Original Article

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Non-Periarticular Locking Plates for Complicated and/or Geriatric Olecranon Fractures

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Objective: Many reports have assessed the outcomes of olecranon fractures following plating osteosynthesis. This retrospective study assessed the outcome of complicated and/or geriatric olecranon fractures following locking plate osteosynthesis.

Methods: From March 2010 to January 2015, 16 consecutive patients with complicated and/or geriatric olecranon fractures were treated by locking plate osteosynthesis. The median age of the 12 female and 4 male patients at the time of surgery was 50 years (24 – 91 years). We also investigated complications such as pain, limited range of motion, nonunion, and implant failure.

Results: At the final follow-up, median Mayo elbow performance scores and visual analog score were 95 (80 – 100) and 1 (1 – 3), respectively. The median arc of range of motion was 125˚ with extension at 5˚ (0˚ – 20˚) and flexion at 130˚ (110˚ – 140˚). The median union time was 16 (12 – 22) weeks. No hardware breakage was noted.

Conclusion: We found a high rate of satisfaction, union and fewer complications following locking-plate osteosynthesis without the application of intramedullary screws for the treatment of patients in our study. We believe that this technique is an effective and safe procedure for the treatment of complicated and/or geriatric olecranon fractures.

Key words: olecranon fractures, locking plates, geriatric fractures, complicated fractures

Introduction

Olecranon fractures account for 10% of all upper-extremity fractures.[1] Surgical treatment includes tension-band wiring, screw fixation, or plate fixation. Tension-band wiring is a popular technique recommended for noncomminuted fractures.[2] However, complications such as pin migration and hardware symptoms occur with a relatively high prevalence.[2,3] Plate fixation has been associated with fewer hardware symptom prominence and nonunion instances.[2] The novel method, namely physiologic osteosynthesis, involving the usage of locking plates, was shown to be successful in

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multifragmentary diaphyseal and metaphyseal geriatric fractures.[4-6] However, very few studies describe the treatment outcome of locking plate osteosynthesis for complicated and/or geriatric olecranon fractures. We designed this study to assess the outcomes of these fractures following locking plate osteosynthesis.

Materials and Methods

From March 2010 through January 2015, we treated 127 patients with olecranon fractures at our institute. Among the olecranon fracture cases, 17 patients were categorised as complicated and/or geriatric fractures. These included: (1) Fractures with more than three fragments or radial head fractures (n = 6), (2) other failed operative treatments (n = 4), and (3) patients of age > 60 years (n = 7). All patients underwent locking plate osteosynthesis. One elderly patient died 8 months after osteosynthesis due to comorbidity. The median age of the remaining 12 female and 4 male patients at the time of surgery was 50 (24 – 91) years. Patients' fractures were caused by simple falls (n = 5) or traffic accidents (n = 11). Both Schatzker classification and Mayo elbow classification were used to describe olecranon fracture patterns.[7] In Schatzker classification, type A is a simple transverse fracture, type B is a transverse impacted fracture, type C is an oblique fracture, type D is a comminuted fracture, type E is a more distal extra-articular fracture, and type F is fracture-dislocation. In Mayo elbow classification, type I is a non-displaced, stable fracture with no disruption of the extensor mechanism. Type II is a displaced fracture with a stable ulnohumeral joint. Type III fractures accompany ulnohumeral joint instability. The subtypes A and B are noncomminuted and comminuted, respectively. Fourteen patients were above Schatzker type D/Mayo type IIB fractures, and the other two patients having Schatzker type A/Mayo type IIA fractures were revised for implant fixation failure.

Surgical technique

All patients were placed in decubitus position with arms draped over a bolster, under general anesthesia. A longitudinal, posterior skin incision was made. The reconstruction locking plate (Depuy Synthes, West Chester, PA, U.S.) was contoured to position along the posterior crest of the olecranon and the dorsal surface of the proximal ulna. The plate was typically bent between the first and the second screw holes such that the proximal locking screw was almost perpendicular to the second screw. At the proximal end of the ulna, unicortical screws were applied to avoid intra-articular penetration of the screws, but the screws were as long as possible to increase their working length.

After the operation, the elbow joint was immobilized with a splint for 5 – 7 days. Subsequently, the splint was removed and patients were advised to flex and extend their elbows actively. Patients were evaluated at 4 – 8 week intervals until fracture union and at 3-month intervals thereafter. If the patients encountered joint stiffness (motion arc < 100˚), physical therapy was administered. If the conservative treatment failed, a secondary operation was planned 6 months later.

Clinical assessment

The clinical outcome was evaluated at the final follow-up using Mayo elbow performance (MEP) scores (range: 0 – 100). This score includes pain assessment (45 points maximum), range of motion (20 points), stability (10 points), and function (25 points). A score of > 90 points was considered 'excellent' while a score between 75 – 89 points was 'good'.[8] A limited range of motion was defined as motion less than 100˚. Furthermore, visual analog score (VAS) (range: 0 – 10), symptomatic implant prominence, and flexion contractures were also evaluated and recorded.

Radiographic assessment

Postoperative and follow-up radiographs were examined for quality of reduction, fracture union, or migration of implants. Quality of reduction was graded as (1) 'good' when articular step-off was < 1 mm, (2) 'fair' when articular step-off was 1 – 2 mm, and (3) 'poor' when articular step-off was > 2 mm. Radiographic bone union, quality of reduction, and migration of implants were recorded.

Results

All patients attended follow-up examinations for a minimum of 1 year. The median follow-up period was 24 months (range: 12 – 36 months). Fourteen fractures were comminuted olecranon fractures. Four cases of fracture occured in patients with a history of failed operative treatments. Of these four patients, two patients were initially treated with tension-band wiring which subsequently snapped. The other two were initially treated with conventional compression plates with implant failure (one was nonunion and the other was a broken plate) (Fig. 1). Six elderly patients had olecranon fractures. The operation time averaged 60 minutes (range: 30 – 80 minutes) and blood loss averaged 50 mL (range: 20 – 100 mL). Associated injuries were presented in three patients. There were no known neurovascular injuries. Of these fractures, four were classified as Gustilo and Anderson type III open fractures (three type IIIA and one type IIIB).[9,10]

Clinical outcomes

There was no infection noted. Three of 16 (19%) patients requested plate removal due to prominence and discomfort. There were two cases of joint stiffness (motion arc < 100˚), which were both open fractures with soft tissue degloving injury. Following secondary operation for fibrous tissue release and manipulation under general anesthesia, the functional arc was restored (motion arc > 100˚) (Fig. 2). At the most recent follow-up, median MEP and VAS scores were 95 (range: 80 – 100) and 1 (range: 1 – 3), respectively. All patients achieved 'good' and 'excellent' MEP score results. The median arc of range of motion was 125˚ with extension and flexion at 5˚ (range: 0˚ – 20˚) and 130˚ (range: 110˚ – 140˚), respectively.

Radiographic outcomes

As per the definition of quality of reduction, 12 patients showed 'good' reduction, four showed 'moderate' reduction, and no patient showed 'poor' reduction. All fractures showed radiographic union. The median union time was 16 (range: 12 – 22) weeks. No hardware breakage was noted.

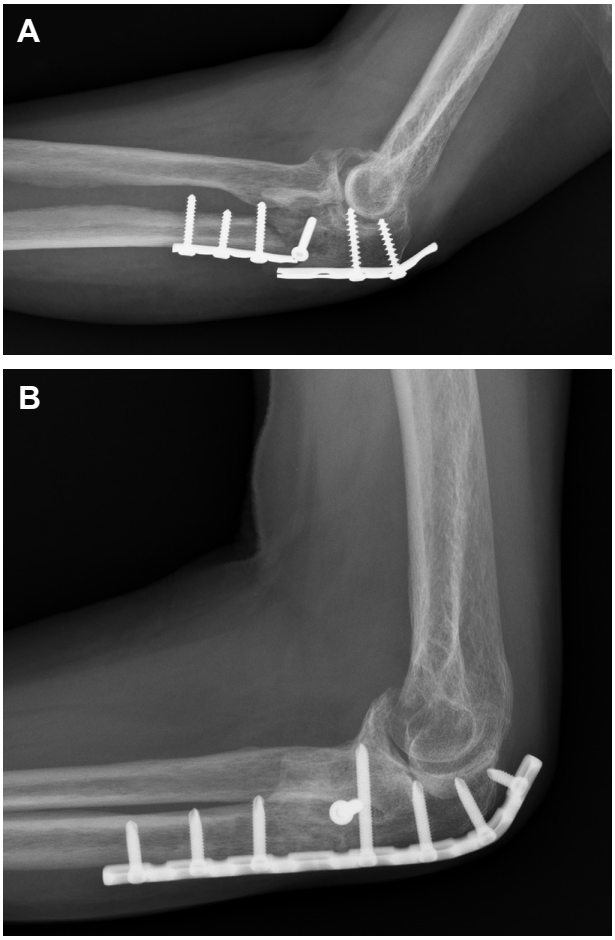

Fig. 1 (A) A 80-year-old woman visited our out-patient clinic with broken plate. (B) The nonunion was repaired with a reconstruction locked plate and X-ray showed bone union with good alignment at one year.

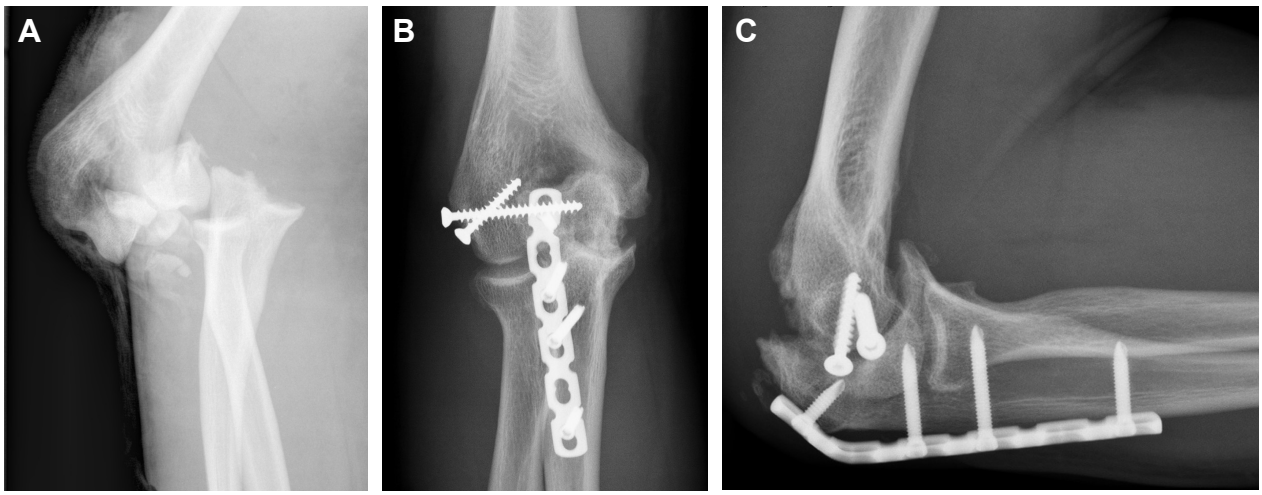

Fig. 2 (A) A 33-year-old man sustained a Gustilo type IIIA, Mayo type IIIB olecranon fracture. (B) and (C) The fracture was stabilized with a locked plate and X-ray showed union without malalignment at the 12-month follow-up visit.

Discussion

Treatment of olecranon fractures for stable fixation is essential to allow postoperative rehabilitation and early range of motion exercise, which eventually result in positive functional outcomes.[2,7] Several treatment options for fracture fixation have been described, including tension-band wiring, plate fixation, intramedullary screw fixation, and even triceps advancement after fragment excision. The method of internal fixation is chosen primarily based on the fracture type. Mayo type IIA is a stable fracture where tension band wiring is usually adequate. However, if the fracture line is distal to the coronoid process, plate-and-screw constructs are indicated. In case of geriatric patients, extensive comminution, or small proximal fragments, excision of the fractured fragments with triceps advancement can be a useful option.[11] However, comminuted or geriatric olecranon fractures remain a challenging problem.

Some advocate plating the medial and/or lateral ulna to improve soft tissue coverage. However, Gordon et al.[12] reported that plating of the dorsal ulna has shown to be 48% stronger biomechanically than plating the medial and/or lateral ulnar surface. Posterior plating was shown to be a stable construct and may be the preferred method of fixation for comminuted olecranon fractures. Regarding the plating systems, there are several plate designs including one-third tubular plates, 3.5-mm pre-contoured limited contact dynamic compression plates, 3.5-mm reconstruction plates, pre-contoured locking compression plates (LCP), and the novel contoured olecranon locking compression plates.[13-16] Plate fixation is being applied for over a century. The breakthroughs in plate fixation occurred in the 1950s from the founders of the Swiss Association for the Study of Internal Fixation. The angular stable plating has been widely used since the introduction of the LCP, which are preferable over conventional plates. It serves as an "internal-external fixator" and preserves blood circulation of the periosteum.[4] Furthermore, LCP fixations do not involve toggling of unlocking screws as in conventional plates. Thus it theoretically improves fixation in cases with decreased bone mineral density and severe comminution.[17,18]

Choosing the best among plating techniques for comminuted olecranon fractures remains controversial. Buijze and Kloen[16] reported that using a pre-contoured LCP combined with an intramedullary screw

provides sufficient stability in the treatment of acute comminuted olecranon fractures. This promotes early postoperative functional rehabilitation, with excellent fracture union rates leading to favorable clinical outcomes. Intramedullary screws may have mechanical advantages in such fractures.[12] In our study, no locking home-run screw was used since the overbending would damage the structure of locking holes in the peri-articular area. It showed success in fixing complicated and/or geriatric olecranon fractures, even without intramedullary screws.

Recently, Anderson et al.[13] reported that contoured olecranon locking plates (Mayo Congruent Elbow Plate System) have a low rate of hardware removal and are a safe and effective option for the treatment of olecranon fractures. In their study, 5 of 32 (16%) patients underwent symptomatic hardware removal, and 2 of 5 showed infections and failure of fixation. In our study, 3 of 16 (19%) patients requested plate removal due to prominence and discomfort. In general, Taiwanese patients expect the endpoint of treatment to be a stage where no implant is remaining in the body. Between pre-contoured and contoured LCP, the contoured locking plates provide additional "home-run screw" from proximal fragment into the coronoid process. These may have one or two more screw holes to fix proximal ulnar fragments, providing strength and stability. Besides, contoured LCP may save the bending time intra-operatively. The potential benefit of shorter surgery duration is expected, but further studies are required to demonstrate this aspect. However, contoured LCP is more expensive than pre-contoured LCP.

In Taiwan, conventional dynamic compression plate is covered by National Health Insurance (NHI), unlike LCP. However, NHI was considering LCP in the benefits package recently. This study provided small evidence that nonperiarticular LCP was associated with satisfactory results, low rate of complications and was less expensive than contoured LCP.

The underlying premise of this study was to evaluate the use of a nonperiarticular locking plate indicated for complicated and/or geriatric olecranon fractures. In our retrospective review, we excluded olecranon fractures below Mayo type IIA and only included in our case series, two Mayo-IIA cases revised due to implant failure. There were six patients (37.5%) older than 60 years in our study. The median age of patients was 50 years. The sample size was relatively small and lacked a control group in our study, indicating its limitations. Satisfactory results and low rate of complications in our study indicated that nonperiarticular locking-plate osteosynthesis without intramedullary screws can be performed safely and successfully to fix complicated and/or geriatric olecranon fractures.

Author Contributions

CH Wu, CH Ma, CY Yen and YK Tu did the surgery; CH Wu and YK Tu designed the study; CH Wu and YW Li collected the data, did the statistics, and drafted the manuscript, figures, and tables; YH Hsueh interpreted the data and searched the literature. All authors have read and approved the published version of the manuscript.

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Institutional Review Board Statement

The study was conducted in accordance with the Declaration of Helsinki and approved by the Institutional Review Board of E-Da Hospital (EMRP-103-051).

Informed Consent Statement

This research study was conducted ret-

rospectively from data obtained for clinical purposes. We consulted extensively with the Institutional Review Board of E-Da Hospital who determined that our study did not need the informed consent.

Data Availability Statement

The data that support the finding of this study are available from the corresponding author on reasonable request.

Conflicts of Interest

The authors declare no conflict of interest.

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