

## Efficacy of External Fixation, K-Wire Fixation and Volar Locking Plate in the Management of Intra Articular Distal Radius Fractures in Adults

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Conflict of interest: Nil

### Abstract

**Background:** Intra articular fractures of distal radius are unstable and complex fractures leads to severe pain, swelling, restricted range of motion. These fractures faced instability because fail to achieve anatomical reduction of fragments and surrounding ligaments. The present prospective study was designed to evaluate functional and radiological outcome of closed intrarticular distal radius fractures. A total of 42 cases with acute closed intra articular fracture of distal radius > 25 years of age were recruited. Among the study participants, 15 cases were treated with K-wire fixation, 15 with volar plating and 12 with external fixation method. Gartland and Werley score was used to assess functional recovery and Lindstrom and Frykman grading was used for anatomic evaluation. The functional outcome was assessed by Gartland and Werley score and anatomical outcome by Lindstrom and Frykman grading showed statistically significant between study groups ( $p < 0.05$ ). The grip strength and functional status was statistically significant between study groups. Wrist stiffness and infection are commonly associated with all fixation methods. Volar locking plating showed superiority in terms of radiological outcome and patient satisfaction than k-wire fixation and external fixation.

**Keywords:** External fixation, volar locking plate, K-wire fixation, Gartland and Werley score, Lindstrom and Frykman grading

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### Background

Distal radius fractures are potentially damage the normal function of hand and accounts for 17% of all skeletal fractures in adults with ratio of 1:10000 people [1-3]. The fractures are commonly intra articular in younger cases due to high energy trauma, whereas extra articular in elderly cases due to low energy trauma [4,

5]. The distal radius fractures of intrarticular type illustrate complex, high grade and unstable injuries [6]. Due to their complexity the optimal treatment option remains controversial [7]. The treatment goal for distal radius fracture is maximum restoration of hand anatomy and function. There are controversial reports

on the standard treatment choice for distal radius fracture. Several treatment modalities are available to manage distal radius fractures including external fixation, limited open reduction, closed reduction with cast immobilization, internal fixation with or without Kirschner (K) wires and percutaneous pinning [8]. Closed reduction with cast immobilization is a preferable non-surgical treatment choice for stable fractures but reported devastating outcome for unstable fractures [9].

For three decades, external fixation and volar locking plates are preferable surgical choice for distal radius fractures [10, 11]. External fixation claimed immense functional outcome in the management of intra and extra articular distal radius fractures. It is immense due to ease of application, less surgical exposure and less surgical trauma [12]. Volar locking plate is a gold standard method for unstable distal radius fractures [13]. Few studies have compared volar locking plate, external fixation, and K-wire fixation, but there is still insufficient evidence about which method gives the best possible outcome. Therefore, the present study was designed to evaluate functional and radiological outcome of closed intrarticular distal radius fractures.

### Materials and Methods

This prospective study was conducted in Department of Orthopaedics, Government Medical College and Hospital, Nalgonda during September 2020 to December 2021.

A total of 42 cases with acute closed intra articular fracture of distal radius attending outpatient department of Orthopedics at Government Medical College, Nalgonda, above 25 years of age were recruited. Written informed consent was obtained

from all the participants and study protocol was approved by institutional ethics committee.

**Inclusion criteria:** Cases with acute closed intra articular fracture of distal radius, >25 years of age.

**Exclusion criteria:** Cases with open intra articular fracture of distal radius, <25 years of age, with skeletal deformities, with history of multi united fractures, with cardiovascular complication were excluded.

All participants were undergone to mandatory laboratory investigations and clinical examination. Radiological evaluation (PA and Lateral view radiographs) was done to assess the fractured bone length, angulation, related communication and inclination and ulnar variance. Fracture pattern was assessed by CT scan. Among the study participants, 15 cases were treated with K-wire fixation, 15 with volar plating and 12 with external fixation method. Under aseptic conditions fractures were managed with appropriate fixation method under the vision of C-arm. Postoperative follow up was done at the end of 4<sup>th</sup> week, 8<sup>th</sup> week, 12<sup>th</sup> week. Gartland and Werley score was used to assess functional recovery and Lindstrom and Frykman grading was used for anatomic evaluation.

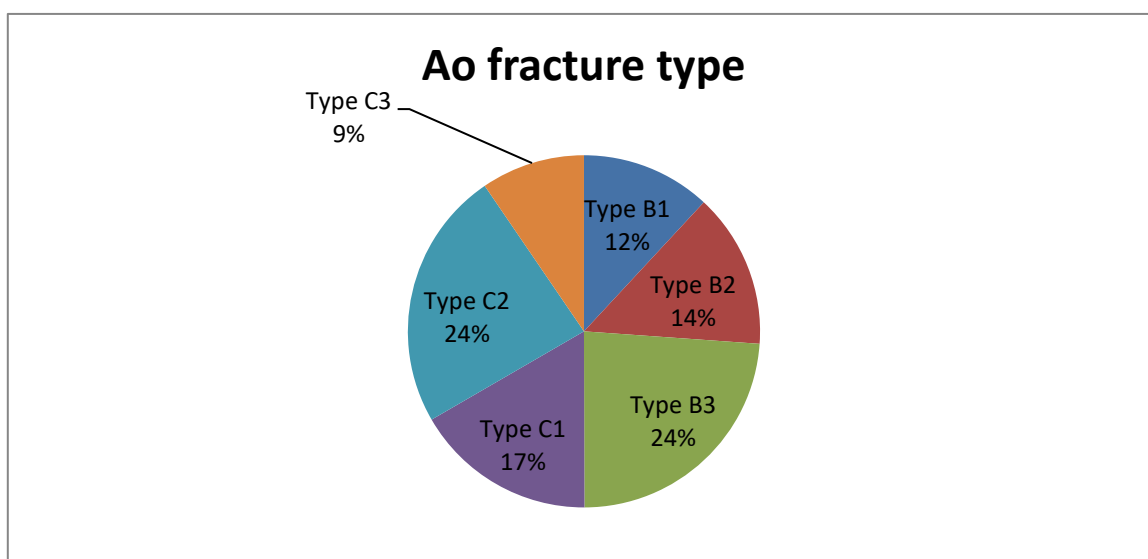
### Results

Majority cases were between age group 31-50 years with more male participants (61.90%). Falling from height (50%) was common cause of fractures followed by road traffic accidents (45.24%) and due to assault (4.6%). Right sided limb was commonly involved in majority cases (Table 1). Majority cases underwent surgery with 5 days (83.34%) of injury.

**Table 1: Demographic data of study participants**

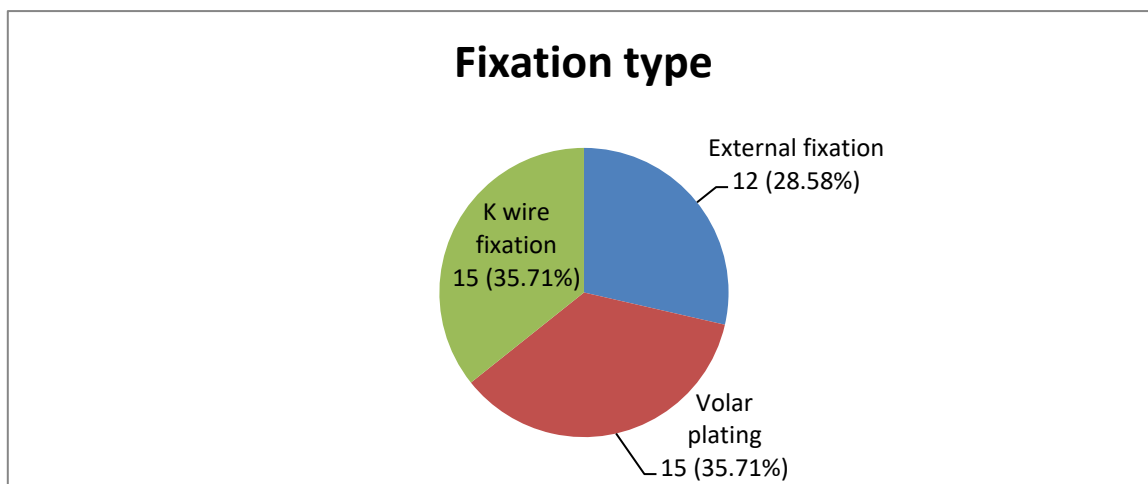
Demographic variables	Total no of cases (n=42)	
	Frequency	Percentage
Age		
25-30	05	11.90%
31-40	12	28.5%

41-50	24	57.14%
>50	01	2.38%
<b>Gender</b>		
Male	26	61.90%
Female	16	38.10%
<b>Mode of injury</b>		
Road traffic accidents	19	45.24%
Fall from height	21	50%
Assault	02	4.76%
<b>Laterality of injury</b>		
Right	28	66.67%
-Left	14	33.33%
<b>Duration from injury to surgery</b>		
0-5 days	35	83.34%
6-10 days	07	16.66%



**Figure 1: Distribution of cases as per AO fracture type**

According to AO fracture type, majority fractures were type B3 (24%) and type C2 (Graph 14%) (F). Distal radial fracture in 35.71% cases were managed with volar plating method, 35.71% with K-wire fixation and 28.58% had external fixation (Graph 2).



**Figure 2: Distribution of cases according to different fixation types**

**Table 2: Functional outcome among study participants**

Fixation type	Gartland and Werley score				p value
	Excellent	Good	Fair	Poor	
External fixation (n=12)	04	07	01	00	0.0312
K-wire fixation (n=15)	04	10	01	00	
Volar plating (n=15)	03	10	02	00	

The functional outcome was assessed by Gartland and Werley score showed excellent and good outcome in 4 and 7 cases managed with external fixation respectively. In cases managed with K-wire fixation showed excellent and good functional outcome in 4 and 10 cases respectively. In cases managed with volar plating showed excellent and good functional outcome in 3 and 10 cases respectively. None of the cases reported poor functional outcome in three fixation techniques. The functional outcome between the different fixation techniques was statistically significant ( $p=0.0312$ ) (Table 2).

**Table 3: Anatomical outcome among the study participants**

Fixation type	Lindstrom and Frykman Criteria				p value
	Grade I	Grade II	Grade III	Grade IV	
External fixation	11	01	-	-	0.0246
K-wire fixation	11	03	01	-	
Volar plating	12	02	01	-	

Lindstrom and Frykman criteria used anatomical outcome assessment showed Grade I outcome in 11 cases managed with external fixation and K-wire fixation and in 12 cases managed with volar plating. The anatomical outcome between study groups was statistically significant ( $p=0.0246$ ) (Table 3).

The majority cases managed with external fixation (10 cases) and volar plating (11 cases) showed excellent grip strength. Whereas, K-wire fixation showed excellent grip strength in 3 cases, good strength in 8 cases and fair strength in 3 cases. Stiffness was observed in 3 cases commonly among three fixation methods. Majority cases showed 76-100% range of motion in three fixation groups.

**Table 4: Comparison of functional status with various fixative approaches**

Functional status	Fixation type			p value
	External fixation	K-wire fixation	Volar plating	
Grip strength				
Excellent	10	03	11	0.001
Good	01	08	03	
Fair	01	03	01	
Poor	00	01	00	
Stiffness				
Present	03	03	03	0.610
Absent	09	12	12	
Range of motion				
51-75%	01	02	01	0.364
76-100%	11	13	14	
Functional status				
Regular work	10	12	14	0.0128
Restricted work	01	01	01	
Not able to work	01	02	00	

After fixation, 93.33% cases managed with volar plating, 80% cases in K-wire fixation and 83.3% cases with external fixation were attending to regular works. Two cases in K wire fixation and 1 case in external fixation group showed difficulty in work (Table 4). The grip strength and functional status of fracture was statistically significant ( $p < 0.05$ ). In volar plating group, 3 cases reported wrist stiffness and 1 case showed infection. In external fixation, 2 cases reported wrist stiffness, 1 case each showed infection and radial sensory nerve deficit. In K-wire fixation, 3 cases showed wrist stiffness and 2 cases reported infection (Table 5).

**Tale 5: Post-operative complications among the study participants.**

Postoperative complications	Fixation methods		
	External fixation	K-wire fixation	Volar plating
No complications	08	12	12
Infection	01	02	01
Wrist stiffness	02	03	03
Radial sensory nerve deficit	01	00	00
Superficial nerve neuropraxia	00	00	00

## Discussion

Fractures to the distal end of radius are common upper extremity fractures and account for approximately 17% of all fractures [14, 15]. Multiple approaches like manipulation, plaster immobilization and operative intervention can achieve anatomical reduction of fracture [16]. Intra-articular fractures are usually high energy fractures frequent in young people [17]. This study was undertaken to evaluate the anatomical, functional and radiological outcome of closed intra articular fractures to distal radius managed with external fixation, K-wire fixation and volar plate. Majority cases were belonged age group 4<sup>th</sup> and 5<sup>th</sup> decade. Falling from height (50%) was common cause of fractures followed by road traffic accidents (45.24%) and due to assault (4.6%). The duration between injury and surgery was <5 days in 83.34% cases. Gill S *et al.*, in their study found majority cases between age group 4<sup>th</sup> (54.8%) and 5<sup>th</sup> decade (69.69%) and road traffic accidents was common cause of injury followed by fall on outstretched hand [18]. Pinnamaneni SR *et al.*, reported average duration from injury to surgery was 3.9 days [19].

In current study, functional outcome was assessed by Gartland and Werley score showed excellent and good outcome in 4 and 7 cases in external fixation group, 4

and 10 in K-wire fixation group and 03 and 10 volar plating group respectively. None of the cases reported poor functional outcome in three fixation techniques. The functional outcome between the different fixation techniques was statistically significant ( $p = 0.0312$ ) (Table 2). The Lindstrom and Frykman criteria used anatomical outcome assessment showed Grade I outcome in 11 cases managed with external fixation and K-wire fixation and in 12 cases managed with volar plating. Pinnamaneni SR *et al.*, reported excellent outcome in 60% and good in 35% cases treated with ORIF, 20% good results in external fixator group and 60% good result I K-wire fixation group (19). The anatomical outcome between study groups was statistically significant ( $p = 0.0246$ ). Xu GG *et al.*, assessed functional outcome by Gartland and Wertley scoring and reported ORIF was better than external fixation [20]. Sanjay R *et al.*, evaluated anatomical outcome using Sarmiento's modification of Lindstrom criteria found excellent outcome in ORIF group [21].

In current study, majority cases managed with external fixation (10 cases) and volar plating (11 cases) showed excellent grip strength. Whereas, K-wire fixation showed excellent grip strength in 3 cases, good strength in 8 cases and fair strength in 3

cases. Stiffness was observed in 3 cases commonly among three fixation methods. Majority cases showed 76-100% range of motion in three fixation groups. Gill S *et al.*, in their study reported pinsite infection (11.1%), wrist stiffness (11.1%), hand shoulder syndrome (3.7%) and superficial nerve neuropraxia (7.4%) in external fixation group, whereas in open reduction and internal fixation (ORIF) group infection in 6.06%, wrist stiffness in 9.09%, hand shoulder syndrome in 6.06% and superficial nerve neuropraxia in 9.09% [18]. A study by Shukla R *et al.*, assessed fracture outcome by Green and O'Brien score reported excellent or good outcome in 85.5% cases managed with external fixation and 73.3% cases managed with volar plating. Higher levels of pain were observed in external fixator group and no significant difference was observed between volar locking plate and external fixator at one year after surgery [22].

Gill S *et al.*, concluded that reduction and internal fixation with volar plate was better method than close reduction and external fixation in cases with intrarticular fracture to distal radius [18]. Xu GG *et al.*, found no significant difference in the outcome of intrarticular fracture managed with external fixation and ORIF [20]. Sanjay R *et al.*, stated that there is no standard treatment option for distal radius fractures. However, treatment depends on fracture type, patients demand, and surgeons choice and fracture characteristics [21]. A study by Kumbaraci M *et al.*, reported that volar locking plate method had better functional and radiological outcome than external fixation [23]. Anant S *et al.*, stated that cases with distal radial fractures managed with plating technique reported better functional outcome than external fixation in the radiological assessment [24]. A meta-analysis by Margaliot Z *et al.*, stated that there is no evidence to claim that ORIF is better than external fixation. However, external fixator group showed postoperative neuritis, infection, pin loosening and hardware failure [25]. Kapoor H *et al.*, stated that ORIF facilitate

better anatomical restoration, but should be avoided in severe comminuted fractures [26]. Vargaonkar G evaluated anatomical outcome by Sarmiento's modification of Lindstrom Criteria, and reported more frequent excellent outcome in plating groups than external fixation [27]. A meta-analysis by Gouk C *et al.*, reported that ORIF provide better range of motion than external fixation in long term. However, there is no significant difference in terms of grip strength, subjective functional outcome between ORIF and external fixation [28]. Shukla R *et al.*, reported that external fixation was superior than volar locking plate in terms of range of motion, grip strength and final outcome in cases with distal radius fractures [29]. Sharma A *et al.*, stated that volar locking plating had early recovery and mobilization over external fixation [30]. The current study findings were indicating that volar locking plate is superior to external fixation and K-wire fixation in terms of functional and anatomical outcomes.

## Conclusion

The volar plating, k-wire fixation and external fixation methods did not showed considerable difference in terms of grip strength, range of motion, return to work, functional and anatomical outcome. However, volar locking plating showed superiority in terms of radiological outcome and patient satisfaction than k-wire fixation and external fixation.

## References

1. Handoll HH, Vaghela MV, Madhok R. Percutaneous pinning for treating distal radial fractures in adults. Cochrane Database of Systematic Reviews. 2007;3.
2. Alluri RK, Hill JR, Ghiassi A. Distal radius fractures: approaches, indications, and techniques. The Journal of Hand Surgery. 2016 Aug 1;41(8):845-54.
3. Owen RA, Melton LJ 3rd, Johnson KA

- et al.* Incidence of Colles' fracture in a North American community. *Am J Public Health* 1982;72(6):605-7.
4. Lester GE, Anderson JJ, Tylavsky FA, Sutton WR, Stinnett SS, DeMasi RA, *et al.* Update on the use of distal radial bone density measurements in prediction of hip and Colles' fracture risk. *J Orthop Res* 1990; 8:220-6.
  5. Chandan K, Kumar R, Ranjan R, Amar R. Functional outcome of intra-articular fracture of distal end of radius treated by open reduction and internal fixation with locking distal radius system. *J Orthop Dis Traumatol* 2021;4:3-8
  6. Germaine GQ Xu, Siew Pang Chan, Mark Edward Puhaindran, Winston YC Chew. Prospective Randomised Study of Intra-Articular Fractures of the Distal Radius: Comparison Between External Fixation and Plate Fixation. *Ann Acad Med Singapore* 2009; 38:600-5.
  7. Kundu AK, Wale N, Phuljhele S, Ghritlahre D, Gurudatta HS. Intra articular distal radius fractures and volar plate fixation: A prospective study. *Int J Res Orthop* 2017; 3:589.
  8. McCamley C, Tamblyn P, Kimber C, Quinn S, Watts A. Fractures of Distal Radius: A randomized controlled Trial of 180 patients comparing volar locking plates and alternative fixation methods. *J orthop Trauma and Treatment* 2016;5(2):308.
  9. Beumer A, McQueen MM. Fractures of the distal radius in low-demand elderly patients: closed reduction of no value in 53 of 60 wrists. *Acta Orthop Scand.* 2003 Feb;74(1):98-100.
  10. Schnall SB, Kim BJ, Abramo A, Kopylov P. Fixation of distal radius fractures using a fragment-specific system. *Clin Orthop.* 2006; 445:51–57.
  11. Konstantinos CX, Dionysios AV, Konstantinos JK. Classifying fractures of the distal radius: impossible or unnecessary? Review of the literature and proposal of a grouping system. *MedSciMonit.* 2009;15(3):RA 67–RA74.
  12. Slutsky DJ. External fixation of distal radius fractures. *J Hand Surg Am.* 2007; 32:1624–1637.
  13. Chung KC, Watt AJ, Kotsis SV, Margaliot Z, Haase SC, Kim HM. Treatment of unstable distal radial fractures with the volar locking plating system. *J Bone Jt Surg Am.* 2006; 88:2687–2694.
  14. Nagi ON, Dhillon MS, Aggarwal S, Deogaonkar KJ. External fixators for intraarticular distal radius fractures. *Indian J Orthop* 2004; 38:19-22.
  15. Ark J, Jupiter JB. The rationale for precise management of distal radius fractures. *Orthop Clin North Am* 1993; 24:205-10.
  16. Stewart HD, Innes AR, Burke FD. Factors affecting the outcome of Colles' fracture: an anatomical and functional stud. *Injury.* 1985; 16:289–95.
  17. Meena S, Sharma P, Sambharia AK, Dawar A. Fractures of distal radius: An overview. *J Fam Med Primary Care* 2014; 3:325-32.
  18. Gill S, Raj M, Singh S, Rajpoot A, Mittal A, Yadav N. Intra-articular fracture distal end radius external fixation versus locking volar radius plate: A comparative study. *J Orthop Traumatol Rehabil* 2019; 11:31-43.
  19. Pinnamaneni SR, Padya S, Kumar PTVK. A prospective study of various methods of management of distal radius fractures. *J. Evolution Med. Dent. Sci.* 2016;5(77):5755-5758.
  20. Xu GG, Chan SP, Puhaindran ME, Chew WY. Prospective randomised study of intra-articular fractures of the distal radius: comparison between external fixation and plate fixation. *Ann Acad Med Singap.* 2009 Jul;38(7):600-6.
  21. Sanjay R, Aakash V, Menakuru SR, Ram KG. Retrospective study on management of the distal end of the radius fractures. *JPRI.* 2021;33(48B): 67-73.

22. Shukla R, Jain RK, Sharma NK, Kumar R. External fixation versus volar locking plate for displaced intra-articular distal radius fractures: a prospective randomized comparative study of the functional outcomes. *J Orthop Traumatol.* 2014 Dec;15(4):265-70.
23. Kumbaraci M, Kucuk L, Karapinar L, Kurt C, Coskunol E. Retrospective comparison of external fixation versus volar locking plate in the treatment of unstable intra-articular distal radius fractures. *Eur J Orthop Surg Traumatol* 2013;24(2):173–178.
24. Anant S, Agarwal S, Gupta S, Lal AK. External fixation versus plating in intra-articular distal end radius fractures. *Int J Res Orthop* 2019; 5:680-6.
25. Margaliot Z, Haase SC, Kitsis SV, *et al.* A metanalysis of outcomes of external fixation versus plate osteosynthesis for unstable distal radius fractures [J]. *J Hand Surg* 2005;30(6):1185-99.
26. Kapoor H, Agarwal A, Dhaon BK. Displaced intraarticular fractures of distal radius: a comparative evaluation of results following closed reduction, external fixation and open reduction and internal fixation [J]. *Injury* 2000;31(2):75-9.
27. Vargaonkar G. Distal end radius fractures: evaluation of results of various treatments and assessment of treatment choice. *Chin J Traumatol.* 2014;17(4):214-9.
28. Gouk C, Ng SK, Knight M, Bindra R, Thomas M. Long term outcomes of open reduction internal fixation versus external fixation of distal radius fractures: A meta-analysis. *Orthop Rev (Pavia).* 2019 Sep 24;11(3):7809.
29. Shukla R, Jain RK, Sharma NK, Kumar R. External fixation versus volar locking plate for displaced intra-articular distal radius fractures: a prospective randomized comparative study of the functional outcomes. *J Orthop Traumatol.* 2014 Dec;15(4):265-70.
30. Sharma A, Pathak S, Sandhu H, *et al.* (February 02, 2020) Prospective Randomized Study Comparing the External Fixator and Volar Locking Plate in Intraarticular Distal Radius Fractures: Which Is Better?. *Cureus* 12(2): e6849.