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ORIGINAL ARTICLE

Operative Treatment of Intra-articular Distal Radius Fractures Using the Small AO External Fixation Device

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Background: A retrospective group study was done to evaluate the effect of the small AO external fixator in the management of acute intra-articular fractures of the distal radius.

Methods: Between January 1995 and December 1996, 70 consecutive patients with articular fractures of the distal radius were treated by closed reduction and external fixation with small AO external fixators. The mean age at the time of surgery was 58.9 years (range, 14–87 years). There were 58 Colles' Barton's fractures and 12 Smith's Barton's fractures. The follow-up period was 104 months (range, 92–118 months).

Results: All fractures united in a mean of 5.8 weeks (range, 4–10 weeks). At the final follow-up, the average range of motion was 56.3 ± 11.6° in flexion, 58.6 ± 10.7° in extension, 21.5 ± 4.2° in ulnar deviation, 9.1 ± 2.9° in radial deviation, 71.5 ± 8.5° in pronation, and 67.3 ± 9.2° in supination. Compared with the normal side, the average grip force was 87 ± 6%. The overall clinical and functional outcomes, according to the scoring system of Gartland and Werley, showed that 22 patients (31.4%) had excellent results, 36 (51.4%) had good results, 9 (12.9%) had fair results, and 3 (4.3%) had poor results.

Conclusion: Closed reduction and external fixation with the small AO external fixator is useful and effective in the management of displaced comminuted articular fractures of the distal radius. [*J Chin Med Assoc* 2005; 68(10):474–478]

Key Words: AO external fixator, articular fracture, distal radius

Introduction

Fractures of the distal radius are very common injuries, estimated to account for up to 1-sixth of all fractures.[1–3] Treatment of such injuries can be problematic and demanding, particularly when the fracture is severely comminuted or has intra-articular involvement. The incidence of complications, including stiffness and loss of reduction, has been reported to be as high as 31%.[4]

There are diverse options for the management of these fractures, including closed reduction with plaster-cast immobilization, pins and plaster,[5] open reduction and internal fixation,[6] closed reduction and, more recently, augmented external fixation.[7–10] However, the reports of treatment methods and results are still conflicting. If the distal radius fracture is severely comminuted intra-articularly, the treatment will be more challenging. Restoration of congruity of the articular surface is the most critical factor for a good functional result. If 3 or more cortices show comminution on the anteroposterior and lateral films

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in conjunction with radial shortening of more than 5 mm and/or intra-articular involvement in the radiocarpal or radioulnar joint, Pennig and Gausepohl[9] have recommended that external fixation be used to restore the radial anatomy. Attention must be paid to prevent possible complications such as re-displacement, pin-tract infection, and late collapse.

We performed this retrospective study to elucidate the effect of the small AO external fixation device in the management of intra-articular fractures of the distal radius.

Methods

Between January 1995 and December 1996, 83 consecutive patients with intra-articular distal radius fractures were treated with closed reduction and external fixation using small AO external fixators in our institute. We use small AO external fixators routinely if there is intra-articular involvement in a distal radius fracture. The only contraindication is poor general health that makes the surgery too risky (American Society of Anesthesiologists status IV or V). Six patients died and 7 cases were lost to follow-up. Data for the 70 patients with complete records were collected for final evaluation.

Thirty-one patients were male and 39 were female. The mean age at the time of surgery was 58.9 years (range, 14–87 years). The mechanism of injury was fall in 47 and motor vehicle crash in 23. Forty-one fractures involved the right wrist and 21 involved the left. In three cases (4.3%), the fractures were open. There were 12 associated injuries, including 5 humerus fractures, 1 scaphoid fracture, 2 ankle fractures, and 1 each of talus fracture, Jones' fracture, femoral neck fracture, and brachial plexus injury. All were managed as needed and would not interfere with the evaluation of the results. All intra-articular fractures were referred to as Colles' Barton's or Smith's Barton's, depending on the pattern of involvement of the distal radioulnar and radiocarpal joint surface and the displacement. There were 58 Colles' Barton's fractures and 12 Smith's Barton's fractures. Fifty-six of our patients underwent surgery on the day of injury, 14 within 1–3 days after injury, and none more than 3 days after injury. All 3 open fractures were managed appropriately within 8 hours after injury.

The aim of treatment was to restore anatomy by application of the fixator in the frontal plane. All fractures were characterized by bone loss and shortening of the affected radius, with dorsal or volar tilt and lateral displacement of the distal fragment. Fractures were reduced under regional anesthesia. After reduction and restoration of radial length and wrist congruity, fractures were fixed and stabilized with the aid of a small AO external fixator. This is a rigid device consisting of 4 threaded pins (2.5 × 150 mm), clamps and connecting bars. After small skin incisions were made and the bones were drilled with a 2-mm drill bit, the pins were inserted manually with a universal chuck, two proximally to the fracture in the distal radius and two in the shaft of the second metacarpal bone. These pins were inserted at an angle of 60° to the horizontal plane. After manipulation and distraction, the fracture was reduced and the connecting bars were applied and secured firmly to the threaded pins with clamps. Anteroposterior and lateral roentgenograms were obtained after the fixator was applied to ensure proper positioning of fractured bone ends (Figure 1).

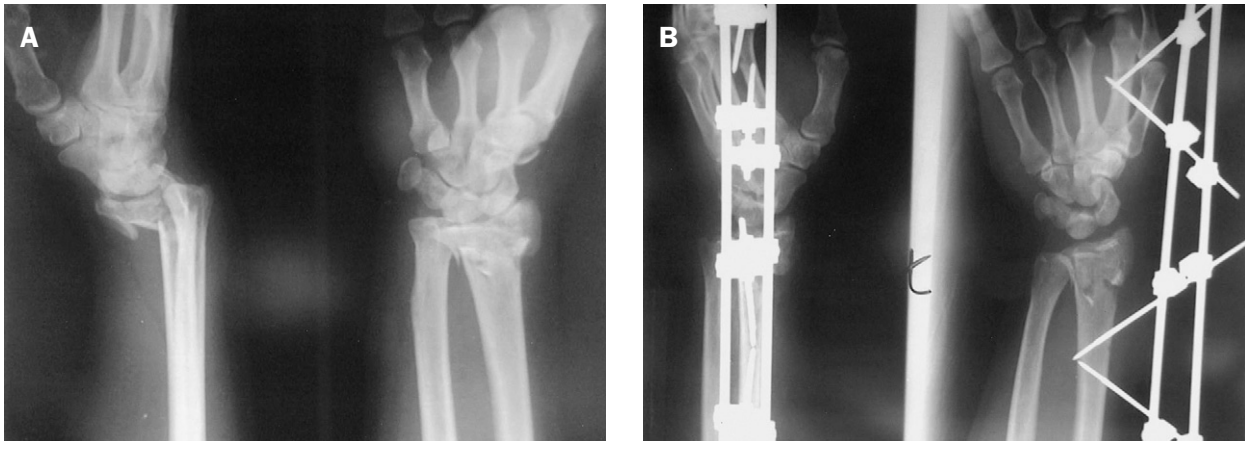

Figure 1. (A) Preoperative X-ray of a 73-year-old man with comminuted Smith's Barton's fracture of the left wrist. (B) Immediate postoperative X-ray showing good alignment after use of the small AO external fixator.

Most patients were discharged on the day of surgery, except the 3 with open fractures and another 7 patients who complained of severe pain who were discharged on the next day. Physiotherapy and range-of-motion exercises started immediately after surgery. The first postoperative follow-up was 2 weeks after discharge, and patients were followed every 2 weeks until union of the fracture. All external fixators were then removed and patients were followed every 6 months thereafter. At every follow-up visit, anteroposterior and lateral radiographs were taken. The mean follow-up period was 104 months (range, 92–118 months).

Function was evaluated using a modification of the scoring system described by Gartland and Werley.[11] Residual deformity and subjective evaluation were recorded in the same way as in their original scoring system. Range of motion was determined using a goniometer measuring dorsal and volar flexion, radial and ulnar deviation, pronation, and supination, and the sum was calculated as a percentage of the unaffected wrist.[12] The grip strength was included in the score and measured with a "My-Gripper", and the result was also calculated as the percentage of the unaffected side. In radiographic evaluation, the radial length, volar tilt, and radial inclination were also measured at the last follow-up.

Results

All fractures united in an average of 5.8 weeks (range, 4–10 weeks). We encountered 8 (11.4%) episodes of complications, including 3 patients with irritation of the superficial branch of the radial nerve, 1 with loss of reduction, 3 with pin-tract infection, and 1 with reflex sympathetic dystrophy. The irritation of the superficial branch of the radial nerve was incomplete in nature, and resolved spontaneously and completely within 3 months after removal of the external fixators. In 1 patient with a Smith's Barton's fracture, loss of reduction and collapse of the fracture in 6 weeks led to the development of moderate arthritis at the radiocarpal joint (Figures 2 and 3). The final range of motion was 45° in flexion, 50° in extension, 20° in ulnar deviation, 10° in radial deviation, 65° in pronation, and 60° in supination. This patient refused any further surgical treatment and had a poor result according to the scoring system of Gartland and Werley. Three patients developed pin-tract infection. With appropriate antibiotic treatment, all symptoms resolved after removal of the pins and there was no sequelae. The reflex sympathetic dystrophy resolved with physical therapy after removal of the fixator.

At the final patient visits, the radiographic evaluation showed that the mean radial length, volar tilt, and radial inclination were 9.7 ± 2.2 mm, –2.3 ± 1.9°, and 18.4 ± 3.3°, respectively. The average range of motion was 56.3 ± 11.6° in flexion, 58.6 ± 10.7° in extension, 21.5 ± 4.2° in ulnar deviation, 9.1 ± 2.9° in radial deviation, 71.5 ± 8.5° in pronation, and 67.3 ± 9.2° in supination. The grip force, compared to the normal side, was 97 ± 8% for right-side fractures and 78 ± 5% for left-side fractures, giving an average of 87 ± 6%. Using the scoring system of Gartland and Werley, the overall clinical and functional result was excellent in 22 patients (31.4%), good in 36 (51.4%), fair in 9 (12.9%), and poor in 3 (4.3%).

Figure 2. At the postoperative 6-week follow-up, the X-ray shows loss of reduction and collapse of the fracture.

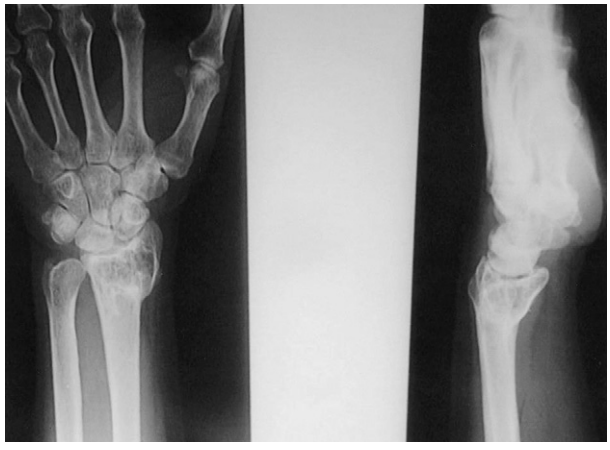

Figure 3. After 98 months of follow-up, the X-ray shows development of moderate arthritis in the radiocarpal joint.

Discussion

Fracture of the distal end of the radius is an injury that orthopedic surgeons deal with frequently.[1–3] Early scholars studied these injuries as a common group and achieved reasonable results.[11,13] With a better understanding of the disrupted anatomy and the biomechanics of the injury pattern and improved imaging techniques, surgeons today have the opportunity to improve maximum functional outcome and reduce the possibility of post-traumatic arthritis.[14] Several methods of fixation have been described, and numerous investigators have made biomechanical comparisons of those methods.[15–17] In a biomechanical study to evaluate and compare the rigidities of 4 external fixators, including the small AO, the mini Hoffman, Roger Anderson, and Ace Colles', using the Instron universal testing instrument, Nakata et al[16] found that the small AO external fixator was the most rigid instrument, about twice as rigid as the other 3. The clinical results of the current study completely agree with their observation. We used small AO external fixators to immobilize intra-articular fractures of the distal radius, and the results were excellent in view of the rigidity of the implants: only 1 patient (1.4%) showed loss of reduction and there was no nonunion.

The union time in this series was 5.8 weeks (range, 4–10 weeks), which is comparable with other series.[15,16,18,19] To evaluate the overall functional result, we used the scoring system of Gartland and Werley, believing that a specific functional index can be used in clinical practice to represent all functions of the wrist joint as accurately as possible. After a mean follow-up of 104 months, 82.8% of our patients had excellent or good results and 17.2% of patients had fair or poor results.

Some controversies still exist as to whether bridging or non-bridging external fixation provides better results in the management of distal radius fractures. Conventional bridging external fixation relies on ligamentotaxis to apply traction and restore displacement. However, non-bridging external fixation may provide better reduction of the distal fragment and better functional results. McQueen[20] compared bridging and non-bridging fixators in a randomized prospective study and concluded that normal volar tilt, carpal alignment, grip strength, and flexion are better maintained with non-bridging fixators. However, their study comprised different types of fractures, extra-articular (77% AO type A) and intra-articular (23% AO type C2), and no comminuted intra-articular (AO type C3) fractures. We agree that, for extra-articular fracture, the pins in the distal fragment may permit the surgeon to have direct control that allows exact repositioning. For intra-articular fractures, however, there is not sufficient purchase on the distal fragments to allow reduction control and maintain alignment. We recommend that bridging external fixation is a more suitable and reliable method for the management of intra-articular distal radial fractures than non-bridging fixation.

In conclusion, closed reduction and external fixation is useful and effective in the management of displaced comminuted articular fractures of the distal radius. Meticulous reduction and rigid fixation with a small AO external fixation device are the key factors to achieving good final clinical results.

References

1. Golden GN. Treatment and prognosis of Colles' fracture. *Lancet* 1963;i:511–5.
2. Hollingsworth R, Morris J. The importance of the ulnar side of the wrist in fractures of the distal end of the radius. *Injury* 1976;7:263–6.
3. Owen RA, Melton LJ III, Johnson KA, Ilstrup DM, Riggs BL. Incidence of Colles' fracture in a North American community. *Am J Public Health* 1982;72:605–13.
4. Cooney WP III, Dobyns JH, Linscheid RL. Complications of Colles' fracture. *J Bone Joint Surg Am* 1980;62:613–9.
5. Robertsson GO, Jonsson GT, Sigursjonsson K. Epidemiology of distal radius fractures in Iceland in 1985. *Acta Orthop Scand* 1990;61:457–9.
6. McBirnie J, Court-Brown CM, McQueen MM. Early open reduction and bone grafting for unstable fractures of the distal radius. *J Bone Joint Surg Br* 1995;77:571–5.
7. Pennig D. Dynamic external fixation of distal radius fractures. *Hand Clin* 1993;9:587–602.
8. Pennig D, Gausepohl T. Extraarticular and transarticular external fixation with early motion in distal radius fractures and malunions. *Orthop Surg Tech* 1995;9:51–65.
9. Pennig D, Gausepohl T. External fixation of the wrist. *Injury* 1996;27:1–15.
10. Seitz WH, Putman MD, Dick HM. Limited open surgical approach for external fixation of distal radius fractures. *J Hand Surg Am* 1990;15:288–93.
11. Gartland JJ, Werley CW. Evaluation of healed Colles' fractures. *J Bone Joint Surg Am* 1951;33:895–907.
12. Solgaard S, Carlsen A, Kramhoft M, Petersen VS. Reproducibility of goniometry of the wrist. *Scand J Rehabil Med* 1986;18:5–7.
13. Glowacki KA, Weiss APC, Akelman E. Distal radius fractures: concepts and complications. *Orthopedics* 1996;19:601–8.
14. Knirk JL, Jupiter JB. Intraarticular fractures of the distal end of the radius in young adults. *J Bone Joint Surg Am* 1986;68:645–59.
15. Werber KD, Raeder F, Brauer RB, Weiss S. External fixation of distal radial fractures: four compared with five pins. *J Bone Joint Surg Am* 2003;85:660–6.
16. Nakata RY, Chand Y, Matiko JD, Frykman GK, Wood VE. External fixators for wrist fractures: a biomechanical and clinical study. *J Hand Surg Am* 1985;10:845–51.

17. Wolfe SW, Austin G, Lorenze M, Swigart CR, Panjabi MM. A biomechanical comparison of different wrist external fixators with and without K-wire augmentation. *J Hand Surg Am* 1999;24:516–24.
18. Herrera M, Chapman CB, Roh M, Strauch RJ, Rosenwasser MP. Treatment of unstable distal radius fractures with cancellous allograft and external fixation. *J Hand Surg Am* 1999;24: 1269–78.
19. Harley BJ, Scharfenberger A, Jomha N, Weber DW. Augmented external fixation versus percutaneous pinning and casting for unstable fractures of the distal radius: a prospective randomized trial. *J Hand Surg Am* 2004;29:815–24.
20. McQueen MM. Redisplaced unstable fractures of the distal radius: a randomized, prospective study of bridging versus non-bridging external fixation. *J Bone Joint Surg Br* 1998;80: 665–9.