiotherapy. No deep or superficial surgical site infections, K-wire back-out, nonunions, or ulnar nerve symptoms were encountered.

Table 1 Radiological, Functional, and Complication Outcomes at 6 Months

Outcome Parameter	TBW (n = 30)	PF (n = 30)	Total (N = 60)	p value
Time to radiographic union, weeks	10.4 ± 1.6	10.8 ± 1.8	10.6 ± 1.7	0.370
Elbow Flexion Arc, degrees	134.5 ± 6.8	136.2 ± 5.9	135.4 ± 6.4	0.305
Extension Deficit, degrees	4.2 ± 2.4	3.8 ± 2.1	4.0 ± 2.2	0.495
Mean MEPS (0–100)	91.4 ± 7.2	93.2 ± 6.1	92.3 ± 6.7	0.301
VAS Pain Score (Baseline / 3 Mo / 6 Mo)	7.6 / 3.4 / 1.5	7.8 / 3.2 / 1.3	7.7 / 3.3 / 1.4	0.166 (6 Mo)
Total Complications, n (%) (2 implant prominence in TBW; 1 stiffness in PF)	2 (6.7%)	1 (3.3%)	3 (5.0%)	1.000

(Insert Figure 1: Visual summary showing [A] Mean time to radiographic union with SD error bars, [B] Overall postoperative complication proportion [3/60, 5.0%], [C] MEPS functional outcome grading at 6 months, and [D] Postoperative VAS pain trajectory.)

IV. DISCUSSION

Our clinical audit of 60 patients managed at RKDF Medical College Hospital and Research Centre, Bhopal, indicates that both TBW and dorsal PF reliably secure union (100%), substantially alleviate pain, and restore high levels of elbow function within 6 months, accompanied by a low overall complication rate of 5.0%.

The demographic profile of our cohort—characterized by a male majority (63.3%) and an average age of 42.6 years—closely parallels broader epidemiological findings reported by Duckworth et al.[1] as well as Indian clinical data from Tada et al.,[3] where domestic falls and vehicular accidents predominate. During surgery, TBW took roughly 16 minutes less to perform than dorsal plating (48.5 ± 8.4 min vs. 64.2 ± 11.6 min; p < 0.001). This time advantage echoes observations by Gong et al.[10] and Gathen et al.,[5] and is largely attributable to a smaller surgical exposure and faster hardware placement. Despite this intraoperative difference, radiological healing timelines (10.4 vs. 10.8 weeks) and 6-month functional scores (MEPS and arc of motion) were virtually indistinguishable between the two techniques, reinforcing conclusions from the randomized trial by Duckworth et al.[9] and comparative cohorts evaluated by Giardina et al.[6] and Çağlar et al.[11]

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Adverse events were limited to three mild cases (5.0%): two instances of palpable subcutaneous wires in the TBW arm and a single case of mild extension stiffness in the plating arm. As highlighted in biomechanical and clinical studies by Wilson et al.[12] and Schneider et al.,[7] the sparse subcutaneous tissue covering the dorsal olecranon leaves patients vulnerable to wire irritation; bending the proximal K-wire tips and seating them deep beneath the split triceps fibres likely kept symptomatic prominence low in our patients. Meanwhile, the lone case of mild postoperative stiffness after plate fixation was probably linked to the wider soft-tissue stripping required for plating and resolved with structured rehabilitation. Certain limitations warrant mention, including the retrospective single-institution design, modest cohort size, and a 6-month observation window that may have missed delayed elective hardware removals.

V. CONCLUSION

Both tension band wiring and dorsal plate fixation represent dependable, safe surgical options for displaced Mayo Type II olecranon fractures, delivering 100% bone union and comparable good-to-excellent elbow function at 6 months. TBW provides the advantage of shorter operative time with a slight risk of palpable subcutaneous hardware, whereas dorsal plating ensures rigid stability with negligible implant prominence. Ultimately, surgeons should base implant selection on fracture configuration, bone stock quality, and soft-tissue envelope integrity.

➢ *Declaration by Authors*

- Ethical Approval: Approved by the Institutional Ethics Committee, RKDF Medical College Hospital and Research Centre, Bhopal, Madhya Pradesh, India.
- Source of Funding: None.
- Conflict of Interest: The authors declare no conflict of interest.

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