Operative Treatment of Communitied Olecranon Fractures Using Tension-band Wiring and Miniplate Augmentation

Hyoung Keun Oh, MD; Suk Kyu Choo, MD; Chang Soo Lee, MD; Jae Gwang Song, MD

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Olecranon fractures are intra-articular injuries that require anatomic restoration of the articular surface. To begin early range of motion (ROM) exercises and to prevent stiffness of the elbow joint, the fracture fixation must be securely fixed. Several methods of internal fixation are commonly used, including tension band wiring, plate fixation, intramedullary screw fixation, and fragment excision with triceps advancement. No single treatment method is appropriate for all fractures because of the variability of fracture patterns and associated injuries. A direct blow to the olecranon will force it into the distal humerus, causing comminuted fractures with depressed articular surfaces, whereas an indirect mechanism of injury can cause an avulsion-type fracture caused by the triceps pull, producing transverse or short oblique fractures.

Tension-band wire fixation can be effectively used for most simple noncomminuted transverse olecranon fractures. The tension band technique converts the tensile force of the triceps to a dynamic compressive force along the articular surface. To use tension band wiring, the anterior cortex must be intact and provide a buttress that will allow compression. If this does not occur, using tension band wiring in comminuted fractures can cause a loss of fracture reduction in the sigmoid notch.

Plate fixation has become the standard fixation method for comminuted olecranon fractures. However, concerns about dorsal plating include the necessity of wider skin exposure and symptomatic plate irritation on the skin. The current study reports the authors’ experiences of tension band wire fixation with miniplate augmentation in 9 patients with comminuted olecranon fractures.

MATERIALS AND METHODS
From September 2009 to May 2010, nine comminuted olecranon fractures (Figure 1) treated by tension band wiring and miniplate augmentation were reviewed retrospectively. All patients were followed at regular intervals until osseous healing, defined as the presence of crossing trabeculae on both anteroposterior and lateral radiographs. Fracture union was assessed by the 2 senior authors (H.K.O., S.K.C.). Pain was graded as none, mild, moderate, or severe. Elbow ROM was measured. The overall objective outcome was assessed with the joint-specific Mayo Elbow Performance Score, which measures pain, motion, stability, and function; the results were graded as excellent (>90), good (75-89), fair (60-74), or poor (<60).

Surgical Technique
Surgery was performed with the patient in the supine position.
Position while under general anesthesia. Following limb exsanguination, a tourniquet was inflated and the arm was prepared, draped, and positioned across the patient’s chest to allow for a full range of motion from extension to flexion. The fracture was exposed through a posterior midline incision with the proximal end curving toward the lateral aspect of the olecranon. The ulnar nerve was not routinely exposed. After debridement of hematoma and interposed soft tissue, the impacted and comminuted articular fracture fragment was reduced. Precise articular reconstruction was performed by lifting and repositioning the depressed articular fragment according to the contour of the trochlea.

After articular fragment reduction, a 2.4- or 2.7-mm locking plate was positioned on the medial or lateral ulnar border according to the fracture patterns and the size of the bone defect developed after articular impaction reduction. Cancellous chip bone grafting was performed when a metaphyseal bone defect developed after lifting the impacted articular fragment; thus, comminuted fractures were converted to simple transverse fractures (Figure 2). Then, separated transverse fracture fragments were reduced and maintenance of the reduction was performed using a reduction clamp. Two parallel 1.8-mm K-wires with 10 mm of separation were inserted from the olecranon into the distal fragment. The authors preferred to place the K-wire through the ulna anterior cortex to reduce the pullout strength.

After a drill hole was created 3 cm distal to the fracture site, the circlage wire was tightened in a figure-8 around the K-wires using a single knot. The K-wires were bent 180° and cut, leaving 3 mm of wire. The wires were rotated in their longitudinal axis, tapped down, and buried through the triceps tendon. Intraoperative fracture stability was checked with passive full flexion and extension of elbow joint.

Postoperatively, the elbow was immobilized in a removable posterior splint in 90° of elbow flexion. Passive and active elbow ROM were encouraged as tolerated. Posterior splints were postoperatively removed within 2 weeks in all cases.

**RESULTS**

Nine comminuted olecranon fractures treated using tension band wiring and miniplate augmentation were reviewed retrospectively. Four male and 5 female patients with a mean age of 61 years (range, 31 to 81 years) were included in the study. The mechanism of injury was a simple fall in 7 patients, a fall from a height in 1 patient, and a motor vehicle accident in 1 patient. Three patients had associated injuries: 1 each had a femoral shaft injury, an ipsilateral proximal humerus fracture, and an acetabular fracture. No open fractures were observed. According to AO/OTA classification, all fractures were multifragmentary combined intra- and extra-articular ulnar (Type B1.3).

To buttress the impacted articular fragment, a mini-locking compression plate was used for all fractures depending on the fracture patterns and the size of the bone fragment. A 2.4-mm plate was used in 4 cases and a 2.7-mm plate was used in 5 cases. Cancellous chip bone grafts were used in 6 cases because of metaphyseal defects that developed after articular impaction reduction.

Average follow-up was 13 months (range, 12-16 months) postoperatively. At the most recent follow-up, 8 patients reported no pain and 1 patient reported mild pain. All fractures united without a loss of fracture reduction, and average time to union was 10 weeks (Figure 3). According to the Mayo Elbow Performance Score, the results were considered excellent 8 cases and good in 1 case. One patient reported skin irritation over the site of the K-wire (Figure 4). Full elbow ROM compared with the contralateral side could be obtained in all patients. No fixation failures,
infection, or neurological lesions were reported.

**Discussion**

The purposes of operative treatment of comminuted intra-articular olecranon fractures are to restore anatomic joint surface and provide a stable fixation to begin early range of motion exercise. Anatomic restoration of the articular surface of the olecranon with internal fixation that allows for early elbow ROM can be accomplished through a variety of techniques. Several methods of internal fixation are commonly used, including tension band wiring, plate fixation, intramedullary screw fixation, and fragment excision with triceps advancement.

Tension-band wiring with K-wires is used in the surgical treatment of olecranon fractures, especially noncomminuted transverse fractures, and may provide a stable construct to allow for early joint ROM. A tension band construct is advantageous because it theoretically converts dorsal distraction force to compression at the fracture site on the articular surface. However, if the articular surface is comminuted and unstable, early motion after tension band wiring can cause compression failure. Thus, to be able to use a tension band, the anterior cortex must not be comminuted and must provide a buttress to allow for compression.

In comminuted olecranon fractures, it is difficult to provide a sufficient buttress to the impacted articular fragment, and in the cases of concomitant osteoporosis, bone defects in the metaphyseal area of the distal segment may develop because of severe impaction of the articular surface. For the application of effective tension bands in comminuted olecranon fractures, the authors believed that if it was possible to convert a comminuted fracture to a simple transverse fracture, then the tension band fixation would be the most simple and effective treatment method for the olecranon fractures. To support comminuted articular fragments to their anatomical position, posterior-to-anterior directed small locking head screws combined with locking plate were useful.

To avoid skin irritation, the authors positioned the plate on the medial or lateral border of the ulnar shaft, depending on the fracture patterns, instead of dorsal plating. They believe that an additional bone graft for a metaphyseal defect may be useful to support the impacted articular fragments. The combination of a small mini-locking compression plate and a bone graft could enable tension band wiring to compress the fracture site and allow for early elbow ROM even in osteoporotic bones. In the current series, no reduction loss of the articular fragment was observed at the last follow-up and all patients regained their preinjury functional status without a limitation of elbow ROM.

Neurovascular injuries after placement of K-wires through anterior ulnar cortex have been reported. However, cadaveric studies have shown that K-wires that penetrate the anterior cortex require approximately double the force of intramedullary K-wires to pull out. The current authors placed K-wires though the anterior ulnar cortex under the tactile feedback in all cases so the neurovascular structures were not violated. The stable configuration of the tension band wiring was an important factor in their good operative results. The limitations of the

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**Figure 3:** Immediate postoperative anteroposterior (A) and lateral (B) and final anteroposterior (C) and lateral (D) radiographs of the patient presented in Figure 1 showing stable bony union without articular reduction loss and K-wire migration.

**Figure 4:** Preoperative (A), immediate postoperative (B), and 3-month postoperative (C) lateral radiographs of a 79-year-old woman with symptomatic irritation caused by a migrated K-wire. However, stable bony union and full elbow range of motion were achieved.
current study include its retrospective nature, the small number of patients, and non-comparison study of different fixation methods.

The combination of mini-locked compression plate and tension band wiring appears to be a simple and effective fixation method in comminuted olecranon fractures. Mini-locked compression plates with locking head screws can provide a stable buttress for the impacted articular fragment and allow early ROM without complications, even for osteoporotic bones.

**REFERENCES**