

A study on the functional outcome of closed reduction and K-wire fixation in the treatment of extra-articular distal radius fractures



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ABSTRACT

Background: Fractures of the distal end of the radius are among the most common skeletal injuries with diverse treatment options. There is no clear consensus regarding the functional outcomes of the diverse treatment options. **Aims and Objectives:** The aim of the study was to evaluate functional outcomes in distal radius fractures treated with closed reduction and K-wire fixation. **Materials and Methods:** Fifty-seven patients (26 males and 31 females) with different types of distal radial fractures were treated. Closed reduction and K-wire fixation were performed under axillary block or general anesthesia. Functional outcomes were evaluated using the Mayo Wrist Scoring System. **Results:** According to the Mayo score, 50.9% (n = 29) of our patients had good outcomes, 36.8% (n = 21) had fair outcomes, and 12.3% (n = 7) had satisfactory outcomes. **Conclusions:** Closed reduction and Kirschner wire fixation are inexpensive procedures that provide anatomical reduction, fracture fixation, and maintenance of reduction with an adequate method of immobilization.

Key words: Closed reduction; Distal radius fracture; "K" wire; MAYO score; Functional outcome

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INTRODUCTION

Fracture of the distal end of the radius is a common (nearly 16% of all fractures) skeletal injury. The optimal management for displaced distal radius fractures has not yet been established.^{1,2} Fracture of the distal end of the radius is conventionally treated by closed manipulation and plaster cast immobilization. However, difficulty in maintaining the reduction achieved with a plaster cast often leads to malunion and deformity, which can result in functional disability, such as poor grip strength.³

Although the association between radiological and functional outcome is controversial, restoration of normal anatomy has been recommended in active patients.³ Maintenance of radial length is one of the most crucial

factors in regaining grip functions with shortening of >4–6 mm compromising function.⁴ Due to the natural inclination for loss of reduction in distal radius fractures, several measures, including the usage of percutaneous Kirschner wire fixation, external fixators, internal fixation with screws and plates, bone grafting, and bone cementing, have been employed to prevent redisplacement, but there is much disagreement as to the best modality. Even with the gradual shortening at the fracture site that occurs during the healing process, excellent reduction has been reported.^{5,6} According to recent research, using supplemental percutaneous Kirschner wire fixation after closed reduction can help maintaining the initial reduction and radial length, as well as preventing any subsequent late collapses.^{7,8}

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K-wire fixation is a simple and minimally invasive technique used to maintain the reduction in extra- and intra-articular fractures. Clinical guidelines from the American Academy of Orthopedic Surgeons moderately recommend an anatomically stable surgical fixation, instead of cast fixation, to be followed by early wrist motion for treatment of patients with displaced distal radius fractures.⁹

This study aimed in assessing the functional results of closed reduction and K-wire stabilization in the management of extra-articular distal radius fractures, to determine whether a more precise reduction could be attained and maintained during healing, and to evaluate whether the results could be improved through closed reduction and supplemental percutaneous Kirschner wire fixation.

Aims and objectives

To assess the functional outcome of closed reduction and K-wire fixation in the treatment of extra articular distal radius fractures.

MATERIALS AND METHODS

This study was conducted prospectively on 57 patients with extra-articular radius fractures, who had undergone treatment with K-wire fixation and closed reduction for 1-year period from November 2018 to April 2020. The subjects were followed up for 6 months, and during each follow-up, the subjects were assessed. Subjects with fractures of the distal end radius on either side or both sides, over the age of 18 years, of either sex with extra-articular distal radius fractures (Frykman 1 and 2), which are <2 weeks old (Figure 1).

Patients aged <18 years, with intra-articular fractures of the distal radius, fractures older than 2 weeks, open fractures, and patients suffering from cognitive impairment/psychiatric illness were not included in the study.

Surgical procedure

The subject was in the supine position on an OT table with an arm on a side table. The fracture was painted and draped under regional anesthesia. Threaded K-wires were used in the case of osteoporotic bone (Figure 2).

The fracture was reduced using ulnar and flexion deviation maneuvers under an image intensifier. The lower forearm was subjected to a reduction process on a sandbag/kidney tray positioned underneath it. After the reduction, one of the two methods was randomly followed (Figure 3).

Method 1

Extra focal pinning: The 1.6-mm K-wires were placed distally to proximally, entering from the radial styloid across the site of the fracture and fixing to the ulnar side of the radial cortex. Another K-wire was passed from the dorsoplantar aspect of the distal radius to engage the volar radial cortex of the proximal fragment (Figures 4 and 5).

Method 2

Intrafocal pinning: The site of the fracture was treated using a minimum of two to three K-wires, which was determined by the fracture configuration and stability. The pins were inserted to pry the distal fragment into the ideal position, creating a buttress effect to prevent displacement.

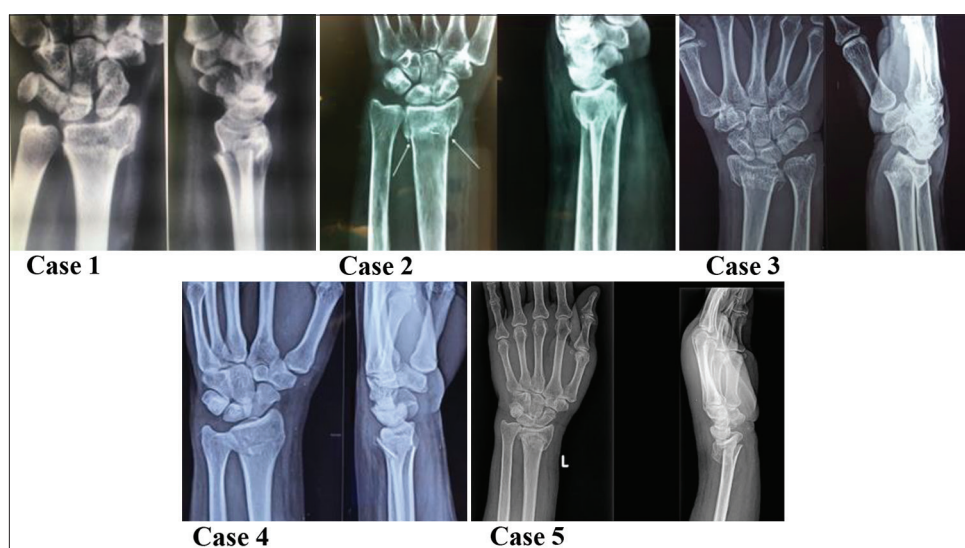


Figure 1: Case 1 – Pre-operative. Frykman Type 1 distal radius fracture, Case 2 – Pre-operative. Frykman Type 1 distal radius fracture, Case 3 – Pre-operative. Frykman Type 2 distal radius, and Case 4 – Pre-operative. Frykman Type 1 distal radius fracture, Case 5 – Pre-operative. Frykman Type 1 distal radius fracture

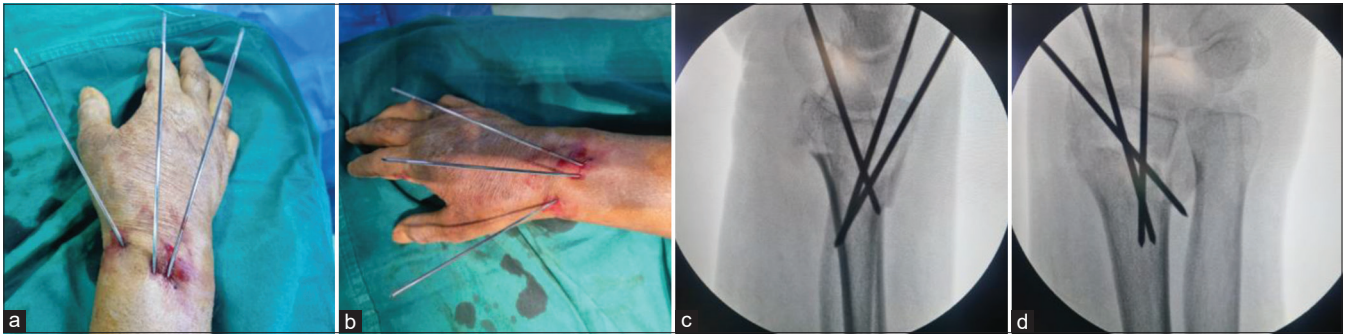


Figure 2: (a and b) Threaded K-wires insertion inside osteoporotic bone, (c and d) After K-wire fixation Kapandji's method of intrafocal pinning



Figure 3: Closed reduction with supporting sandbag under the lower 1/3rd forearm with the wrist in flexion and ulnar deviation

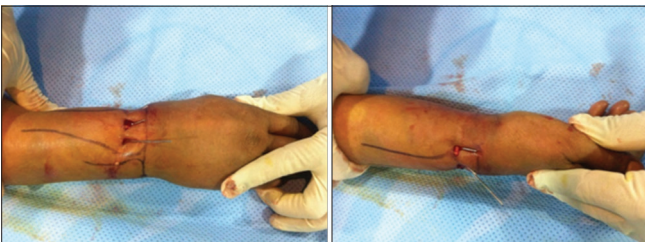


Figure 4: K-wire insertion

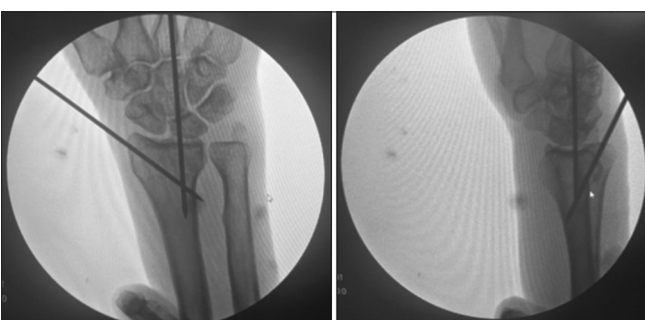


Figure 5: Intraoperative picture confirming K-wire position and reduction with C-arm image intensifier

The pin sites were dressed, followed by a below-elbow cast/slab with palmar flexion and ulnar deviation.

Post-operative protocol

Following surgery, the patient underwent limb elevation to reduce swelling and active finger movements. Shoulder

and elbow mobilization was initiated the following day. The patient was discharged after 2 days, and no complications were reported during the period of follow-up. The cast/slab was removed at the end of 4 weeks, and the patient was assessed for tenderness, pin track infection, and free range of movements at the wrist and distal radioulnar joint. Radiological signs of union and the K-wires' position were checked. The subject was taught daily intermittent mobilization, and the slab was reapplied for 2 weeks. The subject was reviewed at 6 weeks, and physiotherapy assistance was provided if movements were unsatisfactory. The removal of K-wires was contingent on the satisfactory progress of the union, the absence of pain at the fracture site, and painless range of motion for a period of 4–6 weeks (Figures 4-7).

Functional evaluation

The subjects were evaluated using the Mayo wrist score (Table 1). It is a physician rating scoring system. Pain was rated on the basis of patient's description.

RESULTS

The age distribution of patients mostly fell within the age ranges of 31–50 and 61–70 and 17.5% were aged between 51 and 60 years. The mean patient age was 49 years. The majority were female (54.4%), while 45.6% were male, with a female predominance. In addition, 19.3% of patients had diabetes, 7% had hypertension, and 5.3% had both conditions (Table 2).

Among the 57 (100%) patients, 68.4% experienced fractures as a result of slip and fall incidents, characterized as low-velocity injuries. Moreover, 22.8% of the subjects sustained fractures due to road traffic accidents (RTAs), which are considered high-velocity injuries. In addition, 9% of patients sustained fractures following falls from heights, which are also classified as high-velocity injuries. Among the patients, 50.9% sustained fractures in the left wrist, 29.8% experienced fractures in the right wrist, and 5.3% had bilateral distal radius fractures. Furthermore, 14% of the subjects had associated injuries. Interestingly,

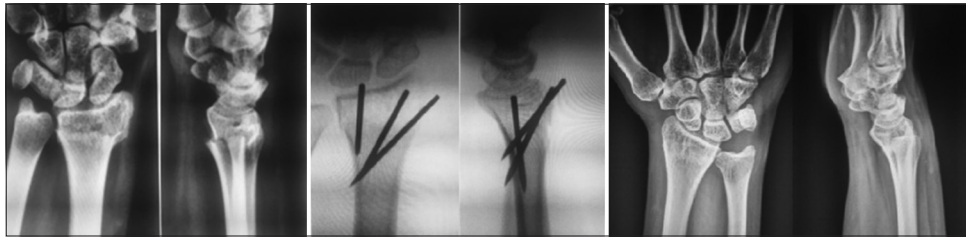


Figure 6: Pre-operative, post-operative and 6-month follow-up X-rays of a patient from the K-wiring insertion



Figure 7: Patient from the closed reduction and K-wiring showing the final range of movements

approximately 73.7% of the patients sustained fractures in their non-dominant hand, specifically on the left side, while 26% experienced fractures in their dominant hand (Table 3).

Most patients (64.9%) had Frykman Type 1 fractures. Frykman Type 2 fractures made up 35.1% of the total fractures. According to the Mayo wrist score, 36.8% of patients achieved an “excellent” outcome, while 50.9% reported a “good” outcome. A “satisfactory” outcome was noticed in 12.3% of patients on basis of Mayo wrist score. Complications were reported in 5.4% of the subjects, including pin track infection, malunion, and complex regional pain syndrome (CRPS), each occurring in one subject (Table 4).

DISCUSSION

Fractures of the distal radius are among the most common fractures encountered in the emergency department. Due to the increasing average life expectancy, it is crucial for orthopedic surgeons to prioritize the management of osteoporotic fractures, especially in postmenopausal women, as highlighted by Young and Rayan.¹⁰ The majority of fractures arise from falling on the outstretched hand with the

Table 1: Functional outcome analyzed using Mayo score

Category	Findings
Pain	No pain
	Mild, occasional
	Moderate, tolerable
	Severe to intolerable
Functional status	Returned to regular employment
	Restricted employment
	Able to work, but unemployed
	Unable to work due to pain
Range of movements (% of normal) (%)	100
	75–99
	50–74
	25–49
	0–24
If only injured hand examined	>120
	90–120
	60–90
	30–60
	<30
Grip strength (% of normal)	100
	75–99
	50–74
	25–49
	0–24

Interpretation: 90–100: Excellent, 80–90: Good, 60–80: Satisfactory, below 60: Poor

Table 2: Demographic details of the patients

Age group	Frequency (n)	Percent
21–30	4	7.0
31–40	14	24.6
41–50	14	24.6
51–60	10	17.5
61–70	13	22.8
71–80	1	1.8
81–90	1	1.8
Total	57	100.0
Gender		
Female	31	54.4
Male	26	45.6
Total	57	100.0
Co-morbidities		
Diabetic	11	19.3
Hypertensive	4	7.0
Hypertensive and diabetic	3	5.3
None	39	68.4
Total	57	100.0

wrist dorsiflexed. These fractures can cause significant distress to patients and lead to disability if not managed adequately

Table 3: Mode of injury, diagnosis, and dominance of hand

Mode of injury	Frequency (n)	Percent
RTA	13	22.8
Fall from height	5	8.8
Slip and fall	39	68.4
Total	57	100.0
Diagnosis (Side fracture and associated fracture)		
Bilateral distal radius fracture	3	5.3
Distal radius fracture left side	29	50.9
Distal radius fractures with other injuries	8	14.03
Distal radius fracture right side	17	29.8
Total	57	100.0
Side of fracture		
Dominant hand	15	26.3
Non-dominant hand	42	73.7
Total	57	100.0

RTA: Road traffic accident

Table 4: Functional outcome according to Frykman classification, Mayo wrist score and complications

Frykman classification	Frequency (n)	Percent
Type 1	37	64.91
Type 2	20	35.09
Total	57	100.0
Mayo wrist score grading		
Excellent	21	36.8
Good	29	50.9
Satisfactory	7	12.3
Total	57	100.0
Complications		
CRPS	1	1.8
Malunion	1	1.8
Pin track infection	1	1.8
Total	3	5.4

CRPS: Complex regional pain syndrome

and in time. Managing fractures of the distal radius have always been a debatable and challenging issue for orthopedic surgeons. The ultimate goal is to restore motion and grip strength, allow a quick return of function, and minimize the risk of future degenerative changes in the wrist joint. Closed reduction followed by fixation of the fracture with percutaneous pins and a cast is a widely used method. The pins may be inserted by a variety of methods; across fracture fixation or with the intrafocal Kapandji technique.^{11,12}

Walton et al., proposed a technique for stabilizing unstable distal radius fractures using blunt-ended K-wires through intrafocal and intramedullary insertion, which modified the Kapandji method. A total of 102 subjects suffering from unstable distal radius fractures were treated using this technique and their functional and clinical outcomes were assessed using the modified Lidstrom scoring system. This method was presented as a dependable and practical

approach for treating these common fractures, especially in bones with osteoporosis.¹³

As per a study conducted by Das et al., (n.d.), 32 individuals aged 18–70 years with extra-articular distal radius fractures were prospectively examined. The patient's treatment involved using two-three K wires for closed reduction and percutaneous pinning. The researchers determined that percutaneous pinning followed by immobilization of the wrist in a neutral position is an efficient and simple technique for maintaining reduction and averting stiffness of the hand and wrist.¹⁴ Percutaneous pinning is best suited for extra-articular fractures without substantial communication.

Percutaneous pinning is linked to complications, such as pin-site infection, radial nerve lesions, pin loosening, redisplacement, and CRPS. It requires approximately 5 weeks of immobilization, which often leads to temporary wrist joint stiffness. Our study included 57 patients (26 male and 31 female patients with aged 21–90 years. Of the patients, 19.3% had diabetes, 7% had hypertension, and 5.3% had hypertension and diabetes. The right side was involved in 15 patients (26.3%), and the left side in 42 patients (73.7%). Bilateral distal radius fractures were present in 5.3% of the cases. Moreover, 14% of patients had accompanying injuries. In 68.4% of cases, the mode of injury was slip and fall, 22.8% were RTA, and 8.8% were from a fall from a height. Ali et al., conducted a study involving 40 patients, consisting of 16 male and 24 female patients showed similar results. Among them, 16 patients (40%) had injuries on the right side, while 24 patients (60%) had injuries on the left side. Most of the cases (85%) were caused by falls and RTA, and assaults accounted for the remaining 15%. On the basis of the AO classification, the most common types of injuries were C (n=16) at 40.0% and A (n=15) at 37.5%, which may be due to increased occurrence of high-velocity injuries.¹⁵

As per the Frykman classification, Type 1 fractures were seen in 64.91% of patients and Type 2 fractures in 35.09% of patients. About 36.8% of patients achieved an "excellent" outcome, while 50.9% reported a "good" outcome as per Mayo wrist score. As per the reports of Ali et al., and Kumar and Kisan, similar outcomes in their study on percutaneous Kirschner wire fixation of distal radius fractures and found that as per Mayo score, 72.5% (n=29) of the subjects had excellent to good outcomes, while 27.5% (n=11) had fair to poor outcomes. Kumar and Kisan observed excellent to good results in 75% of cases and fair to poor outcomes in 25% of patients.¹⁵ Most of our patients had a smooth recovery. One patient had CRPS, one patient had malunion, and one patient showed pin-track infection. Patients suffered from stiffness and five patients had pin-site infections. Ali et al., also found that most of their subjects had a smooth

recovery and six patients suffered from stiffness and five patients had pin-site infection.^{15,16} In fact, we observed less complication in patients compared to Ali et al., study.¹⁵ In Bansal et al., assessed functional outcomes using the demerit score system of Gartland and Werley. In K wiring patients, 16 were excellent, eight were good, one was fair, and none poor as per demerit score.¹⁷

Limitations of the study

Our study's main limitation was that the sampling was limited to only one centre. The study's functional outcomes were analyzed at 24 weeks, and larger comparative studies assessing the long-term outcomes of the study are required.

CONCLUSIONS

Percutaneous Kirschner wire fixation and closed reduction are affordable procedures for extra-articular distal radial fractures, offering excellent clinical results lacking substantial comminution and providing fracture fixation, anatomic reduction, and maintenance of reduction with adequate immobilization.

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Authors Contributions:

KSB, JP, and SRM- Contributed to the design and implementation of the research, to the analysis of the results, and to the writing of the manuscript.

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