Case Report

Delayed reconstruction for olecranon fracture with extensive soft tissue injury and bone loss: A case report

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ABSRACT

Delayed surgery for intraarticular fractures of the elbow is usually avoided, especially to prevent complications such as stiffness. We described an interesting case of a young patient who presented with open fracture of right olecranon, with extensive soft tissue injury and bony loss. He was treated with a 3-stage surgical procedure, prioritising on the soft tissue healing first before undergoing a delayed, definitive fixation of the olecranon, which was done 4 weeks after the trauma. The 3 stages include initial debridement and temporary skeletal stabilisation using Kirschner wires and external fixator, second look debridement with shoelace (dermato-traction) technique of delayed wound closure, and a definitive, reconstructive surgery using tricortical iliac bone graft with anatomical locking plate. The subsequent radiographs showed restored articular congruency of the elbow joint, before the olecranon eventually achieved bony union. He recovered well with excellent outcomes, as the elbow range of motion achieved almost full flexion at 120° and the extension lag at 10° and the Disabilities of the Arm, Shoulder and Hand (DASH) score of 3.3 was recorded. Delayed reconstructive surgery for olecranon fracture with extensive soft tissue and bone loss is a viable option to avoid complications, including infection and non-union. A judicious consideration by prioritising soft tissue management over expeditious bony surgery is important to achieve excellent outcomes.

ABSTRAK

Operasi yang tertunda untuk fraktur siku intraartikular biasanya dihindari, terutama untuk mencegah komplikasi seperti kekakuan. Kami menggambarkan sebuah kasus menarik dari seorang pasien muda dengan fraktur terbuka pada olekranon kanan dan cedera jaringan lunak yang luas, disertai dengan hilangnya sebagian tulang. Pada pasien dilakukan prosedur bedah 3 tahap dengan mendahulukan penyembuhan jaringan lunak sebelum dilakukan fiksasi definitif olecranon 4 minggu setelah trauma. Tiga tahap pembedahan termasuk debridemen awal dan stabilisasi kerangka sementara menggunakan Kirschner wires *dan fiksator eksternal,* second look *debridemen dengan teknik* shoelace (dermato-traction) *pada penutupan luka yang tertunda, dan bedah rekonstruksi definitif menggunakan cangkok tulang iliaka trikortikal dengan* locking plate *anatomis. Radiografi berikutnya menunjukkan kongruensi sendi siku yang membaik sebelum tulang olekranon menyatu. Kondisi pasien membaik dengan luaran yang sangat baik, yang dibuktikan dengan rentang gerakan siku hampir mencapai fleksi penuh pada 120 ° dan perpanjangan ekstensi pada 10 ° dan skor Disabilitas Lengan, Bahu dan Tangan (DASH) 3,3. Operasi rekonstruksi yang tertunda untuk fraktur olekranon dengan kerusakan jaringan lunak dan kehilangan tulang yang luas adalah pilihan yang layak untuk menghindari komplikasi, termasuk infeksi dan* non-union. *Pertimbangan yang bijaksana dengan memprioritaskan penatalaksanaan jaringan lunak dibanding menyegerakan operasi tulang menjadi hal yang penting untuk mencapai luaran yang sangat baik.*

Keywords: Olecranon fracture, delayed, reconstruction, extensive, shoelace technique
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INTRODUCTION

Olecranon fracture might present in a spectrum of injuries, from a simple fracture pattern to a more complex fracture-dislocation that requires urgent attention. Delayed surgery for intra-articular elbow fractures is usually avoided, as restoration of elbow function and prevention of stiffness are important.[1,2] Delayed surgery is associated with poor outcomes, attributed to difficulty and failure to reconstruct articular cartilage[1,2], osteopenic fragment[3], triceps muscle contracture[3], and formation of heterotopic ossification.[1]

As the olecranon is relatively subcutaneous, open fracture of olecranon with extensive soft tissue loss may provide a dilemma to decide the best algorithm of treatment. We describe a case of young patient who presented with an open fracture of right olecranon with extensive soft tissue injury and bony loss, and whose definitive bony fixation was delayed in favour to prioritise soft tissue healing, until eventually achieve excellent outcomes.

Case Report

A 27-year-old male presented to the Casualty Department after being involved in a motor-vehicle accident, during which he fell from his motorcycle after being hit by a passing car and landed on his right side of the body onto the ground. He had excruciating pain over his right elbow, accompanied by a bleeding wound. There was numbness over dorsum of the right forearm and hand.

Examination revealed a huge, degloving wound over the right elbow measuring around 10cm x 13cm. The elbow joint was exposed with noticeable bone loss between the olecranon process and proximal ulnar shaft. The wound was highly contaminated with presence of grass, dirt and road debris. He was unable to extend his right elbow.

Subsequent right elbow radiograph showed fracture of the olecranon, with extensive bone loss [Figure 1]. The elbow joint was subluxated with loss of articular congruency. There was no associated fracture involving proximal radius or distal humerus.

The diagnosis of open fracture of the right olecranon with elbow dislocation was established. Intravenous antibiotics (gentamicin and cefuroxime) were commenced immediately. He later underwent wound exploration, debridement and fracture stabilisation with temporary Kirschner wires [Figure 2]. A cross-elbow external fixator was applied to further stabilise the elbow joint and facilitate wound dressing. Adequate soft tissue coverage for the joint and bone was achieved (Gustilo-Anderson grade IIIA); however, the wound was left open due to the highly-contaminated condition. The fracture was thereafter also classified according Mayo classification for olecranon fracture as type IIIB (unstable, comminuted).

Figure 1. Lateral radiograph of the right elbow on presentation to the casualty department. There was fracture of the right olecranon with extensive bone loss, with incongruent articular surface. The elbow joint was subluxated with the humeral condyles protruded through the fracture gap. There were multiple, small radiopaque debris visible in the x-ray.

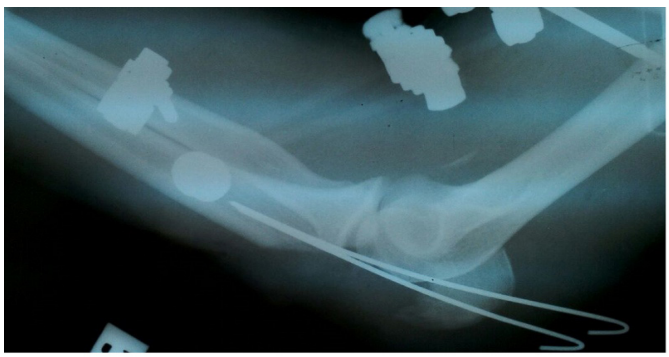

Figure 2. Lateral radiograph of the right elbow after the initial surgery which involved wound debridement, reduction of elbow subluxation, temporary fixation of the fracture fragment with Kirschner wires and a cross-elbow external fixation. The subluxation was reduced with acceptable radio-capitellar line. The fracture fragment was held in place by the Kirschner wires and the elbow joint was maintained at 90° flexion with the external fixator in-situ. The pre-operative radiopaque debris were not visible indicating complete removal of the foreign bodies .

The patient underwent daily dressing for the wound management. 72-hours after the initial surgery, he underwent a second-look debridement – this time, a shoelace-technique of wound closure was applied. Using two small-sized vessel loops, they were anchored at one end and

passed from one wound edge to another in alternating fashion [Figure 3]. Staples were used to accommodate the vessel loops at the wound edges. Tightening of the vessel loops was started 48 hours after the debridement. About 1.5 cm of the vessel loop was pulled every day until the wound was well-approximated at 9 days after the procedure. Delayed primary closure using interrupted non-absorbable suture was done thereafter in the ward under local analgesia.

The definitive surgery then was slightly delayed to allow the soft tissue to completely heal. At the 4th week post trauma, reconstruction surgery for the olecranon was done. The existing gap was filled up by autograft which was harvested en bloc from the right iliac crest. The graft was shaped according to the missing part of the olecranon using high-speed burr and bone file, and fixed with a locking plate. Articular surface congruency was examined through direct visualisation and confirmed using image intensifier guidance. The right elbow joint was passively-mobilised and able to achieve almost full flexion with no impingement.

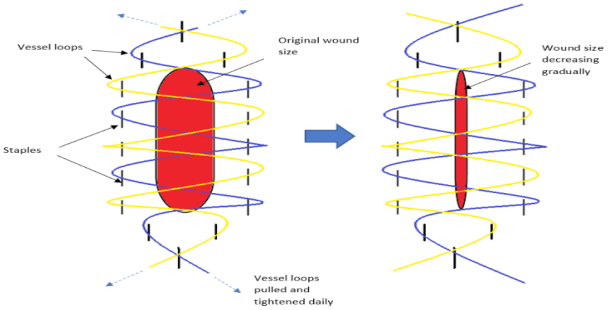

Figure 3. Diagram showing dermato-traction or shoelace technique for wound closure. This delayed closure technique employs 2 vessel loops, anchored at each side of the wound by staples. The vessel loops were pulled around 1.5cm per day each, and as the wound contracts, it gradually decreases in size.

Postoperative radiograph showed successful restoration of the articular congruency of the elbow joint [Figure 4]. The immediate postoperative range of motion achieved was 30° to 90° active flexion. The patient was followed-up every 3 weeks until the 12th week post-reconstruction, then monthly after that. Following intensive physiotherapy, subsequent improvement of range of motion were recorded [Table 1]. At 12th week post-operative follow-up, the range of motion for the elbow had improved to almost full flexion at 120° and the extension lag at 10° [Figure 5]. The Disabilities of the Arm, Shoulder and Hand (DASH) score was recorded at 3.3. The patient was satisfactory with this outcome as he was able to execute his daily activities with no problem and had returned to work.

Table 1. Chronological improvement of range of motion of the right elbow

Chronology	Range of motion achieved
After initial surgery until 4 weeks post trauma	Elbow fixed at flexion 90° (patient was put on cross-elbow external fixator)
Immediately after reconstruction	Elbow flexion 30° up to 90°
3rd week after reconstruction	Flexion up to 90°, extensor lag 20°
6th week after reconstruction	Flexion up to 105°, extensor lag 15°
12th week after reconstruction	Flexion up to 120°, extensor lag 10°
After removal of implant	Flexion up to 120°,extensor lag 10°

Note: Gradual improvement was owed to intensive physiotherapy, and the patient achieved final range of motion of up to 120° flexion, with minimal extensor lag. He is able to execute daily activities with no difficulty.

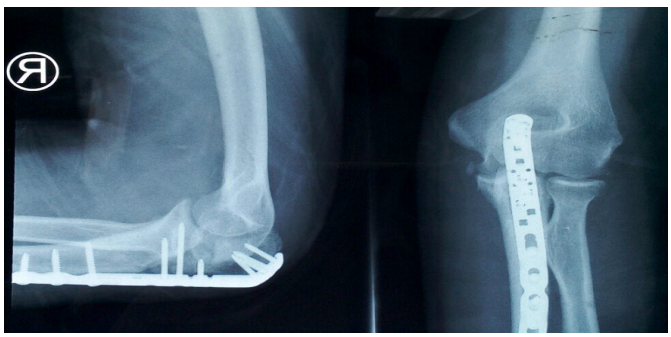

Figure 4. Post-operative lateral and AP radiographs of the right elbow. The articular surface of olecranon that involves in elbow joint managed to be reconstructed and the joint line appeared congruent. The pre-contoured plate conformed the anatomy of the olecranon. Multiple options for screw holes especially over the proximal fragment and the tricortical helped the surgeons to obtain adequate cortical purchase.

However, at 5 months after surgery, the patient complained of itchiness over the surgical scar, for which he had scratched and created a small abrasion [Figure 6]. Taking into consideration of radiographic union with successful incorporation of the bone graft, the patient underwent removal of the locking plate at around 6 months after the reconstructive surgery. Post-removal, X-ray revealed a congruent elbow joint with minimal marginal

heterotopic ossification [Figure 7]. He recovered well post removal of the implant and achieved the pre-removal range of motion.

Figure 5. The active range of motion of the right elbow taken at 12th week after the definitive reconstructive surgery. The patient able to attain about 120° of flexion, but there was extensor lag for about 10°. This range of motion, however, is adequate for him to execute his activities of daily living and led him to return to work.

Figure 6. Comparison between the wound on presentation and the healed scar prior to removal of implant. The initial trauma left the patient with extensive wound, and the ulna can be seen exposed. After meticulous soft tissue management using shoelace technique, coverage was achieved, and allowed for reconstruction of the olecranon. However, the hyperpigmented, hypertrophied scar caused itchiness, thus the implant was removed after union to prevent problems due to the thin soft tissue envelope.

Figure 7. The lateral and AP radiographs of the right elbow taken post-removal of implant. The fracture of the olecranon achieved union, with good incorporation of the bone graft. The elbow joint congruency was still maintained. There was small marginal heterotopic ossification visible on the AP view, extending from the medial condyle.

DISCUSSION

Successful treatment for olecranon fractures is not only important to restore the extensor mechanism, but also to preserve the elbow joint stability.[1,2] Anatomical reduction and stable internal fixation are, therefore, vital to restore function. Early definitive fixation is always favourable as it helps to mobilise the elbow immediately, thus preventing complications such as elbow stiffness and muscle atrophy.

The challenges present in this complex case, however, rendered the fixation to be delayed. The obstacles can be divided into 2 main components - the soft tissue management and the bony fixation. As the patient presented with highly-contaminated, extensive-sized wound over the elbow, urgent debridement and washout was deemed as a priority, and the need to delay closure as a necessity. The soft tissue loss during the trauma was irreversible – therefore judicious debridement was required to balance between acquiring healthy wound base to prevent infection, and to minimise further loss of muscle bulk for adequate soft tissue coverage.

Delayed primary closure using dermato-traction or the shoelace technique was chosen over other types of closure such as split skin grafting or flap based on few reasons. First, shoelace technique is an easier, simpler method that provides some time for the wound to contract physiologically to further reduce its size, without being under undue tension. If the wound needs to be re-explored and debrided in the presence of unexpected infection, it is rather inconvenient to be done if it has been covered with flap or skin graft. Donor site morbidity may also be avoided by using shoelace technique. And lastly, shoelace technique has been reported to have better outcome in regards to cosmetic appearances and providing sensate skin.[4]

At the initial stage, while prioritising the soft tissue healing, the objective was to stabilise the fracture with extensive bone loss and to obtain reduction of the elbow subluxation. Hence, the choice of Kischner wires and cross-elbow external fixator was made. Immediate fixation of the olecranon was ruled out in view of the presence of heavy contamination and possibility of worsening the soft tissue condition – the need to cover the implant may have resulted in tissue necrosis due to the tension applied while performing the forced closure. One of the adjuncts that should have been given serious consideration for the

initial stage was the Masquelet technique or procedure.[5] Filling the bony gap with supplementary antibiotic cement spacer would have provided a few advantages including delivery of high local antibiotic concentration, whereas the cement would form a pseudo-membrane for insertion of the bone graft later.[5]

The need for bone graft was inevitable to manage bony defect in this case. The choice of tricortical iliac bone graft was decided over other donor sites (especially fibula) based on its convenience and less donor site morbidity, in regards to post-operative pain, neurovascular complications and muscle weakness.[6] Harvesting the intended size of iliac graft, which is wider and less rounded than the fibula, helps to tailor and shape the graft according to the defect to reconstruct the articular surface. Non-vascularised iliac bone graft is easier to harvest and technically less demanding as compared to the vascularised graft, although the complications are relatively similar for both.[7]

There are a number of fixation options available for olecranon fracture - the two most common are by tension band wiring and plating.[1,8] The tension band wiring was less suitable –not only because its primary indication is simple transverse, non-comminuted fracture proximal to the sigmoid notch, it also has high complication and re-operation rate.[8,9] Comminuted fracture of the olecranon treated with tricortical bone graft with multiple tension band wiring is reported sporadically in the literature[10], but in this case, application of multiple hardware used might further compromise the soft tissue condition.

Anatomical locking plate was adopted as the reconstructive fixation, as it provides multiple advantages – including lower in profile, anatomically well pre-contoured and has more screw options for proximal fragment. [9,11] It is easier to accommodate the tricortical graft by using locking plate, and without intimate bone-plate interface on the graft, it allows better healing by avoiding disruption of cortical bone perfusion. It also allows the graft to be placed at the intended area without alteration to its osseous segment when tightening of the screws was done (as in conventional plates).[11] Biomechanically, the locking plate provides adequate angular stability and provides significantly greater compression compared to tension band wiring.[11,12]

The factors contributing to the poor outcomes for delayed surgery of the elbow can be divided into two : the preventable factors (i.e. failure to anatomically reconstruct the articular surface, infection) and factors which are difficult to predict or prevent (i.e. triceps contracture, heterotopic ossification formation).[1,2,3] The single main factor influencing the outcome is anatomical reduction and reconstruction of articular surface. In our patient, this played a major role as he regained great range of elbow motion due to anatomical reconstruction of the articular surface. Judicious management of the soft tissue in this patient also had prevented the occurrence of infection, thus influencing the good outcome. Other methods to prevent infection from causing poor outcomes include meticulous handling of soft tissue during surgery, thorough and justifiable debridement of unhealthy, non-viable tissue in open fracture cases and the use of prophylaxis antibiotics.

Complications of delayed surgery in patients with extensive soft tissue and bone loss in an olecranon fracture may be preventable. In this patient, the usage of cross-elbow external fixator might contribute to the extension lag as soft tissue contracture may have occurred. This is combined with the loss of original extensor muscles bulk from the extensive wound, which later healed with fibrosis. Delayed surgery also predisposes to non-union and malunion of the olecranon, thus altering the axis of elbow motion and influencing the functional outcome[13] – although this was not observed in this patient. The usage of plate in a previously compromised soft tissue condition may have also contributed to the early removal of implant in this patient. The thin, compromised soft tissue envelope may predispose to wound breakdown, in addition to the proximal ulna being placed in tension with elbow flexion.[9] Heterotopic ossification is another commonly reported complication of an olecranon internal fixation, although whether it will cause limitation of the elbow function is still debatable.[1,14]

CONCLUSION

Further studies are still needed to establish an algorithm for management of open olecranon fractures with extensive bone and soft tissue loss. This may include (but not limited to) comparative studies using hinged and non-hinged cross-elbow external fixator as temporary measure to prevent muscle contracture which may influence the outcome of delayed surgery; and mosaicplasty using femoral condyle (instead of tricortical bone graft) to reconstruct the articular surface.

In conclusion, a delayed reconstructive surgery for an olecranon fracture with extensive soft tissue and bone loss is a viable option to ensure that greater complications, including infection and non-union, that may arise can be avoided. A judicious consideration by prioritising soft tissue management over expeditious bony surgery is important to achieve excellent outcomes in these patients.

Consent

The authors declare that the patient has given written consent for his case and related clinical images to be published.

Competing Interests

All of the authors declare that they have no competing interests.

Acknowledgement

AAA and NK carried out the clinical works – including the assessment, investigations, surgery and follow-ups of the patient. AAA acted as primary author of the manuscript, with FC contributed in writing some parts of the discussion and in preparation of the diagram. All authors read and approved the final manuscript. The clinical works were carried out in Hospital Tawau, Sabah, Malaysia (where AAA used to work prior to his transfer to the current institution).

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