e-ISSN: 0975-9506, p-ISSN: 2961-6093

Available online on www.ijpqa.com

International Journal of Pharmaceutical Quality Assurance 2026; 17(1); 334-343

Original Research Article

A Prospective Randomized Comparative Study of Functional and Radiological Outcomes of Percutaneous Kirschner Wire Fixation Versus Volar Locking Plate Fixation in the Management of Intra-Articular Distal Radius Fractures at a Tertiary Care Centre in Jaipur, Rajasthan

Sushil Kumar[1], Kapil Dayma[2], S.K. Goyal[3]

[1]Post Graduate Resident, Department of Orthopaedics, SMS Medical College & Attached Hospitals, Jaipur, Rajasthan, India

[2]Senior Resident, Department of Orthopaedics, SMS Medical College & Attached Hospitals, Jaipur, Rajasthan, India

[3]Professor, Department of Orthopaedics, SMS Medical College & Attached Hospitals, Jaipur, Rajasthan, India

Received: 28-11-2025 / Revised: 27-12-2025 / Accepted: 28-01-2026

Corresponding Author: Dr. Kapil Dayma

Conflict of interest: Nil

Abstract:

Background: Distal radius fractures are among the most frequently encountered injuries in trauma emergency departments, accounting for approximately 17% of all fractures. Intra-articular fractures of the distal radius pose a significant challenge due to the need for accurate reduction and stable fixation. The optimal surgical method for managing these fractures remains debatable. This study aimed to compare the functional and radiological outcomes of percutaneous Kirschner wire (K-wire) fixation versus volar locking plate (VLP) fixation in the management of intra-articular distal radius fractures.

Materials and Methods: This prospective randomized interventional study was conducted at the Department of Orthopaedics, SMS Medical College, Jaipur, from December 2023 to October 2024. Seventy patients with intra-articular distal radius fractures (Frykman type III, IV, VII, and VIII) were randomly allocated into two groups: Group A (n=35) treated with percutaneous K-wire fixation and Group B (n=35) treated with volar locking plate fixation. Functional outcomes were assessed using the Quick DASH (QDASH) score and Modified Mayo Wrist Score (MMWS) at 6 months follow-up. Radiological parameters including radial height, radial inclination, and volar tilt were evaluated.

Results: The mean age was 37.82±8.68 years (K-wire group) and 38.28±9.53 years (VLP group) with male predominance in both groups. Road traffic accidents were the commonest mode of injury. At final follow-up, the VLP group demonstrated significantly better radiological parameters: mean radial height (9.94±1.69 mm vs 8.48±1.40 mm, $p<0.05$) and radial inclination (19.48±1.61° vs 17.8±2.44°, $p<0.05$). The VLP group showed significantly better functional outcomes with lower QDASH scores (28.30±10.13 vs 35.38±9.45, $p<0.05$) and higher MMWS (81.85±8.14 vs 76.85±7.38, $p<0.05$). Grip strength was significantly higher in the VLP group (80.54±5.33% vs 76.2±4.15%, $p<0.05$). Complications were minimal in both groups.

Conclusion: Volar locking plate fixation provides superior radiological and functional outcomes compared to percutaneous K-wire fixation in the management of intra-articular distal radius fractures. VLP fixation can be considered the preferred modality for treating these fractures with fewer complications and better long-term functional recovery.

Keywords: Distal radius fracture, Intra-articular fracture, Kirschner wire, Volar locking plate, Quick DASH, Modified Mayo Wrist Score, Radiological outcome.

DOI: 10.25258/Ijpqa.17.1.54

This is an Open Access article that uses a funding model which does not charge readers or their institutions for access and distributed under the terms of the Creative Commons Attribution License (http://creativecommons.org/licenses/by/4.0) and the Budapest Open Access Initiative (http://www.budapestopenaccessinitiative.org/read), which permit unrestricted use, distribution, and reproduction in any medium, provided original work is properly credited.

Introduction

Distal radius fractures are one of the most frequently encountered injuries in the trauma emergency department. In the adult population, distal radius fractures (DRFs) are the most common fractures and their incidence has been on an upward trend. [1] These injuries account for approximately one-sixth of all fractures treated in the emergency room and constitute around 17% of all fractures and 75% of all forearm fractures. [2,3] It has been estimated that the incidence of distal radius fractures has a high incidence around 20–40 per 10,000 person-years. Moreover, its incidence is similar among women

and men below 50 years of age, and women over 80 years have the highest incidence of 120 per 10,000 person-years.[1,4] The age distribution of patients is bimodal, affecting younger and older age groups accounting for high-energy and low-energy trauma respectively, with an initial peak among 18–25 year olds and a second peak among elderly patients in their sixties. Postmenopausal osteoporosis increases the fracture risk in females fourfold as compared to males. [1,2] High-energy trauma such as sports injuries, falls from height, and traffic accidents, is a common cause of fractures among adolescents and young adults; however, the elderly population experiences osteoporotic low-energy fractures. [4,27] Along with sex, age group, ethnicity, family history and early menopause, decreased bone mineral density also accounts as one of the risk factors for fractures of the distal end of the radius. [5,20] Fractures of distal radius typically occur after an impact on the outstretched hand, with the type of fracture depending upon the loading rate and the magnitude and direction of the load. Overall, 90% of the radius fractures are caused by stress loading with the wrist in dorsiflexion. [2,4]

Fractures of the distal radius in younger adults usually have intra-articular involvement as a result of high-energy trauma, while in elderly patients, low-energy trauma and osteoporosis may cause an intra-articular fracture.[6] Being the intra-articular fracture of distal radius, accurate reduction and stabilization is the challenge for these complicated injuries. Volar/dorsal tilt, radial inclination, ulnar variance, and intra-articular step-off are the important factors to assess the severity of the injury and decide on the optimum treatment option for the fracture. [27] The merit of fracture reduction of distal end radius is saliently evaluated by the restoration of the pre-fractured value of radial inclination and the volar tilt. Loss of the radial height along with the altered palmar tilt has a substantial influence on the kinesiology and the grip strength of the wrist joint. Furthermore, the ulnar variance is an important parameter for the management of the distal end radius. Hence, the morphometric measurement of the distal end radius includes necessary parameters such as radial inclination, volar tilt, radial height, and ulnar variance. [29]

By continuing interest in the distal radius fractures and post-fracture biomechanics of the wrist, it was clinically proved that the correction of intra-articular step-off and radial shortening had improved patient functional outcome. [2] Restoration of radial height, radial inclination, volar tilt and congruity of the articular surface is important for a good functional result. Failure to achieve and maintain near anatomic reduction can lead to degenerative arthritis, distal radioulnar instability, and ulnar impaction syndrome with resultant pain, decreased mobility, strength, and function.[3] Understanding both the pathology and mechanics of these injuries highlights many issues faced by patients including limitation of movements and joint arthritis, along with instability in cases where the anatomical reduction of fracture fragments is not achieved. The chances of unfavourable outcomes after an intra-articular fracture of the distal radius increase with the occurrence of malunion and stiffness of the wrist joint; surgical corrections are often needed to achieve a functionally acceptable outcome and anatomical position.[5]

DRFs can be treated conservatively with a cast or splint immobilisation after attempted closed reduction, where warranted. Current evidence demonstrates that young and active patients with displaced DRFs and higher functional demands benefit from operative treatment. [1] Different types of treatment modalities are available including closed reduction and plaster of Paris application, external fixation, internal fixation, and percutaneous pin fixation. Out of all modalities of treatment, percutaneous pin fixation is the least morbid surgical treatment accounting for the advantage of both non-operative and operative treatment. [2] Various studies have previously compared the merits and demerits of external fixation with internal fixation, but there is a lack of sufficient evidence about which technique has the best possible outcome.[5]

In the treatment of intra-articular distal radius fractures (IDRF), percutaneous pinning, external fixator (EF), plates, and their combinations could be used after closed or open reduction. Generally, CRPP with EF and ORIF with volar locking plates are accepted methods to treat IDRF. CRPP with or without EF is a minimally invasive and cost-effective method, but complications such as reduction loss, pin tract infection, stiffness, and complex regional pain syndrome are its disadvantages. Recently, ORIF with a volar locking plate is the preferred and more popular method. It allows immediate range of motion of the wrist while maintaining alignment, resulting in rapid functional recovery, but this method is more expensive and surgically more demanding, especially in intra-articular fractures. [6,8,19] For an optimal result, an accurate restoration of skeletal anatomy and most importantly supervised rehabilitation by skilled physiotherapy is required. The best method of obtaining and maintaining an accurate restoration of articular anatomy, however, remains a topic of considerable controversy.[20]

Therefore, the purpose of our study is to compare percutaneous K-wires versus volar locking plate fixation in terms of clinical, functional, and radiological outcomes and complications in cases with intra-articular distal end of radius fractures.

Aim and Objectives

Aim: To compare the functional and radiological outcomes of fixation of intra-articular distal radius

fractures with percutaneous K-wires versus volar locking plate.

Primary Objective: To compare the mean QDASH (Quick Disabilities of Arm, Shoulder & Hand) score and MMWS (Modified Mayo Wrist Score) at 6 months follow-up among both study groups.

Secondary Objective: To estimate the proportion of cases who developed complications within 6 months of procedure in both groups.

Materials and Methods

Study Design and Setting: This prospective randomized interventional study was conducted in the Department of Orthopaedics at SMS Medical College, Jaipur, from December 2023 to October 2024 after obtaining ethics committee approval.

Sample Size: A sample size of 35 patients in each group was calculated with 95% confidence level and 80% study power assuming a mean difference of 5.44% in QDASH score with a standard deviation of 5.26% in percutaneous fixation with K-wires versus volar locking plate fixation for displaced intra-articular distal radius fractures, as per the index reference article. The final sample size was enhanced to 35 patients in each group expecting 20% dropouts.

Inclusion Criteria: Patients above 18 years of age of either sex with intra-articular distal radius fractures (injury less than 2 weeks old), willing to participate in the study, and available for a follow-up period of at least 6 months were included.

Exclusion Criteria: Open fractures, bilateral distal radius fractures, isolated radial styloid fractures, same side upper limb injuries that may affect the overall functional outcome, and patients not willing for surgery were excluded.

Methodology: After applying inclusion and exclusion criteria, selected patients were recruited and written informed consent was obtained. All patients were classified into two groups based on randomization: Group A (n=35) treated with percutaneous fixation with K-wires and Group B (n=35) treated with volar locking plate fixation. All patients were evaluated with detailed history including the mode of trauma and thorough clinical examination. Plain X-ray anteroposterior and lateral views were taken to classify fractures as per Frykman classification. Frykman type III, IV, VII, and VIII intra-articular distal end radius fractures were included.

K-wire Fixation Technique: Patients were positioned supine with supraclavicular regional block. After closed reduction confirmed under fluoroscopy, two or multiple 1.8 mm K-wires were inserted from the radial side with the forearm in pronation. The routine K-wire fixation provides coronal and sagittal plane stability but fails to provide rotational stability as the wires converge and cross at a point at or near the fracture. Therefore, radioulnar pins were also added to transfix the distal radioulnar joint and provide rotational stability. The added advantage of this was maintaining radial length during fracture union, effectively countering late collapse which is an important influencing factor for a poorer outcome. Quality of reduction and fixation were confirmed under image intensifier. K-wires were bent and cut, pin-tract dressing was done, and below elbow slab was applied. Radiological parameters (radial inclination, volar tilt, radial length, ulnar variance) were evaluated postoperatively. Analgesics and antibiotics were prescribed. Active and passive ROM exercises of the digits, elbow and shoulder were initiated on the first postoperative day.

Volar Locking Plate Technique: Surgery was performed under appropriate anaesthesia (general anaesthesia or supraclavicular block) with tourniquet control. A modified Henry incision of approximately 8 cm was given in the distal forearm between the flexor carpi radialis (FCR) and radial artery. The skin, subcutaneous fascia and deep fascia were consecutively cut open. The radial artery was protected and retracted to the radial side while the FCR tendon and median nerve were retracted to the ulnar side. The pronator quadratus was sharply released from its radial insertion and reflected to expose the fracture site. Under direct visualization and fluoroscopy guidance, fracture reduction was achieved and maintained with temporary K-wire fixation. A volar locking plate was placed and initially secured proximal to the fracture site with a 3.5 mm cortical screw in the oblong hole. Distal fixation with locking screws was then performed while maintaining fracture reduction under image intensifier. The remaining proximal fixation was completed using appropriate size cortical screws.[16] After wound closure in layers, the forearm was immobilized in a below elbow slab. Analgesics and antibiotics were prescribed postoperatively. Active and passive wrist motion was initiated on day 1 postoperatively.

Follow-up and Assessment: Patients were reviewed every 2 weeks for a month, then at 6 weeks, 12 weeks, and final follow-up at 6 months. In the K-wire group, wires were removed at 6 weeks after confirming radiological union. Radiological parameters (radial height, radial inclination, and volar tilt) were measured on anteroposterior and lateral radiographs. Functional outcomes were assessed using the Modified Mayo Wrist Score (MMWS) and Quick DASH (QDASH) scoring system. QDASH questionnaire was validated by the patient evaluating the ability to perform daily activities. MMWS scale was validated by the orthopaedic surgeon based on pain, functional status, range of wrist motion and grip strength. Range of motion (dorsiflexion, volar flexion, ulnar

deviation, radial deviation, pronation and supination) was measured with a goniometer. Grip strength was measured in both wrists with a Jamar dynamometer. MMWS scores were interpreted as: poor (<65), fair (65–79), good (80–89), and excellent (≥90). QDASH scores were graded as: excellent (<25), good (26–35), moderate (36–45), and poor (>45). Postoperative complications including wound infection, malunion, tendon rupture, osteoarthritis, joint mobility disorders, persistent neuropathy and complex regional pain syndrome were monitored during follow-up.

Statistical Analysis: Data was entered in Microsoft Excel and analysed using SPSS Statistics version 15.0 (IBM, Armonk, NY, USA). Continuous variables were summarized as mean and standard deviation while categorical variables were expressed as frequencies and percentages. Appropriate parametric tests were used for linear variables and non-parametric tests were used for categorical variables. A comparison of quantitative variables between study groups was done using Student's unpaired t-test. A p-value of less than 0.05 was considered statistically significant with a 95% confidence interval.

Results

A total of 70 patients with intra-articular distal end radius fractures were included in this study and were randomly divided into two groups of 35 patients each.

Table 1: Demographic and Clinical Characteristics of Study Population

Parameter	Category	K-wire Group (n=35)	VLP Group (n=35)	Total (n=70)
Age (years)	Mean ± SD	37.82 ± 8.68	38.28 ± 9.53	-
	Range	20 – 62	22 – 55	-
Sex	Male	19 (54.29%)	20 (57.14%)	39
	Female	16 (45.71%)	15 (42.86%)	31
Mode of Injury	RTA	21 (60%)	24 (68.57%)	45
	FFH	8 (22.86%)	7 (20%)	15
	FOOSH	6 (17.14%)	4 (11.43%)	10
Injured Side	Right	22 (62.86%)	17 (48.57%)	39
	Left	13 (37.14%)	18 (51.43%)	31
Dominant Hand	Involved	24 (68.57%)	26 (74.29%)	50
	Not involved	11 (31.43%)	9 (25.71%)	20

RTA = Road Traffic Accident; FFH = Fall From Height; FOOSH = Fall On Outstretched Hand; SD = Standard Deviation.

The mean age of presentation was 37.82±8.68 years (range: 20–62 years) in the K-wire group and 38.28±9.53 years (range: 22–55 years) in the VLP group. Males were predominantly affected in both groups with 54.29% in the K-wire group and 57.14% in the VLP group. Road traffic accident was the most common mode of injury in both groups (60% and 68.57% respectively), followed by fall from height and fall on outstretched hand. The dominant hand was involved in the majority of patients in both groups (68.57% and 74.29% respectively).

Table 2: Distribution of Patients According to Frykman Classification

Frykman Type	K-wire Group (n=35)	VLP Group (n=35)	Total (n=70)
Type III	12 (34.29%)	11 (31.43%)	23 (32.86%)
Type IV	8 (22.86%)	11 (31.43%)	19 (27.14%)
Type VII	9 (25.71%)	8 (22.86%)	17 (24.29%)
Type VIII	6 (17.14%)	5 (14.29%)	11 (15.71%)

Frykman type III was the most common fracture pattern in both groups (34.29% in K-wire and 31.43% in VLP group), followed by type IV, type VII, and type VIII fractures (Table 2).

Table 3: Comparison of Radiological Parameters Between Study Groups

Parameter	Time Point	K-wire Group (Mean ± SD)	VLP Group (Mean ± SD)	p-value	Significance
Radial Height (mm)	Post-op	10.2 ± 2.13	10.71 ± 2.23	-	-
	6 months	8.48 ± 1.40	9.94 ± 1.69	<0.05	S
Radial Inclination (°)	Post-op	19.42 ± 2.46	20.05 ± 1.92	-	-
	6 months	17.8 ± 2.44	19.48 ± 1.61	<0.05	S
Volar Tilt (°)	Post-op	11.71 ± 2.45	12.88 ± 2.31	-	-
	6 months	8.88 ± 3.57	11.97 ± 2.12	>0.05	NS

S = Significant; NS = Not Significant; SD = Standard Deviation

Radiological parameters were compared between both groups at immediate postoperative and final follow-up (6 months). At final follow-up, the VLP group demonstrated significantly better radial height (9.94±1.69 mm vs 8.48±1.40 mm, $p<0.05$) and radial inclination (19.48±1.61° vs 17.8±2.44°, $p<0.05$). The difference in volar tilt, although higher in the VLP group (11.97±2.12° vs 8.88±3.57°), was not statistically significant ($p>0.05$). A greater loss of radiological parameters was observed in the K-wire group between immediate postoperative and final follow-up measurements (Table 3).

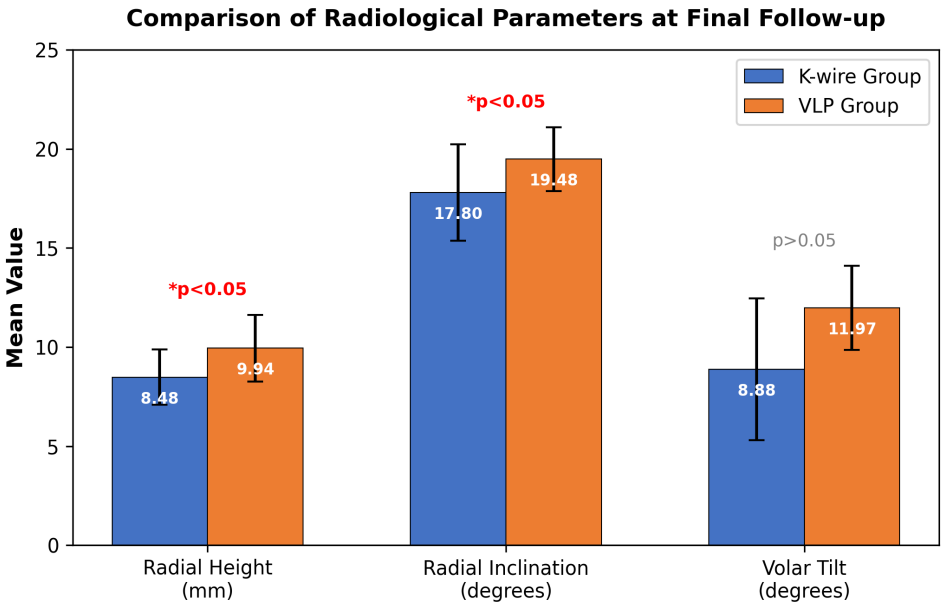

Figure 1: Comparison of Radiological Parameters at Final Follow-up Between K-wire and VLP Groups

Table 4: Comparison of Range of Motion and Grip Strength at Final Follow-up

Parameter	K-wire Group (Mean ± SD)	VLP Group (Mean ± SD)	p-value	Significance
Dorsiflexion (°)	68.82 ± 5.38	75.88 ± 3.67	>0.05	NS
Palmar Flexion (°)	64.8 ± 7.55	73.22 ± 7.29	>0.05	NS
Radial Deviation (°)	10.62 ± 2.38	11.48 ± 2.70	>0.05	NS
Ulnar Deviation (°)	24.11 ± 4.80	29.4 ± 4.72	>0.05	NS
Pronation (°)	68.51 ± 3.56	73.42 ± 4.74	>0.05	NS
Supination (°)	71.8 ± 3.94	75.14 ± 4.11	<0.05	S
Grip Strength (%)	76.2 ± 4.15	80.54 ± 5.33	<0.05	S

S = Significant; NS = Not Significant; SD = Standard Deviation

At the final follow-up, all range of motion parameters were higher in the VLP group compared to the K-wire group. However, the differences in dorsiflexion, palmar flexion, radial deviation, ulnar deviation, and pronation were not statistically significant ($p>0.05$). Supination (75.14±4.11° vs 71.8±3.94°, $p<0.05$) and grip strength (80.54±5.33% vs 76.2±4.15%, $p<0.05$) were significantly better in the VLP group (Table 4).

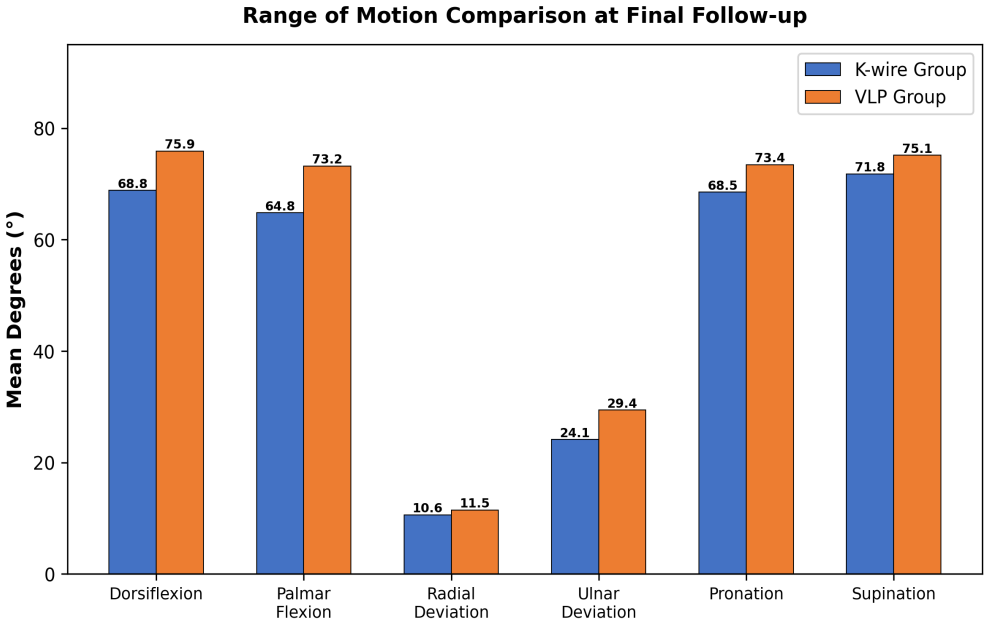

Figure 2: Comparison of Range of Motion Between K-wire and VLP Groups at Final Follow-up

Table 5: Comparison of Functional Outcome Scores at Final Follow-up

Outcome Measure	K-wire Group (Mean ± SD)	VLP Group (Mean ± SD)	p-value	Significance
QDASH Score	35.38 ± 9.45	28.30 ± 10.13	<0.05	S
MMWS	76.85 ± 7.38	81.85 ± 8.14	<0.05	S
Grip Strength (%)	76.2 ± 4.15	80.54 ± 5.33	<0.05	S

S = Significant; QDASH = Quick Disabilities of Arm, Shoulder & Hand; MMWS = Modified Mayo Wrist Score

The QDASH score of the K-wire group was 35.38±9.45 compared to 28.30±10.13 in the VLP group, and the difference was statistically significant ($p<0.05$). The MMWS was 76.85±7.38 in the K-wire group compared to 81.85±8.14 in the VLP group, with a statistically significant difference ($p<0.05$). Both functional outcome measures demonstrated the superiority of volar locking plate fixation over K-wire fixation (Table 5).

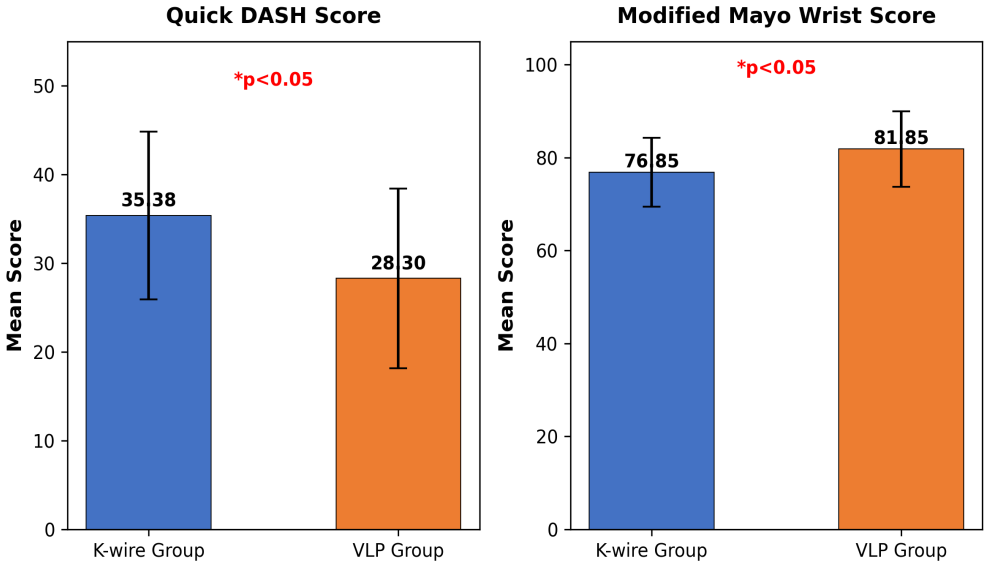

Figure 3: Comparison of Quick DASH Score and Modified Mayo Wrist Score Between Study Groups

Complications

None of the patients in our series developed any severe complications in either study group. In the K-

wire group, 3 cases (8.57%) reported superficial pin-tract infection and 6 cases (17.14%) developed wrist joint stiffness. In the VLP group, 1 case (2.85%) reported superficial surgical site infection and 4 cases (11.42%) developed wrist joint stiffness. Superficial pin-tract infection subsided with pin-tract care and a short course of antibiotics. Surgical site infection was managed with intravenous antibiotics and daily wound dressing. Patients with wrist joint stiffness were advised physiotherapy protocol.

Discussion

Distal radius fractures are a much-discussed topic from the early eighteenth century since Abraham Colles first described it. The distal end of the radius fractures are the most common fractures presenting to the emergency department. Though prevalent in the elderly population due to osteoporosis, it is also more commonly present in the young population due to high-velocity injuries. Intra-articular fractures of the distal radius are complex injuries, and the primary goal of treatment is to achieve proper restoration of disrupted anatomy, maintain intra-articular congruity, provide adequate stability, and allow early return of hand function without complications. In this study, we compared the functional and radiological outcomes of percutaneous K-wire fixation versus volar locking plate fixation in 70 patients with intra-articular distal radius fractures classified using the Frykman classification.

In our study, the average age of patients in the K-wire group was 37.82 years and 38.28 years in the VLP group. In the study of Patel et al. [3] the average age of the 34 patients was 40.53 years. Thus, the average age of the patients in our study was almost similar. In our study, males were predominantly affected with 54.29% in the K-wire group and 57.14% in the VLP group. In Patel et al. [3] study, 76.48% were male, showing a male preponderance. Sharma et al. [5] showed similar results with 60% males and 40% females. Ahmed et al. [27] included 49 patients with 59.2% males and 40.8% females. The male preponderance can be attributed to the fact that most of the traumas were a result of motor vehicle accidents and males are more likely to be involved in outdoor activities.

The majority of the fractures were caused by road traffic accidents in both groups—21 (60%) and 24 (68.57%)—followed by fall from height and trivial fall. This is comparable with most reported studies. Vipin et al. [2] supports our study showing that RTA was the major mode of injury. In Patel et al. [3] study, the majority of fractures (70.58%) were caused by RTA. Chavhan et al. [16] also showed that the most common cause of injury was RTA in 57.1% patients. Due to modernization of lifestyle, industrial working conditions, extensive use of two-wheelers, poor road conditions, and lack of adherence to traffic rules seem to have contributed to the high prevalence of RTA as a causative factor.

In our study, 68.57% patients had dominant hand involvement in the K-wire group and 74.29% in the VLP group. Vipin et al. [2] supports our study showing that 55% patients had dominant right hand involvement. Similar findings were seen by Patel et al. [3] where 58.82% had right-side involvement. Sharma et al. [5] reported dominant side involvement in 63.3% of total patients. Dominant hand predilection was also found in the study of Ahmed et al. [27] This may be due to the fact that the dominant extremity reaches out first to have the initial impact of trauma.

In this study, 34% patients had Frykman type III, 23% type IV, 26% type VII and 17% type VIII fracture in K-wire group, whereas 32% had type III, 31% type IV, 23% type VII and 14% type VIII in VLP group. A study by Varshney et al. [9] showed that 47% had Frykman type III in the K-wire group and 23% in the VLP group. Both studies show that the majority of patients had Frykman type III fracture in the K-wire group.

At the final follow-up, radiological parameters in both the study groups were compared. Mean radial height was 8.48±1.40 mm and 9.94±1.69 mm in K-wire and VLP groups respectively. Mean radial inclination was 17.8±2.44° and 19.48±1.61° in K-wire and VLP groups respectively. The mean RH and RI differences between these study groups were significant ($p<0.05$). Mean volar tilt was 8.88±3.57° and 11.97±2.12° in K-wire and VLP groups respectively, but the difference was not significant ($p>0.05$). Saruhan et al. [6] compared the groups radiologically and found the ORIF group to be better than CRPP regarding radial height and volar tilt, with no difference found regarding radial inclination and ulnar variance. Varshney et al. [9] showed mean volar tilt at union was 10.43±2.06 in K-wire group and 13.17±2.77 in volar plate group. Mean radial height at union was 10.30±1.05 in K-wire group and 11.00±0.83 in volar plate group, indicating volar plate has superior radiological outcome compared to K-wire. Our study results were comparable to Varshney et al. [9] study.

This study shows that mean dorsiflexion was 68.82±5.38° and 75.88±3.67° ($p>0.05$); mean palmar flexion was 64.8±7.55° and 73.22±7.29° ($p>0.05$); mean radial deviation was 10.62±2.38° and 11.48±2.70° ($p>0.05$); mean ulnar deviation was 24.11±4.80° and 29.4±4.72° ($p>0.05$); mean pronation was 68.51±3.56° and 73.42±4.74° ($p>0.05$); mean supination was 71.8±3.94° and 75.14±4.11° ($p<0.05$) at final follow-up in K-wire and VLP groups respectively. Saruhan et al. [6] evaluated wrist flexion-extension, pronation–supination arch, radial–ulnar deviation, and grip

strength and found no statistically significant differences between the groups. Varshney et al. [9] showed that dorsiflexion was 77.83±6.65° in the VLP group and 68.67±9.55° in the K-wire group ($p<0.001$); palmar flexion was 76.50±6.97° and 65.67±9.98° respectively; pronation was 74.83±7.82° and 70.17±7.93° respectively ($p=0.025$); and supination was 75.83±5.10° and 72.00±6.64° respectively.

This study shows that mean grip strength was 76.2±4.15% and 80.54±5.33% in K-wire and VLP groups respectively ($p<0.05$). The QDASH score of K-wire and VLP groups was 35.38±9.45 and 28.30±10.13 respectively ($p<0.05$). The MMWS was 76.85±7.38 and 81.85±8.14 of K-wire and VLP groups respectively ($p<0.05$). Saruhan et al. [6] supported our study, finding Q-DASH scores to be significantly better in the ORIF group compared to CRPP. Varshney et al. [9] showed mean DASH score of 33.47±5.26 in K-wire group and 28.03±5.19 in volar plate group, indicating VLP group has better functional outcome, which was statistically significant ($p<0.05$). Beyer et al. [39] in their meta-analysis found that volar plating outperformed percutaneous pins for loss of reduction, infection, DASH score, and ulnar deviation. Chaudhry et al. [42] in their meta-analysis of randomized controlled trials found that volar locking plates show better DASH scores compared with K-wires for displaced distal radius fractures; however, these differences were small and unlikely to be clinically important. Brennan et al. [38] in their study of 318 patients found that although volar plate treatment resulted in superior radiological outcomes, there was no evidence that this translated into a superior functional outcome. They suggested that K-wiring remains a suitable inexpensive option for simple fractures, while volar plating should be reserved for complex fractures.

In our study, wrist joint stiffness was the most common reported complication—17.14% and 11.42% in K-wire and VLP study groups respectively. Superficial pin-tract infection was noted in 8.57% cases in K-wire group and superficial surgical site infection in 2.85% cases in VLP group. Sharma et al. [5] showed similar results as wrist stiffness (16.66%) was the most common complication, 13.33% in the external fixator group and 3.33% in the plating group. Ward et al. [45] reported that transient nerve dysfunction was the most common complication in their series of volar plate fixations, and that the incidence of complications decreased significantly with increased surgeon experience.

The superiority of VLP fixation can be attributed to its biomechanical advantages including rigid subchondral support of the articular surface, ability to achieve and maintain anatomical reduction, and provision of early stable fixation allowing earlier rehabilitation. [36] In contrast, K-wire fixation, although minimally invasive and cost-effective, is prone to loss of reduction, late collapse, and delayed rehabilitation due to prolonged immobilization. [11,15] Akdemir et al. [40] suggested that no single method is directly superior to other methods; however, the best radiological results for comminuted intra-articular fractures were obtained with volar plates. Meena et al. [28] suggested that ORIF offers the best chances of an optimum outcome in intra-articular fractures while low-energy extra-articular fractures are best managed conservatively.

Conclusion

In the radiological results, all parameters were found to be better in the VLP group. With the exception of the volar tilt, these results were statistically significant. Hence, it is concluded that stabilizing intra-articular distal radius fractures with open reduction and internal fixation by volar locking plate and screws is an effective method to maintain the reduction until union and prevent collapse of fracture fragments.

In the examination of clinical results, the flexion-extension arch, supination-pronation arch, and radial-ulnar deviation were found to be higher in the VLP patients when compared to the K-wire group, but there was no statistically significant difference. However, the grip strength values were found statistically significantly higher in the VLP group when compared to the K-wire group.

With respect to the functional results, the QDASH score of the VLP patients was lower than that of those in the K-wire group and MMWS score was higher in VLP group compared to K-wire group. The difference was statistically significant.

In the present study, it was found that the majority of participants had excellent and good functional outcome with minimal complications after volar plate fixation. Hence, volar locking plate fixation can be used as the preferred modality in treating intra-articular fractures of distal end radius with fewer complications. However, K-wire fixation remains a viable, minimally invasive, and cost-effective option, particularly for simpler fracture patterns and resource-limited settings.

Limitations

This study has certain limitations because it is a comparative study of prospective design with only a limited number of cases in the stipulated period and short-term follow-up of most cases. Another limitation is that different subtypes of fracture pattern were not fixed with the same method of fixation. Long-term follow-up studies with larger sample sizes are needed to further validate these findings.

Source of Funding

None.

References

1. Nordback PH, Ragupathi T, Cheah AEJ. A proposed paradigm shift in the management of distal radius fractures. Journal of Orthopaedics. 2023;49:117-122.
2. Vipin R, Rengarajan N, Manoharan M, Kesavan K. A Novel 5-pin Fixation for Distal Radius Fractures and Its Functional Assessment. J Orthop JS. 2021;3(1):13-17.
3. Patel RH, Asati GS, Bidoliya V, Lunagariya R. Functional outcome of intra-articular distal end radius fracture treated with volar plate fixation. J Orthop Dis Traumatol. 2023;6(3):237-241.
4. Patel S, Deshmukh A, Yadav P, Phalak M, Gurnani S, Yadav S, et al. Assessment of Functional and Radiological Outcomes of Comminuted Intra-Articular Distal Radius Fracture Treated With Locking Compression Plate. Cureus. 2022;14(1):e21398.
5. Sharma A, Pathak S, Sandhu H, Bagtharia P, Kumar N, Bajwa RS, et al. Prospective Randomized Study Comparing the External Fixator and Volar Locking Plate in Intraarticular Distal Radius Fractures: Which Is Better? Cureus. 2020;12(2):e6849.
6. Saruhan S, Davulcu CD. Closed reduction percutaneous pinning versus open reduction internal fixation in the treatment of intraarticular distal radius fractures: mean four-year results. Ulus Travma Acil Cerrahi Derg. 2021;27(2):238-242.
7. Jia Z, Wang S, Jiang W, Li C, Lin J, Liu Q, et al. The treatment of complex intra-articular distal radius fractures with turning radius and distal volaris radius plate fixation. Eur J Med Res. 2020;25:66.
8. Zengin EC, Ozcan C, Aslan C, Bulut T, Sener M. Cast immobilization versus volar locking plate fixation of AO type C distal radial fractures in patients aged 60 years and older. Acta Orthop Traumatol Turc. 2018;53:15-18.
9. Varshney A, Garg V, Srivastava S, Sundararajan S. Percutaneous fixation with Kirschner wires versus volar locking plate fixation in adults for displaced intra articular fracture of distal radius. IJOS. 2020;6(3):64-72.
10. Kulkarni RS, Kulkarni RA, Kulkarni AP, Kulkarni RR, Deshpande RS, Kulkarni SR. Epidemiology and Long Term Trend of Distal Radius Fracture in Elderly of Sindhudurg, West Coast of Maharashtra, India: A 12 Years Follow Up Study. AJORR. 2022;5(2):172-178.
11. Kandeel AAM. Elderly unstable distal radius fractures: a prospective cohort study of bone substitutes-augmented percutaneous pinning. BMC Musculoskelet Disord. 2022;23:239.
12. Kumar R, Kumar N, Kumar A. Comprehensive Comparative study of fracture distal end radius with plating and K-Wire fixation. J Orthop Dis Traumatol. 2021;4:9-11.
13. Jati S, Goyal D, Awasthi D. A study of correlation between radiological and functional outcome of distal radius fracture treated by various modalities. Orthop JMPC. 2017;23(1):32-35.
14. Suman NV, Chincholi S. Study of occurrence of fracture of distal radius in Indian adult population. IJOS. 2020;6(1):50-52.
15. Kaushik SB, Pereira J, Shenoy RM. A study on the functional outcome of closed reduction and K-wire fixation in the treatment of extra-articular distal radius fractures. AJMS. 2024;15(11):155-160.
16. Chavhan AN, Dudhekar UJ, Badole CM, Wandile KN. Functional and radiological outcome in distal radius fractures treated with locking compression plate. Int J Res Med Sci. 2017;5(2):574-582.
17. Patel VA, Pushkarna VA, Padhiyar HS. Study of treatment for distal end radial fractures by open reduction and internal fixation with volar locking compression plates. Surg Rev Int J Surg Trauma Orthoped. 2020;6(6):347-353.
18. Sakale H, Agrawal AC, Verma S, Kar B. Distal radius plating: Role and significance. J Orthop Dis Traumatol. 2020;3(2):45-48.
19. Naik A, Singh S, Pandey M, Panda N, Das SP. Evaluation of functional results of different treatment modalities in intra-articular fracture of distal end of radius in adults at a tertiary care hospital in Eastern India. Indian J Orthop Surg. 2023;9(2):81-88.
20. Chandan K, Kumar R, Ranjan R, Amar R. Functional outcome of intra-articular fracture of distal end of radius treated by open reduction and internal fixation with locking distal radius system. J Orthop Dis Traumatol. 2021;4(1):3-8.
21. Chhabra AB, Yildirim B. Adult Distal Radius Fracture Management. J Am Acad Orthop Surg. 2021;29:e1105-e1116.
22. Singh VP, Sharma J, Ghodela A, Johar M. Comparison of hand grip strength in patients with distal radius fracture treated by closed reduction with cast versus open reduction and internal fixation. Indian J Orthop Surg. 2023;9(2):49-52.
23. Bhasme VK, Shettar VG, Battur MN. Functional Outcome Analysis of Fixation of Distal Radius Fractures using 'Five Pin Technique'. Int J Contemp Med Res. 2018;5(9):114-118.
24. Ermutlu C, Mert M, Kovalak E, Kanay E, Obut A, Oztürkmen Y. Management of Distal Radius Fractures: Comparison of Three Methods. Cureus. 2020;12(8):e9875.

25. Khader FA, Sooraj SAG, Priyadarshan SVR, Girikrishnan A. Recent perspectives in the management of distal radius fractures. Int J Orthop Sci. 2022;8(2):189-192.
26. Gu Y, Zhao L, Ren Y, Nyeenya NJ, Wang Y, Xu C, et al. Clinical Study of Volar Median Approach Combined with Lateral Radial Auxiliary Approach in Treatment of C-Type Distal Radius Fractures: Our Clinical and Radiological Results. Med Sci Monit. 2023;29:e938806.
27. Ahmed M, Ahmed N, Kumar S, Kumar M, Bux M, Hussain G. Functional Outcome of Intraarticular Fracture of Distal Radius Managed by Volar Locking Plate. Cureus. 2020;12(10):e11271.
28. Meena S, Sharma P, Sambharia AK, Dawar A. Fractures of Distal Radius: An Overview. J Fam Med Primary Care. 2014;3(4):325-332.
29. Mishra PK, Nagar M, Gaur SC, Gupta A. Morphometry of distal end radius in the Indian population: A radiological study. Indian J Orthop. 2016;50(6):610-615.
30. Ansari E, Tank PM, Chawda RV, Patel VJ, Patel NB. Surgical treatment of distal end of radius fracture with volar locking plate: Clinicoradiological outcome of 25 cases. Indian J Orthop Surg. 2018;4(3):264-269.
31. Ballal A, Sadasivan AK, Hegde A, Shetty A. Open Reduction and Volar Plate Fixation of Dorsally Displaced Distal Radius Fractures: A Prospective Study of Functional and Radiological Outcomes. J Clin Diagn Res. 2016;10(12):1-4.
32. Choudhari P, Desai R, Jain N, Jain S. To evaluate the functional outcome of volar plating in distal end radius fractures. Int J Adv Res. 2023;11(03):805-814.
33. Ramnath DS, Ravikiran N, Kolla S. Study of outcome after fracture reduction and internal fixation with volar locking plates in distal end radius fractures. Int J Med Res Rev. 2016;4(6):987-992.
34. Kotian P, Mudiganty S, Annappa R, Austine J. Radiological Outcomes of Distal Radius Fractures Managed with 2.7mm Volar Locking Plate Fixation—A Retrospective Analysis. J Clin Diagn Res. 2017;11(1):9-12.
35. Kaushal A, Patel J, Katariya J, Usdadia SK, Kalathia C. Clinical outcome and evaluation of patients with distal end radius fractures operated with volar plate and pronator quadratus repair versus no repair. Indian J Orthop Surg. 2019;5(4):252-257.
36. Hadzhinikolova M, Zderic I, Ciric D, Barcik JP, Enchev D, Baltov A. Volar versus combined dorsal and volar plate fixation of complex intraarticular distal radius fractures with small dorsoulnar fragment—a biomechanical study. BMC Musculoskelet Disord. 2022;23:35.
37. Wilson J, Viner JJ, Johal KS, Woodruff MJ. Volar Locking Plate Fixations for Displaced Distal Radius Fractures: An Evaluation of Complications and Radiographic Outcomes. Hand. 2018;13(4):466-472.
38. Brennan S, Kiernan C, Beecher S, O'Reilly R, Devitt B, Kearns S, et al. Volar plate versus K-wire fixation of distal radius fractures. Injury. 2016;47:372-376.
39. Beyer J, Wynkoop E, Liu J, Ebraheim N. Interventions for Distal Radius Fractures: A Meta-analysis of Comparison Studies. J Wrist Surg. 2021;10:440-457.
40. Akdemir M, Kilic A, Kurt C, Capkin S. Open Reduction and Plate Fixation, External Fixator, and Conservative Treatment for Intra-articular Distal Radius Fractures. Cureus. 2024;16(1):e52014.
41. Bhattarai A, Subedi D, Bhandari J, Homagain S, Paudel S, Ghimire J. Neglected volar Barton fracture in adult managed in a rural setting: a case report. Ann Med Surg. 2024;86:2330-2334.
42. Chaudhry H, Kleinlugtenbelt Y, Mundi R, Ristevski B, Goslings J, Bhandari M. Are Volar Locking Plates Superior to Percutaneous K-wires for Distal Radius Fractures? A Meta-analysis. Clin Orthop Relat Res. 2015;473:3017-3027.
43. Qiu W, Li Y, Ji Y, Xu W, Zhu X, Tang X, et al. The comparative risk of developing postoperative complications in patients with distal radius fractures following different treatment modalities. Sci Rep. 2015;5:15318.
44. Dennison D, Blanchard C, Elhassan B, Moran S, Shin A. Early Versus Late Motion Following Volar Plating of Distal Radius Fractures. Hand. 2020;15(1):125-130.
45. Ward C, Kuhl T, Adams B. Early complications of volar plating of distal radius fractures and their relationship to surgeon experience. Hand. 2011;6:185-189.