RESEARCH PAPER

Comparative Evaluation of Crossing Screw Fixation and Tension Band Wiring for Isolated Non-Comminuted Olecranon Fractures in a Tertiary Care Hospital

Dr. Rohan Raj[1*], Dr. Balaji[2], Dr. Vankamaddi Vishnuvardhan[3]

[1*]Junior Resident, Department of Orthopaedics, Saveetha Medical College and Hospital, Saveetha Institute of Medical and Technical Sciences (SIMATS), Chennai, Tamil Nadu, India

ORCID: 0009-0003-2169-8321

Email: s.romanraj@gmail.com

[2]Senior Resident, Department of Orthopaedics, Saveetha Medical College and Hospital, Saveetha Institute of Medical and Technical Sciences (SIMATS), Chennai, Tamil Nadu, India

ORCID: 0000-0002-8018-1395

[3]Senior Resident, Department of Orthopaedics, Saveetha Medical College and Hospital, Saveetha Institute of Medical and Technical Sciences (SIMATS), Chennai, Tamil Nadu, India

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Abstract

Background: Isolated non-comminuted olecranon fractures are commonly treated surgically to restore articular congruity and elbow function. Tension band wiring (TBW) is a conventional fixation method, but implant prominence, soft-tissue irritation, and prolonged operative time may be concerns. Crossing screw fixation offers an alternative approach that may provide stable interfragmentary compression with less soft-tissue disruption.

Aim: To compare the clinical and radiological outcomes of tension band wiring and crossing screw fixation in the treatment of isolated non-comminuted olecranon fractures.

Materials and Methods: This prospective comparative study was conducted in the Department of Orthopaedics, Saveetha Institute of Medical and Technical Sciences, Chennai, Tamil Nadu, with the study period extending to August 2025. Eighteen patients with isolated non-comminuted Mayo type II-A olecranon fractures, aged 20–60 years, were included. Patients were allocated into two groups: Group A (n=9), treated with tension band wiring, and Group B (n=9), treated with crossing screw fixation. Patients with comminuted fractures, Mayo type I or III fractures, Gustilo–Anderson type III open fractures, pathological fractures, previous proximal ulna fracture with malunion, or pre-existing elbow stiffness were excluded. Clinical and radiological evaluations were performed preoperatively and during postoperative follow-up. Operative time, surgical incision length, time from injury to surgery, and time to fracture union were assessed. Statistical analysis was performed using appropriate comparative tests, with $p < 0.05$ considered statistically significant.

Results: The patients had a mean age within the 20–50-year range, with males comprising 66.7% and females 33.3%. Left-sided injuries accounted for 55.6%, while right-sided injuries accounted for 44.4%. The mean follow-up duration was 8.72 ± 1.36 months, ranging from 6 to 11 months. The interval between injury and surgery was significantly longer in the TBW group compared with the crossing screw group (83.22 ± 24.76 hours vs. 11.11 ± 3.48 hours; $p < 0.001$). Operative time and surgical incision length were significantly greater in the TBW group. Conversely, the time to fracture union was significantly shorter in the crossing screw group. No significant difference was observed between the groups for the remaining assessed outcome parameters.

Conclusion: Both tension band wiring and crossing screw fixation provide satisfactory treatment for isolated non-comminuted olecranon fractures. However, crossing screw fixation demonstrated advantages in terms of shorter operative duration, smaller surgical incision, and faster fracture union. It may therefore be considered an effective minimally invasive alternative to conventional tension band wiring in appropriately selected patients.

Keywords: Olecranon fracture; Tension band wiring; Crossing screws; Cannulated screws; Fracture union; Elbow; Internal fixation.

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Introduction

Olecranon fractures are relatively common injuries of the proximal ulna and account for approximately 10% of fractures involving the upper extremity. They may occur following either direct or indirect trauma, with the mechanism influencing the fracture pattern and degree of displacement. Direct trauma commonly results from a fall or blow to the posterior aspect of the proximal forearm, whereas indirect injury may occur when a person falls on an outstretched hand, producing sudden contraction of the triceps and transmission of force through the elbow. [1,2] Because the olecranon forms an important component of the elbow joint and serves as the insertion site of the triceps mechanism, disruption of its continuity can significantly affect elbow stability and extension.

The treatment of olecranon fractures depends on the fracture pattern, displacement, articular involvement, soft-tissue condition, and functional requirements of the patient. Minimally displaced fractures with an intact extensor mechanism may be treated conservatively; however, displaced intra-articular fractures generally require operative fixation to restore articular congruity, re-establish the extensor mechanism, and permit early elbow mobilization. Anatomical reduction and stable fixation are particularly important because inadequate reduction may lead to loss of elbow function, stiffness, instability, and post-traumatic degenerative changes. [3,4]

Several surgical techniques have been described for fixation of olecranon fractures. Tension band wiring (TBW) has traditionally been considered the standard method for simple, transverse, non-comminuted olecranon fractures. The principle of TBW is to convert tensile forces generated by the triceps mechanism into compression across the fracture site during elbow movement. Its advantages include technical simplicity, relatively low cost, and satisfactory fracture union and functional recovery in appropriately selected fractures. [5] Nevertheless, symptomatic hardware remains a major limitation of TBW. Prominent wires, migration of the metallic construct, local irritation, skin breakdown, and the need for secondary implant removal have been frequently reported. [6,7]

Alternative fixation methods include locking plates, intramedullary devices, interfragmentary screws with or without supplementary wires, and excision of small fracture fragments with triceps advancement in selected cases. Plate fixation can provide greater stability in comminuted or unstable fractures but may require greater soft-tissue exposure and may also be associated with hardware prominence. Large-diameter intramedullary or interfragmentary screws provide another option for simple fracture patterns and can achieve compression while potentially reducing the prominence of fixation material. [8,9]

The biomechanical objective of fixation is to provide sufficient stability to maintain anatomical reduction while permitting early mobilization. A fixation construct that provides interfragmentary compression without excessive soft-tissue disruption may therefore be advantageous for isolated non-comminuted fractures. Crossing screw fixation has been proposed as a minimally invasive alternative in which partially threaded, cannulated screws are placed across the fracture in a crossing configuration. The screws can generate compression across the fracture site while avoiding some of the prominent hardware associated with conventional tension band constructs. [10,11]

Crossing screw fixation may also offer biological advantages by limiting periosteal stripping and preserving the local soft-tissue environment. By achieving stable compression at the fracture site, the technique may facilitate direct fracture healing and permit earlier restoration of elbow movement. However, the technique requires appropriate fracture morphology, accurate screw positioning, adequate bone quality, and protection of the surrounding neurovascular structures. Its effectiveness compared with the established TBW technique therefore warrants clinical evaluation.

Despite the widespread use of TBW, concerns regarding implant-related complications have stimulated interest in alternative fixation methods for simple olecranon fractures. A direct comparison of crossing screw fixation and tension band wiring may help determine whether screw fixation can provide comparable or superior union and functional outcomes while reducing hardware-related morbidity. Therefore, the present study was undertaken to compare the clinical, radiological, and functional outcomes of crossing screw fixation versus tension band wiring in patients with isolated non-comminuted olecranon fractures.

Aim

To compare the clinical, radiological, and functional outcomes of crossing screw fixation versus tension band wiring in the treatment of isolated non-comminuted olecranon fractures.

Objectives

1. To compare the functional outcomes following crossing screw fixation and tension band wiring using a validated elbow functional scoring system.
2. To compare the radiological outcomes, including fracture reduction, maintenance of alignment, and time to fracture union, between the two fixation techniques.
3. To compare the incidence of postoperative complications, particularly implant prominence, hardware irritation, migration, infection, and loss of fixation.

Materials and Methods

This prospective comparative study was conducted in the Department of Orthopaedics, Saveetha Institute of Medical and Technical Sciences, Chennai, Tamil Nadu, from December 2024 to August 2026. The study included patients diagnosed with isolated, non-comminuted olecranon fractures who fulfilled the predefined eligibility criteria. Patients aged 20–60 years with isolated non-comminuted Mayo type II-A olecranon fractures, including closed fractures and Gustilo–Anderson type I and II open fractures, were included. Patients with Mayo type I or III olecranon fractures, Gustilo–Anderson type III open fractures, pathological fractures, previous proximal ulna fractures with malunion, or pre-existing elbow stiffness were excluded. Demographic and clinical data were obtained from case records. A total of 18 patients with 18 involved elbows were included, comprising 12 males (66.7%) and 6 females (33.3%). Ten patients had left-sided involvement and eight had right-sided involvement. The mean age at presentation was 30.61 years (range, 20–50 years), and the mean follow-up duration was 6.72 months (range, 3–10 months). All participants were informed about the diagnosis, treatment alternatives, operative procedures, potential risks and complications, expected benefits, and follow-up protocol, and written informed consent was obtained before surgery.

A detailed clinical history and examination were performed for all patients. The mechanism of injury, duration since trauma, comorbidities, affected side, and relevant clinical findings were documented. Clinical assessment included evaluation of pain, swelling, tenderness, deformity, skin condition, elbow range of motion, distal neurovascular status, and integrity of the extensor mechanism. Standard anteroposterior and lateral radiographs of the affected elbow were obtained preoperatively to confirm the diagnosis and assess fracture displacement and morphology. Immediate postoperative radiographs were obtained to evaluate reduction and implant positioning. Serial radiographic assessments were performed at 4, 8, and 12 weeks and at 6 and 12 months postoperatively, or until satisfactory fracture union was achieved. Radiographs were evaluated for quality of reduction, maintenance of alignment, fracture union, implant position, loss of fixation, and other radiological complications.

Patients were treated using either tension band wiring or crossing screw fixation according to the assigned treatment group. For the tension band wiring technique, all procedures were performed under general anesthesia with a pneumatic tourniquet applied after exsanguination of the limb. A posterior curvilinear incision was used to reduce scar-related discomfort over the olecranon tip. Full-thickness flaps were elevated and retracted on either side of the olecranon. The fracture was anatomically reduced using a reduction clamp. Two 1.6-mm Kirschner wires were inserted across the fracture under appropriate fluoroscopic guidance, with adequate spacing maintained between the wires. The wires were cut and bent appropriately, and a tension-band construct was applied to convert tensile forces generated by the triceps into compression across the fracture site. Final fluoroscopic images were obtained to confirm satisfactory reduction and implant placement.

For the crossing screw fixation technique, surgery was performed under general anesthesia with the patient positioned laterally and the affected arm supported on a bolster. Closed or minimally invasive fracture reduction was attempted whenever possible and was maintained using small-point reduction forceps. After satisfactory reduction, a reference Kirschner wire was inserted centrally through the olecranon and its position was confirmed on both anteroposterior and lateral fluoroscopic views. Two additional guide wires were positioned in a crossing configuration, with the wire originating from the medial side directed toward the lateral cortex and vice versa. After confirmation of appropriate wire position, the reference wire was removed and the guide wires were replaced by two partially threaded 4.0-mm cannulated screws with washers. Final fluoroscopic images were obtained to confirm fracture compression, reduction, screw position, and absence of intra-articular penetration.

Postoperatively, the elbow was protected in a removable splint at approximately 90° of flexion to allow soft-tissue healing and protect the fixation. At approximately 4 weeks, radiographs were obtained to assess the stability of fixation and the presence of any fracture gap. When satisfactory fixation and early healing were demonstrated, a supervised rehabilitation program was initiated, consisting of progressive passive and active range-of-motion exercises followed by strengthening under the supervision of a physiotherapist or occupational therapist. Operative time and intraoperative blood loss were recorded for every patient. Functional outcome was assessed using a validated elbow functional scoring system, together with evaluation of elbow range of motion and return to routine activities. Complications including infection, wound problems, implant prominence or migration, loss of reduction, delayed union, nonunion, and need for implant removal were documented throughout follow-up.

Statistical Analysis

All collected data were entered into a Microsoft Excel spreadsheet and analyzed using appropriate statistical software. Continuous variables such as age, operative time, intraoperative blood loss, elbow range of motion, and functional scores were expressed as mean ± standard deviation (SD) or median with range, as appropriate. Categorical variables such as sex, side of injury, fracture union, complications, and implant-related problems were presented as frequencies and percentages. Continuous variables between the crossing screw and tension band wiring groups were compared using the independent-samples t-test for normally distributed data or the Mann–Whitney U test when appropriate. Categorical variables were compared using the Chi-square test or Fisher's exact test. For paired categorical observations, the McNemar Chi-square test was used where applicable. Changes in postoperative functional parameters over time were analyzed using appropriate paired statistical tests. A p-value <0.05 was considered statistically significant, and 95% confidence intervals were reported where applicable.

Result:

We studied 18 cases of Isolated Non-Comminuted Olecranon Fracture with mean age 30.61±9.85 with minimum 20 and maximum 50 years, majority were male with 66.7% and female 33.3%, right side 44.4% and left side 55.6% and we followed them up for 8.72±1.36 with minimum 6 and maximum 11 months allocated in two groups: Group A: Tension Band Wiring; Group B: Crossing Screws. Regarding time between time between injury and surgery; Group A was significantly longer as it was distributed as 83.22±24.76 and11.11±3.48 respectively **(Table 1)**.

Table 1: Time between injury and operative distribution between studied groups

	Group A	Group B	t	P
Time between injury operative interference/hours	**83.22±24.76**	**11.11±3.48**	**8.528**	**0.00****

Figure (3): Mean operation time between studied groups

Operation time was significantly longer among Group A and length of surgical incision also was significantly longer in Group A **(Figure 3,4)**. Time of union was significantly shorter among group **(Table 2)**. No significant difference between groups detected **(Table 3)**.

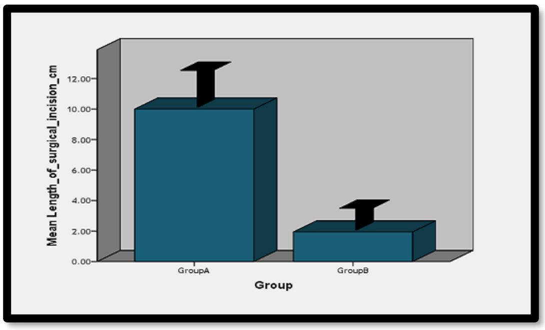

Figure (4): Mean length of surgical incision between studied groups

Table 2: Union time distribution between studied groups

	Group A	Group B	t	P
Time union/weeks	**15.44±3.12**	**10.33±2.06**	**4.094**	**0.001****

Table3: overall outcome distribution between studied groups

			Group		X^2	P
			Group A	**Group B**		
Results	**Excellent**	**N**	**4**	**7**		
		%	**44.4%**	**77.8%**		
	Fair	**N**	**1**	**0**		
		%	**11.1%**	**0.0%**	**2.48**	**0.28**
	Good	**N**	**4**	**2**		
		%	**44.4%**	**22.2%**		
Total		**N**	**9**	**9**		
		%	**100.0%**	**100.0%**		

Discussion

The present comparative study evaluated the clinical and radiological outcomes of tension band wiring (TBW) and crossing screw fixation for isolated non-comminuted Mayo type II-A olecranon fractures. The study included patients aged 20–50 years, with a predominance of males (66.7%) compared with females (33.3%). Left-sided fractures were slightly more frequent (55.6%) than right-sided fractures (44.4%). The mean follow-up duration was 8.72 ± 1.36 months, ranging from 6 to 11 months, allowing assessment of fracture union and early functional recovery. Olecranon fractures commonly affect active adults and are frequently caused by direct trauma or a fall on the outstretched upper limb. [12,13]

An important finding was the significant difference in the interval between injury and surgery**.** Patients in Group A (TBW) underwent surgery significantly later than those in Group B (crossing screws), with mean intervals of 83.22 ± 24.76 hours and 11.11 ± 3.48 hours**,** respectively ($p < 0.001$). This difference may have been influenced by soft-tissue swelling, timing of presentation, medical optimization, or other clinical factors. Although delayed surgery may allow soft-tissue recovery in selected patients, prolonged delay in displaced intra-articular olecranon fractures can potentially postpone rehabilitation and restoration of elbow motion. Early stable fixation followed by appropriate mobilization is generally considered important for minimizing elbow stiffness. [14]

The operative time was significantly longer in the TBW group compared with the crossing screw group. The longer operative duration with TBW may be explained by the requirement for preparation and positioning of multiple Kirschner wires and construction of the tension-band loop, followed by bending and securing the wires. Crossing screw fixation involves guide-wire placement followed by insertion of two partially threaded cannulated screws, potentially allowing a more streamlined fixation procedure. Previous biomechanical and clinical studies have demonstrated that screw-based fixation can provide adequate interfragmentary compression in simple transverse olecranon fractures while avoiding some of the technical steps associated with conventional TBW. [15,16]

Similarly, the length of the surgical incision was significantly greater in the TBW group**.** This finding may represent an advantage of crossing screw fixation, particularly when closed or minimally invasive reduction can be achieved. A smaller incision may reduce soft-tissue disruption, postoperative scar-related discomfort, and the risk of wound complications. The biological principles of minimally invasive fixation emphasize preservation of the soft-tissue envelope and local vascularity while maintaining sufficient mechanical stability. [17]

The study also demonstrated that the time to fracture union was significantly shorter in the crossing screw group**.** The improved compression produced by partially threaded screws may contribute to stable interfragmentary fixation and direct fracture healing in appropriately selected non-comminuted fractures. Compression screw fixation has been described as an effective method for simple olecranon fracture patterns because it provides direct compression across the fracture while minimizing prominent superficial hardware. [15,18]

No significant difference was detected between the two groups for the other assessed parameters. This suggests that despite differences in surgical timing, operative duration, incision length, and union time, both techniques can provide satisfactory fracture stabilization and clinical recovery. TBW remains a widely accepted technique for simple displaced olecranon fractures because of its simplicity, low cost, and established union rates. However, symptomatic hardware prominence and subsequent implant removal remain recognized disadvantages. [19,20]

Crossing screw fixation may therefore represent a useful alternative for isolated, non-comminuted olecranon fractures, particularly when preservation of soft tissues and reduction of hardware prominence are priorities. Nevertheless, the present findings should be interpreted cautiously because of the relatively small sample size and limited follow-up period. Larger randomized studies with longer follow-up are required to determine whether the observed reduction in union time and operative morbidity translates into superior long-term functional outcomes.

Conclusion

The present study demonstrates that both tension band wiring and crossing screw fixation are effective methods for treating isolated non-comminuted olecranon fractures. However, crossing screw fixation showed several favorable perioperative outcomes, including significantly shorter operative time, smaller surgical incision, and significantly faster fracture union compared with tension band wiring. The difference in time from injury to surgery was also significant, with earlier fixation observed in the crossing screw group. Despite these differences, both techniques provided satisfactory fracture stabilization and clinical outcomes during follow-up. Crossing screw fixation may therefore be considered a simple, minimally invasive, and effective alternative to conventional tension band wiring for appropriately selected non-comminuted olecranon fractures. Larger studies with longer follow-up are recommended to confirm these findings and evaluate long-term functional outcomes and implant-related complications.

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