CLINICAL ARTICLE

Mid-term outcomes of contoured plating for comminuted fractures of the olecranon

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Objective: To evaluate the mid-term outcomes of contoured plating for comminuted fractures of the olecranon.

Methods: Twenty eight patients were available for analysis. Their mean age was 41 years (range, 25 to 61 years). Associated fractures were of the coronoid process in three, radial head in four, and both in three patients. A plate and screw system was used to stabilize comminuted fractures of the olecranon in all cases. Coronoid fractures were stabilized according to the fracture patterns. Displaced radial head fractures were treated with either mini-screw fixation or radial head replacement. Because of the severity of their fractures, 12 patients underwent primary bone grafting.

Results: Primary stability was achieved in 25 of 28 cases. There were no cases of non-union. The mean time to union was 15 weeks (range, 12–22 weeks). The mean range of flexion of the elbow was from 14° to 125°, with 65° of pronation and 74° of supination. The end results were 6 excellent, 16 good, 4 fair and 2 poor, based on the Broberg and Morrey scale. The excellent plus good rate was 78.6%.

Conclusion: Favorable mid-term outcomes can be achieved by contoured plating of complex, comminuted fractures of the olecranon.

Key words: Fracture fixation, internal; Therapy; Ulna, fracture

Introduction

The management of complex, comminuted fracture of the olecranon can be extremely difficult, especially when it is combined with fracture of the radial head and/or coronoid process of the ulna or injury of the collateral ligament of the elbow joint^{1,2}. Because the treatment goal is to restore joint congruity and stability, early mobilization should be encouraged. Although a wide range of techniques, including the tension band technique, contoured plate and screws, and excision of the proximal fragment, have been used, no single technique is universally suitable for all olecranon fractures. Over the past two decades, open reduction and internal fixation has become more widely accepted as a means of achieving anatomical restoration of the articular surface and facilitating early mobilization^{2,3}. Nevertheless, authors differ in their opinions with regard to the extent and type of internal fixation required^{4–7}. Very few reports have specifically addressed

the treatment outcomes of comminuted fractures of the olecranon on the basis of a relatively large study⁸.

The purpose of the present study was to evaluate the mid-term outcomes of contoured plating for comminuted fractures of the olecranon.

Materials and methods

Patient data

Thirty-three patients with complex, comminuted fractures of the olecranon were treated between January 2003 and February 2007 at the affiliated hospital of Nantong university. Five of the 33 cases were lost to follow-up. The remaining 28 cases made up the study group. There were 22 male and 6 female patients. The average age at the time of fracture was 41.3 years (range, 25 to 61 years). Sixteen injuries were caused by a fall; ten by a motor-vehicle accident; one by a direct blow; and one by a sports-related accident. All fractures were classified according to the Mayo classification³. Seventeen were type IIB and 11 type IIIB. Associated fractures were of the coronoid in three, radial head in four, and both in three patients. Six of the fractures were open, and these were graded according to the criteria of Gustilo and Anderson as type I in five patients and type II in one⁹. Nine patients sustained at least one additional injury, these associated injuries

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including one closed head injury, four chest injuries, and six other injuries involving a lower extremity. Eight patients were referred from other hospitals due to the complexity of their fracture configurations.

All patients were evaluated preoperatively by two standard plain radiographs, an anterior-posterior and a medial-lateral radiograph. Prophylactic antibiotic treatment was not used preoperatively and intraoperatively except in patients with open fractures.

Treatment

Internal fixation using a contoured plate was performed at an average of 4 days (range, 0–12 days) after injury. All open fractures were treated within 6 h of the time of injury, whereas the closed fractures were stabilized 2–12 days after injury.

The patients were positioned supine with the involved arm across the chest. A sterile pneumatic tourniquet was placed on the upper arm after skin preparation and draping. The surgical technique has been described in detail in previous publications^{2–5}. However, a few particular variations were used by all surgeons in this study. The fracture was reduced and provisionally stabilized by K-wires. Over-compression at the fracture site was avoided to prevent narrowing of the olecranon-to-coronoid distance. Bone graft was required in severe comminuted fractures. There were three choices for implants: reconstructive plate, limited contact-dynamic compression plate (LC-DCP) and locking compression plate (LCP). The implants used for the proximal ulna fractures in this series included 5 reconstructive plates, 18 LC-DCP and 5 LCP.

Coronoid process fracture was found in six cases. According to the O'Driscoll classification¹⁰, there were three cases of type I fracture, one of type II, and two of type III. Type I fractures were repaired with sutures through drill holes. The type II fracture was stabilized by a screw combined with an additional K-wire (Fig. 1). Type III fractures were secured with a dorsal plate and screw.

There were seven cases of radial head fracture. Two Mason type I fractures were not treated surgically. Three Mason type II fractures were stabilized by mini-screws. Radial head arthroplasty was performed in two Mason type III fractures (Fig. 2). Quality of reduction as well as the stability of elbow was checked under the image intensifier.

Postoperative management and evaluation

If primary stability had been achieved, the elbow was immobilized in a long arm splint for 7 days, after which active exercise was started. Where stability was insufficient, exercise was postponed to the third postoperative

Figure 1 A 34 year-old man with a Mayo type IIIB fracture accompanied by coronoid process fracture. (A) Lateral radiograph demonstrating comminuted olecranon fracture combined with anterior dislocation of the radial head. The coronoid process seems to be intact. However, (B) an anteromedial fragment of the coronoid process is obvious in the anteroposterior view. (C, D) Perfect restoration of the articular surface of the trochlear notch was achieved and maintained by a contoured locking compression plate. An additional screw and a K-wire were used to stabilize the anteromedial fragment of the coronoid process.

week. Antibiotic treatment was used postoperatively for 3 days in patients with closed fractures.

For open fractures, antibiotics were prescribed for the first 7 days. Before each patient was discharged from hospital, anterior-posterior and medial-lateral radiographs of the affected elbow were taken to assess fracture reduction. The attending surgeons conducted the patients' follow-up. All patients were followed up with regular radiological and functional assessments. The clinical results were assessed according to the Broberg and Morrey scale³, which categorizes results as excellent (≥ 95 points), good

Figure 2 A 43 year-old woman with a Mayo type IIIB fracture accompanied by a Mason type III fracture of the radial head. (A) Lateral radiograph showing an extensively comminuted intra-articular fracture of the proximal ulna associated with a comminuted fracture of the radial head. (B, C) Alignment of the ulna and its length was achieved and maintained by contoured plating, as seen in both views. The comminuted radial head was replaced.

(80 to 94 points), fair (60 to 79 points), and poor (≤ 59 points). Anterior-posterior and medial-lateral radiographs of the affected elbow were taken at each follow-up visit and any changes in the position of the implant and extent of fracture union noted.

Results

Primary stability was achieved in 25 cases. Immediate postoperative X-rays showed anatomical reduction of the articular surface of the trochlear notch had been achieved in 21 cases. The remaining seven patients had a step of less than 2 mm in their articular surfaces. The mean follow-up was 51 months (range, 36–70 months). There were no cases healed of non-union. The mean time to union was 15 weeks (range, 12–22 weeks). The plate was removed in 17 patients after bone healing had been achieved. Only four patients required plate removal because of hardware prominence irritation. The remaining 13 cases were distressed by the knowledge that there was a foreign substance in their bodies and demanded its removal.

Seventeen patients were pain-free. Six had occasional pain and five had discomfort after manual labor. All but two patients had close to normal muscle strength. Mild post-traumatic degenerative changes were found in six cases. Sub-anatomical reduction was found in five of these cases. Two patients had mild limitation of activities of daily living, one of them having symptoms of instability of

the elbow. The outcomes of these two patients were rated as poor. Four patients were unable to resume their original occupations. Neither failure of fixation nor heterotopic ossification was found in any patient.

At the time of the latest follow up, the average range of flexion was 125° (95° – 140°), with an average flexion contracture of 14° (0° – 30°). The average pronation was 65° (40° – 80°), and the average supination 74° (50° – 90°). According to the functional index of Broberg and Morrey, the outcome was excellent in six patients, good in sixteen, fair in four and poor in two, with a mean score of 84 points. The outcomes of six patients with type IIB fracture were rated as excellent. All 21 patients with anatomical reduction had good or excellent results. Primary elbow stability was not obtained in three patients, their results were rated as poor in two and fair in one (Table 1).

Discussion

Most displaced olecranon fractures should be treated operatively. Since tension band wiring was first introduced in 1963, it has been generally accepted and used widely. However, this technique is problematic when it is used to stabilize severe comminuted olecranon fractures, as it can lead to shortening of the olecranon and incongruity of the articular surface¹¹. Although fragment excision with triceps advancement has been advocated for comminuted fragments, it is rarely performed because of the potential for subsequent instability¹¹. In the presence

Table 1 Results: comparison of fracture type, quality of reduction and primary stability

Results	Fracture type		Quality of reduction		Primary stability	
	IIB	IIIB	Anatomical reduction	Sub-anatomical reduction	Yes	No
Excellent	6	0	6	0	6	0
Good	7	9	15	1	16	0
Fair	4	0	0	4	3	1
Poor	0	2	0	2	0	2

of comminution, plate fixation with supplementary K-wires, screws or bone grafting may be the best solution^{5,13–16}. Plates are mostly applied to the dorsal surface of the ulna, which is the tension side of the olecranon. In severely comminuted fractures, the use of plate fixation offers the option of bone grafting to support depressed articular fragments¹⁶. In this study, all 28 patients with comminuted fracture of the olecranon were stabilized using this technique. We found it very effective in maintaining the longitudinal axis of the ulna and preserving its length.

There are many reports of favorable results using a plate and screws system for stabilizing olecranon fractures. Anderson *et al.* reported 92% (22 of 24) good or excellent results after congruent plate fixation of olecranon fracture¹⁷. However, only six of them were comminuted fractures. Ring *et al.* reported 88% (15 of 17) good or excellent results after plate fixation of trans-olecranon fracture-dislocations, with a mean flexion of 14° to 127°¹⁸. Seyed *et al.* treated eight patients with trans-olecranon fracture-dislocations, all seven treated with plating had a good or excellent result¹⁹. Nevertheless, not all these trans-olecranon fracture-dislocations involved comminuted fracture of the olecranon. To our knowledge, few reports have specifically addressed the treatment outcomes of comminuted fractures of the olecranon. Ikeda *et al.* treated ten patients with comminuted fractures of the olecranon by multiple tension-band wiring and a graft from the iliac crest⁸. They reported that 100% of their patients had an excellent or good result, with a mean flexion of 15° to 135°. This technique has not been widely accepted, despite these amazing results. This might be explained by the fact that it was a relatively small case series and the procedure is technically demanding. In our study, 79% of patients had an excellent or good result with a mean flexion of 14° to 125°. Our results were less favorable than those of Ikeda, but better than those reported by Tesdall²⁰. The latter obtained 69% favorable outcomes after plate fixation of comminuted olecranon fractures with a mean flexion of 20° to 118°.

Our series of 28 patients included 11 Mayo type IIIB fractures. An unstable elbow is the key feature of IIIB fractures. One of the problems with type III fractures is the high incidence of additional elbow trauma, including radial head fracture, coronoid process fracture, and ligament rupture. Ten of the 11 Mayo type IIIB fractures sustained coronoid process and/or radial head fractures. These injuries were treated simultaneously because they have a tremendous impact on the results achieved. We managed these concomitant injuries according to the fracture patterns and 9 of the 11 IIIB fractures had good results. We did not compare the results between IIB and IIIB fractures because of the small size of each group. However, it seemed that the patients with type IIIB fractures had similar results to those with type IIB fractures (Table 1).

Rommens *et al.* reviewed the treatment outcomes of 69 patients with olecranon fracture and found that primary elbow stability was a prognostic factor for elbow function²¹. Our results are consistent with his report. In our series, primary elbow stability was not obtained in three patients, and these patients' results were rated as poor in two and fair in one. Although anatomical reconstruction of the articular surface has been emphasized in most previous reports, few authors have analyzed their results by comparing the quality of reduction in detail. In this series, anatomical reduction was achieved in 21 cases and sub-anatomic reduction (a step in the articular surface of less than 2 mm) in 7 cases. All 21 patients with anatomical reduction had good or excellent results. Only one patient with sub-anatomic reduction had a good result. This may indicate that the elbow cannot tolerate a step in the articular surface of the trochlear notch; even when it is less than 2 mm.

In conclusion, contoured plating is a safe and effective option for the treatment of comminuted olecranon fractures. Any concomitant injuries of the coronoid process and radial head should be properly managed. Anatomic reduction as well as primary stability is of paramount importance in obtaining good results.

Disclosure

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