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Original Research Article

COMPARATIVE STUDY OF OUTCOMES OF DISTAL END RADIUS FRACTURE MANAGEMENT BY VOLAR LOCKING PLATE VERSUS EXTERNAL FIXATOR: A PROSPECTIVE STUDY

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ABSTRACT

Background: Distal end radius fractures are among the most common fractures encountered in orthopedic practice. While stable fractures can be managed conservatively, unstable and intra-articular fractures often require surgical fixation to restore wrist anatomy and function. External fixation and volar locking plate fixation are widely used treatment modalities, each with distinct advantages and limitations. The present study was undertaken to compare the clinical and radiological outcomes of these two techniques. The aim is to compare the functional and radiological outcomes of unstable distal end radius fractures treated with external fixation and volar locking plate fixation.

Materials and Methods: This prospective comparative study included 46 patients with unstable distal end radius fractures treated surgically between 1st October 2024 till 30th March 2026. Twenty-one patients underwent external fixation (Group A) and twenty-five patients underwent volar locking plate fixation (Group B). Patients were evaluated clinically and radiologically at regular follow-up visits. Functional assessment included wrist range of motion, while radiological evaluation comprised measurement of ulnar variance, articular step-off, palmar tilt, and radial inclination. Postoperative complications were also recorded.

Results: The majority of patients were males (71.7%), and the most commonly affected age group was 31–50 years (47.8%). Road traffic accidents were the predominant mode of injury (60.9%). Type III fractures according to the Frykman classification were the most frequent (30.4%). At the final follow-up, patients treated with volar locking plates demonstrated better wrist mobility, with mean palmar flexion of 75°, dorsiflexion of 70°, radial deviation of 20°, supination of 80°, and pronation of 76°, compared with 70°, 64°, 16°, 76°, and 72°, respectively, in the external fixation group. Radiological assessment also favored the plating group, showing better restoration of ulnar variance (0.58 mm vs 1.07 mm), palmar tilt (9.3° vs 7.03°), and radial inclination (19.66° vs 15.5°). Superficial infection occurred in two patients following volar plating, whereas postoperative wrist stiffness was observed in two patients treated with external fixation. Loss of reduction occurred in one patient in each group.

Conclusion: Both external fixation and volar locking plate fixation provide satisfactory outcomes in the management of unstable distal end radius fractures. However, volar locking plate fixation offers superior restoration of wrist anatomy and improved functional recovery, allowing earlier mobilization of the wrist. External fixation remains an effective alternative in selected cases, particularly where soft-tissue conditions favor a less invasive approach. Treatment should be individualized based on fracture characteristics, patient factors, and surgeon expertise.

Keywords: Distal end radius fracture, Volar locking plate, External fixator, Frykman classification, Functional outcome, Radiological outcome, Wrist fractures.

INTRODUCTION

Fractures involving the distal end of the radius are among the most frequently encountered injuries treated by orthopedic surgeons and represent a substantial proportion of upper limb fractures in both young and elderly patients. The pattern of injury varies with age and mechanism of trauma. Younger individuals commonly sustain these fractures following high-energy injuries such as road traffic accidents or sports-related trauma, whereas elderly patients usually present after low-energy falls due to age-related osteoporosis. Because the distal radius forms an important component of the wrist joint, disruption of its anatomy can significantly impair hand function and affect activities of daily living if not managed appropriately.[1,2]

The objectives of treatment extend beyond fracture union and include restoration of the normal articular surface, maintenance of radial length, radial inclination, volar tilt, and stability of the distal radioulnar joint. Failure to achieve satisfactory alignment may alter wrist biomechanics, resulting in pain, reduced grip strength, stiffness, loss of forearm rotation, and the development of post-traumatic arthritis. Therefore, achieving anatomical reduction and maintaining it throughout fracture healing are considered essential for obtaining good functional results.[3,4]

Management of distal radius fractures has undergone considerable evolution over the past few decades. Although stable extra-articular fractures may be treated successfully with closed reduction and cast immobilization, displaced, unstable, and intra-articular fractures often require operative intervention to prevent secondary displacement and malunion. Various surgical techniques have been described, including percutaneous Kirschner wire fixation, external fixation, dorsal plating, fragment-specific fixation, bridge plating, and volar locking plate fixation. Each technique has distinct indications, advantages, and limitations, making the choice of treatment dependent on fracture morphology, bone quality, patient characteristics, and surgeon experience.[5,6]

External fixation was introduced on the principle of ligamentotaxis, whereby longitudinal distraction through intact soft tissues assists in restoring fracture alignment and maintaining reduction. It has demonstrated satisfactory results in comminuted and intra-articular fractures while minimizing additional soft-tissue dissection. However, prolonged external immobilization may be associated with wrist stiffness, pin tract infection, loss of reduction, reflex sympathetic dystrophy, and patient discomfort. These limitations have encouraged the search for fixation methods that provide greater stability while permitting early mobilization.[7-9]

The development of fixed-angle volar locking plates has significantly influenced the surgical management of distal radius fractures. The locking mechanism between the screw and plate creates a stable construct capable of supporting subchondral bone and maintaining fracture reduction even in osteoporotic patients. In addition, the volar approach provides excellent exposure of the distal radius while reducing the risk of extensor tendon complications associated with dorsal implants. Stable internal fixation achieved with volar locking plates allows early wrist motion, thereby facilitating rehabilitation and improving functional recovery.[10-12]

Although both external fixation and volar locking plate fixation are widely accepted treatment options for unstable distal radius fractures, controversy remains regarding their relative effectiveness. Several studies have suggested that volar locking plates provide earlier functional recovery and better restoration of wrist motion, whereas external fixation continues to produce satisfactory long-term outcomes with relatively simple surgical technique and lower implant costs. Differences in fracture pattern, patient age, associated osteoporosis, and rehabilitation protocols may further influence treatment outcomes. Consequently, there is no universal consensus regarding the optimal method of fixation for unstable distal radius fractures.[13-15]

Assessment of treatment success should include both radiological and functional parameters. Restoration of radial height, radial inclination, volar tilt, and articular congruity should be correlated with clinical outcomes such as wrist range of motion, grip strength, pain relief, and return to daily activities. Standardized scoring systems including the Disabilities of the Arm, Shoulder and Hand (DASH) score, Patient-Rated Wrist Evaluation (PRWE), and Modified Mayo Wrist Score are widely used to objectively evaluate postoperative function and compare different treatment methods.[16-18]

Considering the continued debate regarding the advantages of internal fixation with volar locking plates over external fixation, further comparative clinical evaluation remains justified. The present study was undertaken to compare the radiological and functional outcomes of distal end radius fractures treated with volar locking plate fixation and external fixation, with particular emphasis on fracture union, restoration of wrist anatomy, functional recovery, and procedure-related complications.

MATERIALS AND METHODS

This is a prospective comparative hospital based prospective study being done at the Department of Orthopedics KIMS, Koppal starting from 1st October 2024 till 30th March 2026.

Methods of collection of data

- Data was collected from 46 patients aged 18 years and above both male and female diagnosed with distal radius fracture who have attended Orthopedics opd and admitted.
- Clinical study was through questionnaires and clinical examination.

- All patients has undergone preoperative and postoperative x-ray investigations, and if needed CT scan.
- Surgical management of the fracture.
- Post-operative observation of patients for any complications.
- 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.
2. Distal radius fracture associated with Neuro-vascular Deficit.
3. Distal radius fracture associated with Carpals injury
4. Old fracture more than 3 weeks.
5. 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. Postero-anterior view

2. Lateral view

Fractures classified according to Frykman classification. Patients satisfying the inclusion criteria were selected.

Operative Procedure:

Volar Plating

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.

External fixation

- Reduce the fracture manually or with the aid of sterile finger traps or traction
- Make a stab incision over the dorsoradial aspect of the index metacarpal base and use blunt dissection with scissors to expose the metacarpal. Take care to preserve and reflect the branches of the dorsal radial sensory nerve.
- Place a soft-tissue protector on the metacarpal and insert 2.7-mm self-tapping schanz-pins at a 30- to 45-degree angle dorsal to the frontal plane of the hand and forearm. Confirm pin position and length with fluoroscopy.
- Make a stab skin incision 8 to 10 cm proximal to the ~ 295 ~ International Journal of Orthopedics Sciences reduction while the volar plate is placed. www.orthopaper.com wrist joint and just dorsal to the midline.
- With blunt dissection, expose the superficial branches of the lateral antebrachial cutaneous nerve and the radial sensory nerve, the latter of which exits in the mid forearm from the investing fascia between the brachioradialis and extensor carpi radialis longus.

- Insert two 3.5-mm schanz-pins, 1.5 cm apart, through a soft tissue protector between the radial wrist extensors at a 30-degree angle dorsal to the frontal plane of the forearm. The pins should just perforate the medial cortex of the radius. Confirm pin position and length with fluoroscopy.
- Gentle sustained longitudinal traction with manual molding of the fracture fragments back into a normal alignment was performed.
- Apply the selected external fixation frame according to the manufacturer's instructions. For relatively stable fractures and when using Kirschner wires for augmentation of the fixation, a simple single-bar frame usually is sufficient, more complex fixators allow independent palmar carpal translation to adjust the volar tilt.
- In the presence of articular depression, percutaneous Kirschner wire was used to maneuver the fragments and to secure the radial styloid fragment. The fixation device was left in place for an average of 6 to 8 weeks until both clinical and radiological evidence of healing was seen.

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 46 patients with distal end radius fractures were included in the present comparative study. Among them, 21 patients (45.7%) were treated with external fixation (Group A) and 25 patients (54.3%) underwent volar locking plate fixation (Group B). All patients completed the scheduled follow-up and were evaluated clinically and radiologically.

Table 1: Distribution according to treatment group

Treatment group	No. Of patient	Percentage (%)
Group A (External Fixator)	21	45.7
Group B (Volar Locking Plate)	25	54.3
Total	46	100

Age distribution: The majority of patients belonged to the 31–50 years age group (47.8%), followed by 51–60 years (26.1%). Young adults (<30 years) constituted 17.4% of the study population, while only four patients (8.7%) were older than 60 years.

Table 2: Age distribution

Age(year)	Number	Percentage (%)
<30	08	17
31-50	22	47.8
51-60	12	26.1
>60	04	8.7
Total	46	100

Sex distribution: There was a clear male predominance, with 33 males (71.7%) and 13 females (28.3%).

Table 3: Sex distribution

Sex	Number	Percentage (%)
Male	33	71.7
Female	13	28
Total	46	100

Side involved: The left wrist was more frequently involved than the right. Left-sided fractures accounted for 27 cases (58.7%), whereas 19 patients (41.3%) sustained right-sided injuries.

Table 4: Side involved

Side	Number	Percentage (%)
Right	19	41.3
Left	27	58.7
Total	46	100

Mode of injury: Road traffic accident (RTA) was the commonest mechanism of injury, accounting for 28 patients (60.9%), followed by fall on an outstretched hand (FOOSH) in 13 patients (28.3%) and fall from height in 5 patients (10.9%).

Table 5: Mode of injury

Mode of injury	Number	Percentage (%)
RTA	28	60.9
FOOSH	13	58.3
FALL FROM HEIGHT	05	10.9
TOTAL	46	100

Frykman classification: Type III fractures were the most common fracture pattern, accounting for 14 cases (30.4%), followed by Type IV fractures in 7 patients (15.2%). The distribution of fracture types is shown below.

Table 6: Frykman classification

Frykman	Number	Percentage (%)
TYPE 1	3	6.5
TYPE 2	6	13.0
TYPE 3	14	30.4
TYPE 4	7	15.2
TYPE 5	2	4.3
TYPE 6	6	13.0
TYPE 7	6	13.0
TYPE 8	2	4.3
TOTAL	46	100

Functional outcome: At the final follow-up, patients treated with volar locking plate fixation demonstrated better wrist mobility than those treated with external fixation. Mean palmar flexion was 75° in the plating group compared with 70° in the external fixation group. Mean dorsiflexion was 70° in the plating group compared with 64° in the external fixation group. Ulnar deviation was identical in both groups (30°), whereas radial deviation was greater in the plating group (20° vs 16°). Similarly, forearm rotation was superior in the plating group, with mean supination of 80° and pronation of 76°, compared with 76° and 72°, respectively, in the external fixation group.

Table 7: Functional outcome at final follow-up

Parameter	External fixator	Plating
PALMAR FLEXION (°)	70	75
DORSIFLEXION (°)	64	70
ULNAR DEVIATION (°)	30	30
RADIAL DEVIATION (°)	16	20
SUPINATION (°)	76	80
PRONATION (°)	72	76

Radiological outcome: Radiological assessment revealed satisfactory fracture reduction in both groups. The mean ulnar variance was 1.07 mm in the external fixation group and 0.58 mm in the plating group. Mean articular step-off measured 0.08 mm in the external fixation group and 0.33 mm in the plating group. Mean palmar tilt was 7.03° following external fixation and 9.3° after volar locking plate fixation. The mean radial inclination was 15.5° in the external fixation group compared with 19.66° in the plating group, indicating better restoration of normal distal radial anatomy following plate fixation.

Table 8: Radiological outcome

Parameter	External fixator	Plating
ULNAR VARIENCE (mm)	1.07	0.58
ARTICULAR STEP (mm)	0.08	0.33
PALMAR TILT (°)	7.03	9.30
RADIAL INCLINATION (°)	15.50	19.66

Complications: Postoperative complications were minimal in both groups. No infection or significant intraoperative blood loss was observed in the external fixation group, whereas two patients in the plating group developed superficial wound infection and one patient experienced increased intraoperative blood loss. Loss of reduction occurred in one patient in each treatment group. Wrist stiffness was observed in two patients treated with external fixation, while no patient in the plating group developed postoperative stiffness.

Table 9: Complications

Complication	External fixator	Plating
Infection	0	2
Increased blood loss	0	1
Loss of reduction	1	1
Wrist stiffness	2	0

Overall, both treatment modalities achieved satisfactory fracture healing and acceptable radiological restoration. However, patients treated with volar locking plate fixation demonstrated superior wrist range of motion and better restoration of palmar tilt and radial inclination at the final follow-up. External fixation was associated with fewer wound-related complications but a higher incidence of postoperative wrist stiffness.

DISCUSSION

Distal end radius fractures continue to be one of the most frequently encountered injuries in orthopedic practice. The choice of surgical treatment for unstable fractures remains controversial, with external fixation and volar locking plate fixation being the two most employed methods. The present prospective comparative study evaluated the clinical and radiological outcomes of these two treatment modalities in 46 patients.

In the present study, most patients (47.8%) belonged to the 31–50-year age group, with a mean predominance of young and middle-aged adults. Similar observations were reported by Chung et al,[11] and Arora et al,[14] who found that unstable distal radius fractures are more frequently encountered in active adults following high-energy trauma, whereas elderly patients generally sustain these injuries after low-energy falls. The predominance of younger patients in our study may be attributed to the higher incidence of road traffic accidents in our region.

A male predominance (71.7%) was observed in the present study, which is comparable to the findings of Kapoor et al,[21] and Wei et al.[13] This observation probably reflects the greater involvement of males in outdoor activities, occupational work, and vehicular travel, making them more susceptible to high-energy injuries.

Road traffic accident was the commonest mode of injury (60.9%) followed by fall on an outstretched hand (28.3%). Similar findings have been reported by Jupiter and Fernandez04 in younger adults, whereas studies from Western countries have demonstrated a higher incidence of low-energy osteoporotic fractures among elderly females. These differences may be related to geographical variations in patient demographics and injury mechanisms.

Type III fractures according to the Frykman classification constituted the largest subgroup in our study (30.4%). Comparable distributions of unstable intra-articular fractures have been described by Cooney et al,[24] emphasizing that displaced intra-articular fractures usually require surgical stabilization to restore wrist anatomy and function.

Restoration of anatomical alignment is an important determinant of long-term wrist function. In the present study, volar locking plate fixation demonstrated better restoration of radial inclination (19.66° versus 15.5°) and palmar tilt (9.3° versus 7.03°) compared with external fixation. Mean ulnar variance was also lower in the plating group (0.58 mm versus 1.07 mm), suggesting improved maintenance of radial length. These findings are consistent with the randomized trial by Chung et al,[11] and the systematic review by Hammer et al,[15] both of which demonstrated superior radiological restoration with volar locking plate fixation. The fixed-angle construct provided by locking plates effectively supports the subchondral bone and minimizes secondary collapse, particularly in comminuted metaphyseal fractures.

Functional recovery was superior in the plating group throughout the follow-up period. Patients treated with volar locking plates achieved greater palmar flexion (75° versus 70°), dorsiflexion (70° versus 64°), radial deviation (20° versus 16°), supination (80° versus 76°), and pronation (76° versus 72°). Ulnar deviation was comparable in both groups. Similar results have been reported by Rozental and Blazar26 and Wei et al,[13] who observed earlier recovery of wrist motion following volar plating because stable internal fixation permits early mobilization without prolonged external immobilization. External fixation relies on ligamentotaxis and often requires longer immobilization, which may contribute to postoperative stiffness.

Fracture healing was achieved satisfactorily in both groups, indicating that both treatment methods provide adequate stability for fracture union. Although the present study did not demonstrate delayed union or non-union, functional recovery favored volar plating because of improved restoration of wrist biomechanics and earlier rehabilitation.

The complication profile differed between the two treatment groups. Superficial infection occurred in two patients treated with volar locking plates, whereas no infection was observed in the external fixation group. One patient in each group experienced loss of reduction. Wrist stiffness occurred only in the external fixation group (two patients), while one patient in the plating group experienced increased intraoperative blood loss. Similar complication patterns have been reported by Margaliot et al,[9] who observed that external fixation is associated with postoperative stiffness and pin-related problems, whereas plating carries risks related to surgical exposure, including wound complications and tendon irritation. Despite these differences, the

overall complication rate remained low in both groups.

The findings of the present study support the growing evidence favoring volar locking plate fixation for unstable distal radius fractures. Better restoration of anatomical parameters and superior wrist motion were achieved with plating, while external fixation remained an effective alternative with acceptable functional and radiological outcomes. The choice of treatment should therefore be individualized according to fracture configuration, soft-tissue condition, patient factors, and surgeon experience. In fractures with significant metaphyseal comminution or intra-articular displacement, volar locking plate fixation appears to offer the advantage of more accurate anatomical reduction and earlier functional recovery.

Although the present study provides valuable prospective data, certain limitations should be acknowledged. The sample size was relatively small, the study was conducted at a single institution, and long-term evaluation of post-traumatic arthritis and implant-related complications was beyond the period of follow-up. Larger multicenter randomized studies with longer follow-up are recommended to further define the optimal treatment strategy for unstable distal radius fractures.

CONCLUSION

The present comparative study demonstrates that both external fixation and volar locking plate fixation are effective treatment modalities for unstable distal end radius fractures, providing satisfactory fracture healing and acceptable functional outcomes. However, patients treated with volar locking plate fixation showed better restoration of distal radial anatomy, with improved radial inclination, palmar tilt, and ulnar variance, along with superior wrist range of motion at the final follow-up.

Although external fixation remains a reliable method of treatment, particularly in fractures with significant soft-tissue injury or where minimally invasive stabilization is preferred, it was associated with a higher incidence of postoperative wrist stiffness in the present study. In contrast, volar locking plate fixation allowed earlier wrist mobilization and better functional recovery but was associated with a small risk of wound-related complications and increased intraoperative blood loss.

Based on the findings of the present study, volar locking plate fixation appears to be the preferred treatment option for unstable distal end radius fractures, particularly in patients requiring early rehabilitation and restoration of wrist function. External fixation continues to be a valuable alternative in carefully selected cases, producing satisfactory clinical and radiological outcomes when performed with appropriate surgical technique.

The choice of fixation should ultimately be individualized according to fracture pattern, bone quality, soft-tissue condition, patient functional demands, and surgeon expertise. Further prospective randomized studies with larger sample sizes and longer follow-up are recommended to evaluate long-term functional outcomes, post-traumatic arthritis, and implant-related complications.

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