

Internal fixation of olecranon fractures using tension band wiring and high resistance suture materials

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ABSTRACT

Objectives: Open reduction and internal fixation using tension band wiring is an efficient approach that offers predictable results in patients with olecranon fractures types 2A and 3A (Mayo Classification). Many surgeons consider it a simple and reproducible technique for restoring the anatomy responsible for elbow extension, as well as its functional continuity. This technique may be associated with a relatively high percentage of complications, as well as the need to remove the previous cerclage wire, if present. The purpose of our study was to determine if replacing the traditional 1.6 mm Kirschner wires with high resistance suture materials could reliably maintain reduction in patients with olecranon fractures types 2A and 3A (Mayo Classification), and to analyze the results. **Materials and Methods:** Twenty-five consecutive patients were studied retrospectively. All of them presented olecranon fractures types 2A and 3A (Mayo Classification) and were treated with open reduction and internal fixation using tension band wiring built with two 1.6 mm Kirschner wires and two high resistance sutures (ultra-high molecular weight polyethylene). A minimum 12-month follow up was performed in all patients. Time to bone healing, range of motion and functional scores were evaluated, and complications recorded. **Results:** All fractures healed in an average time of 6.83 weeks (range 6-10). The average Mayo score was 96.6 (range 85-100). The average range of motion for active elbow flexion-extension was 139 degrees (range 130-150). The average range of extension and flexion was -4.8 degrees (range 0 to -20) and 143.8 (range 130-150), respectively. Four cases of proximal migration of the Kirschner wires and one case of a 3 mm loss of reduction in the third postoperative week were reported. Two patients required a second intervention for removal of the Kirschner wires. None of the patients reported pain or discomfort as a result of the sutures. **Conclusions:** Tension band wiring using high resistance suture materials is an adequate alternative for the surgical management of olecranon fractures types 2A and 3A (Mayo Classification). Clinical and radiological outcomes in this series were satisfactory, and the complication rate was low. The use of high resistance suture materials may simplify the procedure and reduce the need of a second intervention to remove the hardware.

Keywords: Fracture; olecranon; tension band; wire; high resistance sutures.

Level of Evidence: IV

Osteosíntesis de olécranon. Sistema absorbe-tracción utilizando suturas de alta resistencia

RESUMEN

Introducción: La reducción abierta y fijación interna mediante el sistema absorbe-tracción es un método que ha demostrado su eficacia y logra resultados predecibles en el tratamiento de las fracturas de olécranon tipos IIA y IIIA de la Clasificación de la Clínica Mayo. Considerada por muchos cirujanos como una técnica sencilla y reproducible a la hora de restaurar la anatomía y la continuidad del aparato extensor del codo, su empleo puede asociarse con una tasa de complicaciones relativamente alta, y no es infrecuente la necesidad de retirar el cerclaje de alambre previamente colocado. El objetivo de este estudio fue determinar si reemplazar el clásico alambre de 1,6 mm por suturas de alta resistencia aporta la estabilidad suficiente para el tratamiento de las fracturas de olécranon tipos IIA y IIIA, y analizar los resultados obtenidos en una serie de casos. **Materiales y Métodos:** Se estudió, en forma retrospectiva, a 25 pacientes consecutivos con fracturas de olécranon tipos IIA y IIIA, tratados mediante reducción abierta y fijación interna con sistema absorbe-tracción compuesto por alambres de Kirschner de 1,6 mm y suturas de alta

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resistencia (polietileno trenzado de alto peso molecular), con un seguimiento mínimo de 12 meses. Se evaluaron el tiempo de consolidación radiográfica, el rango de movilidad, el puntaje MEPS, y se registraron las complicaciones. **Resultados:** Todas las fracturas consolidaron, en un promedio de 6.83 semanas (rango 6-10). El puntaje MEPS promedio fue de 96,6 (rango 85-100). El arco total de movilidad promedio para la flexo-extensión activa del codo fue de 139° (rango 110-150°). La extensión promedio fue de -4,8° (rango 0-20°) y la flexión, de 143,8° (rango 130-150°). Se registraron cuatro casos de migración proximal de los alambres de Kirschner y un caso de pérdida de reducción de 3 mm en la tercera semana del posoperatorio. Dos pacientes requirieron una segunda intervención para retirar los alambres de Kirschner. Ninguno refirió dolor o molestias inherentes al uso de la sutura. **Conclusiones:** El sistema absorbe-tracción utilizando suturas de alta resistencia es una opción a la hora de realizar la osteosíntesis de una fractura de olécranon tipos IIA y IIIA. Los resultados clínicos y radiográficos han sido satisfactorios, con una baja tasa de complicaciones. El uso de suturas ultrarresistentes simplifica el procedimiento y disminuye la necesidad de una segunda intervención para retirar el alambre.

Palabras clave: Fractura; olécranon; absorbe-tracción; alambre; suturas de alta resistencia.

Nivel de Evidencia: IV

INTRODUCTION

The fracture of the olecranon is a relatively common injury and accounts for up to 40% of all fractures around the elbow joint.¹

The treatment of displaced fractures seeks to repair the articular surface and to restore the continuity of the extensor mechanism as well as the elbow function.

The open reduction and internal fixation using the tension band wiring (TBW) is considered the first-choice method; its use is widely spread and approved by surgeons, as they consider TBW to be a reproducible, cost-efficient and easily performed procedure.

However, and in contrast to the widespread belief, TBW complication rate reaches up to 80%.² Pain and discomfort due subcutaneous position of the K-wires are common complaints that often require a second operation for implant removal.^{3,4} For this reason the use of TBW has been critically revised in search of new alternatives that may maintain outcomes and may reduce the number of complications. The systematic use of the wire has been challenged and prompted the analysis and the possibility of its replacement by high resistance sutures, which provide enough strength, but have a lower profile and are potentially less symptomatic.

The purpose of our study was to describe the TBW surgical approach using two high resistance sutures instead of the traditional 1.2 mm K-wire and to evaluate the clinical and radiological outcomes in patients with Mayo types 2A and 3A olecranon fractures. Our hypothesis is that said construct provides adequate mechanical strength and results in less discomfort related to the implant in the ulnar dorsal aspect.

MATERIALS AND METHODS

Between March 2015 and October 2017, 25 consecutive patients with Mayo types 2A and 3A olecranon fractures were surgically treated with open reduction and internal fixation using TBW built with two 1.6 mm K-wires and two #5 ultra-high molecular weight polyethylene (UHMWPE) sutures.

We conducted a cross-sectional descriptive study in all patients that underwent surgery between March 2015 and October 2017 for Mayo types 2A and 3A olecranon fractures using the previously mentioned approach.

All patients were assessed before surgery using antero-posterior (AP) and lateral X-rays of the affected elbow. The two cases of associated radial head fractures were assessed using CT. According to the Mayo Classification, 19 fractures were type 2A (68.75%) and 6 were type 3A (31.25%).

Clinical and radiographic (AP and lateral of the elbow) postoperative controls were carried out at the first day after surgery, at 1, 2, 4 and 6 weeks, and later monthly until complete radiographic healing was observed. Once bone union was achieved, the following controls were at 6 and 12 months, when the final clinical and radiographic examinations were performed.

We contacted all patients for clinical assessments during the time of this study. The average follow-up was 24.5 months (range 12-36).

We studied the radiographic bone healing, and the active motion using goniometric measurements, and used the Mayo Elbow Performance Score (MEPS) and the Visual Analogue Scale (VAS) to assess functional outcome and pain.

Surgical technique

Surgery was performed under regional anesthesia with the patients in the supine position. The forearm was placed over the patient's thorax with the elbow in a 90-degree flexed position.

A posterior approach centered on the olecranon was utilized (Figure 1). Two 2.0-mm holes were drilled perpendicular to the shaft of the ulna and 3-4 cm distal to the fracture. The distance between both holes has to be approximately 2 cm. High resistance sutures were passed through the ulnar holes, in a double-row fashion. The fracture was reduced and temporarily fixed with a reduction clamp (Figure 2).



Figure 1. Patient in the supine position. Posterior longitudinal approach of the elbow.



Figure 2. Passage of sutures through the distal holes, in a double-row fashion. Temporary fracture reduction.

Two parallel 1.6-mm K-wires were inserted from the proximal fragment to ideally the dorsal cortex of the ulna (Figure 3).

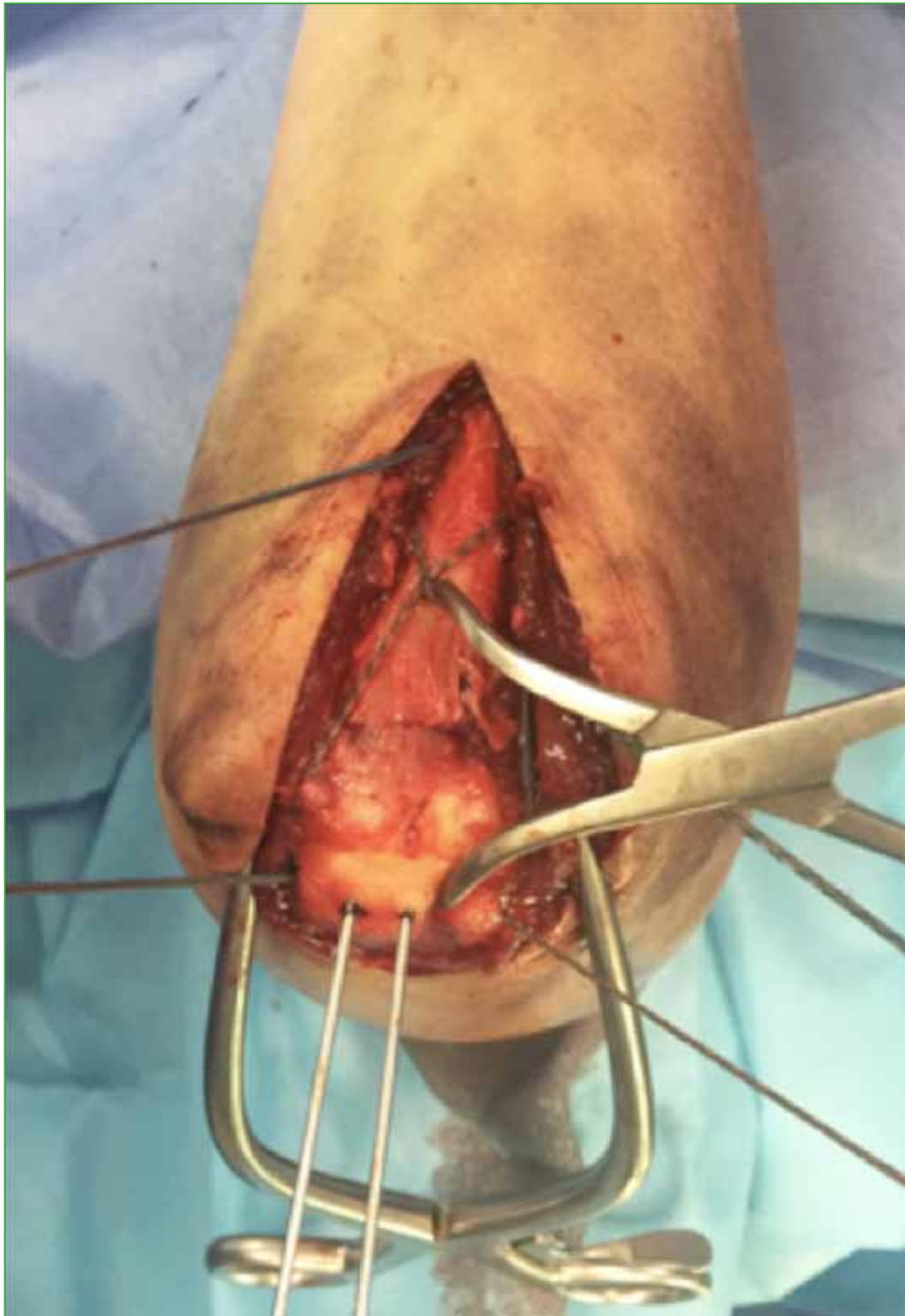


Figure 3. Fixation with 16mm K-wire. Suture passage in a X-shaped and a U-shaped manner.

Intraoperative fluoroscopic examinations confirmed the correct reduction of the fracture and the correct placement of the pins. Thereafter, sutures were passed from distal to proximal direction, through the fracture site and over the K-wires. The suture was proximally looped in a figure-of-eight configuration, and distally in a circular loop, using a 2.0 nylon suture and a straight needle to pass it under the triceps. Sutures were tied with a modified Nice Knot technique, which allows for a sliding knot that is self-locking, adjustable, solid and easy to perform⁶ (Figures 7 and 8) and promotes interfragmentary compression. Thereafter, the reduction clamp was removed, and a stability test was performed (Figure 4).

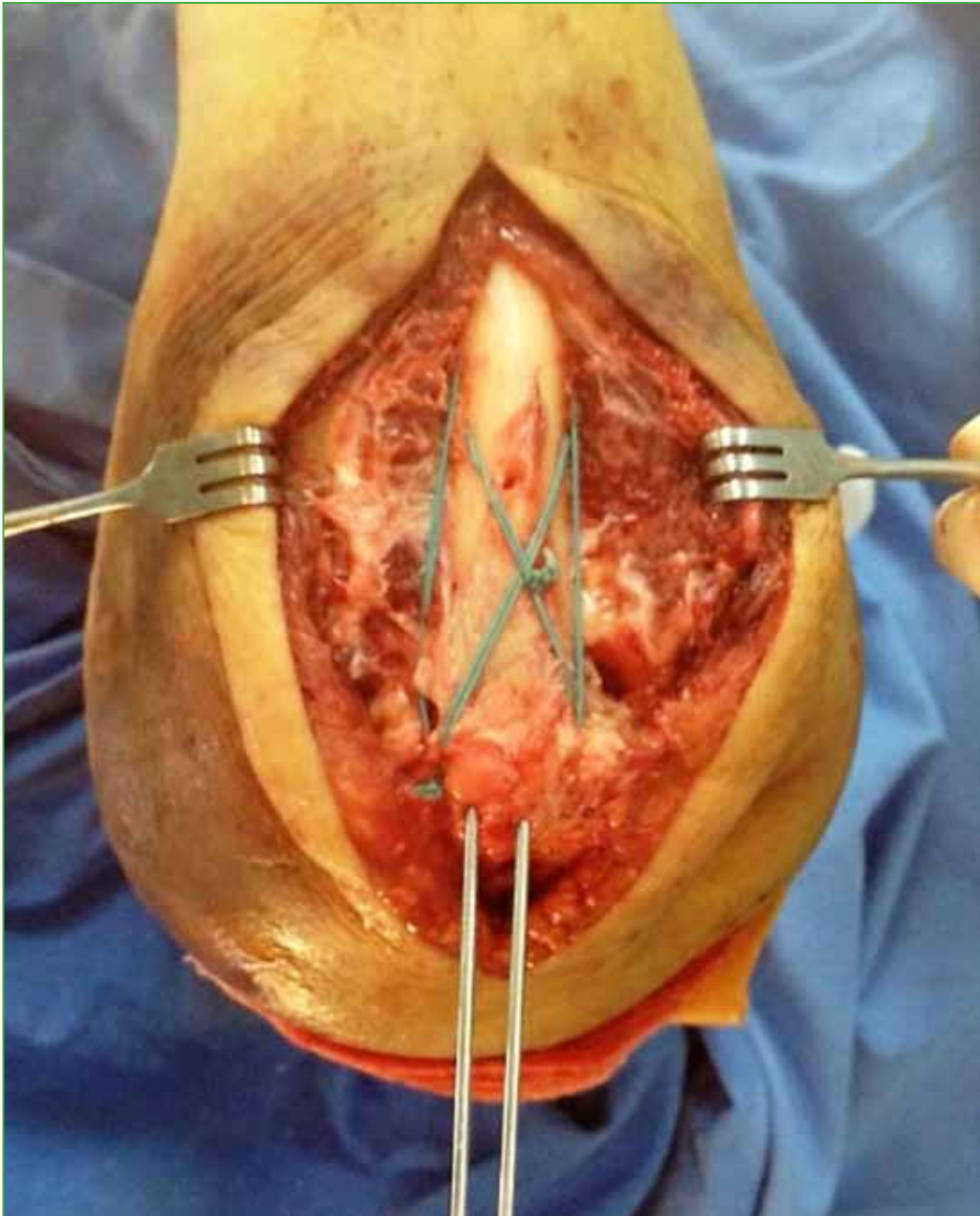


Figure 4. Internal fixation after the sutures were tied. Stability testing.

Pins were bent over (180°), cut and impacted into the bone, before a 1cm longitudinal incision was made on the triceps tendon, at their entry site.

The incisions on the triceps tendon were sutured using non-absorbent materials to reduce the possibility of pins' proximal migration.

A fluoroscopic examination was performed and afterward the wound was closed with a fascial suture.

Finally, immobilization with plaster splint was applied leaving the wrist free for 1-2 weeks (according to the type of fracture and bone quality), after which sutures were removed and patients began the rehabilitation regime.



Figure 5. Elbow X-rays (AP and lateral). X-rays show fracture consolidation.

RESULTS

Fifteen fractures involved the dominant arm. There were 3 verified cases of associated injuries: contralateral patellar fracture (1 patient) and ipsilateral radial head fractures (2 patients). The average age at the time of the fracture was 68 years (range 32-90) and the most common mechanism of injury was a fall from standing height resulting in the direct impact of the back of the elbow against the floor (22 patients) (Table 1).

Table 1. Demographics

n	Age	Sex	Mayo Classification	Arm	Dominant arm	Follow-up
1	74	F	3A	R	R	36
2	72	F	2A	L	R	36
3	76	F	2A	R	R	36
4	68	F	2A	R	R	36
5	34	F	2A	L	R	36
6	86	F	2A	L	R	32
7	68	F	3A	R	R	31
8	61	F	2A	L	L	31
9	70	F	3A	L	R	30
10	84	F	2A	R	R	30
11	74	F	3A	R	L	28
12	83	F	2A	R	R	27
13	32	F	3A	R	R	24
14	59	F	2A	L	R	22
15	60	M	2A	R	R	22
16	88	F	2A	L	R	22
17	56	M	3A	R	R	18
18	70	F	2A	L	R	17
19	34	M	2A	L	L	16
20	67	F	2A	L	R	15
21	76	F	2A	R	R	15
22	73	M	2A	R	R	14
23	90	F	2A	R	R	14
24	58	F	2A	R	R	13
25	87	F	2A	L	R	12

F = female, M = male, R = right, L = left.

All fractures healed. The average time of radiographic bone union was 6.83 weeks (range 6-10). The average range of flexion-extension motion was 139 degrees (range 130-150). The average range of extension and flexion was -4.8 degrees (range 0 to -20) and 143.8 (range 130-150), respectively. All patients achieved complete pronosupination. According to the VAS, the average pain was 0.44 (range 0-2). The average Mayo score was 96.6 (range 85-100), with good outcomes observed in 4 patients and excellent outcomes in 21 patients (Table 2).

Table 2. Results

n	Time to bone healing (weeks)	MEPS	VAS	Flexion	Extension	Range of motion
1	8	100	0	145	0	145
2	10	95	0	140	10	130
3	6	100	0	150	0	150
4	6	100	1	140	0	140
5	6	100	0	150	15	135
6	8	85	2	150	10	140
7	6	85	0	130	20	110
8	8	100	1	140	5	135
9	6	100	0	145	5	140
10	6	100	0	150	0	150
11	8	100	0	140	10	130
12	6	95	1	150	5	145
13	8	85	2	150	0	150
14	6	100	0	140	0	140
15	6	100	0	150	5	145
16	6	95	0	140	10	130
17	6	100	1	150	0	150
18	6	100	0	140	0	140
19	8	100	1	140	5	135
20	6	100	0	150	0	150
21	6	100	0	140	0	140
22	8	95	0	140	10	130
23	6	100	0	145	0	145
24	NR	85	2	140	10	130
25	8	95	0	140	0	140
Average	6.833333333	96.6	0.44	143.8	4.8	139

MEPS = Mayo Elbow Performance Score, VAS = Visual Analogue Scale.

There were five minor complications. One case of a 3 mm loss of reduction with respect to immediate postoperative. Four patients (16%) had proximal migration of one of the K-wires and only two complained of pain. Only one patient agreed to undergo a second operation for K-wire removal. Another patient, although she experienced no pain, required K-wire removal.

None of the patients complained of pain or discomfort in the ulnar dorsal aspect, the suture area.

DISCUSSION

TBW with 1.6 mm K-wire and 1.2 wire is the most common method of internal fixation for the surgical treatment of Mayo types 2A and 3A olecranon fractures.⁷ However, the subcutaneous placement of K-wires or pins may be responsible for pain, skin lesions and the need for a second surgery for the removal of the internal fixation material.⁸⁻¹⁰

The high rate of complications, as well as the need to remove the internal fixation, have led to the critical rethinking and revision of the TBW, in search of new alternatives that may improve the outcomes and may reduce the number of complications. Several authors have published modified versions of this technique, such as placing bicortical pins to increase the system stability and reduce the rate of proximal migration, or using an intramedullary screw, a second cerclage wire, FiberWire or polyester suture to perform the internal fixation without pins.¹¹⁻¹³ Lalliss and Branstetter performed cadaveric model studies on olecranon fractures and proved that UHMWPE sutures (FiberWire) have similar resistance and fatigue patterns to 18mm wires.¹⁴

Our modified version of the standard TBW technique consisted of using two double loops of UHMWPE sutures and two 1.6mm pins. This construct provided adequate mechanical stability, which resulted in a fast functional recovery with less skin irritation and pain in the posterior edge of the ulna, due to the absence of wire knots and to the methodical closure of the triceps after the pins were impacted. When necessary, material removal would involve only the pins, which amounts to a less invasive procedure that removing a standard TBW construct.

We have employed this system as our method of olecranon osteotomy fixation for treating distal humerus fractures, and the outcomes have been satisfactory. Such cases have not been included in this study.

It is important to highlight that the complications encountered in this series were unrelated to the modification of the TBW technique.

The limitations of this study are its retrospective nature, small sample size, and short follow-up period.

CONCLUSIONS

TBW using high resistance suture materials instead of wires is an adequate alternative for the surgical management of Mayo types 2A and 3A olecranon fractures. Clinical and radiological outcomes in this series were satisfactory, and the complication rate was low. High resistance sutures provide adequate mechanical strength and result in less discomfort related to the implant in the ulnar dorsal aspect. We consider that this modification does not only simplify the procedure, but also reduces the need for a second intervention to remove the hardware.

Conflict of interest: Authors claim they do not have any conflict of interest.

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