Repair of comminuted (Mayo type IIB) olecranon fracture using Ethi-bond 5 sutures without metallic implants: A novel technique

Sheng Xu*, Heng An Lin, Merng Koon Wong

Department of Orthopaedic Surgery, Singapore General Hospital, Singapore

1. Introduction

Olecranon fracture is a common upper limb fracture accounting for approximately 10% of all fractures of upper extremity¹ and 40% of all fractures around the elbow joint.² These fractures can result from a direct trauma to the elbow joint, or indirectly due to abrupt forceful contraction of the triceps against resistance such as in the case of a fall onto an outstretched hand. Many classifications have been described in an attempt to better classify olecranon fractures for ease of intra-disciplinary communication and to guide therapeutic decision-making. Common classifications include: 1. The Mayo classification, based on comminution, displacement and fracture-dislocation. 2. The Schatzker classification, which divides fractures based on fracture pattern and grouped as transverse, transverse-impacted, oblique, comminuted, oblique-distal, or fracture-dislocation. 3. The AO classification, which divides the fractures into intra- or extra-articular subtypes. The standard teaching in the management of such fractures has always been rigid fixation with absolute stability, with emphasis on the restoration of intra-articular joint. In 1883, Joseph Lister pioneered internal fixation of the olecranon using a wire loop.³ Since then, a number of fixation methods have been employed. In 1963, Weber and Vasey described a technique using Kirschner (K-) wires and a stainless-steel wire loop⁴ which continues to be the most common method of fixation in transverse fractures and osteotomies of the olecranon today. For displaced fractures with significant comminution, plate fixation has been advocated as it allows for more anatomic reductions and better maintenance of reductions than tension band wiring.^{5–7}

Tension band wiring is the most widely used technique for the treatment of olecranon fracture.⁵ The technical advantage of tension band wiring is that the tension band fixation can neutralize the distracting forces on the outer cortex of the ulna during elbow flexion and change it to a compressive force on the articular surface of the olecranon, making the fracture site more closely opposed and better promote fracture healing. Good to excellent elbow function has been reported in both short and long-term follow-up studies.^{23,24} Although tension band-wiring is a common treatment for fixation of olecranon fractures, it is often not as easy as it seems. The challenges associated with this operation are often underestimated.² Complication rate for

tension band-wiring has been reported to be as high as 80% in the literature. Among the complications, the most common three include 1. Persistent pain post operatively 2. Migration of the K-wires and 3. Prominence of the implant.^{8–11} Other common complications described include infection, malunion or non-union, and damage to neurovascular structures.^{9,12–14} The issue of implant prominence is not limited to K-wires only. Due to the limited subcutaneous tissue in this region, all implants used in surgical fixation including plates and screws have a significant rate of implant removal after the fractures have healed.¹⁵

A number of studies have attempted to address the issue of symptomatic K-wire related complications by using sutures as an alternative option to olecranon fracture fixation.^{16–19} Although results were reported to be promising in surgical outcome, these were limited to the treatment of non-comminuted fractures or osteotomies.

We attempt to refine the surgical technique using surgical sutures in the fixation of olecranon fractures, and further extends the usage of this technique in the management of Mayo type IIB (displaced, comminuted) olecranon fractures. We report our case series of six such patients using the surgical suture fixation technique.

1.1. Indication

This technique is used by the authors for fixation of displaced comminuted (Mayo type IIB) fractures of the olecranon, on top of the simple displaced fractures of olecranon.

1.2. Contraindications

This technique is not advocated for fractures with associated ulno-humeral instability (Mayo type III).

2. Surgical technique

The patient is placed in the supine position. The affected arm is placed on a pillow above the chest. A tourniquet is tied pre-operatively and inflated after patient has been put under general anaesthesia. The classical posterior midline skin incision is made over the tip of the olecranon to expose the fracture site (Fig. 1).

* Corresponding author. Department of Orthopaedic Surgery, Singapore General Hospital, 20 College Road, Academia, Level 4, 169865, Singapore.
E-mail address: sheng.xu@mohh.com.sg (S. Xu).

Fig. 1. Exposure.

In comminuted olecranon fractures with depressed articular surface, the joint congruity is restored by elevation of the depressed articular surface using an osteotome. Bone allograft is then interposed into the bone defect.

Using Whipstitch technique through the triceps tendon, two Ethibond 5 sutures are anchored over the proximal fracture fragment, 1 medially and 1 laterally (Fig. 2a). The whipstitch technique is similar to that commonly employed in the preparation of hamstring tendon for Anterior Cruciate Ligament (ACL) reconstruction. The suture was first passed through the triceps tendon as close to the olecranon as possible and 5 suture throws were performed from distally to proximally over a distance of 30 mm, before reversing the direction and another 5 suture throws were performed with the final throw exiting as close to the olecranon as possible, leaving a pitch between the suture throws of 5 mm. The whipstitches should have a width of about 10 mm to allow sufficient hold on the triceps tendon. The needle attached to the Ethibond 5 suture was then cut and that completes the preparation of one whipstitch. The same technique is used to perform the second whipstitch on the other side. The 2 whipstitches are spaced apart with the outer aspect of the whipstitches near the medial and lateral margins of the olecranon to allow equal distribution of forces.

Two beath pins are used to pass through the proximal bone fragment, at an area just distal to the Whipstitches. The trajectory is aimed towards the center of the medullary cavity. The pins entered the outer cortex and exited from the medullary canal of the proximal fragment fracture site. The medial and lateral Whipstitches are then passed through the two beath pins respectively. The beath pins are then pulled through distally, allowing the sutures to pass through the drill holes into the fracture site (Fig. 2b).

Over at the distal end of the fracture site, separate two beath pins are drilled through and entered the medullary canal of the fracture site.

The beath pins should enter the center of the medullary canal of the distal fragment at equal distance as the sutures on the proximal fragment to allow correct opposition during tightening. The pins then exited from the dorsal cortex of the distal fragment (Fig. 3a and b). The beath pins should exit the distal cortex at about 2 cm from the fracture site to prevent pull out of sutures. Two Ethibond 5 sutures are again passed through the beath pins respectively, and the beath pins are pulled through distally, allowing the sutures to pass through the drill holes out of the cortex of the distal fragment (Fig. 3c).

Fracture is reduced using pointed reduction clamp and sutures are tied individually with simple non-sliding knot (Fig. 4a and b). Range of motion is checked intra-operatively to determine degree of flexion before gaping appears in the fracture. Wound is washed with normal saline before closure in layers with Vicryl 2/0 and Prolene 3/0. After application of sterile dressing, a front slab is applied at 10 degrees of elbow flexion.

All patients underwent a standardized post-operative rehabilitation protocol in which the front slab was kept for 2 weeks to protect the fracture site after which the patients will be referred to the physiotherapy to start gentle progressive range of motion exercises. Range of motion exercises are started 2 weeks post-operatively to minimize stiffness which is particularly common in periarticular fractures of the elbow. The focus of the physiotherapy in the first 3 month post-operatively would be on improving range of motion, and typically patients would be reviewed by the physiotherapist weekly to bi-weekly and their range of motion increased by up to 30° every 2 weeks provided there is no pain on increasing range of motion. After which, during the next 3 months, patients will continue their physiotherapy sessions and the focus then would be on progressive strengthening exercises.

3. Results

A total of 6 patients were treated with the above-mentioned sutured band techniques. Of the 6 patients (4 females to 2 males), the mean age was 68.8 years (youngest 56, eldest 82 years) (Table 1). All patients sustained a Mayo type IIB olecranon fracture with no other associated bony injuries. Other than 1 patient who passed away due to metastatic malignancy, all patients were followed up in outpatient clinic until 8 months post-operatively after which they were discharged upon achieving satisfactory pain free range of motion. X-rays were performed at every visit to check for fracture union till discharge (Fig. 5).

Thus far, there were no reported complications during the intra-operative or immediate post-operative period, as well as follow-ups at 1, 3, and 8 months post operatively.

At 1-month post operatively, the active range of motion varies from full extension to 30 degree of flexion deformity and up to 95 degrees of flexion. Range of motion improves significantly on review at 3-month post operatively. 3 patients manage to achieve full extension while the other 3 patients had a flexion deformity of 5–10°. Range of flexion varies from 85 to 150° with 5 patients being able to achieve active

Fig. 2. Ethibond 5 whipstitch of proximal fragment.

Fig. 3. Passing of Ethibond 5 sutures through distal fragment.

Fig. 4. Fracture opposition and final tie down.

flexion past 90°. At 8 months follow up, all patients managed to achieve a minimal flexion of 120°. 1 patient experienced prominence of suture knot at the elbow post operatively and underwent removal of suture knot at 6 months post-operatively. This patient managed to achieve satisfactory range of motion of 0–145° at 8 months follow up. All patients were discharged from clinic after their 8-month review with open date appointments upon achieving fracture union and satisfactory functional range of motion.

4. Discussion

Olecranon fracture is a common upper limb fracture. Current treatment options include tension band wiring and plate fixation. Tension band wiring has been described by literature as a convenient

and readily available surgical option. However, there are concerns with regards the prevalence of surgical imperfection. In the study by M. Schneider et al.,² the myth of technical simplicity and osteosynthetic perfection cannot be over-emphasized. In his study of 239 patients that had undergone tension band wiring, an average of 4.24 surgical imperfections was noted. Common imperfections include missing proximal fixation of K-wire, non-parallel K-wires, and K-wires surmounting the contralateral cortex too far. These imperfections were reported to be as common as 40% of all olecranon tension band fixation.² Furthermore, the common complication related to implant prominence that requires subsequent surgical removal has been reported in many papers.

The concept of tension band construct has also been challenged in the literature. Brink et al.²⁰ cadaveric study in 2012 scrutinized the

Table 1
Patient demographics and post-operative outcome.

	Patient demographic	Fracture type	Intra-operative finding	Progress
Case 1	75 years old Chinese Female	Mayo IIb left olecranon fracture	Comminuted fracture with bone loss on lateral olecranon	1month: 20–80° 3month: 5–150° 8month: 0–150°
Case 2	72 years old Chinese Female	Mayo IIb left olecranon fracture	Comminuted fracture with 2 intra-articular fragments depressed into fracture site.	1month: 0–60° 3month: 0–85° 8month: 10–120°
Case 3	68 years old Chinese Male	Mayo IIb right olecranon fracture	Comminuted fracture with depressed articular surface on medial side	1month: 30–90° 3month: 0–100° 8month: passed away due to metastatic malignancy
Case 4	82 years old Caucasian Male	Mayo IIb left olecranon fracture	Comminuted fracture with multiple sagittal split	1month: 25–90° 3month: 5–90° 8month: 5–140°
Case 5	56 years old Chinese Female	Mayo IIb right olecranon fracture	Comminuted fracture with at least 5 fragments	1month: 5–95° 3month: 0–110° 8month: 0–145°
Case 6	60 years old Chinese Female	Mayo IIb right olecranon fracture	Comminuted fracture with longitudinal split into 3 parts and depressed distal articular surface	1month: 10–80° 3month: 10–90° 8month: 0–140°

Fig. 5. Pre- and post-operative X-ray.

tension band principle, pointing out that tension band wiring in the elbow in fact functions more as a static compression device as opposed to one that offers dynamic compression. In his study, 6 fresh frozen cadaveric upper limbs were treated with tension band wiring and applied various loading protocols. It was interesting to note that the dynamic compression principle of the tension band was only achieved when the elbow was actively extended against gravity at between 30° and 120°. Hutchinson et al.²¹ also found lack of compression at the anterior olecranon in the study of 10 cadaveric elbows fixed with tension band construct that were subjected to cyclic loading.

In terms of long term surgical outcome thus far, Karlsson et al.²² has one of the longest follow up series of 15–25 years of follow up. It is interesting to note that among his patients, 96% had good to excellent results despite reduced range of elbow motion and the development of subsequent degenerative changes around the elbow. This is regardless of the type of treatment that the patients had received, be it conservative management, tension band wiring in figure-of-eight technique or Rush pins fixation technique. Although approximately 50% of the patients showed degenerative changes, among them only four patients developed symptoms related to elbow osteoarthritis. This brings about the question of whether olecranon fracture often yield good clinical results in the first place, regardless of the chosen therapy.

In the light of the previous published data, we propose a revised approach in the treatment of displaced, comminuted olecranon fracture that does not require any metallic implants, thus eliminating the high rate of implant complications and its removal as mentioned earlier. We have decided to use Ethi-bond 5 sutures as our fixation device, as this suture was used in previous cadaveric studies with proven satisfactory strength and durability in maintaining olecranon fractures through biomechanical testing.¹⁷

The use of sutures in olecranon fracture fixation is not a new concept. JF Henseler et al.¹⁶ in 2014 has described olecranon fracture fixation using non-absorbable sutures in 3 elderly patients. In his described technique, the non-absorbable sutures are passed through drilled holes in both the proximal and distal fragments and the surgical knot is tied deep to the triceps insertion. A separate figure of eight construct was used with a separate non-absorbable suture, with knot tied lateral to the triceps insertion. A. Nimura¹⁸ et al., in 2010 described a case report of olecranon fracture fixation using Fiberwire, by first drilling 2 k-wires from distal fragment to proximal fragment, and retrieved the Fiberwires from proximal to distally using wire retriever. The sutures were knotted at the olecranon.

The main concerns we had in such fractures were that of bone quality, bone fragment size and accessibility from the surgical approach perspective, as well as bone loss and comminution. In our revised approach, we have decided to use whipstitch techniques over the triceps tendon prior to passing the sutures through the distal fragments. This

gives a possible advantage over previous described techniques as recruitment of triceps tendon as part of the construct helps to distribute the stress of repair over a larger area, instead of concentrating the stress at the often soft and osteoporotic distal fragment. This may potentially give rise to lesser possibility of suture cut-outs through the bone. In addition, using the whipstitch technique lessened the dependence on the size of the proximal bony fragment, which in certain potential cases may be too small or fragmented to allow passing of two drill holes. In such events, the Ethi-bond sutures can be passed directly through to the distal fragment.

Tying of knots deep to the triceps insertion while maintaining good suture tension requires good adequate exposure, which means triceps insertion may have to be peeled off or partly compromised in order to achieve this. After the index case where we experienced knot prominence that requires removal, we have subsequently revised the technique to tie the knot at the radial border of the ulna, which offers a much better soft tissue coverage as compared to the subcutaneous dorsal or medial borders. With this revision, our remaining patients did not complain of any knot prominence issue.

From a concept perspective, since tension band wiring technique probably serves more as a static compression device as evident in recent literature, it can be used in comminuted fractures as well. In our series, this surgical technique is used alongside bone grafting, and the sutures were able to hold the fixation construct well until bony healing is complete. One technique we used was to pack the bone graft granules tight and ensuring that the joint congruity is restored before closing the access window via reduction.

One limitation of this case series is the relatively small number of cases as well as limitation of patient demographics to older patients with less functional demand. As this was a technique for fixation of displaced comminuted (Mayo type IIB) olecranon fracture with sutures which has not been previously described in the literature, the authors hope that this could serve as a pilot study to investigate the feasibility of this technique and the initial success of this technique could prompt future larger case series to examine its safety and efficacy in greater details. Another limitation is the relatively short duration of follow up of 8-month. It is a routine practice in the authors institution in which patients are discharged with open date follow up after achieving complete bony union and satisfactory level of functional status. However, longer follow-up period would be beneficial to investigate the long-term outcome of this surgical technique and future larger studies with long follow up would be performed to further validate our results. In addition, these are selected cases of olecranon comminution that requires bone grafting. The patients achieved good post-operative functional outcomes related to range of motion. Even though 1 patient experienced prominent suture knot post-operatively and underwent removal, we believe that this could be eliminated with careful knot

placement.

5. Conclusion

Our proposed revised technique using suture repair in the management of displaced and comminuted olecranon fracture is based on existing scientific evidence that has yield promising results without the high risk of conventional methods. Patients have satisfactory range of motion and are generally satisfied with the clinical outcome.

Conflict of interest and source of funding

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