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## **Analysis of functional outcome of volar locking plate in the management of intra-articular distal end radius fractures**

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### **Abstract**

**Background & Objectives:** Distal Radius fractures with intra articular involvement are challenging fractures to treat. They are associated with an articular incongruity and involve the radiocarpal, radioulnar joint as well as the ulnar styloid. The effectiveness of intervention has a direct bearing on wrist function. Various treatment modalities exist each having its own advantage. This study aims to evaluate the functional outcome of these fractures treated with volar locking plate.

**Methods:** This is a prospective study of 30 cases of intraarticular lower end radius fractures in adults aged between 36 to 57 years. These cases were operated with open reduction and internal fixation with volar locking plate at a tertiary care hospital. Regular follow up was done and outcome was assessed at 1 year using DASH criteria.

**Results:** 13 patients had excellent results, 9 patients had good results, 6 patients had satisfactory results, 2 patient had poor result. We had 2 patients with complications, 1 patient with radiocarpal arthritis and 1 patient with median nerve neuropathy. The mean time for union was 3.4 months.

**Conclusion:** Operative management of intra- articular distal radial fractures, produces excellent to good results with proper pre-operative evaluation, early fixation and reduction, proper wound care and early post-operative rehabilitation and patient education.

**Keywords:** lower end radius, volar locking plate, open reduction

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### **Introduction**

Distal radius fractures are one of the most common fractures seen in orthopaedic emergency. They are usually associated with fall on outstretched hand or a road traffic accident. Those fractures that are caused by high energy trauma, result in an intra-articular involvement and comminution leading to fragments that are often unstable and difficult to reduce. They are also associated with a high prevalence of complications such as post-traumatic arthritis of the radiocarpal joint, decreased grip strength and endurance<sup>1</sup>

It is well accepted that the fundamental principles of treating these fractures is the restoration of articular congruity as well as achieving functional, painless motion of wrist and hands is required for good results<sup>[2]</sup>. They pose a challenge to the orthopaedic surgeon due to the increasing functional demands of patients in modern day.

The results of closed reduction, percutaneous pin fixation, internal and external fixation have been variable and have been determined largely by the pattern of the fracture<sup>[3]</sup>. The choice between open reduction internal fixation with plating versus closed reduction with external fixation has not yet reached a common consensus. External fixation is associated with complications such as loss of reduction, pin-tract infections<sup>[4]</sup>.

After the introduction of locking plates, open reduction and

internal fixation has become the method of fixation for treatment of distal radius fractures. Plates have the advantage of providing secure fixation throughout the entire healing process without protruding wires or pins and allowing early and intensive forearm, wrist, and digital exercises<sup>[5]</sup>.

The purpose of this study was to evaluate the functional outcome of surgical management of distal radial fractures in adults using open reduction and internal fixation with plate and screws.

### **Aims and objectives**

- To assess functional outcome of plating for intra articular distal radius fractures at 1 year follow up
- To assess the complications.

### **Methodology**

This is a prospective study of 30 adult patients with distal radius intra articular fractures, who were treated at a tertiary care hospital under the Department of Orthopaedics by a single surgeon.

### **Inclusion criteria**

- Intra-articular distal end radius fracture.
- Skeletally mature patients between 20-60 years of age

- Closed fracture
- Patient giving informed and written consent

**Exclusion criteria**

- Open fractures
- Other fracture in ipsilateral limb.
- Any neurovascular deficit in that limb.
- Patients with congenital deformities

The patients were followed a period of 1 month, 3 months, 6 months and 1 year. Functional evaluation in terms of ROM, DASH score, time to union and complications were evaluated

**Methodology**

**Initial Work Up**

Following admission to the hospital, a careful history was elicited

from the patients and / or attendants to reveal the mechanism of injury and the severity of trauma. All patients were thoroughly examined. Their general condition, associated systemic diseases and associated injuries were noted. Standard radiographs in PA and lateral views were taken for confirmation of the diagnosis and also to know the type of fracture. Oblique views were also taken in a few patients who had complex comminuted fractures. The fracture fragments were analysed and involvement of radiocarpal and distal radioulnar joints were assessed and classified according to the Frykman's classification <sup>[6, 8]</sup>

**Pre op work up**

Necessary pre-operative work up was done and Physician fitness was obtained for all patients. Consent for surgery was taken and patients were operated after a pre-anaesthetic check-up.

Type	Fracture
I	Extra-articular radial fracture
II	Extra-articular radial fracture with an ulnar fracture
III	Intra-articular fracture of the radiocarpal joint without an ulnar fracture
IV	Intra-articular fracture of the radius with an ulnar fracture
V	Fracture of the radioulnar joint
VI	Fracture into the radioulnar joint with an ulnar fracture
VII	Intra-articular fracture involving radiocarpal and radioulnar joints
VIII	Intra-articular fracture involving radiocarpal and radioulnar joints with an ulnar fracture

**Fig 1**

**Surgical Procedure**

The duration from the date of injury to date of operation ranged from 1-10 days (average 2.64 days). The operations were performed under general anaesthesia in 4 cases and brachial block in 26 cases. The patient was placed supine on the operating table, a pneumatic tourniquet was used in all cases. A modified henrys approach was taken for distal radius and all the fragments were provisionally reduced with K wire after which fixation was

done with a volar locking plate

**Post-Operative Care and Rehabilitation**

Post-operatively patients received analgesics and intravenous antibiotics. Active physiotherapy was started next day after surgery and patients were discharged according to wound status. Periodic post op check-up was done in OPD on regular basis.



Fig 2

**Results**

**Age distribution**

The overall age of the patients varied from 36 – 57 years with the mean age of 44.96 years. The mean age in females was 45 years and mean age of males was 44.94 years.

**Gender distribution**

There were 18 (60%) males and 12(40%) females

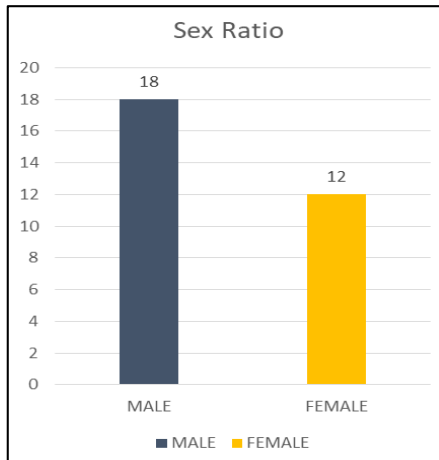


Fig 3

**Side**

Right wrist was involved in 18 (60%) patients and left was involved in 12 (40%) patients

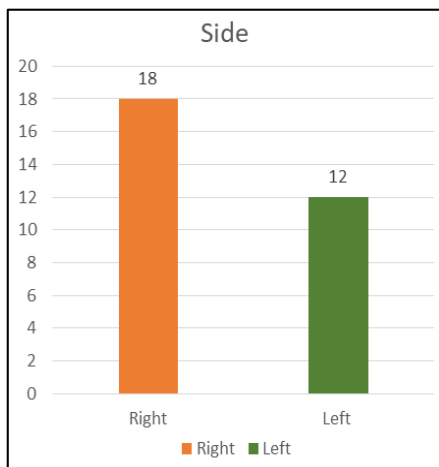


Fig 4

**Mode of Injury**

In our study there were 17(56.66%) patients with road traffic accidents and 13(43.33%) patients fell on their outstretched hand

**Associated injuries**

Out of 30 cases, 6 (20%) patients had associated injuries.

**Injury Surgery Interval**

Surgery was done between 1-5 days in 26 patients as an elective procedure. It was delayed up to the 10th day in 4 patients; one had ischaemic heart disease and one underwent emergency laparotomy for hemoperitoneum, others had medical comorbidities.

**Duration of Union**

In the present study the mean union time was 3.4 months

**Deformity**

Out of 30 patients, 1 patient had a residual deformity. 1 patient had a prominent ulnar styloid.

**Range of Motion**

In our study 24(80%) patients had dorsiflexion within the normal functional range (minimum 45°), 23(76.6%) had palmar flexion within the normal functional range (minimum 30°), 25 (83.3%) had radial deviation within the normal functional range (minimum 15°) and 23(76.6%) patients had ulnar deviation within the normal functional range (minimum 15°).

24(80%) patients had grip strength more than 60% compared to the opposite side. 1 had significant loss of grip strength (< 60% compared to the opposite side). 1 patients had pain in the distal radioulnar joint. 2 patients initially had stiffness but responded well to physiotherapy within 10 to 15 days regained maximum range of movements.



Fig 5

**Complication**

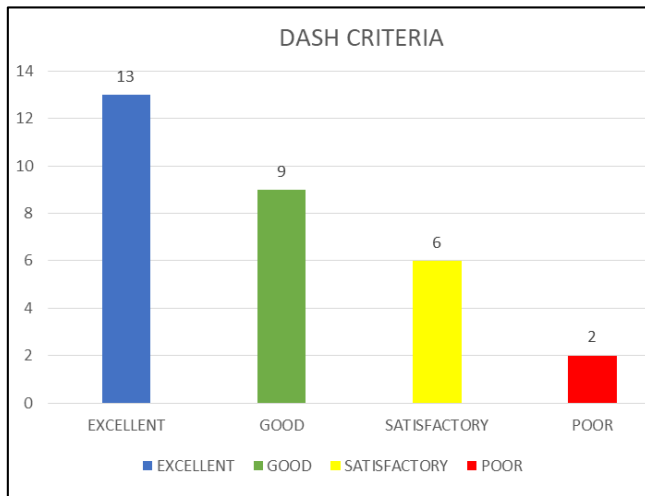
2 patients had radiocarpal arthritis while 1 patient had median nerve neuropathy.

## Evaluation of Results

Functional outcome was evaluated based on DASH criteria [7]

**Table 1**

Outcome	No of Patients
Excellent	13
Good	9
Satisfactory	6
Poor	2



**Fig 6**

## Results

In our series, we had 43.3% excellent, 30% good, 20%, fair and 6.66% poor result at 1 year.

## Discussion

Abraham Colles gave a detailed description of the fracture of the distal end of the radius more nearly 80 years before the development of radiographs. He described a method of reduction and application of the tin and wooden splint, to provide a good outcome [9].

Orthopaedic surgery has evolved with advanced imaging and fixation systems since then but the this fracture remains one of the most challenging of the fractures to treat [15]. The fracture pattern most commonly observed in geriatric age group is extra-articular while the high-energy intra-articular type is most frequent in young adult patients. In intra articular involvement, high energy trauma, frequently causes shear and impacted fractures of the articular surface of radiocarpal joint with displacement of fragments.

Studies have shown that extra-articular fractures as well as impacted stable fractures with minimal shortening can be managed conservatively. However intra-articular fractures that involve the radiocarpal joint and/or the distal radioulnar joint, require an anatomical reduction of the joint surface to reduce the incidence of post-traumatic arthritis and to guarantee a successful treatment outcome. Treating these fractures conservatively, especially in young individuals is not recommended and the results have been poor [16, 17, 18].

The operative method selected to achieve the treatment objectives requires a careful study of the individual fracture

pattern, level of activity, quality of bone and general medical condition.

Volar Locking Plates provide successful outcomes especially for the treatment of intraarticular unstable fractures of distal radius. Volar approach provides access with minimal surgical trauma on distal radius. The aim of this surgery is the anatomic realignment of the intra articular fragments which allows early joint motion due to the fixation strength. It has been proven to restore wrist ROM, ulnar variance and articular congruency much better than external fixator.

We evaluated our results and compared them with those obtained by various other studies utilizing different modalities of treatment. Our analysis is as follows.

**Table 2: Age distribution**

Series	Average Age
Jesse B. Jupiter <i>et al</i> <sup>10</sup>	40
Louis Catalano <i>et al</i> <sup>11</sup>	32
Harish Kapoor <i>et al</i> <sup>12</sup>	39
Das <i>et al.</i> <sup>13</sup>	41.4
Our Study	44.96

Average age of the patients in this study was comparable to previous studies

**Table 3: Sex distribution**

Study	Males %	Females %
Jesse B. Jupiter <i>et al</i> <sup>10</sup>	60	40
Louis Catalano <i>et al</i> <sup>11</sup>	67	33
Harish Kapoor <i>et al</i> <sup>12</sup>	72	28
Das <i>et al.</i> <sup>13</sup>	56	44
Our study	60	40

Our study had a male preponderance with 60 % male patients and 40% female patients and is comparable to the following previous studies mentioned in the table above. Increased incidence in males is probably due to their involvement in outdoor activities, riding vehicles and heavy manual labour.

Involved side:

**Table 4**

Series	Right %	Left %
Jesse B. Jupiter <sup>10</sup> <i>et al</i>	61	39
Louis Catalano <i>et al</i> <sup>11</sup>	48	52
Harish Kapoor <i>et al</i> <sup>12</sup>	65	35
Das <i>et al.</i> <sup>13</sup>	66	34
Our Study	60	40

In the present study right wrist was involved more than left wrist. The series of Jesse B. Jupiter *et al* (1996) and Harish Kapoor *et al* (2000) had increased involvement of the right wrist. But John K. Bradway *et al* <sup>[14]</sup> (1989) had equal involvement of both wrists in their study.

## Mode of injury

In our study 56.6% of the patients had road traffic accident and 43.3% had a fall on the out stretched hand.

**Table 5**

Series	RTA %	FALL %
Jesse B. Jupiter <i>et al</i> <sup>10</sup>	67	33
Louis Catalano III <i>et al</i> <sup>11</sup>	24	76
Harish Kapoor <i>et al</i> <sup>12</sup>	70	30
Das <i>et al.</i> <sup>13</sup>	34	66
Our Study	56.6	43.3

John K. Bradway *et al* (1989) and Louis Catalano III *et al* (1997) reported fall on the outstretched hand as the most common mode of injury. We reported road traffic accident as the more common mode of injury. Jesse B. Jupiter *et al* (1996) and Harish Kapoor *et al* (2000) also reported similar findings in their series.

Type of fracture

Based on Frykman’s classification, we had 23.3 %, Type I and II fractures 46.4%, Type III and IV fractures, 3.33% Type V and VI fractures, and 26.66% Type VII and VIII fractures.

Patients, who obtained excellent results, had no residual deformities or pain. Range of motion was within the normal functional range. They had no arthritic changes or other complications. They were operated within 4 days after injury. Radial height, volar tilt and articular step-off were within acceptable limits. All patients were co-operative for physiotherapy. Patients with good and satisfactory results had no residual deformities or pain. Rest of their findings was within acceptable parameters. Patients with poor results, along with residual deformity and limitation of movements, also had pain in the distal radio-ulnar joint.

John K. Bradway *et al* (1989) and Jesse B. Jupiter *et al* (1996) had similar percentage of excellent and good results.

**Table 6**

Series	Excellent	Good	Satisfactory	Poor
John K. Bradway <i>et al</i> <sup>14</sup>	44 (44%)	12 (12%)	44 (44%)	0
Jesse B. Jupiter <i>et al</i> <sup>10</sup>	63 (63%)	20 (20%)	17(17%)	0
Harish Kapoor <i>et al</i> <sup>12</sup>	15 (36%)	15(36%)	8 (19%)	4 (9%)
Das <i>et al.</i> <sup>13</sup>	26 (81%)	4(12%)	2(7%)	0
Our study	13(43.3%)	9(30%)	6(20%)	2(6.6%)

Complications:

2 patients had radiocarpal arthritis while 1 patient had imedian nerve neuropathy, which was a complication rate of 6.66%. We did not have any non-union or infection related complications.

John K. Bradway *et al* (1989) and Jesse B. Jupiter *et al* (1996) reported a complication rate of 30% and 36% respectively. However, Harish Kapoor *et al* (2000) reported a complication rate of just 4% in their series.

**Conclusion**

Operative management of distal radius fractures with volar locking plate, produces excellent to good results with proper pre-operative evaluation, selection of the method based on fracture pattern, early fixation, reduction and stability, early post-operative rehabilitation and patient education.

**References**

1. Meena S, Sharma P, Sambharia AK, Dawar A. Fractures of distal radius: an overview. Journal of family medicine and primary care, 2014;3(4):325–332. [https://doi.org/10.4103/](https://doi.org/10.4103/2249-4863.148101(1ST_STATEMENT))

2249-4863.148101(1ST\_STATEMENT)

2. Szabo RM. Comminuted distal radius fractures. Orthop Clin of Nam,1992;23:1-5.

3. Strohm PC, Müller CA, Boll T, Pfister U. Two procedures for Kirschner wire osteosynthesis of distal radial fractures. A randomized trial. J Bone Joint Surg Am,2004;86(12):2621-8. Doi: 10.2106/00004623-200412000-00006. PMID: 15590845.

4. Williksen JH, Husby T, Hellund JC, Kvernmo HD, Rosales C, Frihagen F. External Fixation and Adjuvant Pins Versus Volar Locking Plate Fixation in Unstable Distal Radius Fractures: A Randomized, Controlled Study With a 5-Year Follow-Up. J Hand Surg Am,2015;40(7):1333-40. doi: 10.1016/j.jhsa.2015.03.008. Epub 2015 Apr 23. PMID: 25914018.

5. Freeland Alan, Luber Kurre. Biomechanics and Biology of Plate Fixation of Distal Radius Fractures. Hand clinics. 2005;21:329-39. 10.1016/j.hcl.2005.03.002.

6. Frykman G. Fractures of the distal radius, including sequelae - shoulder-hand-finger syndrome, disturbance in the distal radio-ulnar joint and impairment of nerve function: A clinical and experimental study. Acta Orthop Scand 1967;108:3+.

7. Gummesson C, Atroshi I, Ekdahl C. The disabilities of the arm, shoulder and hand (DASH) outcome questionnaire: longitudinal construct validity and measuring self-rated health change after surgery. BMC musculoskeletal disorders, 2003;4-11. <https://doi.org/10.1186/1471-2474-4-11>

8. Kleinlugtenbelt YV, Groen SR, Ham SJ, Kloen P, Haverlag R, Simons MP *et al*, Classification systems for distal radius fractures. Acta orthopaedica,2017;88(6):681–687.

9. Bain G. Abraham Colles oration: 200 years on. BMC Proc,2015;9:A33.

10. Jupiter JB, Knirk JL. Intra-articular fracture of the distal end of the radius. J Bone Joint Surg,1991;73-A:461-69.

11. Catalano LW III, Cole RJ, Gelberman RH, Evanoff BA, Gilula LA, Borrelli J Jr. Displaced intra-articular fractures of the distal aspect of the radius. J Bone Joint Surg,1997;79-A(9):1290-1302.

12. Kapoor H, Agarwal A, Dhaon BK. Displaced intra-articular fractures of distal radius: A comparative evaluation of results following closed reduction, external fixation and open reduction with internal fixation. Injury,2000;31(2):75-79.

13. Das AK, Sundaram N, Prasad TG, Thanavelu SK. Percutaneous pinning for non-comminuted extra-articular fractures of distal radius. Indian journal of orthopaedics, 45(5), 422–426. <https://doi.org/10.4103/0019-5413.83949>

14. Bradway JK, Amadio PC, Cooney WP III. Open reduction and internal fixation of displaced, Comminuted intra-articular fractures of the distal end of the radius. J Bone Joint Surg,1989;71-A(6):839-847.

15. Chen Neal C, Jupiter Jesse B. “Management of distal Radial Fractures”, J Bone Joint Surg,2007;89:2051-2062.

16. Jakob M, Rikli DA, Regazzoni P. Fractures of the distal radius treated by internal fixation and early function. A prospective study of 73 consecutive patients. J Bone and Joint Surg,2000;82-B(3):340-344.

17. Kapoor H, Agarwal A, Dhaon BK. Displaced intra-articular

fractures of distal radius: A comparative evaluation of results following closed reduction, external fixation and open reduction with internal fixation. *Injury*,2000;31(2):75-79.

18. Rogachefsky RA, Scott RL, Applegate B, Ouellette EA, Savenor AM, McAuliffe JA. Treatment of severely comminuted intra-articular fractures of the distal end of the radius by open reduction and combined internal and external fixation. *J Bone and Joint Surg*,2001;83-A(4):509-519.