ISSN: 0975-3583, 0976-2833 VOL14, ISSUE 08, 2023

Open reduction internal fixation by tension band wire vs a pre-contoured locking plate for managing olecranon fixation.

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Abstract:

Objective: The aim of this study was to compare the results of surgically treating olecranon fractures using tension band wire versus plate fixation. Due to more complicated injuries, we hypothesise that plate fixation patients would have much worse outcomes.

Methodology: This retrospective cohort analysis recruited 108 patients with isolated olecranon fractures who underwent surgery. There were 40 patients, of whom 20 had received tension band wiring treatment, and 20 had received plating fixation treatment. The Weseley Score is an active grading system that assigns consequences into three categories, from superb to fair, based on information concerning discomfort and loss of function. The intensity of pain, range of mobility, stability, and everyday function are all considered by the Mayo Elbow Performance Score (MEPS), a mixed subjective and objective grading score.

Results: The two fracture types with the highest prevalence, according to the Mayo classification, were a 2b-type fracture in the plate fixation group (70%) and a 2a-type fracture in the tension band wiring group (80%). The tension band wiring group had

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70% more "A" fractures than the plate fixation group, which had 45% more "D" fractures, according to the Schatzker classification. The mean hospitalization duration of tension band wiring group was comparitively high than plate fixation (10.9 ± 9.6 vs 7.8 ± 9.8). The median DASH Score for the TBW group was 7.8 (3.5-13.6), whereas for the plate fixation group it was 12.3 (5.4-24.7). In 21 instances, the Wesley Score showed extraordinary performance. In contrast to nine cases and eight patients in the TBW group, nine cases in the PF group showed remarkable results.

Conclusion: In conclusion, both treatments depend on several elements, such as physical prerequisites, bone quality, and fracture patterns, to be successful. We predicted that individuals with PF would have far worse functional outcomes from more challenging surgical procedures and traumas. The extensive plate-fixing practice had no discernible harmful effects.

Keywords:

Tension band wiring, Plate fixation, Olecranon fx

Introduction:

Olecranon fractures, up to 10% of all upper limb fractures, are the most common bone injury to the elbow joint.[1][2] These show a bimodal distribution, with younger patients suffering high-energy injury and senior groups taking part after low-energy falls having low bone quality, respectively.[3] A fracture is frequently caused by a direct blow to the posterior region with bending between 60° and 110°. Simple falls and car accidents are the most common incidents, and bone quality, age, and point of impact affect fracture patterns.[4][5] Due to stress on the triceps brachii muscle, most fractures are displaced and inappropriate for conservative therapy.[5] There are many classification systems for olecranon fractures, such as Mayo, Schatzker, and Colton; however, none is well-liked or provides precise instructions on operational methods. Their low repetition rates also raise questions about their use in clinical and research contexts.[7][8] According to the AO classification, olecranon fractures are classified as proximal forearm injuries, while Schatzker and Colten classify fractures based on the number of pieces and fracture lines.[9][10]

For outcome evaluation, various scoring techniques are used, including the Mayo Score, Weseley Score, and the DASH (disabilities of the arm, shoulder, and hand) questionnaire. The Mayo and M Weseley Score systems, which focus more on motion,

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pain, and stability, are not as subjective as the DASH, which takes into account activities of daily living and incorporates the functionality of the entire upper extremity.[11][12]

There are many documented surgical procedures; however, most surgeons choose tension band wiring (TBW) or plate fixation (PF) depending on the fracture pattern.[13] Tension band wiring is a simple, dependable, and cost-effective technique. Some of the method's shortcomings include its limited ability to treat more difficult fractures and the high occurrence of K-wires as symptoms. While posterior plate fixation can be used for all types of fractures, it is advised for unstable, oblique, and complex fractures. The most popular implants are pre-contoured locking compression plates or reconstruction plates that are one-third tubular.[14][15] Pre-contoured plates are recommended more commonly because they can lessen overcorrection and loss of reduction. One frequent drawback of plate fastening is that it is more expensive than tension band wiring.[16][17] Contrary to various alternative techniques, such as percutaneous screw fixation, intramedullary nailing, or cable pin systems, tension band wire or plate fixation is usually used.[18][19]

To determine the optimal course of action for each case, this study compares two commonly used treatment modalities for olecranon fractures. Outcome variables considered in this comparison include range of motion, time to return to work, and sequelae. According to the accepted idea, individuals with plate fixation would suffer significantly worse outcomes since their injuries were more intricate.

Methodology:

This retrospective cohort analysis recruited 108 patients with isolated olecranon fractures who underwent surgery. There were 40 patients, of whom 20 had received tension band wiring treatment, and 20 had received plating fixation treatment. Patients without epiphyseal fusion, follow-up procedures following an unsuccessful initial treatment at another facility, and pathological fractures caused by malignant tumours were omitted. Regional or local risk factors did not result in the exclusion of any patients. The patients' follow-up should last for at least 24 months as an inclusion criterion. All operations were performed at a level I trauma centre approved by skilled, board-certified orthopaedic and trauma surgeons.

Physical examinations, blood tests, and analyses of each patient's medical records were all performed. Before surgery, a computed tomography scan and an X-ray of the elbow

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joint in two planes (lateral and anterior-posterior projection) were performed. Because no single classification method can be used for all fractures, the fractures were assessed using the Schatzker, Mayo, and AO categories to precisely identify the fracture pattern. The regional institutional review board gave its approval to the project.

After being placed in the belly position, each patient received an upper arm pneumatic tourniquet with a short arm board. To preserve the ulnar nerve, an incision was created at the proximal end of the olecranon and wrapped radially around the prominence of the olecranon. For most olecranon fractures, a longitudinal posterior approach was sufficient; however, in more difficult injuries, further access to the medial or lateral elbow was required, and the patient was then positioned supine. To avoid infection, resection was done if the bursa olecranon was injured.[20]

Tension band wiring:

Tension band wire was frequently employed for simple and stable fractures. After alignment and surgical approach reduction were accomplished under radiological supervision, a tenaculum clamp was used for temporary fixation. The fracture site was anterogradely crossed by two parallel 1.6-mm K-wires inserted into the distal anterior cortex. Migration of the proximal wire is less likely than with intramedullary implantation. The 180-degree bent proximal end of the wire was intended to be inserted into the bone just below the triceps fibres. A 2-mm drill made a hole in the ulna around 40 mm distal to the fracture line. Through the drilled hole, a 1-mm wire was inserted and wrapped in a figure-eight pattern around the ends of the K-wires. Next, the two wire ends were twisted together, and the tongs were used to tighten them. Two knots—one radial and one ulnar—were inserted and afterwards bent down to the cortex to create symmetric stress at the fracture site and more rigid fixation—the Figure eight wire loop functions as a tension band when tightened.

Plate Fixation:

In fractures that were unstable, oblique, and multi-fragmented, olecranon-locking compression variable angle plates were employed. Tension band wire is compared to the posture and approach. The temporary reduction was stabilised using K-wires, and fluoroscopy confirmed it. It might have been essential to remove the triceps attachment to obtain bone contact once the vasculature was bent to match the shape of the proximal ulna. Locking screws were utilised everywhere they could be positioned cortically and without sticking into the joint. It is occasionally possible to treat severe coronoid

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fractures or interfragmentary compression by driving extra lag screws through the plate.

Both patient groups received the same aftercare plan following surgery. The injured extremity was put in a two- to three-day cast. On the first day following surgery, physiotherapy was begun for passive mobilisation in a pain-free range of motion. Active mobilisation for flexion, extension, pronation, and supination was permitted after wound healing as long as no pain developed. Following surgery, the elbow could not be loaded for six weeks. Information from the outpatient clinic's follow-up appointments was used to evaluate the results.

Six months, a year, and 24 months after surgery, physical and radiological examinations were performed on each patient. For measuring pain, the Visual Analogue Scale (VAS) was used. The Weseley, Mayo, and DASH Scores were calculated for functional outcomes. The Weseley Score is an active grading system that assigns consequences into three categories, from superb to fair, based on information concerning discomfort and loss of function. The intensity of pain, range of mobility, stability, and everyday function are all considered by the Mayo Elbow Performance Score (MEPS), a mixed subjective and objective grading score. Poor (less than 60 points), fair (60-74 points), good (75-89 points), and extraordinary (90-100 points) are the potential assessments for the outcome. The DASH questionnaire examines difficulties with the upper extremities as a functional unit using a 30-item disability/symptom scale.[21]

The DASH includes inquiries about pain, weakness, and participation in social activities, in addition to questions about how challenging it is to carry out physical duties. The overall score is determined and ranges from 0 (no disability) to 100 (the most severe handicap).[11][12] The DASH, tested in numerous languages, was employed in its German form. The subjective elbow value (SEV) was considered in subsequent evaluations. With a maximum of 100%, a single numerical number represents the elbow's condition.

Additionally noted were the number of modifications, length of hospital stay, and size of operation. We considered both the socioeconomic level and the period of injury recovery.

Statistical Analysis:

The characteristics of the study participants are presented as mean values (with

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standard deviation), median values (with IQR), or numbers (with percentages). The two therapy groups (PF versus TBW) were compared concerning patient characteristics using the Fisher's Exact test for categorical data and the Mann-Whitney U test for continuous variables. To account for the limited range of the data, the Weseley, Mayo, DASH Score, SEV, extension, flexion %, and score variables were examined. The beta distribution includes data ranging from zero to one while allowing right or left skewness. A linear regression model was used to assess how long it took each therapy group to get back to work compared to the other. Age, gender, and Schatzker categorisation were all considered in the regression models. The coefficient estimates, and 95% confidence intervals are used to display the estimates from the regression models. It was deemed significant at P 0.05. R Software for Statistical Computing, Version 3.3.1, was used for all analyses.

Results:

This study recruited 40 patients overall, 20 were suggested for tesnion band wiring while 20 patients were placed for plate fixation group.Age, sex, and BMI did not significantly differ between the two cohorts at the start of the experiment. Table 1 summarises the data and includes specific information on patient characteristics, fracture classifications, and surgical time periods. The final assessment was completed after, 73.5 ± 43.7 months for the tension band wiring group and 64.5 ± 45.23 month. Falls from less than 3 m were the most frequent cause of injury in both groups, accounting for 23 fractures (57%), while high-energy trauma, such as a fall from a height (> 3 m) or a car crash, was responsible for 17 fractures (32%). The two fracture types with the highest prevalence, according to the Mayo classification, were a 2b-type fracture in the plate fixation group (70%) and a 2a-type fracture in the tension band wiring group (80%). The tension band wiring group had 70% more "A" fractures than the plate fixation group, which had 45% more "D" fractures, according to the Schatzker classification. (Table 2)

The characteristics of the response variables for the two groups are listed in Table 3. The median DASH Score for the TBW group was 7.8 (3.5-13.6), whereas for the plate fixation group it was 12.3 (5.4-24.7). In 21 instances, the Wesley Score showed extraordinary performance. In contrast to nine cases and eight patients in the TBW group, nine cases in the PF group showed remarkable results.

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Table 1: Characteristics of recruited population

Parameters	Plate Fixation	Tension Band wiring	p-value
Age	52.2 ± 19.4	54.7 ± 20.9	0.79
Gender			0.44
Male	10 (50%)	6 (30%)	
Female	10 (50%)	14 (70%)	
Follow up in 30 days	64.5 ± 45.23	73.5 ± 43.7	0.56
Medical history of Trauma			0.78
TraffIc Accidents	7 (35%)	5 (25%)	
Fall >3 m	2 (10%)	3 (15%)	
Fall <3 m	11 (55%)	12 (60%)	
Duration of Surgery (in minutes)	94.2 ± 46.9	191 ± 112	<0.001
Duration of hospitalization (in days)	7.8 ± 9.8	10.9 ± 9.6	0.046

Table 2: Classification of Olecranon fx

Parameters	Tension band wiring	Plate fixation	p-value
Schatzker classification			0.002
A	14 (70%)	3 (15%)	
B	6 (30%)	5 (25%)	
C	0 (0%)	3 (15%)	

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D	2 (10%)	9 (45%)	
E	0 (0%)	0 (0%)	
F	1 (5%)	1 (5%)	
Muller AO classification			0.014
Type B1.1	15 (75%)	7 (35%)	
Type B1.3	3 (15%)	9 (45%)	
Type B3.3	0 (0%)	2 (10%)	
Type C1.1	3 (15%)	0 (0%)	
Type C2.1	1 (5%)	1 (5%)	
Type C2.2	1 (5%)	1 (5%)	
Type C3.2	0 (0%)	1 (5%)	
Type C3.3	0 (0%)	1 (5%)	
Mayo classification			0.003
Type 1a	0 (0%)	0 (0%)	
Type 1b	0 (0%)	0 (0%)	
Type IIa	16 (80%)	7 (35%)	
Type IIb	4 (20%)	14 (70%)	
Type IIIa	1 (5%)	1 (5%)	
Type III b	1 (5%)	0 (0%)	

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Table 3: Outcomes

Parameters	Tension band wiring	Plate fixation	Estimate Effect	p-value
Mayo score in median (IQR)	100 (93 to 100)	100 (86 to 100)	0 (-0.7 to 0.68)	0.89
Morey score in median (IQR)	98.5 (94 to 100)	96 (91.25 to 99.4)	0.04 (-0.55 to 0.66)	0.789
Weseley				0.438
Excellent	13	8		
Good	8	9		
Fair	0	2		
DASH score in median (IQR)	7.8 (3.5 to 13.6)	12.3 (5.4 to 24.7)	-0.02 (-0.66 to 0.57)	0.894
Flexion in median (IQR)	5 (0 to 10)	10 (3.6 to 11.4)	-0.11 (-0.79 to 0.55)	0.32
Extension deficit in median (IQR)	5 (0 to 15)	5 (0 to 20)	-0.33 (-0.96 to 0.27)	0.77
Time to return in work	6.6 ± 2.3	10.7 ± 6.4	-2.06 (-6.71 to 2.65)	0.35
Complication (%)	9 (45%)	7 (35%)		0.026

Discussion:

This study primarily focuses on the two surgical approaches for treating olecranon fractures. Reconstructing a pain-free, functional joint is difficult because of compromised soft tissue, implant migration, and high complication rates. A thorough review indicated inadequate data to draw firm conclusions about the impact of various surgical treatment choices. Few studies have compared therapy methods, including

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patient-reported follow-up information on tension band wire versus plate outcomes.[22]

By any metric, both groups in our cohort had good to exceptional results. The frequency of issues, the length of hospitalisation, and the turnaround time for returning to work did not differ significantly. Additionally, the SEV, a more straightforward exam for assessing functional results and satisfaction levels, was successful for both groups.

Recent clinical trials on the effects of plate fixation and tension band wire have yielded conflicting results. According to DelSole et al.,[23] patients with olecranon fractures who just had plate fixation experienced slower extension and union times than those who also underwent tension band wire fixation. For patients with Mayo IA-IIIA fractures, the authors claimed that tension band wiring fared better than plate osteosynthesis. A study comparing tension band wire with plate fixation in simple and complicated displacement fractures included 78 participants. Clinical outcomes were reported as excellent or good for both groups, with moderate pain and functional loss.[24] More hardware had to be removed in the tension band wiring group, and 29% of all patients had problems.[25] Due to the overlap in the fracture patterns treated by tension band wire or plate fixation in the two investigations, there is no precise methodology to decide which treatment is most suited. A 67-person random experiment found no discernible variance in DASH Score after a year of follow-up.[26]

Due to symptomatic metal work, the tension band wire group's complication rate was much greater than the plate fixation group's, and only severe complications occurred in the plate fixation group. Some of these conclusions concur with ours, notably because both groups experienced successful operational outcomes, and both strategies were viable. Even though the rate was just 2% higher in the tension band wiring group and 40% higher in the plate fixation group, our investigation indicated that difficulties occurred in 32.5% of cases (n = 13). Tension band wire was used to treat the majority of these patients (n = 7), and in 10 points, 25% of patients experienced problems. Two infections happened, both in the group using plate fixation. Interestingly, despite the significant complication rates, the patient seems to have an acceptable or exceptional functional prognosis.

The literature indicates that osteoarthritis, K-wire migration, non-union, and postoperative restricted range of motion, particularly for extension, are the most frequent problems. The rate of complications varies from 19 to 82%. Even after

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successful treatment, significant reoperation rates are caused by the olecranon's subcutaneous site and evident metal work.[27][28]

Following tension band wire or plate fixation, Edwards et al.[29] discovered a 64.5% total implant removal rate 19 months after surgery. Of the patients who had their metal removed, 39% still attributed the implant to their functional impairment. As evidenced by the fact that 78% of patients who underwent removal had their metal removed by a surgeon other than the one who performed the initial surgery, the removal rates may be a much more frequent than anticipated justification for repeat surgery after tension band wiring and plate fixation following olecranon fractures.

In the past, tension band wire has been used to treat more minor fractures, whereas plates have been utilised to treat more complicated or comminuted fractures. The method for operational therapy is still up for debate, despite some evidence indicating that TBW in comminuted fractures and PF in non-comminuted fractures have positive clinical outcomes.[30][25]

Biomechanical investigations revealed that plate fixation had higher interfragmentary compression and a lower risk of secondary displacement than TBW.[31] According to recent research, pre-contoured locking plate systems are a better fixing option than one-third of high-bending loads, even in cases of low bone quality.[32]

Nevertheless, TBW is a popular choice due to lower material prices and, according to several sources, quicker surgery times. There isn't yet a method that can be considered the gold standard, though. Although there are other methods, the DASH Score is the most often used metric for assessing functional progress following elbow surgery. It varies from other outcome assessment endpoints in that it may track changes in impairment over time following elbow surgery, making it a more meaningful endpoint than elements like complications or reoperation.

Non-operative therapy might occasionally be preferable to the methods being thought about. This entails carefully supervised physical therapy for movement together with the use of a cuff and collar sling or arm plaster with the elbow flexed by roughly 60 degrees. Due to an unacceptably high complication rate of 82% in the operative treatment group, a prospective randomised trial comparing non-surgical versus operational therapy of olecranon fractures in older adults was discontinued early.[33]

The mean DASH score, which was often an excellent score, showed no notable

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improvement a year later, according to the data collected. Another study found that non-operative treatment was more commonly employed for olecranon fracture cases and that the results were positive even in younger patients.[34][35] We only recommend a non-operative procedure in select situations, such as non-displaced fractures in older patients or patients with modest functional expectations, in light of our findings, experience, and the literature. To identify recurrent dislocation or non-union, routine radiological and clinical follow-up assessments are required.

The main flaws in this study are the limited sample size and retrospective study design. Another issue is that different surgical approaches were utilised based on the fracture type, making it impossible to compare the two patient groups. A best-practice, structured questionnaire to assess the success of surgery for single olecranon fractures does not exist either.

Conclusion:

In conclusion, both treatments depend on several elements, such as physical prerequisites, bone quality, and fracture patterns, to be successful. We predicted that individuals with PF would have far worse functional outcomes from more challenging surgical procedures and traumas. The extensive plate-fixing practice had no discernible harmful effects. Even though independent studies and our data showed that surgical therapy has considerable complication rates, the long-term results and satisfaction rates are excellent. More study is required to create more varied therapy algorithms because the results did not establish which strategy would suit a particular situation.

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