



Management of Distal Radial End Fractures with Close Reduction and Percutaneous K-Wire Fixation

KEYWORDS

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INTRODUCTION

Distal radius fractures are the most common type of fracture. Fractures of the distal radius represent one-sixth of all fractures treated in emergency department. Closed reduction and cast immobilization has been the mainstay of treatment of these fractures, but invariably it results in malunion, poor functional and cosmetic outcome. Restoration and maintenance of anatomy correlates well with function. The residual deformity of the wrist as a result of malunion is unsightly.

Closed reduction and cast immobilization often leads to collapse of the radius. Percutaneous K-wire fixation provides additional stability and is one of the earliest forms of internal fixation.

Kapandji described double intrafocal pinning into the fracture surface and Rayhack described ulno-radial pinning with fixation of distal radioulnar joint. Bridging external fixators and ligamentotaxis indirectly reduce the fracture. Ruch *et al* and many others described open reduction and internal fixation of distal radius fracture. Doi *et al.* recommended it for comminuted intra-articular fractures.

This study was conducted to examine the functional outcome of distal end radius fractures treated with closed reduction and percutaneous K-wire fixation.

MATERIAL AND METHOD

Thirty consecutive patients with distal radius fracture were prospectively enrolled for the study between September 2013 and December 2014. 17 patients were male and 13 were female. The mean age of patients was 42.7 years (range 18-70 years). The fracture involved right hand in 18 patients and left hand in 12 patients.

Surgical indications for this technique included displaced extra-articular fracture, intra-articular fracture without significant comminution, and articular step-off less than 2 mm. The surgery excluded patients with oblique volar fractures, significant dorsal comminution, presenting later than 2 weeks of injury, patients in whom ulnar shaft was not intact, open fracture, bilateral fractures, and multiple fractures. The patients with multiple injuries were also excluded. All patients sustained closed distal radius fractures.

Fourteen cases were caused by a traffic accident, and sixteen fractures resulted from falls. Preoperative radiographs were assessed for fracture pattern, degree of comminution, and articular fragmentation. All of the fracture were classified using the Arbeitsgemeinschaft für Osteosynthesefra-

gen (AO) classification. According to the AO classification, there were 12 A2 fractures, 6 A3 fractures, 3 C1 fractures, 7 C2 fractures, and 2 C3 fracture.

OPERATIVE TECHNIQUE

The patients were scheduled for operative treatment either the same day or within 48 h of injury. Under axillary block or general anesthesia, the patient was placed in the supine position. Closed reduction of the fracture was achieved by longitudinal traction and direct pressure over the displaced fragment under anesthesia. Hyperextension or flexion manoeuvres to disimpact the fragments were not recommended. Reduction was checked under image intensifier in both anteroposterior and lateral planes.

After acceptable reduction of the fracture was achieved, two percutaneous K-wires were inserted through the radial styloid with the wrist in traction to maintain the reduction. Image intensification fluoroscopy was used to assist the insertion of the K-wires throughout the entire procedure. The wires were drilled proximally through the radial styloid until they penetrated the intact cortex of the shaft. K-wires with a diameter of 1.5 to 2.0 mm were selected for use, with smaller wires for women and larger wires for men. After checking the stability of the fracture under image intensifier, if required, a third K-wire was passed from dorsolateral aspect from distal to proximal fragment. The wires were drilled to engage the opposite cortex. The wire insertion was performed with a power K-wire driver to allow the surgeon to hold part of the reduction with one hand during K-wire insertion. K-wires were bent at a right angle and cut short outside the skin for easy removal. A sterile dressing including sponge padding was applied to prevent skin irritation. All procedures were carried out under full sterile preparation and draping.

With the wrist in the neutral position, a dorsoradial below elbow plaster of Paris slab was applied up to the knuckles. Postoperative radiographs are obtained in the anteroposterior and lateral planes.

Postoperatively active finger, shoulder and elbow mobilization was started at the earliest. Patients were discharged 24 hours post surgery after ensuring good distal circulation of fingers. At 3 weeks follow-up, X-rays were taken, both in the anteroposterior and lateral planes to check the position of the fracture. The slab was removed and active finger, wrist exercises and forearm pronation and supination exercises were started. Handgrip was improved by using soft ball exercises. At 6 weeks, anteroposterior and lateral view radiographs were repeated. K-wires were then re-

moved without anaesthesia. Wrist physiotherapy and hand-grip exercises were continued for another 2 to 4 weeks.

Results were evaluated clinically and radiologically at 6 months using Solgaard's modification of the scoring system described by Gartland and Werley (Table 1). The functional outcome was easy to evaluate with simple instruments in this scoring system. The residual deformity and the subjective evaluation were recorded in the same way as the original scoring system. The range of motion was measured using a goniometer to measure dorsal and volar flexion, radial and ulnar deviation, and supination and pronation, and the sum was calculated as the percentage of the unaffected wrist. The grip strength was measured with a gripper, and the result was classified using a nomogram. The final results of the patients with excellent and good functional outcome were considered satisfactory.

Table 1

| | | Points |
|-----------------------|--|--------|
| Deformity | Prominent ulnar styloid | 1 |
| | Radial deviation | 1-2 |
| | Dinner-fork deformity | 1-3 |
| | Maximum | 6 |
| Subjective evaluation | No pain, no limitation of motion | 0 |
| | Slight pain, slight limitation of motion | 2 |
| | Occasional pain, some limitation of motion, weakness | 4 |
| | Pain, limitation of motion, activities restricted | 6 |
| | Maximum | 6 |
| Range of motion | Limitation of motion <20% | 0 |
| | Limitation of motion 20-50% | 2 |
| | Limitation of motion >50% | 6 |
| | Stiffness of wrist | 6 |
| | Maximum | 6 |
| Grip strength | Normal (within 2 SD) | 0 |
| | 2-4 SD | 2 |
| | 4-6 SD | 4 |
| | <6 SD | 6 |
| | Maximum | 6 |
| Complications | None or minimal | 0 |
| | Slight crepitation | 1-2 |
| | Severe crepitation | 3-4 |
| | Median nerve compression | 1-3 |
| | Pulp-palm distance 1 cm | 3 |
| | Pulp-palm distance >2 cm | 5 |
| | Pain in distal radio-ulnar joint | 1-3 |
| | Maximum | 16 |
| Total score | Excellent | 0-2 |
| | Good | 3-7 |
| | Fair | 8-18 |
| | Poor | 19-39 |

Table 1 Functional scoring system modified after Gartland and Werley

RESULTS

All of the fractures healed in our study group. Excellent results were noted in 16 patients, good in 11 patients, fair in two, and poor in one patient. Most of the patients returned to their preinjury activity level with 90% satisfaction rate. There were two patients rated as fair, which correlated with radial shortening, especially on the step-off of the radio-ulna joints. There were two cases of pin tract infection in which the removal of the k-wire in an earlier stage was necessary. Both cases responded well to antibiotic treatment and wound care after the removal of the wires. At the time of last follow-up, there was no recurrent infection, and the functional results were good in both cases. One case had unsightly tethered scars at the site of radial pin insertion, but the functional result was excellent at the time of follow-up. A 68 year old female patient had k-wires loosening due to severe osteoporosis. The patient had malunion with dinner fork deformity and joint stiffness and had a poor end result.

Assessment of postoperative radiographs showed that the average radial height was 10.83 mm (range=6-17 mm) and volar tilt was 10.14° (range=7-16°) on immediate postoperative radiographs. At the time of removal of percutaneous K-wires, the average radial height was 9.78 mm (range=6-16 mm), and the volar tilt was 9.84° (range=6-14°). The radial height was 7.57 mm (range 2-12 mm) and volar tilt 8.73° (range -3- 13°), at 6 month follow-up.

DISCUSSION

Distal radius fracture is a very common injury. The importance of anatomic reduction has been demonstrated by clinical studies. In fractures with articular surface displacement greater than 2 mm, radial shortening greater than 5 mm, or dorsal angulation more than 20°, suboptimal results have been reported in previously published studies. Therefore, every effort should be made to restore normal length, alignment, and articular surface congruency of the distal radius.

An accurate reduction in the fracture is the first step in the treatment of the distal radius fracture. After anatomic reduction in the fracture is achieved, many methods are available to maintain alignment and prevent repeat displacement. The methods of immobilization include casting, percutaneous pinning, ligamentotaxis with external fixation, internal fixation with plate, or internal fixation combined with external fixation depending on the different types of fractures. Every method has its advantages and some limitations.

The most common traditional method is closed reduction and cast immobilization, but this often fails to prevent early radial collapse and is associated with a high risk of malunion, joint stiffness and painful wrist. Hence, this method is for low-demand elderly patients.

External fixators can maintain radial length and radial inclination by ligamentotaxis, but cannot effectively maintain palmar tilt. Also complication rates as high as 60% have been reported with the use of external fixators.

Open reduction and internal fixation techniques should be reserved for partial and complex intra-articular distal radius fractures. This technique can not be used for elderly patients with comorbidities.

Percutaneous pinning with K-wires was first recommended

by Green as a simple and inexpensive procedure. Closed reduction and percutaneous pinning relies on reduction and pinning to hold the fracture in an appropriate anatomic alignment. This techniques involve minimal procedure, less time consumption and helpful for maintain reduction in elderly patients and patients with comorbidities in which open reduction is not possible.

Active finger mobilization was started immediately. In our study we did not encounter reflex sympathetic dystrophy.

Two cases in our study had pin tract infection in which the removal of the k-wire in an earlier stage was necessary. Both cases responded well to antibiotic treatment and wound care after the removal of the wires. One case had unsightly tethered scars at the site of radial pin insertion, but the functional result was excellent at the time of follow-up.

One patient had k-wires loosening due to severe osteoporosis. The patient had malunion with dinner fork deformity and joint stiffness.

Three patients had radial shortening, in which two had fair result and one had poor result.

There was no incidence of posttraumatic arthritis reported in our patient population because long-term follow-up is not available.

Chin et al. reported a 90.7% satisfactory result in 54 patients treated with percutaneous pinning if the articular surface of the radius was not severely comminuted.

In our study, the average radial height was 10.83 mm postoperatively and 9.78 mm after k-wire removal. The average volar tilt angle was 10.14° postoperatively and 9.84° after k-wire removal. We consider that the percutaneous k-wire fixation technique can efficiently stop radial shortening and dorsal tilting during the time of bone healing. Most of our study patients [90%] achieved excellent to good functional results 6 months after removal of the k-wire.

In conclusion, closed reduction and percutaneous k-wire fixation is a simple procedure and excellent technique for both extra-articular and intra-articular fractures without severe comminution of the distal radius. The technique involves a minimal procedure that provides anatomic reduction, fracture fixation and maintenance of reduction with adequate functional results after early rehabilitation.

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