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Dorsally displaced distal radius fractures fixation: Dorsal versus volar plating. A randomized controlled study

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Abstract
Background: Distal radius fractures are one of the most common fractures of human skeleton accounting for one sixth of all fractures seen in emergency room. Close reduction and cast immobilization used to be the mainstay of treatment of the fractures of the distal radius. Best modality of achieving restoration of anatomy of wrist is by open reduction and internal fixation with plating. Significant controversies exist about whether dorsal or volar plating is superior for fixation of dorsally comminuted distal radial fractures. The aim of this study is to compare outcome of dorsally displaced fracture of distal end radius managed with Dorsal plating vs volar plating.
Materials and methods: The study was conducted in Department of Orthopaedics, RIMS, and Ranchi from October 2016 to October 2017 (one year duration). Thirty skeletally mature patients of either sex (18 male and 12 female), presenting with dorsally displaced distal radius fracture, (AO type A and C) were selected for the study. The mean age of the patients was around 50 yrs. We conducted a prospective randomized study between a group of 16 patients treated with a dorsal plating (group 1) and a group of 14 patients managed with volar plating (group II). We analyzed both the clinical results (complications and functional evaluation) and the radiographic results from A/P and lateral radiographs in the early postoperative period and at 6 weeks, 3 months, 6 months follow up.
Results: Volar plating had better range of wrist movement in all directions with significant difference in dorsiflexion, pronation and supination movement. As per Gartland and werley score, functional outcome in both groups increased post operatively with continued physiotherapy and rehabilitation. The differences were non-significant. Radiological determinants were volar angle, radial length and radial inclination. Results shows, marginal better maintenance of radiological parameters with dorsal plating then volar plating but the differences between two groups are statistically non- significant, {p>0.05}. Complications between two groups have no significant difference Incidence of neurological complication was more seen with volar plating, while dorsal plating associated with tendon irritation and hardware problems
Conclusion: Both Dorsal plating and Volar plating are valid approach to fix dorsally displaced fracture distal end radius. As functional outcome in patients managed with volar plating is better than those managed with dorsal plating so, volar plating should be the approach of choice.

Keywords: Distal radius, volar plate, dorsal plate

1. Introduction
Distal radius fractures are one of the most common fractures of human skeleton accounting for one sixth of all fractures seen in emergency room. These fractures occur in two different age categories: the young and the elderly. There is a high incidence of unsatisfactory results in the treatment of fractures of the lower end of the radius. Many treatment options for obtaining acceptable alignment in these injuries have been described. Close reduction and cast immobilization used to be the mainstay of treatment of the fractures of the distal radius. [12,13] Various methods for maintaining the reduction with additional fixation have been attempted like Kirschner wire, bridging and non-bridging external fixation, open reduction and internal fixation with dynamic compression plate and fixed angle/ variable angle locking plates and arthroscopic assisted reduction techniques. Distal radial fractures with dorsal angulation are common and tend to suffer secondary displacement after conservative treatment.

Because the distal radius is important in kinematics of radio-carpal and radio-ulnar joints, open reduction of the articular surface, reconstruction of articular congruity and restoration of the radial length, volar angulation and radial inclination are the prerequisite for good clinical outcome. Open reduction and internal fixation which allow better restoration and preservation of distal radius radiological parameters are recommended for unstable distal radius fractures. [3, 10] Fracture can be fixed using volar plating and or dorsal plating. Significant controversies exist about whether dorsal or volar plating is superior for fixation of dorsally comminuted distal radial fractures. The dorsal approach to treat distal radius fractures has fallen into disfavour during the past few years because of reports of problems with tendon irritation, ruptures, and fracture collapse that occurred with plates that were anatomically correct but had a relatively high profile. [16, 16, 17] Lately, new literature has also confirmed that the results of dorsal plating are comparable to those of the volar approach. [24] To our minds, the big advantage of the dorsal plate fixation for dorsally displaced fractures is the direct visualization of the dorsal defects that are created by the collapse and multifragmentation present in most of these injuries, especially in the senior population. The specific aim of this study was to compare the radiological and functional outcomes of volar and dorsal plating for the management of dorsally displaced distal radius fractures.

Materials and Methods

The study was conducted in Department of Orthopaedics, RIMS, Ranchi from October 2016 to October 2017 (one year duration). Thirty skeletally mature patients of either sex (18 male and 12 female) presenting with dorsally displaced distal radius fracture, (AO type A and C) were selected for the study. AP and Lateral radiograph of wrist was obtained pre-op, post-op and during the course of follow up. The mean age of the patients was around 50 yrIt is an analytic prospective comparative study between two groups. The patients were divided into two groups, one group managed with volar plating and other with dorsal plating. One surgeon performed the procedures on all patients, and decision for selecting patient whether for volar or dorsal plating was done by draw of chits (randomization).

Every alternative patient was enrolled in group-I and group-II as per inclusion and exclusion criteria and after taking informed consent.

Group-I patients managed with dorsal plating

Group-II patients managed with volar plating

Blinding of study was not possible because of nature of the study.

Patient was taken up for orthopaedic surgery after reviewing the investigations and obtaining pre-anesthetic check-up and clearance.

The procedure was performed under general or regional anesthesia. Either of the following 2 surgical approaches was used. In every patient, for fixation of fracture fragments same type of plate (Ellis) was used.

Approach used: For volar plating: The Henry and Trans-FCR Approach

Fig 1: Intra-op Picture of volar approach

Fig 2: Pre –op X-Ray

Fig 3: Post-op X-Ray managed by voalr approach

Fig 4: 6 month follow up

For dorsal plating: The Trans-EPL Approach

Fig 5: Intra op picture of dorsal approach

Fig 6: Pre –op X-ray

Fig 7: Post-op X-ray managed by

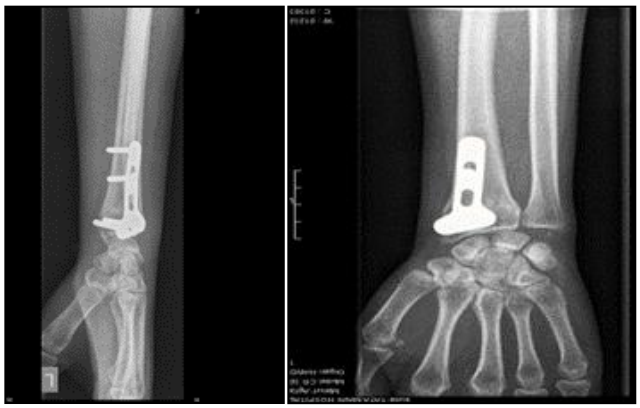

Fig 8: 6 month follow up

Dorsal appraoach

Early postoperative mobilization of the wrist was allowed in all cases**.** Patients were then reviewed during follow-up visits at 6weeks, 3 months and at last follow-up (6 months) by an examiner different from the operator. Evaluation of result were done in terms of:

1. Radiological evaluation

X-rays were taken at each follow up, evaluated and scored by using Sarmiento *et al* s modification of the Lidstrom's scoring systemthat is Stewart score system. [30, 31, 32]

Thus, the patients will be categorized as: Excellent reduction (score 0), Good reduction (score 1-3), Fair reduction (score (4-6) and Poor reduction (score 7-12).

2. Functional Evaluation:

The results were assessed on the basis of Gartland and Werley Score[6] which included subjective and objective evaluation along with assessment of any residual deformity and complications. Result were categorized as: Excellent (score 0-2), Good (score 3-8), Fair (score 9-20) and Poor (score >20).

3. Complications

The severity of complications was evaluated using the scoring system of McKay *et al*. [17] The occurrence of postoperative complications was segregated into 7 categories: hardware discomfort (including pain), tendon irritation/rupture, failure of reduction, infection, CRPS, stiffness, and neuropathy/hypersensitivity. Failure of reduction was defined as exhibiting any of the following 4 criteria: (1) greater than 10° dorsal angulation, (2) greater than 25° volar angulation, (3) greater than 2 mm articular step-off or gap, or (4) greater than 5 mm radial shortening. Stiffness was assessed subjectively, based on the surgeon's notes. Rate of complications was evaluated using Fisher's exact test.

Results

Mean age of all patients was 46.8 years and maximum no. of patients were in age group of 41-50. There were 18 male and 12 were female patients. More common mechanism of injury was road traffic accident in 18 patients (60%) while 12 (40%) had injury following fall. Most common side involved was right side, 19 patients while 11 had left side fracture. Out of these 21 were in dominant hand. Most common type of fracture was type C, as per AO classification (18 patients, 60%) while as per Frykman classification 50% patients had type VI-VIII fractures. These denote more complex nature of fracture pattern. For radiological evaluation 1st post-operative day measurements were also recorded. In Volar plating group, at final follow up mean dorsiflexion was 22.21 ± 6.08, mean

palmar flexion was 58.86 ± 6.46, mean pronation was 82.07 ± 5.81 and mean supination was 82.07 ± 5.17 while in dorsal plating group mean dorsiflexion was 58.38 ± 5.69, mean palmar flexion was 57.75 ± 7.64, mean pronation was 77.5 ± 3.65. and mean supination was 78.44 ± 4.37. Volar plating had better range of wrist movement in all directions with significant difference in dorsiflexion, pronation and supination movement. As per Gartland and werley score, functional outcome in both groups increased post operatively with continued physiotherapy and rehabilitation. In volar plating 5 patient had excellent functional outcome (35.71%) and 9 patients had good result (64.29%). While in dorsal group 5 patient had excellent functional outcome (31%) and 9 patients had good result (69%). The differences were non-significant.

Table 1: Overall Functional outcome results

Score	Dorsal		Volar	
	No. of patients	Percentage	No. of patients	Percentage
Excellent	5	31.25%	5	35.71%
Good	11	68.75%	9	64.29%
Fair	0	0%	0	0%
Poor	0	0%	0	0%

Radiological determinants were volar angle, radial length and radial inclination. The mean volar tilts, radial length, radial inclination at final evaluation in volar plating group were 5.57±7.06, 9.50±1.60, 21.07 ±1.32 respectively, whereas, in dorsal plating group as 6.06 ±5.14, 9.69±1.25, 21.19±1.16 respectively. Results shows, marginal better maintenance of radiological parameters with dorsal plating then volar plating but the differences between two groups are statistically non-significant, {p>0.05}. The Lindstrom score at final follow up in dorsal group is less (better) then the volar group (dorsal: volar: 0.625:1).But the difference is not statistically significant. p=0.1228, {p>0.05} Also as per Lindstrom scoring all patients achieved good to excellent reduction in dorsal group, excellent in 7 patients and good in 9 patients. While in volar group 8 patients achieved good reduction and 5 excellent reductions and 1 patient had fair reduction, due to dorsal collapse. The result between two group is significant p - value = 0.5314 {p>0.05}.

Table 2: Radiological outcome

Score	Dorsal		Volar	
	No. of patients	Percentage	No. of patients	Percentage
Excellent	7	43.75%	5	35.71%
Good	9	56.25%	8	57.14%
Fair	0	0%	1	7.14%
Poor	0	0%	0	0%

Both Volar plating and dorsal plating resulted in some complications, which were evaluated as per Mckay *et al*. [17] The rate of Complications between two groups have no significant difference, p value=1.00, P>0.05. But the type of frequent complications in two type of plating is different. Incidence of neurological complication was more seen with volar plating, while dorsal plating associated with tendon irritation and hardware problems. Other complications faced were surgical site infection, RSD.

Discussion

Fracture of distal end radius is very common and most of them were and are being treated non-operatively. But now a days in order to obtain better anatomic restoration and better functional outcome, Surgeons are favouring for open reduction and internal fixation with buttress plate. Dorsal displacement of fracture fragments is most common deformity seen after fracture and can be managed by either dorsal approach or volar approach. Both approach resulted in union of fracture in all patients. All patients had good to excellent functional outcome at final follow up in both groups. But volar plating resulted in better achievement of range of movement of wrist then dorsal plating. Anatomical restoration of distal end radius as seen on x rays was better in group with dorsal plating then volar plating especially better maintenance of dorso-palmar angle. But the difference was not statistically significant. Complications were seen in both groups and there is no statistically significant difference between them. Neurological complication was seen more with volar plating, while dorsal plating associated with tendon irritation and hardware problems.

Various studies demonstrate that range of motion and grip strength continue to improve even after 6 months. Complications like rupture of Flexor and Extensor tendons appear late, [63] the time period was insufficient to evaluate the outcome as a whole. Profile of plate may alter the final outcome and complications especially in dorsal plating group.

Conclusion

Open reduction and plate fixation should be done in distal end radius fracture wherever it is indicated. Both Dorsal plating and Volar plating are valid approach to fix dorsally displaced fracture distal end radius. As functional outcome in patients managed with volar plating is better than those managed with dorsal plating so, volar plating should be the approach of choice. Longer follow up of patients are required to know the late complications such as tendon irritation and tendon rupture.

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