

FUNCTIONAL OUTCOME OF TREATMENT OF DEVIATED OLECRANON FRACTURE (MAYO 2A) BY AN INTRAMEDULLARY SCREW WITH TENSION BAND COMPARED TO CLASSIC TENSION BAND - A PROSPECTIVE RANDOMIZED STUDY

RESULTADO FUNCIONAL DO TRATAMENTO DA FRATURA DO OLÉCRANO DESVIADA (MAYO 2A) COM PARAFUSO INTRAMEDULAR COM BANDA DE TENSÃO COMPARADO À BANDA DE TENSÃO CLÁSSICA - ESTUDO PROSPECTIVO RANDOMIZADO

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ABSTRACT

Objective: evaluate the functional treatment outcome of deviated transverse olecranon fractures (Mayo 2A) after treatment with tension-banded intramedullary screw (PIBT) compared to classical tension band (BTC). **Methods:** Prospectively collect all deviated transverse olecranon fractures from 2012 to 2016 and randomize them into PIBT and BTC groups. Range of motion (ROM) was measured after 2 and 5 weeks, 3 and 6 months, and 1 and 2 years. Functional assessments (DASH, Oxford Elbow Score, and Mayo Elbow Performance Index) were performed after 3 and 6 months and 1 and 2 years. Complications were collected up to 2 years of follow-up. **Results:** 22 patients were included, 11 in each group. The mean age was 47.9 years, and the left side was injured in 13 (59.0%) patients. All patients completed the 2-year follow-up. There was no ROM difference at any time between the two groups ($p > 0.005$). Flexion and extension gain was maximum at three months and remained unchanged until two years. Neither flexion nor extension returned to normal, missing around 10°. Pronation and supination returned to normal. All three functional scores showed almost complete recovery of elbow function after three months postoperatively, with no difference between the groups. No group had complications, no reoperation, and no implant removal. **Conclusion:** PIBT had similar results in ROM and functional score compared to BTC. Both had low complication rates and no need for implant removal. **Level of evidence I; Randomized Trial.**

Keywords: Olecranon Process. Fracture Fixation, Internal. Treatment Outcome.

RESUMO

Objetivo: Avaliar o resultado funcional do tratamento das fraturas transversas desviadas do olécrano (Mayo 2A) após o tratamento com parafuso intramedular com banda de tensão (PIBT) em comparação com a banda de tensão clássica (BTC). **Métodos:** Foram coletados prospectivamente todas as fraturas transversas do olécrano desviadas de 2012 a 2016 e randomizá-las em dois grupos: PIBT e BTC. A amplitude de movimento (ADM) foi medida após 2 e 5 semanas, 3 e 6 meses e 1 e 2 anos. As avaliações funcionais (DASH, Oxford Elbow Score e Mayo Elbow Performance Index) foram realizadas após 3 e 6 meses e 1 e 2 anos. As complicações foram coletadas até 2 anos de acompanhamento. **Resultados:** Foram incluídos 22 pacientes, 11 em cada grupo. A idade média foi de 47,9 anos, e o lado esquerdo foi lesado em 13 (59,0%) pacientes. Todos os pacientes completaram o acompanhamento de 2 anos. Não houve diferença na ADM em nenhum momento entre os dois grupos ($p > 0,005$). O ganho de flexão e extensão foi máximo aos 3 meses e permaneceu inalterado até 2 anos. Nem a flexão nem a extensão voltaram ao normal, faltando em torno de 10°. A pronação e a supinação voltaram ao normal. Todos os três escores funcionais mostraram uma recuperação quase completa da função do cotovelo após 3 meses de pós-operatório, sem diferença entre os grupos. Nenhum grupo apresentou complicações, nem reoperação ou retirada do implante. **Conclusão:** O PIBT teve resultados semelhantes na ADM e pontuação funcional em comparação com o BTC. Ambos tiveram baixas taxas de complicações e não há necessidade de remover implantes. **Nível de evidência I; Estudo clínico randomizado.**

Descritores: Olécrano. Fixação Interna de Fraturas. Resultado do Tratamento.

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INTRODUCTION

Olecranon fractures commonly occur from falls from ground-level height or more high energy trauma in young patients.¹ They account for 10% of upper extremity injuries and simple type transverse fractures account for approximately 85% of all adult olecranon fractures.^{2,3}

Except for undisplaced fractures, most of the olecranon fractures require open reduction and internal fixation with primary aim to restore articular congruity with anatomical reduction, restoration of the extensor mechanism and a stable fixation to allow early range of motion.⁴

For intra-articular simple transverse fractures (Mayo IIA) the tension band wiring remains the AO recommended first-line treatment, as it allows early mobilization, it is relatively simple technique and is of low cost.⁵

Because some biomechanical studies questioned the thought that the tension band wiring converts tensile forces in compressive forces at the joint surface^{6,7} and complications like painful hardware prominence, heterotopic ossification, non-union and ulnar nerve neurapraxia are commonly reported,^{8,9} other different methods of fixation started to be used.

Amongst different types of fixation options, the 6.5 mm intramedullary cancellous screw with tension band wiring is a reliable option because it provides a rigid fixation with the combination of inter-fragmentary compression given by the lag screw and the tension band effect given by the cerclage wire.¹⁰ Ahmed et al. showed good clinical results and low re-operation rates with this technique.¹¹ The aim of this study is to compare the functional results and complications of displaced simple olecranon fractures using intramedullary screw combined with tension band and the classic AO tension band wiring.

CASUISTICS AND METHODS

This is a prospective randomized study looking at simple transverse olecranon fractures (Mayo 2A), in a tertiary teaching hospital from 2012 to 2016. The study was approved by the Scientific and Ethic Commission of the University under the number 164.130. The CONSORT guidelines were used to ensure comprehensive reporting of this study.¹²

The inclusion criteria were simple transverse fracture of the olecranon, displaced, Mayo 2A, mature skeleton, closed fracture, be able to comply with the functional evaluation, signed term of consent and agreement to complete 2-year follow-up.

The exclusion criteria were pathologic fractures, multifragmentary fractures, open fractures, associated injury in the ipsilateral upper extremity, polytraumatized patients, not able to comply to the functional evaluation, previous elbow stiffness and incomplete follow-up. The demographic data collected from the enrolled patients were age, gender, injury side, dominance, and mechanism of trauma. The patients were randomly divided into two groups: 1 - AO tension band wiring (TBW) and 2 - intramedullary screw with tension band (ISTB), following a list generated in Microsoft Excel file, in groups of five. To decrease bias the randomization was done immediately before the surgery and the surgeons didn't have access to the randomization list.

The TBW followed the classic technique with insertion of two parallel 1.6 mm Kirschner wires, placed antegrade across the fracture, penetrating the anterior cortex. A 1.0 mm stainless steel wire was passed through a pre-drilled hole perpendicular to the ulnar shaft and then passed in a figure of eight and tensioned symmetrically under gentle traction (Figure 1).¹³

The ISTB involved the intramedullary insertion of a partially threaded 6.5 mm cancellous screw with a washer through the tip of the

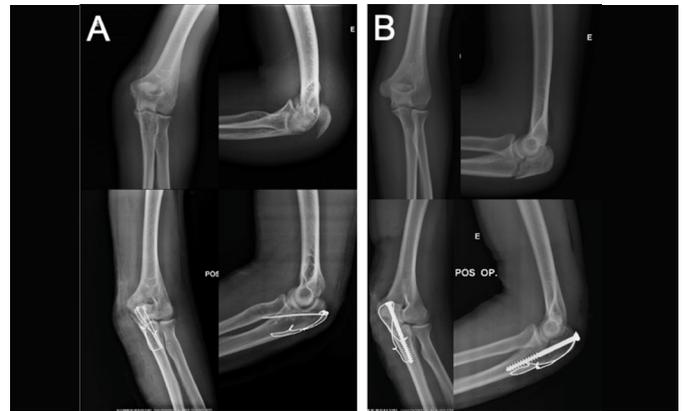


Figure 1. Cases representing: A- tension band wiring (TBW), and B- intramedullary screw with tension band.

olecranon crossing the fracture site and a 1.0 mm stainless steel wire passed and tightened (Figure 1).¹⁴

All patients were put in a back slab for seven days, and then gentle active exercises were gradually started, with flexion-extension and pronation-supination exercises done four times a day.

Check X-rays (anteroposterior and lateral views) were obtained after 2, 6, 12 weeks, 6 months, 1 and 2 years.

The range of motion (flexion, extension, supination and pronation) was evaluated with a goniometer after 2 and 6 weeks, 3 and 6 months, and 1 and 2 years. The assessor was blinded regarding the surgical procedure performed in the patient.

The functional evaluation was done at 3, 6, 12 and 24 months. The assessments were done with the DASH score, Oxford Elbow Score and Mayo Elbow Performance Index.

Complications that were collected included implant loosening, loss of reduction, non-union, infection and re-operation.

For binary and ordinal variables proportions and percentage were presented. For continuous variables the descriptive statistics were presented in counts, mean and standard deviation. Comparison among two groups for each continuous dependent variable were done using non-parametric Wilcoxon Rank Sum test. For comparison between independent groups of variables the Mann-Whitney test was used. The level of significance was 5%. The software used for the analysis was the SPSS v.18 for Windows.

RESULTS

A total of 22 patients were included in the study, 11 in the TBW group and 11 in the ISTB group. In total 9 (40.9%) patients were male and 13 (59.1%) female. The average age in TBW was 48.7 ± 15.6 years and in ISTB was 47.1 ± 14.6 years ($p = 0.7414$). There was a slight predominance of injury on the left side, 13 (59.0%) patients. The dominant side was injured in 15 (68.1%) patients (Table 1). The groups were comparable in the characteristics of the patients. The main mechanism of trauma was fall from ground-level height in 12 (54.5%) patients, followed by motorbike accident in 5 (22.7%). All patients completed 2 years follow-up with radiographic and functional evaluations.

The results of the evolution of the active flexion and extension measurements in 2 and 6 weeks, 3 and 6 months and 1 and 2 years are shown in Figure 2 and 3, respectively. In the 3-month evaluation ISTB had a slight better active flexion, but it was not statistically significant ($p = 0.168$). For the active extension, overall, it was greater in the ISTB group, but it was also not statistically significant ($p > 0.05$).

Figure 4 and 5 show the results of active pronation and supination. There was no statistical difference between the groups at any point in

Table 1. Characteristics of study participants.

Characteristics	n _{missing}		n = 22	n (%)
Gender	0	Male	9	(40,9)
		Female	13	(59,1)
Race/ color	1	White	12	(57,1)
		Black	1	(4,8)
		Brown	7	(33,3)
		Yellow	1	(4,8)
Body mass index (kg/m ²)		Mean (SD)		24,7 (3,0)
		Median (min-max)		24 (19,0-29,4)
Dominance	9	Right	12	(92,3)
		Left	1	(7,7)
Occupation	9	Retired	1	(7,7)
		Cleaning assistant	1	(7,7)
		Realtor	1	(7,7)
		Dentist	1	(7,7)
		From home	2	(15,4)
		Bank clerk	1	(7,7)
		Student	3	(23,1)
		Photographs	1	(7,7)
		Teacher	1	(7,7)
		Saleswoman	1	(7,7)
Smoking	8	No	12	(85,7)
		Yes	2	(14,3)
Associated diseases	8	No	8	(57,1)
		Yes	6	(42,9)
Continuous use medication	8	No	7	(50,0)
		Non-steroidal anti-inflammatory drugs	1	(7,1)
		Antihypertensives	2	(14,3)
		Antihypertensives+antidiabetics	1	(7,1)
		Antihypertensives+anticoagulants	1	(7,1)
		Antihypertensives+anticoagulants+other	1	(7,1)
		Other	1	(7,1)
ASA	8	1	8	(57,1)
		2	6	(42,9)
Physical activity	9	No	5	(38,5)
		Bodybuilding	1	(7,7)
		Other activity	7	(53,8)
Labor dispute	13	No	7	(77,8)
		Yes	2	(22,2)

SD: standard deviation; min: minimum value; max: maximum value.

time ($p = 0.05$), both achieving the maximum range of motion. What can be seen is the faster recovery of the supination over the pronation. Figure 6 shows the assessment with the DASH score, Figure 7 with the Oxford Elbow Score and Figure 8 with Mayo Elbow Performance Index. None of the functional score showed any difference between the functional results between TBW and ISTB in any point in time ($p > 0.005$). There was no complication noted in any of the groups.

DISCUSSION

We were able to include same number of patients in each group, with a predominance of the fracture in women (59.0%), but with the same distribution between the two groups. In the non-displaced olecranon fractures, the conservative treatment with immobilization and serial radiographs to monitor for

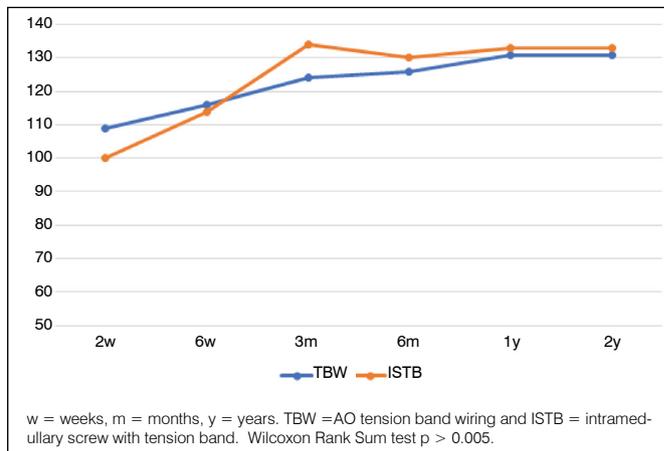


Figure 2. Active elbow flexion. Comparison between TBW and ISTB techniques.

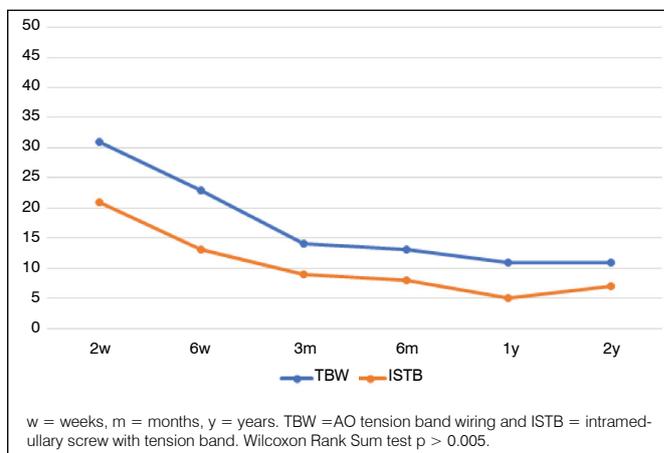


Figure 3. Active elbow extension. Comparison between TBW and ISTB techniques.

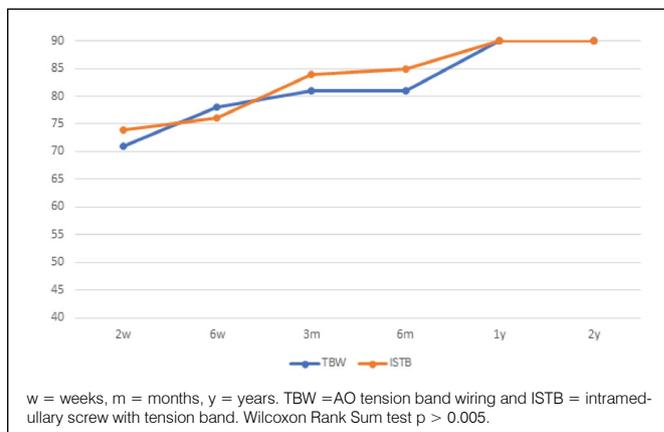


Figure 4. Active elbow pronation. Comparison between TBW and ISTB techniques.

displacement is the treatment of choice.¹⁵ For the displaced fractures multiple surgical treatment have been described, including tension band wiring (TBW), plate fixation (PF), intramedullary screw fixation (IMS), intramedullary screw with tension band (ISTB) and fracture excision with triceps advancement.^{15,16} The PF has better results over the TBW in olecranon fractures with articular comminution, fractures extending distal to the semilunar

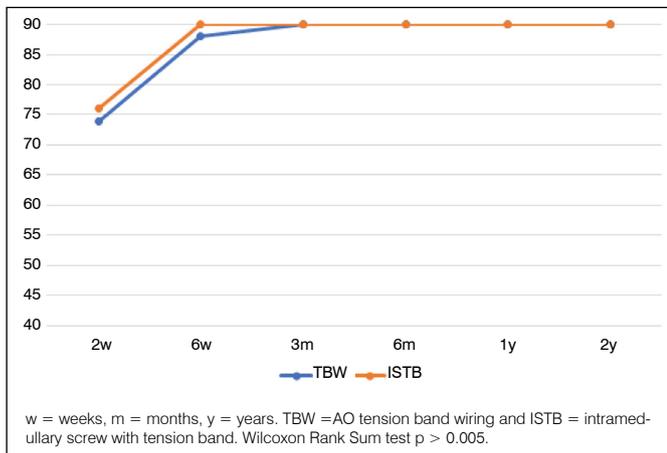


Figure 5. Active elbow supination. Comparison between TBW and ISTB techniques.

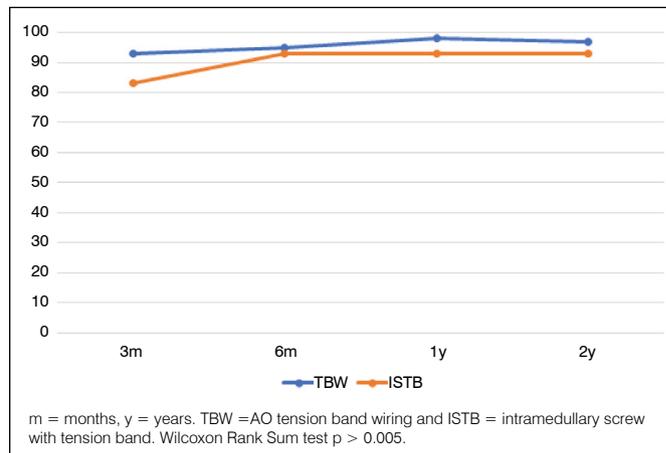


Figure 8. Mayo Elbow Performance Index. Comparison between TBW and ISTB.

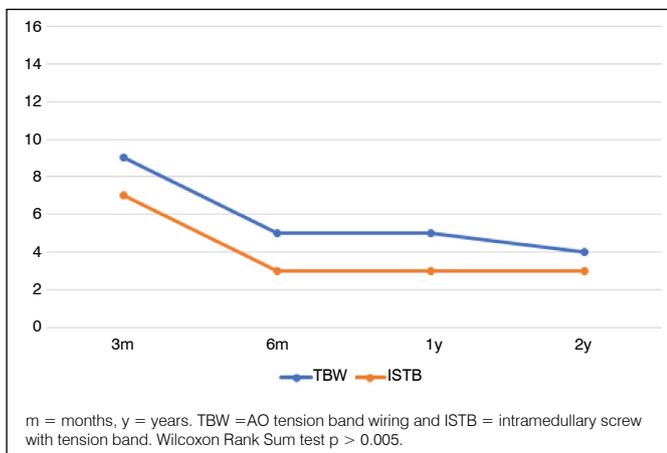


Figure 6. DASH score. Comparison between TBW and ISTB techniques.

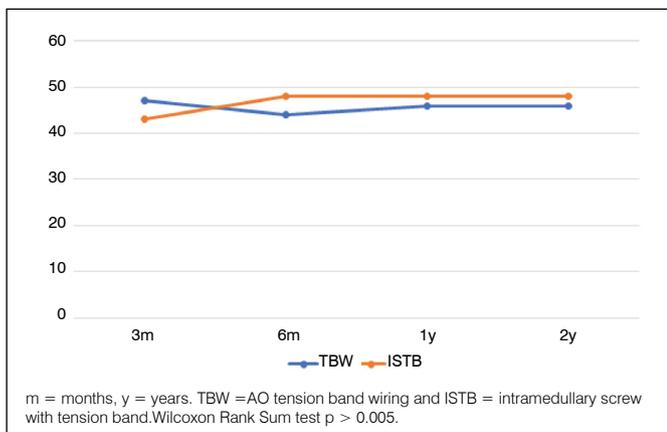


Figure 7. Oxford Elbow Score. Comparison between TBW and ISTB techniques.

notch, and olecranon fracture dislocation (Mayo III).¹⁷ For transverse olecranon fractures (Mayo IIA) several studies showed similar functional results, but PF constructs are more costly, requires more extensive dissection, and often fail to match the anatomic proximal ulna dorsal angulation, which may lead to mal-reduction.¹⁸⁻²⁰ In the other hand, the TBW had a higher rate of symptomatic hardware and implant failure.^{17,20}

An alternative construct for the simple transverse fracture is the intramedullary screw with tension band (ISTB).^{11,21} This construct is infrequently used by orthopedic surgeons, but maybe a good option to the traditional TBW.

In this study only transverse fractures of the olecranon were included, because in simple but oblique fractures the shearing force may lead the TBW to fail and have worse results.²²

There was no difference between the two groups in the flexion and extension in any point in time ($p > 0.005$). In both groups the final flexion/extension was achieved after 3 months, maintaining stable until 2 years. Neither the flexion nor the extension went back totally to normal. The flexion gap was in average 10° and the extension gap was 7° for the ISTB and 13° for the TBW ($p = 0.433$). This is consistent to what was achieved by Ahmed et al.¹¹ who studied prospectively 30 patients including both transverse and oblique fractures.

Both pronation and supination went back to the normal amplitude (90°), with no difference between the two groups. What called our attention is that the supination went back to normal in 6 weeks, but the pronation took between 6 months to 1 year to recover full range of motion.

The functional evaluation with the DASH score, Oxford Elbow Score and Mayo Elbow Performance Index showed the same trend, with almost full recovery of the elbow function after 3 months post-operatively, and few improve after 6 months, 1 or 2 years.

Post-operative loss of reduction or implant failure did not occur in any of the patients of the two groups. In the literature it's described displacement of more than 2 mm in up to 20% of the cases.²³ One possible explanation for this is that we only included simple transverse fractures, which are intrinsically stable after reduction and the compression given by the fixation, either TBW or ISTB, creates an absolute stability with no movement in the fracture site.

One could expect that the intramedullary screw fixation with a washer could have a higher rate of soft tissue irritation leading to a higher rate of implant removal, but it did not happen. None of the patients had complains about the implant and did not ask for implant removal. The zero incidence of post-operative infection may also be explained by the inclusion criteria, where the complex fractures and more severe soft tissue injury were not included.

The limitation of the study is the low number of patients, 11 per group. Another limitation is that the joint range of motion was measured manually and there is possibility of error. In addition, the scores for functional evaluations were filled in according to patient's statements and may thus show subjective results.

The final result of this study showed similar range of motion and functional results for the ISTB compared to TBW.

CONCLUSION

Both TBW and ISTB showed to be an efficient method for the treatment of the displaced transverse olecranon fracture (Mayo 2A), with recovery of the range of motion and excellent functional results. None of them presented any complication after 2 years follow-up.

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