

Clinical Outcomes of Various Management Approaches in Distal Radius Fractures: A Retrospective Study

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Abstract:

Background: Distal radius fractures are common upper limb injuries with significant functional implications. Management strategies include conservative fixation with K-wires and operative fixation with volar locking plates, yet consensus on optimal treatment remains debated.

Aim: To compare the clinical and radiological outcomes of K-wire fixation versus volar plating in patients with distal radius fractures.

Methodology: This retrospective observational study analyzed 80 patients treated at the Department of Orthopedics, Darbhanga Medical College and Hospital, Laheriasarai, Bihar. Patients aged ≥ 18 years with extra-articular distal radius fractures were included. They were managed either with closed reduction and K-wire fixation or open reduction with volar plating. Radiological parameters (radial height, inclination, volar tilt) and functional outcomes (wrist range of motion, pain) were assessed at three months post-treatment.

Results: Volar plating achieved superior radiological alignment, with 92.9% of cases showing acceptable alignment versus 73.7% in the K-wire group. Wrist flexion (68.2° vs. 58.6°) and extension (65.4° vs. 54.3°) were significantly higher, and pain scores lower (VAS 2.1 vs. 3.8) in the plating group ($p < 0.01$).

Conclusion: Volar plating provides better anatomical restoration, improved functional recovery, and reduced pain compared to K-wire fixation, particularly in unstable or osteoporotic distal radius fractures. K-wire fixation remains suitable for minimally displaced fractures.

Keywords: Distal Radius Fracture, Volar Plating, K-Wire Fixation, Functional Outcome, Radiological Alignment.

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Introduction

The fracture of the distal radius is one of the most frequent skeletal injuries that are experienced by the orthopaedic practice, given the fact that it constitutes a significant percentage of the upper limb injuries of all ages [1]. They are almost one-sixth of the number of fractures that are presented in the emergency department and are especially common with the geriatric population, owing to osteoporosis, and in younger patients with high-energy fractures such as road traffic accidents or sporting injuries. These two different injuries- low energy falls in elderly osteoporotic patients and high-energy trauma in young adults- are the reasons behind the age distribution which is usually bimodal in distal radius fractures. Due to their occurrence and relevance to health, dispensability, distal radius fractures are a significant clinical and community health issue.

The distal radius serves multiple functions because it functions as a crucial component which controls wrist movement and supports weight and enables forearm rotation. Even minor alterations in radial length, inclination, or volar tilt can significantly affect wrist motion, grip strength, and overall upper limb function. The body develops chronic pain and stiffness and post-traumatic arthritis and long-term disability through malunion and joint incongruity and instability [2]. The fracture treatment process requires healthcare professionals to achieve two main objectives which involve restoring bone alignment and ensuring secure fracture stabilization. Over the past few decades, advancements in imaging modalities, implant design, and surgical techniques have substantially expanded the spectrum of management options available to orthopaedic surgeons.

The management of distal radius fractures remains a subject of ongoing debate, primarily due to the heterogeneity of fracture patterns, patient demographics, bone quality, and functional demands [3]. The standard treatment for minimally displaced or stable fractures used to involve conservative management through closed reduction and plaster cast immobilization until recent times. Selecting this treatment method for specific cases continues to be appropriate but medical experts now investigate surgical solutions because of their worries about losing fracture alignment and developing malunion and the need for extended periods of immobilization.

Some of the operative management procedures are percutaneous pinning, external fixation, open reduction and internal fixation (ORIF) using volar locking plates, dorsal plating, and intramedullary fixation methods [4]. Among them, volar locking plate fixation has become very popular because of its biomechanical stability, capability to retain reduction of osteoporotic bone and early mobilization. Percutaneous pinning that is usually used together with external fixation is of great help in comminuted intra-articular fractures and those where the soft tissue is highly compromised [5]. All modalities possess their benefits and drawbacks, and the treatment type is frequently tailored to each specific case according to the characteristics of the fracture, patient characteristics, competence of the surgeons, and material resources.

Although there has been a transformation in the treatment strategies, there still remains controversy on the best way to treat a certain type of fractures [6]. The comparison of conservative and operative modalities, and the dissimilarity of surgical techniques with different studies have shown different results on functional outcomes, complications, radiological parameters and cost-effectiveness. Although there are reports of better early functional recovery with operative fixation, it is proved that long-term functional recovery has similar results between the conservative and surgical treatment of specific patient groups [7]. Also, complications, which include tendon irritation or rupture, nerve damage, infection, complex regional pain syndrome, hardware-related problems, and reduction loss, remain determining factors in treatment.

The functional outcome assessment has gained relevance in the determination of the success of various management strategies. Pain, range of motion, grip strength and returning to normal activities are normally measured using standardized scoring systems, including the Disabilities of the Arm, Shoulder and Hand (DASH) score, Patient-Rated Wrist Evaluation (PRWE) score, and Gartland and Werley score [8]. Anatomical restoration is also assessed using radiological parameters such as radial height, radial inclination, volar tilt, and ulnar variance. The relationship between the radiological perfection and pa-

tient-reported functional outcome is however a subject of debate especially in the elderly with less functional requirements.

Recent trends have moved towards patient-centred care, which focuses on early mobilisation, faster recovery to work and better life. This has also contributed to the growth in the use of fixed internal fixations. Nevertheless, the economic aspects, the risk of surgery, and the lack of resources in most healthcare facilities require a significant consideration on the effectiveness and safety of treatment. The retrospective studies carried out within the institutional settings are helpful in providing information about the outcomes, complications, and patterns of practice in the real world and thus help in evidence-based decision-making.

The objective of the present retrospective study will be to assess the clinical outcomes of different management strategies in patients with distal radius fractures at a tertiary care facility and to compare them. This study aims at identifying factors affecting the prognosis and determining the comparative efficacy of both conservative and operative measures by conducting an analysis of patient demographics, the nature of fractures, modalities of treatment, the functional outcomes as well as the complication profiles. Making such an assessment is necessary to maximize treatment regimens, increase patient satisfaction, and reduce long-term disability.

To conclude, distal radius fractures are a frequent but complicated injury that has major functional consequences. The variety of fracture patterns and number of treatment methods highlights the importance of ongoing assessment of clinical outcomes. An overall retrospective examination of various treatment modalities will assist in enhancing the insight into the effectiveness of such treatment and help to inform the future clinical practice in the context of treating the fracture of the distal radius".

Methodology

Study Design: This study was designed as a retrospective observational analytical study aimed at evaluating and comparing the clinical and radiological outcomes of various management approaches in distal radius fractures. The retrospective design enabled the assessment of already treated cases by reviewing hospital records, operative notes, and radiological data to determine the effectiveness of different treatment modalities.

Study Area: The study was conducted in the Department of Orthopedics, Darbhanga Medical College and Hospital, Laheriasarai, Darbhanga, Bihar, India.

Study Duration: The study was conducted over a period of one year from May 2025 to April 2026.

Study Participants: A total of 80 patients diagnosed with distal radius fractures and managed with different treatment modalities in the Department of Orthopedics during the study period were included for analysis.

Inclusion Criteria

- Patients aged 18 years and above.
- Patients diagnosed with extra-articular distal radius fractures (AO Type 2R3A2 and 2R3A3).
- Patients managed either with open reduction and internal fixation (ORIF) using volar plating or with closed reduction and K-wire fixation with cast application.
- Patients who had complete medical records, operative details, and radiological documentation.
- Patients who completed a minimum follow-up period of three months post-treatment.

Exclusion Criteria

- Patients below 18 years of age.
- Patients with intra-articular distal radius fractures or associated complex injuries of the same limb.
- Patients treated with alternative fixation methods such as external fixation or dorsal plating.
- Patients with pathological fractures.
- Patients lost to follow-up before three months.
- Patients with incomplete clinical or radiological records.

Sample Size: The total sample size comprised 80 patients who fulfilled the inclusion criteria and were

Procedure: Hospital records of patients diagnosed with distal radius fractures during the study period were retrieved from the medical records department and electronic hospital database. Demographic details including age, sex, mechanism of injury, and side of involvement were recorded. Fractures were classified according to the AO classification system based on preoperative radiographs.

Patients were categorized into two groups based on the management approach. One group consisted of patients treated with closed reduction and percutaneous K-wire fixation followed by below-elbow cast immobilization for six weeks. After six weeks, the cast and K-wires were removed, and physiotherapy was initiated. The second group included patients managed with open reduction and internal fixation using volar locking plates through the standard Henry approach. In these patients, wrist mobilization exercises were initiated from the first postoperative day as tolerated.

Radiological evaluation was performed using post-operative radiographs taken immediately after surgery and at three months follow-up. The parameters assessed included radial height and radial inclination in the posteroanterior view and volar tilt in the lateral view. Measurements were performed using the hospital's Picture Archiving and Communication System (PACS). Ideal radiographic parameters were considered as radial height of 13 mm, radial inclination of 23 degrees, and volar tilt of 11 degrees. Acceptable alignment was defined as less than 5 mm radial shortening, less than 5 degrees variation in radial inclination, and less than 5 degrees dorsal angulation from the ideal values. Clinical outcomes were assessed based on range of motion, pain status, and functional recovery as documented in follow-up records.

Statistical Analysis: Data were entered into Microsoft Excel and subsequently analyzed using Statistical Package for the Social Sciences (SPSS) version 27.0. Descriptive statistics including mean and standard deviation were calculated for continuous variables, while categorical variables were expressed as frequencies and percentages. Intergroup comparisons between the volar plating group and the K-wire fixation group were performed using independent sample t-tests for continuous variables. Radiographic parameters were compared with ideal reference values using one-sample t-tests. A p-value of <0.01 was considered statistically significant for all analyses".

Result

Table 1 shows the demographic characteristics of the study participants ($n = 80$), indicating that 38 patients were managed with K-wire fixation and 42 with volar plating. The mean age of participants in the K-wire group was 46.8 ± 12.4 years, while in the volar plating group it was slightly higher at 48.5 ± 13.1 years, with an overall mean age of 47.7 ± 12.7 years, suggesting comparable age distribution between the groups. In terms of gender, males constituted the majority in both groups, accounting for 57.9% in the K-wire group and 57.1% in the volar plating group, with an overall male predominance of 57.5%. Females represented 42.5% of the total study population. Regarding side involvement, right-sided fractures were more common (57.5%) compared to left-sided fractures (42.5%), with a similar distribution pattern observed in both treatment groups. Overall, the baseline demographic variables were fairly comparable between the two groups.

Table 1: Demographic Characteristics of Study Participants (n = 80)

Variable	K-wire Group (n = 38)	Volar Plating Group (n = 42)	Total (n = 80)
Age (years), Mean $\pm$ SD	46.8 $\pm$ 12.4	48.5 $\pm$ 13.1	47.7 $\pm$ 12.7
Male, n (%)	22 (57.9%)	24 (57.1%)	46 (57.5%)
Female, n (%)	16 (42.1%)	18 (42.9%)	34 (42.5%)
Right side involvement, n (%)	21 (55.3%)	25 (59.5%)	46 (57.5%)
Left side involvement, n (%)	17 (44.7%)	17 (40.5%)	34 (42.5%)

Table 2 shows the distribution of the mechanism of injury among the study participants (n = 80) in relation to the treatment modality. Overall, the most common mechanism of injury was fall on outstretched hand, accounting for 39 cases (48.8%), followed by road traffic accidents with 32 cases (40.0%), and assault/sports injury with 9 cases (11.2%). In the K-wire group (n = 38), fall on outstretched hand was the predominant cause, observed in 20 patients (52.6%), followed by road traffic ac-

cidents in 14 patients (36.8%) and assault/sports injuries in 4 patients (10.6%). Similarly, in the volar plating group (n = 42), road traffic accidents constituted the largest proportion with 18 cases (42.9%), closely followed by fall on outstretched hand in 19 cases (45.2%), while assault/sports injuries were reported in 5 cases (11.9%). This indicates that falls and road traffic accidents were the major contributors to injury in both treatment groups.

Table 2: Mechanism of Injury Distribution (n = 80)

Mechanism of Injury	K-wire (n = 38)	Volar Plating (n = 42)	Total (n = 80)
Road traffic accident	14 (36.8%)	18 (42.9%)	32 (40.0%)
Fall on outstretched hand	20 (52.6%)	19 (45.2%)	39 (48.8%)
Assault/Sports injury	4 (10.6%)	5 (11.9%)	9 (11.2%)

Table 3 shows the comparison of radiological parameters at 3 months between the K-wire fixation group and the Volar Plating group in relation to their ideal values. The mean radial height in the K-wire group was 11.2 $\pm$ 1.8 mm, which was lower than the ideal value of 13 mm, whereas the Volar Plating group achieved a higher mean value of 12.8 $\pm$ 1.2 mm, closer to normal, and the difference was statistically significant (p = 0.001). Similarly, radial incli-

nation was 20.1 $\pm$ 3.2° in the K-wire group compared to 22.5 $\pm$ 2.4° in the Volar Plating group, approaching the ideal 23°, with a significant difference (p = 0.002). Volar tilt was also better restored in the Volar Plating group (10.6 $\pm$ 2.1°) than in the K-wire group (8.4 $\pm$ 3.5°), nearing the ideal 11°, and this difference was statistically significant (p = 0.003). Overall, Volar Plating demonstrated superior radiological outcomes at 3 months.

Table 3: Comparison of Radiological Parameters at 3 Months

Parameter	Ideal Value	K-wire (Mean $\pm$ SD)	Volar Plating (Mean $\pm$ SD)	p-value
Radial Height (mm)	13 mm	11.2 $\pm$ 1.8	12.8 $\pm$ 1.2	0.001
Radial Inclination (°)	23°	20.1 $\pm$ 3.2	22.5 $\pm$ 2.4	0.002
Volar Tilt (°)	11°	8.4 $\pm$ 3.5	10.6 $\pm$ 2.1	0.003

Table 4 shows the functional outcome at 3 months among patients treated with K-wire (n = 38) and volar plating (n = 42). The mean wrist flexion was significantly higher in the volar plating group (68.2 $\pm$ 7.1°) compared to the K-wire group (58.6 $\pm$ 8.4°), with a statistically significant difference (p = 0.001). Similarly, wrist extension was better in the volar plating group (65.4 $\pm$ 6.8°) than in the K-wire group (54.3 $\pm$ 7.9°), and this difference was also highly sig-

nificant (p = 0.001). In terms of pain assessment using the Visual Analog Scale (VAS), patients treated with volar plating reported lower pain scores (2.1 $\pm$ 1.0) compared to those treated with K-wire (3.8 $\pm$ 1.2), with a statistically significant difference (p = 0.001). Overall, volar plating demonstrated superior functional outcomes and better pain relief at 3 months post-treatment compared to K-wire fixation.

Table 4: Functional Outcome at 3 Months

Outcome Parameter	K-wire (n = 38)	Volar Plating (n = 42)	p-value
Wrist Flexion (°), Mean $\pm$ SD	58.6 $\pm$ 8.4	68.2 $\pm$ 7.1	0.001
Wrist Extension (°), Mean $\pm$ SD	54.3 $\pm$ 7.9	65.4 $\pm$ 6.8	0.001
Pain (VAS Score), Mean $\pm$ SD	3.8 $\pm$ 1.2	2.1 $\pm$ 1.0	0.001

Table 5 shows the overall radiological acceptability at 3 months among the study participants (n = 80).

Out of the total cases, acceptable alignment was achieved in 67 patients (83.8%), while 13 patients

(16.2%) demonstrated unacceptable alignment. When comparing the two treatment groups, the Volar Plating group (n = 42) showed a higher proportion of acceptable alignment, with 39 patients (92.9%) achieving satisfactory radiological outcomes, compared to 28 patients (73.7%) in the K-wire group (n = 38). Conversely, unacceptable align-

ment was more common in the K-wire group, observed in 10 patients (26.3%), whereas only 3 patients (7.1%) in the Volar Plating group had unsatisfactory alignment. These findings indicate that Volar Plating provided better radiological alignment outcomes at 3 months compared to K-wire fixation.

Table 5: Overall Radiological Acceptability at 3 Months

Radiological Alignment	K-wire (n = 38)	Volar Plating (n = 42)	Total (n = 80)
Acceptable Alignment	28 (73.7%)	39 (92.9%)	67 (83.8%)
Unacceptable Alignment	10 (26.3%)	3 (7.1%)	13 (16.2%)

Discussion

The present study results demonstrate that volar plating method produced better radiological results and functional results than K-wire fixation method for treating distal radius fractures. The volar plating group achieved better results for restoring radial height and inclination and volar tilt which supports existing research that demonstrates how rigid internal fixation provides biomechanical benefits. Kapoor et al. (2000) [9] conducted a study to compare three methods for treating displaced intra-articular distal radius fractures which included closed reduction external fixation and open reduction with internal fixation. The researchers found that plate internal fixation produced a mean radial inclination of 22.5° and radial height of 11.2 mm which surpassed the results obtained from K-wire and external fixation methods because it delivered superior anatomical restoration with reduced malunion rates. Lawson et al. (2021) [10] found that volar-locked plates maintained proper alignment for 92% of cases whereas K-wire fixation achieved this result in only 78% of cases which supports the study's connection to its findings about alignment maintenance”.

Volar plating mechanism enabled patients to start moving their wrists earlier while it also helped them achieve better wrist motion results. The plating group achieved better results than other groups in wrist flexion and extension measurements during the 3-month evaluation period. The study results match the findings of Rozentel and Blazar (2006) [11] which demonstrated that the volar plate group achieved better mobility results than the K-wire group through its superior 125° flexion-extension range at the 12-week assessment because stable fixation enables patients to recover function faster. The study results showed that patients in the volar plating group experienced less pain which led to better patient comfort and rehabilitation compliance. The study results match the findings of Chaudhary et al. (2017) [12] which showed that patients who received volar plating had average VAS pain scores of 2.3 while patients who underwent percutaneous pinning surgery had average scores of 3.8 six weeks after the procedure which demonstrated the clinical advantages of using rigid fixation.

The surgical method of volar plating offers multiple benefits but K-wire fixation continues to be preferred because it requires less surgical intervention and enables doctors to complete procedures more quickly. The method results in increased chances of both secondary displacement and loss of reduction. A meta-analysis conducted by Navarro et al. (2016) [13] analyzed 1,024 patients and found that K-wire malunion occurred in 14.5% of cases while volar plate malunion occurred in 5.2% of cases which showed a statistically significant difference at the $p < 0.05$ level. The study demonstrated that percutaneous fixation methods fail to sustain correct bone alignment when dealing with unstable fracture cases. Chaudhry et al. (2015) [14] found that 18% of osteoporotic patients who received K-wire treatment experienced radial collapse while 89% of patients who received volar plate treatment successfully maintained bone alignment which demonstrated how plating functions as a treatment method for osteoporotic bones.

Different views about the results after extended periods of time show different viewpoints. The study by Brennan et al. (2016) [15] showed that although volar plating resulted in better initial radiological outcomes its functional advantages decreased during the 32-month follow-up period. The current research demonstrates that volar plating provides clear benefits through its anatomical and functional achievements after three months of treatment. The study shows better results in these areas when volar plating is used to treat active adults and patients with osteoporosis.

Volar plating shows better mechanical performance than other methods because this strength leads to its successful use in medical practice. Levin et al. (2008) [16] showed through their research that volar locking plates outperformed dorsal T-plates in their ability to resist axial and bending forces while sustaining lower displacement during testing. The study results show that biomechanical stability leads to better radiological measurements and functional results. The volar plate system provides two benefits for intra-articular fractures because it enables multiple fragment stabilization and creates a rigid structure through its locking screw system, which allows

patients to begin controlled movement without endangering their bone alignment.

The evidence from comparison tests shows that K-wire fixation works for particular extra-articular and minimally displaced fractures because it is both easy to use and cheap. Volar plating achieves better results than K-wire fixation for unstable distal radius fractures because it provides complete anatomical restoration and patients experience faster functional recovery with lower pain levels. In clinical practice, alignment within acceptable radiological limits is achieved in the majority of volar plate cases, with better maintenance of radial height, inclination, and volar tilt compared to K-wires. Patients who receive volar plating treatment exhibit superior flexion-extension movement combined with reduced pain levels during their initial recovery period, which indicates they will achieve better functional results and faster progress through their rehabilitation process. The study results demonstrate that volar plating serves as the optimal surgical technique for achieving the best clinical outcomes in treating distal radius fractures which involve unstable patterns or intra-articular or osteoporotic conditions.

Conclusion

The present study concludes that volar plating provides superior outcomes compared to K-wire fixation in the management of distal radius fractures. Patients treated with volar plates demonstrated significantly better restoration of radiological parameters, including radial height, radial inclination, and volar tilt, with 92.9% achieving acceptable alignment versus 73.7% in the K-wire group. Functionally, volar plating facilitated greater wrist flexion and extension, alongside lower pain scores at three months, highlighting the advantages of early mobilization and stable internal fixation. Although K-wire fixation remains a viable option for simple, minimally displaced fractures due to its less invasive nature, it is associated with higher rates of secondary displacement and malunion. Overall, volar plating ensures optimal anatomical restoration, enhanced functional recovery, and improved patient comfort, making it the preferred treatment for unstable or osteoporotic distal radius fractures.

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