

## VOLAR LCP IN TREATMENT OF INTRA-ARTICULAR FRACTURES OF DISTAL END OF RADIUS

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### Abstract

**Background:** Distal end radius fractures are among the most common fractures of upper limb. Distal end radius fractures account for approximately 1/6th (16%) of all fractures and treated in emergency rooms. Reduction and stabilization of intra-articular distal end radius fractures is challenging in these injuries. Volar locking plate is an increasingly popular choice for distal radial fractures, owing to its wider availability and reliability of the locking technology adapted to the wrist. Volar locking plate fixation has been demonstrated to restore radiographic parameters within accepted standards. **Materials and Methods:** A descriptive prospective hospital based study was conducted at Department of Orthopaedics, Shaheed Hasan Khan Mewati Government Medical College (SHKM GMC), Nalhar, Nuh, Haryana among the adult population coming to SHKM, GMC with intra-articular distal end radius fracture. The study was carried out for a period of 18 months from June 2020 to December 2021 after approval was obtained from Institutional Ethics Committee. All patients between 18-60 years of age with closed, type III to type VIII Frykman type intra articular fractures of distal end radius with indication of surgery as the main treatment were included in the study while compound fractures, extra articular fractures and with other forearm and hand injuries were excluded from the study. **Result:** There were 72.5% males and 27.5% females among study population. Left side was affected among 14 (35.0%) and Right side among 26 (65.0%) subjects. The mode of injury was Fall among 11 (27.5%) and Road traffic accident injury among 29 (72.5%) subjects. Gartland and Werley's Demerit point system score increased significantly from 6 weeks to 3 months to 6 months to 9 months. There was Excellent outcome among 13 (32.5%), Good among 18 (45.0%), Fair among 8 (20.0%) and Poor among 1 (2.5%) subjects. **Conclusion:** Volar plating has relatively better outcome for distal end fractures of radius, particularly volar Barton fractures. Open reduction with volar locked plates accompanied with early physiotherapy provide better function and stability because of stable construct and reduce chances of complications. The present study documents 77.5% excellent to good functional results which suggests that stabilizing the fracture fragments with volar plate and screws in the management of the fractures of distal radius, is an effective method to maintain the reduction till union and prevent collapse of the fracture fragments.

## INTRODUCTION

Distal end radius fractures are among the most common fractures of the upper limb. Distal end radius fractures account for approximately 1/6th (16%) of all fractures treated in emergency rooms.<sup>[1-3]</sup> These fractures are prevalent nowadays, and the incidence is increasing in younger individuals too. The prevalence in men aged 35 years and above is 90/1lac per year and in females older than 40 years, it is 1150/1lac per year.<sup>[4,5]</sup>

Fall onto an outstretched hand with the wrist in dorsiflexion is the most common mechanism of injury. The definitive history of fractures distal end radius begins with a fall from a height, a road traffic accident or a history of athletic participation. Low energy mechanism such as falls from a standing height may be the cause in elderly individuals. Distal radius fractures with the high energy mechanism are often associated with poor results and higher complications.

Many management options for distal end radius fractures have been proposed and tested, including closed reduction with radial slab, cast, volar plating, external fixation, percutaneous pinning and dorsal plating. Non-surgical treatment remains the main line of management in extra-articular fractures. Factors affecting the treatment include fracture pattern, local factors like energy of the injury, bone quality, soft tissue injury and comminution and patient factors including age, hand dominance, associated injuries and other medical conditions.<sup>[10-13]</sup>

Volar locking plate is an increasingly popular choice for distal radial fractures, owing to its wider availability and reliability of the locking technology adapted to the wrist.<sup>[1]</sup> The ability to keep the plate behind the watershed line reduces the incidence of tendon irritation and the anatomical design of the plate aids fracture reduction.<sup>[14]</sup> The Distal volar radius plate system is direct and easy to operate, allowing patients to regain wrist movement quickly.<sup>[15]</sup> Numerous studies have confirmed the importance of restoring and maintaining anatomic alignment for optimal functional outcomes,<sup>[16-20]</sup> and preventing residual articular incongruence, which is associated with the development of post-traumatic arthritis.<sup>[20,21]</sup> Volar locking plate fixation has been demonstrated to restore radiographic parameters within accepted standards.<sup>[22-24]</sup> The current study aimed to assess the functional outcome of intra-articular distal radius fractures managed with a distal radius volar locking compression plate.

## MATERIALS AND METHODS

A descriptive prospective Hospital based study was conducted at Department of Orthopaedics, Shaheed Hasan Khan Mewati Government Medical College (SHKM GMC), Nalhar, Nuh, Haryana among the adult population coming to SHKM, GMC with intra-articular distal end radius fracture. The study was carried out for a period of 18 months from June 2020 to December 2021 after approval was obtained from Institutional Ethics Committee. All patients between 18-60 years of age with closed, type III to type VIII Frykman type intra articular fractures of distal end radius with indication of surgery as the main treatment were included in the study while compound fractures, extra articular fractures and with other forearm and hand injuries were excluded from the study. All the patients eligible for the study were enrolled consecutively using non-random convenience sampling technique till the desired sample was reached. A total of 40 patients were included in the study after receiving written informed consent from the study participants. Once the patients were admitted with forearm injury, thorough history was taken to assess the force and nature of violence, mode of injury, co-morbid illness history of previous surgeries and to rule out head injury or other system involvement. Thorough general examination and evaluation was done of the patient as a whole and the limb in specific survey was done. In case of

polytrauma due to road traffic accident, complete skeletal survey including the clavicle, chest, whole spine, pelvis and all long bones was done, otherwise wrist x-ray alone were ordered. Systemic examination of cardiac, respiratory, abdominal, and neurological functions was done. The upper limb was surveyed for the injuries, to assess the skin condition, neurovascular status, clinical signs of fracture and its displacement with deformity. Radial and ulnar artery pulses were checked and compared with other hand. Peripheral Nerve Examination was carried out with particular importance to Median nerve considering its proximity to fracture in volar compartment of forearm. This explains its propensity to cause compartment syndrome. All those patients who belonged to our inclusion criteria were subjected to further radiological evaluation. The involved extremity was immobilized in below elbow POP slab and kept elevated. Pain and inflammation were managed by using analgesics and NSAIDS. Routine investigations were done to obtain anaesthetic fitness, in this Pandemic time, pre operative Covid-19 RTPCR test were done. All our patients were Covid-19 negative. Radiographic imaging is important in diagnosis, classification, treatment, and follow-up assessment of these fractures. Radiographic evaluation of the affected was done at time of hospitalization with antero-posterior and lateral views and the fractures classified according to Frykman Classification (Table 1). Frykman published a simple and useful classification system based on the involvement of radiocarpal and radioulnar joint associated with or without ulnar styloid fractures.

**Table 1: FRYKMANN CLASSIFICATION**

Type I	Extraarticular fracture
Type II	Extraarticular fracture plus ulnar styloid fracture
Type III	Radio carpal articular involvement
Type IV	Radiocarpal involvement plus ulna styloid fracture
Type V	Radioulnar involvement
Type VI	Radioulnar involvement plus ulnar styloid fracture
Type VII	Radioulnar and Radiocarpal involvement
Type VIII	Radioulnar and radiocarpal involvement plus ulnar styloid fracture

After the radiographic evaluation, all the patients having type III to type VIII fractures were included for which Open reduction and internal fixation with volar buttress plate was done after explaining the Treatment modality to the patients and family including procedure, expected outcome and complications. Rest pre surgical procedures were followed as per standard methods.

### Surgical Technique

After regional anesthesia and part preparation, tourniquet inflated before incision. The standard volar approach named modified Henry Approach (FCR approach) was used to address the distal radius fragments. Longitudinal incision was made overlying the tendon of flexor carpi radialis. Plane is developed

between radial artery radially and the flexor carpi radialis ulnarly to expose the pronator quadratus muscle. The pronator quadratus muscle was divided to expose the underlying volar aspect of distal radius. At this point, fracture site was exposed and reduced. Appropriate distal volar plate was applied over the fracture site and fixed with the help of appropriate screw size (Figure 1). Implants used in all patients were of Indian manufacturers. All patients were followed up at 6 weeks, 12 weeks, 24 weeks & 9 months. The collected data was entered into the Microsoft excel and the statistical analysis was performed by statistical software SPSS version 21.0. The Quantitative (Numerical variables) were present in the form of mean and SD and the Qualitative (Categorical variables) were present in the form of frequency and percentage. The repeated measures ANOVA test was used for comparing the mean values between different time intervals. The p-value was considered to be significant when less than 0.05.



**Figure 1: Surgical technique. A: Position of Limb, B: Incision, C: Exposed Fracture Site and D: Fixed distal volar radius plate.**

Post operative care: Range of motion exercises started at 3rd post-operative day. Suture removal done at 14th day. All patients went through standard physiotherapy and rehabilitation. Follow-up was done at 6 weeks, 12 weeks, 24 weeks & 9 months. Functional follow up was done according to Gartland and Werley's demerit point system. [Ref.]

## RESULTS

Findings of 40 patients were included in the results. Table 3 describes the socio-demographic details of the study patients. Majority of the subjects belonged to 41-50 years (50.0%) followed by 31-40 years (27.5%), > 50 years (15.0%) and 21-30 years (7.5%). The mean age of the study population was  $42.98 \pm 8.31$  (range = 25-59) years. There were 29 (72.5%) males and 11 (27.5%) females. [Table 3] [Table 4] describes injury profile of the study participants. Left side was affected among 14 (35.0%) and Right side among 26 (65.0%) subjects. The mode of injury was Fall among 11 (27.5%) and Road traffic accident injury among 29 (72.5%) subjects. Associated injury occurred among 32.5% subjects. In our study 6 patients had metatarsal fractures, 3 patients had fracture both bone leg, 2 patients had femur fracture, 2 patients had patella fracture. Maximum subjects reported with Frykman type IV and VII (22.5% each). Residual deformity showed that Prominent ulnar styloid among 18 (45.0%), Residual dorsal tilt among 8 (20.0%) and Radial deviation of hand among 2 (5.0%) subjects. Subjective evaluation showed Excellent outcome 9 (22.5%), Good among 13 (32.5%), Fair among 12 (30.0%) and Poor among 6 (15.0%). Objective evaluation showed Loss of Palmar flexion (< 300) and Loss of Radial deviation (< 150) among 4 each (10.0% each), Loss pronation (<500) among 4 (10.0%), Loss of ulnar deviation (< 150) among 6 (15.0%) and Loss of dorsiflexion (< 450) among 2 (5.0%) subjects. There was minimum arthritic change among 10 (25.0%), Moderate change among 6 (15.0%), Moderate with pain among 7 (17.5%) and Severe among 1 (2.5%).

**Table 2: 2: Gartland and Werley's Demerit point system**

Criteria	Points
Residual Deformity (0-3) Prominent ulnar styloid Residual dorsal tilt Radial head deviation	1 2 2-3
B. Subjective evaluation (0-6) Excellent: No pain, disability, limitation of motion Good: Occasional pain, slight limitation of motion, no disability Fair: Occasional pain, some limitation of motion, feeling of weakness in wrist. Poor: Pain, limitation of motion, disability, activities restricted	0 2 4 6
C. Objective evaluation (0-5) Loss of dorsiflexion (<450) Loss of Ulnar deviation (<150) Loss of supination (<500) Loss of palmar flexion (<300) Loss of radial deviation (<150) Loss of circumduction Pain in distal radio-ulnar joint Grip Strength-60% less of opposite side	5 3 2 1 1 1 1 1 1

Loss of pronation (<500)	2
D. Complications (0-5)	
Arthritic change:	
Minimum	1
Minimum with pain	3
Moderate	2
Moderate with pain	4
Severe	3
Severe with pain	5
Nerve(median) complications	1-3 1-2
Poor function due to cast	
Final Results	Total Points range
Excellent	0-2
Good	3-8
Fair	9-20
Poor	21 and above

**Table 3: Socio-demographic distribution of study participants (N=50)**

Variables		Frequency	Percent
Age groups	18-30 years	3	7.5%
	31-40 years	11	27.5%
	41-50 years	20	50.0%
	50-60 years	6	15.0%
Gender	Male	29	72.5%
	Female	11	27.5%

**Table 4: Distribution of study participants according to the factors related to injury and the surgical outcomes**

Variables		Frequency	Percent	
Side of Injury	Left	14	35.0%	
	Right	26	65.0%	
Mode of Injury	Fall	11	27.5%	
	RTA	29	72.5%	
Associated injury	Absent	27	67.5%	
	Present	13	32.5%	
Frykman classification	III	8	20%	
	IV	9	22.5%	
	V	6	15%	
	VI	6	15%	
	VII	9	22.5%	
	VIII	2	5%	
	Residual deformity	No	12	30.0%
		Prominent ulnar styloid	18	45.0%
Residual dorsal tilt		8	20.0%	
Radial deviation of hand		2	5.0%	
subjective evaluation of pain*	Excellent	9	22.5%	
	Good	13	32.5%	
	Fair	12	30.0%	
	Poor	6	15.0%	
Functional assessment of range of motion at wrist joint *	No Restriction	20	50.0%	
	Loss of Palmar flexion (< 300)	4	10.0%	
	Loss of Radial deviation (< 150)	4	10.0%	
	Loss pronation (<500)	4	10.0%	
	Loss of ulnar deviation (< 150)	6	15.0%	
	Loss of dorsiflexion (< 450)	2	5.0%	
Complications*	None	16	40.0%	
	Minimum Arthritic change	10	25.0%	
	Moderate Arthritic change	6	15.0%	
	Moderate Arthritic change with pain	7	17.5%	
	Severe Arthritic change	1	2.5%	
Functional outcomes *	Excellent	13	32.5%	
	Good	18	45.0%	
	Fair	8	20.0%	
	Poor	1	2.5%	
Other complications	Stiffness	20	50.0%	
	Superficial infections	2	5.0%	
	Malunion	1	2.5%	
	Non-union	1	2.5%	

\*Using the Gartland and Werley's Demerit point system

Gartland and Werley's Demerit point system score increased significantly from 6 weeks to 3 months to

6 months and further to 9 months and was found to statistically significant (p=0.001). There was

Excellent outcome among 13 (32.5%), Good among 18 (45.0%), Fair among 8(20.0%) and Poor among 1 (2.5%) subject. The complications reported were Stiffness among 20 (50%), Superficial infections among 2 (5.0%), Malunion and Non-union among 1 (2.5%) subject each.

## DISCUSSION

Distal radius fractures are one of the commonest injuries presenting in orthopedic emergency. Although severe articular fractures account for less than 5% of distal radius fractures, they are the most challenging to treat. There remains debate about the effect of articular incongruity on the eventual outcome of these fractures but it is still recommended that intra-articular fractures with articular displacement of more than 2 mm in fit, active patients require surgical treatment. Despite the lack of evidence, there has been a large shift in the treatment of unstable intra-articular distal radius fractures toward the use of the volar locking plates, especially among younger orthopedic surgeons.<sup>[56]</sup>

In our study, majority of the subjects belonged to 41-50 years (50.0%) with the mean age of the study population as  $42.98 \pm 8.31$  years which was found similar to other studies which reported mean age between 42 to 48 years.<sup>[59,67,69,48]</sup> In our study, majority were males which is in line with another study,<sup>[59]</sup> while others report a higher percentage of females in their studies.<sup>[70-72]</sup> In present study, Right side was involved in about one third of the participants which is in line with other studies,<sup>[60,66]</sup> although both of them have inferred that statistically there was no significance of side involvement in the study. In current study, more than half of these injuries were caused due to Road traffic accidents. In line with our study, other studies also reported the most common cause of such injuries as road traffic accidents and second being falls.<sup>[59,67-69]</sup> Around one third of the participants in our study also suffered associate injuries aside from the radial fractures similar to other studies.<sup>[73,74]</sup> Contrastingly, two other studies reported smaller prevalence of associated injuries.<sup>[55,59]</sup>

Volar plate fixation with fixed-angle locking screws for the operative treatment of unstable intra-articular distal radius fractures has generally produced acceptable outcomes with respect to both functional and radiographic parameters.<sup>[55]</sup> Certain studies have found loss of reduction at short-term follow-up using fixed angle volar plates.<sup>[15,23,75,76]</sup>

Khan et al,<sup>[55]</sup> stated that the volar locking plate group had a significantly better restoration of radial length, radial inclination, and volar angle with significant P value and also at the final follow-up the radiological reconstruction was significantly better in the volar plate group as compared to the K-wire and cast application group. Other studies compared the Radiographic results and inferred that the post-treatment radiographic evaluation of distal radius

fractures is significantly better in patients treated by open reduction and internal fixation using a volar plate compared to those treated with manipulation and K-wire fixation.<sup>[77]</sup>

Several reports have shown that the effect of DVR on the anatomical structure and wrist function was satisfactory after the operation based on a 3-month follow-up.<sup>[78,79]</sup> For fractures far from the distal radius watershed, many researchers tend to use an external fixation device for fixation, as they believe that it is difficult to fix the plate effectively. However, Jorge Mora et al,<sup>[80]</sup> reported that the occurrence of complications from an external fixation device is significantly higher than that from the DVR system. The placement of a DVR plate is simple, leading to increased accuracy and decreased operation time.<sup>[75]</sup> The various studies conducted on therapeutic effects of volar anatomical plates versus locking plates for volar Barton's fractures evaluated wrist according to Sarmiento et al.'s<sup>35</sup> modification of the Gartland and Werley<sup>17</sup> system, and the results showed an excellent and good rate of 75% in the anatomic plate group and 94.1% in the locking plate group, similar to those reported in the literature.

In our study, Gartland and Werley's Demerit point system score increased significantly from 6 weeks to 3 months to 6 months to 9 months. As per Gartland and Werley's Demerit point system, there was fair outcome in almost half of the patients followed by excellent outcome while poor outcome among only 2.5% subjects which is in line with other studies showing higher range of outcomes in majority of the patients [59,64, Suthar and Patel].

In current study, the complications reported were Stiffness among half of the patients but none had any functional disability in daily activities while another study reports a very lower prevalence of complications treated with the variable-angle locking system.<sup>[83]</sup> The higher proportion of complications in our study could be contributed to lack of provision of post-operative physiotherapy.

Previous studies suggest that it is safe to mobilize wrists immediately after fixation with a volar locking plate which is due to the fact that the threaded locking screws and locking plate can provide an internal-external fixator, which acts as a single unit to support and hold the bone. This is particularly important in osteoporotic bone and in very comminuted fractures.<sup>[80]</sup>

**Limitations of our study:** Sample was not Homogenous. Sample size of our study is limited to one centre and is small. So, generalization cannot be made to a larger population.

Hence, we conclude that Volar plating has relatively better outcome for distal end fractures of radius, particularly volar Barton fractures, with minimum chance of loosening of implant. In unstable intra-articular distal radius fractures open reduction with volar locked plates accompanied with early physiotherapy provide better function and stability because of stable construct and reduces chances of complications. This technique has minimal

complications thus proving that it is the prime modality of treatment for distal radius fractures. In spite of prominent ulnar styloid either due to radial collapse or non-union, the functional results of fracture end radius managed by volar plating are acceptable. We recommend the use of volar locking plate system in intra-articular distal end radius fractures especially in fit and active patients.



**Figure 2: Patient 45 years/male with intra-articular distal end radius fracture following road traffic accident. A: Pre-operative X-Ray of right wrist showing intra-articular distal end radius fracture (AP/Lateral views) (Frykman type- VII), B: Pre-operative fluoroscopic photographs showing intra-articular distal end radius fracture (Right) (AP/Lat.view), C: Peri-operative fluoroscopic view showing fracture fixed with distal volar radius plate and D: Post-operative radiographs of Right wrist (Oblique/lateral/AP view).**



**E: Patient Follow-Up at 9 months**

## CONCLUSION

Volar plating has relatively better outcome for distal end fractures of radius, particularly volar Barton fractures. Open reduction with volar locked plates accompanied with early physiotherapy provide better function and stability because of stable construct and reduce chances of complications. The present study documents 77.5% excellent to good functional results which suggests that stabilizing the fracture fragments with volar plate and screws in the management of the fractures of distal radius, is an effective method to maintain the reduction till union and prevent collapse of the fracture fragments.

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