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COMPARISON OF THE FUNCTIONAL OUTCOMES OF VOLAR PLATE VERSUS K – WIRES FIXATION FOR DISTAL RADIUS ARTICULAR FRACTURES

Original Research

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ABSTRACT

Background: Distal radius fractures (DRFs) are among the most common upper limb injuries, particularly affecting elderly osteoporotic individuals and young adults. Optimal surgical management for intra-articular DRFs remains debated, with volar locking plates and K-wire fixation being widely used techniques.

Objective: To compare the short-term functional outcomes of volar locking plate versus K-wire fixation in adult patients with intra-articular distal radius fractures.

Methods: This randomized controlled trial was conducted over six months at the Department of Orthopedics, Khyber Teaching Hospital, Peshawar. A total of 174 patients aged 30–65 years with distal radius fractures were enrolled and randomized into two equal groups. Group A (n=87) underwent volar locking plate fixation, and Group B (n=87) received percutaneous K-wire fixation. Patients were followed for six weeks, and functional outcomes were assessed using the Quick Disabilities of the Arm, Shoulder, and Hand (Quick DASH) score. Data were analyzed using SPSS version 26, with significance set at $p \leq 0.05$.

Results: Group A showed significantly better functional outcomes, with 47.1% achieving excellent DASH scores compared to 31.0% in Group B. Poor outcomes were observed in 17.2% of patients in the K-wire group and none in the volar plate group. The mean DASH score was lower in the volar plate group (8.9 ± 4.7) versus the K-wire group (14.6 ± 6.2), indicating better function and recovery in the former.

Conclusion: Volar locking plate fixation demonstrated superior early functional outcomes compared to K-wire fixation. It may be the preferred option in cases requiring faster rehabilitation and better early recovery, although both methods remain clinically viable.

Keywords: Adult, Bone Plates, Fracture Fixation, Fracture Healing, Kirschner Wires, Radius Fractures, Randomized Controlled Trial.

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INTRODUCTION

Distal radius fractures (DRFs) are among the most frequently encountered injuries in orthopedic and emergency medicine, accounting for nearly one-fourth of all upper limb fractures presenting to emergency departments (1). They represent the most common upper limb fracture and rank third in overall osteoporotic fractures following those of the hip and spine (2). Notably, these fractures exhibit a bimodal distribution, affecting young males—typically due to high-energy trauma—and postmenopausal women—often due to low-energy falls related to osteoporosis (3). The global burden of DRFs is anticipated to rise with an aging population and increased life expectancy, underscoring the importance of optimizing their management. The treatment of distal radius fractures ranges from conservative methods such as closed reduction and immobilization in a cast, to more advanced surgical options like percutaneous pinning and open reduction with internal fixation. While conservative approaches remain effective for stable and minimally displaced fractures, more complex or unstable patterns often require surgical intervention to restore anatomic alignment and function (3,4). Among the surgical options, two commonly employed techniques are percutaneous fixation using Kirschner wires (K-wires) and open reduction with internal fixation (ORIF) using volar locking plates. K-wire fixation is favored for its minimally invasive nature, simplicity, cost-effectiveness, and utility in cases with metaphyseal instability or simple intra-articular involvement (5). However, it may offer limited control over fragment positioning and is associated with complications such as pin migration and infection.

On the other hand, volar locking plate fixation has emerged as a preferred modality for intra-articular and unstable fractures due to its ability to achieve and maintain better fracture reduction and alignment, while allowing earlier mobilization and potentially better functional outcomes (6). Nonetheless, this technique is not without drawbacks, as it entails greater surgical invasiveness and a higher risk of complications including tendon injury, hardware-related issues, and wound problems (7,8). Functional recovery following these interventions can vary widely, and tools such as the Quick Disabilities of the Arm, Shoulder, and Hand (Quick DASH) score provide validated means to quantify patient-reported outcomes. Despite the widespread use of both techniques, limited local evidence exists comparing their functional outcomes, especially in the early postoperative period. In a randomized trial patients undergoing volar plating demonstrated superior outcomes at six weeks compared to those treated with K-wire fixation, although complications were observed across both groups (9,10). This underscores the need for contextualized, evidence-based guidance to inform surgical decision-making and optimize patient recovery. Given the clinical relevance and ongoing debate regarding the optimal fixation method for distal radius articular fractures, this study aims to compare the functional outcomes of volar plate fixation versus K-wire fixation. The results are anticipated to guide best practices and enhance treatment protocols for managing these commonly encountered fractures.

METHODS

This randomized controlled trial was conducted in the Department of Orthopedics at Khyber Teaching Hospital, Peshawar, over a period of six months following formal approval of the research synopsis by the Institutional Research and Ethics Committee. Ethical approval was secured prior to the initiation of data collection and written informed consent was obtained from all participants after thorough explanation of the study's objectives, potential risks, and benefits. Participants were assured of confidentiality, the voluntary nature of their participation, and their right to withdraw at any stage without affecting their standard medical care. The study population included adult patients aged between 30 and 65 years of both sexes who were diagnosed with distal radius fractures based on standard radiographic confirmation, as per the operational definition. Patients were excluded if they had open fractures, a body mass index (BMI) exceeding 30 kg/m², were polytraumatized, had a history of smoking, or demonstrated a poor Glasgow Coma Scale (GCS) score, which could interfere with compliance or follow-up. These exclusion criteria were selected to reduce confounding variables that may influence fracture healing or post-operative functional recovery (11,12). Sample size was calculated using OpenEpi software, taking into account an anticipated Quick DASH score of 63.08% for the volar plate group and 41.54% for the K-wire group, with a power of 80% and a confidence level of 95%. This yielded a total sample size of 174 participants, with 87 patients assigned to each group. A non-probability consecutive sampling technique was employed, and patients were randomly allocated to treatment arms using blocked randomization with age-matching to minimize allocation bias.

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Group A patients underwent open reduction and internal fixation with volar locking plates, while group B patients were treated with closed reduction and percutaneous fixation using K-wires. Surgical procedures were performed under standardized protocols by qualified orthopedic surgeons. All patients were followed up at six weeks post-surgery to evaluate their functional outcomes. Functional assessment was carried out using the Quick Disabilities of the Arm, Shoulder, and Hand (Quick DASH) score, which is a validated instrument designed to assess physical function and symptoms in people with musculoskeletal disorders of the upper limb. Baseline demographic and clinical variables including age, gender, BMI, side of injury, duration of fracture presentation (in hours), educational status, profession, socioeconomic background, and AO fracture classification were recorded on a pre-designed data collection proforma by the principal investigator (13-15). All outcomes were objectively documented at the six-week follow-up. Statistical analysis was performed using IBM SPSS Statistics version 26. Continuous variables such as age, BMI, duration of fracture, and DASH scores were assessed for normal distribution using the Shapiro-Wilk test. Means and standard deviations (or medians and interquartile ranges where appropriate) were reported for continuous data, while frequencies and percentages were computed for categorical variables such as gender, fracture laterality, AO type, and functional outcome categories. Comparative analysis of functional outcomes between the two treatment groups was conducted using the Chi-square test or Fisher's exact test, as appropriate. To control for potential confounding, functional outcomes were stratified by variables such as age, gender, BMI, laterality, AO fracture type, and fracture duration, followed by post-stratification testing using Chi-square or Fisher's exact test. A p-value of ≤ 0.05 was considered statistically significant.

RESULTS

A total of 174 patients with distal radius articular fractures were enrolled and randomized into two equal groups: 87 patients received volar locking plate fixation (Group A), and 87 underwent closed reduction and percutaneous fixation with K-wires (Group B). The mean age in Group A was 48.6 ± 9.3 years and 49.1 ± 8.7 years in Group B. Gender distribution was similar across both groups, with a slightly higher proportion of males in both groups. The average BMI was 24.1 ± 3.2 in the volar plate group and 24.5 ± 3.5 in the K-wire group. Most participants in both groups belonged to the middle socioeconomic status category. Employed individuals constituted the majority of both cohorts, and urban residents slightly outnumbered rural participants in both arms. The average injury duration before presentation was 9.2 ± 2.1 hours in the volar plate group and 9.5 ± 2.3 hours in the K-wire group. AO fracture classification revealed comparable distributions in both groups, with Type B being the most frequent fracture type followed by Type C and Type A.

Functional outcomes at 6 weeks were assessed using the Quick DASH score. In Group A, 41 patients (47.1%) had excellent outcomes, 26 (29.9%) had good outcomes, 20 (23.0%) reported satisfactory results, and none experienced poor outcomes. In contrast, Group B showed excellent outcomes in 27 patients (31.0%), good in 22 (25.3%), satisfactory in 23 (26.4%), and poor in 15 patients (17.2%). The mean Quick DASH score in the volar plate group was 8.9 ± 4.7, while it was higher in the K-wire group at 14.6 ± 6.2, indicating a greater functional limitation in the latter. These results highlight that while both treatment modalities yielded favorable outcomes in a significant number of cases, volar locking plate fixation was associated with a higher frequency of excellent outcomes and lower incidence of poor outcomes at six weeks post-operatively. Differences in AO fracture distribution and baseline demographics were comparable between the two groups, strengthening the internal validity of outcome comparisons.

Table 1: Demographics

Variable	Group A: Volar Locking Plate (n=87)	Group B: K-wire (n=87)
Age (mean ± SD)	48.6 ± 9.3	49.1 ± 8.7
Gender		
Male	52	49
Female	35	38
BMI (mean ± SD)	24.1 ± 3.2	24.5 ± 3.5
Socioeconomic Status		
Lower	26	30
Middle	48	45
Upper	13	12
Occupation Status		
Employed	63	58

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Variable	Group A: Volar Locking Plate (n=87)	Group B: K-wire (n=87)
Unemployed	24	29
Residence		
Rural	33	35
Urban	54	52

Table 2: Functional Outcomes by DASH Score

DASH Outcome Category	Group A: Volar Locking Plate (n=87)	Group B: K-wire (n=87)
Excellent (0–5)	41 (47.1%)	27 (31.0%)
Good (6–15)	26 (29.9%)	22 (25.3%)
Satisfactory (16–35)	20 (23.0%)	23 (26.4%)
Poor (>35)	0 (0.0%)	15 (17.2%)

Table 3: DASH Score Summary

Group	Mean DASH Score ± SD
Volar Locking Plate	8.9 ± 4.7
K-wire	14.6 ± 6.2

Table 4: AO Fracture Type Distribution

AO Fracture Type	Group A: Volar Locking Plate (n=87)	Group B: K-wire (n=87)
Type A	25	27
Type B	30	29
Type C	32	31

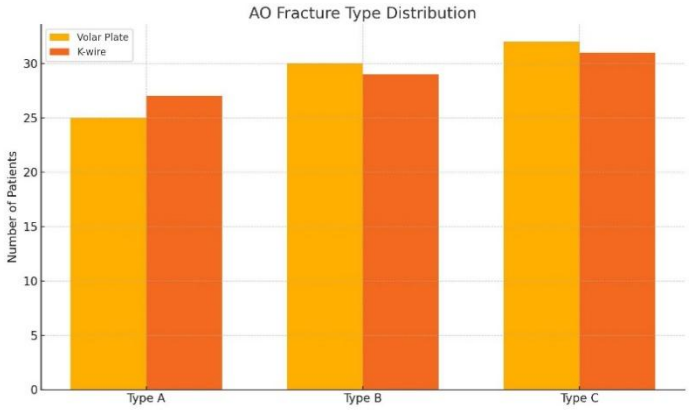

Figure 1 AO Fracture Type Distribution

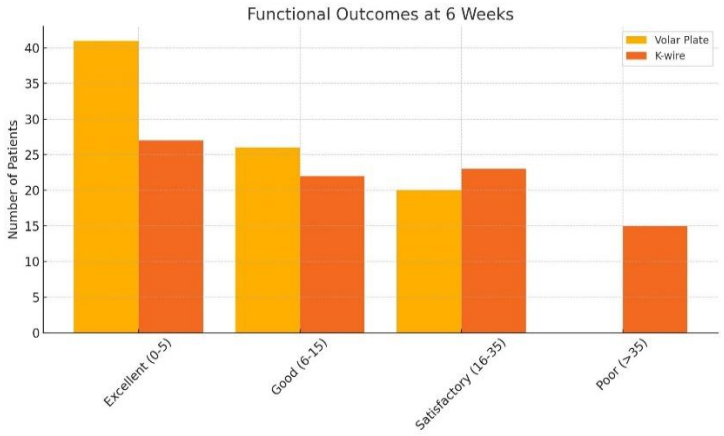

Figure 2 Functional Outcomes at 6 Weeks

DISCUSSION

The findings of this study contribute to the growing body of evidence comparing volar locking plate fixation and percutaneous K-wire fixation for distal radius articular fractures. The superior early functional outcomes associated with volar plate fixation observed in this trial align with numerous recent studies. At six weeks, patients in the volar plate group demonstrated significantly better DASH scores and a higher proportion of excellent functional outcomes compared to those in the K-wire group, suggesting a more favorable early recovery trajectory. These findings are supported by a study, which reported improved DASH and PREW scores in the volar plate group at three and six months, although long-term outcomes between both techniques converged over time (16). Similarly, a study noted that,

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while both techniques resulted in comparable functional scores after 12 months, the volar plate group had significantly better scores at three and six months (17). A recent meta-analysis encompassing 14 randomized controlled trials with over 1,400 patients reinforced these observations. It found that volar locking plate fixation yielded better DASH scores and greater range of motion, especially in the early postoperative period, although the differences narrowed after 12 months (18).

Despite these advantages, the study acknowledges that both techniques are effective and widely practiced. As demonstrated by a study, while volar plate fixation offers superior joint range of motion and lower complication rates, K-wire augmented fixation remains a viable alternative in cases where minimally invasive intervention is preferred (19). Nevertheless, a nuanced understanding of complications is essential. The current study found no instances of poor outcomes in the volar plate group, whereas 17.2% of patients in the K-wire group experienced poor outcomes. This aligns with the findings of a study, which indicated a higher rate of superficial infections and hardware-related discomfort in the K-wire cohort, though functional recovery was eventually comparable in both groups (20). Importantly, the early benefits of volar plating may have socioeconomic implications, especially in working populations where faster return to function is critical. Studies highlighted that early recovery in range of motion and grip strength with volar plates may support earlier rehabilitation and return to daily activities (21,22). However, this study is not without limitations. First, the relatively short follow-up period of six weeks restricts insights into long-term functional outcomes and late complications such as post-traumatic arthritis or hardware irritation. While early DASH scores favor volar plating, long-term studies suggest that both techniques yield similar results over a year. Secondly, the absence of blinding may introduce bias in outcome assessment. Third, the use of a single center and non-probability sampling may limit the generalizability of the findings to broader populations.

Nevertheless, the study's strengths include a randomized design, age-matching across groups, and the use of validated outcome measures. The inclusion of real-world variables such as socioeconomic status, occupation, and urban-rural distribution enhances the external validity of the results. Future research should explore long-term outcomes, patient-reported satisfaction, and cost-effectiveness of both techniques. Additionally, multicenter trials with larger sample sizes and subgroup analyses by fracture type (e.g., AO classification) or age groups may yield more nuanced guidance for individualized care (23). In conclusion, volar locking plate fixation was associated with superior early functional outcomes and a lower rate of poor outcomes compared to K-wire fixation in distal radius articular fractures. While both techniques remain effective, the early advantages of volar plating may guide clinical decision-making in cases where rapid functional recovery is prioritized.

CONCLUSION

This study demonstrated that volar locking plate fixation offers superior early functional outcomes compared to K-wire fixation for distal radius articular fractures, with a higher proportion of excellent recoveries and fewer poor results at six weeks. While both techniques are effective, the volar plate approach may be preferable when rapid rehabilitation and functional recovery are prioritized. These findings support its growing use in clinical practice and highlight the importance of individualized surgical decision-making based on fracture characteristics and patient needs.

AUTHOR CONTRIBUTION

Author	Contribution
Kashan Shahid*	Substantial Contribution to study design, analysis, acquisition of Data Manuscript Writing Has given Final Approval of the version to be published
Awal Hakeem	Substantial Contribution to study design, acquisition and interpretation of Data Critical Review and Manuscript Writing Has given Final Approval of the version to be published
Muhammad Siraj	Substantial Contribution to acquisition and interpretation of Data Has given Final Approval of the version to be published
Alina Gul	Contributed to Data Collection and Analysis Has given Final Approval of the version to be published
Mamen Shahid	Contributed to Data Collection and Analysis Has given Final Approval of the version to be published

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