

Original Research Article

Functional outcome of displaced distal radius fractures treated with the five K-wire fixation technique: a prospective observational study

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ABSTRACT

Background: Distal radius fractures are among the most frequently encountered fractures in orthopaedic practice and can result in significant impairment of wrist function if inadequately managed. Although several surgical techniques are available for unstable distal radius fractures, the optimal fixation method remains controversial. The five K-wire fixation technique is a minimally invasive, cost-effective method that aims to provide stable fracture fixation while preserving soft tissue integrity and fracture biology. The present study evaluated the functional outcome of displaced distal radius fractures treated using this technique.

Methods: A prospective observational study was conducted over one year among 30 adult patients with displaced intra-articular distal radius fractures managed with the five K-wire fixation technique. Fractures were classified according to the Frykman classification. Functional outcome was assessed using the Modified Mayo Wrist Score (MMWS) at 6 weeks, 3 months and 6 months. Fracture union, wrist range of motion and postoperative complications were also evaluated. Statistical analysis was performed using SPSS version 26.0 and a p value <0.05 was considered statistically significant.

Results: The mean age of the participants was 44.13±14.22 years and 56.7% were male. Fall on an outstretched hand was the most common mechanism of injury (53.3%). Fracture union was achieved within 6–8 weeks in 86.7% of patients. The mean modified mayo wrist score improved significantly from 65.50±7.97 at 6 weeks to 76.60±8.77 at 3 months and 85.03±8.87 at 6 months (p<0.001). At final follow-up, 46.7% of patients had excellent functional outcomes, 36.7% had good outcomes and 16.7% had fair outcomes. Pin tract infection was the most frequent complication, occurring in 10% of patients.

Conclusions: The five K-wire fixation technique provides satisfactory fracture union, significant functional improvement, acceptable wrist mobility and a low complication rate. It represents a safe, minimally invasive and economical treatment option for displaced distal radius fractures, particularly in resource-constrained healthcare settings.

Keywords: Distal radius fracture, Kirschner wire, Modified mayo wrist score, Percutaneous fixation

INTRODUCTION

Distal radius fractures are among the most common fractures encountered in orthopaedic practice, accounting for approximately one-sixth of all fractures presenting to emergency departments. They affect individuals across all age groups and are associated with considerable morbidity

because of their impact on wrist function, grip strength and activities of daily living.

The incidence demonstrates a bimodal distribution, occurring predominantly in younger adults following high-energy trauma and in elderly individuals, particularly postmenopausal women, after low energy falls associated

with osteoporosis.¹⁻³ The primary objective in managing distal radius fractures is to restore normal wrist anatomy and biomechanics while facilitating early functional recovery. Failure to achieve adequate reduction may result in malunion, persistent pain, reduced range of motion, diminished grip strength, instability and post-traumatic osteoarthritis, ultimately compromising long-term functional outcomes.^{4,5}

Restoration of radial height, radial inclination and volar tilt is therefore considered essential for optimal clinical results. Treatment strategies for distal radius fractures have evolved substantially over the past few decades. Stable extra-articular fractures are generally managed conservatively with closed reduction and cast immobilization, whereas unstable or intra-articular fractures frequently require surgical intervention to maintain reduction and prevent secondary displacement. Currently available surgical options include percutaneous Kirschner wire fixation, external fixation, dorsal or volar plating and combined fixation techniques. Although volar locking plates provide rigid fixation and permit early mobilization, they are associated with greater soft tissue dissection, implant-related complications, tendon irritation and increased treatment costs.⁶⁻⁹

Percutaneous Kirschner wire fixation remains an attractive alternative because it is minimally invasive, technically straightforward and cost-effective. By preserving the fracture haematoma and limiting soft tissue disruption, it promotes biological fracture healing while providing satisfactory stability in appropriately selected fractures. Nevertheless, conventional K-wire configurations may not adequately resist collapse or rotational instability in certain fracture patterns, prompting modifications in wire placement to improve construct stability.^{10,11}

The five K-wire fixation technique, described by Vasudevan and Lohith, was developed to provide a standardized percutaneous fixation construct in which each wire serves a specific biomechanical purpose to maintain reduction and resist deforming forces. The technique aims to achieve stable fixation without extensive surgical exposure while maintaining the biological advantages of percutaneous management. Because of its simplicity, affordability and minimal soft tissue injury, it may be particularly valuable in resource-limited healthcare settings.¹²

Although encouraging results have been reported with this technique, published evidence remains limited, particularly from prospective observational studies evaluating functional recovery using validated outcome measures. Further clinical evaluation is therefore required to determine its effectiveness and safety in routine orthopaedic practice. The present study was undertaken to evaluate the functional outcome of displaced distal radius fractures treated with the five K-wire fixation technique using the modified mayo wrist score, while also assessing

fracture union, restoration of wrist motion and postoperative complications.

METHODS

A prospective observational study was conducted over one year in the Department of Orthopaedics of a tertiary care teaching hospital in western India after obtaining approval from the Institutional Ethics Committee. The study adhered to the ethical principles outlined in the Declaration of Helsinki. Written informed consent was obtained from all participants before enrolment.

Adult patients presenting with displaced intra-articular distal radius fractures who fulfilled the eligibility criteria were consecutively enrolled. A total of 30 patients underwent treatment using the five K-wire fixation technique and completed the scheduled follow-up.

The sample size was calculated using the standard deviation of the modified mayo wrist score reported in a previous study, assuming a 95% confidence level, 80% study power and 10% anticipated attrition. The minimum calculated sample size was 26; therefore, 30 patients were included.

Inclusion criteria

Age ≥ 20 years with closed distal radial physis. Displaced intra-articular distal radius fracture, injury presenting within two weeks, closed fracture, willingness to provide written informed consent.

Exclusion criteria

Ipsilateral fractures involving the same upper limb. Open fractures, associated neurovascular injury, pathological fractures, medical conditions likely to interfere with fracture healing or rehabilitation.

All patients underwent detailed history taking, clinical examination and neurovascular assessment. Standard posteroanterior and lateral radiographs of the wrist were obtained. Fractures were classified according to the Frykman classification. Routine preoperative investigations were performed according to institutional protocol. All procedures were performed under regional or general anaesthesia under fluoroscopic guidance by experienced orthopaedic surgeons using a standardized five K-wire fixation technique.

Following closed reduction, five Kirschner wires were inserted sequentially to stabilize different fracture fragments and maintain radial height, alignment and distal radioulnar joint stability. Adequate reduction and wire placement were confirmed using an image intensifier. The protruding wire ends were bent externally, sterile dressings were applied and the wrist was immobilized using a below-elbow cock-up splint. Finger mobilization was encouraged immediately after surgery. Patients were reviewed at

regular intervals for wound assessment, pin-site care, radiological evaluation and supervised rehabilitation. Wrist mobilization was initiated according to fracture healing and pain tolerance. K-wire removal was performed after radiological evidence of satisfactory union as per institutional protocol.

Outcome measures

The primary outcome was functional recovery assessed using the MMWS at 6 weeks, 3 months and 6 months.

The secondary outcomes included

Time to radiological union, wrist range of motion (dorsiflexion, palmar flexion, pronation and supination), Maintenance of fracture reduction and postoperative complications, including pin tract infection, pin loosening and wrist stiffness.

Radiological union was defined as bridging trabeculae across at least three cortices on standard radiographs, together with the absence of tenderness at the fracture site.

Statistical analysis

Data were entered into Microsoft Excel and analysed using SPSS version 26.0. Continuous variables are presented as mean±standard deviation, whereas categorical variables are expressed as frequency and percentage. Changes in MMWS during follow-up were analysed using repeated-measures analysis with appropriate post hoc comparisons. Associations between categorical variables were assessed using the Chi-square or Fisher's exact test. A p value <0.05 was considered statistically significant.

RESULTS

A total of 30 patients with displaced intra-articular distal radius fractures underwent fixation using the five K-wire technique and completed the 6-month follow-up. No patient was lost to follow-up. The mean age of the study population was 44.13±14.22 years. Most patients belonged to the 35–49-year age group (36.7%). There were 17 (56.7%) males and 13 (43.3%) females. The right wrist was involved in 18 (60.0%) patients. Fall on an outstretched hand (FOOSH) was the commonest mechanism of injury (53.3%), followed by road traffic accidents (26.7%) (Table 1).

According to the Frykman classification, Type III and Type VII fractures were the most frequently encountered fracture patterns (20.0% each). Type I fractures were the least common (6.7%) (Table 2). Radiological union was achieved within 6–8 weeks in 26 (86.7%) patients, whereas the remaining four patients achieved union between 9 and 11 weeks (Table 3). The modified mayo wrist score showed a progressive and statistically significant improvement during follow-up ($p<0.001$). The mean score increased from 65.50±7.97 at 6 weeks to

76.60±8.77 at 3 months and 85.03±8.87 at 6 months (Table 4).

Table 1: Baseline demographic and injury characteristics of study participants (n=30).

Variables	N	%
Mean age±SD (in years)	44.13±14.22	
Gender		
Male	17	56.7
Female	13	43.3
Involved site		
Right side	18	60
Left side	12	40
Mechanism of injury		
Fall on outstretched hand	16	53.3
Road traffic accident	8	26.7
Fall from height	4	13.3
Sports injury	2	6.7

Table 2: Distribution of fractures according to Frykman classification (n=30).

Frykman type	N	%
I	2	6.7
II	3	10
III	6	20
IV	3	10
V	4	13.3
VI	3	10
VII	6	20
VIII	3	10

Table 3: Time to radiological fracture union (n=30).

Time to union	N	%
6-8 weeks	26	86.7
9-11 weeks	4	13.3

Table 4: Modified Mayo Wrist Score during follow-up.

Follow up	Mean±SD	P value
3 months	76.60±8.77	<0.001
6 weeks	65.50± 7.97	<0.001
6 months	85.03±8.87	<0.001

Table 5: Functional outcome at final follow-up according to modified mayo wrist score (n=30).

Outcome	Score	N	%
Excellent	91-100	14	46.7
Good	80-90	11	36.7
Fair	65-79	5	16.7
Poor	<65	0	0

At the final follow-up, 14 (46.7%) patients achieved excellent functional outcomes, 11 (36.7%) had good outcomes and 5 (16.7%) had fair outcomes. No patient had a poor outcome (Table 5). At 6 months, satisfactory restoration of wrist motion was observed (Table 6). Most patients (83.3%) experienced no postoperative complications. Pin tract infection occurred in 3 (10.0%) patients, while wrist stiffness and pin loosening were each observed in one patient (3.3%) (Table 7).

Table 6: Wrist range of motion at final follow-up (6 months).

Wrist movement	Mean	SD
Dorsi flexion	66.67	8.83
Palmer flexion	64.13	8.36
Supination	73.57	7.95
Pronation	75.50	8.56

Table 7: Postoperative complications (n=30).

Complications	N	%
Pin tract infection	3	10
Wrist stiffness	1	3.3
Pin loosening	1	3.3

DISCUSSION

The present prospective observational study evaluated the functional outcome of displaced distal radius fractures treated with the five K-wire fixation technique. Overall, the findings demonstrated satisfactory fracture union, progressive improvement in wrist function, restoration of range of motion and a low incidence of postoperative complications. These results support the use of this minimally invasive technique as an effective treatment option for appropriately selected unstable distal radius fractures. The mean age of the study population was 44.13 ± 14.22 years, with a slight male predominance. This demographic profile is consistent with previous epidemiological studies, which have reported that distal radius fractures commonly affect younger males following high-energy trauma and older females with osteoporotic low-energy injuries.¹⁻³ the relatively younger age observed in the present study may reflect the higher proportion of trauma-related injuries in the study population. Fall on an outstretched hand was the predominant mechanism of injury, accounting for more than half of all cases. Similar observations have been reported in previous studies, confirming FOOSH as the most frequent cause of distal radius fractures irrespective of treatment modality.⁴ This finding emphasizes the importance of preventive strategies aimed at reducing fall-related injuries.

Radiological union was achieved within 6–8 weeks in most patients, indicating that the five K-wire construct provides adequate stability while preserving the biological environment necessary for fracture healing. The minimally invasive nature of the procedure minimizes periosteal

stripping and maintains fracture haematoma, both of which contribute to early bone union. Comparable healing times have been described following percutaneous pinning techniques in previous clinical studies.^{5,6}

A progressive improvement in modified mayo wrist score was observed throughout the follow-up period, with statistically significant improvement at six months. More than four-fifths of patients achieved excellent or good functional outcomes at final follow-up. These findings are comparable with other studies, who also demonstrated favourable functional recovery following five K-wire fixation using validated wrist scoring systems.⁷⁻⁹ the gradual improvement in function is likely attributable to stable fracture fixation, preservation of soft tissues and structured postoperative rehabilitation. The mean wrist movements recorded at the final follow-up indicated satisfactory restoration of dorsiflexion, palmar flexion, pronation and supination.

Restoration of functional range of motion is an important determinant of patient satisfaction following distal radius fracture treatment. The present findings are consistent with previous reports showing that adequate anatomical reduction combined with stable fixation facilitates recovery of wrist mobility and return to daily activities.¹⁰ No significant association was observed between Frykman fracture type and final functional outcome. This suggests that successful restoration of anatomy and appropriate rehabilitation may have a greater influence on functional recovery than fracture classification alone. Similar conclusions have been reported in previous studies, where patient-related factors, quality of reduction and postoperative rehabilitation were stronger predictors of outcome than fracture morphology.¹¹ Postoperative complications were infrequent. Pin tract infection was the most common adverse event but was successfully managed with local wound care and antibiotics, without compromising fracture healing. The overall complication profile compares favorably with previous reports evaluating percutaneous K-wire fixation.^{6,7} the absence of major complications such as tendon rupture, deep infection or neurovascular injury further supports the safety of the technique when meticulous surgical technique and appropriate postoperative care are employed.

Compared with volar locking plate fixation, the five K-wire technique offers several practical advantages, including lower implant cost, shorter operative time, limited soft tissue dissection and preservation of fracture biology. Although volar locking plates may provide superior stability in highly comminuted fractures, systematic reviews have shown that long-term functional outcomes between plating and percutaneous fixation are often comparable in carefully selected patients.^{12,13} Therefore, the five K-wire technique remains an attractive option, particularly in resource-constrained healthcare settings where cost-effectiveness is an important consideration.

CONCLUSION

The present study demonstrated that the five K-wire fixation technique is an effective and reliable treatment option for displaced intra-articular distal radius fractures. The technique achieved satisfactory fracture union, progressive improvement in functional outcome and restoration of wrist mobility with a low rate of postoperative complications. More than 80% of patients achieved excellent or good functional outcomes at six months and most fractures united within eight weeks. The minimally invasive nature of the procedure, preservation of fracture biology, short operative time and relatively low implant cost make this technique particularly suitable for appropriately selected patients, especially in resource-limited healthcare settings.

Although encouraging clinical outcomes were observed, larger multi-centre comparative studies with longer follow-up are required to establish the long-term effectiveness of this technique and to compare it directly with contemporary fixation methods such as volar locking plate osteosynthesis.

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