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# Functional and Radiological Outcomes of Volar Locking Plate Fixation in Intra-Articular Distal Radius Fractures in the Elderly Population

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## A B S T R A C T

**Background:** Distal radius fractures are among the most common fractures in the elderly, often resulting from low-energy falls. Intra-articular involvement poses additional challenges due to comminution, osteoporosis, and the risk of post-traumatic arthritis. Volar locking plate (VLP) fixation has gained popularity for its biomechanical stability and ability to facilitate early mobilization. This study aimed to evaluate the functional and radiological outcomes of VLP fixation in intra-articular distal radius fractures in elderly patients. **Materials and Methods:** A prospective study was conducted on 60 elderly patients (≥60 years) with AO type C distal radius fractures treated with VLP fixation. Inclusion criteria were closed fractures, surgery within 7 days of injury, and minimum 6-month follow-up. Functional outcome was assessed using the Disabilities of the Arm, Shoulder and Hand (DASH) score and the Modified Mayo Wrist Score (MMWS) at 6 and 12 months. Radiological assessment included radial height, radial inclination, and volar tilt measured on standard posteroanterior and lateral radiographs. Statistical analysis was performed using paired t-tests, with $p < 0.05$ considered significant. **Results:** The mean age was 68.2 ± 5.9 years, with a female predominance (65%). At 12 months, the mean DASH score improved from 58.4 ± 6.8 at baseline to 14.7 ± 4.2 ($p < 0.001$). The mean MMWS increased from 48.5 ± 8.6 to 87.3 ± 6.1 ($p < 0.001$). Radiologically, radial height improved from 5.2 ± 1.3 mm preoperatively to 11.1 ± 0.9 mm postoperatively, radial inclination from 12.4° ± 2.6° to 21.8° ± 1.5°, and volar tilt from −6.5° ± 3.2° to 7.2° ± 1.1° ($p < 0.001$ for all). Complications included transient median nerve symptoms in 3 patients (5%) and superficial wound infection in 2 patients (3.3%), both resolving with conservative management. **Conclusion:** Volar locking plate fixation in elderly patients with intra-articular distal radius fractures provides excellent functional recovery and restoration of anatomical alignment, with a low complication rate. Early mobilization and stable fixation make it a favorable option in this age group.

**Keywords:** Distal radius fracture, volar locking plate, elderly, functional outcome, radiological outcome, intra-articular fracture

## INTRODUCTION

Distal radius fractures (DRFs) are among the most common skeletal injuries in the elderly, accounting for up to 18% of all fractures in this age group, largely due to low-energy falls in osteoporotic bone [**1**]. Intra-articular fractures, particularly AO type C patterns, present additional management challenges owing to comminution, instability, and the risk of post-traumatic arthritis [**2**].

Traditionally, treatment options ranged from closed reduction and casting to external fixation and percutaneous pinning. While conservative management remains suitable for stable extra-articular fractures, unstable intra-articular fractures often demonstrate loss of reduction and poor functional recovery when treated non-operatively, especially in osteoporotic bone [**3**, **4**].

The volar locking plate (VLP) system has gained widespread acceptance for the management of unstable distal radius fractures. It offers stable fixation through angular stability, even in poor bone quality, and allows for early postoperative mobilization, which is crucial in preventing stiffness and promoting functional recovery in elderly patients [**5**, **6**]. Furthermore, several studies have reported that VLP fixation facilitates restoration of anatomical parameters such as radial height, radial inclination, and volar tilt, which are essential for optimal wrist biomechanics [**7**, **8**].

However, despite its popularity, there remains ongoing debate regarding the superiority of VLP fixation over other surgical modalities in elderly populations, given the potential risks of hardware-related complications and the varying functional demands in this age group [**9**, **10**]. This study aims to evaluate both functional and radiological outcomes of VLP fixation in intra-articular distal radius fractures among elderly patients, thereby contributing to evidence-based decision-making in this clinical scenario.

**Materials and Methods**

A total of 60 patients aged 60 years and above, diagnosed with intra-articular distal radius fractures classified as AO type C, were included. Diagnosis was confirmed by standard posteroanterior and lateral radiographs.

**Inclusion Criteria:**

- Age ≥ 60 years
- Closed intra-articular distal radius fractures (AO type C)
- Surgery performed within 7 days of injury
- Minimum follow-up of 6 months

**Exclusion Criteria:**

- Open fractures
- Associated ipsilateral upper limb fractures
- Previous wrist pathology or deformity
- Polytrauma cases or medically unfit for surgery

**Surgical Procedure:**

All patients underwent volar locking plate fixation under regional or general anaesthesia. A standard volar approach via the modified Henry incision was used. After anatomical reduction under fluoroscopic guidance, a pre-contoured VLP was applied and fixed with locking screws. Intraoperative fluoroscopy confirmed restoration of radial height, inclination, and volar tilt. Wound closure was performed in layers, and a below-elbow splint was applied for initial immobilization.

**Postoperative Protocol:**

Active finger and shoulder mobilization was encouraged from the first postoperative day. Wrist mobilization was initiated after suture removal at 10–14 days. Patients were reviewed at 6 weeks, 3 months, 6 months, and 12 months.

**Outcome Assessment:**

Functional outcomes were assessed using the Disabilities of the Arm, Shoulder and Hand (DASH) score and Modified Mayo Wrist Score (MMWS) at 6 and 12 months. Radiological outcomes were evaluated using standard anteroposterior and lateral radiographs to measure radial height, radial inclination, and volar tilt.

**Statistical Analysis:**

Data were analysed using SPSS software version 25.0 (IBM Corp., Armonk, NY, USA). Continuous variables were expressed as mean ± standard deviation (SD) and compared using paired *t*-tests. Categorical data were compared using the chi-square test. A $p$-value < 0.05 was considered statistically significant.

**Results**

A total of 60 patients meeting the inclusion criteria were enrolled. The mean age was 68.2 ± 5.9 years, with a female predominance (39 females, 21 males). The dominant wrist was involved in 56.7% of cases. The average time from injury to surgery was 4.3 ± 1.6 days.

**Functional Outcomes:**

The mean DASH score improved significantly from 58.4 ± 6.8 at 6 weeks to 14.7 ± 4.2 at 12 months ($p < 0.001$). Similarly, the mean MMWS increased from 48.5 ± 8.6 at 6 weeks to 87.3 ± 6.1 at 12 months ($p < 0.001$) (Table 1).

**Table 1.** Functional outcome scores at different follow-up periods.

| Parameter | 6 Weeks (Mean ± SD) | 6 Months (Mean ± SD) | 12 Months (Mean ± SD) | *p*-Value |
|---|---|---|---|---|
| DASH Score | 58.4 ± 6.8 | 26.3 ± 5.5 | 14.7 ± 4.2 | <0.001* |
| Modified Mayo Wrist Score | 48.5 ± 8.6 | 75.1 ± 7.2 | 87.3 ± 6.1 | <0.001* |

*Statistically significant

**Radiological Outcomes:**
Radiological assessment demonstrated significant postoperative improvement in anatomical parameters, with maintained alignment throughout follow-up (Table 2). Mean radial height increased from 5.2 ± 1.3 mm preoperatively to 11.1 ± 0.9 mm postoperatively, radial inclination from 12.4° ± 2.6° to 21.8° ± 1.5°, and volar tilt from −6.5° ± 3.2° to 7.2° ± 1.1° ($p < 0.001$ for all).

**Table 2.** Radiological parameters before and after surgery.

| Parameter | Preoperative (Mean ± SD) | Postoperative (Mean ± SD) | *p*-Value |
|---|---|---|---|
| Radial Height (mm) | 5.2 ± 1.3 | 11.1 ± 0.9 | <0.001* |
| Radial Inclination (°) | 12.4 ± 2.6 | 21.8 ± 1.5 | <0.001* |
| Volar Tilt (°) | −6.5 ± 3.2 | 7.2 ± 1.1 | <0.001* |

*Statistically significant

**Complications:**
Postoperative complications were minimal. Three patients (5%) experienced transient median nerve symptoms, which resolved with conservative management. Two patients (3.3%) developed superficial wound infections, treated successfully with oral antibiotics. No cases of implant failure, tendon rupture, or loss of reduction were observed during the follow-up period.

Functional improvements were consistent with radiological restoration of wrist anatomy, suggesting that VLP fixation provided stable fixation and enabled early rehabilitation (Table 1, Table 2).

**Discussion**
In this study, volar locking plate (VLP) fixation for intra-articular distal radius fractures in the elderly population demonstrated excellent functional recovery and significant restoration of anatomical parameters, with low complication rates over a 12-month follow-up period. The mean DASH score improvement from 58.4 to 14.7 and the increase in MMWS from 48.5 to 87.3 indicate substantial functional gains, consistent with previous reports highlighting the role of VLP in enabling early mobilization and improved wrist performance in osteoporotic bone [**1–3**].

Radiological outcomes in our study showed marked correction of radial height, inclination, and volar tilt postoperatively, maintained throughout follow-up. These findings align with those of Chung et al. [**4**] and Arora et al. [**5**], who reported that VLP fixation offers reliable anatomical restoration even in elderly patients with comminuted fractures. Anatomical alignment has been linked to better long-term wrist biomechanics and reduced incidence of post-traumatic arthritis [**6,7**]. Our complication profile was low, with transient median nerve symptoms (5%) and superficial wound infections (3.3%), similar to rates observed in earlier trials [**8,9**]. Importantly, no tendon ruptures or implant failures were recorded, which have been documented in 1–4% of cases in other series [**10**].

Compared with conservative management, surgical fixation using VLP has shown superior functional outcomes in unstable intra-articular fractures, especially in patients over 60 years of age [**11,12**]. While external fixation and percutaneous pinning remain alternatives, they are associated with higher rates of loss of reduction and pin tract infections in osteoporotic bone [**13**].

Despite concerns regarding surgical intervention in elderly patients with potentially lower functional demands, several studies, including ours, suggest that restoration of anatomy and stability translates into better quality of life and independence [**14,15**]. Our results reinforce the view that age alone should not be a deterrent for surgical fixation in appropriately selected cases.

**Limitations** of the present study include the relatively small sample size, short follow-up period, and lack of a direct comparison group receiving non-operative management. Future multicenter randomized controlled trials with longer follow-up are warranted to assess functional sustainability and long-term complication rates.

**Conclusion**
Volar locking plate fixation in elderly patients with intra-articular distal radius fractures provides stable fixation, facilitates

early mobilization, and results in excellent functional and radiological outcomes with minimal complications. It remains a favorable treatment option in this patient population when surgical intervention is indicated.

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