Orthopaedics & Traumatology: Surgery & Research 102 (2016) 333–338

Available online at
ScienceDirect
www.sciencedirect.com

Elsevier Masson France
EM|consulte
www.em-consulte.com/en

Original article

Minimally invasive percutaneous plate osteosynthesis for distal radius fractures with long-segment metadiaphyseal comminution

X.-m. Wei[a,b], Z.-z. Sun[b], Y.-j. Rui[b], X.-j. Song[b], W.-m. Jiang[a,*]

[a] Orthopedics Department, The First Affiliated Hospital of Soochow University, 188, Shizi Street, 215006 Soochow, China
[b] Orthopedics Department, Wuxi Ninth People's Hospital Affiliated to Soochow University, 999, Liangxi Road Wuxi, 214062, China

ARTICLE INFO

Article history:
Received 28 May 2015
Accepted 17 December 2015

Keywords:
Minimally invasive plate osteosynthesis
Volar locking compression plate
Distal radius fracture
Metadiaphyseal comminution

ABSTRACT

Introduction: Distal radius fractures with both metaphyseal and diaphyseal comminution are commonly encountered injuries due to high-energy trauma. However, effectively treating patients with this disease remains challenging for the surgeon.
Hypothesis: The goal of this study was to evaluate the outcomes of minimally invasive percutaneous plate osteosynthesis (MIPPO) technique for distal radius fractures with long-segment metadiaphyseal comminution.
Material and methods: Nine patients with distal radius fractures involving long-segment metadiaphyseal comminution were treated with MIPPO from June 2011 to May 2012. Radiograph index, the range of motion of the wrist and forearm, grip strength, the Disabilities of the Arm, Shoulder, and Hand (DASH) score were assessed at final follow-up. Additionally, time to bone healing, time to return to work or activity, and postoperative complications were also recorded.
Results: All nine fractures healed by 13 ± 1.3 weeks postoperatively. At an average follow-up of 15.9 ± 3.6 months, the radiographs revealed a mean radial inclination of $18.2 \pm 2.7^{\circ}$, a mean volar tilt of $10.7 \pm 3.2^{\circ}$, and a radial shortening of 2.3 ± 1.0 mm. Nine patients had excellent wrist function according to the DASH score, range of motion, and grip strength. Except one patient experienced delayed healing of the distal incision, no complications occurred. All patients resumed work or activity within 16.2 ± 1.9 weeks.
Discussion: Volar MIPPO is a safe and effective surgical treatment method for distal radius fractures with long-segment metadiaphyseal comminution, with few potential complications.
Type of study/level of evidence: Therapeutic IV.

1. Introduction

Distal radius fractures with both metaphyseal and diaphyseal comminution are commonly encountered injuries as a result of high-energy trauma. These extensively comminuted fractures of the wrist complicate the proper reduction and restoration of anatomical alignment and thus remain a major clinical challenge for the surgeon. Currently, only a few treatment options have been entertained to treat these difficult fractures, including distraction plate fixation [1,2], fixed angle volar plate fixation [3] and long volar locking compression plate (LCP) fixation [4–6], among which the long volar LCP plate has gained favor because it can allow simultaneous reduction of the articular surface and diaphyseal segment and facilitate earlier return to work and normal daily activities due to no demand of long period of immobilization [5]. However, the classic Henry approach usually requires pronator quadratus (PQ) muscle incision and extensive soft-tissue stripping over the metaphysis, which may devascularize the fracture fragments and consequently result in delayed healing [7]. Therefore, how to preserve an intact PQ muscle to provide better conditions for bone union is a hot research direction recently [8,9].

The minimally invasive percutaneous plate osteosynthesis (MIPPO) technique is one of the widely recommended techniques in which division of the PQ muscle was not involved, but a long LCP was inserted through two small incisions made on the volar side of distal forearm [10]. This procedure has been demonstrated to be more safe and effective for treatment of distal radial fractures [11–14], however, there are rare reports on the use of MIPPO for complex distal radius fractures involving both metaphyseal and diaphyseal comminution [15].

In addition, with regard to skin incisions, Imatani et al. [10] recommended two parallel, longitudinal incisions (3 cm), whereas Zenke et al. [11] recommended a distal transverse skin incision along the wrist skin crease and a proximal longitudinal incision

* Corresponding author. Tel.: +86 0510 85879335; fax: +86 0510 85879335.
E-mail address: weimingjiangwmj@163.com (W.-m. Jiang).

http://dx.doi.org/10.1016/j.otsr.2015.12.024
1877-0568/

(3 cm). Compared with the longitudinal incision, the transverse incision along the wrist skin crease may achieve superior cosmetic result which is the concern for most of young patients [11]. Our previous study [13] also suggested to using the similar incisions as Zenke et al. [11]. Until now, there are no reports on the use of MIPPO via this pair of perpendicular incisions for treatment of comminuted distal radius fractures with both metaphyseal and diaphyseal involvement.

The purpose of this report was to describe this specific operative technique and to evaluate the clinical, radiographic, and functional outcomes of distal radius fractures with long-segment metadiaphyseal comminution in mainland Chinese patients. We hypothesize that volar MIPPO may be a safe and effective option for treating distal radius fractures with long-segment metadiaphyseal comminution.

2. Materials and methods

2.1. Patients

The study was approved by the Medical Ethics Committee of local hospital. All patients gave informed consent to allow their wrist images, clinical outcomes, and radiography data to be used for publication.

This retrospective study excluded patients presented with open fractures, simple distal radial fractures without long-segment metadiaphyseal comminution, and neurovascular injuries of the forearm. Nine patients who suffered closed displaced distal radius fractures with long-segment metadiaphyseal comminution at least 5 cm proximal to the radiocarpal articulation, with or without simple intra-articular fractures, were included from June 2011 to May 2012 and were treated with volar MIPPO in our hospital. Table 1 lists the demographic characteristics of the patients. The 5 women and 4 men had a mean age at surgery of 55.1 ± 9.7 years (range: 38–71 years). The mean time from injury to surgery was 7.3 ± 2.7 days (range: 5–14 days). According to the AO classification, there were 5 type 23-A3.3 and 4 type 23-C2.3. The causes of injury were road traffic accidents in 4 patients, work-related accidents in 4 patients and a simple falling from a height in 1 patient. The right wrist was injured in 6 patients and the left wrist was injured in 3 patients.

2.2. Operative technique

At a mean of 7.3 ± 2.7 days (5 to 14 days) after injury, the surgery was performed by the same one senior orthopedic surgeon as described previously [13]. The patient was placed on a radiolucent operating table in the supine position under brachial plexus block. Two assistants pulled the patient's forearm longitudinally, with the forearm in full pronation and the elbow flexed to 90°. Under the traction of the fracture site, manual reduction was performed by the surgeon. Once a satisfactory reduction was achieved under C-arm fluoroscopy guidance, one or two 1.5 mm kirschner wires were obliquely inserted to temporarily maintain the reduction, followed by placing the injured forearm in full supination with the shoulder abducted to 90°. A 2-cm long transverse incision was made at the proximal wrist crease (Fig. 1). Further dissection was performed in the interval between the flexor carpi radialis laterally and the radial artery medially. The flexor pollicis longus tendon was retracted medially to expose the PQ, portion of which was split longitudinally (less than 1.5 cm) to expose the anterior cortex of the distal radius. This incision was not necessary for patients with incomplete injury in the PQ. A submuscular extraperiostal tunnel was made between the flexor pollicis longus muscle and the underlying periosteum. A 10- or 12-hole, 2.4-mm, precontoured, titanium T-shaped LCP (Synthes GmbH, Oberdorf, Switzerland) [4] was inserted through the transverse incision and passed over the

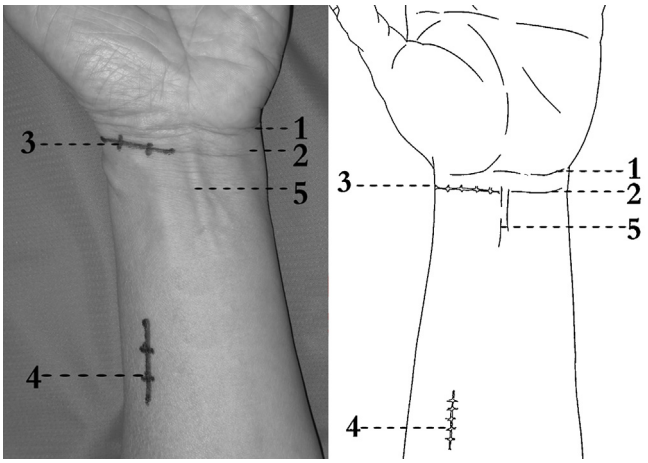

Fig. 1. Illustrations of the two incisions. 1: distal wrist crease; 2: proximal wrist crease; 3: distal incision (at the proximal wrist crease); 4: proximal incision (made along the medial border of the brachioradialis, approximately in the mid-forearm); 5: palmaris longus.

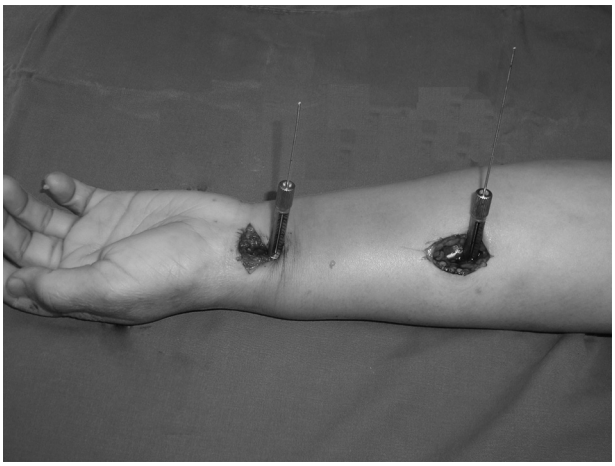

Fig. 2. Demonstration of the procedure. A long volar locking compression plate (LCP) was inserted sub-muscularly, and two drill guides were locked into the LCP.

fracture site and down to an additional, 2-cm longitudinal incision which was made along the medial border of the brachioradialis, approximately in the mid-forearm (Fig. 1). A 1.5-mm K-wire was then inserted through a distal screw drill guide in the plate to temporarily fix the plate (Fig. 2). The alignment, length, and rotation of the fracture were checked with the C-arm fluoroscopy, and any obvious deformity was corrected by manual manipulation. When the anatomical alignment was achieved, the brachioradialis and radial vessels were retracted laterally while the flexor carpi radialis (FCR) was retracted medially, followed by inserting another 1.5-mm K-wire through a proximal screw drill guide in the plate (Fig. 2). The alignment, length, and rotation of the fracture were confirmed again under anteroposterior and lateral fluoroscopic views. Two suitable locking screws were placed through the incisions distally and proximally. Then, the above 2 K-wires were removed, and other suitable locking screws were placed separately, with at least 3 screws in each end of the LCP. Care must be taken not to put the distal screws into the wrist joint. The incisions were closed in layers.

2.3. Postoperative care and follow-up

Postoperatively, neither a splint nor any other means were used to strengthen the fixation. Shoulder, elbow, and digit motions were