



ANALYSIS OF THE FUNCTIONAL OUTCOME IN COMMINUTED DISTAL RADIUS FRACTURE TREATED BY CLOSED REDUCTION THROUGH DISTRACTOR AUGMENTED WITH K-WIRE

Orthopaedics

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ABSTRACT

Introduction: In clinical practice, distal radius fractures are the most frequent fractures of the upper extremity. K-wire fixation is a straightforward, minimally intrusive method for maintaining the reduction of extra- and intra-articular fractures. **Methodology:** This prospective study was carried out at the Department of Orthopaedic Surgery, Hind Institute of Medical Sciences Barabanki. After obtaining ethical clearance and informed consent, 40 patients of age more than 18 years of either gender with Intraarticular or Open or comminuted distal radius fractures were enrolled as per inclusion-exclusion criteria. The functional outcome was evaluated using the quick DASH scoring system after Distractor removal, and the radiological outcome was assessed using Sarmiento's modification of the Lindstrom criteria. **Results:** The majority of the patients were aged between 36-50 years [16(40.00%)], followed by 21-35 years [14(35.00%)]. The majority of the patients were male [24(60.00%)]. The mean Mayo score of enrolled patients was recorded [75.25±16.81]. The majority of the patients showed good results [13(32.50%)], followed by poor results [11(27.50%)]. A short duration of surgery in patients was noted as an excellent outcome [2.67±1.37] [$p=0.0071^*$]. The majority of the patients had an excellent functional outcome for palmar [81.67±3.73], dorsiflexion [71.67±3.73], supination [80.00±0.00] and pronation [71.67±3.73]. **Conclusion:** Based on the findings of this study, the distractor augmented with the k-wire technique showed excellent radiological and functional outcomes. Thus, we can say that the distractor augmented with K-wire fixation of comminuted distal radius fracture is an effective method for preventing re-displacement.

KEYWORDS

Comminuted Distal Radius Fracture, Closed Reduction, K-Wire, Distractor Augmented

INTRODUCTION

Fracture of the distal end of the radius is one of the most frequent fractures. Rapid socioeconomic developments in emerging countries, defined by urbanization, contribute to an increased reliance on motor vehicles as a mode of transportation. This causes an increase in all types of injuries, particularly complicated fractures of the limbs. In the past decade, the incidence of distal radius fractures that are intra-articular and comminuted has grown dramatically.¹ These fractures have the potential to severely impair the mechanical function of the hand. Closed reduction and the application of plaster typically result in an early loss of reduction and a delayed collapse. In the majority of cases, a positive functional outcome is attainable through the skilled and intelligent application of various therapeutic techniques. However, the majority of surgeons in developing nations encounter numerous obstacles in their pursuit of good results.²

In clinical practice, distal radius fractures are the most frequent fractures of the upper extremity. Distal radius fractures have been a topic of discussion for almost two centuries and account for around 17 percent of all fractures. Osteoporosis affects older women more frequently than any other population.³

However, the pattern of injury was determined by the position of the hand, the quality of the bone, the impact surface, and the velocity of the injury. Distal radius fractures result in damage to the triangular fibrocartilage complex (TFCC) and the interosseous carpal ligaments. Chondral lesions are also a risk factor for arthritic changes. External fixators are advantageous for distal radius fractures because they are straightforward, cost-effective, and can be administered under local anaesthesia with few post-operative complications.⁴ The treatment of

the majority of distal radial fractures is conservative (non-operatively). This often involves reduction under anaesthesia of a dislocated fracture and immobilization of the forearm in a plaster cast or brace for approximately six weeks.

Distal radius fractures are a major medical condition. The incidence of these injuries is anticipated to rise as the population ages. The optimal treatment of distal radius fractures continues to be discussed by orthopaedic profession. Closed reduction and pin fixation with or without external fixation are common surgical procedures for unstable distal radius fractures. There are reports that compare variations and forms of pinning/external fixation. Numerous other researchers have attempted to compare various forms of CRIF, internal fixation, and open reduction and internal fixation (ORIF) with dorsal, volar, and fragment-specific techniques.⁵

The majority of research on percutaneous pinning focuses on the significant residual stiffness of the hand and wrist. The acute palmar flexion of the wrist during surgical immobilization was cited as the primary cause of stiffness. The benefits of Dorsal spanning plate fixation have been described as an effective treatment option for unstable comminuted distal radius fractures, bilateral wrist fractures with metaphyseal bone loss or diaphyseal extension, and complex injuries necessitating extensive soft tissue and bone reconstruction.⁶ In addition, this approach permits early weight bearing and transfer in patients with pelvic and lower extremity fractures who have had multiple traumas. Under the extensor tendons of the second or third metacarpal, the pin is temporarily affixed. After fracture repair is established at around 12 weeks, the plate is removed and wrist motion

and strengthening therapy is commenced. Surgical treatment aims to restore normal wrist kinematics and anatomic reduction of the distal radius.⁷⁻⁹

K-wire fixation is a straightforward, minimally intrusive method for maintaining the reduction of extra- and intra-articular fractures. For patients with displaced distal radius fractures, the American Academy of Orthopaedic Surgeons (AAOS) clinical recommendations moderately suggest anatomically stable surgical fixation as opposed to cast fixation, followed by early wrist motion. The radiological parameter radial length has been demonstrated to correlate with functional results.¹⁰

In this study, the evaluation of therapeutic interventions covered the initial anatomical restoration obtained by the compared procedures. Still, the focus was on the final outcome regarding residual deformity, functional and clinical outcome, and the presence of comorbidities.

MATERIAL AND METHODS

This prospective study was carried out at the Department of Orthopaedic Surgery, Hind Institute of Medical Sciences Barabanki. After obtaining ethical clearance and informed consent, 40 patients of age more than 18 years of either gender with intraarticular or open or comminuted distal radius fractures were enrolled as per inclusion criteria. However, patients with pathological fractures, neurovascular deficit, uncontrolled diabetes mellitus and the patient is not willing for surgery were excluded as per exclusion criteria.

Functional Outcome:

The functional outcome of the patients with fracture of the comminuted distal radius fixed with Distractor with K-wire technique was evaluated using the **quick DASH scoring system after Distractor removal**.

Radiological Outcome:

The radiological outcome of the patients with fracture of the distal radius fixed using the Distractor with K-wire technique was evaluated using Sarmiento's modification of the Lindstrom criteria. The assessment was based on the residual radial angulation, radial shortening and the loss of radial inclination.

Statistical Analysis:

Data were entered in Microsoft Excel and analyzed using statistical software SPSS version 26 (SPSS Inc., Chicago, IL, USA). The continuous variables were evaluated by mean (standard deviation) or range value when required. The dichotomous variables were presented in number/frequency and were analyzed using the Chi-square test. For comparison of the means between the two groups, analysis by ANOVA test was used. A p-value of <0.05 or 0.001 was regarded as significant.

RESULTS

The majority of the patients were aged between 36-50 years [16(40.00%)], followed by 21-35 years [14(35.00%)]. Statistically, a non-significant difference was observed in age distribution. Male dominance was observed [24(60.00%) $p=0.3687$]. The majority of the patients had injuries on their right side [24(60.00%)], followed by injuries on the left side [15(37.50%)]. Statistically, a significant difference was observed in the side of injury [$p=0.0011^*$] [Table-1].

Most of the patients had B2 distraction injuries [14(35.00%)], followed by C2 displacement injuries [12(30.00%) $p=0.0177^*$] [Table-2]. The mean duration of surgery was recorded [5.60±4.04] of enrolled patients. The functional outcome showed a mean value of [64.88±18.29] in the duration of the palmar movement. At the same time, the mean value for supination was [54.63±21.92], dorsiflexion was [52.75±52.75], and pronation was [43.50±19.94] in enrolled patients. The mean radial inclination was noted higher in patients [13.13±5.44], followed by radial height [5.23±3.37]. At the same time, the radiological outcome showed that most patients had no arthritis [28(70.00%)]. Statistically, a non-significant difference was observed in radiological outcomes [$p=0.0679$].

The mean Mayo score of enrolled patients was recorded [75.25±16.81] [Figure-1]. The majority [$p<0.0001^*$] of the patients showed good results [13(32.50%)], followed by poor results [11(27.50%)] [Figure-2]. Most patients had no complications [29(72.50%)]. At the same time, malunion stiffness was observed in [6(15.00%)] patients. Statistically, a significant difference was observed in complication

[$p<0.0001^*$]. A short duration of surgery in patients was noted as an excellent outcome [2.67±1.37], whereas a longer time of surgery in patients was noted as a poor outcome [8.73±4.02] [$p=0.0071^*$]. The majority of the patients had an excellent functional outcome for palmar [81.67±3.73], dorsiflexion [71.67±3.73], supination [80.00±0.00] and pronation [71.67±3.73] [Figure-2]. The majority of the patients showed excellent radiological outcomes in volar tilt [10.67±0.75], radial height [10.67±0.75] and radial inclination [22.00±1.41] [Figure-3]. Statistically, a significant difference was observed in functional and radiological parameters with respect to the outcome [Table-3 and 4].

DISCUSSION

Fracture of the distal radius is among the most prevalent fractures. Rapid socioeconomic changes in developing nations, as exemplified by urbanisation, contribute to an increased reliance on automobiles as a form of transportation. This produces an increase in all types of injuries, notably complicated fractures of the limbs. The incidence of distal radius fractures that are intra-articular and comminuted has increased dramatically during the past decade¹. These fractures have the ability to affect the hand's mechanical function significantly. Typically, closed reduction and the application of plaster result in an early loss of reduction and a delayed collapse. In most situations, a positive functional outcome can be achieved through applying numerous treatment procedures with competence and intelligence. In spite of this, the majority of surgeons in underdeveloped nations face significant challenges in their pursuit of excellence². In clinical practice, distal radius fractures are the most common upper extremity fractures. Approximately 17 percent of all fractures are distal radius fractures, which have been discussed for nearly two centuries. Older women are more frequently affected by osteoporosis than any other population³. K-wire fixing is a simple, less invasive technique for preserving the reduction of extra- and intra-articular fractures. The American Academy of Orthopaedic Surgeons (AAOS) clinical recommendations moderately advise anatomically stable surgical fixation as opposed to cast fixation, followed by early wrist motion for patients with displaced distal radius fractures. It has been proven that the radiological parameter radial length correlates with functional outcome¹⁰. In this study, the evaluation of therapeutic interventions covered the initial anatomical restoration obtained by the compared procedures. Still, the focus was on the outcome in terms of residual deformity, functional and clinical outcome, and the presence of comorbidities.

In this study, the patient's mean age was recorded [40.90±12.92]. The majority of the patients were aged between 36-50 years [16(40.00%)], followed by 21-35 years [14(35.00%)]. The majority of the patients were male [24(60.00%)], followed by the female [16(40.00%)]. Similarly, another study observed the mean age of patients was [36.4±8.6]. The majority of the patients [38(95.00%)] were aged between <50 years. Male dominance was also observed [34(85.00%)].¹¹ In another study, they included 59 patients, of which 39 (66%) were females, and 20 (34%) were males. The mean patient age was 56 years. 56% of the population was 65 years old, whereas 44% was 65. Age and gender did not affect the loss of radiological parameters following the k-wire.¹²

This study, the majority of the patients had road traffic accidents [31(77.50%)], followed by falls on their outstretched hands [9(22.50%)]. In contrast, most of the patients had injuries from falling down [26(65.0%)], followed by falling down from height [10(25.0%)] and road traffic accidents [4(10.0%)].¹¹ In the present study, the majority of the patients had injuries on their right side [24(60.00%)], followed by injuries on the left side [15(37.50%)]. Only 1 patient had a bilateral injury. In contrast, Ali AH et al. noted patients with left-side injuries [26(65%)] followed by right-side injuries [14(35%)].¹¹ Similarly, Raza A et al. noted most of the patients had right side injury [28(56%)], followed by left side [22(44%)].¹³

In the present study, the majority of the patients had B2 distraction injuries [14(35.00%)], followed by C2 displacement injuries [12(30.00%)], C3 injuries [11(27.50%)], B3 injuries [2(5.00%)] and C1 injury [1(2.50%)]. In contrast, Ali AH et al. noted C3 type of injuries [20(50%)], followed by C2 [14(35%)]. 2 patients with C1, B3 and B2 were also noted.¹¹ Further, Kurup H et al. showed most of the patients with A3 [n=18] class according to the AO classification of fracture, followed by C1, C2, A2 and C3.¹⁴ No patients were in class B. The AO classification is the most comprehensive and practical approach for classifying distal radial fractures with the substantial

interobserver agreement.^{13,15} In this study, the mean duration of surgery was recorded [5.60±4.04] of enrolled patients. In contrast, Ali AH et al. noted that the majority of the patients had surgery within 1-3 days [26(65.00%)]. Only, [14(35.0%)] were operated on within the first day of injury.¹¹

In the present study, the functional outcome showed a mean value of [64.88±18.29] in the duration of the palmar movement. At the same time, the mean value for supination was [54.63±21.92], dorsiflexion was [52.75±52.75], and pronation was [43.50±19.94] in enrolled patients. In the present study, the mean radial inclination was noted higher in patients [13.13±5.44], followed by radial height [5.23±3.37] and volar tilt [2.79±4.47]. At the same time, the radiological outcome showed that most patients had no arthritis [28(70.00%)], while 12 patients had arthritis. Patel S et al. noted the score improved after six weeks, with 27 patients experiencing no pain; the average Mayo score of the group was 24.5.¹⁶ The average Mayo score for ROM was 23.3 in 21 patients who exhibited wrist and forearm movement similar to the opposite side. Twenty-one patients had difficulty returning to their pre-injury work status, with an average Mayo score of 23.5. When compared to the opposite side, 20 patients had greater than 90% grip strength, and their average Mayo score was 21.2. The present study recorded the mean Mayo score of enrolled patients [75.25±16.81]. Similarly, Patel S et al. observed a mean final mayo score of [84.7±9.3].¹⁶ Suryawanshi V observed excellent results as the patients were able to adapt to their household and occupational activities.¹⁷ In contrast, Suryawanshi V evaluated functional and radiological outcomes by Disability of Arm, Shoulder and Hand (DASH) scoring, and a score of [45.31] was noted.¹⁷ Non-surgical therapy for distal radius fractures was studied by Okamura A et al., and Li J et al. both agreed that these treatments were ineffective for distal radius fractures. They had unsatisfactory radiographic and functional results.¹⁸⁻¹⁹ Walton et al. did a study in which they employed intramedullary and intrafocal K-wire implantation to treat 103 patients with unstable distal radius fractures.²¹ The radiological and functional scores were determined using a modified Lidstrom grading system. It was proved that K-wire fixation for distal radius fractures is an effective and safe technique.¹

In this study, the majority of the patients showed good results [13(32.50%)], followed by poor results [11(27.50%)], fair [10(25.00%)] and excellent [6(15.00%)]. According to Patel S et al. they observed the majority of the patients with good results, followed by excellent results.¹⁶ Patients with old age may have weak bones, but their prognosis is unaffected. Further, Ali AH et al. noted excellent outcomes in most patients. At the same time, poor outcomes were not noted in their study. Using the k-wire form of fixation, distal radius fractures would not incur a significant loss of fracture position restitution upon removal of the pin.¹¹ Variables like gender, AO type, fracture type, age, and duration of wire fixation did not affect the quality of treatment.²¹

In this study, most patients had no complications [29(72.50%)]. At the same time, Malunion stiffness was observed in [6(15.00%)] patients, followed by pin loosening [2(5.00%)], stiffness [2(5.00%)] and pin site infection and loosening [1(2.50%)]. Similar to the present study, Ali AH et al. observed malunion and stiffness in most of the patients [5(12.5%)], followed by complex regional pain syndrome [4(10.0%)] and pin tract infection [2(5.0%)].¹¹ A study by Suryawanshi V showed that most patients with pin tract infections exhibited superficial radial neuropathy. At the six-week follow-up, seven patients (35%) in this group had finger stiffness, which gradually resolved in five patients by twelve weeks, and by the end of twelve weeks, only two patients had mild finger stiffness.¹⁷ Two patients (10%) experienced shoulder stiffness unrelated to the surgical procedure, gradually improving with shoulder mobilisation exercises after nine weeks. Also, two patients (10%) developed an infected needle site. In one instance, antibiotics cured the infection without further complications. In another patient, the infection worsened, forcing the removal of the K-wire in the third week. Furthermore, Raza A et al. observed only [5(10%)] patients with infection.¹³

In the present study, a short duration of surgery in patients was noted as an excellent outcome [2.67±1.37], whereas a longer time of surgery in patients was noted as a poor outcome [8.73±4.02]. In between, good and fair outcomes had a duration of injury [4.92±3.89] and [4.80±3.06], respectively. Most of the patients had an excellent functional outcome for palmar [81.67±3.73], dorsiflexion

[71.67±3.73], supination [80.00±0.00] and pronation [71.67±3.73]. Also, patients showed excellent radiological outcomes in volar tilt [10.67±0.75], radial height [10.67±0.75] and radial inclination [22.00±1.41]. A study by Ali AH et al.¹¹ showed that the proportion for the external fixation group was 85% (70% scored excellent, and 15% scored good).

Most of the prior studies support these radiological results²²⁻²⁵. 97.5% of patients had acceptable functional outcomes as measured by the Gartland & Werley score (62.5% excellent, 35.5% good) compared to 75% of patients in the external fixation group (60% excellent, 15% good). Many studies observed similar results.²⁶⁻²⁸ According to various studies, fixing the percutaneous K wire in the distal radius surgery led to satisfactory functional and radiological outcomes.²⁶⁻²⁹

CONCLUSION

Based on the findings of this study, the distractor augmented with the k-wire technique showed excellent radiological and functional outcomes. Thus, we can say that the distractor augmented with K-wire fixation of comminuted distal radius fracture is an effective method for preventing re-displacement.

Table-1: Demographical profile of the enrolled patients.

DEMOGRAPHICAL PROFILE	No.	%	P-VALUE
AGE			
21-35	14	35.00%	X=0.7261 p=0.6955
36-50	16	40.00%	
51-66	10	25.00%	
GENDER			
Female	16	40.00%	X=0.8081 p=0.3687
Male	24	60.00%	
MODE OF INJURY			
FOOSH	9	22.50%	X=6.545 p=0.0105*
RTA	31	77.50%	
SIDE OF INJURY			
RIGHT	24	60.00%	X=13.69 p=0.0011*
LEFT	15	37.50%	
B/L	1	2.50%	
DURATION TO SURGERY (days)			
MEAN±SD	5.60±4.04		

Table-2: AO Type of fractures in enrolled patients

A.O. TYPE	No.	%	P-VALUE
B2	14	35.00%	X=11.95 p=0.0177*
B3	2	5.00%	
C1	1	2.50%	
C2	12	30.00%	
C3	11	27.50%	

Table-3: Functional outcome with respect to the outcome of enrolled patients

FUNCTION OUTCOME	OUTCOME				P-VALUE
	EXCELLENT	GOOD	FAIR	POOR	
Palmar	81.67±3.73	72.69±6.39	71.00±11.36	40.91±14.43	F=28.96 p<0.0001*
Dorsi Flexion	71.67±3.73	58.46±10.26	55.00±10.25	33.64±7.71	F=27.73 p<0.0001*
Supination	80.00±0.00	61.15±10.77	63.00±13.27	25.45±11.57	F=40.27 p<0.0001*
Pronation	71.67±3.73	50.00±13.59	43.00±11.87	43.50±19.94	F=6.006 p=0.0020*

Table-4: Radiological outcome with respect to the outcome of enrolled patients

RADIOLOGICAL OUTCOME	OUTCOME				P-VALUE
	EXCELLENT	GOOD	FAIR	POOR	
Volar Tilt	10.67±0.75	3.31±1.68	1.60±1.96	1.40±3.67	F=22.93 p<0.0001*
Radial Height	10.67±0.75	5.54±3.10	2.30±2.33	4.55±0.50	F=19.10 p<0.0001*
Radial Inclination	22.00±1.41	12.69±5.25	9.80±2.09	11.82±3.86	F=13.71 p<0.0001*

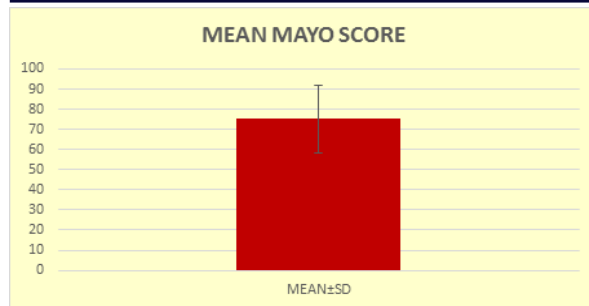


Figure-1: Mayo Score of enrolled patients



Figure-2: Outcome of enrolled patients

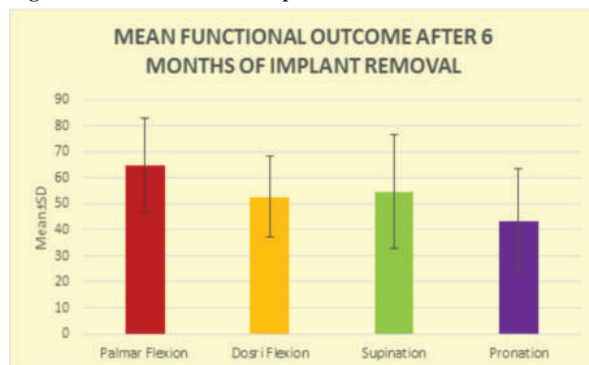


Figure-3: Functional outcome after 6 months of implant removal of enrolled patients

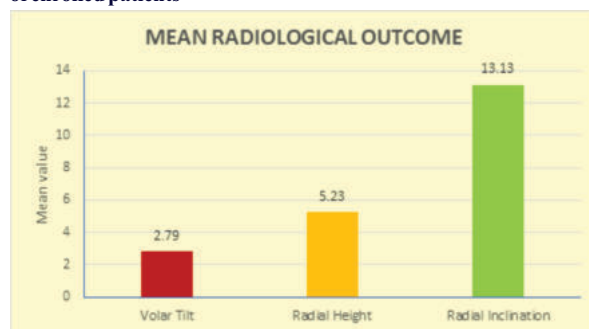


Figure-4: Mean radiological outcomes of enrolled patients.

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