

## Original Research Article

# A retrospective analysis comparing functional and radiological outcomes after treatment of unstable distal radius fractures using volar locked plate versus percutaneous fixation

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### ABSTRACT

**Background:** Distal radius fractures are one of the most routinely encountered injuries in an orthopaedic setting. Despite the wide variety of treatment options available there is still debate about the optimal way to treat these fractures. The aim was to evaluate and compare functional and radiological outcomes of unstable distal radius fractures treated by either by using volar locking compression plating (VLP) or by using percutaneous fixation augmented by Kirschner (K) wires (EF).

**Methods:** A retrospective analysis was carried out on all cases of acute unstable unilateral fracture distal radius who were admitted between January 2015 and December 2017 and were treated either by VLP or EF. QuickDASH score and PRWE were documented at every follow up in OPD at 6 weeks, 6 months and 1 year post-op along with serial X-rays at immediate post-op and 01 year which were then compared.

**Results:** A total of 122 cases of fracture distal radius were selected for study which fulfilled the inclusion criteria out of which 49 were treated by VLP and 73 by EF. There was no statistical difference in QuickDASH, PRWE scores or wrist ROM between two groups at 1 year follow up. However VLP group was better in maintaining palmar tilt, radial length and inclination at the end of 1 year.

**Conclusions:** Both VLP and EF show comparable and predictable good outcomes in treating unstable distal radius fractures when measured in terms of ROM and clinically validated patient outcome scores at 01 year follow up with similar rate of complications.

**Keywords:** Distal radius, Volar locking plate, External fixation

### INTRODUCTION

Distal radius fractures are and remain one of the most common injuries treated by orthopaedic surgeons worldwide.<sup>1</sup> With increasing life expectancy and presuming that the world populace will continue to pursue an active lifestyle the incidence of these fractures will keep on rising globally.<sup>2</sup> Historically fractures were treated with manipulation and casting, with or without

Kirschner (K) wire fixation. However in contemporary times plating techniques have been advocated to restore anatomical alignment and allow early mobilization and have shown growing trend in their application especially in western hemisphere.<sup>3-6</sup> The benefits of early mobilization have recently been questioned and there is still remains an active debate as to the best way to manage these injuries.<sup>7,8</sup>

Recently, it has been stressed that fractures of the wrist should be treated on the same principles as any other fracture involving joint that is, by anatomical reconstruction, stable fixation and early function. Open reduction has become increasingly useful in reaching the goal of good reduction with advantages that include accurate restoration of bony anatomy, stable internal fixation, a decreased period of immobilization, and early return of wrist function. However the disadvantages are also numerous starting from surgical site infection, implant mal-positioning requiring repeat surgeries to tendon ruptures.<sup>9,10</sup> Recent RCT's have questioned the hypothesized benefits of better functional outcome following volar locking compression plating (VLP) especially after 1 to 2 yr. follow up in intra-articular fractures.<sup>11,12</sup>

The aim of this study was to evaluate and compare the functional outcomes of cases with fracture distal end radius treated either by open reduction and internal fixation using VLP (Peri-loc system Smith and Nephew Cordova USA) or modular bridging external fixation augmented by K wires (EF) (distal radius external fixation Pitkar, Pune India) treated in a single center on a skeletally mature population.

## METHODS

After obtaining clearance from local ethics committee, the study was retrospectively carried out on all the cases of acute fracture distal radius who were admitted at Military Hospital, Kirkee and were treated either by VLP or EF between January 2014 and December 2017.

The inclusion criteria for study were: intra-articular fractures, partial-articular fractures of distal radius with step or gap in the joint surface more >2 mm and/or instability due to metaphyseal comminution(AO/OTA type B &C); comminuted displaced extra articular fractures of distal radius especially osteoporotic unstable fractures (AO/OTA type A); recent fractures with failed close reduction and unsatisfactory check X-ray; and unilateral fractures and fractures not older 14 days in skeletally mature patients

The only type of distal radius fracture which was excluded from the study was AO/OTA B2 and B3 also known eponymously as Barton (volar/dorsal) fractures occurring due to shear type of injury. It was felt that these fractures would not be adequately reduced and held by closed reduction and external fixation thereby necessitating mandatory buttress plating.

Radiograph of both affected and unaffected wrist including forearm and hand in AP and lateral projection were taken. Fracture pattern, geometry and angulations were recorded with contralateral radiological parameters for comparison.

## Surgical technique

The patients were operated under general anesthesia/regional block at the discretion of the anaesthiologist. All the surgeries were performed by surgeons with minimum 5 years of experience in trauma surgery.

### Volar locking plate

For the VLP group fractures were exposed by modified volar Henry approach as described by AO under pneumatic tourniquet control in supine position with limb on a side arm trolley (Figures 1 and 2). A limited capsulotomy was done to look for articular congruity in intra-articular fracture. Post-operatively the operated limb was kept elevated for 48 to 72 hours and was monitored clinically for any neurovascular deficit. Broad spectrum antibiotics were administered intravenously for two to five days, active and passive shoulder, elbow, wrist, fingers movements were started from the day of surgery. Sutures were removed on 14th postoperative day in all cases.



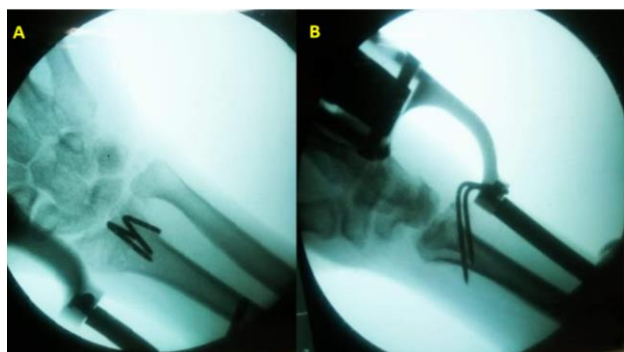
**Figure 1: Fracture fixation using volar locking plate.**



**Figure 2: Pre-op and post-op radiograph volar locking plate.**

### External fixation

In the EF group two 3.5 mm Schanz screws were inserted over the dorsolateral aspect of radius approximately 10 cm proximal to wrist, subsequently two 2.5 mm Schanz screws were introduced over 2nd metacarpal shaft with care taken to avoid extensor tendons of index finger. The rods and blocks were mounted and traction applied with reduction achieved under fluoroscopic guidance. Two or three 1.6/1.8 mm K wire were added to the construct which provided extra stability and support to the reduction. The k wires were not buried (Figure 3).



**Figure 3 (A and B): Post-op images external fixation.**

Protected use of limb was advised throughout the healing phase with finger movements allowed on postoperative

day 1, but contact sports and lifting heavy weights were prohibited. Supervised physiotherapy to regain movements of wrist, pronation and supination of the forearm were started immediately and consists of active movements. The external fixator was removed on 6th post op week on OPD basis. Patients were followed up clinically after a period of 06 weeks, following removal of sutures and later at 6 months and 1yr post op. Follow-up radiographs of the wrists were taken to assess reduction and bony union.

The mode of evaluation was both subjective and objective. Functional outcomes and patient reported results were documented at every follow up in ortho OPD at 6 weeks, 06 months and 01 year post op using criteria laid down by QuickDASH score and patient related wrist evaluation score (PRWE).<sup>13,14</sup>

### Statistical analysis

The baseline and demographic details of the both groups (Table 1) were analyzed by independent t test for normally distributed data and Mann Whitney U test for skewed data employing means and SD's or as frequencies and percentages. Both the groups were found to be comparable i.e., no statistically significant difference was found. The functional outcome results i.e., QuickDASH VAS and PRWE were analysed by independent t test whereas complications were compared using chi-square test.

**Table 1: Demographic details.**

Variable	VLP (n=49)	EF (n=73)
<b>Age at injury (years)</b>	49.28*	51.76
<b>Male/female (%)</b>	22/27 (45/55)	32/41 (44/56)
<b>Type of fractures</b>		
A1	8	5
A2	8	10
A3	10	15
B1	8	18
C1	6	11
C2	6	10
C3	3	4
<b>Injury dominant hand N (%)</b>	18 (36.7)	39 (53.4)
<b>Mechanism of injury N (%)</b>		
Low energy trauma	27 (55.1)	36 (49.3)
High energy trauma	22 (44.9)	37 (50.7)
<b>Occupation N (%)</b>		
Office work	6 (12.2)	8 (11)
Manual labourer	11 (22.4)	15 (20.5)
Retired	7 (14.3)	14 (19.2)
Soldier	13 (26.5)	25 (34.2)
HM	12 (24.5)	11 (15.1)
<b>Closed reduction prior to surgery N (%)</b>	12/49 (24.5)	35/73 (47.9)
<b>Time until surgery</b>	3.08* (2.37 <sup>#</sup> )	3.63* (2.33 <sup>#</sup> )

\*Mean; # S.D.

## RESULTS

A total of 191 cases of fracture distal radius were operated during the period from January 2015 to December 2017. Out of which 179 cases were selected for study which fulfilled the inclusion criteria. Data of these patients was retrieved from hospital records and was analyzed. In the EF group the mean age was 51.76 years whereas in VLP the mean age was 49.28 years. Majority of patients sustained fractures due to high energy trauma (47%) which included RTA, fall from height, contact sports, the rest were due to low energy trauma which included domestic falls. The mean time interval between injury and surgery was 3.63days.

All fractures were classified according to AO/OTA's classification. 66cases were simple extra-articular (AO type A), 26 were partial-articular (AO/OTA type B), and the rest 40 cases were articular fractures. There were a total 3 open fractures (Gustilo's type 1). None of the

patients required Bone grafting. The operating time ranged from 25 minutes to 65 minutes.

### Radiological evaluation

Reduction was deemed satisfactory if the following criteria were met: Dorsal tilt less than  $<10^\circ$ , an intraarticular gap or step  $<2$  mm and radial shortening  $<3$  mm.

There was no significant difference in the number of satisfactory reductions in both groups ( $p=0.089$ ).<sup>15,16</sup>

After analysis of X rays at immediate post-op and 1 year follow up it was noted that there was a significant difference between the two groups with regards to maintenance of reduction. The VLP group in comparison had better radial length ( $p=0.04$ ), volar tilt ( $p=0.03$ ) and radial inclination ( $p=0.03$ ) at the most recent follow-up (Table 2).

**Table 2: Radiographic results in VLP and EF.**

Variable	VLP (n=49)		EF (n=73)		P value
	Mean	SD	Mean	SD	
<b>Prior to reduction</b>					
Volar tilt ( $^\circ$ )	-20.326	3.35651	-19.876	3.26150	0.462
Radial length (mm)	3.9592	2.07122	4.1233	1.97164	0.660
Radial inclination ( $^\circ$ )	8.7347	3.52831	8.4521	3.41582	0.659
Intraarticular step (mm)	1.7347	2.74451	1.6712	2.71853	0.9
Intraarticular gap (mm)	2.2041	3.38489	1.9863	3.16005	0.784
<b>Immediate post-operative</b>					
Volar tilt ( $^\circ$ )	6.6531	2.51289	8.9589	1.76728	0.040
Radial length (mm)	9.3061	1.93869	10.8082	1.46873	0.020
Radial inclination ( $^\circ$ )	18.1633	3.05742	21.1507	1.87581	0.003
Intraarticular step (mm)	0.5918	0.81441	0.0000	0.0000	0.811
Intraarticular gap (mm)	0.3878	0.63954	8.9589	1.76728	0.244
<b>At 1yr follow up</b>					
Volar tilt ( $^\circ$ )	4.4694	2.59087	6.6575	2.80485	0.003
Radial length (mm)	8.9184	2.09002	6.9726	3.02054	0.004
Radial inclination ( $^\circ$ )	17.5306	3.13649	17.9589	3.06612	0.030
Intraarticular gap (mm)	0.3673	0.66752	0.4384	0.72622	0.624
Intraarticular gap (mm)	4.4694	2.59087	6.6575	2.80485	0.023

### Clinical outcomes

#### Functional scoring

Present study has used QuickDASH, visual analog score and PRWE for evaluation of results. The VLP group failed to demonstrate any superiority over EF when mean QuickDASH scores, VAS & PRWE scores at all follow-ups were statistically analysed (Table 3).

#### Range of motion

As enumerated in the Table 4, both in VLP & EF group patient's ROM improved in all successive follow-ups which were done at 06 weeks, 06 months and 1year. However there was no statistical difference between the

two groups. Nonetheless there remained residual restriction of ROM even at 01 year follow-up when compared to the uninjured site

### Complications

A total of 15 major complications and 21 minor complications occurred (Table 5). There was no significant statistical difference between the two groups with respect to both minor and major complications. However the EF group tended to have an increased number of minor complications and the prevalence of CRPS was higher as compared to VLP. The VLP group in turn had higher number of major complications like implant removal and SSI.



**Table 3: Patient reported outcome measures at all follow up evaluation in VLP and EF groups.**

Outcome measures	Mean (SD)		P value
	VLP (n=49)	EF (n=73)	
<b>QuickDASH score</b>			
6 weeks	71.3918 (3.5279)	71.2726 (3.3703)	0.851
6 months	57.3551 (10.0618)	56.8410 (10.8974)	0.847
1 year	24.8061 (4.6903)	25.0847 (4.5391)	0.744
<b>VAS</b>			
6 weeks	3.8163 (1.2528)	3.9589 (1.2520)	0.539
6 months	2.4897 (1.043)	2.6027 (1.1022)	0.61
1 year	1.8125 (0.9375)	1.9166 (0.9893)	0.529
<b>PRWE score</b>			
6 weeks	32.326 (8.837)	29.753 (7.536)	0.169
6 months	60.775 (10.484)	58.014 (8.153)	0.23
1 year	85.775 (6.783)	86.219 (7.036)	0.730

**Table 4: Functional outcomes of all follow-up evaluations in VLP and EF groups.**

Range of motion (in degrees)	VLP (n=49)		EF (n=73)		P value
	Mean (SD)	% Uninjured wrist	Mean (SD)	% Uninjured wrist	
<b>6 weeks</b>					
Flexion	20.61 (9.05)	22.902	20.68 (8.90)	22.98	*0.9369
Extension	22.65 (7.84)	25.169	23.15 (8.31)	25.72	*0.7666
Pronation	54.08 (10.39)	64.53	54.10 (11.40)	60.12	0.989
Supination	53.06 (10.6)	58.95	52.32 (11.48)	58.14	0.723
<b>6 months</b>					
Flexion	26.32 (9.28)	29.25137	26.712 (9.86)	29.68004	*0.874
Extension	28.97 (8.71)	32.19912	29.72 (9.57)	33.02856	*0.704
Pronation	59.79 (9.23)	66.43922	59.72 (9.85)	66.36156	0.969
Supination	26.32 (9.28)	29.25137	26.712 (9.86)	29.68004	*0.874
<b>1 year follow up</b>					
Flexion	42.24 (10.05)	46.93820	42.73 (10.30)	47.48808	*0.8086
Extension	50 (14.57)	55.55500	47.67 (15.32)	52.96747	0.403
Pronation	66.73 (9.44)	74.14881	65.75 (9.70)	73.05860	0.581
Supination	68.97 (8.95)	76.64312	68.63 (9.619)	76.25490	0.840

**Table 5: Total registered complications at 1 year follow up.**

Complications	VLP (n=49)		EF (n=73)	
	No.	%	No.	%
<b>Major complications</b>				
Implant malposition leading to repeat surgery	2	4.08	0	0
Suboptimal osteosynthesis leading to repeat surgery	1	2.04	2	2.73
CRPS	2	4.08	4	5.47
Deep SSI	1	2.04	0	0
Carpal tunnel syndrome	1	2.04	0	0
Tendon ruptured	1	2.04	0	0
Nerve injury	1	2.04	0	0
Total	9	18.36	6	8.21
<b>Minor complications</b>				
Pin track infection/superficial SSI	2	4.08	8	10.95
Transient nerve dysfunction	2	4.08	4	5.48
Loosening EF	2	4.08	0	0

Continued.

Complications	VLP (n=49)		EF (n=73)	
	No.	%	No.	%
Scar adhesions	3	6.12	0	0
Total	9	18.36	12	16.4376

## DISCUSSION

Complex articular fractures of the distal radius represent an ever increasing challenge for surgeons and burdens growing demand for the design of innovative surgical implants and techniques which include fragment specific plates and arthroscopy assisted surgery. There is an extensive work to show that locked volar plates are well tolerated, allow early movement and maintain position even for intra-articular fractures.<sup>17,18</sup>

The various methods to treat this fracture have in the past failed to meet clinical expectations hence the progression from simple manipulation and casting, through pin and plaster, K wiring, external fixation and now ORIF,<sup>8,19-22</sup> The results of treatment in plaster with manipulation from Bacorn demonstrated poor results associated with poor reduction.<sup>20,23</sup> McQueen demonstrated poor results of plaster immobilization in elderly patients with late collapse of the fracture after the period of immobilization had ended.<sup>24</sup>

External fixation with or without K wire augmentation has remained unpopular due to increased risk of CRPS which occurs primarily due to over distraction and poor patient compliance owing to the cumbersome nature of the construct.

All these above mentioned factors influenced an increasing trend of VLP being used to treat distal radius fractures especially in western world during recent times.<sup>23,24</sup> The initial studies did show locking plate as a better choice of implant as compared to other traditional methods of treatment. However these reports being case series or nonrandomized comparative studies lacked sufficient level of evidence.<sup>7,25-27</sup> The minimum age in our series was 19 yrs. and maximum was 71 yrs. with a mean age of 50 yrs. Nevertheless, we recognize that patients are actively selected for this surgical intervention based on patient and fracture characteristics.

Open reduction is not without its problems and complications have been reported. Tendon irritation intra-articular screw placement and infection have all been implicated.<sup>28,29</sup> Our study shows major complication rate of 12.2% (15/122) and a minor complication rate 17.21% (21/122) which is comparable to other recent reports in the literature (Table 5).<sup>7,15,30</sup> Clearly not every fracture of the distal radius should be operated on; a decision must be taken based on the degree of displacement or deformity and the functional level of the patient. This study demonstrates that a good radiological and clinical outcome can be achieved in both groups with no difference in either ROM or validated patient related

outcome scores like QuickDASH which was similarly reflected in other studies.<sup>15</sup> However hammer et al and other studies showed significant difference in QuickDASH scores in their report at 1year follow-up which contradicts our result.<sup>15,30,31</sup> The radiological outcome after 01 year follow up shows better maintenance of palmar tilt, radial length and inclination in VLP group which is substantiated by other studies.

Previous work has shown that patients achieve most of their improvement in range of movement and grip strength by 6 months although they may continue to improve up to around 24 months.<sup>32,33</sup> None of our patients suffered any extensor tendon or flexor pollicis longus rupture although we had 02 cases of extensor pollicis tendinitis one of which was managed conservatively and one required implant removal. These complications are well described and we believe care should be taken intra-operatively to ensure that the dorsal cortex is reached but not penetrated by the distal locking screws and the pronator quadratus is laid back over the metalwork, tacking it into place where possible.<sup>28,29,34,35</sup> Both extensor tendon and flexor pollicis longus rupture have been reported late in the literature and should be vigilantly looked for.<sup>29</sup> Our patients are routinely followed up with physiotherapy and subsequently asked to return to clinic should they have any further problems. Cost analysis of both procedure should be given due significance especially in our healthcare setting which is completely state sponsored. Shyamalan et al observed VLP costing nearly 400% more than K wire as per NHS tariff.<sup>36</sup>

Our study has several limitations, the first being that it is a retrospective nonrandomized comparative study from a single center. The cases which were included in the study were consecutive presentations and the decision to treat either with VLP or EF was taken by the treating surgeon on a case by case basis which will inevitably lead to a selection bias. Both the groups have a wide distribution with respect to the type of fractures included and patient's age which ranged from osteoporotic fractures in the elderly to fractures in the young resulting from high energy trauma with additional soft tissue injuries. Despite this our results are encouraging and add to the growing body of evidence in comparing both the modalities of fixation in these fractures.

## CONCLUSION

Both VLP and EF show comparable and predictable good outcomes in treating unstable distal radius fractures when measured in terms of ROM and clinically validated patient outcome scores like QuickDASH and PRWE till 1 year follow up. EF should be an indispensable part of our armamentarium while treating these fractures. Further

studies need to be done regarding cost analysis and prevalence of late complications like radio carpal arthritis between these two groups.

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