

Original research article**A study of management of distal radius fractures by internal fixation with volar locking plate****¹Dr. Deepthi Papireddy, ²Dr. Arava Rajeswari, ³Dr. Varakuti Santhi Swaroop, ⁴Dr. Lakshmi Venkatesh Deety**¹Assistant Professor, Department of Orthopedics, Kurnool Government Medical College, Kurnool, Andhra Pradesh, India²Assistant Professor, Department of Orthopedics, SVMC, Tirupati, Andhra Pradesh, India³Assistant Professor, Department of Orthopedics, Government Medical College, Ananthapuramu, Andhra Pradesh, India⁴Associate Professor, Department of Orthopedics, Government Medical College, Kadapa, Andhra Pradesh, India**Corresponding Author:**

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Abstract

Background: Distal radius fractures are very commonly encountered fractures. The locking distal radius plate screws are a preferred alternative amongst other surgical treatment options. This study was conducted to clinically assess the results of using a locking distal radius plate system to treat distal radius fractures.

Materials and Methods: 60 patients with fractures of distal radius who presented to the Department of Orthopedics were included in this study. They were admitted and the fracture was managed by volar locking plates. Post-operative physiotherapy was advised and patients were asked to follow up after 6 weeks, 3 months, 6 months, and one year.

Results: The mean age was 41.2 years. 60% were males and 40% females. Right-sided fractures were more common when compared to the left side. Most of the fractures were due to road traffic accidents in the younger individuals when compared to the older individuals where it is due to history of fall. 73% of fractures united between 2-3 months after surgery.

Conclusion: Volar locking plates offer superior functional outcomes while maintaining anatomical integrity and minimal hospital stay.

Keywords: Distal radius fractures, volar locking plates, surgery

Introduction

Distal radius fractures are the most common fractures of the upper extremity, constituting 17% of all fractures and 75% of all forearm fractures¹, failure in the management of which may cause permanent disability. Distal end fractures crush the mechanical foundation of the man's most elegant tool, the hand, and the grip.

Various surgical techniques have been reported in the literature but open reduction and internal fixation with a volar locking compression plate system is currently advocated for the treatment of distal radius fractures as it provides a stable fixation of osteoporotic bones, leading to anatomical restoration of the articular surface and extra-articular alignment. It results in good reduction and provides immediate mobilization of the wrist joint, thereby reducing wrist stiffness.² Open reduction and internal fixation are indicated to address the unstable distal radius fractures and those with articular incongruity that cannot be anatomically reduced and maintained through closed manipulation and ligament O taxis (ligamentotaxis) and percutaneous pinning.

Most fractures of the distal radius are dorsally angulated and displaced, which makes the dorsal surface the most appropriate for buttress plating as it counteracts the deforming forces. However, dorsal plating has its disadvantages such as the implant is subcutaneous with hardly any soft-tissue cover, the dorsal surface of the distal radius is convex, as a result of which the extensor tendons rub against the plate leading to tenosynovitis and or their rupture and loss of palmar flexion due to dorsal scarring.

Difficulties with dorsal fixed-angle plates prompted the use of volar fixed-angle plates for dorsal fractures.³ In the volar approach, the implant is placed on the tension side of the fracture. Fixing the radius through a volar approach offers some advantages like scars are better tolerated as they are less obvious and the blood supply to the radius is less likely to be disturbed; reduction of the fracture is easier as the volar cortex is typically less comminuted than the dorsal cortex, less painful, decreased risk of displacement and low complication rate.

Considering the high incidence of distal radius fractures and scarcity of data regarding the optimal

treatment, the present study was undertaken to evaluate the clinical and functional outcomes of distal radius fractures treated with volar locking plate fixation.

Materials and Methods

A prospective study was conducted in the Department of Orthopedics; ACSR government medical college and hospital, Nellore over 2 years from September 2020 to August 2022. Patients aged >18 years who had sustained distal radius fractures, who were considered ideal for treatment with volar locking plates, and who were fit for giving anesthesia were included in the study. Patients with skeletal immaturity, stable extra-articular fractures, compound fractures, or patients with associated injuries in the same forearm were excluded from the study. A total of 60 patients were selected for this study.

The selected patients were briefed about the nature of the study and written informed consent was obtained. Information such as sex, age, details of injury, duration, and progression were obtained through an interview. Clinical and local examination was done. Careful inspection of the deformity, swelling, and ecchymosis was done. Tenderness, bony irregularity, crepitus, and the relative position of radial and ulnar styloid processes were elicited. Movements of the wrist and forearm were examined. Distal vascularity was assessed by radial artery pulsations, capillary filling, pallor, and paraesthesia over fingertips.

The involved forearm was immobilized in a below-elbow POP slab and kept elevated till the edema subsided. Pain and inflammation were managed using analgesics and anti-inflammatory medications

Routine pre-operative hematological investigations were done. Fractures were assessed by standard radiographs in PA, lateral, and oblique views, and if required CT scans were taken. The fracture fragments were analyzed and involvement of radio-carpal and distal radioulnar joints was assessed and classified according to Frykman’s classification. Surgical and anesthesia fitness were obtained.

Patients were treated with open reduction and internal fixation using a locking compression plate or buttress plate. All the surgeries were performed under general anesthesia and a brachial block was administered to the patients.

Follow-up of patients was done at 6 weeks, 3 months, 6 months, and one year following the surgery. The outcome was evaluated by QUICK DASH evaluation questionnaire which measures physical function and symptoms in upper limb musculoskeletal disorders.

Observations and Results

A total of 60 cases who sustained lower radius fractures were included in the study.

Table 1: Incidence of DRFS in different age groups

Age in Years	No. of cases	Percentage
18-30	12	20
31-40	20	33.3
41-50	14	23.3
51-60	12	20
61-70	2	3.3

In this study, the age of the patients ranged from 18-70 years with an average of 41.2 years. Most of the patients belonged to 31-40 yrs of age group (n = 20; 33.33%), followed by 41-50 years age (n =14; 23.3%). Males to females ratio is 3:2, with 36 patients being males and the rest females (n = 24). The right radius (n = 42) was more involved than the left (n = 18). Road traffic accidents (n = 36; 60%) was the most common mode of injury in our study followed by fractures due to fall on outstretched hand (n =24; 40%).

Table 2: Type of Fracture according to Frykman’s Classification

Type	No. of Cases	Percentage
I	6	10%
II	1	1.66%
III	16	26.66%
IV	9	15%
V	13	21.6%
VI	2	3.33%
VII	10	16.6%
VIII	3	5%

The fractures of all 60 patients were assessed radiologically and classified according to Frykman’s system. Type III (n = 9; 15%) fractures were the most common type, followed by Type V (n = 13; 21.6%) and Type VII (n = 10; 16.6%). 38(63.3%) were intra-articular fractures and the rest 22(36.66%) were of extra-articular type.

Most of the patients (n = 56; 93%) were operated within 1-5 days of injury and the rest 4 (7%) were

operated later, i.e., between 6-10 days.

Table 3: Duration of Fracture Union

Time of Union	No. of cases	Percentage
2-3months	44	73
3-4months	12	20
4-6 months	04	07

In the present study, 44(73%) patients had a union within 2-3 months and 12 (20%) patients had a union in 3-4 months and 4 (07%) had a union in 4-6 months. 2 patients had stiffness of the joint; 2 patients had extensor pollicis longus tendon irritation due to long screw placement through the cortex. The functional outcomes were assessed using the DASH score. As per DASH score, 48 (80%) had excellent results, 12 (20%) had good results, and 0 patients had poor results.

Table 4: Quick Dash Score

Score	Number of cases	Percentage
≤25	48	80
26to50	12	20
51to75	-	-
Total	30	100.00



Preop X-ray

Postop X-ray

12 Weeks follow-up X-ray



Dorsiflexion

Palmarflexion

Supination

Pronation

Discussion

Distal radius fractures are the most frequently seen upper extremity fractures. The main objective of its treatment is the re-establishment of anatomic integrity and to maintain inter(INTRA)-articular integrity and the radial length by providing good reduction and immediate stability thus allowing the quick return of hand function. Fracture healing depends on a minimal gap, adequate stability, and sufficient blood supply.

In theory, the locking plate minimizes the compressive forces exerted on the bone to achieve stability, which may prevent periosteal compression and associated impairment of blood supply, and it is favored for fracture healing.

The present study was undertaken to assess the functional outcome of operative management of distal radial fractures using volar locking plate fixation.

In our study, the age group ranged from 18-70 years with a mean age of 41.2 yrs. In our study, distal radius fracture was more common in the age group of 31 to 40 years group and was related to RTA. Yukichi Zenke *et al.* [4] in Japan, observed that the mean age was 64.7 years with a standard deviation of ±17.8 years in the conventional group their study compared conventional management with the MIPO technique for volar locking plate fixation for distal radius fractures.

Our study had a male preponderance with 36 male patients and 24 female patients. This can be attributed to the working group of the population in which males are a predominant working group. However,

Yukichi Zenke *et al.*^[4], reported female preponderance in both conventional and surgical groups akin to which can be explained due to the higher incidence of osteoporosis in females as their age increases. Similar results have been reported by Tamara D *et al.*^[5] with female preponderance in their study. Right-sided fractures were more common when compared to the left side in the present study. Similar reports were reported by Tamara D *et al.*^[5] They reported a predominance of right-sided fractures in both CRIF & ORIF groups 95% & 78% respectively. This can be attributed to the dominant hand available to protect during the event of injury. However, Yukichi Zenke *et al.*^[4] reported a left-sided predominance in the surgical group as well as the total incidence of side in their study.

Road traffic accident (60%) was the most common mode of injury observed in the present study. While Anakwe *et al.*^[6] reported falling from a standing height as the most common mechanism of injury, Zhibing Tang^[7] *et al.* reported high-energy injuries as motor vehicle collisions as the most common injuries in their study.

In the present study, 2 patients had stiffness of the joint and 2 patients had extensor pollicis longus tendon irritation due to long screw placement through the cortex. Yukichi Zenke^[4] *et al.* reported 3% incidence of complications including EPL tendon rupture, incomplete palsy of the superficial branch of the median nerve and loosening of cortical screws in the conventional ORIF group and 1% incidence of distal locking pin protrusion in the MIPO group. Rohit Arora *et al.*^[8] reported that 36% of the operative treatment group had complications. Five patients in their study had extensor tenosynovitis which they attributed to the screw penetration of the dorso-radial cortex. Four patients developed flexor tendon tenosynovitis which necessitated implant removal; they reported one case of EPL tendon rupture with a volar locking plate.

Fractures were classified according to Frykman's system and the predominant types of fractures involved were type III with an incidence of 26.66%. Yukichi Zenke *et al.*^[4] classified fractures by OTA classification and the A2 type was most commonly observed.

In the present study, the average radial inclination preoperatively was 7.76 ± 5.8 degrees and the average post-operative radial inclination was 18.2 ± 3.3 degrees. The average radial inclination achieved was 10.44 degrees. K. Egol *et al.*^[9] reported a pre-reduction radial inclination of 14.6 ± 8 degrees and 13.8 ± 7.9 degrees in external fixation and volar plate fixation groups respectively, they reported a post-operative reduction of values of 18.8 ± 6.5 degrees in the external fixation group and 17.1 ± 4.7 degrees in plating group postoperatively. These results are similar to the present study.

The preoperative mean volar tilt in the present study was -17.1 ± 7.82 degrees and the mean postoperative volar tilt was 6.95 ± 4.54 degrees. The total correction achieved was 19.63 ± 7.56 degrees. Similar to the present study, K. Egol *et al.*^[9] reported preoperative mean volar tilt of -15.8 ± 19.1 degrees with the external fixation group and -14.5 ± 22.1 degrees in a volar plating group these results closely approximate our results.

In our study preoperative mean radial length was 3.66 ± 1.79 mm and an immediate postoperative radial length of 9.08 ± 1.65 mm; we achieved a mean correction of 6.15 ± 2.66 mm during the surgical procedure. K. Egol *et al.*^[9] reported a mean radial length of 7 ± 4.2 mm pre-reduction value in the external fixation group, 6.9 ± 4.2 mm in the volar plating group preoperatively they achieved a radial length of 9.5 ± 3.5 mm in external fixation group and 9.3 ± 3 mm in the volar plating group. They showed no statistical significance in achieving radial length. Marco Rizzo *et al.*^[10] others reported an immediate post-operative radial height of 11mm in the volar plate group and 10mm in the external fixation/pinning group.

A Quick DASH score was taken at 6 weeks, 3 months, 6 months, and 1 year intervals along with range of motion. In the present study Quick DASH score at 6 months follow-up is 17.16 ± 8.73 .

Phadnis J *et al.*^[11] in 2011 reported that 74% of the patients with good or excellent DASH and MAYO scores. This study demonstrated good to excellent results in the majority of patients after volar locking plate fixation of the distal radius, with complication rates comparable to other non-operative and operative treatment modalities and they recommended this mode of fixation for distal radius fractures. A study by Rozental *et al.*^[12] showed mostly good and excellent functional outcomes in 45 patients at 17 months of mean follow-up. K. Egol *et al.*^[9] showed functional DASH score at 6 months as 32.6 ± 23.8 in the external fixator group, and 25.0 ± 21.7 in the volar plating group.

The mean range of motion achieved in different movements was comparable to studies done by Yukichi Zenke *et al.*^[4] and Tamara D *et al.*^[5].

Table 5: Comparison of the range of motions achieved in different studies

Studies	Palmar flexion	Dorsi flexion	Radial deviation	Ulnar deviation	Supination	Pronation
Yukichi Zenke <i>et al.</i> [4]	86.0 ⁰ ±6.7 ⁰	68.3 ⁰ ±5.6 ⁰			88.2 ⁰ ±5.7 ⁰	88.8 ⁰ ±3.4 ⁰
Tamara D <i>et al.</i> [5]	58 ⁰ ±13 ⁰	58 ⁰ ±14 ⁰	22 ⁰ ±9 ⁰	35 ⁰ ±6 ⁰	84 ⁰ ±13 ⁰	85 ⁰ ±11 ⁰
Present study	77 ⁰ ±3.10 ⁰	71.5 ⁰ ±3.17 ⁰	18.16 ⁰ ±5 ⁰	32.60 ⁰ ±4 ⁰	73.75 ⁰ ±4.07 ⁰	69.41 ⁰ ±3.33 ⁰

Conclusion

This study concludes that volar locking plate fixation provides successful results for the treatment of both extra-articular and intra-articular unstable fractures of distal radius. This method allows restoration of the anatomy, stable internal fixation, a decreased period of immobilization, and early return of wrist function, all with minimal surgical trauma on distal radius and a better adaptation to surrounding tissues. With volar locking compression plates, there is an improved range of movement and radiological outcome at 3 months; 6 months, and 1-year follow-up. Thus, with the execution of good surgical techniques, proper plate positioning, proper insertion of screws, and avoidance of past pointing, a satisfactory functional and radiological outcome can be obtained for a great majority of patients with most distal radius fractures by using a volar locking plate fixation.

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References

- Colles A. On the fracture of the carpal extremity of the radius. *Edinburgh Med. Surg.* 1814;10:182-6.
- Kwan K, Lau TW, Leung F. Operative treatment of distal radial fractures with locking plate system-a prospective study. *Int. Orthop.* 2011 Mar;35(3):389-94. Doi: 10.1007/s00264-010-0974-z. Epub 2010 Feb 21. PMID: 21369946; PMCID: PMC3047652.
- Ruch DS, Papadonikolakis A. Volar versus dorsal plating in the management of intra-articular distal radius fractures. *J Hand Surg. Amer.* 2006;31:9-16.
- Yukichi Zenke MD PhD, Akinori Sakai MD PhD, Toshihisa Oshige MD PhD, Shiro Moritani MD, Yoshifumi Fuse MD, Takashi Maehara MD PhD, *et al.* Clinical Results of Volar Locking Plate for Distal Radius Fractures: Conventional versus Minimally Invasive Plate Osteosynthesis *J Orthop Trauma*, 2011 July, 25(7).
- Tamara D Rozental, Philip E Blazar, Orrin I Franko, Aron T Chacko, Brandon E Earp, Charles S. Day: Functional Outcomes for Unstable Distal Radial Fractures Treated with Open Reduction and Internal Fixation or Closed Reduction and Percutaneous Fixation. A Prospective Randomized Trial. *J Bone Joint Surg. Am.* 2009;91:1837-1846. Doi: 10.2106/ JBJS.H.01478
- Anakwe RE, Khan LAK, Cook RE, McEachan JE. Locked volar plating for complex distal radius fractures: Patient reported outcomes and satisfaction *J Orthop. Surg. Res.* 2010;5:51.
- Tang Z, Yang H, Chen K, Wang G, Zhu X, Qian Z. Therapeutic Effects of Volar Anatomical Plates Versus Locking Plates for Volar Barton's Fractures. *Orthopedics.* 2012 Aug;35(8):e1198-203. Doi: 10.3928/01477447-20120725-19. Available from <http://www.ncbi.nlm.nih.gov/pubmed>.
- Arora R, Lutz M, Hennerbichler A, Krappinger D, Espen D, Gabl M. Complications following internal fixation of unstable distal radius fracture with a palmar locking-plate. *J Orthop Trauma.* 2007;21(5):316-22.
- Egol K, Walsh M, Tejwani N, McLaurin T, Wynn C, Paksima N. Bridging external fixation and supplementary Kirschner-wire fixation versus volar locked plating for unstable fractures of the distal radius A Randomised, Prospective Trial. *J Bone Joint Surg. [Br].* 2008;90-B:1214-21.
- Marco Rizzo, Brian A Katt, Joshua T. Carothers: Comparison of Locked Volar Plating Versus Pinning and External Fixation in the Treatment of Unstable Intra-articular Distal Radius Fractures. *HAND.* 2008;3:111-117. Doi: 10.1007/s11552-007-9080-0.
- Phadnis J, Trompeter A, Gallagher K, Bradshaw L, Elliott DS, Newman KJ. Mid-term functional outcome after the internal fixation of distal radius fractures. *J Orthop Surg Res.* 2012 Jan;7:4. Doi: 10.1186/1749-799X-7-4. PMID: 22280557; PMCID: PMC3398340.
- Rozental TD, Blazar PE. Functional outcome and complications after volar plating for dorsally displaced, unstable fractures of the distal radius. *Am J Hand Surg.* 2006;31(3):359-65.