CASE REPORT

Intramedullary Cancellous Screw Fixation of Simple Olecranon Fractures

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Abstract

Olecranon fractures and osteotomies are treated with either tension-band wiring or plate-screw fixation; however, these methods of fixation have high rates of symptomatic hardware, resulting in revision surgery. We describe the novel use of intramedullary noncannulated long screws to gain rigid internal fixation and allow early range of motion. Our procedure differs from traditional intramedullary olecranon fixation as the longer screws, which can commonly be found on many pelvic fixation sets, allow for endosteal purchase at the isthmus of the ulna, which increases the pull-out strength of the screw. This procedure can be done quickly and requires minimal exposure, which minimises anaesthetic exposure, blood loss, and tourniquet time. The construct is not palpable subcutaneously and therefore is less likely to result in symptomatic hardware and revision surgery.

Keywords: Elbow, Fracture, Olecranon, Technique.

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Introduction

Olecranon fractures make up approximately 10% of elbow fractures[1] and typically result from direct trauma to the elbow or falls on outstretched hands.[2] Olecranon osteotomies are often utilised to visualise the joint surface when reducing distal humeral fractures. Due to articular involvement and the high risk of posttraumatic elbow contracture with prolonged immobilisation, surgical management allowing for early range of motion is typically preferred. Tension band wiring is a commonly used fixation technique, which utilises the tensile pull of the triceps to provide compression at the fracture site. However, postoperative complications such as Kirschner (K) wire migration, loss of fixation, and hardware irritation are common, with rates recently reported up to 63% following use of tension band wiring.[3] We present a procedure and technical pearls using an illustrative case, which applies tension band principles, provides low-cost rigid fixation, and bypasses complications related to wiring as well as plating.

The goals of treatment for these articular injuries are to obtain and maintain anatomical reduction and provide stability to allow for early range of motion.[4,5] In fractures with less than a 2-mm step of the articular surface and intact extensor mechanism, these goals may be achieved with conservative treatment.[6] Less-comminuted patterns that primarily consist of simple transverse fracture patterns are typically treated with tension band wiring.[7] Intramedullary fixation has been described for both comminuted and noncomminuted fracture patterns; however, they have been criticised for their cost and uncertain efficacy.[6,8]

Utilisation of intramedullary screw fixation for olecranon fracture reduction has the advantage of decreasing irritation to surrounding tissues, while providing stability to facilitate early range of motion.[9–12] Intramedullary fixation has been previously proposed using the 6.5-mm cancellous screws from the Arbeitsgemeinschaft für Osteosynthesefragen (AO) large fragment set, which typically houses screw lengths ranging from 80 to 105 mm.[13] Limited data supports that the use of one of these screws along with a tension band construct provides further compression at the fracture site which will facilitate healing.[13] In our experience, the isthmus of the ulna is typically between 110 mm and 130 mm from the tip of the olecranon, so screws on a standard large fragment set provide less rigid fixation, requiring augmentation with plates or tension bands.

The present report describes the technical details surrounding the use of long, solid 6.5 mm partially threaded cancellous screws for intramedullary fixation of simple, transverse olecranon fractures. This technique allows for rigid, anatomic fixation of the articular surface by anchoring fixation at the isthmus with the distal screw threads, which typically requires screws at lengths greater than 110 mm, longer than those typically found in the large fragment sets. This fixation applies compression both directly and through tension band principles, which provides stability to allow for early range of motion without the need for problematic and prominent K-wires.

Case Description

A 35-year-old, otherwise healthy female was assessed in June of 2017 for her isolated right olecranon injury. She described being bucked off a horse with a direct blow to her right elbow.

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Her physical exam revealed a closed injury, soft compartments, and intact neurovascular status. Initial X-rays demonstrated a simple transverse fracture pattern of her olecranon with no evidence of articular depression, osteopaenia, or substantial comminution (Fig. 1). She was splinted for comfort and consent was obtained for open reduction internal fixation of the right elbow.

In the operating room, she was positioned in lateral decubitus with the right side up and right elbow prepped and draped, and positioned on a sterile padded mayo stand. Alternatively, the patient may be positioned supine or prone with a radiolucent arm board. A tourniquet was applied to the proximal arm prior to prepping and draping, but was not inflated. A 7-cm longitudinal incision was made over the posterior aspect of the elbow. The incision may be curved medially or laterally around the olecranon, so as not to sit directly over the prominence of the olecranon process, and continued along the subcutaneous border of the proximal ulna. Sharp dissection was carried on through the skin and the subcutaneous tissue. The facia was incised midline, and the location of the ulnar nerve medially was identified and protected throughout the remainder of the case. The fracture site was identified and assessed. The broad insertion of the triceps on the proximal fragment was maintained, and control of the fragment was obtained using a sharp towel clip. The elbow joint and fracture surfaces were irrigated and anatomically reduced using sharp bone reduction clamps. The proximal tine was placed away from the olecranon tip as to avoid the start point for the screw. At this point, additional temporary K-wires can be used peripherally to help maintain the reduction as needed. Augmentation with unicortical mini fragment plate fixation may also be useful at this point, particularly as a buttress for sheer-type fracture planes.

The start point in our experience typically lies 2 mm radial to the midpoint on the medial-lateral plane and 2 mm dorsal to the apex of the olecranon in the dorsal-volar plane (Fig. 2). This allows the trajectory to include the natural varus of the proximal ulna of 17.5° (range 11–23°), and the anterior deviation of 4.5° (range 1–14°).[14] The goal of the start point is to permit a screw trajectory in line with the intramedullary canal, while accommodating the proximal ulna dorsal angulation (PUDA), which is a slight ulnar inclination starting 47 mm from the apex of the olecranon, at an angle of 5.7°.[15] An X-ray of an intact contralateral proximal ulna can be used to determine the optimal start point if needed by drawing a line corresponding to the screw trajectory, in line with the ulnar diaphysis, similar to the trajectory shown in Figure 2. Dorsal start points may cause volar displacement of the proximal fragment as the screw engages the isthmus and volar start points may result in dorsal displacement, resulting in nonanatomic reduction. A triceps split was made with a scalpel and the 3.2-mm drill bit was used to obtain access to the intramedullary canal of the ulna, which was then overdrilled with a 4.5-mm drill bit. Position prior to drilling was confirmed fluoroscopically (Fig. 3). Once within the intramedullary canal, the drill can be used on oscillate or reverse to avoid breaching the cortex.

A 6.5-mm tap was inserted by hand to determine the length at which good endosteal cortical bite was obtained. A bone clamp was placed on the ulnar shaft to gauge the torque generated by the hand tap. Ideally, this tap should be calibrated; however, a sterile tape can be used to mark the depth at which good cortical engagement is achieved, and the length measured afterward with a ruler. In this particular case, the length was 130 mm. A partially threaded, noncannulated screw from the pelvic set was utilised and inserted with a washer. Excellent bite and fracture compression was achieved. Care was taken to advance both the tap and the screw slowly as it engaged the isthmus, as rapid advancement could generate hoop stress high enough to create secondary fractures (particularly in osteoporotic bone). For fractures with minimal dorsal commination, this construct may still be supplemented with a tension-band wire, or low-profile mini-fragment plates.

In our experience, 6.5-mm solid partially threaded cancellous screws of the appropriate length are typically not available on most standard large fragment set; however, they can be found on most pelvis fixation implant sets or are available separately wrapped or as part of an extra-long screw caddy. Solid screws are preferred to their cannulated counterparts, which tend to be too stiff to accommodate the natural curvature of the proximal ulna.

The bone clamps were removed and final fluoroscopic X-rays were taken to confirm anatomic reduction of the proximal ulna throughout full range of motion with no gapping at the fracture site (Fig. 4). The incision was irrigated. The triceps split was repaired over the head of the screw using a #1 vicryl suture, and superficial tissues were closed with running 2-0 vicryl and interrupted 3-0 nylon, followed by placement of a sling to allow for early range of motion. Total operative time was 18 minutes and blood loss was negligible.

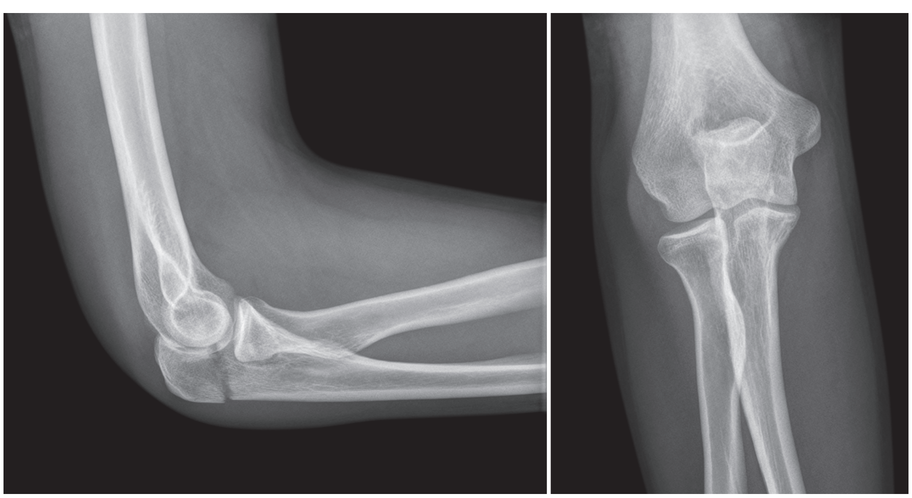
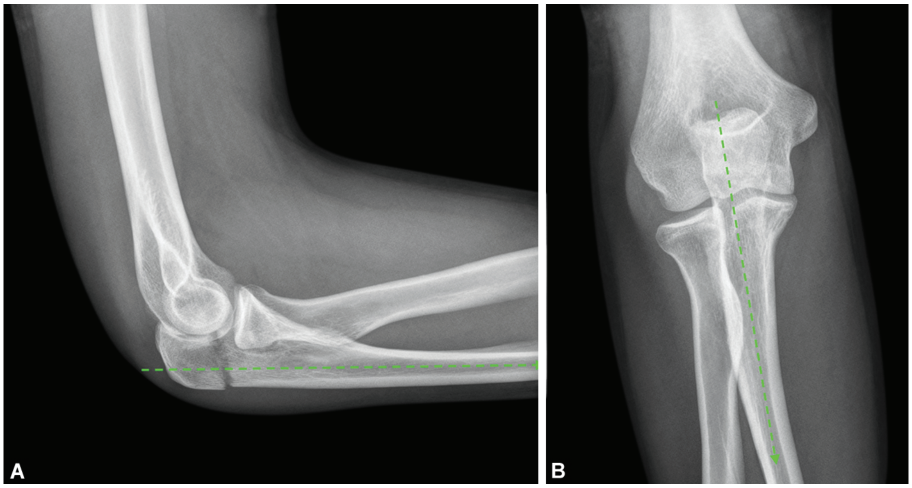
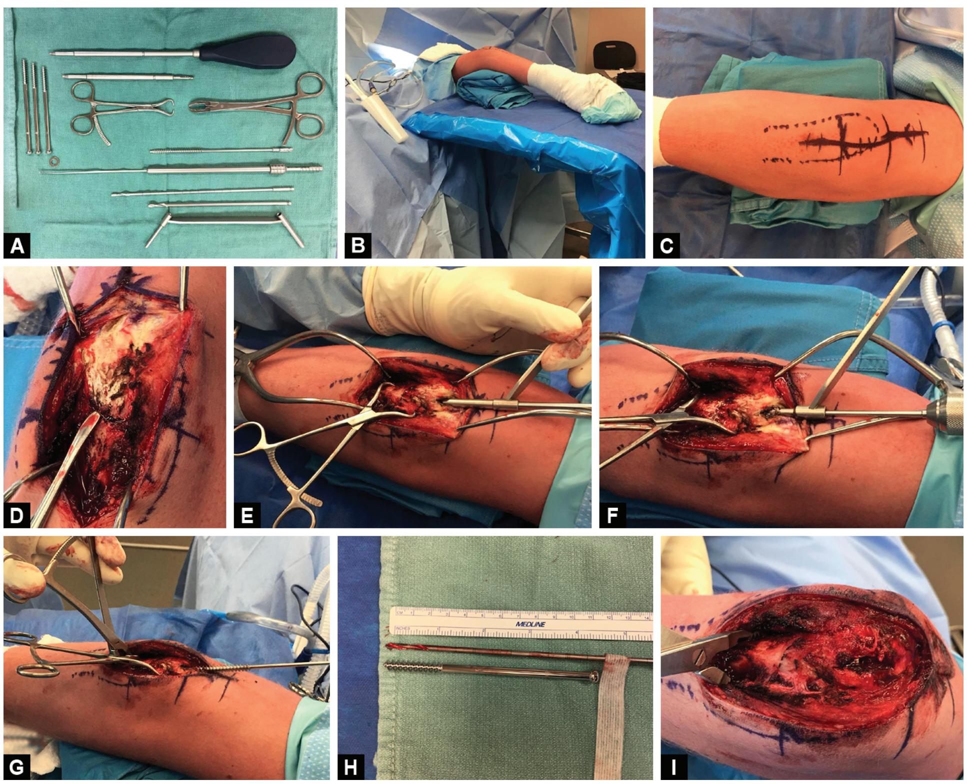


Fig. 1: Preoperative images of right elbow demonstrating an olecranon fracture, transverse pattern without comminution



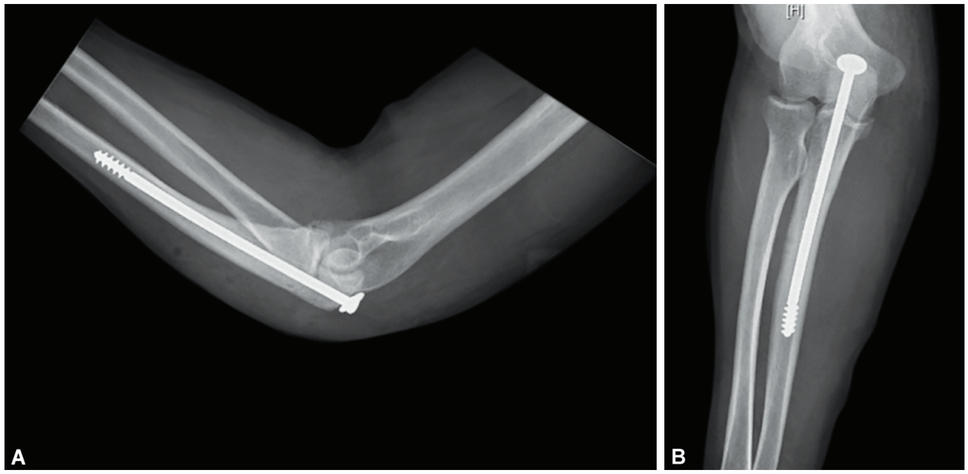
Figs 2A and B: Anterior–posterior and lateral radiographs of right elbow demonstrating the start point on the olecranon so as to be in line with the endosteal cortex of the isthmus of the ulna. Note the start point 2 mm dorsal to the apex on the lateral radiograph (A) and 2 mm radial to midline on the medial-lateral plane (B)



Figs 3A to I: Intraoperative steps of olecranon fracture reduction with intramedullary cancellous screw: (A) Standard large frag screw driver, AO bone clamp, lobster claw, depth gauge, drill bits (4.3 mm and 3.2 mm) with tissue protector, 6.0-mm-large frag tap, and appropriately sized noncannulated screws with washer; (B) Patient is positioned in lateral decubitus with arm on padded Mayo stand; (C) Curvilinear incision marked over proximal ulna; (D) Fracture site is identified with local debridement; (E) Fracture is reduced with AO bone clamp. Triceps are split with tissue protector and starter 4.3-mm drill; (F) A 3.2-mm drill used to enter intramedullary canal; (G) A 6.0-mm tap advanced until good purchase identified, which is approximately 110–120 mm in length at the isthmus; (H) Selection of appropriate screw, which is typically a matta screw found in the pelvic set. Screw measured to be approximately 120 mm in length; (I) Advanced with washer through triceps split

Discussion

Proper alignment of the proximal ulna is important to prevent maltracking of the radial head and ensure proper rotation of the forearm. This report provides key technical details to guide the use of long solid partially threaded cancellous screws in the management of olecranon fractures. The described method produces anatomic reduction of the articular surface and rigid fixation, which allows for early range of motion. As that head of the screw is buried under the triceps, fixation is not palpable subcutaneously, making it less likely to be symptomatic than traditional tension band wire or plating



Figs 4A and B: (A) Postoperative anterior–posterior and (B) lateral films of a right elbow demonstrating anatomic reduction of simple transverse proximal humerus fracture with intramedullary fixation using Matta pelvic screw with washer

techniques. This would lead to fewer subsequent reoperations from the prominent hardware. In our experience, the procedure can be done in less time than tension band wiring or plate fixation, with less blood loss, which minimises exposure to general anaesthesia.

While olecranon fractures comprise a small proportion of upper extremity injuries, they are associated with significant morbidity due to hardware removal. Percutaneous wire pull out and soft tissue irritation are among the complications commonly seen in patients undergoing tension band wiring (TBW). Use of K-wires may result in penetration of the anterior cortex of the proximal radioulnar joint, decreasing pronation and supination. Rommens et al. found that 65% of patients complain of symptoms until hardware is removed, with 24% of patients indicating that they had constant pain.[1] Following these injuries, range of motion results in an average of 91° of flexion, which is below the accepted 100° functional arc for this joint.[16] Skin breakdown is a particularly devastating complication that can result in significant patient morbidity.[1] In one retrospective review of twenty patients treated with tension band wiring, four patients (20%) experienced skin breakdown resulting in multiple reoperations.[17] Clinical and biomechanical evidence has demonstrated that the advent of plating provides an option that offers more rigid fixation.[18] The position of plating for olecranon remains a contentious issue, with some recommending lateral or medial placement to reduce complications.[19]

Utilisation of the intramedullary screw for fixation of olecranon fractures has been reported as early as 1942[9,10] in an attempt to bypass these complications. The intramedullary location of this implant shields it from the triceps tendon and the superficial skin during normal motion, and may reduce adhesions to facilitate improved postoperative healing and rehabilitation. In one retrospective review of 28 patients, all but one went on to successful union,[20] and only 8.3% of reported patients had a loss of 30° of flexion or more. Other complications included superficial wound infection and a spontaneously resolving ulnar neuropathy. The authors comment on the importance of engaging the endosteal cortex of the ulnar diaphysis, but make no reference to the screw lengths needed.[20]

To utilise a sufficient screw length, one has to move beyond what is typically offered in standard large fragment sets. Separately wrapped screws and extra-long screw sets are available, but most pelvic screw sets will offer screws at lengths and diameters that allow surgeons to capture the endosteal cortex circumferentially at the isthmus of the ulna. In our institutional experience, while the large fragment sets typically have screws ranging from 60 to 95 mm in length, the isthmus of the ulna, where endosteal purchase is made by longer screws, is typically between 100 mm and 140 mm. Additionally, adding a washer disperses the contact pressure over a larger surface area, allowing for greater compressive forces to be achieved at the time of surgery to facilitate stability and healing. This type of fixation is best suited for transverse fracture pattern and those with minimal fixation. For those with sheer fracture planes, or moderate dorsal comminution, using supplemental low-profile mini-fragment plates and figure-of-eight wires may be beneficial. This method of fixation does not offer the stability of plate and screw constructs and should not be used in the setting of osteopaenia or highly comminuted fractures. Future prospective studies are needed to further evaluate intramedullary cancellous screw to determine its generalisability.

Ethical Standards

All procedures performed in studies involving human participants were in accordance with the ethical standards of the institutional and/or national research committee and with the 1964 Helsinki Declaration and its later amendments or comparable ethical standards.

Informed Consent

An informed consent was obtained from all individual participants included in the study.

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