Section: Orthopedics

Original Research Article

FUNCTIONAL AND RADIOLOGICAL OUTCOME OF DISTAL END RADIUS FRACTURE TREATED WITH VOLAR LOCKING PLATE IN 30 PATIENTS: A PROSPECTIVE STUDY

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ABSTRACT

Background: Distal radius fractures are among the most common upper-limb fractures in adults and frequently result from high-energy trauma or low-energy falls. Unstable fractures often require surgical fixation to restore anatomical alignment and facilitate early functional recovery. Volar locking plate fixation has gained widespread acceptance because of its biomechanical stability and ability to permit early mobilization. The aim is to evaluate the functional and radiological outcomes of unstable distal radius fractures treated with volar locking plate fixation. **Materials and Methods:** This prospective observational study included 30 adult patients with unstable closed distal radius fractures treated with open reduction and internal fixation using a volar locking plate. Patients were followed clinically and radiologically until fracture union. Functional outcomes were assessed using the Mayo Wrist Score, while radiological outcomes were evaluated using Sarmiento's modification of Lindstrom's criteria. Wrist range of motion, fracture union, radiographic parameters, and postoperative complications were also analyzed. **Results:** The mean age group was 40–60 years, with a slight male predominance. Road traffic accidents accounted for 80% of injuries, and AO type C fractures were the most common. Fracture union was achieved within 12 weeks in 86.7% of patients. At final follow-up, mean wrist flexion, extension, pronation, and supination were 75.2°, 70.8°, 76.2°, and 78.5°, respectively ($p < 0.001$). Radiological assessment demonstrated satisfactory restoration of palmar tilt, radial height, radial inclination, and minimal articular step-off. According to the Mayo Wrist Score, 70% of patients achieved excellent outcomes, 23.3% good outcomes, and 6.7% fair outcomes. Radiological evaluation showed excellent results in 66.7% and good results in 33.3% of patients. The overall complication rate was 13.3%, with no major implant-related failures. **Conclusion:** Volar locking plate fixation provides stable anatomical reduction, reliable fracture union, excellent restoration of wrist function, and satisfactory radiological outcomes with a low complication rate in unstable distal radius fractures. Early surgical intervention combined with structured rehabilitation contributes to favorable clinical outcomes, supporting the use of volar locking plates as an effective treatment option for unstable distal radius fractures.

INTRODUCTION

Fractures involving the distal end of the radius represent one of the most frequently encountered injuries in orthopedic practice. They account for nearly one-fifth of all fractures seen in adults and are associated with considerable functional impairment when not treated appropriately. The incidence of these fractures shows a bimodal distribution, affecting younger individuals following high-energy trauma such as road traffic accidents or sports injuries, while in older adults they are more commonly the result of low-energy falls associated with osteoporotic bone. Owing to their high incidence and potential to cause long-term disability, distal radius fractures continue to be an

important topic in orthopedic research and clinical practice.[1,2]

The distal radius is an essential component of the wrist joint, contributing significantly to load transmission, stability, and coordinated movements of the hand and forearm. Disruption of the normal anatomy following fracture may alter wrist biomechanics, resulting in pain, decreased grip strength, restricted motion, and reduced ability to perform routine activities. Failure to restore anatomical alignment, particularly in displaced or intra-articular fractures, may predispose patients to malunion, distal radioulnar joint dysfunction, and post-traumatic osteoarthritis. Consequently, successful treatment aims not only to achieve fracture union but also to restore wrist anatomy and function as completely as possible.[3,4]

Management of distal radius fractures has evolved considerably over the past few decades. Stable extra-articular fractures can often be treated successfully with closed reduction and cast immobilization. However, unstable fracture patterns frequently lose reduction during conservative treatment, leading to unsatisfactory radiological and functional outcomes. Advances in implant technology and surgical techniques have therefore expanded the role of operative management. Currently available surgical options include percutaneous Kirschner wire fixation, external fixation, dorsal plating, fragment-specific fixation, and volar locking plate fixation, with each method having specific indications, advantages, and limitations.[5,6]

Among these techniques, fixation using a volar locking plate has gained widespread acceptance because it provides stable internal fixation through fixed-angle screw technology. The locking construct resists collapse of metaphyseal fragments and offers reliable fixation even in osteoporotic bone. In addition, the volar approach minimizes the risk of extensor tendon complications associated with dorsal implants and facilitates early mobilization of the wrist. Early restoration of wrist movement is considered beneficial in reducing stiffness, improving grip strength, and promoting an earlier return to occupational and daily activities.[7,9]

Although numerous reports have described favorable clinical outcomes following volar locking plate fixation, the relationship between radiographic restoration and functional recovery remains an area of continued investigation. Several patient-related factors, including age, bone quality, fracture configuration, associated soft-tissue injury, and adherence to postoperative rehabilitation, may influence the final functional result. Furthermore, implant-related complications such as tendon irritation, screw prominence, median nerve compression, infection, loss of reduction, and complex regional pain syndrome continue to be reported despite improvements in implant design and surgical technique.[10,12]

Assessment of treatment success should therefore extend beyond radiographic union alone. Patient-reported outcome measures and functional scoring systems provide valuable information regarding pain relief, range of motion, grip strength, and return to normal activities. Instruments such as the Disabilities of the Arm, Shoulder and Hand (DASH) questionnaire, the Patient-Rated Wrist Evaluation (PRWE), and the Modified Mayo Wrist Score have become standard methods for evaluating functional recovery following distal radius fracture fixation and allow objective comparison between different treatment modalities.[13,15]

Despite increasing use of volar locking plates worldwide, variations still exist regarding patient selection, fracture characteristics, timing of surgery, rehabilitation protocols, and expected functional outcomes. Additional clinical studies are therefore necessary to evaluate the effectiveness of this technique in different populations and healthcare settings. The present study was undertaken to assess the functional outcome of distal end radius fractures treated with volar locking plate fixation, with particular emphasis on recovery of wrist function, radiological alignment, and postoperative complications.

MATERIALS AND METHODS

This is a prospective comparative hospital based prospective study being done at the Department of Orthopedics, Koppal institute of medical sciences Koppal starting from 1st October 2024 till 30thMarch 2026.

Methods of collection of data

1. Data was collected from 30 patients aged 18 years and above both male and female diagnosed with distal radius fractures who have attended Orthopedics opd.
2. Clinical study was through questionnaires and clinical examination.
3. All patients has undergone preoperative and postoperative x-ray investigations.
4. Surgical management of the fracture.
5. Post-operative observation of patients for any complications.
6. Regular follow up and health education for the patients treated to study the functional outcome.

Inclusion criteria

1. Age group of 18-75years of both sexes
2. Fractures of distal end radius of either side or both with or without ulnar styloid.
3. Patients who are medically fit and willing for surgery
4. Radiological findings confirming fracture of distal end radius

Exclusion criteria

1. Patients who are unfit for surgery due to associated medical problems.

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2. Distal radius fracture associated with Neurovascular Deficit.
3. Distal radius fracture associated with Carpals injury
4. Old fracture more than 3 weeks
5. Patients below 18 years
6. Open fractures
7. Pathological fracture
8. Patients with existing disorders having a relevant effect on the healing process, such as multiple sclerosis or paraplegia.

Preoperative assessment

Pre-operative evaluation: immediate management Following admission, proper history regarding the mode of injury, severity of trauma was obtained. Their general condition, systemic diseases and associated injuries were noted. After stabilizing general condition of the patient all patients were carefully inspected for skin condition, swelling, tenderness, deformity, wound, bony irregularity and the relative position of radial and ulnar styloid process.

Movements of the wrist and forearm were checked. Distal vascularity was assessed by radial artery pulsation, capillary filling, pallor and paresthesia. The involved forearm was immobilized in a below elbow POP slab and kept elevated.

Radiographic examination: Radiographs of injured wrist 1. Posteroanterior view 2. Lateral view Fractures classified according to Frykman classification. Patients satisfying the inclusion criteria were selected.

Operative Procedure

Anesthesia: Regional/ General Anesthesia.

Most of the patients were operated under the brachial block.

Position and tourniquet: Supine position with the forearm in supination. Injured limb was exsanguinated, the mid-arm pneumatic tourniquet was applied and the limb was placed on a side arm board. Forearm and hand thoroughly scrubbed, painted with betadine and draped.

Approach: Henry's volar approach)

After successful fracture reduction, position the volar plate under fluoroscopic guidance and insert a screw into the oblong or gliding hole first to allow proximal-distal adjustment.

Use a 2.5-mm drill bit to drill into the center of the oblong hole and insert a self-tapping 3.5-mm screw.

Confirm proper placement of the volar plate with C-arm fluoroscopy. If necessary, shift the plate proximally or distally to provide the best placement for the distal screws.

Use a 2.0-mm drill bit to drill the distal holes. Measure the holes for screw length and insert smooth locking screws. Use a screw that is 2 mm shorter than the measured length to avoid having a prominent distal screw perforate the dorsal cortex; typically, 20- to 22-mm screws are optimal, except for screws directed into the radial styloid, which are significantly shorter. Threaded screws may gain better bone dorsally.

Once the first screw is inserted, distal traction on the fingers can be released because the fracture usually is appropriately reduced and fixed.

Because of the fixed-angle design, the screws may perforate into the radiocarpal joint if the plate is placed too far distally. Obtain fluoroscopic views tangential to the subchondral bone in both the coronal and sagittal planes to assess for intraarticular penetration. Adjust the plate or screws, or both as indicated. After placement of the distal screws, place the remaining proximal screws.

If the ulnar styloid is fractured and displaced, making the distal radioulnar joint unstable, fix the styloid with one or two percutaneous Kirschner wires Close the wound in layers and apply a splint.

Post-operative care and rehabilitation

Patients were kept nil per oral for 4-6hours post-surgery. Intravenous fluids & analgesics were given as needed. Patients were encouraged limb elevation and active finger mobilization exercises in the immediate post-op period. Distal neuro-vascularity was assessed regularly, and intravenous antibiotics were given for 3 days and after that changed to oral antibiotics for 5 days. Suture removal was done for all the cases between 9 to 12 days post-operative.

After suture removal, gentle active wrist mobilization exercises were started.

Resisted exercises were started about 6 weeks after surgery.

All the patients were then followed up at two weekly intervals for the first two months and then monthly for the next six months.

The union was assessed by callus formation on both AP and Lateral radiographs and clinically absence of tenderness at the fracture site.

After the union was achieved, each patient was subjected to a series of radiological and clinical examinations, which included both subjective and objective evaluations of the resultant. The Augusto Sarmiento modification of the Gartland and Werley Demerit point system was used to evaluate each patient.

RESULTS

A total of 30 patients with closed distal radius fractures were included in the study. Most patients were 40–60 years old (56.7%), with a slight male predominance (53.3%). The right wrist was affected in 70% of cases, and road traffic accidents (80%) were the leading mechanism of injury.

Table 1: Distribution of study subjects on their age

Age group	Frequency
0-20yrs	01
20-40yrs	12
>40yrs	17

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Table 2: Distribution of study subjects on their gender

Gender	frequency
Male	16
Female	14

Table 3: Distribution of study subjects on the side

Side	frequency
Left	09
Right	21

Table 4: Distribution of study subjects on the mode of injury

Mode of injury	Frequency
RTA	15
FOOSH	13
Fall from height	02

According to the AO classification, type C fractures were the most common, with C3 (30%) and C2 (26.7%) accounting for over half of all fractures. Most patients (63.3%) underwent surgery within two days of injury.

Table 5: Distribution of study subjects on the AO type

AO TYPE	Frequency
B1	2
B2	3
B3	4
C1	4
C2	8
C3	9

At the final follow-up, patients demonstrated satisfactory wrist function with mean flexion of 75.2°, extension 70.8°, pronation 76.2°, supination 78.5°, ulnar deviation 25.8°, and radial deviation 18.8° (all $p < 0.001$). Radiological assessment showed an average articular step-off of 0.56 mm, palmar tilt 9.1°, radial height 10.1 mm, and radial inclination 21.1°, indicating restoration of normal wrist anatomy.

Table 6: functional outcome –Last follow-up

Movements	MEAN ROM	Mayo wrist score	frequency
Palmar flexion	75.16^0	Excellent	21
Dorsi flexion	70.83^0	Good	07
Ulnar deviation	25.80^0	Fair	02
Radial deviation	18.80^0		
Supination	78.50^0		
Pronation	76.50^0		

Table 7: Radiological measurements

Radiological parameter	Mean measurements
Articular step	0.56mm
Palmar tilt	9.06^0
Radius height	10.09mm
Radial inclination	21.06^0

Table 8: complication

Complication	frequency
EPL irritation	01
Stiffness	01
Superficial infection	02

Table 9: Duration of union

Duration	frequency
12 weeks	26
20week	02
21weeks	02

Table 10: radiological outcome: sarmento's modification of lindstrom's criteria

Radio outcome	frequency
excellent	20
good	10

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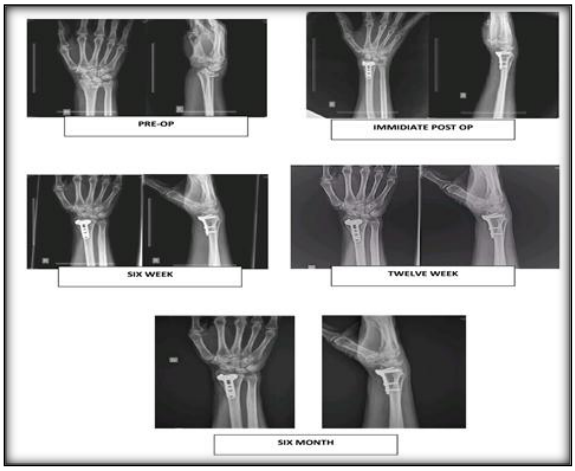
Fracture union was achieved in 86.7% of patients within 12 weeks, while delayed union occurred in 13.3%. Postoperative complications were uncommon (13.3%), including superficial infection, extensor pollicis longus irritation, and wrist stiffness.

Functional evaluation using the Mayo Wrist Score revealed excellent outcomes in 70%, good in 23.3%, and fair in 6.7% of patients. Radiological evaluation using Sarmiento's modification of Lindstrom's criteria demonstrated excellent results in 66.7% and good results in 33.3% of cases.



DISCUSSION

The present study demonstrated that 70% of patients achieved excellent functional outcomes, while 23.3% had good outcomes according to the Mayo Wrist Score. Radiological evaluation also showed 66.7% excellent and 33.3% good results using Sarmiento's modification of Lindstrom's criteria, indicating that volar locking plate fixation provides excellent restoration of wrist anatomy and function.

These findings are consistent with the study by Kapoor et al., who reported that open reduction and internal fixation with a volar locking plate achieved excellent anatomical reduction, stable fixation, and good functional recovery in unstable distal radius fractures. Similar to our study, they emphasized that accurate restoration of articular congruity and early mobilization contributed to improved clinical outcomes.[16]

Our results are also in agreement with the systematic review by Margaliot et al., which concluded that volar locking plate fixation provides reliable maintenance of fracture reduction and allows early return of wrist function. However, the review noted that long-term functional superiority over other fixation methods was limited because several treatment modalities eventually achieved comparable outcomes. This observation may explain why our excellent short-term functional results are comparable with previously published literature.[17]

Similarly, Wei et al. demonstrated through a meta-analysis that patients treated with volar locking plates experienced lower disability scores, better maintenance of volar tilt and radial inclination, and fewer complications than those treated with external fixation. Our study also demonstrated satisfactory radiological restoration, a high union rate (86.7%), and a low complication rate (13.3%), supporting these findings.[18]

The findings of the present study differ slightly from those reported by Costa et al. (DRAFFT Trial). Costa and colleagues compared volar locking plates with Kirschner-wire fixation and found no clinically significant difference in patient-reported functional outcomes at one year, despite the higher cost of plate fixation. In contrast, our study observed predominantly excellent functional outcomes after volar locking plate fixation. This difference is likely attributable to variations in fracture pattern, study design, sample size, surgical expertise, and the absence of a comparison group in the present study.[19]

Likewise, Grewal et al. compared volar locking plate fixation with external fixation and found that volar plates offered faster recovery, improved early wrist motion, and fewer complications, although long-term outcomes were comparable between groups. Our findings agree with their observation of excellent early functional recovery, restoration of wrist range of motion, and minimal postoperative complications following volar locking plate fixation.[20]

Overall, the findings of the present study support the growing body of evidence that volar locking plate fixation is an effective treatment for unstable distal radius fractures. The high rate of fracture union, excellent functional recovery, satisfactory radiological alignment, and low complication rate observed in our patients are consistent with previously published literature and reinforce the role of volar locking plates as a preferred fixation method in appropriately selected patients.

CONCLUSION

Volar locking plate fixation is an effective treatment option for unstable distal radius fractures. The

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technique provides stable anatomical reduction, promotes early fracture union, restores wrist motion, and achieves excellent functional and radiological outcomes with a low complication rate. Early operative management combined with appropriate postoperative rehabilitation contributes significantly to successful recovery. Therefore, volar locking plate fixation can be considered a reliable surgical method for managing unstable distal radius fractures in adult patients.

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Ethical approval

Permission for the study was obtained from the College authorities prior to commencement.

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