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Functional outcomes and complication patterns in adult distal radius fractures managed with volar locking plates: A prospective hospital-based observational study.

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Abstract

Background
Distal radius fractures remain among the most frequent upper-limb injuries in adults. Volar locking plates have become a preferred treatment option due to their stable fixation and predictable functional recovery.
Aim: To assess functional outcomes and complication patterns in adults with distal radius fractures managed using volar locking plates.

Methods
This hospital-based observational study included 100 adult patients treated with volar locking plate fixation. Demographic features, fracture types, mechanism of injury, and operative details were recorded. Functional outcomes were assessed at 6 weeks, 3 months, and 6 months using the Modified Mayo Wrist Score (MMWS). Complications were documented throughout follow-up. Data were summarised using descriptive statistics.

Results
The mean age of participants was 44.6 ± 12.8 years, with a male predominance. Road-traffic accidents were the major cause of injury. AO Type C fractures formed the largest subgroup. Anatomical reduction was achieved in 90% of cases. Functional performance improved across follow-up, and 84% demonstrated excellent or good outcomes by 6 months. The mean final MMWS was 86.3 ± 9.4, reflecting favourable wrist function in most individuals. Complications occurred in 18% of patients. Transient median nerve neuropathy, superficial infection, tendon irritation, malunion, and implant loosening were the main issues; however, no case of tendon rupture or deep infection was recorded. Functional independence was regained by 92% at the end of follow-up.

Conclusion
Volar locking plate fixation offers stable anatomical restoration, reliable union, and robust functional recovery in distal radius fractures. The complication rate remained low, and most issues were manageable with timely intervention.

Recommendations
Future practice should incorporate early presentation, consistent radiographic monitoring, and structured physiotherapy to enhance long-term functional gains. Detailed preoperative planning is advisable for complex fractures to minimise malalignment. Strengthening postoperative surveillance can help detect implant-related issues early.

Keywords: *Distal radius fracture; Volar locking plate; Functional outcome; Modified Mayo Wrist Score; Fracture fixation; Postoperative complications*
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Introduction

Distal radius fractures are among the most frequent skeletal injuries encountered in adult trauma practice, contributing substantially to upper-limb morbidity across the world. Their incidence continues to rise due to increasing road-traffic events, workplace accidents, and fall-related trauma, echoing patterns described in earlier observational and clinical studies [1,2]. While many fractures are amenable to conservative care, unstable, displaced, or intra-articular variants often require operative stabilisation to restore joint congruity and maintain long-term wrist function [3].

The advent of volar locking plate systems has markedly advanced surgical management strategies. These implants provide angular stability, support comminuted and osteoporotic fragments, and facilitate early mobilisation—an advantage repeatedly demonstrated across multiple clinical evaluations [1,4,5]. Despite these strengths, functional outcomes vary widely. Factors such as fracture configuration, timing of surgery, precision of reduction, implant positioning, and postoperative rehabilitation all influence recovery trajectories [2,4]. Earlier reports have also highlighted complication patterns involving median nerve irritation, tendon problems, malalignment, and implant-related issues, underscoring the need for vigilant follow-up and improved surgical planning [1,3,6].

Objective assessment tools, particularly the Modified Mayo Wrist Score, have gained prominence for evaluating pain, motion, grip strength, and functional use. These measures offer a comprehensive view of postoperative recovery and help benchmark the effectiveness of treatment across diverse populations [2,5]. However, the variability in published outcomes ranging from excellent long-term results to reports of persistent stiffness or hardware-related discomfort emphasises the need for additional hospital-based analyses that reflect real-world scenarios [1,3,6].

Given these considerations, continuous assessment of the real-world performance of volar locking plates remains relevant. This study was therefore undertaken to analyse functional outcomes and complication patterns in adults with distal radius fractures treated with volar locking plate fixation in a tertiary-care hospital setting. The findings aim to contribute practical evidence to guide clinicians in decision-making, surgical planning, and postoperative management.

Methodology

Study design

This was a hospital-based observational study with prospective follow-up of adult patients undergoing volar locking plate fixation for distal radius fractures.

Study setting

The study was conducted in the Department of Orthopaedics, Government Medical College, Quthbullapur, Telangana, India, a tertiary-care teaching hospital catering to urban and rural populations. The study period extended from July 2024 to June 2025.

Participants

Adult patients aged ≥18 years presenting with acute distal radius fractures requiring operative fixation were consecutively enrolled. Eligibility was based on clinical assessment and radiographic confirmation. Patients meeting the inclusion criteria and providing informed consent were included, while those fulfilling predefined exclusion criteria were excluded.

Study size

A sample size of 100 adult patients was chosen based on feasibility, patient inflow during the study period, and consistency with similar hospital-based observational studies. This number was considered adequate to provide a reliable description of functional outcomes and complication patterns in routine clinical practice.

Inclusion criteria

The inclusion comprised adults aged 18 years and above with acute distal radius fractures requiring operative stabilisation, including displaced, unstable, intra-articular, or comminuted patterns. Patients who provided informed consent and were available for follow-up for at least six months were enrolled.

Exclusion criteria

The exclusion included open fractures involving extensive soft-tissue injury, pathological fractures, polytrauma patients requiring prioritised management of life-threatening injuries, previous wrist surgery on the affected limb, and individuals lost to follow-up.

Data collection

Demographic characteristics, mechanism of injury, side affected, and fracture classification were recorded at presentation. Radiographs were evaluated using the

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AO/OTA classification system. Operative details, including time from injury to surgery, surgical duration, reduction quality, and intraoperative difficulties, were noted.

Surgical technique

All patients underwent volar locking plate fixation under regional or general anaesthesia. The modified Henry approach was used in every case. Fracture reduction was achieved under fluoroscopic guidance, followed by placement of an anatomically contoured volar locking plate. Stability and joint congruity were reassessed before wound closure. A below-elbow splint was applied postoperatively.

Follow-up and outcome assessment

Patients were reviewed at 6 weeks, 3 months, and 6 months. Wrist mobility, grip strength, and pain were assessed clinically. Functional outcomes were measured using the Modified Mayo Wrist Score (MMWS). Radiographic union, maintenance of reduction, and any complications such as neuropathy, infection, tendon irritation, malunion, or implant-related issues were documented.

Bias

Selection bias was minimised by enrolling consecutive eligible patients during the study period. Measurement bias was reduced by using a standardised surgical technique and a validated functional outcome tool (Modified Mayo Wrist Score). Outcome assessments were performed at fixed follow-up intervals using uniform criteria.

Statistical analysis

Data were analysed using descriptive statistics and presented as frequencies, percentages, means, and standard deviations. Results were interpreted to evaluate overall functional performance and complication trends.

Ethical considerations

Ethical approval was obtained from the Institutional Ethics Committee. Written informed consent was secured from all participants. Confidentiality was maintained throughout data collection, and all procedures adhered to the principles of the Declaration of Helsinki.

RESULTS

Participant flow

During the study period, 112 adult patients with distal radius fractures were assessed for eligibility. Of these, 106 patients met the inclusion criteria. Six patients were excluded due to open fractures with extensive soft-tissue injury (n = 3) and polytrauma requiring prioritised management (n = 3).

Among the eligible patients, 100 patients consented to participate and were enrolled in the study. Six patients declined participation or were unavailable for regular follow-up. All enrolled participants completed the scheduled follow-up visits at 6 weeks, 3 months, and 6 months and were included in the final analysis.

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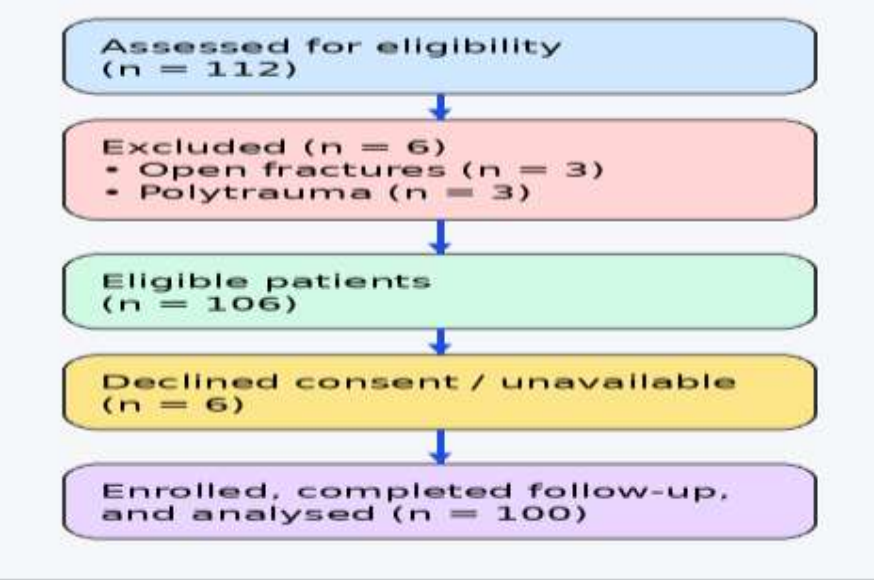

Figure 1: Participant flow diagram

A total of 100 adults with distal radius fractures were included in the study. The demographic profile is summarized in Table 1, which shows a mean age of 44.6 ± 12.8 years, with 58 males and 42 females. Right-sided fractures were more common (62%). Road-traffic accidents were the leading cause of injury (48%), whereas falls accounted for 44%, and workplace trauma for 8% (Table 1).

Table 1. Demographic and injury characteristics of the study population (n = 100)

Variable	Value
Total patients	100
Age (mean ± SD)	44.6 ± 12.8 years
Sex distribution	Male: 58 (58%) Female: 42 (42%)
Side involved	Right: 62% Left: 38%
Mode of injury	
Road-traffic accident	48%
Fall on outstretched hand	44%
Workplace trauma	8%

Fracture configurations and operative variables are presented in Table 2. AO Type C fractures formed the largest proportion (42%), followed by Type A (36%) and Type B (22%). The average interval from injury to surgery was 4.2 days, and the mean operative time was 72 minutes. Anatomical reduction was achieved in 90% of patients, while 10% required minor adjustments during early follow-up.

Table 2. Fracture pattern and operative details

Parameter	Value
AO Fracture Type	
Type A	36%
Type B	22%
Type C	42%
Time from injury to surgery (mean)	4.2 days
Operative duration (mean)	72 minutes

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Anatomical reduction achieved	90%
Minor adjustment required	10%

Progressive improvement in functional recovery was noted across follow-up visits, as shown in Table 3. At six weeks, 54% demonstrated fair wrist mobility, though grip strength remained limited in many cases. By the third month, 72% of individuals achieved good functional scores. At six months, 84% showed excellent or good outcomes according to the Modified Mayo Wrist Score, with a mean final score of 86.3 ± 9.4. Functional independence in daily activities was restored in 92% of the cohort.

Table 3. Functional outcomes over follow-up

Outcome Parameter	6 Weeks	3 Months	6 Months
Wrist mobility	Fair in 54%	Improved in the majority	Good to excellent in 84%
Functional score status	–	72% good	84% excellent/good
Mean MMWS	–	–	86.3 ± 9.4
Functional independence	–	–	92% achieved

The overall complication burden was 18%, detailed in Table 4. Transient median nerve neuropathy was the most frequent complication (6%), followed by superficial surgical-site infection (4%). Tendon irritation, primarily involving the flexor pollicis longus, occurred in 3%, while radiological malunion was recorded in 3% of cases. Implant loosening was noted in 2%, and no patient developed tendon rupture or deep infection.

Table 4. Complication profile (n = 100)

Complication	Frequency
Transient median nerve neuropathy	6%
Superficial surgical-site infection	4%
Tendon irritation (FPL)	3%
Radiological malunion	3%
Implant loosening	2%
Tendon rupture	0%
Deep infection	0%
Overall complication rate	**18%**

Discussion

This hospital-based study offers an updated perspective on the functional restoration and complication profile of adults with distal radius fractures managed with volar locking plates. The favourable outcomes observed in this cohort echo earlier comparative evaluations, which also reported strong functional performance across both young and older adults following volar plate fixation [7]. The predominance of middle-aged individuals aligns with established trauma patterns globally, where active adults frequently sustain high-energy injuries and are more exposed to road-traffic and fall-related events.

A high proportion of AO Type C fractures in the present cohort indicates a predominance of complex, intra-articular injury patterns; however, the encouraging functional outcomes suggest that volar locking plate fixation provides sufficient angular stability to maintain reduction even in comminuted fractures. Stable fixation allows early wrist mobilisation, which likely contributed to progressive improvement in range of motion, grip strength, and overall wrist function, culminating in excellent or good Modified Mayo Wrist Scores by six months [8,9].

The observed complication rate of 18% aligns with reported ranges for surgically managed distal radius fractures and reflects the predictable risk profile of volar plating in heterogeneous fracture patterns. Most complications were transient or low grade and resolved with conservative measures, indicating that careful surgical technique and structured follow-up can effectively mitigate morbidity while preserving favourable functional recovery.

Systematic reviews have documented that neuropathic symptoms and flexor tendon irritation represent recognisable complications of volar plating, though their long-term impact is often limited when early intervention is provided [10]. The absence of deep infections and tendon ruptures in the present series is reassuring and parallels findings from studies evaluating outcomes in elderly populations, where complication severity also

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tended to be low when fixation was performed appropriately [11].

Radiological malunion primarily affected fractures with marked comminution, highlighting the ongoing challenge of achieving durable stability in complex intra-articular patterns. Rare instances of implant loosening observed in this cohort align with prior meta-analyses, which emphasised the need for structured postoperative monitoring, particularly in high-demand individuals or osteoporotic bone [12]. Overall, the findings support the continued role of volar locking plates as a dependable fixation method across a wide spectrum of distal radius fractures.

Generalizability

The findings of this study can be applied to similar tertiary-care settings that manage adult traumatic wrist fractures using standardised surgical and rehabilitation protocols. Although the study reflects outcomes from a single institution, the procedures, implants, and follow-up assessments used are widely adopted elsewhere, supporting broader applicability.

Conclusion

Volar locking plate fixation proved to be a dependable method for managing adult distal radius fractures, offering stable anatomical alignment, predictable union, and meaningful functional recovery across varied fracture patterns. Most patients achieved excellent or good outcomes by six months, demonstrating the effectiveness of early mobilisation made possible by rigid internal fixation. Complications were generally mild and manageable, with no deep infections or tendon ruptures recorded in this cohort. Overall, the procedure delivered high functional independence and low morbidity, making it a suitable option for routine orthopaedic practice. The results reinforce the continued preference for volar plating, especially in displaced, unstable, or intra-articular fractures.

Limitations

This study was limited by its single-centre design and modest sample size, which may restrict comparisons across subgroups. The follow-up duration of six months, although adequate for early functional assessment, does not capture long-term outcomes such as late degenerative changes or residual stiffness. Radiographic evaluations were not supplemented with advanced imaging, potentially overlooking subtle articular incongruities. Additionally, rehabilitation adherence varied among patients, which may have influenced functional scores. These factors should be considered when interpreting the findings.

Recommendations

Strengthening follow-up systems, ensuring timely radiographic reviews, and reinforcing early physiotherapy can further enhance wrist recovery after volar plate fixation. Surgeons should emphasise meticulous intraoperative technique, particularly in plate positioning, to prevent tendon irritation and neuropraxia. Complex fractures benefit from comprehensive preoperative planning and counselling. Institutions may consider developing structured rehabilitation pathways to standardise postoperative care. Future research should incorporate multicentre cohorts with longer follow-up periods to assess the durability of functional improvement and late complications. Comparative studies between plating systems may also provide valuable insights for optimising implant selection and surgical strategy.

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Abbreviations

MMWS – Modified Mayo Wrist Score
AO – Arbeitsgemeinschaft für Osteosynthesefragen
FPL – Flexor pollicis longus
SD – Standard deviation
RTA – Road-traffic accident

Source of funding

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Conflict of interest

The authors declare no conflict of interest.

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Author contributions

DV-Concept and design of the study, results interpretation, review of literature, and preparing the first draft of the manuscript. Statistical analysis and interpretation, revision of manuscript.
VP-design of the study, results interpretation, review of literature, and preparing the first draft of the manuscript. Statistical analysis and interpretation, revision of manuscript.
KK- results interpretation, review of literature, and preparing the first draft of the manuscript. Statistical analysis and interpretation, revision of manuscript.
KKN-design of the study, results interpretation, review of literature, and preparing the first draft of the manuscript. Statistical analysis and interpretation, revision of manuscript.

Data availability

Data available on request

Author biography

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