The use of bioabsorbable compression screws & polyethylene tension band for fixation of displaced olecranon fractures

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ABSTRACT

Introduction: Transverse fractures of the olecranon are commonly fixed using tension-band wiring techniques. However the superficial nature of this area leads to high complication rates requiring removal of metalwork. The purpose of this retrospective study is to report and evaluate functional outcomes of polyethylene tension-band and bioabsorbable Magnesium alloy screw fixation of olecranon fractures.

Methods: A retrospective case-control study was undertaken. Demographics, injury type and post-operative details were collected. All patients were treated in the same institution by a single surgeon. Primary outcomes included radiographic healing and post-operative range of motion. Secondary outcome was post-operative complications.

Results: A total of five cases were identified. Mean age was 52.4. The control group was made up of six patients treated with a traditional tension band wire fixation. One patient in study group was lost to follow up. 80% of fractures in study group demonstrated anatomic post-operative radiographic union, compared with 83% of control group. All patients had range of motion above 100°, with full pronation and supination. One patient did have an extension lag of 15°.

Conclusion: Surgical repair of olecranon fractures is often complicated by the need for re-operation. This method provides both intramedullary fixation and conversion of distraction forces to compression forces with bioabsorbable materials, and aims to reduce the high re-operation rates commonly seen by avoiding the use of permanent indwelling metal hardware.

1. Introduction

Olecranon fractures are common injuries of the upper limb. They account for 1% of all adult fractures and 10% of upper extremity fractures in adult populations.^{1,2} While there is an argument for conservative management in low demand elderly patients, they typically require surgical fixation.³ The goal of surgical fixation is to restore the anatomy of the articular surface, repair the extensor mechanism, restore joint stability and mobility and prevent stiffness. There are several techniques available for surgeons to reduce and fix these fractures, with significant debate in the literature on the optimal technique.^{4,5} Tension-band wires, plate osteosynthesis, with or without bone graft augmentation are some of the surgical techniques for fixation of these injuries. No one technique is suitable for all olecranon fractures, however early mobilisation is a fundamental principle for optimising functional outcome as per the AO.⁵⁻⁷ There is no consensus in the literature on whether plate osteosynthesis or tension band wire fixation is superior.²

Tension-band wire (TBW) fixation is a commonly used technique for repairing displaced intra-articular olecranon fractures. This has been shown in the literature to be performable, reproducible and effective in both allowing for fracture healing, but also in restoring the extensor elbow complex and allowing early mobilisation. However, hardware complications have been reported, with infections and pin-migration often requiring subsequent removal of the implants.⁸ A single centre review of 129 olecranon fractures comparing plate and TBW techniques did not show any clinical difference between the techniques for Mayo Type 2A olecranon fractures. However 33% of olecranon fractures fixed using tension band wire technique required an additional operation due to hardware irritation.⁹ Another randomised trial of the two techniques demonstrated similar results, with no differences noted in terms of functional outcomes but increased hardware related complications for those treated with TBW.¹⁰

Intra-operative assessment of tension-band wire fixation has been fraught for some time. Schneider et al., in 2014 identified a number of

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issues and quality assessment tools for tension band-wire fixation of olecranon fractures.^{11,12} These included:

- (1) nonparallel K-wires,
- (2) long K-wires,
- (3) K-wires extending radially outwards,
- (4) insufficient fixation of the proximal ends of the K-wires,
- (5) intramedullary K-wires,
- (6) perforation of the joint surface,
- (7) single wire knot,
- (8) jutting wire knot(s),
- (9) loose figure-of-eight configuration, and
- (10) incorrect repositioning to evaluate radiographs of olecranon fractures.

Bio-absorbable material is increasingly becoming used for management of fractures. Literature has shown magnesium-based compression screws offer suitable fixation, with the added feature of being bio-absorbable, not requiring removal.¹³ Other early case reports show these implants to be safe and suitable for intra-articular fracture fixation.¹⁴ Bioabsorbable magnesium-based Magnezix® compression screws (Syntellix, Hanover, Germany) have also been shown to be safe and suitable for fixation as an augment to first ray surgery in hallux valgus corrections.¹⁵

Polyethylene tapes have been increasingly used for and to augment soft tissue repairs in trauma, such as quadriceps and patellar tendon injuries. These tapes provide intrinsic strength, allowing the repaired construct to act against tensile forces.¹⁶ Neoligaments™ are an open-weave mesh implant which act as a scaffold, allowing tissue ingrowth.¹⁷

We present a retrospective case series of five displaced intra-articular olecranon fractures who underwent open reduction internal fixation using a magnesium-based bioabsorbable compression screw with polyethylene tension band construct. We planned to compare them with a similar cohort of olecranon fractures treated with a traditional tension band wire fixation.

2. Methods

A retrospective case-control study of five displaced intra-articular olecranon fractures was undertaken. No power analysis or calculation performed was performed given the retrospective nature of the study and the relatively small number of patients treated. A control group of six traditionally managed olecranon fractures with a tension-band wire fixation were used for comparison. This group were managed in the same institution during the same time-period. Demographic data and injury type were collected and analysed. All patients were treated in the same institution by a single surgeon. The Mayo olecranon classification system was used to classify fracture morphology.

Technique for fixation followed a traditional approach for open reduction internal fixation of an olecranon, with patients under general anaesthetic being positioned supine, with the operative upper limb draped appropriately and positioned across the patient's chest. Fractures were reduced anatomically. Fixation of fracture fragments was performed using a Magnezix® compression screw and application of a Neoligaments™ polyethylene band in a figure of 8 to act as a tension band, passed through a transverse drill-hole created in the olecranon distal to the fracture site. Following the transferable quality assessment tools described by Schneider et al., double-knots were tied in the neoligament construct. The figure-of-eight construct was assessed to be appropriately tensioned. Confirmation of satisfactory fixation was undertaken using intra-operative image intensifier. None of the other issues identified by Schneider et al. were relevant as they assessed position of Kirschner wires used in a traditional tension-band fixation.

A single Mayo 3A fracture was included in this study. This typically requires rigid fixation of the olecranon due to ulno-humeral collateral

ligament instability.^{18,19} This fracture was reduced satisfactorily and fixation performed with the technique described above. No significant laxity noted on valgus stress test under image intensifier. No ligamentous reconstruction undertaken.

Patients received an early functional rehabilitation with no post-operative immobilisation of the elbow joint. Clinical follow-up was undertaken at two weeks, six weeks and twelve weeks post-operatively.

Primary outcomes included radiographic healing, the need for removal of implants and post-operative range of motion.

Secondary outcomes included post-operative complications.

Statistic analyses were carried out using IBM SPSS Statistics for Windows, Version 24.0. Armonk, NY. Tests required included descriptive statistics such as mean, median and standard deviations. Fischers's exact test was used to calculate categorical variables.

3. Results

A total of five patients were identified for the study group, treated by this novel technique. Three were male and two were female. Mean age was 52.4 year (SD± 24.09). Age ranges were 24–79 years. A total of six patients were identified for the control group who underwent standard tension band fixation of olecranon fractures. Three were male and two female. Mean age was 59.17 years (SD ± 21.5). Ages ranges were 18–79 years.

All injuries were closed intra-articular olecranon fractures.

There were a variety of olecranon fracture morphologies treated using this novel technique, both simple and comminuted. The Mayo Olecranon classifications included in the study group were two Mayo 2A, two Mayo 2B and one Mayo 3A. Of the control group, five were Mayo 2A type fractures and there was one Mayo 2B.

3.1. Primary outcomes

Of the novel neoligament and magnesium-based screw technique, four of the five patients (80%) demonstrated anatomic bony union on follow-up radiographs. One patient was lost to follow up and did not attend follow-up review. Bio-absorbable compression screws were noted to be resorbing on follow-up imaging, as demonstrated in Fig. 1. Of the traditional tension-band wire technique, at post-operative review, anatomic bony union noted in five of the six cases (83%). This was not statistically significant ($P = 0.45$, Fischers exact test) (see Fig. 2).

0% of those in the study required removal of metal. Of the six traditionally managed tension-band wire fixations, five of the six patients (83%) had the metalwork removed or had been listed for removal. This was statistically significant with a P value of 0.015 (Fischers exact test).

Of the novel technique group post-operative range of motion was excellent. All patients followed up reported greater than 100° of flexion at the elbow and full range for pronation and supination. One patient had an extension lag of 15°. Of the tension-band wire technique, four of the six patients had excellent post-operative range of motion, after removal of tension-band wire fixation ($P = 1$, Fischers exact test). One of these patients was with restricted extension was referred for removal of implants but is still awaiting surgery. The final patient with restricted range of motion had reduced flexion, but was clinically satisfied and was not seeking any further intervention.

3.2. Secondary outcomes

For the study group of patients treated with the novel technique, no patients had any wound related or other general complications. No patients required revision operation or intervention.

Of the control tension-band wire group, one patient did develop a minor post-operative wound infection after twelve weeks. This was managed with oral antimicrobial agents and patient underwent removal of metalwork. No further issues were noted.

Fig. 1. A-Lateral pre-operative image Mayo 2B fracture. B-AP pre-operative image Mayo 2B fracture. C-AP intra-operative image Mayo 2B fracture. D-AP post-operative image Mayo 2B fracture. E-Lateral post-operative image Mayo 2B fracture.

4. Discussion

The AO tension band wire technique is the typical approach for displaced transverse fracture of the olecranon. This generates a compressive force at the fracture site through converting distraction generated by the extensor elbow complex.²¹ Studies demonstrate that post-operative outcomes comparing TBW with plate osteosynthesis show comparable results in rates of union and in post-operative patient reported outcome measures.²² A retrospective study of 48 olecranon fractures demonstrated both plates and TBW technique had excellent functional outcomes. Plate fixation did mean for a longer time to radiographic union (19 ± 8 vs. 12 ± 6 weeks, $p = 0.001$) and slightly less terminal extension ($-8.6^\circ \pm 7^\circ$ vs. $-3.5^\circ \pm 9.3^\circ$, $p = 0.036$) compared with those treated by TBW.²³ Another retrospective review between plate fixation and TBW techniques resulted in similar post-operative DASH scores, but did comment on longer operative time for plate fixation.²⁰ Two further meta-analyses demonstrates no differences between TBW or plate fixation for functional outcomes, but did comment on higher rates of hardware complication and need for removal in the TBW groups.^{24,25}

Based on review of the data, patient reported outcomes between TBW and plate fixation are similar. TBW does appear to allow for better functional range of motion but also has higher rates of hardware failure. This issue with hardware complications have been reported in the literature with high rates of patients needing to have the implants removed on an elective basis post-operatively. In a retrospective review of 189 olecranon fixations, 29.1% of all cases needed hardware removal.²⁶ Another retrospective review of 177 olecranon fixations also reported higher rates of wound infection and removal of hardware in TBW cases.²⁷ Clearly reviewing the details, there are increased costs and

morbidity in patients undergoing traditional TBW fixation, with higher rates of removal of hardware and wound issues.²⁸

The technique described in this case series, utilising implants that are low profile and does not need to be removed routinely is certainly strength of this technique. Patients benefit from early mobilisation and excellent patient reported outcomes as well as excellent functional range of motion. One patient did have an extension lag of 15° . Post-fixation xray was satisfactory and stiffness was deemed to be due to early pain related reluctance to mobilise injured joint. Post-traumatic stiffness is a common issue after elbow trauma. The functional arc of elbow motion is 30° – 130° .²⁹ Patient in question was very satisfied with outcome and discharged to physical therapy. No patient reported palpable hardware or irritation that is typically associated with TBW fixation.

5. Limitations

This was a small case-control study of a novel technique for olecranon fixation. Statistically significant findings were only apparent in one variable. One of the study group was lost to follow up.

6. Conclusions

We present a novel augmentation to the traditional AO tension band wire technique using bio-absorbable magnesium compression screws with a polyethylene mesh tape. This has the biomechanical benefits of TBW fixation without the associated hardware concerns. This has been demonstrated to be successful in a small cohort of olecranon fractures, with no hardware related or other significant complications. None of these patients required implant removal, compared with 83% of the control group treated with a traditional tension-band wire technique

Fig. 2. A-Lateral pre-operative image Mayo 2A fracture. B-AP pre-operative image Mayo 2A fracture. C-Lateral intra-operative image Mayo 2A fracture. D AP intra-operative image Mayo 2A fracture. E-Lateral post-operative image Mayo 2A fracture. F-Lateral post-operative image Mayo 2A fracture.

($P = 0.015$). This does not preclude the need for larger case-control studies and randomised trials to objectively compare this technique with more traditional TBW fixation and plate fixation.

Permission statement

This retrospective study was conducted in the manner of an audit, reviewing outcomes of tension band wire fixation for olecranon fractures. As such, as per Health Service Executive (HSE) clinical audit guidelines, audit activity does not require institutional ethical approval.

Range of motion, functional assessments post injury and complication details are all routinely followed up.

No specific patient details are described and radiographs in figures section are anonymised.

Declaration of competing interest

None to declare.

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