Original Article

Minimally invasive plate osteosynthesis for distal radius fractures

Xu-ming Wei, Zhen-zhong Sun, Yong-jun Rui, Xiao-Jun Song

Abstract

Background: Fractures of distal radius are common injury in all age groups. Cast treatment with or without close reduction is a viable option. However, the results are often unsatisfactory with restricted function. The open reduction and internal fixation often results in extensive soft tissue dissection and associated high rates of infect and delayed/nonunion. The distractor/external fixator have reported good functional and anatomical results but the incidence of pin traction infection nerve injury and cosmedic deformity are high. We introduced a modified operative technique for minimally invasive plate osteosynthesis (MIPO) for distal radial fracture and evaluated the functional outcomes and complications.

Materials and Methods: 22 distal radial fractures (10 left, 12 right) were treated using the MIPO technique and two small incisions with a palmar locking plate from August 2009 to August 2010. The wrist function was assessed according to Dienst wrist rating system, and postoperative complications were recorded.

Results: According to Dienst wrist rating system, 13 patients showed excellent results, 6 cases showed good results and 3 patients had moderate results. No patient had poor results. Thus, the excellent and good rate was 86.4%. One patient had anesthesia in the thenar eminence and this symptom disappeared after 3 months. One patient had delayed healing in the proximal wrist crease. Two patients had mild pain on the ulnar side of the wrist and two patients had limited wrist joint function.

Conclusion: The MIPO technique by using two small palmar incisions is safe and effective for treatment of distal radial fractures.

Key words: Distal radius fracture, minimally invasive plate fixation, palmar locking plate

Introduction

Distal radius fracture is a common injury in all age groups. However, there are several controversies in the operative indication, surgical approach and the best treatment method. The gold standard in the treatment of distal radius fracture remains uncertain.[1] Cast treatment with or without closed reduction has long been considered a viable option for treatment of distal radius fractures. However, the results are often unsatisfactory with restricted function and disabilities.[2,3] Several studies have reported good anatomical and functional results of distal radius fractures treated with external fixation but also described high incidence of pin tract infection, cosmetic deformity, and nerve injury.[4] Traditional open reduction and internal fixation often results in extensive soft tissue dissection and periosteal injury and may be associated with high rates of infection, delayed union and nonunion.[4,5]

Fortunately, the technique of minimally invasive plate osteosynthesis (MIPO) recently emerged and this technique can minimize soft tissue stripping and damage to the vascularity of the bone.[6] It can lead to a reduction in complications caused by conventional treatment. MIPO has been widely used in the treatment of the femoral and tibial fractures.[7,8] More recently its use has also been expanded for the fixation of upper extremity fractures.[9-12] In 2005, Imatani *et al*.[13] first reported that five patients of distal radius metaphysis comminuted fracture were treated by MIPO in which reduction and internal fixation was completed by two longitudinal incisions (3 cm) on the palmar side of distal forearm. Inspired by the report, we designed two kinds of incisions (2 cm) according to the distance between the main fracture line and the wrist for further minimizing soft tissue related complications, such as tendon injury, nerve dysfunction, and vascular compromises.[14] Besides, mini-incision can offer better cosmetic results.[15,16] Plate fixation of distal radius fractures usually involves two kinds of

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incisions: Palmar and dorsal. The palmar approach has been demonstrated to be more superior because it can avoid the complications caused by the attrition of the extensor tendon in the dorsal approach.[17-19] In addition, the cortex on the palmar side of distal radius is wide and flat which benefits the exposure of fracture fragments and placement of the plate, especially for a die-punch type of fracture. Importantly, the operative scar of the wrist is not very obvious, leading to an excellent appearance.[20] A palmar locking plate has superior biomechanics compared with traditional dorsal locking plate.[21]

We reviewed our experience in treating distal radius fractures using the palmar locking plate and two kinds of incisions in the MIPO technique, in order to assess the functional outcome and complications following this method.

Materials and Methods

22 patients with distal radial fractures (10 left, 12 right) were treated by the modified MIPO technique with a T-shaped palmar locking plate. An informed consent was taken from the patients and the approval of the ethics committee of Hand Surgery Hospital was obtained.

We used the AO/ASIF classification of distal radius fracture using plain radiographs. Our indications for using MIPO were type A2, type A3, type B1, type B3, type C1 and type C2 distal radial fractures. Patients with type A1, B2 or C3 of distal radius fracture were not included in this study.

Operative procedure

Patient was placed on a conventional table in the supine position under brachial plexus block. Manual reduction was performed under fluoroscopy. Once a satisfactory reduction was achieved, one or two 1.5 mm kirschner wires were obliquely inserted from the styloid process of radius to the proximal ulnar side to maintain the reduction, sometimes the kirschner wires were inserted from the opposite direction as well. It is necessary to add another K wire, parallel to the articular surfaces of the distal radius for a type C fracture. The two skin incisions of 2 cm each were made [Figure 1]. For patients with a distance between the main fracture surface and articular surface of distal radius within 1 cm, distal skin incision was made along the proximal wrist crease. If this distance was more than 1 cm, distal skin incision was made on the radial side along the proximal wrist crease, parallel to flexor carpi radialis. After cutting the superficial and deep fascia on the radial side of flexor carpi radialis, the flexor carpi radialis and the radial artery were retracted to the radial or ulnar side respectively. Then the flexor pollicis longus was retracted to the ulnar side to expose the pronator quadratus. A longitudinal incision was made at the middle of distal partial pronator. This incision was not needed for patients with incomplete injury to the pronator quadratus. For a few patients with unsatisfied closed reduction, the incision should be made on the fracture end to help reduction under direct vision. A suitable, oblique, T-shaped palmar locking plate was inserted through the incision extraperiosteally. After satisfactory fracture reduction and fixation of the plate, a 2 cm proximal skin incision was made on the radial side of the flexor carpi radialis. The superficial and deep fascia was cut to retract the radial artery and the flexor pollicis longus was dissected using forceps to expose the proximal end of the locking plate. The incisions were closed in layers [Figure 2].

Plaster splints were not applied to any patient postoperatively. We encouraged the patients to exercise their shoulders, elbows, metacarpophalangeal joints, interphalangeal joints 2 or 3 days after operation. Patients were advised to perform extension and flexion movement of the affected wrist joints

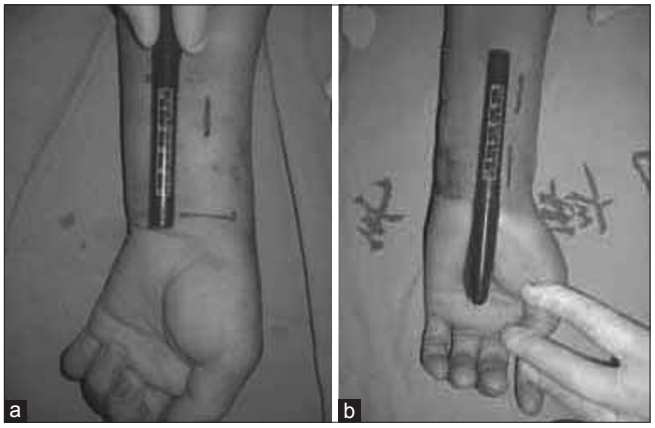

Figure 1: Preoperative clinical photographs showing (a) One horizontal and one vertical incision. (b) Two vertical incisions.

Figure 2: Intraoperative clinical photographs showing (a) One horizontal and one vertical incisions were made at the palmar side. (b) The locking screws were inserted to fix the plate.(c) Intraoperative X-ray showing the reduction of the fracture on the lateral and anteroposterior view

after 3-5 days post surgery. Two weeks postoperatively, active rotational exercises for forearm were also added. The patients were followed up every 2 months [Figure 3].

Results

The average age of the patients was 65 years (range 37-80 years). There were 7 males and 15 females. The mean time from injury to surgery was 7 days (range 0.5 hour-10 days). They were all closed fracture and were classified according to AO/ASIF system, including type A2 (n=5), type A3 (n=3), type B1 (n=4), type B3 (n=7), type C1 (n=2), and type C2 (n=1). All 22 patients were followed up for an average time of 12 months (range, 10-18 months). According to wrist function evaluation criteria described by Dienst *et al.*,[22] 13 patients obtained excellent results, six cases had good results and three patients had moderate results. None of the patients had poor results [Figure 4]. Thus, excellent and good results were seen in 86.4%. One patient had anesthesia in the thenar eminence and this symptom disappeared after 3 months. One patient had delayed healing in the proximal wrist crease. Two patients had mild pain on the ulnar side of the wrist. Two patients had limited wrist joint function.

Discussion

MIPO has become popular in the treatment of fractures due to satisfactory clinical outcomes. Since the first MIPO techniques were developed for subtrochanteric and distal femoral fractures, these methods were modified and adapted for use in other fracture types as well, including the distal tibia,[23,24] humeral shaft[9,25] and the foot.[26] In this study, we adopted a modified MIPO technique that used a palmar locking plate through two small incisions to treat distal radial fractures. Incision length was determined according to the distance between the main fracture line and the articular surface of distal radius.

A prospective, randomized study analyzed 90 patients with displaced intraarticular distal radius fractures with an average of 4-year followup to evaluate the functional outcomes of three modes of treatment (plaster immobilization, external fixation, and open reduction with internal fixation). Good or excellent results were achieved in 43%, 80%, and 63% in each group, respectively.[4] Similarly, another prospective, randomized study reported that good or excellent outcomes of conventional closed reduction and immobilization with or without Norian SRS (Skeletal Repair System) cement in the management of intra or extraarticular distal radial fractures were 45%.[27] It appears that the functional outcome was similar when compared our results with that using external fixation. However, patients undergoing external fixation are at high risk for infection. Pin tract infection was the major complication of external fixation of fractures and the rates of infection ranged from 0.5% to 30%.[28] Some bacteria, usually *Staphylococcus aureus* and Staphylococcus epidermidis, often colonized at the site of external fixation pins[28] that resulted in these infection. In our study, there were no infections. Conventional closed reduction using only simple plaster cast immobilization is insufficient to maintain the reduction and Cherubino *et al*. observed a secondary loss of reduction during plaster cast immobilization in 35% of cases.[2] A traditional open surgical approach may increase the risk of nonunion, delayed healing and infection due to extensive soft tissue stripping.[30] In addition, the complication of nerve injuries are commonly reported after operative treatment of distal radius fractures. The incidence has been estimated from 0% to 17%, with the median nerve being the most commonly injured followed by the radial and ulnar nerves.[31] However, in present study, no damage of radial artery and median nerve occurred in all 22 patients postoperatively since our longitudinal incisions were usually along the radial side of the flexor carpi radialis

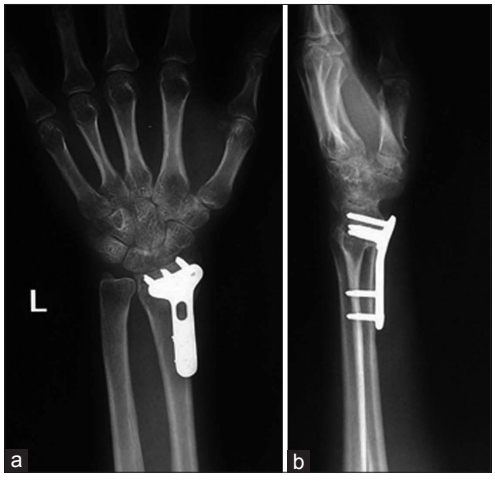

Figure 3: Postoperative X-rays (a) anteroposterior (b) lateral views at 2 months followup demonstrating a healed distal radius fracture

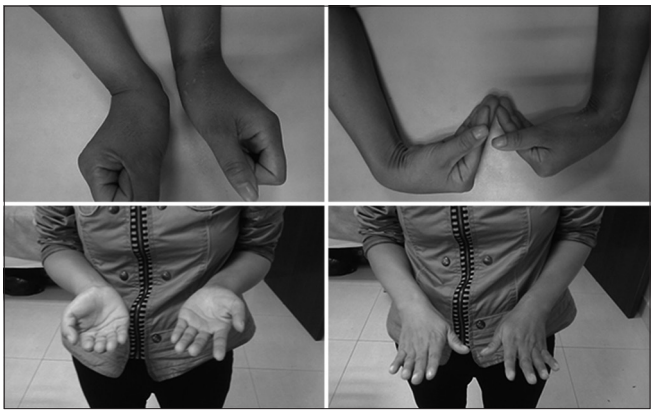

Figure 4: Postoperative clinical photographs showing functional results. The extension and flexion of the wrist and the supination and pronation of the forearm were all good

and our surgery was performed strictly in the safety window area to avoid accidental injury.[32] Besides, the radial artery and median nerve were not exposed during the operation in current study 27% cases developed complications in our study including anesthesia (4.5%), delayed healing (4.5%), pain (9%) and limited extension and rotation (9%) 27% complication rate associated with MIPO used in our study for various types of fractures shows that this method is not suitable for all distal radius fractures. A specific treatment method and selection of individuals will certainly reduce the number of complications.

The limitations of this study include the small sample size, the short followup time, and the absence of a control group.

In conclusion, two small incisions to implant a palmar locking plate by MIPO for distal radius fractures give good functional results. But further research also should be carried out to explore more suitable treatment for specific individuals.

References

1. Handoll HH, Madhok R. Surgical interventions for treating distal radial fractures in adults. Cochrane Database Syst Rev 2003:CD003209.
2. Cherubino P, Bini A, Marcolli D. Management of distal radius fractures: Treatment protocol and functional results. Injury 2010;41:1120-6.
3. Westphal T, Piatek S, Schubert S, Winckler S. Outcome after surgery of distal radius fractures: No differences between external fixation and ORIF. Arch Orthop Trauma Surg 2005;125:507-14.
4. Kapoor H, Agarwal A, Dhaon B. Displaced intraarticular fractures of distal radius: A comparative evaluation of results following closed reduction, external fixation and open reduction with internal fixation. Injury 2000;31:75-9.
5. Kreder H, Hanel D, Agel J, McKee M, Schemitsch E, Trumble T, *et al.* Indirect reduction and percutaneous fixation versus open reduction and internal fixation for displaced intraarticular fractures of the distal radius: A randomised, controlled trial. JBone Joint Surg Br 2005;87:829-36.
6. Helfet DL, Shonnard PY, Levine D, Borrelli Jr J. Minimally invasive plate osteosynthesis of distal fractures of the tibia. Injury 1997;28:A42-8.
7. Apivatthakakul T, Chiewcharntanakit S. Minimally invasive plate osteosynthesis (MIPO) in the treatment of the femoral shaft fracture where intramedullary nailing is not indicated. Int Orthop 2009;33:1119-26.
8. Collinge C, Kuper M, Larson K, Protzman R. Minimally invasive plating of high-energy metaphyseal distal tibia fractures. JOrthop Trauma 2007;21:355-61.
9. Lau T, Leung F, Chan C, Chow S. Minimally invasive plate osteosynthesis in the treatment of proximal humeral fracture. Int Orthop 2007;31:657-64.
10. An Z, Zeng B, He X, Chen Q, Hu S. Plating osteosynthesis of middistal humeral shaft fractures: Minimally invasive versus conventional open reduction technique. Int Orthop 2010;34:131-5.
11. Shetty MS, Kumar MA, Sujay K, Kini AR, Kanthi KG. Minimally invasive plate osteosynthesis for humerus diaphyseal fractures. Indian J Orthop 2011;45:520-6.
12. Takada N, Otsuka T, Yamada K, Suzuki H, Hasuo T, Kondo A, *et al.* Minimally invasive plate osteosynthesis for distal radius fractures with a palmar locking plate. Eur J Trauma Emerg Surg 2012;38:627-32.
13. Imatani J, Noda T, Morito Y, Sato T, Hashizume H, Inoue H. Minimally invasive plate osteosynthesis for comminuted fractures of the metaphysis of the radius. J Hand Surg Br 2005;30:220-5.
14. Davis DI, Baratz M. Soft tissue complications of distal radius fractures. Hand Clin 2010;26:229.
15. Wong TC, Chiu Y, Tsang WL, Leung WY, Yeung SH. A double-blind, prospective, randomised, controlled clinical trial of minimally invasive dynamic hip screw fixation of intertrochanteric fractures. Injury 2009;40:422-7.
16. Gosens T, Bongers KJ. Neurovascular complications and functional outcome in displaced supracondylar fractures of the humerus in children. Injury 2003;34:267-73.
17. Axelrod TS, McMurtry RY. Open reduction and internal fixation of comminuted, intraarticular fractures of the distal radius. J Hand Surg Am 1990;15:1-11.
18. Rozental TD, Beredjiklian PK, Bozentka DJ. Functional outcome and complications following two types of dorsal plating for unstable fractures of the distal part of the radius. J Bone Joint Surg Am 2003;85-A: 1956-60.
19. Khanduja V, Ng L, Dannawi Z, Heras L. Complications and functional outcome following fixation of complex, intraarticular fractures of the distal radius with the AO Pi-Plate. Acta Orthop Belg 2005;71:672-7.
20. Nunley JA, Rowan PR. Delayed rupture of the flexor pollicis longus tendon after inappropriate placement of the pi plate on the volar surface of the distal radius. J Hand Surg Am 1999;24:1279-80.
21. Leung F Zhu L, Ho H, Lu WW, Chow SP. Palmar plate Wxation of AO type C2 fracture of distal radius using a locking compression plate-a biomechanical study in a cadaveric model. J Hand Surg Br 2003;28:263-6.
22. Dienst M, Wozasek GE, Seligson D. Dynamic external fixation for distal radius fractures. Clin Orthop Relat Res 1997;338:160-71.
23. Hazarika S, Chakravarthy J, Cooper J. Minimally invasive locking plate osteosynthesis for fractures of the distal tibia-results in 20 patients. Injury 2006;37:877-87.
24. Ronga M, Shanmugam C, Longo UG, Oliva F, Maffulli N. Minimally invasive osteosynthesis of distal tibial fractures using locking plates. Orthop Clin North Am 2009;40:499-504.
25. Zhiquan A, Bingfang Z, Yeming W, Chi Z, Peiyan H. Minimally invasive plating osteosynthesis (MIPO) of middle and distal third humeral shaft fractures. J Orthop Trauma 2007;21:628-33.
26. Thermann H, Krettek C, Tscherne H, von Glinski S. Minimally invasive fracture stabilization in foot trauma. Tech Orthop 1999;14:176-90.
27. Cassidy C, Jupiter JB, Cohen M, Delli-Santi M, Fennell C, Leinberry C, *et al.* Norian SRS cement compared with conventional fixation in distal radial fractures A randomized study. JBone Joint Surg 2003;85:2127-37.
28. Parameswaran AD, Roberts CS, Seligson D, Voor M. Pin tract infection with contemporary external fixation: How much of a problem? J Orthop Trauma 2003;17:503-7.

29. Haidukewych GJ. Innovations in locking plate technology. J Am Acad Orthop Surg 2004;12:205-12.
30. Imatani J, Noda T, Morito Y, Sato T, Hashizume H, Inoue H. Minimally invasive plate osteosynthesis for comminuted fractures of the metaphysis of the radius. J Hand Surg Br Eur 2005;30:220-5.
31. McKay SD, MacDermid JC, Roth JH, Richards RS. Assessment of complications of distal radius fractures and development of a complication checklist. J Hand Surg 2001;26:916-22.
32. McCann P, Amirfeyz R, Wakeley C, Bhatia R. The volar anatomy of the distal radius: An MRI Study of the FCR approach. Injury 2010;41:1012-4.
33. Tosti R, Foroohar A, Park M, Steinberg D, Bozentka D. Distal radius fractures. Minerva Ortop Trauma 2011; 62:443-57.

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