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Original Research Article

Clinical and Radiological Outcome of Extra articular and in tra articular distal radius fractures in adults treated using "5K wire technique"- A descriptive Study

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Abstract:

Background: Distal radius fractures are common injuries, and various treatment methods have been described. This study aimed to assess the clinical and radiological outcomes of extra-articular and intra-articular distal radius fractures treated using the 5 K-wire technique.

Methods: A prospective descriptive study was conducted on 44 patients with distal radius fractures treated using the 5 K-wire technique. Functional outcomes were assessed using the Modified Mayo Score and Patient-Rated Wrist Evaluation (PRWE) score at 6 weeks, 3 months, and 6 months post-operatively. Radiological outcomes were evaluated using loss of radial height (LRH), loss of radial inclination (LRI), and loss of volar tilt (LVT).

Results: At 6 months, 60.0% of female patients and 44.2% of male patients had good to excellent outcomes based on the Modified Mayo Score. The PRWE score showed 40.0% good and 60.0% fair outcomes in female patients, and 32.4% good and 67.6% fair outcomes in male patients. LRH, LRI, and LVT significantly improved from pre-operative to post-operative and 6 months follow-up ($p<0.05$). Complications were observed in 15.9% of patients.

Conclusion: The 5 K-wire technique is effective in treating extra-articular and intra-articular distal radius fractures, with good to fair functional outcomes and significant improvements in radiological parameters at 6 months post-operatively. The complication rates are comparable to those reported in the literature.

Keywords: Distal Radius Fracture, 5 K-wire Technique, Functional Outcome, Radiological Outcome, Complications.

Introduction

Distal radius fractures (DRFs) are among the most common fractures encountered in orthopedic practice, accounting for approximately 17.5% of all adult fractures [1]. These fractures occur more frequently in elderly individuals, with a higher incidence in postmenopausal women due to osteoporosis [2]. DRFs can be classified as extra-articular or intra-articular based on their involvement of the radiocarpal joint. Extra-articular fractures do not extend into the joint, while intra-articular fractures involve the articular surface [3].

The management of DRFs aims to restore anatomical alignment, achieve stable fixation, and allow early mobilization to prevent stiffness and promote functional recovery [4]. Various treatment options are available, including conservative management with cast immobilization, closed reduction and percutaneous pinning, external fixation, and open reduction and internal fixation (ORIF) [5]. The choice of treatment depends on several factors, such as fracture pattern, patient age, bone quality, and surgeon preference [6].

Percutaneous pinning, also known as Kirschner wire (K-wire) fixation, is a minimally invasive technique commonly used for the treatment of DRFs [7]. The "5 K-wire technique" is a specific method of percutaneous pinning that involves the insertion of five K-wires to achieve fracture reduction and stabilization. This technique has gained popularity due to its simplicity, minimal soft tissue disruption, and ability to provide adequate fracture fixation [8].

Several studies have investigated the clinical and radiological outcomes of DRFs treated with percutaneous pinning. A systematic review by Handoll et al. found that percutaneous pinning was associated with better functional outcomes and

lower complication rates compared to conservative treatment [9]. However, the optimal K-wire configuration and the comparison between extra-articular and intra-articular fractures treated with the "5 K-wire technique" have not been extensively studied.

This descriptive study aims to evaluate the clinical and radiological outcomes of extra-articular and intra-articular DRFs in adults treated using the "5 K-wire technique." The study will assess parameters such as fracture union, functional recovery, range of motion, grip strength, and complications. The findings of this study will contribute to the existing literature on the management of DRFs and provide insights into the effectiveness of the "5 K-wire technique" for both extra-articular and intra-articular fractures.

Aims and Objectives

The study aimed to assess the clinical and radiological outcomes in patients with extra-articular and intra-articular distal radius fractures treated by the 5 K-wire technique. The primary objective was to evaluate the clinical outcome using the Patient-Rated Wrist Evaluation (PRWE) score and the Modified Mayo Wrist Score (MMWS), as well as the radiological outcome through three parameters (loss of radial height, loss of radial inclination, and loss of volar tilt) in these fractures treated at the Department of Orthopaedics, Government Medical College Kozhikode, from September 2021 to October 2022. The secondary objectives included the assessment of various factors influencing functional and radiological outcomes, such as age, gender, and side of involvement, and the evaluation of complications associated with the 5 K-wire technique in distal radius fracture fixation.

Materials and Methods

Study Design and Setting

A prospective descriptive study was conducted at the Government Medical College Kozhikode from November 2020 to October 2022.

Study Population and Sample Size

The study population included patients presenting with distal radius fractures in the outpatient department or casualty of the hospital during the study period, who were willing to undergo standardized 5 K-wire fixation and met the study criteria. The sample size was calculated based on the prevalence of positive outcomes (46%) in a parent study by Virendra K Bhasme et al., using the formula n=4pq/d^2 [p=46%, q=100-46, d=15%]. The calculated sample size was 44 patients.

Inclusion and Exclusion Criteria

The inclusion criteria were age between 18 and 60 years, AO classes A, B1, C1, and C2, and unstable distal radius fractures according to LaFontaine's criteria. The exclusion criteria were Barton fractures (AO type B2 and B3), AO type C3 fractures, polytrauma (associated severe head, chest, and abdomen injuries), associated ulnar shaft fractures, patients unfit for anesthesia, and patients not willing for surgery and follow-up.

Preoperative Evaluation and Surgical Technique

After admission, a detailed history and clinical examination were performed, along with necessary radiological evaluations, blood investigations, and pre-anesthetic workup. Informed written consent was obtained from all patients. The surgical technique involved fracture reduction under general anesthesia or supraclavicular brachial plexus block, followed by the placement of five K-wires in a specific order and configuration. The first wire was the distal radio-ulnar wire, followed by the radial styloid wire, Lister's tubercle wire, ulnar corner wire, and proximal ulno-radial wire. In die-punch fractures, the depressed fragment was elevated using percutaneous K-wires.

Postoperative Care and Follow-up

Postoperative splinting was done with a volar slab in the functional position of the wrist. Patients were discharged on the third day with oral antibiotics, calcium tablets, and a short course of vitamin C tablets. Pin sites were checked and cleaned on day 10, and all wires were removed at 6 weeks after radiographic evaluation. Following pin removal, wrist bracing, active movements, and gentle household activities were advocated. Radiographic evaluation and functional outcome measurements using MMWS and PRWE scores were performed at 3-month and 6-month intervals.

Data Collection and Outcome Measures

Required data were collected using a study proforma. The functional outcome was measured using the MMWS (physician-rated) and PRWE score (patient-rated). The radiological outcome was measured using three parameters: loss of radial height, loss of radial inclination, and loss of volar tilt.

Results

The study included a total of 44 patients, with the majority (36.4%) in the 41-50 years age group, followed by 27.3% in the 31-40 years age group. The gender distribution showed a predominance of male patients (77.3%) compared to female patients (22.7%). The most common mechanisms of injury were road traffic accidents (RTA) and fall from height, each accounting for 45.5% of cases, while domestic falls contributed to 9.1% of cases. Left-

sided injuries (56.8%) were more common than right-sided injuries (43.2%). The fracture type distribution revealed that C1 fractures were the most prevalent (59.1%), followed by C2 (29.5%), B1 (6.8%), and A (4.5%) fractures. The majority of patients (79.5%) had no comorbidities, while the remaining patients had various comorbidities such as diabetes, hypertension, coronary artery disease, hepatitis B, thyroid disorders, and asthma. Complications were observed in 15.9% of patients, with pin loosening, pin infection, buried K-wire, and complex regional pain syndrome (CRPS) each occurring in 4.5%, 4.5%, 4.5%, and 2.3% of patients, respectively (Table 1).

The functional outcome at 6 months, as assessed by the Modified Mayo Score, showed that 60.0% of female patients had a good outcome, while 40.0% had a fair outcome. Among male patients, 11.8% had an excellent outcome, 32.4% had a good outcome, 52.9% had a fair outcome, and 2.9% had a poor outcome. The PRWE score at 6 months revealed that 40.0% of female patients had a good outcome, and 60.0% had a fair outcome. In male patients, 32.4% had a good outcome, and 67.6% had a fair outcome. When considering the side of injury, 15.8% of patients with right-sided injuries had an excellent outcome, 36.8% had a good outcome, and 47.4% had a fair outcome according to the Modified Mayo Score. For left-sided injuries, 4.0% had an excellent outcome, 40.0% had a good outcome, 52.0% had a fair outcome, and 4.0% had a poor outcome. The PRWE score showed that 42.1% of patients with right-sided injuries had a good outcome, and 57.9% had a fair outcome, while 28.0% of patients with left-sided injuries had a good outcome, and 72.0% had a fair outcome (Table 2).

The functional outcome at 6 months, based on the mechanism of injury, demonstrated that patients with RTA had 5.0% excellent, 30.0% good, 60.0% fair, and 5.0% poor outcomes according to the Modified Mayo Score. The PRWE score for RTA patients showed 15.0% good and 85.0% fair outcomes. Patients with fall from height had 15.0% excellent, 45.0% good, and 40.0% fair outcomes based on the Modified Mayo Score, while the PRWE score showed 50.0% good and 50.0% fair outcomes. Patients with domestic falls had 50.0% good and 50.0% fair outcomes according to both the Modified Mayo Score and PRWE score. When considering the fracture type, patients with type A fractures had 50.0% excellent and 50.0% good outcomes based on the Modified Mayo Score, and 100.0% good outcomes according to the PRWE score. Patients with type B1 fractures had 66.7% excellent and 33.3% good outcomes based on the Modified Mayo Score, and 100.0% good outcomes according to the PRWE score. For type C1 fractures, 3.8% had excellent, 42.3% had good, and 53.9% had fair outcomes based on the Modified Mayo Score, while 34.6% had good and 65.4% had fair outcomes according to the PRWE score. Patients with type C2 fractures had 30.8% good, 61.5% fair, and 7.7% poor outcomes based on the Modified Mayo Score, and 7.7% good and 92.3% fair outcomes according to the PRWE score (Table 3).

The comparison of PRWE and Modified Mayo Scores over time showed that at 6 weeks, 100.0% of patients had poor outcomes according to both scores. At 3 months, 20.5% had poor outcomes, and 79.5% had fair outcomes based on the PRWE score, while 54.5% had poor outcomes, and 45.5% had fair outcomes according to the Modified Mayo Score. At 6 months, 65.9% had fair outcomes, and 34.1% had good outcomes based on the PRWE score, while 2.3% had poor outcomes, 50.0% had fair outcomes, 38.6% had good outcomes, and 9.1% had excellent outcomes according to the Modified Mayo Score (Table 4).

The comparison of loss of radial height (LRH), loss of radial inclination (LRI), and loss of volar tilt (LVT) over time showed that the mean LRH decreased from 9.5 mm pre-operatively to 1.8 mm post-operatively and 1.2 mm at 6 months. The mean LRI decreased from 14.8° pre-operatively to 3.6° post-operatively and 3.0° at 6 months. The mean LVT decreased from 9.5° pre-operatively to 4.5° post-operatively and 3.5° at 6 months (Table 5).

The functional outcomes based on LRH, LRI, and LVT showed that pre-operatively, 86.4% of patients had poor outcomes, and 11.4% had fair outcomes for LRH. Post-operatively, 11.4% had fair outcomes, and 88.6% had good outcomes for LRH. At 6 months, 9.1% had fair outcomes, and 90.9% had good outcomes for LRH. For LRI, pre-operatively, 84.1% had poor outcomes, and 15.9% had fair outcomes. Post-operatively, 20.5% had fair outcomes, and 79.5% had good outcomes for LRI. At 6 months, 18.2% had fair outcomes, and 81.8% had good outcomes for LRI. Regarding LVT, pre-operatively, 50.0% had poor outcomes, and 50.0% had fair outcomes. Post-operatively, 50.0% had fair outcomes, and 50.0% had good outcomes for LVT. At 6 months, 84.1% had fair outcomes, and 15.9% had good outcomes for LVT (Table 6).

The individual components of the Modified Mayo Score at 6 weeks and 6 months showed an improvement in all aspects. The pain score increased from 16.9 at 6 weeks to 24.3 at 6 months. The occupational status improved from 0.0 at 6 weeks to 19.7 at 6 months. Wrist movements increased from 0.0 at 6 weeks to 19.3 at 6 months. Grip strength improved from 0.0 at 6 weeks to 15.0 at 6 months. The total Modified Mayo Score

increased from 16.9 at 6 weeks to 76.1 at 6 months (Table 7).

Table 1: Demographic and Injury Data Distribution

Category	Subcategory	Frequency	Percent
Age Distribution	Up to 20 years	1	2.3%
	21 - 30 years	9	20.5%
	31 - 40 years	12	27.3%
	41 - 50 years	16	36.4%
	Above 50 years	6	13.6%
Gender Distribution	Female	10	22.7%
	Male	34	77.3%
Mechanism of Injury	RTA	20	45.5%
	Fall from height	20	45.5%
	Domestic fall	4	9.1%
Side of Injury	Right	19	43.2%
	Left	25	56.8%
Fracture Type	A	2	4.5%
	B1	3	6.8%
	C1	26	59.1%
	C2	13	29.5%
Comorbidity	Nil	35	79.5%
	Diabetes	2	4.5%
	HTN	3	6.8%
	CAD	1	2.3%
	Hep B	1	2.3%
	Thyroid	1	2.3%
	Asthma	1	2.3%
Complications	Nil	37	84.1%
	Pin loosening	2	4.5%
	Pin infection	2	4.5%
	Buried K wire	2	4.5%
	CRPS	1	2.3%

Table 2: Functional Outcome by Gender and Injury Side

Category	Subcategory	Modified Mayo Score 6 Months (%)	PRWE Score 6 Months (%)
Gender Distribution	Female (n=10)	Excellent: 0.0, Good: 60.0	Good: 40.0
		Fair: 40.0, Poor: 0.0	Fair: 60.0
	Male (n=34)	Excellent: 11.8, Good: 32.4	Good: 32.4
		Fair: 52.9, Poor: 2.9	Fair: 67.6
Side of Injury	Right (n=19)	Excellent: 15.8, Good: 36.8	Good: 42.1
		Fair: 47.4, Poor: 0.0	Fair: 57.9
	Left (n=25)	Excellent: 4.0, Good: 40.0	Good: 28.0
		Fair: 52.0, Poor: 4.0	Fair: 72.0

Table 3: Functional Outcome by Mechanism of Injury and Fracture Type

Category	Subcategory	Modified Mayo Score 6 Months (%)	PRWE Score 6 Months (%)
Mechanism of Injury	RTA (n=20)	Excellent: 5.0, Good: 30.0	Good: 15.0
		Fair: 60.0, Poor: 5.0	Fair: 85.0
	Fall from height (n=20)	Excellent: 15.0, Good: 45.0	Good: 50.0
		Fair: 40.0, Poor: 0.0	Fair: 50.0
	Domestic fall (n=4)	Excellent: 0.0, Good: 50.0	Good: 50.0
		Fair: 50.0, Poor: 0.0	Fair: 50.0
Fracture Type	A (n=2)	Excellent: 50.0,	Good: 100.0

		Good: 50.0	
		Fair: 0.0, Poor: 0.0	Fair: 0.0
	B1 (n=3)	Excellent: 66.7, Good: 33.3	Good: 100.0
		Fair: 0.0, Poor: 0.0	Fair: 0.0
	C1 (n=26)	Excellent: 3.8, Good: 42.3	Good: 34.6
		Fair: 53.9, Poor: 0.0	Fair: 65.4
	C2 (n=13)	Excellent: 0.0, Good: 30.8	Good: 7.7
		Fair: 61.5, Poor: 7.7	Fair: 92.3

Table 4: Comparison of PRWE and Modified Mayo Scores Over Time

Category	Subcategory	6 Weeks	3 Months	6 Months
PRWE Score	Poor	100.0%	20.5%	0.0%
	Fair	0.0%	79.5%	65.9%
	Good	0.0%	0.0%	34.1%
Modified Mayo Score	Poor	100.0%	54.5%	2.3%
	Fair	0.0%	45.5%	50.0%
	Good	0.0%	0.0%	38.6%
	Excellent	0.0%	0.0%	9.1%

Table 5: Comparison of LRH, LRI, LVT Over Time

Category	Pre-Op	Post-Op	6 Months
LRH	9.5 mm	1.8 mm	1.2 mm
LRI	14.8°	3.6°	3.0°
LVT	9.5°	4.5°	3.5°

Table 6: Functional Outcomes of LRH, LRI, LVT

Category	Pre-Op Poor (%)	Pre-Op Fair (%)	Post-Op Fair (%)	Post-Op Good (%)	6 Months Fair (%)	6 Months Good (%)
LRH	86.4	11.4	11.4	88.6	9.1	90.9
LRI	84.1	15.9	20.5	79.5	18.2	81.8
LVT	50.0	50.0	50.0	50.0	84.1	15.9

Table 7: Individual Components of Modified Mayo Score at 6 Weeks and 6 Months

Component	6 Weeks	6 Months
Pain Score	16.9	24.3
Occupational Status	0.0	19.7
Wrist Movements	0.0	19.3
Grip Strength	0.0	15.0
Total Score	16.9	76.1

Discussion:

The present study aimed to assess the clinical and radiological outcomes of extra-articular and intra-articular distal radius fractures treated using the 5 K-wire technique. The results demonstrated that the majority of patients achieved good to fair functional outcomes at 6 months, with significant improvements in radiological parameters and individual components of the Modified Mayo Score.

The age distribution in our study showed a higher incidence of distal radius fractures in the 41-50 years age group (36.4%), followed by the 31-40 years age group (27.3%). This finding is consistent with the study by Kilic et al., which reported a mean age of 45.3 years for patients with distal radius fractures [11]. However, a study by Sharma et al. found a higher incidence in the 18-30 years age group (33.3%), followed by the 31-40 years age group (26.7%) [12].

The gender distribution in our study revealed a male predominance (77.3%), which is in contrast to the findings of Kilic et al. and Sharma et al., who reported a higher incidence in females (61.4% and 53.3%, respectively) [11,12]. This discrepancy could be attributed to differences in the study population and the mechanisms of injury.

In our study, the most common mechanisms of injury were road traffic accidents (45.5%) and fall from height (45.5%). This is similar to the findings

of Kilic et al., who reported fall from height as the most common cause (54.3%), followed by road traffic accidents (28.6%) [11]. However, Sharma et al. found fall on outstretched hand as the most common mechanism of injury (60%) [12].

The fracture type distribution in our study showed a higher incidence of C1 fractures (59.1%), followed by C2 (29.5%), B1 (6.8%), and A (4.5%) fractures. This is comparable to the findings of Sharma et al., who reported a higher incidence of AO type C fractures (53.3%) [12]. However, Kilic et al. found AO type A fractures to be the most common (48.6%) [11].

The functional outcome at 6 months, as assessed by the Modified Mayo Score, showed that 60.0% of female patients and 44.2% of male patients had good to excellent outcomes. This is similar to the findings of Sharma et al., who reported good to excellent outcomes in 66.7% of patients using the Modified Mayo Score [12]. Kilic et al. also reported good to excellent outcomes in 77.1% of patients using the Gartland and Werley Score [11].

The radiological outcome in our study demonstrated a significant improvement in LRH, LRI, and LVT from pre-operative to post-operative and 6 months follow-up. This is consistent with the findings of Kilic et al. and Sharma et al., who reported significant improvements in radiological parameters following treatment with percutaneous K-wire fixation [11,12].

Complications in our study were observed in 15.9% of patients, with pin loosening, pin infection, buried K-wire, and CRPS being the most common. This is comparable to the complication rates reported by Kilic et al. (11.4%) and Sharma et al. (13.3%) [11,12].

The individual components of the Modified Mayo Score showed significant improvements from 6 weeks to 6 months post-operatively. This finding highlights the effectiveness of the 5 K-wire technique in improving pain, occupational status, wrist movements, and grip strength over time.

The 5 K-wire technique is an effective method for treating extra-articular and intra-articular distal radius fractures, with good to fair functional outcomes and significant improvements in radiological parameters. The complication rates are comparable to those reported in the literature. However, further studies with larger sample sizes and longer follow-up periods are needed to validate these findings.

Conclusion

The 5 K-wire technique is an effective method for treating extra-articular and intra-articular distal radius fractures. The results of this study demonstrate good to fair functional outcomes and significant improvements in radiological parameters at 6 months post-operatively. The complication rates are comparable to those reported in the literature. The individual components of the Modified Mayo Score, including pain, occupational status, wrist movements, and grip strength, showed significant improvements over time. However, further studies with larger sample sizes and longer follow-up periods are needed to validate these findings and assess the long-term outcomes of this technique.

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