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***Original Research Article***

# Functional Outcomes of Distal Radius Fractures Undergoing Variable Angle Volar Locking Compression Plates

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**Abstract:** *Distal radius fractures are among the most common orthopedic injuries in adults, and stable fixation is essential to restore wrist function and prevent long-term disability. Variable-angle volar locking compression plates have gained popularity due to improved biomechanical stability and early mobilization.* ***Objective:*** *To determine the functional outcomes of distal radius fractures undergoing variable-angle volar locking compression plate management.* ***Methods:*** *Descriptive study. Study setting and duration: 10-11-2024 to10-05-2025 Department of Orthopaedic Surgery, Lady Reading Hospital, Peshawar. The present study was conducted on 75 patients aged 18-65 years with a distal radius fracture. Patients with open or complicated fractures were excluded. All patients underwent a variable-angle volar locking compression plate approach. The functional outcome was assessed 60 days after the procedure, using the modified Mayo wrist score. Data analysis was performed using SPSS 27, and frequency and percentages were used for functional outcomes. The chi-square test was used to evaluate the association between functional outcomes and demographics and comorbidities, with p-values < 0.05 considered significant.* ***Results:*** *Mean age of the cohort was 36.73 ± 11.93 years, with male gender 64.0% (n=48). The mean postoperative modified Mayo wrist score was 88.55 ± 5.82. Functional outcomes were excellent in 54.7% of cases (n=41) and good in 38.7% (n=29). Statistically significant association of fair functional outcome was found with increasing age, diabetes, hypertension, and smoking. Fewer complications were observed.* ***Conclusion:*** *Variable-angle volar locking compression plates for the management of distal radius fractures demonstrated excellent to good outcomes in the majority of patients. The procedure showed a favorable safety profile with minimal complications.*

**Keywords:** Distal radius fracture, Volar locking plate, Variable angle, Functional outcome, Mayo wrist score, Comorbidities.

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## Introduction

Distal radius fractures (DRFs) characterize a significant number of orthopedic injuries affecting people throughout their lifetime, often resulting from falls and high-energy trauma (1,2). There is a substantial shift toward surgical fixation in patients with intra-articular DRFs to restore anatomical alignment and encourage early mobilization. Open reduction and internal fixation (ORIF) using volar locking compression plates is among the most frequently used surgical interventions worldwide. Evidence indicates that the emergence of variable-angle volar locking compression plates offers the benefits of managing complex fractures and improving overall functional recovery (3). Volar plating usually offers superior functional outcomes at midterm follow-up compared with conservative management or percutaneous pinning, particularly in unstable fracture patterns (4).

Volar plating has refined surgical options by enabling surgeons to adapt screw trajectories to the exceptional geometry of each fracture, including intra-articular and comminuted patterns (5). In a study, the volar locking compression plate yielded primarily satisfactory scores, with DRFs demonstrating its clinical effectiveness (6). Another study from Pakistan found that volar locking plate fixation results in a considerably better DASH score than K-wire fixation postoperatively (13.01 + 4.60 vs. 20.66 + 4.96), suggesting that plating methods offer greater functional benefits than percutaneous techniques (7). Volar locking plates have highlighted the functional restoration capabilities of surgical fixation methods across dissimilar fracture configurations (8).

Multiple studies have shown that patients with DRFs managed with volar plating achieve excellent ROM and high satisfaction rates during follow-up, encouraging its general adoption in existing orthopedic practice. This technique also showed promising results in managing complex DRFs. Multicenter trials are needed to validate the benefits across heterogeneous populations and refine evidence-based guidelines for implant selection and rehabilitation practices (9-12).

Although volar locking compression plates are widely adopted and have become a standard treatment for complex DRFs. Despite their increasing use, there remains inadequate and inconsistent data on the extent to which variable-angle constructs confer superior functional outcomes compared with conventional fixation methods. Variations in fracture patterns and rehabilitation protocols further add to uncertainty in outcome predictability. Evaluating functional outcomes after fixation with variable-angle volar locking compression plates is essential for determining their clinical value and optimizing postoperative rehabilitation strategies to restore wrist motion and overall functional independence. This study aims to determine the functional outcomes of distal radius fractures treated with variable-angle volar locking compression plates.

## Methodology

This descriptive study was conducted in the Department of Orthopaedic Surgery at Lady Reading Hospital, Peshawar from 10-11-2024 to10-05-2025 with ethical approval from the IRB. The sample size for this study was 75, which was determined using the OpenEPI web-based sample size calculator, taking the previous frequency of fair outcome 7.50%,(6) confidence level 95%, and margin of error 6%. Patients were selected via consecutive non-probability sampling.

Patients aged 18 to 65 years, of either gender. These patients had a distal radius fracture, defined as a distal radius fracture with angulation of fracture fragments and multiple fracture fragments on X-ray, in patients presenting with all of the following features: pain (VAS > 3), swelling, and bruising. Patients with open comminuted fractures, patients with

distal radius fractures with vascular injuries, and pregnant or lactating patients were excluded.

The goal and benefits of this study were explained to all patients. Informed written consent will be taken. Patient details, including age, gender, BMI, residence area, and socioeconomic status, were recorded. Patients diagnosed with distal radius fractures on X-ray assessment underwent a 2.7mm variable-angle volar locking compression plate management under general anesthesia. The patient was positioned in the supine position, and a longitudinal incision was made on the volar Aspect of the wrist. Alignment and reduction of the fracture fragments were made anatomically by using the K-wires to stabilize the fracture. 2.7mm variable-angle volar locking compression plate, which was positioned over the distal radius to ensure that the plate's locking screws align with the fracture and provide proper fixation. Insertion of screws was made into the plate's locking holes. Fluoroscopy was used to confirm adequate screw placement and alignment. Screws were locked into place using a locking mechanism provided by the plate system. Confirmation of the stability of the fracture and the fixation was made with intraoperative fluoroscopy. Functional outcomes were evaluated using the modified Mayo wrist score, which ranges from 0 to 100 and is categorized as excellent (91 to 100), good (80 to 90), fair (65 to 79), and poor (< 65), at 60 days after surgical intervention. Post-procedure complications were also assessed, including wrist stiffness, superficial infection, and nonunion. The entire assessment was conducted under the guidance of an orthopedic surgeon with at least 5 years of post-fellowship experience.

SPSS 27 was used for analysis. Frequencies and percentages were used for functional outcomes, gender, residence area, side of fracture, diabetes, hypertension, smoking, post-procedural complications, and fracture type. socio-economic status. The mean and standard deviation were used for age, the modified Mayo wrist score, and BMI. Functional outcome was stratified by age, gender, BMI, diabetes, smoking, and hypertension, and analyzed using the Chi-square test; p-values < 0.05 were considered significant.

**Results**

In the present study, seventy-five patients were included. The cohort had a mean age of 36.73 ± 11.93 years. Male patients accounted for 48 (64.0%), while female patients accounted for 27 (36.0%). The remaining demographic data are presented in Table 1.

Table 2 presents the comorbidity and clinical profile of the patients; diabetes mellitus was present in 8 (10.7%) cases. Hypertension was present in 14 (18.7%) cases (Table II).

Functional outcomes were evaluated using the Mayo Wrist Score. Excellent outcomes were observed in 41 (54.7%) cases. Good outcomes were observed in 29 (38.7%) cases (Figure 1). The mean Mayo Wrist Score was 88.55 ± 5.82.

Table 3 presents the analysis of the association between functional outcomes and various demographic and comorbidities. Older age (>45 years) was significantly associated with a fair outcome (P = 0.001). Similarly, diabetes (p = 0.001), hypertension (p = 0.005), and smoking (p = 0.03) were associated with fair outcomes. Table 4 presents the post-procedural complications.

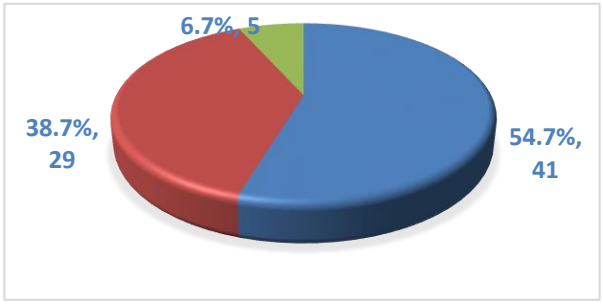


**Figure 1: Functional outcomes**

**Table 1: Demographic details of the patients**

| **Quantitative demographics** | | **Mean** | **SD** |
|---|---|---|---|
| Age (Years) | | 36.73 | 11.93 |
| BMI (Kg/m$^2$) | | 24.73 | 1.61 |
| Categorical demographics | | n | % |
| Age distribution (Years) | 18 to 30 | 31 | 41.3% |
| | 31 to 45 | 27 | 36.0% |
| | > 45 | 17 | 22.7% |
| Gender | Male | 48 | 64.0% |
| | Female | 27 | 36.0% |
| Area of residence | Urban | 42 | 56.0% |
| | Rural | 33 | 44.0% |
| Socioeconomic status | Low class | 36 | 48.0% |
| | Middle class | 26 | 34.7% |
| | Upper class | 13 | 17.3% |

**Table I2: Comorbidity & clinical profile of the patients**

| **Comorbidities & clinical presentation** | | n | % |
|---|---|---|---|
| Diabetes | Yes | 8 | 10.7% |
| | No | 67 | 89.3% |
| Hypertension | Yes | 14 | 18.7% |
| | No | 61 | 81.3% |
| Smoking | Yes | 15 | 20.0% |
| | No | 60 | 80.0% |
| Side of fracture | Right | 50 | 66.7% |
| | Left | 25 | 33.3% |
| Type of fracture | AO Type A | 20 | 26.7% |
| | AO Type B | 28 | 37.3% |
| | AO Type C | 27 | 36.0% |

**Table 3 Association of functional outcomes with demographics and comorbidities**

| Demographics & comorbidities | | Functional outcome | | | | | | P value |
|---|---|---|---|---|---|---|---|---|
| | | Excellent | | Good | | Fair | | |
| | | n | % | n | % | n | % | |
| Age distribution (Years) | 18 to 30 | 23 | 56.1% | 7 | 24.1% | 1 | 20.0% | 0.001 |
| | 31 to 45 | 16 | 39.0% | 9 | 31.0% | 2 | 40.0% | |
| | > 45 | 2 | 4.9% | 13 | 44.8% | 2 | 40.0% | |
| BMI (Kg/m$^2$) | 18.5 to 24.9 | 27 | 65.9% | 16 | 55.2% | 1 | 20.0% | 0.12 |
| | > 24.9 | 14 | 34.1% | 13 | 44.8% | 4 | 80.0% | |
| Gender | Male | 25 | 61.0% | 18 | 62.1% | 5 | 100.0% | 0.22 |
| | Female | 16 | 39.0% | 11 | 37.9% | 0 | 0.0% | |
| Diabetes | Yes | 4 | 9.8% | 1 | 3.4% | 3 | 60.0% | 0.001 |
| | No | 37 | 90.2% | 28 | 96.6% | 2 | 40.0% | |
| Hypertension | Yes | 3 | 7.3% | 8 | 27.6% | 3 | 60.0% | 0.005 |
| | No | 38 | 92.7% | 21 | 72.4% | 2 | 40.0% | |
| Smoking | Yes | 5 | 12.2% | 7 | 24.1% | 3 | 60.0% | 0.03 |
| | No | 36 | 87.8% | 22 | 75.9% | 2 | 40.0% | |
| *Chi-square test used.* | | | | | | | | |

**Table 4: Post-procedural complications**

| Post-procedural complications | | n | % | 95% Confidence Interval (CI) | |
|---|---|---|---|---|---|
| | | | | Lower | Upper |
| Wrist stiffness | Yes | 5 | 6.7% | 0.02 | 0.14 |
| | No | 70 | 93.3% | | |
| Superficial infection | Yes | 3 | 4.0% | 0.008 | 0.11 |
| | No | 72 | 96.0% | | |
| Implant irritation | Yes | 4 | 5.3% | 0.01 | 0.13 |
| | No | 71 | 94.7% | | |
| Non union | Yes | 2 | 2.7% | 0.003 | 0.09 |
| | No | 73 | 97.3% | | |

## Discussion

The present study was conducted to assess functional outcomes after surgical management of distal radius fractures using variable-angle volar locking compression plates. The cohort's mean age was 36.73 years, with male patients comprising the majority. Kumar et al. reported a mean age of 35.2 years and a majority of male patients. (13) These findings show a younger, active population who sustained complex fractures requiring robust internal fixation.

Functional outcomes were measured using the Mayo Wrist Score, which was highly favourable. The mean score was 88.55, which indicated a strong curve of early recovery. Garg et al. reported a mean Mayo score of 91.87 in the variable-angle plate group at 1 year. (3) The present score, achieved at just two months, suggests rapid initial improvement, probably due to stable fixation, leading to early mobilisation. (14) Regarding the functional outcome, an excellent outcome was achieved in 54.7% and a good outcome in 38.7%. This finding was more favorable than the 42.5% excellent rate reported by Ullah et al., while it aligns more closely with the 72% excellent result reported by Singh et al. (10). The high success rate at this early stage highlights the procedural efficacy noted in studies specifically evaluating variable-angle plates. (16)

The present study observed an inverse association between excellent outcome and increasing age, as evident in the analysis; younger patients were more likely to achieve an excellent outcome. This finding is consistent with that of Iqbal et al., who reported that patients under 40 years of age had a higher frequency of excellent outcomes. (17)

The present study found that diabetes mellitus was significantly associated with fair results. These findings have also been reported by Iqbal et al. (17). Patient gender and body mass index did not show a statistically significant association with functional outcomes. This finding aligns with several studies that found no association between gender and BMI and functional outcomes. (17)

The procedure's safety profile was quite reassuring. Lower complication rates were observed in this study, a finding similar to several studies (13,18). The non-union rate in this study (2.7%) was very low, highlighting the biomechanical stability of the locked construct, a key advantage of variable-angle plates in mitigating issues such as screw toggling. (19,20)

Studies have evaluated outcomes at 3 months or more, whereas the current study provided a more detailed analysis of early functional outcomes at 2 months. (21) The present study demonstrated that a favourable functional outcome is achievable within the first two months. The study also quantified the early modifiable risk factors within this time frame.

The study had a few limitations. While the two-month follow-up period was sufficient for assessing the initial functional recovery, it was insufficient to determine long-term outcomes such as arthritis or hardware issues. The single-centre design can affect generalisability. The absence of a randomised control group treated with another alternative method limits the comparison of functional outcomes.

## Conclusion

In conclusion, variable-angle volar locking compression plates for managing distal radius fractures demonstrated excellent to good outcomes in the majority of patients. The procedure exhibited a favorable safety profile with minimal complications. A fair outcome was associated with increasing age, diabetes, smoking, and hypertension.

## Declarations

**Data Availability statement**

All data generated or analysed during the study are included in the manuscript.

**Ethics approval and consent to participate**

Approved by the department concerned.

**Consent for publication**

Approved

**Funding**
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**Conflict of interest**

The authors declared no conflict of interest.

**Author Contribution**

**DK (PGR)**
*Data Collection, Analysis, Manuscript revision and Manuscript drafting*
**BH (Assistant Professor)**
*Study Design, Critical guidance and Final approval*

*All authors reviewed the results and approved the final version of the manuscript. They are also accountable for the integrity of the study.*

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