Section: Orthopaedic Surgery

Original Research Article

CLINICO-FUNCTIONAL AND RADIOLOGICAL OUTCOME OF DISTAL RADIUS FRACTURE TREATED WITH VOLAR LOCKING PLATE

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ABSTRACT

Background: Distal radius fractures (DRFs) constitute one of the most frequently encountered fractures in orthopaedic trauma and account for approximately 15–21% of all skeletal injuries. The incidence shows a bimodal distribution, affecting young individuals following high-energy trauma and elderly osteoporotic patients after low-energy falls. Optimal restoration of anatomy and early rehabilitation are critical for regaining wrist function. Volar locking plates have recently become the preferred surgical option, providing stable fixation and enabling early mobilization. **Materials and Methods:** A prospective clinical study was conducted at the Department of Orthopaedics, Trichy SRM Medical College and Hospital, Samayapuram, between November 2020 and November 2022. Thirty skeletally mature patients with distal radius fractures were included based on inclusion criteria and treated with open reduction and internal fixation using a 2.7-mm volar locking plate through the Modified Henry volar approach. Postoperative rehabilitation included physiotherapy following short-term immobilization. Functional assessment was performed at six weeks, three months, six months, and one year using the Quick DASH scoring system. **Result:** Most patients were males (63.3%), with right-side involvement in 60%. The predominant cause of injury was a fall on an outstretched hand (93.3%). According to Frykman's classification, Type III and IV fractures were most common. At final follow-up, 90% of cases achieved excellent results, 6.6% good, and 3.3% satisfactory outcomes. No significant complications were observed. **Conclusion:** Volar locking plate fixation offers a stable construct for distal radius fractures, allows early functional recovery, and provides excellent long-term outcomes with minimal complications. It remains the preferred option for managing unstable or intra-articular fractures of the distal radius.

INTRODUCTION

Distal radius fractures are among the most common upper limb injuries presenting to trauma and orthopaedic services, accounting for nearly 15–21% of all fractures seen in adults.[1] The incidence demonstrates a clear bimodal age pattern, occurring in young individuals as a result of high-energy trauma and in the elderly population following low-energy falls related to osteoporosis.[2]

Mechanism of injury is a fall onto an outstretched hand with the wrist in extension, producing dorsal angulation at the fracture site.[3,4] Other mechanisms include road traffic accidents, falls from height, occupational injuries, and sports trauma. In elderly individuals, compromised bone quality due to post-menopausal osteoporosis and cortical thinning predisposes to fracture even with minimal impact.[5] Women above 50 years of age have a markedly increased risk of distal radius fractures, with several epidemiological studies demonstrating an approximately four-fold higher incidence compared to men of the same age group.[6]

Historically, distal radius fractures were managed non-operatively using closed manipulation followed by immobilization in a plaster cast.[7] While acceptable outcomes can be achieved in stable and minimally displaced fractures, conservative management carries a significant risk of secondary displacement, malunion, loss of wrist motion, decreased grip strength, and altered radiocarpal and distal radioulnar biomechanics.[8] These

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complications may lead to persistent pain, functional impairment, and early degenerative joint changes.[9]

Several operative techniques have been developed to improve fracture stability and functional outcomes. These include percutaneous Kirschner-wire fixation, external fixation, dorsal plating, and volar locking plate fixation.[10] External fixation, which relies on ligamentotaxis to restore length, can be useful in certain fracture patterns; however, it may not provide adequate reduction or stability in comminuted intra-articular fractures and is associated with pin-tract infections, stiffness, and delayed rehabilitation.[11,12] Kirschner-wire fixation is minimally invasive but often insufficient in osteoporotic bone or fractures with articular involvement, frequently requiring prolonged immobilization.[13]

Dorsal plating was introduced to provide direct buttressing of dorsal fragments and biomechanically strong fixation. However, its close proximity to the extensor tendons is associated with tendon irritation and, in severe cases, tendon rupture, which may necessitate hardware removal.[14,15]

The development of volar locking plate (VLP) fixation has significantly changed treatment strategies for unstable distal radius fractures. The volar surface offers better soft-tissue coverage, reducing the risk of tendon complications.[16] Locking plate technology provides fixed-angle stability, allowing the plate-screw construct to function as an internal fixator rather than relying solely on bone purchase.[17]

This makes VLP particularly beneficial in osteoporotic bone and comminuted fractures, where conventional plates may fail.[18]

Volar locking plates also facilitate early wrist mobilization, which is essential for minimizing post-operative stiffness and optimizing functional recovery.[19] Several clinical studies support the superiority of volar locking plates in restoring wrist anatomy and function. Osada et al. reported excellent outcomes and early functional return with VLP fixation.[20] Egol et al. demonstrated superior early wrist motion and patient-reported outcomes compared to external fixation.[21] Meta-analyses by Esposito et al. and Ochen et al. further confirmed improved functional outcomes, reduced complication rates, and better radiographic restoration with VLP fixation.[22,23]

Despite the widespread acceptance of VLP fixation, certain considerations remain, including plate positioning relative to the watershed line, appropriate screw trajectory to avoid joint penetration, the role of pronator quadratus repair, and long-term incidence of post-traumatic arthritis.[24,25]

Given this background, the present study evaluates the functional outcomes and complication profile of distal radius fractures treated with volar locking plates in a tertiary care hospital setting, using the Quick DASH scoring system as the primary functional assessment tool.

MATERIALS AND METHODS

Study Design and Duration: This prospective observational study was conducted in the Department of Orthopaedics, Trichy SRM Medical college Hospital, Irungalur, Samayapuram, Tamil Nadu, from November 2020 to November 2022.

Inclusion Criteria

1. Distal end radius fractures
2. Skeletally mature (Age: >18 years)
3. Compound fractures of distal end radius up to grade I.
4. Patients who were medically fit and willing for surgery.

Exclusion Criteria

- Skeletally immature patients
- Grade II and III compound fractures
- Pathological fractures or associated neurovascular injury

Sample Size: A total of 30 patients meeting the criteria were included in the study.

Surgical Technique: All procedures were performed under regional block or general anesthesia with the patient in a supine position on a radiolucent table. Modified Henry volar approach was utilized. The incision was made just radial to the flexor carpi radialis tendon. After identifying and retracting the radial artery and median nerve, the pronator quadratus muscle was incised along its radial border and reflected ulnarly to expose the distal radius.

The fracture was reduced by direct manipulation under image intensifier guidance. Temporary K-wires were used for provisional fixation, followed by definitive fixation with a 2.7-mm titanium volar locking compression plate (VLP). The plate was positioned proximal to the “watershed line” to avoid intra-articular screw placement. Locking screws were inserted distally in multiple trajectories to secure subchondral support.

After confirming satisfactory reduction and screw position under fluoroscopy, the pronator quadratus was repaired, and the wound was closed in layers. A sterile dressing and below-elbow plaster slab were applied if necessary.

Postoperative Protocol

- IV antibiotics (Cefoperazone-Sulbactam) for 1 day followed by oral antibiotics for one week.
- Limb elevation for 48–72 hours to minimize edema.
- Sutures removed on postoperative day 14.
- Active finger and shoulder movements were encouraged immediately.
- Wrist mobilization exercises commenced after 4 weeks of immobilization.

Follow-Up Schedule and Evaluation: Follow-up evaluations were conducted at six weeks, 3rd ,4th and 6th month.

At each visit, patients underwent

- Clinical assessment: wrist range of motion, grip strength, pain, and return to daily activities.

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- Radiological assessment: anteroposterior and lateral X-rays to evaluate fracture union and maintenance of reduction.
- Functional assessment using the Quick DASH Score (Disabilities of the Arm, Shoulder and Hand)

Statistical Analysis: Data were analyzed using SPSS v26. Continuous variables were compared using independent t-tests; categorical variables were compared using the chi-square or Fisher's exact test. Kaplan–Meier survival analysis estimated functional improvement timelines. Significance was set at p-<0.05.

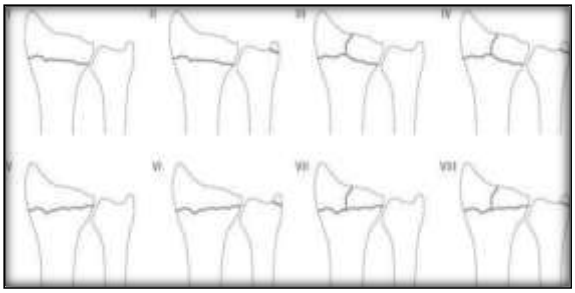

Figure 1: Frykman's classification

Figure 2: Intra-op clinical images showing Henry approach with Volar Locking plate

RESULTS

Thirty patients with distal radius fractures were included in this study. All patients completed a minimum one-year follow-up.

Demographic Profile:

- Age: The mean age was 40.7 years (range 18–62 years).
- Gender: 19 males (63.3%) and 11 females (36.7%).
- Side: The right wrist was involved in 18 cases (60%) and the left in 12 (40%).
- Mode of Injury: Fall on an outstretched hand was the predominant cause (28 cases, 93.3%), followed by road traffic accidents in 2 cases (6.7%).

Fracture Classification: According to Frykman's classification, the most frequent patterns were Type III (20%), Type IV (16.6%), and Type VII (16.6%).

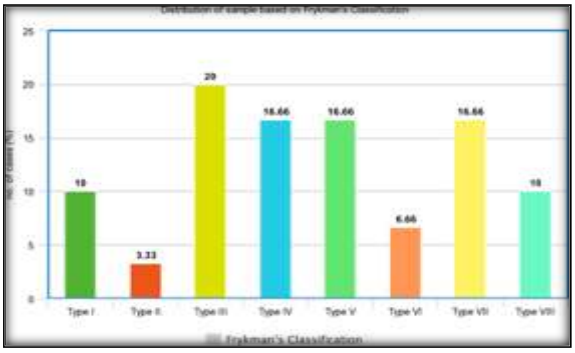

Figure 3: Distribution of the sample based on the Frykman's

Table 1: Distribution of patients based on age

Age (years)	Number of Cases	Percentage
18–30	6	20%
31–40	10	33.3%
41–50	7	23.3%
51–60	6	20%
61–70	1	3.3%

Table 2: Distribution based on gender

Gender	Number of Cases	Percentage
Male	19	63.3%
Female	11	36.7%

Table 3: Fracture type based on Frykman's Classification

Type	Number of Cases	Percentage (%)
I	3	10.0
II	1	3.33
III	6	20.0
IV	5	16.66
V	5	16.66
VI	2	6.66
VII	5	16.66
VIII	3	10.0

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Table 4: Functional outcome based on Quick DASH score

Quick DASH Score	No. of Cases	Percentage	Outcome
0–5	27	90%	Excellent
6–15	2	6.6%	Good
15–30	1	3.3%	Satisfactory

CASE ILLUSTRATION

Image 1: A) Pre op Xray of Left Distal Radius AP and Lateral view, B) Immediate post op Xray, C)6 months old post op Xray, D, E, F, G) Clinical images shows range of movements at Final follow up

Image 2: A) Pre op Xray of Right Distal Radius AP and Lateral view, B) Post Op Xray, C,D,E,F images shows range of movements at Final follow up

DISCUSSION

The aim of treatment for distal radius fractures is to restore wrist anatomy, ensure joint congruity, and allow early functional recovery. Conservative management, though widely practiced, carries the risk of secondary displacement, malunion, and stiffness. Surgical fixation has therefore become the preferred option, particularly for unstable or intra-articular fractures.

In the present study, fixation with a volar locking plate provided excellent outcomes in 90% of cases, comparable to results from previous literature. Osada et al,[18] reported excellent results in 94% of patients with early mobilization and minimal complications. Egol et al,[11] found that volar plate fixation offered superior early wrist motion and grip strength compared with external fixation, although long-term outcomes were similar.

The fixed-angle construct of volar plates functions as an internal fixator, distributing load through the locking screw–plate interface rather than compressing bone fragments, thus minimizing periosteal disruption. This design offers particular advantage in osteoporotic bone where conventional plating often fails due to poor screw purchase.

In our series, the average age was 40.7 years, consistent with the working-age group susceptible to high-energy trauma. The male predominance reflects occupational and outdoor exposure. The majority of fractures resulted from falls on an outstretched hand, similar to observations by Zengin et al.6

Radiographic and functional outcomes were excellent, with all fractures uniting within 12 weeks. The mean Quick DASH score corresponded to excellent functional recovery, comparable with studies by Wright et al.17 and Pichon et al.14 No major complications such as loss of reduction, implant failure, or tendon rupture were noted, emphasizing the safety of this technique when the plate is placed proximal to the watershed line.

Previous reports of dorsal plating often highlighted extensor tendon irritation and need for hardware removal. The volar approach avoids these issues, as the pronator quadratus provides an additional protective layer. Additionally, volar plates offer better soft-tissue coverage and easier surgical access. Meta-analyses by Esposito et al.12 and Ochen et al.20 confirmed significantly improved DASH scores and radiographic parameters with volar locking plates compared to other modalities, supporting our findings. Similarly, Woolnough et al.19 reported that while no surgical technique had major superiority, volar plating achieved lower complication rates, especially in intra-articular fractures.

The absence of significant complications in our series may also be attributed to strict postoperative physiotherapy and early mobilization. Stiffness and complex regional pain syndrome, often reported after immobilization, were not observed.

However, this study had limitations. The sample size was relatively small (n=30), with short-term follow-up of one year. Long-term studies are needed to evaluate the incidence of post-traumatic arthritis and implant-related complications. Moreover, the study did not include a control group treated by other modalities (e.g., K-wire or external fixation), which limits direct comparative analysis.

Despite these limitations, the present findings reinforce the growing body of evidence favoring volar locking plates as a superior modality for treating unstable distal radius fractures. The simplicity of the approach, biomechanical strength of

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the construct, and rapid functional recovery make it a valuable technique, especially in centers equipped for advanced trauma care.

CONCLUSION

Distal radius fractures are among the most common injuries requiring orthopaedic intervention. Their optimal management demands anatomical reduction, stable fixation, and early functional rehabilitation.

The findings from our study demonstrate that volar locking plate fixation achieves excellent functional and radiological outcomes in the majority of cases. The fixed-angle design provides stability even in osteoporotic and comminuted fractures, enabling early wrist mobilization and quicker return to normal activities.

With proper surgical technique and adherence to postoperative rehabilitation, the risk of complications remains minimal. The volar approach also provides favorable soft-tissue coverage, decreasing hardware irritation compared to dorsal plating.

Based on the current results and supporting literature, volar locking plate fixation remains a safe, effective, and reproducible method for managing unstable distal radius fractures, offering the best balance between stability, mobility, and patient satisfaction. Further randomized controlled trials with larger sample sizes and long-term follow-up are recommended to validate these outcomes and establish standardized treatment guidelines.

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