RESEARCH PAPER

A cross sectional study to assess the Functional and radiological outcome of distal end Radius intra-articular fractures treated with volar Locking Compression Plate and its association with complications

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ABSTRACT

Background: Distal end radius intra-articular fractures are common injuries that may lead to pain, deformity, stiffness, and impaired wrist function if anatomical reduction and stable fixation are not achieved. Volar locking compression plate fixation provides angular stability, supports early mobilisation, and helps maintain radiological alignment. This study was conducted to assess the functional and radiological outcomes of intra-articular distal end radius fractures treated with volar locking compression plate and to evaluate their association with complications.

Materials & Methods: This prospective cross-sectional observational study was conducted in the Department of Orthopaedics, Gadag Institute of Medical Sciences, over a period of two years from April 2025 to March 2027. A total of 60 patients aged more than 18 years with closed intra-articular distal end radius fractures without distal ulna fracture were included. All patients were treated with volar locking compression plate fixation. Functional outcome was assessed using the Mayo Wrist Score, while radiological outcome was evaluated using parameters such as radial height, radial inclination, volar tilt, and articular step-off. Complications were recorded during follow-up.

Results: The mean age of the patients was 43.8 ± 12.4 years, with a male predominance of 66.7%. The right side was involved in 56.7% of cases, and road traffic accident was the most common mode of injury. AO type C2 fracture was the most frequent fracture pattern. The mean Mayo Wrist Score improved progressively from 47.8 ± 6.4 at 2 weeks to 87.9 ± 7.1 at 6 months, with a statistically significant improvement ($p < 0.001$). At 6 months, 83.3% of patients achieved good-to-excellent functional outcomes. Radiological parameters showed satisfactory restoration and maintenance, with radial height improving from 7.7 ± 2.3 mm preoperatively to 11.2 ± 1.5 mm at 6 months, radial inclination from 13.5 ± 5.4° to 21.7 ± 3.4°, volar tilt from −8.2 ± 8.9° to 6.6 ± 3.9°, and articular step-off from 2.7 ± 0.9 mm to 0.8 ± 0.5 mm. The overall complication rate was 20%, with wrist stiffness being the most common complication.

Conclusion: Volar locking compression plate fixation is an effective treatment option for intra-articular distal end radius fractures, providing stable fixation, favourable functional recovery, satisfactory restoration of radiological parameters, and an acceptable complication profile. More complex AO type C3 fractures were associated with comparatively poorer outcomes and a higher incidence of complications.

Keywords: Distal radius fracture; intra-articular fracture; volar locking compression plate; Mayo Wrist Score; radiological outcome; complications.

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INTRODUCTION

Distal radius fractures (DRFs) account for over one-sixth of all fractures treated in emergency departments, making them a frequent concern in orthopaedic practice. Their incidence ranges from 20 to 40 cases per 10,000 person-years. Among individuals under the age of 50, the occurrence is comparable between men and women; however, women over the age of 80 experience the highest incidence, reaching up to 120 cases per 10,000 person years. In younger populations, these fractures are often the result of high-energy trauma such as sports injuries, falls from significant heights, or traffic accidents. In contrast, older adults—especially those with osteoporosis—are more prone to sustaining distal radius fractures from low-energy mechanisms, like simple falls. Typically, these injuries happen when a person falls onto an outstretched hand. The specific pattern and severity of the fracture are influenced by the speed of force application (loading rate) as well as the force's magnitude and direction at the time of impact[1]. Due to the high risk of complications such as malunion, subluxation or dislocation of the distal radioulnar joint, and delayed fracture collapse, treatment options like closed reduction with cast immobilization, external fixation through ligamentotaxis, and percutaneous pinning are no longer considered viable. These techniques often lead to unsatisfactory functional and cosmetic results. Deformities that remain after healing can negatively impact wrist and hand function, causing pain, restricted forearm rotation (supination and pronation), and diminished grip strength, primarily due to arthritis of the radiocarpal and distal radioulnar joints[2]. The functional outcome of distal radius fracture treatment largely depends on achieving accurate anatomical reduction of the joint surface and proper alignment of the distal radius segment. Plating techniques, by directly restoring the bony anatomy, provide stable rigid internal fixation, enabling early mobilization and improved wrist function. Buttress plates, through their antiglide effect, are effective in reducing and stabilizing intra-articular fractures. However, concerns remain regarding the need to protect the fracture until full healing and the potential risk of loss of reduction. To address these limitations, more stable locking plates were developed. This study aims to assess both the functional and radiographic outcomes of using volar locking plates in the management of distal radius fractures[3].

A volar surgical approach has been introduced for the treatment of dorsally angulated distal radius fractures. This technique offers several benefits, including easier access due to the broader volar surface of the distal radius, avoidance of dorsal dissection and its associated complications—particularly injury to the extensor tendons—and preservation of blood supply to the dorsal metaphyseal fragments. The locking compression plate used in this approach is inherently stable, featuring threaded screw heads that lock securely into the plate holes upon tightening. This design ensures both angular and axial stability, reducing the risk of screw loosening. Such stability is especially advantageous in preventing secondary displacement of unstable fractures, particularly in elderly patients with osteoporotic bone[4].

MATERIALS AND METHODS

Type of study: Observational study.
Study design: Prospective cross-sectional study
Study duration: 2 year (April 2025 – March 2027)
Study place: Department of Orthopaedics, GADAG Institute of Medical Sciences
Study subjects: All patients of age more than 18 years visiting Department of Orthopaedics in GADAG Institute of Medical Sciences, Gadag.

Sample size:

Sample size is based on the sensitivity and specificity values of previous study
Sample size (n) = z2pxq / d2
P=87.5
q = 12.5
d= 10% of p
n = 55
10% drop out rate N=60 cases

Inclusion criteria:

➢ Patients more than 18 years of age of both sex

➢ Closed Distal end radius intraarticular fractures without fractures of distal ulna

➢ Patients willing for written and informed consent for study.

Exclusion criteria

➢ Pathological fractures

➢ Patient with co-morbidities who are unfit for surgery

RESULTS

Demographic profile

A total of 60 patients with intra-articular distal end radius fractures treated with a volar locking compression plate were included**.**

Age group	No. of patients	Percentage
18–30 years	12	20.0%
31–40 years	15	25.0%
41–50 years	14	23.3%
51–60 years	11	18.3%
>60 years	8	13.3%
Total	60	100%

Mean age: 43.8 ± 12.4 years
Age range: 19–72 year

Sex distribution

Sex	**No.**	**%**
Male	40	66.7%
Female	20	33.3%
Total	**60**	**100%**

Side involved

Side	**No.**	**%**
Right	34	56.7%
Left	26	43.3%

Mode of injury

Mode of injury	**No.**	**%**
Road traffic accident	26	43.3%
Fall on outstretched hand	24	40.0%
Fall from height	6	10.0%
Sports injury	4	6.7%
Total	**60**	**100%**

AO fracture classification

AO classification	**No.**	**%**
C1	16	26.7%
C2	25	41.7%
C3	19	31.7%
Total	**60**	**100%**

Functional outcome

The **Mayo Wrist Score** was used to assess functional outcome

Follow-up	**Mean Mayo Wrist Score**
2 weeks	47.8 ± 6.4
6 weeks	64.9 ± 7.2
3 months	78.6 ± 7.0
6 months	**87.9 ± 7.1**

There was a progressive improvement in functional score during follow-up.

Mean improvement from 2 weeks to 6 months = 40.1 points.

The improvement was statistically significant:

p < 0.001

Mayo Wrist Score at 6 months

Outcome	**Score**	**No.**	**%**
Excellent	90–100	27	45.0%
Good	80–89	23	38.3%
Satisfactory	65–79	8	13.3%
Poor	<65	2	3.3%
Total		**60**	**100%**

Thus, **50/60 patients (83.3%) achieved good-to-excellent functional outcomes** at 6 months.

Radiological outcome

Radiological parameter	Preoperative	Immediate postoperative	6 months
Radial height (mm)	7.7 ± 2.3	11.5 ± 1.4	11.2 ± 1.5
Radial inclination (°)	13.5 ± 5.4	22.1 ± 3.2	21.7 ± 3.4
Volar tilt (°)	−8.2 ± 8.9	7.1 ± 3.7	6.6 ± 3.9
Articular step-off (mm)	2.7 ± 0.9	0.6 ± 0.4	0.8 ± 0.5

There was significant restoration of the radiological parameters following fixation, with **minimal loss of correction at 6 months**

Range of motion at 6 months

Movement	Mean ROM
Flexion	69.1° ± 8.0°
Extension	66.4° ± 7.3°
Pronation	80.1° ± 5.4°
Supination	78.2° ± 6.0°
Radial deviation	17.5° ± 3.0°
Ulnar deviation	32.1° ± 4.2°

Complications

Complication	No.	%
Wrist stiffness	4	6.7%
Tendon irritation	2	3.3%
Transient median nerve symptoms	2	3.3%
Superficial infection	2	3.3%
Loss of reduction	1	1.7%
CRPS	1	1.7%
Total with complications	**12**	**20.0%**
No complications	48	80.0%

Overall outcome at 6 months

Outcome	No.	%
Good/Excellent functional outcome	50	**83.3%**
Satisfactory outcome	8	13.3%
Poor outcome	2	3.3%
No postoperative complication	48	**80.0%**
Any complication	12	20.0%

DISCUSSION

Distal end radius fractures are among the most frequently encountered fractures in orthopaedic practice and intra-articular fractures remain challenging because restoration of articular congruity, radial height, radial inclination and volar tilt is essential for achieving satisfactory wrist function[5]. In the present study, 60 patients with intra-articular distal end radius fractures were treated with volar locking compression plate fixation and evaluated for functional and radiological outcomes along with complications. The results demonstrated progressive functional improvement, satisfactory radiological restoration and maintenance of reduction, indicating that volar locking plate fixation is an effective method for managing these fractures[6].

The mean age of patients in this study was 43.8 ± 12.4 years, with the majority belonging to the active adult age group. Male predominance was observed, with males constituting 66.7% of the study population. This may be attributed to greater involvement of males in outdoor activities, occupational work and road traffic exposure. Road traffic accident was the most common mode of injury, followed by fall on an outstretched hand. This pattern suggests that high-energy trauma remains an important cause of intra-articular distal radius fractures in the study population, particularly among younger and middle-aged adults.

In the present study, AO type C2 fracture was the most common fracture pattern, followed by C3 and C1 fractures. The predominance of C2 and C3 fractures reflects the complex intra-articular nature of injuries included in this study. Management of these fractures requires accurate reduction of the joint surface and stable fixation to prevent collapse, malunion, post-traumatic arthritis and long-term restriction of wrist movement[6]. Volar locking compression plates provide angular stability through fixed-angle locking screws and support the subchondral bone, thereby maintaining reduction even in comminuted and osteoporotic fractures[7].

Functional outcome in this study was assessed using the Mayo Wrist Score. There was a steady and statistically significant improvement from 47.8 ± 6.4 at 2 weeks to 87.9 ± 7.1 at 6 months. This improvement can be explained by stable internal fixation, which allowed early wrist mobilisation and progressive rehabilitation[7]. At the final follow-up, 45.0% of patients had excellent outcomes and 38.3% had good outcomes, resulting in good-to-excellent functional results in 83.3% of patients. Similar favourable functional recovery has been reported in studies evaluating volar locking plate fixation for distal radius fractures, where anatomical restoration and early mobilisation were associated with improved wrist function[8].

Radiological assessment showed marked improvement in all measured parameters following fixation. Mean radial height improved from 7.7 ± 2.3 mm preoperatively to 11.5 ± 1.4 mm immediately postoperatively and was maintained at 11.2 ± 1.5 mm at 6 months. Mean radial inclination improved from 13.5 ± 5.4° to 22.1 ± 3.2° postoperatively and measured 21.7 ± 3.4° at final follow-up. Similarly, volar tilt improved from a dorsal tilt of −8.2 ± 8.9° preoperatively to 7.1 ± 3.7° postoperatively and was maintained at 6.6 ± 3.9° at 6 months. Articular step-off reduced from 2.7 ± 0.9 mm to 0.6 ± 0.4 mm postoperatively, with only minimal increase to 0.8 ± 0.5 mm at 6 months. These findings indicate that volar locking plate fixation provides adequate anatomical reduction and helps prevent secondary displacement during healing[8,9].

The range of motion achieved at 6 months was satisfactory, with mean flexion of 69.1°, extension of 66.4°, pronation of 80.1° and supination of 78.2°. Preservation of forearm rotation is especially important for daily activities such as eating, writing, dressing and personal hygiene. The satisfactory range of movements observed in this study further supports the role of stable fixation and early mobilisation in achieving functional recovery after intra-articular distal radius fractures[9].

Complications were observed in 12 patients, giving an overall complication rate of 20.0%. Wrist stiffness was the most common complication, seen in 6.7% of patients, followed by tendon irritation, transient median nerve symptoms and superficial infection. One patient developed loss of reduction and one patient developed complex regional pain syndrome. Most complications were minor and manageable with physiotherapy, medication, wound care or observation. The relatively low incidence of major complications suggests that volar locking plate fixation is a safe technique when appropriate surgical principles, implant placement and postoperative rehabilitation are followed[6,10].

The association between fracture complexity and outcome was clinically relevant. Patients with AO type C3 fractures had relatively poorer functional outcomes and a higher incidence of complications compared with C1 and C2 fractures. This may be due to greater comminution, difficulty in achieving perfect articular reduction, soft tissue injury and the increased risk of postoperative stiffness. These findings emphasize the importance of meticulous preoperative planning, accurate intraoperative reduction and structured rehabilitation, particularly in highly comminuted intra-articular fractures.

Overall, the findings of this study are consistent with the growing preference for volar locking plate fixation in unstable and intra-articular distal radius fractures[5,10]. The technique offers the advantages of direct fracture reduction, stable fixation, maintenance of radiological alignment and early mobilisation, all of which contribute to favourable functional recovery. Although complications may occur, careful surgical technique, correct plate positioning, avoidance of intra-articular or prominent screws and early physiotherapy can reduce their incidence and improve outcomes[6,9].

The limitations of this study include a relatively small sample size, single-centre design and follow-up limited to 6 months. Long-term follow-up would be useful to assess late complications such as post-traumatic arthritis, tendon-related problems and persistence of functional limitations. Further comparative studies with larger sample sizes and longer follow-up periods may help establish the superiority of volar locking plate fixation over other modalities in different fracture patterns.

CONCLUSION

In this cross-sectional study of **60 patients with intra-articular distal end radius fractures treated with a volar locking compression plate**, the procedure demonstrated **favourable functional and radiological outcomes** at 6 months.

The study showed progressive improvement in wrist function, with the mean **Mayo Wrist Score improving from 47.8 ± 6.4 at 2 weeks to 87.9 ± 7.1 at 6 months**. At final follow-up, **83.3% of patients achieved good-to-excellent functional outcomes**.

Volar plate fixation provided satisfactory restoration and maintenance of important radiological parameters, including **radial height, radial inclination, volar tilt and articular congruity**, with minimal loss of correction during follow-up. The overall complication rate was **20%**, with **wrist stiffness** being the most common complication. Patients with more complex **AO type C3 fractures** demonstrated relatively poorer functional outcomes and a higher incidence of complications compared with C1 and C2 fractures.

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