

## ORIGINAL RESEARCH

# Clinical outcome of intra-articular distal end radius fractures treated with open reduction and internal fixation with volar locking plate

<sup>1</sup>Dr. Amardeep MR, <sup>2</sup>Dr. Sudhir Kumar Garg, <sup>3</sup>Dr. Siddharath SP, <sup>4</sup>Dr. Prasanna TY

<sup>1</sup>Assistant Professor, Department of Orthopaedics, ESI Medical College, Rajajinagar, Bengaluru, Karnataka, India

<sup>2</sup>HOD, Department of Orthopaedics, GMCH-32, Chandigarh, India

<sup>3</sup>Assistant Professor, Department of Orthopaedics, ESI Medical College, Rajajinagar, Bengaluru, Karnataka, India

<sup>4</sup>Associate Professor, Department of Orthopaedics, ESI Medical College, Rajajinagar, Bengaluru, Karnataka, India

### Corresponding Author

Dr. Prasanna TY

Associate Professor, Department of Orthopaedics, ESI Medical College, Rajajinagar, Bengaluru, Karnataka, India

Received: 02Sept, 2023

Accepted: 25Sept, 2023

### Abstract

#### Introduction:

Open reduction and internal fixation (ORIF) with volar locking plate has now become the treatment of choice in intra-articular distal end radius fractures during the past decades. The present study was conducted to assess the clinical outcome after 6 months.

**Aims and objective:** To study the outcome of intra-articular distal end radius fracture treated with open reduction and internal fixation (ORIF) with volar locking plate.

**Methodology:** Present prospective study was conducted for patients with intra-articular distal radius fracture attending to the department of Orthopedics, who underwent open reduction and internal fixation with volar plates. The clinical outcome was assessed by measuring the range of dorsiflexion, palmar flexion, radial deviation, ulnar deviation, pronation and supination at 6 weeks, 3 months, and 6 months and compared with the normal side at 6 months.

**Results and Discussion:** Achievements of different movements in operated hand as compared to the normal side were dorsiflexion (90% of normal), palmar flexion (92%), radial deviation (89%), ulnar deviation (85%), pronation (96%) and supination (91%).

**Conclusion:** ORIF with volar locking plate and early mobilization in patients with intra-articular fractures of distal end radius shows excellent functional outcome in terms of the range of movements at the wrist and were able to achieve was more than 90% movements compared to the normal side.

**Keywords:** Open reduction and internal fixation (ORIF), intra-articular (IA)

---

This is an open access journal, and articles are distributed under the terms of the Creative Commons Attribution-Non Commercial-Share Alike 4.0 License, which allows others to remix, tweak, and build upon the work non-commercially, as long as appropriate credit is given and the new creations are licensed under the identical terms.

---

### Introduction

Fracture distal end radius is one of the most common skeletal injuries accounting for approximately one-sixth of all fractures seen and treated<sup>1</sup>. Road traffic accidents are a major cause of fracture in young adults and fall on out-stretched hand is the major cause in the elderly.<sup>2,3</sup>

Intra-articular fractures pose a therapeutic challenge as compared to extra-articular fractures because they are more difficult to reduce and stabilize. If not

reduced adequately, it may result in malunion, post-traumatic arthritis, decreased grip strength, endurance, as well as limited motion and carpal instability leading to less satisfactory functional outcome thus affecting the quality of life of the patient.<sup>4-7</sup>

A better understanding of the distal end radius fractures has led to the changing concepts of the treatment.<sup>8</sup> The optimal method of obtaining and maintaining an accurate restoration of distal radius anatomy remains a topic of considerable controversy.

These fractures can be treated with closed reduction and immobilization with a cast for 6 weeks, percutaneous pinning, external fixation and open reduction and internal fixation. All these modalities are being used justifying the fact that there is no ideal modality of treatment.<sup>9</sup>

Among these modalities, open reduction and internal fixation with plating is emerging as a treatment of choice because proper reduction can be achieved and maintained and allows early postoperative mobilization. Plating of distal radial fractures with volar displacement was popularized by Ellis in 1965 where it acted as a buttress to prevent displacement of the distal fragment<sup>10</sup>. However these plates were not suitable for fractures with dorsal displacement. However recently introduced volar locking plates are able to stabilize dorsally displaced fractures because as fixed angle devices, these plates provide sufficient stability to the dorsally displaced distal fragments<sup>11,12</sup>. As open reduction and internal fixation is emerging as a modality of treatment, there is paucity of data documenting the clinical outcome in these patients. Hence, the present study was planned to assess the clinical outcome after open reduction and internal fixation of intra-articular distal end radius fractures.

**Aims and objectives:** To study the outcome in intra-articular distal end radius fractures treated with ORIF with volar locking plate

**Material and methods:** This was a prospective study. The study population was patients with intra-articular distal radius fractures who underwent open reduction and internal fixation with volar plating during the year 2018-19.

#### **Inclusion criteria**

1. Patients with Isolated intra-articular fracture distal end radius.
2. Patients with unilateral fractures.
3. Patients willing to participate in the study.

#### **Exclusion criteria**

1. Patients with pathological fractures.
2. Patients with polytrauma.
3. Patients with open fractures.
4. Patients with neglected fracture distal end radius.
5. Patients with extra-articular fracture distal end radius.
6. Patients with associated ulnar styloid process fracture.

The study was approved by the ethical committee of the institute. A valid written informed consent was taken from the patients.

Data were collected with a pre-tested questionnaire. Data included demographic details like age, sex etc. and clinical history. A thorough clinical examination was done. All patients underwent a pre-operative assessment. Investigations required for pre-operative

assessment like complete blood count, renal function tests, liver function tests were done. Besides appropriate X-rays, pre-operative CT scan with 3D reconstruction of the affected part was done in all patients.

All patients underwent open reduction and internal fixation with volar plates by modified Henry's approach by a single Surgeon. All patients were evaluated and assessed at 6 weeks, 3 months and 6 months from the day of surgery.

At every follow-up, patients were examined clinically for signs of infection and radiologically to assess the maintenance of reduction and status of bone union.

The functional outcome was assessed by Gartland and Werley demerit score and PRWE score and also by measuring the range of dorsiflexion, palmar flexion, radial deviation, ulnar deviation, pronation, and supination at 6 weeks, 3 months, and 6 months and compared with the normal side at 6 months. Data were subjected to statistical analysis using the statistical package for social sciences (SPSS v 21.0, IBM). Data were described by using percentages and frequency. Clinical outcome parameters were compared during the course of follow up by using pair-wise comparison based on estimated marginal means with Bonferooni correction to see the trend in the subsequent follow-up. Outcomes were also compared with the normal side by using a paired t-test and a value of < 0.05 is taken as significant.

#### **Results**

A total of 32 patients were studied. The majority of the patients were in the age group of 31-40 years (15 out of 32) followed by 21-30 years (7 out of 32). The mean age of patients was  $36 \pm 10$  years. There were 6 females and 26 males (Table 1). 19 (60%) patients had a left-sided injury and 13 (40%) patients had a right-sided injury. The mean delay between the injury and surgery was  $10 \pm 7$  days. Injuries were classified according to AO/OTA classification and 12 out of 32 were 23-C2, 8 were 23-C1, 7 were 23-B2 and 5 were 23-B3. In all cases, fracture was approached using modified Henry approach. After a satisfactory reduction, a single indigenous version of 4 holes variable angle distal radius locking plate was applied on the volar surface. No additional fixation such as additional plate or K-wire etc. was used. None of the patient required bone grafting. Postoperatively except a well-padded dressing, no mode of immobilization was given. Mobilization was started a day after the operation as tolerated by the patient and gradually increased.

There was no incidence of superficial or deep infection. There was no loss of reduction in any of the patient. The union was determined clinically by absence of pain and radiologically complete bridging of the fracture site in both orthogonal projections. The mean radiological union time was  $8 \pm 1$  weeks. The functional outcome at various follow up periods is as below.

Gartland and Werley demerit score from 6 weeks to 6 months is improving from fair to excellent and by end of 6 months 91% of patients had excellent score and 9% had good score.

Mean dorsiflexion in the operated side at 6 weeks, 3 months, and 6 months was 46°, 55°, and 70° respectively (fig 1). There was a significant improvement in the range of dorsiflexion from 6 weeks to 6 months. Comparing the dorsiflexion of the operated side to the normal side at 6 months, the operated side has achieved 94% dorsiflexion of the normal side which was statistically insignificant (Table2).

Mean palmar flexion in the operated side at 6 weeks, 3 months, and 6 months was 49°, 57°, and 66° respectively, from 6 weeks to 6 months there was a significant improvement in the range of palmar flexion (fig 1) and at 6 months, operated side has achieved 92% of normal side without any significant statistical difference (Table 3).

The mean radial deviation of the operated side was 14°, 16°, and 21 at 6 weeks, 3 months, and 6 months respectively. We observed significant improvement in the range of radial deviation from 6 weeks to 6 months (fig 2). At the end of 6 months operated side

has achieved a radial deviation of 89% of the normal side with a statistically significant difference between the two (Table 4).

The mean ulnar deviation of the operated side was 24° at 6 weeks, 28° at 3 months, and 34° at 6 months (fig 2). We compared the ulnar deviation of the operated side to the normal side at 6 months and found that the operated side has achieved statistically significant improvement (85%). (Table 5).

There was a significant improvement in the range of pronation from 6 weeks (70°) to 6 months (83°). Comparing the pronation of the operated side to the normal side at 6 months, the operated side has achieved 96% of the normal side with no statistically significant difference. (Fig 3)

Mean supination of the operated side at 6 weeks, 3 months, and 6 months was 51°, 58°, and 66° respectively, assessing the range of supination from 6 weeks to 6 months there is a significant improvement and at 6 months. Comparing the supination of the operated side to the normal side, the operated side has achieved 91% of the normal side with a statistically significant difference between the two. (Fig 3).

**Table 1: Distribution of patients according to age and sex**

Age	Sex		Total
	F	M	
11-20 yrs.	1	1	2
21-30 yrs.	0	7	7
31-40 yrs.	4	11	15
41-50 yrs.	1	4	5
51-60 yrs.	0	2	2
61-70 yrs.	0	1	1
Total	6	26	32

**Table 2: Comparison of mean dorsiflexion at subsequent follow-ups**

(I) Time	(J) Time	Mean Difference (I-J)	Std. Error	Sig. <sup>b</sup>
At 6 Weeks	AT 3 Months	-8.750*	.809	.000
	AT 6 Months	-19.063*	1.410	.000
At 3 Months	AT 6 Weeks	8.750*	.809	.000
	AT 6 Months	-10.313*	1.002	.000
At 6 Months	AT 6 Weeks	19.063*	1.410	.000
	AT 3 Months	10.313*	1.002	.000

**Table 3: Comparison of palmar flexion in subsequent follow-ups**

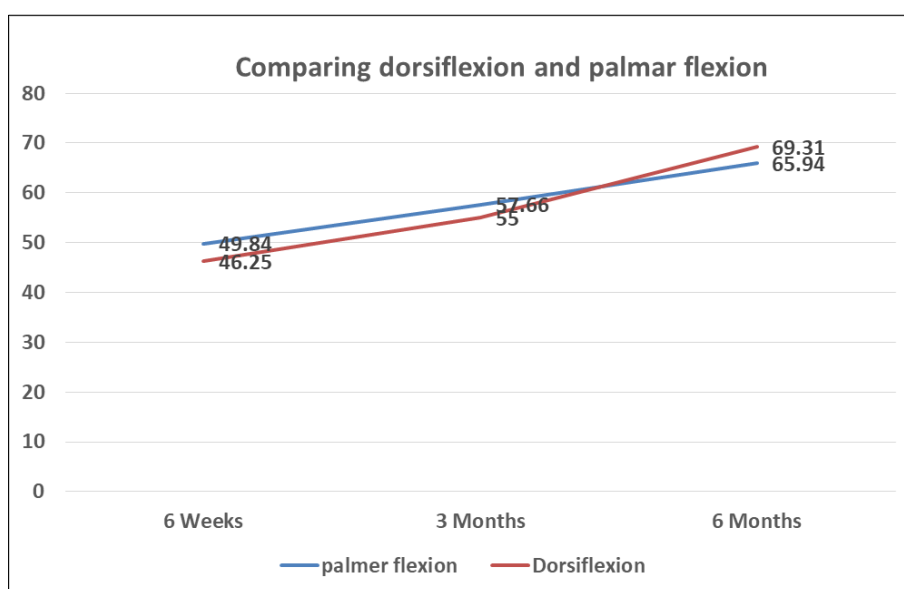
(I) Time	(J) Time	Mean Difference (I-J)	Std. Error	Sig. <sup>b</sup>
At 6 Weeks	At 3 Months	-7.813*	1.027	.000
	At 6 Months	-16.094*	1.304	.000
At 3 Months	At 6 Weeks	7.813*	1.027	.000
	At 6 Months	-8.281*	.942	.000
At 6 Months	At 6 Weeks	16.094*	1.304	.000
	At 3 Months	8.281*	.942	.000

**Table 4: Comparison of radial deviation in subsequent follow-ups**

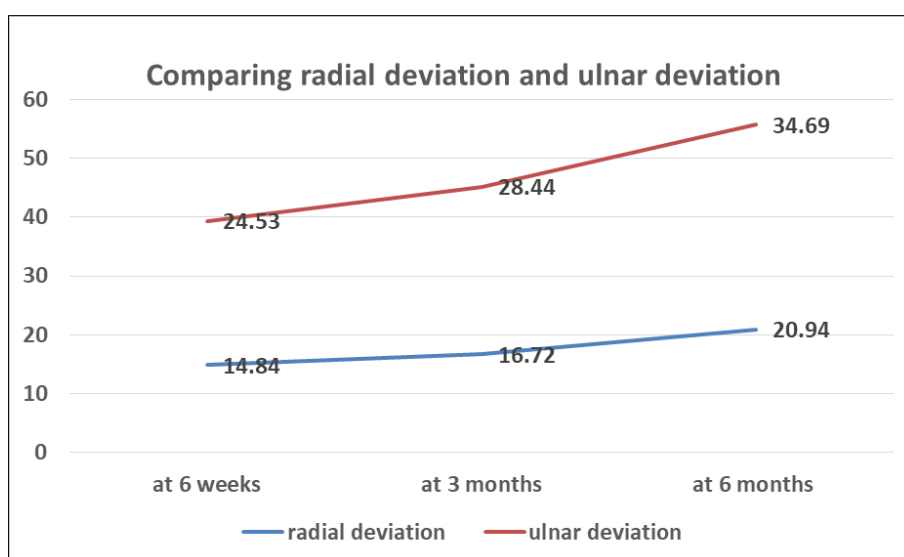
(I) Time	(J) Time	Mean Difference (I-J)	Std. Error	Sig. <sup>b</sup>
At 6 Weeks	At 3 Months	-1.875*	.583	.009
	At 6 Months	-6.094*	.624	.000
At 3Months	At 6 Weeks	1.875*	.583	.009
	At 6 Months	-4.219*	.748	.000
At 6 Months	At 6 Weeks	6.094*	.624	.000
	At 3 Months	4.219*	.748	.000

**Table 5: Comparison of ulnar deviation at subsequent follow-ups**

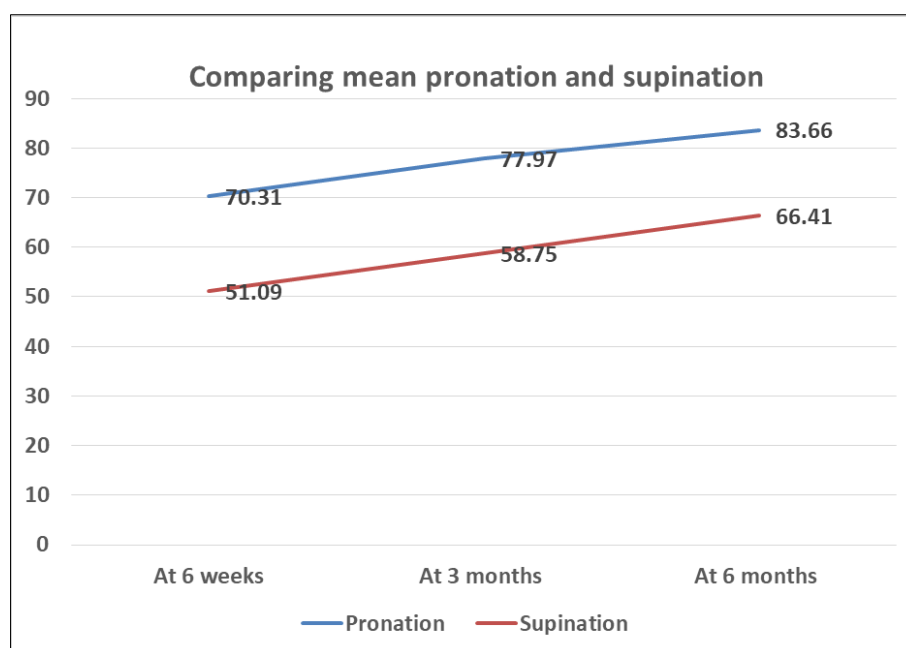
(I) Time	(J) Time	Mean Difference (I-J)	Std. Error	Sig. <sup>b</sup>
At 6 Weeks	At 3 Months	-3.906*	.832	.000
	At 6 Months	-10.156*	.761	.000
At 3 Months	At 6 Weeks	3.906*	.832	.000
	At 6 Months	-6.250*	.745	.000
At 6 Months	At 6 Weeks	10.156*	.761	.000
	At 3 Months	6.250*	.745	.000



**Fig 1: Comparison of mean dorsiflexion and palmer flexion at follow ups**



**Fig 2: Comparison of mean radial deviation and palmar ulnar deviation at follow ups**



**Fig 3: Comparison of mean pronation and supination at follow ups**

### Discussion

Management of intra-articular fractures has significantly evolved over the past decade with better understanding of patho-anatomy of fractures and availability of locking plates. Open reduction and internal fixation with locking plates has become the treatment of choice, especially in young active patients. It has resulted in excellent restoration of the anatomy and high union rate. However there is limited data available on the functional outcome in such patients. This prospective study was carried out to assess whether these patients also achieve functional outcome which is in consonance with the anatomical results.

A total number of 32 patients with AO/OTA 23 B and C type distal radius fracture were included, who underwent open reduction and internal fixation with a volar locking plate for intra-articular distal radius fractures operated by a single surgeon, all by Modified Henry's approach. The mean age of patients was  $36 \pm 10$  years. Most patients presented to us were in middle age, similar age group pattern was observed by Knirk *et al.*<sup>13</sup>, Rozental *et al.*<sup>14</sup> and Kundu *et al.*<sup>15</sup> in their studies.

Out of 32 patients in the study group, there were 6 females and 26 males. Among the patients, 19 had a left-sided injury, and 13 had a right-sided injury and dominant hand being right in all the 32 patients. The mean days after injury till fixation were 10 days with a standard deviation of 7 days.

In our study, post-operatively patients were not given any mode of immobilization. Physiotherapy with movements at wrist joint were started a day after the operation as tolerated by the patient. Patients were followed up at 6 weeks, 3 months, and 6 months, where clinical parameters were assessed and compared with the normal side at 6 months.

Significant improvement in the range of dorsiflexion and palmar flexion was observed from 6 weeks to 6 months and compared to the normal side at 6 months, the operated side has achieved a range of motion of 94% and 92% respectively, having no statistical difference between the two ( $p > 0.05$ ).

The radial and ulnar deviation also had a statistically significant improvement in their range of motion from 6 weeks to 6 months follow up and at 6 months they had achieved a range of motion of 89% and 85% of normal side respectively, with a significant difference between the normal and operated side ( $p < 0.05$ ).

The range of pronation and supination also significantly improved throughout follow up from 6 weeks to 6 months. When at 6 months compared with the normal side, the operated side had achieved the range of motion of 96 and 91% respectively.

Fitoussi *Fet al.*<sup>16</sup>, Orbay *Jet al.*<sup>17</sup>, Kilic *Aet al.*<sup>18</sup>, Kundu *Aet al.*<sup>15</sup>, and many more papers showed significant improvement in the range of palmar flexion, dorsiflexion, radial deviation, ulnar deviation, supination, and pronation in subsequent follow-ups similar to our study.

### Conclusion

Open reduction and internal fixation with volar locking plate and early mobilization in patients with intra-articular fractures of distal end radius shows excellent functional outcome in terms of the range of movements at the wrist and were able to achieve was more than 90% movements compared to the normal side.

### References

1. Jakim I, Pieter HS, Sweet MBE. External fixation for intra-articular fracture of distal radius. *J Bone Joint Surg.*1991;73:302-06.

2. Rockwood, Green's Fracture in adults, distal end radius fractures epidemiology 8th edition. 1:1059.
3. Kate.W.Nellas, Evan Kowalski, Kevin C. Chung. Epidemiology of fractures. Hand Clin. 2012;28:113-125.
4. Cooney WP, Linscheid RL, Dobyns JH *et al.* External pin fixation for unstable Colles' fractures. J Bone Joint Surg. 1979;61:840-45.
5. Arora R, Lutz M, Deml C, Krappinger D, Haug L, Gabl M. A prospective randomized trial comparing non-operative treatment with volar locking plate fixation for displaced and unstable distal radial fractures in patients sixty-five years of age and older. J Bone Joint Surg. 2011;93:2146-153.
6. Trumble TE, Schmitt SR, Vedder NB. Factors affecting the functional outcome of displaced intraarticular distal radius fractures. J Hand Surg. 1994;19:325-40.
7. Fitoussi F and Chow SP *et al.* Treatment of displaced intraarticular fractures of distal end radius with plates. J Bone Joint Surg. 1997; 79: 1303-311.
8. K. D werber, F. Raeder, R. B brauer *et al.* External fixation of distal end radius fracture: four compared with five pins. J Bone Joint surg 2003.85A: 660-666.
9. Nana AD, Joshi A, Lichtman D *et al.* Plating of the distal radius. J Am Acad Orthop Surg. 2005; 13: 159-71
10. Ellis J. Smith's and Barton's fractures. A method of treatment. J Bone Joint Surg. 1965;47:724-727.
11. Orbay JL, Fernandez D *et al.* Volar fixation for dorsally displaced fractures of the distal radius: a preliminary report. J Hand Surg. 2002;27:205-15.
12. Musgrave DS, Idler RS. Volar fixation of dorsally displaced distal radius fractures using the 2.4-mm locking compression plates. J Hand Surg. 2005; 30:743-49.
13. Knirk JL, Jupiter JB *et al.* Intra articular fractures of distal radius in young adults. J Bone Joint Surg. 1986;68:547-49.
14. Rozental TD, Blazar PE *et al.* Functional outcome and complications after volar plating for dorsally displaced, unstable fractures of the distal radius. J Hand Surg. 2006; 31:359-65.
15. Kundu A, Wale N, Phuljhele S, Ghritlahre D, Gurudatta H *et al.* Intra articular distal radius fractures and volar plate fixation: a prospective study. Int J Res Orthop. 2017;3:589.
16. Fitoussi F and Chow S P *et al.* Treatment of displaced Intra articular fractures of distal end radius with plates. J Bone Joint surg. 1997;79:1303- 1311.
17. Orbay J, Fernandez D *et al.* Volar fixed-angle plate fixation for unstable distal radius fractures in the elderly patient. J Hand Surg. 2004;29:96-102.
18. Kilic A *et al.* Volar locking plate fixation of unstable distal radius fractures. Acta Orthop Traumatol Turc. 2009;43:303-08.