The application of central tension plate with sharp hook in the treatment of intra-articular olecranon fracture

Abstract

Background: Plate fixation can be used to treat intraarticular olecranon fracture with satisfactory funtional recoveris, but accompanied with implant related complications. This study aims to report the functional outcome of intraarticular olecranon fractures treated with the use of central tension plate with sharp hook.

Patients: Twenty six patients sustained intraarticular olecranon fractures were treated in our department from August 2007 to December 2008. There was 10 Type IIA, 9 Type IIB, 4 Type III A and 3 Type IIIB fractures according to Morrey classification. Associated fractures were of coronoid in one, radial head in two and other bone in ten. The patients were treated with the central tension plates with sharp hook. Patients were followed up. The functional recovery of the affected up limbs were evaluated using Mayo Elbow Performance (MEP) score and Disability of the Arm, Shoulder and Hand questionnaire (DASH).

Results: Postoperative radiographic assessment revealed anatomical or nearly anatomical reduction of all olecranon fractures. All olecranon fractures healed at an average of 14 weeks (range, 9-32 weeks). The patients were followed up for 42 months (range, 32-54 months). The mean DASH score was 8.5 (range, 0 to 31.7). The mean MEP score was 93.6 (range, 75 to 100). Based on the MEP score, all patients achieved good or excellent outcomes. No symptomatic plate removal was performed.
Conclusion: The central tension plate with sharp hook contours the anatomical morphology of the proximal ulna. Treating intra-articular olecranon fracture with the new plate can achieve good to excellent functional recovery with a high union rate and a low incidence of hardware related complications.

Key Words: Olecranon; Fracture; Plate fixation; Central tension plate

Background

Olecranon fractures are intraarticular fractures except the avulsion fractures of brachial triceps. They are among the most common injuries of the upper extremity [1]. Approximately 10% of fractures about adult elbow consist of olecranon fractures and range from simple nondisplaced fractures to complex fracture-dislocations of the elbow [2]. To avoid arthritis of the elbow joint, anatomical reduction and internal fixation are required for intraarticular olecranon fracture. Tension band wiring (TBW) is once considered as the gold standard fixation for treating displaced transverse intraarticular olecranon fractures [3]. However, TBW fixation has a high incidence of reoperation for the removal of symptomatic hardware [4-8]. Internal fixation of comminuted fractures has evolved toward more stable constructs [9-11]. Plate fixation gradually gained its popularity. The olecranon plate can be placed either laterally or posteriorly [12]. Plate fixation is reported to give adequate stability and achieve fracture union in both simple and comminuted olecranon fractures [12]. However,
some plates can’t contour well the anatomical feature of the proximal ulna, which
may require removal because of prominence under skin [13]. Accordingly, the central
tension plate with sharp hook was engineered to reduce the risk of complications and
improve the clinical outcome. The paper aims to introduce the fixation technique for
olecranon fractures using this construct and present the preliminary results with a
minimal follow-up of 32 months.

Patients and methods

Patients

Twenty six patients sustained olecranon fractures were treated with central tension
plates with sharp hook in our department from August 2007 to December 2008. The
patients included 16 men and 10 women with a mean age of 39.8 years (range,
19.2-74.5 years). There were 11 left and 15 right olecranon fractures. Based upon
Morrey classification [14], there were 10 Type IIA, 9 Type IIB, 4 Type III A and 3
Type IIIB fractures (Figure 1). Mechanisms of injury included 11 slips, 7 falls from
bicycles or height more than 3 meters, and 8 traffic accidents. All olecranon fractures
were closed injuries. Besides olecranon fractures, 10 patients sustained other fractures
including 2 radial head fractures, 1 coronoid fracture, 1 lumber fracture, 1 pelvic
fracture, 3 femoral fractures and 5 tibial and fibular fractures.

The signed inform consents were obtained from all patients. The Ethical Board
Review of the local hospital approved the study after thorough examination and
verification.

The structure of central tension plate with sharp hook

The central tension plate with sharp hook has obtained the Certificate of Invention Patent (Certificate No. 649355, Patent No. ZL 2008 1 0079748.X). The plate with low profile consists of angle-plate shaped body, the gourd-shaped proximal part and the sharp hook (Figure 2). The plate is placed on the dorsal tension surface of the proximal ulna rather than the lateral surface. The plate body is of bilaterally symmetrical angle-plate shape. The angle of the plate body changes gradually from 110 degrees in the proximal end to 80 degrees in the distal end, which can match well with the anatomical morphology of the ulna crest [15]. The gourd-shaped proximal part of the plate is designed to contour the olecranon. There are three holes in the proximal part of the plate, which are used for multiple-angle insertion of screws to fix comminuted fragments.

Operative technique

A sterile tourniquet is placed on the upper arm after skin preparation and draping. A centered longitudinal posterior skin incision is made to expose the olecranon. The dorsal surface of the proximal ulna is exposed far enough to fit the plate. If present, the impacted articular fragments are elevated and the coronoid is reduced and fixed to the ulna with one or two K-wires. After primary reduction and provisional fixation of the olecranon fracture, the plate is fixed to the proximal ulna as follows. The plate is
placed on the dorsal tension surface of the proximal ulna. The proximal part of the plate can match the contour of the olecranon. The sharp hook is inserted into the triceps tendon just over the tip of the olecranon. The plate is held in position and screw holes distal to the fracture line are drilled, measured, and tapped. Cortical screws were inserted into the oval holes leaving a gap between the screw heads and the plate. The gap allowed sliding of the plate to compress the fracture fragments. The holes for the cortical screws lies slightly medial or lateral to the central line of the plate to avoid entering the proximal radioulnar joint and to leave room for an axial cancellous screw, which is later inserted through the most proximal hole along the shaft of the ulna. After compression of the fracture fragments with the insertion of the long intramedullary cancellous screws, the screws distal to the fracture line are then drilled tightly to secure the plate. The subcutaneous tissues and skin are closed in the usual manner. Finally, a removable splint was provided with the elbow flexed to 90 degrees in the operating room to help manage postoperative pain.

Rehabilitation and postoperative evaluation

As soon as pain can be tolerated, active motion of the fingers and isometric contraction of the upper arm is recommended. Gentle active-assistive and passive motion is initiated on 2 or 3 days postoperatively. Patients are instructed to take the arm out of the splint several times daily to do exercises. The patients gently flex and extend the affected elbow with the opposite hand and gradually increased the range of motion. Gentle passive stretching and strengthening supervised by the occupational
therapist started at 6 weeks.

Follow ups were done and radiographic assessments were routinely performed. At follow ups, Mayo Elbow Performance (MEP) score and Disability of the Arm, Shoulder and Hand questionnaire (DASH) were completed. Measurements of elbow flexion, extension, and forearm rotation were done using 1404. Hammer angle gage.

**Statistic analysis**

All data were analyzed using SPSS 11.0, and descriptive summaries of the data were performed. Student’s t tests were used when comparing the scores between unaffected and affected limbs. Difference was regarded as statistically significant when $P$ value was less than 0.05.

**Results**

The patients were operated on after an average of 2.3 days (range, 1-5 days) from initial injury. The mean duration of operation of the olecranon fracture is 78 minutes (range, 55-135 minutes). The average blood loss is 74ml (range, 40-200ml).

Postoperative radiographic assessment demonstrated anatomical or nearly anatomical reduction of olecranon fractures in all patients (Figure 3). No patients showed an articular gap or step of more than 2mm postoperatively. All olecranon fractures in this series went on to heal at an average of 14 weeks (range, 9 to 32 weeks), without malunion, nonunion and soft tissue related complications.

The patients were followed up for 42 months (range, 32-54 months). No loss of
reduction was noted. The evaluation of the functional recovery of the affected elbow was performed at the latest follow up. The measurements of the affected and unaffected elbow flexion, extension, and forearm rotation were done. Only the elbow extension showed a small but statistically significant decrease. (Table 1, $P<0.05$) The mean DASH score was 8.5 (range 0 to 31.7). The mean MEP score was 93.6 (range of 75 to 100). Based on the MEP score, excellent or good outcomes were achieved in all patients. Mild pain due to prominent hardware was notice in one patient but it could be well tolerated. No patients requested plate removal during follow-ups. Radiographic evidence of degenerative changes of the elbow joints has not been observed up to date.

Discussion

The indications of central tension plate include displaced unstable oblique fractures and comminuted olecranon fractures. This technique is also suitable for transverse olecranon fractures in high-demand patients. In the current study, 26 patients were treated with this construct. Postoperative radiographs of the injured elbows demonstrated anatomical or nearly anatomical reduction and satisfactory fixation of the fracture. No fixation failure was reported in the case series. At follow-ups, no plate removal was required secondary to symptomatic hardware such as instrument prominent and painful irritation. The range of motion of the injured elbow was greatly improved. According to MEP and DASH scores, satisfactory functional recovery was achieved in all patients.
For the intra-articular olecranon fracture, restoration of articular congruity and rigid internal fixation permit early range of motion, which are the conventional principles utilized in the management of these fractures [16]. However, the proximal ulna is subcutaneous and various kinds of hardware are prominent, which often causes discomfort to patient and requires implant removal. This is one of the most common complications after internal fixation of olecranon fractures [2]. 80% of TBW fixations reportedly are removed because of migration and painful irritation [4-8, 17]. And, 20% of plates require hardware removal to manage the symptomatic metal prominence [12, 13]. To decrease the risk of hardware prominence, the plate is of low profile, and the proximal part is of gourd shape and congruent with the olecranon well. The sharp hook is inserted into the triceps tendon and sticked closely to the dorsal surface of proximal ulna. In the case series, no symptomatic hardware removal was required, although mild pain over the elbow is noted in one patient, for which the prominent end of one screw should be blamed.

To place the plates properly on the posterior surface of the ulna, the triceps fascia and tendon is partially split to allow the implant to sit on the bone [2], which will inevitably impair the muscle strength of the affected upper extremity. Even though the triceps tendon is sutured and reattached to the ulna, it may also result in a weaker extensor mechanism [18]. The typical lose of motion is 10° to 15° of extension in patients with isolated olecranon fractures, and more severe if patients have associated...
fractures of the radial head or coronoid [2]. In our study, the sharp hook of the plate can be directly inserted into the olecranon through the tendon of triceps muscle without incision, which may result in much less injury than that secondary to routine posterior plating. At follow ups, the flexion and rotation of the affected elbows are similar to the unaffected ones. The extension of the affected elbow is 2 degrees on average less than the contralateral healthy ones.

Posterior plating is commonly used to manage olecranon fractures, which facilitates fracture reduction [19]. In addition, posterior plating is stronger than one-side plating [20]. Gordon et al reported that the posterior plate in the dorsal surface of proximal ulna with an intramedullary screw was significantly stronger than dual medial and lateral plating [19]. In our study, all plates were placed on the dorsal surface of the ulna, the tensional side of the ulna, which can improve the rigidity of fixation. The shape of plate also influences the rigidity of fixation. Reconstruction and one-third tubular plates may not resist sagittal plane bending forces in fractures with intercalary comminution, bone loss, or radial oblique fractures or those associated with radial head subluxation [11], and a stiffer implant should be considered. The body of the new designed plate is of angle-plate shape. It is known that the triangular construct is much stronger than the tubular constructs, which can resist the sagittal plane bending forces better. At follow ups, no loss of reduction is reported. Rigid internal fixation permits early exercises, and good or excellent functional recovery of the elbow was achieved in this case series.
Limitations

The study is limited by the small number of patients treated with the central tension plate with sharp hook. Randomized controlled study compared with commonly used plates should be performed to determine the definite role of the new plate in treating the intra-articular olecranon fractures.

Conclusion

The central tension plate with sharp hook contours the anatomical morphology of the proximal ulna well. Treating intra-articular olecranon fracture with this plate can achieve good or excellent functional recovery with a high union rate and a low incidence of hardware related complications.

Reference


**Figure legends**

Figure 1. A female patient sustained right displaced olecranon fracture which is a type IIA fracture according to the Morrey classification. (Fig. A, the anteroposterior view. Fig. B, the lateral view)

Figure 2. The anterior view of the central tension plate with sharp hook.

Figure 3. Postoperative radiographic assessment demonstrated nearly anatomical reduction of the olecranon fractures. (Fig. A, the anteroposterior view. Fig. B, the lateral view)
Table 1 The range of motion of the affected and unaffected elbows.

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<tr>
<th></th>
<th>affected</th>
<th>unaffected</th>
<th>P</th>
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<tr>
<td>flexion(degrees)</td>
<td>138±10</td>
<td>141±6</td>
<td>NS</td>
</tr>
<tr>
<td>extension(degrees)</td>
<td>7±4</td>
<td>9±2</td>
<td>&lt;0.05</td>
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<tr>
<td>pronation(degrees)</td>
<td>78±8</td>
<td>80±5</td>
<td>NS</td>
</tr>
<tr>
<td>supination(degrees)</td>
<td>75±7</td>
<td>78±6</td>
<td>NS</td>
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Mean±standard deviation, n= 26.