

## Evaluation of the Results of Volar Plating in the Treatment of Fractures of Distal End Radius

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### Abstract

**Background:** Fractures of lower end radius are most common fractures of the upper extremity. Increased awareness of the complexity of the distal end radius fractures have stimulated a growing interest and promoted new ideas regarding their management. Close reduction and cast immobilization had been the mainstay of treatment of these fractures but poor functional and cosmetic results are not uncommon. The volar plate system has been shown to be reliable for the fixation of distal radius fractures. As open reduction and volar plating ensures more consistent correction of displacement and maintenance of reduction, this prospective study evaluates the anatomical and functional outcome of open reduction and plate fixation in the management of fracture distal end radius.

**Method:** In this study 40 patients with distal end radius fractures were included, informed consent was and clearance from ethical committee of the institute was taken. The study was Prospective, interventional and observational for the methods used for management of the fracture. Patients were evaluated pre operatively and post operatively at the end of first, fourth, sixth week, 3 months and then once in 3 months up to 12 months.

**Results:** In the prospective study conducted with forty patients, 88% anatomical and 93% functional, excellent to good results 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, even when the fracture is grossly comminuted / intra-articular / unstable and / or the bone is osteoporotic.

**Conclusion:** This study concludes that open reduction and internal fixation with volar plating has excellent functional outcome with minimal complications. The procedure is applicable for all types of Frykman fractures in young patients with a good bone stock as well as in elderly osteoporotic patients.

**Keywords:** Volar Plating, Distal Radius Fractures, distal end radius.

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### Introduction

Distal radius fractures remain an injury that fosters considerable interest and debate. Interest in distal radius fractures stems not only from its high incidence but also from developing understanding of outcome

variables and influence of technology in evaluation and treatment.

Distal radial fractures have a bimodal age distribution, consisting of a younger group who sustains relatively high-energy trauma

to the upper extremity and an elderly group who sustains both high-energy injuries and insufficiency fractures.

Following a distal radial fracture, the attainment and maintenance of anatomical reduction of the articular surface is crucial to the preservation of wrist function [1]. The degree to which articular step-off, gapping between fragments, and radial shortening can be improved with surgery correlates strongly with improved outcome. Hence, a treatment method that is more likely to achieve these goals will result in better function.

The volar plate system has been shown to be reliable for the fixation of distal radius fractures. The volar approach is less disruptive to the nearby tendon than the dorsal approach, because there is more space available for the plate on the volar surface of distal radius. An advantage of the volar plating technique is the comfort that it provides to patients in initiating early finger and wrist motion. Early rehabilitation possible with the new design, the distal screws are locked to the plate, which stabilizes the screw against lateral movement (toggle) and resist loosening. This provides additional strength to the fixation by constructing a scaffold under the distal radial articular surface. The proximal diaphyseal screws fix the plate strongly to thick cortical bone, completing this stable form of fixation [2].

As open reduction and volar plating ensures more consistent correction of displacement and maintenance of reduction, this study evaluates the anatomical and functional outcome of open reduction and plate fixation in the management of fracture distal end radius.

### **Materials and Methods**

40 patients with distal radius fractures of the treated at Unique Super Specialty Centre,

Indore between May 2013 and May 2015 were included in the study.

#### **Inclusion Criteria:**

- a) Patients with distal radius fractures of wrist
- b) Patient age > 18 years
- c) Closed fractures
- d) Patients willing for treatment and given informed written consent.

#### **Exclusion criteria:**

- a) Patients <18 years of age
- b) Medically unfit cases.
- c) Compound fractures
- d) Pathological fracture
- e) Previously operated & non-functional wrist
- f) Patients with local tissue condition making surgery inadvisable

The standard volar approach was undertaken to fix distal radius fracture using volar buttress or locking plate and screws. The ulnar styloid fracture was managed expectantly. The movement of wrist was restricted in slab for 10 days after operation. After 10 days, slab removed and crepe bandage applied and active motion of the wrist consisting of wrist movements, supination, pronation, finger grip were started.

They were followed up at the end of first, fourth, sixth week, 3 months and then once in 3 months up to 12 months. During follow-up visits AP and lateral x-rays were taken and patients were instructed about the exercises of the elbow, digits and shoulder.

Patients were assessed, which includes objective grading of function and deformity, comparison of final and initial radiograph. Objective examination included inspection of the wrist for deformity, tenderness, abnormal mobility of the distal radio-ulnar

joint, measurement of the range of movements and grip strength.

The subjective, objective and radiographic findings were quantified by Lidstrom's system and Demerit point system. The outcome of each fracture has been graded as excellent, good, fair or poor

## Results

40 patients with distal end radius were enrolled in the study and were treated by volar plating system. The analysis of results showed The mean age of the patients was 39.6 years( range 19-67 years). There were 26 male patients (65%) and 14 female patients (35%) in the study.

**Table 1**  
**Age& Sex Distribution**

Age (Years)	Male	Female	Total
11-30	7	1	8
31-50	15	9	24
51-70	4	4	8
TOTAL	26	14	40

**Table- 2**  
**Frykman classification of fracture**

Type	I	II	III	IV	V	VI	VII	VIII
No. of pt.	6	5	8	17	1	1	1	1
%	15	12.5	20	42.5	2.5	2.5	2.5	2.5

## ANATOMICAL EVALUATION

### Residual dorsal tilt:

The dorsal tilt (from a neutral of 0 degrees) of the distal radial articular surface varied from 4° to 28°. The dorsal tilt decreased from an average of 14° before the reduction to an average of 0.7° at the most recent follow up evaluation.

Postoperatively the dorsal tilt could be corrected to the anatomical palmar tilt or at least a neutral angle in 34 patients (85%)

while in 6 patients (15%) the dorsal tilt could not be restored even to a neutral angle.

Out of these 6 patients, 2 had Frykman Type I fracture, 2 had Type III fracture while one had Frykman Type IV fracture and one had Frykman Type VII fracture.

At the final follow up, two patients (5%) had some loss of correction of dorsal tilt. These patients had a comminuted intra-articular fractures (Type IV and VII).

In 95% of the patients the correction of tilt achieved at surgery was maintained till healing.

**RADIAL LENGTH**

The radial shortening varied from 4mm to 27 mm. It decreased from an average of 12 mm before the reduction to an average of 0.7 mm postoperatively and to 0.8 mm at the most recent follow up.

In 1 patient (3%) there was 5 mm of collapse of radial length from the immediate postoperative to the final follow up period. This patient had comminuted fracture Frykman Type VI.

97% of the fractures maintained their postoperative radial length till union.

The loss of radial inclination varied from 0° to 24°. (Avg 13° ) it was reduced to an average of 1° at the final follow up.

In 2 patients (5%) there was loss 3° to 4° of correction of radial inclination. These 2 patients had comminuted intra articular fractures.

**CLINICAL AND FUNCTIONAL EVALUATION****Residual deformity:**

Prominent Ulnar Styloid – 5patients (12%)

Residual Dorsal Tilt – 4 patients (10%)

Radial Deviation of hand – 0 patients (0%)

**RADIAL ANGLE****OBJECTIVE EVALUATION**

**Table- 3**  
**Objective evaluation**

<b>Objective evaluation</b>	<b>No. of pt</b>
Loss of Dorsiflexion(<45°)	1
Loss of Palmar Flexion (<30°)	2
Loss of Ulnar Deviation (<15°)	1
Loss of Radial Deviation (<15°)	1
Loss of Supination (<50°)	1
Loss of Pronation (<50°)	1
Loss of Circumduction	2
Pain at DRUJ	2
Grip Strength <60% of opposite side	1

**COMPLICATIONS**

**Table- 4**  
**Complication**

Complication	No. of patient
Reflex Sympathetic Dystrophy	1
Joint Stiffness	2
Paraesthesia in distribution of Radial Nerve	1
Impingement of tendons	0
Median Nerve complications	0
OA wrist	1

5 patients (12.5%) developed complications, however, 35 patients (88.5%) were free from complications.

#### **Anatomical score of healed fracture:**

The scoring was done according to the Sarmiento's modification of Lidstrom Criteria.

Anatomically 25 patients (63%) had excellent restoration of anatomy, 10 patients (25%) had good restoration, 3 had fair (7%) and 2 had poor (5%) restoration of anatomy.

Thus 88% patients had excellent to good alignment of fragments and good reduction could not be achieved in 12% patients resulting in fair or poor results.

#### **Functional end result of healed fracture:**

The scoring of healed fracture was done according to the Demerit Point System of Gartland and Werley with Sarmiento et al modification.

Functionally 24 patients (60%) had excellent, 13 good (33%) and 3 patients had fair (7%) restoration of functions. Poor function correlated with residual displacement and poor patient compliance.

The ratio of grip strength of affected hand to normal hand was measured by a standard dynamometer. 24 patients (60%) had excellent grip strength, 11 patients (27.5%) had good grip strength while in 2 patients grip strength measurement was not possible due to bilateral wrist involvement.

#### **Discussion**

In 1814, Abraham Colles outlined the treatment of his choice for distal end radius Fracture [1]. Since then there have been numerous studies to outline the ideal treatment for different fracture types.

In this study of 40 patients the mean age of the patients was 39.6 years (range 19-67 years) with male predominance. Chung et al in his study observed mean age of 48.9yrs with male predominance [2].

Chung K C et al in his study of 161 patients reported flexion of wrist in the injured side 86% of the contralateral side, in this study functional results were good to excellent in 93 % patients [2].

Ratio of grip strength of affected hand to normal hand was excellent in 24 patients and good in 11 patients. There was loss of dorsiflexion(<45<sup>0</sup>) in 1 patient and loss of

palmar flexion( $30^{\circ}$ ) in 1 patient. Flexion of wrist in injured side was 88% of contralateral side after a follow up period of 12 months.

Leung et al conducted a randomized control trial in 137 patients with intra-articular distal radius fracture and compared between external fixation augmented with nails and internal plate fixation of the fractures. At an average of 24 months of follow up period, they reported that the results of plate fixation group were significantly better than the augmented external fixation group [3]. In our prospective study, volar approach for plate fixation in DER fractures also had better functional outcome as well as better alignment of fracture fragments after a 12 month of follow up period.

Figl M et al studied on volar fixed angle plate osteosynthesis of unstable DER fracture with a 12 months follow up in 80 patients. At the time of final follow up, 60 patients(75%) had no radial shortening, 20 patients(25%) had a mean radial shortening by 1.8 mm compared to contralateral side. Radial tilt was average  $22^{\circ}$ , volar tilt was average  $6^{\circ}$ . Grip strength was 65% of contralateral side [4]. In our prospective study, in 95% of the patients the correction of tilt achieved at surgery was maintained till healing. In two patients (5%), there was some loss of correction of dorsal tilt. These patients had a comminuted intra-articular fractures (Type IV and VII). In 1 patient (3%) there was 5 mm of collapse of radial length.

Othman AY conducted a study on fixation of dorsally displaced distal radius fracture with volar plate. 16 patients were included in the study. 88% of fractures were rated as good or excellent according to Gartland and Werley scoring system [5]. In the present study, out of 40 patients enrolled 88% of patients had excellent to good alignment of fracture fragments and functionally, 93% of patients had excellent to good restoration of function. Gruber G et al also reported good

or excellent results in more than 90% patients after volar plate fixation [6].

Dillingham C et al reported that supination and pronation returned more quickly than flexion or extension. Supination and pronation was 92% of the uninjured wrist after 3 months. Flexion improved between 3 to 6 months and all wrist ROM improved till 1 year [7]. In the present study, supination and pronation were both around 90% of uninjured wrist after 3 months. At the time of final follow up there was Loss of Dorsiflexion in 1, Loss of Palmar Flexion ( $<30^{\circ}$ ) in 2 patients, Loss of Ulnar Deviation ( $<15^{\circ}$ ) in 1, Loss of Radial Deviation ( $<15^{\circ}$ ) in 1, Loss of Supination ( $<50^{\circ}$ ) in 1, Loss of Pronation ( $<50^{\circ}$ ) in 1 and Loss of Circumduction in 2 patients. 35 out of 40 cases, showed excellent to good grip strength after a follow up of 1 year.

Lee YS et al conducted a retrospective study to compare the clinical outcome of volar locking plating(VLP) and percutaneous K-wire(PKW) fixation for treatment of displaced Colles' type DER fracture in patients between 50 to 70 years. The results had shown better functional end results with VLP [8]. In the present study, 8 patients were between age 50 and 60 years and 7 patients showed excellent to good functional outcome. However, only one patient had poor outcome with wrist joint stiffness.

Gogna et al conducted a study on osteosynthesis with volar fixed angle locking plates in dorsally comminuted fractures of DER. Final assessment was done as per Demerit point system, which showed 79% (n=26) excellent results, 18% (n=6) good and fair in 3% (n=1). 3 patients had loss of reduction but none had tendon irritation or rupture or non-union at the end of one year of follow up [9]. In the present study, Demerit point system yielded excellent functional end results in 60% (n=24) cases, good in 33% (n=13) cases and fair in 7%

(n=3). Residual dorsal tilt was seen in 10%(n=4), none of the cases showed any radial deviation of hand or tendon irritation or rupture or non-union of fracture fragments at the final follow up after one year.

Kamano M et al in his study the complications as follows: 1 case developed RSD, 1 case had mild superficial skin infection [10]. In the present study, 1 patient developed RSD, radial nerve paresthesia was seen in 1 case, 2 patients developed superficial skin infection at the operated site.

Rozental TD et al in his study in reported 44% infection rate [11]. In our study, out of 40 patients, 5% (n=2) cases developed superficial skin infection at the operated site which was managed conservatively. There was no need for plate removal. 5 patients developed post-operative complications. Arora R et al in his study reported complication rate of 27% (n=31). 57% of complication was due to flexor and extensor tendon irritation which included rupture of FPL tendon in 2 cases, rupture of EPL tendon in 2 cases, 4 cases with extensor tendon tenosynovitis, 9 cases of flexor tendon tenosynovitis, 3 case with carpal tunnel syndrome, 5 cases with RSD, loosening of single screw in 2 cases, delayed union in 3 cases, intra-operative intra-articular screw displacement in 1 patient [12]. In our prospective study, none developed any tendon irritation or rupture but in 1 case there was radial nerve paresthesia and 1 patient developed RSD.

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Too long screws can penetrate the extensor compartment, very distal palmar plate position can interfere with flexor tendon system and distal screws in comminuted fractures can cut through subchondral bone and can penetrate into the radio-carpal joint. So, careful drilling and choice of screw length is vital to avoid such complications. Placing the plate proximally to the watershed line and removing the plate as soon as the fracture united is necessary to avoid the complication of tendon rupture.

Prommersberger KJ et al evaluated non-union after reconstruction surgery of distal radius fracture in 23 patients and reported that open fractures, severe contamination, infection, tissue interposition, devascularization of bone ends and pathologic lesions are risk factors for non-union [13]. In present study, inspite of development of superficial skin infection in 5% (n=2) cases, no case was reported to have non-union of fracture .

## Conclusion

In this prospective study conducted with forty patients, 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, even when the fracture is grossly comminuted / intra-articular / unstable and / or the bone is osteoporotic.

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