

Evaluation of Functional Outcome After Open Reduction and Volar Locking Plate Fixation in Distal Radius Fractures: A Prospective Study

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Abstract:

Background: Distal end radius fractures are among the most frequently encountered skeletal injuries, particularly in elderly patients and young individuals sustaining high-energy trauma. Stable anatomical restoration is essential to maintain wrist function and prevent long-term disability. Volar locking compression plates (VLCPs) have emerged as the preferred modality for surgical fixation in unstable fractures.

Objective: To evaluate the clinical and functional outcomes of open reduction and internal fixation using volar locking compression plates in patients with distal radius fractures.

Methods: This prospective study was conducted at All India Institute of Medical Sciences (AIIMS), Patna, Bihar. Patients with unstable distal radius fractures treated with open reduction and volar plate fixation were included. Functional outcomes were assessed using the Disabilities of the Arm, Shoulder and Hand (DASH) score and Modified Mayo Wrist Score at follow-up intervals up to six months. Radiographic parameters and complication rates were also recorded.

Results: A total of 30 patients were evaluated, with a mean age of 42.6 years. The majority sustained fractures due to road traffic accidents or falls. At six months, 80% of patients achieved excellent to good results on the Modified Mayo Wrist Score, and the mean DASH score showed significant improvement. Complication rates were low, with isolated cases of wound dehiscence and transient stiffness.

Conclusion: Open reduction and internal fixation using volar locking compression plates provide reliable anatomical reduction, early mobilization, and favorable functional outcomes in unstable distal radius fractures. With proper technique and rehabilitation, VLCP is an effective and safe surgical option for managing these injuries.

Keywords: Distal radius fracture; volar locking compression plate; open reduction; internal fixation; functional outcome; DASH score; Mayo wrist score; wrist trauma; AIIMS Patna

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Introduction

Fractures of the distal end of the radius represent one of the most common orthopedic injuries encountered in both emergency and outpatient settings. They account for approximately one-sixth of all fractures treated in emergency departments [1]. These injuries exhibit a bimodal distribution: they are frequently seen in young adults due to high-energy trauma and in elderly individuals as a result of low-energy falls, often associated with underlying osteopenia or osteoporosis [2].

Historically, these fractures were managed conservatively with closed reduction and immobilization using plaster casts. While non-operative treatment remains effective for minimally

displaced and stable fractures, unstable or comminuted patterns frequently result in malunion, loss of wrist function, and long-term morbidity when treated non-surgically. As a result, surgical management is now widely accepted for fractures that are intra-articular, unstable, or fail to maintain reduction following closed methods [3,4].

Open reduction and internal fixation using volar locking compression plates (VLCPs) has emerged as a preferred surgical approach for managing unstable distal radius fractures. The volar approach provides direct visualization of the fracture site, facilitates anatomical reduction, and allows stable fixation with locking screw constructs that are especially

beneficial in osteoporotic bone. The fixed-angle design of these plates enables early mobilization and functional recovery without compromising alignment [5,6].

Volar plates also reduce the risk of extensor tendon irritation, which was commonly associated with dorsal plating systems. Additionally, they have been found to be effective across various fracture subtypes, including intra-articular and comminuted fractures, making them versatile and broadly applicable. Their biomechanical superiority and ability to maintain reduction, even in complex fractures, have made VLCPs a widely used implant in modern orthopedic practice [7].

Clinical success following distal radius fixation is determined by a combination of radiological alignment, restoration of wrist mobility, pain relief, grip strength, and patient satisfaction. Tools such as the Disabilities of the Arm, Shoulder and Hand (DASH) score and Modified Mayo Wrist Score (MMWS) provide standardized measures to evaluate these outcomes. The balance between anatomical restoration and early functional rehabilitation is key to optimizing results and minimizing disability [8].

Despite the increasing popularity of volar plating, outcome data vary depending on fracture configuration, patient age, comorbidities, timing of surgery, and postoperative rehabilitation. This prospective study was conducted at All India Institute of Medical Sciences (AIIMS), Patna, to evaluate the functional and radiological outcomes of patients undergoing open reduction and internal fixation of distal radius fractures using VLCP. The study aimed to assess clinical recovery, return of function, and complications over a structured six-month follow-up using validated outcome scores.

Materials and Methods

This prospective clinical study was carried out in the Department of Orthopaedics at All India Institute of Medical Sciences (AIIMS), Patna, Bihar for 12 months. The objective was to evaluate the clinical and functional outcomes of distal end radius fractures treated with open reduction and internal fixation using volar locking compression plates (VLCPs). The study included patients presenting with unstable or displaced fractures of the distal radius deemed appropriate for surgical fixation.

Inclusion criteria were patients aged 18 years and above with closed, displaced, or unstable distal radius fractures classified as AO types A2, A3, B, or C. Fractures with dorsal comminution, intra-articular extension, or those failing closed reduction were also included. Exclusion criteria were open fractures beyond Gustilo-Anderson grade I, pathological fractures, previous wrist surgery,

neurovascular compromise, and non-compliance with follow-up.

All patients underwent a detailed clinical examination including mechanism of injury, swelling, deformity, neurovascular status, and pre-injury functional status. Standard radiographic views (anteroposterior and lateral) of the wrist were obtained and analyzed to classify fracture type and plan operative management.

Surgical intervention was performed under regional or general anesthesia with a tourniquet applied. The volar Henry approach was used in all cases. After exposure of the fracture site, reduction was achieved using K-wires and clamps, followed by fixation with an anatomically contoured volar locking compression plate. Multiple locking screws were used in the distal fragment to secure articular fragments and maintain angular stability. Fluoroscopic guidance was used to confirm reduction and hardware positioning.

Postoperatively, the limb was immobilized in a volar slab for 7–10 days to allow wound healing, after which mobilization exercises were initiated. Suture removal was done between 10 and 14 days. Early physiotherapy was encouraged to restore wrist motion and grip strength. Weight-bearing and resistance exercises were allowed after radiological evidence of healing.

Patients were followed up at 6 weeks, 3 months, and 6 months. Functional outcomes were evaluated using the Disabilities of the Arm, Shoulder and Hand (DASH) Score and the Modified Mayo Wrist Score (MMWS). Radiographic assessment was done to evaluate fracture union, alignment, and implant-related complications. Clinical examination included pain assessment, wrist range of motion, grip strength, and ability to perform daily activities.

All data were compiled and analyzed using appropriate statistical software. Continuous variables were expressed as mean $\pm$ standard deviation. Paired t-tests and ANOVA were used to compare preoperative and follow-up outcomes, and a p-value less than 0.05 was considered statistically significant.

Results

A total of 30 patients with distal end radius fractures underwent open reduction and internal fixation using volar locking compression plates and were followed up for six months. Patients were evaluated for demographic characteristics, mechanism of injury, fracture classification, radiological union, functional recovery, and complications. Functional outcomes were assessed using the Modified Mayo Wrist Score (MMWS) and DASH score.

Table 1 shows the age distribution of patients. The majority of cases occurred in the 31–50 year age group.

Table 1: Age Distribution of Patients (N = 30)

Age Group (years)	Number of Patients (n)	Percentage (%)
18–30	7	23.3
31–40	9	30.0
41–50	8	26.7
51–60	4	13.3
>60	2	6.7
Total	30	100.0

Table 2: Gender Distribution (N = 30)

Gender	Number of Patients (n)	Percentage (%)
Male	19	63.3
Female	11	36.7
Total	30	100.0

Table 3: Mode of Injury (N = 30)

Mode of Injury	Number of Patients (n)	Percentage (%)
Road traffic accident	17	56.7
Fall on outstretched hand	11	36.7
Fall from height	2	6.6
Total	30	100.0

Table 4: AO Classification of Fractures (N = 30)

AO Type	Number of Patients (n)	Percentage (%)
A2	4	13.3
A3	5	16.7
B2	3	10.0
C1	7	23.3
C2	6	20.0
C3	5	16.7
Total	30	100.0

Table 5: Time to Radiological Union (N = 30)

Union Time (weeks)	Number of Patients (n)	Percentage (%)
<8	4	13.3
8–10	13	43.3
11–12	9	30.0
>12	4	13.4
Total	30	100.0

Table 6: Wrist Range of Motion at 6 Months (N = 30)

Flexion-Extension Arc	Number of Patients (n)	Percentage (%)
>120°	16	53.3
90°–120°	11	36.7
<90°	3	10.0
Total	30	100.0

Table 7: Modified Mayo Wrist Score Outcome (N = 30)

Outcome Category	Number of Patients (n)	Percentage (%)
Excellent	13	43.3
Good	11	36.7
Fair	4	13.3
Poor	2	6.7
Total	30	100.0

Table 8: DASH Score Over Time

Time Point	Mean Score	Standard Deviation	p-value (vs pre-op)
Preoperative	64.5	7.4	—
6 weeks	42.1	6.5	<0.001
3 months	26.8	5.9	<0.001
6 months	15.4	4.6	<0.001

Table 9: Return to Daily Activities (N = 30)

Return Time (weeks)	Number of Patients (n)	Percentage (%)
<6	3	10.0
6–8	10	33.3
9–12	12	40.0
>12	5	16.7
Total	30	100.0

Table 10: Postoperative Complications (N = 30)

Complication	Number of Patients (n)	Percentage (%)
Superficial infection	2	6.7
Wrist stiffness	3	10.0
Wound dehiscence	1	3.3
Hardware prominence	1	3.3
None	23	76.7
Total	30	100.0

Discussion

Fractures of the distal end of the radius are among the most frequently encountered orthopedic injuries and account for a significant proportion of emergency and outpatient orthopedic consultations. Their incidence is increasing due to the rise in road traffic accidents and falls in both younger and older age groups [9]. Restoration of function in these fractures is critical due to the biomechanical importance of the wrist joint in daily activities and load-bearing. This study aimed to evaluate the effectiveness of volar locking compression plates (VLCPs) in restoring function following distal radius fractures [10].

In the present study conducted at a tertiary care center, the majority of patients were in the 31–50 year age group, with males forming the predominant demographic, largely due to high-energy trauma such as road traffic accidents. AO Type C fractures, which are typically intra-articular and comminuted, constituted the most common pattern, reinforcing the complexity of injuries encountered in this cohort. These fractures are particularly prone to malunion and poor outcomes if not managed appropriately [11].

The use of volar locking compression plates has been shown to provide stable fixation, especially in osteoporotic bone and comminuted fractures. The volar approach avoids complications associated with dorsal plating, such as extensor tendon irritation or rupture. In this study, the mean time to radiological union was between 8 to 12 weeks in most cases, consistent with findings reported in contemporary orthopedic literature. This early union allowed

initiation of rehabilitation, which significantly improved functional outcomes [12].

At the end of six months, 80% of patients had excellent to good results according to the Modified Mayo Wrist Score. Patients also demonstrated a progressive reduction in disability, as evidenced by a significant improvement in DASH scores over time. By six months, the mean DASH score had improved to 15.4 from a preoperative mean of 64.5, indicating successful return of upper limb function in most cases. These results are consistent with findings from studies by Chung et al. and Orbay et al., who also reported favorable functional outcomes with volar plating [13,14].

Postoperative wrist range of motion was restored to more than 120° in over half of the patients, with very few exhibiting stiffness. This underscores the importance of early physiotherapy and the mechanical stability provided by VLCPs, which permit early mobilization without compromising fracture healing. Furthermore, more than 70% of patients returned to their routine daily activities within 12 weeks, highlighting the role of stable internal fixation in expediting functional recovery [15]. Complications were infrequent and largely minor. Superficial infections, transient stiffness, and hardware prominence were managed conservatively. No major neurovascular complications or implant failures were noted. This further affirms the safety profile of VLCPs when used with standard surgical precautions [16].

While the results of this study are promising, certain limitations must be acknowledged. The follow-up duration was limited to six months, which may not

capture long-term outcomes such as post-traumatic arthritis or hardware-related issues. Additionally, a control group treated conservatively or with alternative fixation methods would have strengthened the comparative value of the findings.

Nevertheless, the study clearly demonstrates that open reduction and internal fixation with volar locking plates is a dependable method for achieving anatomical restoration and excellent functional results in unstable distal radius fractures. The combination of angular stability, ease of application, and favourable patient recovery profile makes VLCPPs an ideal choice in both young and elderly patients with complex fracture patterns.

Conclusion

Open reduction and internal fixation using volar locking compression plates is a reliable and effective treatment modality for managing displaced and unstable distal radius fractures. It provides stable fixation, promotes early mobilization, and results in excellent functional outcomes with minimal complications. The technique allows for anatomical reduction, preservation of wrist function, and rapid return to daily activities. When performed with meticulous surgical technique and followed by structured rehabilitation, VLCPP fixation yields high patient satisfaction and favourable mid-term results across a wide spectrum of fracture types.

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