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## ORIGINAL ARTICLE

# Early range of motion exercise in pediatric patients with olecranon fractures treated with tension band suture with double loops and double knots

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**Background:** Pediatric patients with olecranon fractures are uncommon. The tension band suture technique was introduced to reduce the burden of implant removal and other complications. However, to our knowledge, early range of motion (ROM) exercise has not been introduced in this population of patients. Double Vicryl loops and knots with 2 cross-pins are used to maintain the benefits of the tension band suture technique and to enhance fixation tensile strength. We believe that early ROM exercises could be achieved without nonunion or fixation failure.

**Methods:** Twelve pediatric patients with olecranon fractures were treated with tension band suture with double loops and knots between 2004 and 2015. Vicryl No. 1 was used for wiring. ROM exercises were initiated 1 week postoperatively with a customized functional brace. Early functional outcomes were evaluated by the Mayo Elbow Performance Score at every visit after 8 weeks postoperatively.

**Results:** Nine boys and 3 girls (average age, 10.6 years; range, 5 years 7 months–16 years 2 months) were included in the study. Initial displacement and angulation of the fractures were 5 mm (2–7 mm) and 12° (4°–25°), respectively. Two cases had radial neck fractures of the ipsilateral elbow. All patients had a perfect Mayo Elbow Performance Score after 8 weeks postoperatively. Pin removals were performed at 13.1 weeks. No complications, including growth arrest, were observed.

**Discussion/Conclusion:** Tension band suture with double loops and knots, combined with early ROM exercise, may be a complete alternative to tension band wiring.

**Level of evidence:** Level IV; Case Series; Treatment Study

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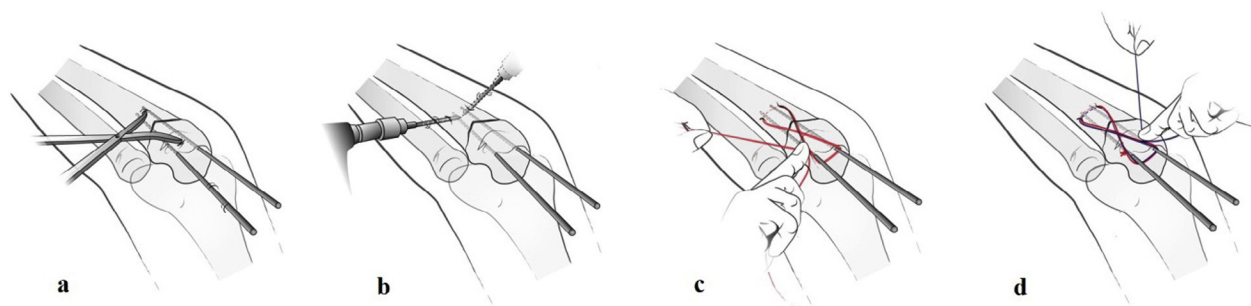
**Keywords:** Olecranon; fracture; pediatric; tension band; suture; range of motion; double knot

This study was approved by the Institutional Review Board of our institute.

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Pediatric olecranon fractures are relatively uncommon and account for approximately 7% of elbow fractures in children.<sup>8</sup> In 80% of cases, these fractures are minimally displaced, and patients have a good prognosis without surgical treatment.<sup>1</sup>



**Figure 1** (A) The fracture site was reduced with a reduction clamp, and 2 K-wires were inserted. (B) Two holes for the tension band canal were made with a 2.5-mm drill bit. (C and D) Vicryl was passed through the canal to place a tension suture in the figure-of-8 technique. One knot was made on the lateral side and the other on the medial side.

However, displaced olecranon fractures can lead to fixed flexion deformity and significant long-term morbidity in this population of patients.<sup>2,8</sup> For these reasons, fractures displaced 2 to 4 mm are considered for surgical treatment.

Many surgical options are available in these cases, including closed reduction with pinning, closed reduction with screw fixation, and open reduction with tension band wiring (TBW). The AO technique of TBW with pinning is widely used for pediatric and adult patients with olecranon fractures.<sup>1,3</sup> Although it provides stable fixation of the displaced fracture, it also has some pitfalls. For example, wires may irritate the skin during motion and be harmful in children because they have weaker skin and a higher risk for unexpected early implant removal surgery.<sup>13</sup>

Evans and Graham reported a technique using a degradable suture material for the tension band principle in 1999.<sup>1</sup> Other surgeons applied that technique and obtained good results compared with conventional TBW.<sup>1,4</sup> However, range of motion (ROM) is usually initiated after 4 weeks of immobilization in these cases, which is longer than in usual practice. Passive ROM exercise starts as early as 5 to 7 days postoperatively in adults with olecranon fractures to reduce postoperative flexion contracture.

In this study, we used double Vicryl loops and knots to maintain the benefits of the tension band suture technique and to enhance fixation tensile strength. Early ROM exercises were achieved without nonunion or fixation failure.

## Materials and methods

This study was a retrospective case series including 12 pediatric patients with olecranon fractures who were surgically treated with tension band suture with double loops between June 2004 and May 2015. Patients were included in the analysis if they did not have a fused olecranon apophysis and had >2 mm of displacement of the fracture fragment on the initial radiograph or step-off defects. Fractures were classified using the AO Pediatric Comprehensive Classification of Long Bone Fractures (<https://aotrauma.aofoundation.org/Structure/education/self-directed-learning/reference-materials/classifications/Pages/classifications.aspx>) and fracture patterns (ie, transverse, oblique, and longitudinal). Patients with open or

severely comminuted fractures requiring external fixation were excluded. Patients with a radial neck fracture around the injured elbow were also treated surgically during surgery if needed.

The procedure followed the TBW technique introduced by the AO. In brief, patients were under general anesthesia in a supine position with shoulders forward flexed and elbows flexed. A longitudinal skin incision was made over the tip of the olecranon, exposing the fracture site. The fracture was reduced and compressed with a reduction clamp after removal of any hematoma and debris. Two No. 3 Kirschner wires (K-wires) were then inserted from the proximal part of the olecranon to the anterior cortex of the proximal ulna (Fig. 1, A). A canal was prepared for the tension band suture, and 2 holes were made on the proximal ulna at the same level. The holes were at a sufficient distance from the fracture site and approximately 4 mm anterior of the posterior cortex of the ulna. The holes were made using a 2.5-mm-diameter drill bit medially and laterally (Fig. 1, B). The 2 arms of a towel clamp were placed and clamped to create a canal through these 2 holes. Vicryl No. 1 (Ethicon, Somerville, NJ, USA) was passed through the canal and wound around the 2 K-wires, creating a figure-of-8. Knots were hand tied to keep maximal tension, and a knot was placed in the middle of the medial proximal part (Fig. 1, C). Another suture was placed using the same method, but the knot was placed laterally (Fig. 1, D). The K-wires were cut and bent laterally and rotated proximally (Fig. 2). ROM and stability of the fixation during motion were checked under C-arm fluoroscopy (Fig. 3). All operations were performed by a single surgeon (J.H.C.).

Patients visited the outpatient clinic at 1, 2, 4, 8, and 12 weeks and then at 6 and 12 months postoperatively. Simple radiographs (elbow anteroposterior, lateral, and both oblique), ROM, degree of pain, and discomfort were evaluated at each visit; the Mayo Elbow Performance Score (MEPS) was evaluated at every visit after 8 weeks. ROM exercises were initiated 1 week postoperatively with a customized functional brace (Fig. 4) and continued for 8 weeks unless the patient had a combined fracture in the ipsilateral elbow. The brace has hinges with ROM limitation set between  $-10^{\circ}$  and  $110^{\circ}$  in  $10^{\circ}$  increments. It also has a handle at the end to facilitate ROM exercise and to limit forearm rotation. Customized braces were used instead of premade ones because all of the children were different sizes. Pin removal was performed 12 weeks postoperatively as an outpatient procedure. The second surgery was performed with patients under sedation but without intubation. Incisions measuring <5 mm were made on the pin site for the implant removal.

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