

Original Research Article

A prospective study of distal radius fracture management by close reduction, percutaneous Kirschner wire fixation and plaster immobilization

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ABSTRACT

Background: Distal radius fracture is one of the most common fractures. It may be sustained due to low-energy trauma or high-energy trauma. Objectives: To compare the clinical effectiveness of Kirschner wire fixation with and plaster immobilization for patients with fracture of the distal radius.

Methods: Interventions Kirschner wire fixation: wires are passed through the skin over the dorsal aspect of the distal radius and into the bone to hold the fracture in the correct anatomical position. About 79 patients with Distal Radial Fractures presented to MGM Medical College and LSK Hospital, Kishanganj between November 2012 and June 2014 were included in the study.

Results: The majority were men (60.4%). Majority of the patients (69.8%) sustained the injury due to fall. The side of involvement was nearly equal and that there was no predominance of the either sides. In our study, according to AO classification, 31 cases were of Type A, 17 were of Type B and 5 were of Type C. The Anatomical evaluation by Sarmiento's Criteria showed 33 patients with excellent result, 15 patients with good result and 5 with a fair result. At final follow-up by 'The Gartland and Werley criteria for functional outcome' 37 patients had excellent result, 13 had good result, 2 had fair result and 1 had a poor result.

Conclusions: This study demonstrates that percutaneous Kirschner wire pinning is a minimally invasive technique that provides an effective means of maintaining the anatomical fracture reduction. It does not required highly skilled personnel or sophisticated tools for application. It is a suitable method for fixation of displaced Colles fracture with minimal intra-articular involvement. The technique involves a minimal procedure that provides anatomic reduction, fracture fixation, and maintenance of reduction with an adequate method of immobilization.

Keywords: Distal radius fracture, Close reduction, Percutaneous Kirschner wire fixation, Plaster immobilization

INTRODUCTION

Fractures of the distal radius constitute one of the most common skeletal injuries treated by Orthopaedic surgeons. These injuries account for one sixth of all

fractures evaluated in emergency room. They make up 8%–15% of all bony injuries in adults.¹ Vast majority of fractures of distal radius are articular injuries that result in disruption of both radio-carpal and radio-ulnar joints. Better understanding of the spectrum of distal radius fractures has led to changing concepts of treatment.² The

optimal method of obtaining and maintaining an accurate restoration of distal radial anatomy remains a topic of considerable controversy. Wide arrays of techniques, including closed, percutaneous and open methods of reduction and stabilization have been increasingly advocated as successful treatment.³ Fracture of the distal radius was first described by Pouteau (1783) and then by Colles (1814).⁴

Prominent among the concept is that optimal management of distal radius fracture requires differentiation of the relatively low energy metaphyseal injuries from the more violent injuries that disturb the articular surface. The articular injuries are more frequently comminuted and unstable, and therefore less suitable for traditional method of closed reduction and cast application. Without supplemental skeletal fixation, re-displacement of the fracture commonly to its pre-reduction position is inevitable, resulting in malunion, limited range of motion, weakness, pain and post traumatic arthritis.²

Pin-in-plaster relies on ligamentotaxis to maintain the reduction. Yet, excessive traction across the wrist ligaments, which leads to stiffness, can be avoided. Postoperatively, the pin-in-plaster functioned as a neutralization device, preventing fracture collapse and decreasing the biomechanical demands on the internal fixation hardware. This procedure can be performed for both intra-articular and extra-articular fractures.

To analyze the results of distal radial fractures treated with closed reduction and percutaneous pinning at MGM Medical College and LSK Hospital, Kishanganj we studied the functional and anatomical outcome.

METHODS

This was a prospective, comparative observational study. About 79 patients with Distal Radial Fractures presented to MGM Medical College and LSK Hospital, Kishanganj between November 2012 and June 2014 were included in the study. Institutional Ethics Committee permission was taken before starting above study. Individual patient's written consent was taken before enrollment in the study. Out of this number, 61 were treated with closed reduction and percutaneous pinning with k-wires. 53 patients, who fulfilled the inclusion criteria, were included in the study. The patients were followed up for an average period of 6 months. During the follow up, X-rays were taken and the patients were assessed. Anatomical analysis was done using 'Sarmiento's Modification of Lindstorm Criteria' and functional analysis was done using 'Sarmiento et al Modification of Demerit Point System of Gartland & Werley'.

Inclusion criteria

Inclusion criteria were sustained a fracture of the distal

radius (comminuted extra-articular and intra-articular), they were over the age of 18 years, the patients presented within 2 weeks of injury.

Exclusion criteria

Exclusion criteria were open fracture with a Gustillo-Anderson grading greater than 1, fractures which required open reduction / ligamentotaxis (external fixator).

Surgical procedure

The patient was positioned supine on the OT table, with the limb on a side table. Under regional anaesthesia (if unsuccessful then it was converted to general anaesthesia at the discretion of the anaesthetist) the parts were painted and draped. The fracture alignment was achieved by traction – counter traction and the reduction confirmed by the image intensifier. 1.5 or 2 mm K-wire was passed from the radial styloid crossing the fracture site obliquely to exit the dorsoulnar cortex of the radial shaft. Another K-wire was passed either parallel to the first wire or from the dorsoulnar aspect of the distal radius between the 4th and 5th extensor compartments and directed to engage the volar radial cortex of the proximal fragment. The exposed ends of the K-wires were then bent and cut. The pin sites were then dressed. Then a below elbow slab was applied on the volar surface with the wrist in neutral position.

Postoperative protocol

In the post-operative period, the limb was kept strictly elevated for a period of 2 days. Patient was encouraged to begin active finger movements as soon as the effect of anaesthesia wore out. Patient at the end of 2 days asked to mobilize his elbow. At this time the pin sites were inspected and then dressed. If pin sites and mobilization were satisfactory, the patient was then discharged the next day.

Follow-up

Patient was asked to review weekly for pin site inspection and follow up. At the end of four weeks a check X-ray was taken and if satisfactory signs of union were present, the pins were removed as was the slab and patient given a crepe bandage. He was then asked to mobilize the wrist gently at home. If at four weeks union was not satisfactory then, patient was followed up at five and then six weeks. At the end of which, the K-wires were removed and patient was asked to mobilize the wrist. We did not encounter any case not showing satisfactory union at 6 weeks. The patient was reviewed at the end of a month after removal of pins as regard to range of motion of the wrist. If there was no satisfactory range of movements, patient was advised to visit the physiotherapist.

Table 1: Anatomical analysis: (Sarmiento’s modification of Lindstorm criteria).

Result	Residual deformity	Loss of palmar tilt (degrees)	Radial shortening (mm)	Loss of radial deviation (degrees)
Excellent	No/Insignificant	0	<3	5
Good	Slight	1 – 10	3 – 6	5 – 9
Fair	Moderate	11 – 14	7 – 11	10 – 14
Poor	Severe	At least 15	At least 12	>14

The objective evaluation was based on the following range of motion as being minimal for normal function. They were dorsiflexion 45°, palmar flexion– 30°, radial deviation– 15°, ulnar deviation– 15°, pronation– 50°, and supination– 50°.

RESULTS

The following observations were made from the data collected during this study. Fifty three patients with distal radial fractures fitting the inclusion criteria were treated by closed reduction and percutaneous fixation with K-wires and follow up done at regular intervals. Table 2 shows the sex distribution pattern of the study patients. The majority were men (60.4%). Majority of the patients (69.8%) sustained the injury due to fall [Table 2]. The side of involvement was nearly equal and that there was no predominance of the either sides. Majority of the patients (79.24%) did not have associated injuries [Table 2]. In our study, according to AO classification, 31 cases were of Type A, 17 were of Type B and 5 were of Type C [Table 3].

Table 2: Demographic and other characteristics of the study participants.

Sex distribution	Number of cases	Percentage
Male	32	60.4%
Female	21	39.6%
Mode of Injury		
Fall	37	69.8%
RTA	16	30.2%
Side Involved		
Left	25	47.2%
Right	28	52.8%
Associated Injuries		
No	42	79.24%
Yes	11	20.76%

Table 3 shows that 58.5% of patients had Type A fracture pattern, 32.1% had Type B and 9.4% had Type C.

In our study, 69.8% of the cases showed “Excellent”, 24.5% of the cases showed “Good”, 3.8% cases showed “Fair” and only 1.9% cases showed “Poor” results [Table 4].

Table 3: Cases as per AO classification among study participants.

AO type	Number of Cases	Percentage
A	31	58.5%
B	17	32.1%
C	5	9.4%

Table 4: Results of the functional outcome analysis among study participants.

Result	Subjective evaluation	End result
	Number of cases	Number of cases
Excellent	33 (62.2%)	37 (69.8%)
Good	16 (30.2%)	13 (24.5%)
Fair	3 (5.7%)	2 (3.8%)
Poor	1 (1.9%)	1 (1.9%)



Figure 1: Traction was given to study participants.



Figure 2: Placement of first K-wire.

Table 5: Result according to AO classification in the present study.

Result	Type A	Type B	Type C
	Number of cases	Number of cases	Number of cases
Excellent	21	15	1
Good	8	2	3
Fair	1	0	1
Poor	1	0	0

Table 6: Anatomical Outcome (sarmiento’s criteria) in the present study.

Result	Residual deformity	Loss of palmar tilt	Radial shortening	Radial deviation	Mean
Excellent	38 (71.7%)	33 (62.3%)	34 (64.2%)	26 (49.1%)	61.83%
Good	2 (3.8%)	15 (28.3%)	18 (33.9%)	25 (47.1%)	
Fair	13 (24.5%)	5 (9.4%)	1 (1.9%)	2(3.8%)	9.9%
Poor	0	0	0	0	0%

The Anatomical evaluation by Sarmiento’s Criteria showed 33 patients (62.3%) with “Excellent” result, 15 patients (28.3%) with “Good” result and 5 with a “Fair” result [Table 6].

Table 7: Comparison of results between the functional and anatomical outcome in the present study.

Result	Gartland & Werley	Sarmiento
Excellent	69.8%	61.83%
Good	24.5%	28.3%
Fair	3.8%	9.9%
Poor	1.9%	0%

At final follow-up by ‘The Gartland & Werley Criteria for Functional Outcome’ 37 (69.8%) patients had “Excellent” result, 13 (24.5%) had “Good” result, 2 (3.8%) had “Fair” result and 1 (1.9%) had a “Poor” result [Table 7].

Table 8: Complications after procedure in the present study.

	Number of cases	Percentage
Pin Site Infection	9	17%
Pin Loosening	2	3.8%

There were no major complication noted except for pin site infection in 9 (17%) cases and pin loosening in 2 (3.8%) cases [Table 8].



Figure 3: C-arm confirmation of K-wires.

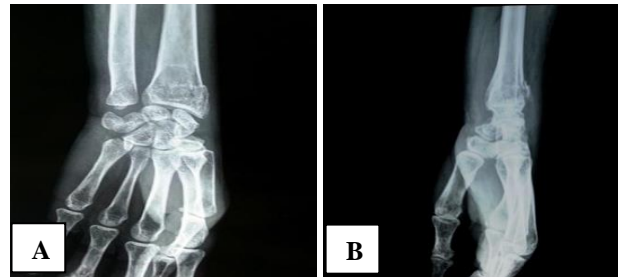


Figure 4 A and 4 B: Preoperative distal radius fracture.

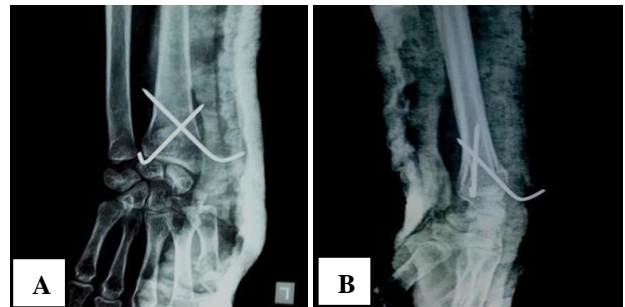


Figure 5 A and 5 B: Immediate postoperative distal radius fracture with percutaneous K-wire fixation.

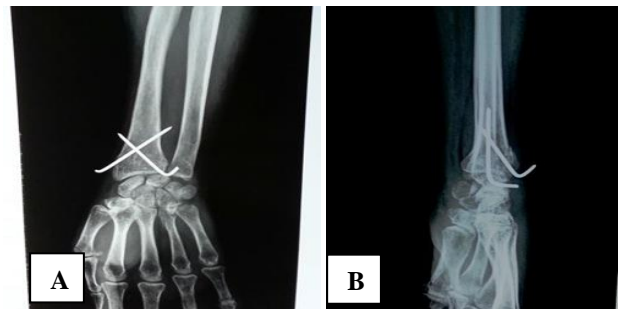


Figure 6 A and 6 B: After 4 weeks of follow-up in case of distal radius fracture with percutaneous K-wire fixation.

Table 9: Functional analysis: (Sarmiento et al modification of demerit point system of Gartland and Werley).

Residual Deformity	
Prominent ulnar styloid	1
Residual dorsal tilt	2
Radial deviation of hand	2 – 3
Point range	0 – 3
Subjective evaluation	
Excellent – No pain, disability or limitation of movement	0
Good – Occasional pain, slight limitation of motion, no disability	2
Fair – Occasional pain, some limitation of motion, feeling of weakness in the wrist, no particular disability if careful, activities slightly restricted	4
Poor – Pain, limitation of motion, disability, activities more or less markedly restricted	6
Objective evaluation	
Loss of dorsiflexion	5
Loss of ulnar deviation	3
Loss of supination	2
Loss of palmar flexion	1
Loss of radial deviation	1
Loss of circumduction	1
Loss of pronation	2
Pain in DRUJ	1
Grip strength – 60% or less of opposite side	1
Point range	0 – 5
End result point ranges	
Excellent	0 – 2
Good	3 – 8
Fair	9 - 20
Poor	21 and above

DISCUSSION

Colles' fracture specifically is defined as metaphyseal injury of cortico-cancellous junction (within 2–3 cm of articular surface) of the distal radius with characteristic dorsal tilt, dorsal shift, radial tilt, radial shift, supination and impaction. Smith's fractures, also referred to as reverse Colles' fracture, have palmar tilt of the distal fragment. Barton's fracture is the displaced intra-articular coronal plane fracture-subluxation of dorsal lip of the distal radius with displacement of carpus with the fragment. Reverse Barton's occurs with wrist in palmar-flexion and involves the volar lip. Chauffer's fracture was described as originally occurring due to backfire of the car starter handles in older models. It involves an intra-articular fracture of radial styloid of variable size.²

Intra-articular component in distal radius fractures usually signifies high-energy trauma occurring in young adults. High-energy injuries frequently cause shear and impacted fractures of the articular surface of the distal aspect of the radius with displacement of the fracture fragments. The fracture pattern most commonly observed in geriatric age group is extra-articular while the high-

energy intra articular type is most frequent in young adult patients.²

Most of the fractures are caused by a fall on the outstretched hand with the wrist in dorsiflexion. The form and severity of fracture of distal radius as well as the concomitant injury of disco-ligamentary structures of the wrist also depend on the position of the wrist at the moment of hitting the ground. The width of this angle influences the localization of the fracture. Pronation, supination and abduction determine the direction of the force and the compression of carpus and different appearances of ligamentary injuries.⁵

Distal radius fractures are the most common type of orthopedic fracture. Some surgeons advocate treatment by manipulation and plaster immobilization.⁶ Many recommend operative intervention as the only methods to obtain anatomical reduction, and some have proposed that the best functional result will only be achieved by obtaining as near an anatomical radiographic result as possible.⁷⁻⁹ Although a study by Young and Rayan found favorable outcomes in low-demand older-aged patients despite deformity, most authors agreed that radial shortening more than 4 mm and radial dorsal angulation

of more than 11° would reduce range of motion of the wrist. Furthermore, wrist pain was the most complaint among those patients.¹⁰⁻¹⁴

The radius initially fails in tension on the volar aspect, with the fracture progressing dorsally where bending forces induce compressive stresses, resulting in dorsal comminution. Cancellous impaction of the metaphysis further compromises dorsal stability. Additional shearing forces influence the injury pattern, resulting in articular surface involvement.³

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, 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.⁸

The most common traditional treatment of distal radius fractures in osteoporotic patients is closed reduction and cast immobilization. Three-point fixation with a well-fitted cast is essential for adequate immobilization. However, extreme flexion should be avoided because carpal tunnel pressure will be increased. This is associated with increased wrist flexion and ulnar deviation when the distal fracture was immobilized with a cast.^{6,8,15} Although cast immobilization alone avoids surgery and complications related to pin placement and pin removal, casts cannot maintain distraction to correct length or control the rotation of the distal fragment when comminution is present.^{6,8,16}

The mean age of patients in our study was 43.9 years (range 19- 72). As age advance, there was osteoporosis and more chance of collapse of the fracture; also the elderly may had a harder time keeping to the rehabilitation protocol. In this study there were marginally more men than women. This might be accounted for by the fact that more involvement of men in outdoor activities, riding vehicles, heavy manual labour and willing to undergo surgical intervention. The mode of injury was fall on outstretched hand in 37 patients and RTA in the other 16 patients. RTAs were generally associated with greater forces and therefore more severe fracture pattern. RTA as a cause for injury was more common in the younger age group in this study. The predominant cause of distal radius fracture as fall on outstretched hand had been comparable to other studies.

11 patients (20.8% of total) in our study had associated injuries. However patients with associated injuries in the same limb were not included in this study, as post op mobilization and thus scoring may had been compromised.

Various studies had suggested that closed reduction and percutaneous pinning may not achieve a satisfactory result. Yet this study suggested that, satisfactory results may be achieved even with minimally comminuted fractures; provided adequate reduction can be achieved with closed reduction.

In our study, 69.8% of the cases showed excellent, 24.5% of the cases showed good, 3.8% cases showed fair and only 1.9% cases showed poor results. The anatomical outcome was evaluated using Sarmiento's modification of Lindstrom's criteria. The results of this study were comparable to the other studies that had been done previously.

Study by Uzzaman et al showed anatomical results (acc. To Sarmiento and Latta's score) was satisfactory in 80% cases of percutaneous K-wire fixation group whereas in conventional group it was 35%.¹⁶ Functional results (Sarmiento and Latta) in above study was satisfactory in 70% of percutaneous fixation group and 30% in conventional group. All these anatomical and functional results correlate with the study of Max Scheck – where satisfactory results were in 75% case⁴ and Gartland and Werley's series – where the satisfactory result was 70%.

Loss of reduction usually happens after 2 weeks of casting despite a perfect initial anatomic reduction.¹¹ Gartland and Werley obtained a 68.3% satisfactory result, and Sarmiento et al reported an 82% satisfactory result treated with the casting technique.¹⁸ Spira and Weigl reported a 51.4% unsatisfactory result with reduction and use of cast in the treatment of comminuted fracture of distal radius with articular involvement.¹⁹ Closed reduction and percutaneous pinning relies on intrafocal manipulation and pinning or manual traction, reduction, and pinning, to hold the fracture in an appropriate anatomic alignment. Clancey reported a 96.4% satisfactory result in 30 patients treated with percutaneous pinning if the articular surface of the radius was not comminuted into more than two fragments.²⁰

The pin-in-plaster technique is a combination of percutaneous pinning, casting, and external fixation. The potential biological advantage is that it allows treatment of the fracture with minimal manipulation and devascularization of the bone.⁸

Because K-wire fixation seldom provide sufficient stability to allow for early motion and often necessitate use of a cast or splint, the addition of two K-wires incorporated into the pin-in-plaster could increase stability of the fracture fixation. Extreme wrist flexion and ulnar deviation could be avoided with this technique.

Percutaneous pinning with Kirschner wire is simple, minimally invasive, and prevents re-displacement of fracture fragments but it is limited to the extra-articular Colles fracture or fractures with minimal intra-articular involvement.²¹ At present arthroscopic reduction is

available for the management of distal radius fractures, which claim better results than the conventional treatment of such injuries.²² There are few disadvantages of percutaneous pinning like the fear of pin tract infection, besides another minor procedure is required for their removal.²³

The comparison between the results of the functional outcome and the anatomical outcome, confirmed what other studies had previously shown, that the functional result need not mirror the anatomical evaluation.²⁴

CONCLUSION

During the period between November 2012 and June 2014, 50 patients with distal radius fracture were treated with closed reduction and percutaneous pinning and followed up for an average period of 6 months at the MGM Medical College and LSK Hospital, Kishanganj. The age group of the patients was from 19 to 72 years with the average age being 41.4 years with no predominance of either left or right side. In our study, according to AO classification, 31 cases were of Type A, 17 were of Type B and 5 were of Type C. The anatomical evaluation by Sarmiento's Criteria showed 33 patients with excellent result, 15 patients with good result and 5 with a fair result. At final follow-up by 'The Gartland and Werley criteria for functional outcome' 37 patients had excellent result, 13 had good result, 2 had fair result and 1 had a poor result. There were no major complication noted except for pin site infection in 9 cases and pin loosening in 2 cases. The results of our study were in accordance with standard studies of distal radius fractures treated with closed reduction and percutaneous pinning. Kirschner wire fixation is cheaper and quicker to perform.

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Ethical approval: The study was approved by the institutional ethics committee

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