MAK HILL Publications Research Journal of Medical Sciences

Research Article
doi: 10.59218/makrjms.2024.5.22.27

Volar Locking Plate Versus Dorsal Locking Plate Fixation for Distal Radial Fractures: A Hospital Based Comparative Prospective Study

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OPEN ACCESS

Key Words
Distal radius fractures, volar locking plate, dorsal locking plate, range of motion

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Received: 25 November 2023
Accepted: 31 December 2023
Published: 8 January 2024

Citation: Puneet Kumar Acharya, Jyoti Krishna, Shekhar Mishra, Kartikeya Singh, A.V.N. Sai Harsha, Vishwakarma C Hodigere, 2024. Volar Locking Plate Versus Dorsal Locking Plate Fixation for Distal Radial Fractures- A Hospital Based Comparative Prospective Study.. Res. J. Med. Sci., 18: 22-27, doi: 10.59218/makrjms.2024.5.22.27

ABSTRACT

The use of low-pro le dorsal and volar locking plates for distal radial fracture surgery has improved results and lowered the complication rate compared with older plate designs. The purpose of the present hospital based comparative study was to compare patient-reported outcomes as well as radiographic and functional results between patients who underwent stabilization with a volar locking plate or a dorsal locking plate for the treatment of dorsally displaced unstable extra-articular distal radial fractures. Present study is hospital based comparative prospective study done in Department of Orthopaedics IMCHRC Indore M.P. duration of study was January 2019 to June 2021 and study subjects can be all patients with distal end radius fracture with dorsal fragment presenting to Orthopaedic OPD. sample size of study 60 Cases and done through convenient sampling method Based on Inclusion and Exclusion criteria, total of 60 patients were selected having fracture distal end radius with dorsal fragment presenting to Orthopedic OPD were enrolled in the study written and informed consent was taken from the patient. In our study majority of patients were of 20-30 age group 38 males (63.3%) and 22 females (36.7%) were operated. 21 males (70%) and 9 females (30%) underwent dorsal locking plate while 17 males (57%) and 13 females (43%) underwent volar locking plate. 43.3% patients had history of fall and 56.7% patients had history of road traffic accidents. majority of the patients had 2R3C2 (n = 33) AO classification. comparing range of motion (in terms of Palmar flexion, Dorsi flexion, Supination, Pronation, Ulnar deviation and Radial deviation) no significant difference were observed at 36 weeks of follow-up. The study suggests that both dorsal and volar locking plates are effective treatments for intra-articular distal end radius fractures with dorsal fragments. Radial length, palmar tilt and articular step-off were similar. Dorsal plating shows displaced fragments and prevents collapse. Dorsal plates are excellent for distal end radius fractures with dorsal displacement. At 36 weeks, both groups had equal Palmar flexion, Dorsi flexion, Radial deviation, Ulnar deviation, Supination and pronation ranges.

INTRODUCTION

Previous versions of dorsal plates employed in distal radial fracture surgery demonstrated a notable frequency of complications[1-4]. Dorsal plates with a low-profile design have demonstrated reliable fracture fixation and reduced occurrences of problems related to the extensor tendons, as evidenced by studies[5-7]. In recent decades, there has been a transition from using dorsal plating to using low-profile volar locking plates[8]. Nevertheless, issues with extensor tendons remain a significant concern when using both dorsal and volar plates. Additionally, volar plating has introduced novel difficulties that are not often observed after dorsal plating of similar fractures[9]. Therefore, other fixation structures have arisen[10]. An example of such an implant is the dorsal locking nail-plate, which was first introduced in 2005[11]. This device is a hybrid implant that consists of a fixed-angle low-profile plate part at the end, which supports the articular surface and proximal intra-medullary locking nail fixation. Bio-mechanical studies have demonstrated that both the dorsal locking nail-plate and the volar plate exhibit much higher yield load during active wrist and finger motion compared to previously reported loads[12-14]. However, there is a lack of studies that have directly evaluated the use of a volar locking plate with intramedullary nailing for therapy[15,16].

The objective of this study was to evaluate and compare the outcomes, radiographic and functional results and complications associated with the treatment of dorsally displaced unstable extra-articular distal radial fractures using either a volar locking plate or a dorsal locking plate.

MATERIALS AND METHODS

Present study is hospital based comparative prospective study done in Department of Orthopaedics IMCHRC Indore M.P. duration of study was January 2019 to June 2021 and study subjects can be all patients with distal end radius fracture with dorsal fragment presenting to Orthopaedic OPD. Sample size of study 60 Cases and done through convenient sampling method, Complete enumeration of cases till desired sample size was achieved. Patients with radiologically confirmed distal end radius fractures with dorsal fragment and ready to give Consent were included in the study. Pediatrics age group, Patients which are only suitable for external stabilization system, Open fractures, Pathological fractures, Mentally retarded patients were excluded from study. Cases were enrolled after taking ethical approval from institutional ethical committee.

Based on Inclusion and Exclusion criteria, total of 60 patients were selected having fracture distal end radius with dorsal fragment presenting to Orthopedic OPD were enrolled in the study written and informed consent was taken from the patient. The patient's clinical history and examination findings was recorded prospectively in a case record form. Pre-operative digital X-ray of the patient's forearm with wrist was taken in AP and Lateral views. Use of dorsal or volar plate was done according to the pre-operative assessment. Post-operative digital X-ray of the patient's forearm with wrist was taken in AP and Lateral views. Patients was followed up for 9 months (at 4,8,16,24 and 36 weeks) and functional out-come was assessed using modified MAYO scoring. Digital X-ray (AP and Lateral views) and the routine pre-operative investigations Based on Inclusion and Exclusion criteria were selected having fracture distal end radius with dorsal fragment presenting to Orthopedic OPD were enrolled in the study. Through history was taken. A structured questionnaire was used to record individual case details. Consent of each patient was taken. The functional outcome was assessed in terms of pain, range of motion, grip strength and activity using Modified Mayo Score with follow-up at4 weeks, 8 weeks, 16 weeks and 32 weeks of surgery.

Statistical analysis: Data analysis was performed by using SPSS (Statistical package for social sciences) version 20.0. Significance was set at $p<0.05$. All analyses were done using the intention to treat principle. used student t test and Chi square test.

SPSS version 20.0 was utilised for the analysis of the study's data-set. Since our analysis was descriptive in nature and included the entire Indore population, neither p-values nor confidence intervals were required to represent the proportions of surgical procedures. We conducted a multinomial logistic regression using the most commonly chosen location as the reference, adjusting for gender and age above 60. In two-sided tests, significance was defined as $p<0.05$. The orthopaedic department of Index Medical College in Indore, Madhya Pradesh, was the site of this study.

RESULT

In the current study, there were nine cases of dorsal plating and eleven cases of volar plating, with the majority of patients being in the 20-30 age range. Next in line was the age group of 41-50 (n = 14). Just six patients were older than sixty years. In the current study that takes sex into account, patients with dorsal plating comprise 21 males (70%) and 09 females (30%), while patients with volar plating comprise 17 males (57%) and 13 females (43%). With a P value of 0.2839, the gender distribution was not significant between the two groups. In the current study analysing the distribution of injury mechanisms by gender, 09 males

Table: 1 Distribution Of Patients

	Dorsal plating			Volar plating		
Particular	Sub-Particular	No of cases	Percentage	No of cases	Percentage	p-value
Age	20-30	09	30	11	36	
	31-40	03	10	05	17	
	41-50	07	23	07	23	
	51-60	07	23	05	17	
	>60	04	14	02	07	
Sex	Male	21	70	17	57	0.2839
	Female	09	30	13	43	

Table:2 Mode of injury associated with gender

Mode of injury	dorsal plating			volar plating		
	Male	Female	Total	Male	Female	Total
Fall	09	04	13	03	10	13
Rta	12	05	17	14	03	17
Mayo score	left	right	total	left	right	total
Plating	13	13	26	14	13	27
Plating and k wire	01	02	03	00	02	02
Plating and ulnar plating	00	01	01	01	00	01
Total	14	16	30	15	15	30
p-value	0.8864	0.86011				

Table: 3 Comparison of types

Ao type	dorsal plating		volar plating		
	no. of cases	percentage	no. of cases	percentage	p-value
2R3C1	12	40%	00	00%	.003631.
2R3C2	11	37%	22	73%	
2R3C3	01	03%	03	10%	
2R3B2	06	20%	05	17%	
Associated injury					
Fair	08	26.66	11	3.66	0.701245
Good	17	56.66	15	50	
Excellent	05	16.66	04	13	

and 04 females in the dorsal plating group had a history of falls and 12 males and 05 females were RTA members: in the volar plating group, 03 males and 10 females had RTA histories and 14 males and 03 females had fall histories. In the current study comparing the lesion sites between groups, 15 patients on the left side and 15 on the right side underwent volar plating, while 14 patients on the left side and 16 patients on the right side underwent dorsal plating. $p>0.05$ indicated that the side involvement comparison was not significant.

Based on the AO classification, the majority of patients in this study suffered fractures of the 2R3C2 type.In the current investigation, of the patients in the Dorsal Plating group, five (16.66%) had excellent results, seventeen (17.66%) had good results and eight (26.66%) had fair results. In contrast, of the patients in the Volar Plating group, four (13%) had excellent results, fifteen (50%) had good results and eleven (3.66%) had fair results.

The surgical waiting period in the current study was 6.03±1.49 days for volar plating and 5.4±1.69 days for dorsal plating. With a $p>0.1$, the comparison of the surgical waiting times in the two groups was not significant. Within the dorsal plating group, the mean radial length was 8.9±0.06 mm, the mean palmar tilt was 8.3±0.79 degree and the mean articular step off was 0.5±0.77 mm in the current study. In contrast, the mean radial length in the other group was 8.53±0.97 mm, palmar tilt was 7.3±0.95 degree and articular step off was 0.36±0.76 mm. When comparing the radiological results between the two groups, the $p<0.05$, indicating in significance. In our study, following 36 weeks of surgery, palmar flexion was 70.9±16.05 degrees in the dorsal plating group and 71.50±11.82 degrees in the volar plating group, the radial deviation in our study was 16.16±3.63 degrees in the dorsal plating group and 16.33±3.45 degrees in the volar plating group, Ulnar deviation was 23.60±5.71 degrees in the Volar plating group and 24.16±5.09 degrees in the Dorsal plating group, pronation was 72.33±10.80 degrees in the Dorsal plating group in our study and 72.66±10.56 degrees in the Volar plating group, supination was 70.66±9.80 degrees in the volar plating group in our study, while it was 71.16±9.16 degrees in the dorsal plating group.

In our study, 05 patients (04 male and 01 female) in the Dorsal Plating group had excellent scores: 17 patients (13 male and 04 female) had good scores and 08 patients (04 male and 04 female) had fair scores. In the Volar Plating group, 04 patients (02 male and 02 female) had excellent scores 14 patients had good scores (09 male and 05 female) and 12 patients (06 male and 06 female) had fair scores.

DISCUSSIONS

An intra-articular fracture of the distal end of the radius is a type of injury that is caused by high energy and is complex and unstable. The best therapy for this type of fracture is still a subject of debate. The rising

Table: 4 Comparison of Surgical Waiting Period And Outcome

Dorsal plating			volar plating		student 't' test value	significance 'p' value
	Mean	SD	Mean	SD		
Surgical waiting period (Indays)	5.4	1.69	6.03	1.49	1.5316	0.1
Radiological outcome						
Radial length(mm)	8.53	0.97	8.9	0.60	0.3244	0.7
Palmar tilt(degree)	7.3	0.95	8.3	0.79	0.8094	0.4
Articular step-off(mm)	0.36	0.76	0.5	0.77	0.1294	0.8
Palmar flexion(weeks)						
4Weeks	18.83	4.08	16.83	3.59	0.557	0.5
8 Weeks	34.33	5.83	32.16	5.03	0.2818	0.7
16 Weeks	52	6.89	52.16	6.78	0.0025	0.9
24 Weeks	69.66	8.50	70.16	9.51	0.0392	0.9
36 Weeks	71	13.15	71.83	8.55	0.0529	0.9
Dorsiflexion(weeks)						
4 Weeks	18.33	5.46	18.83	8.77	0.0484	0.96
8 Weeks	33	4.84	31.5	6.71	0.2236	0.8
16 Weeks	49.83	7.00	48.33	9.76	0.1249	0.9
24 Weeks	69.33	10.72	69.66	12.10	0.0204	0.9
36 Weeks	70.9	16.05	71.5	11.82	0.0532	0.9
Radial deviation(weeks)						
4 Weeks	3.5	0.97	4.5	7.70	0.1289	0.8
8 Weeks	6.4	1.50	5.56	1.47	0.4000	0.6
16 Weeks	9.96	1.92	9.63	1.71	0.1284	0.8
24 Weeks	15	2.62	14.7	2.80	0.0732	0.9
36 Weeks	16.16	3.63	16.33	3.45	0.2236	0.8
Ulnar deviation(weeks)						
4 Weeks	5.9	1.60	6.23	1.88	0.1529	0.8
8 Weeks	10.66	2.85	11	3.45	0.0760	0.9
16 Weeks	17.1	3.79	17.26	4.80	0.0042	0.9
24 Weeks	23.5	4.38	22.6	5.22	0.1321	0.8
36 Weeks	24.16	5.09	23.6	5.71	0.0732	0.9
Pronation(weeks)						
4 Weeks	17	4.84	20.66	4.86	0.5336	0.5
8 Weeks	37.83	8.77	40.66	7.73	0.2421	0.8
16 Weeks	55.16	11.40	57.66	10.72	0.1598	0.8
24 Weeks	70.16	11.10	72.33	10.96	0.1391	0.8
36 Weeks	72.33	10.80	72.66	10.56	0.0218	0.9
Supination(weeks)						
4 Weeks	12	2.81	12.16	2.52	0.0424	0.9
8 Weeks	27	6.24	25.5	4.57	0.19	0.8
16 Weeks	47.66	8.48	50.83	8.10	0.2703	0.7
24 Weeks	66.16	8.57	69.16	9.83	0.2300	0.8
36 Weeks	71.16	9.16	70.66	9.80	0.0373	0.9

Table: 5 Comparison Between Gender And Mayo Score

Mayo score	Dorsal plating		Volar plating	
	no. of cases Male	no. of cases Female	no. of cases Male	no. of cases Female
Excellent	04	01	2	02
Good	13	04	09	05
Fair	04	04	06	06
p-value	0.5	0.7		

occurrence and diverse manifestations of complexity in younger individuals mostly stem from severe physical injuries caused by high-energy trauma, such as road traffic accidents. The demographic most frequently impacted by this condition is older women, typically as a result of a fall that involves landing on an outstretched hand. If these apparently uncomplicated fractures are not promptly and appropriately managed, they can lead to substantial suffering and impairment for the patients. Our study found that around 56.7% of patients arrived to the emergency department due to a road traffic collision, whereas 43.3% had a history of falling. The precise occurrence and demographic characteristics of distal radius intra-articular fractures have not been mentioned in the literature. Age distribution of patients: There were a total of 20 patients in the age category of 20-30 yrs, with 9 patients undergoing dorsal plating and 11 patients undergoing volar plating. The majority of patients in our study belonged to the same group, which is consistent with the findings of Mehara *et al*[13], Zoubos *et al* [14], Kilic *et al*[15] and Aggarwal *et al*[5]. The study conducted by Rozental and colleagues in 2006 is referenced as[16]. The 41-50 age group (n = 14) was followed by the 51-60 age group. There were a total of 6 patients who were over the age of 60. Gender Distribution In our study, we observed that among the patients who underwent dorsal plating, there were 11 males and 9 females. On the other hand, among those who underwent volar plating, there were 17 males and 13 females. These findings can be compared to the male-female ratios reported by Sailer, Ulmer,

Hruhesch, Fink, Hoser, Rangger (3:1), Bruce, Rizkallah, Kwon, Goldherg, Walsh (3:1) and Sperner, Wanitsshek, Benedetto, Glozer (2.5:1). An analysis of the relationship between the method of injury and gender. In the group of individuals who had dorsal plating, there were 9 males and 4 females who had a history of falling, while 12 males and 5 females had a history of road traffic accidents (RTA). In our current investigation, there were 3 males and 10 females with a history of falls and 14 males and 3 females with a history of road traffic accidents (RTA) in the volar plating group. This is consistent with the findings of Aggarwal *et al*[5] and Zoubos *et al*[14]. The study found that the average time for fracture healing was 3 months in 88% of cases, which is similar to the findings of Kilic *et al*[15] and Aggarwal *et al*[5]. Mayo-Score Comparison The current study evaluated the functional outcome of 60 patients using the modified MAYO grading system. Within the volar plating group, 4 patients (2 male and 2 female) achieved an exceptional score, 14 patients (9 male and 5 female) achieved a good score and 12 patients (6 male and 6 female) had a fair score. In the Dorsal Plating group, 5 patients (4 male and 1 female) achieved an exceptional score, 17 patients (13 male and 4 female) achieved a good score and 8 patients (4 male and 4 female) had a medium score. Although there was minimal functional disparity observed between the two groups in this study, the dorsal locking plating group exhibited favourable radiological outcomes. Egol, Walsh, Tejwani *et al* conducted a study that followed a randomised approach in 88 instances. The individuals who underwent volar plating treatment exhibited negligible clinical significance in terms of range of motion differences. After 9 months of follow-up, the radiological, clinical and functional outcomes were comparable in both groups. Neither treatment exhibited a discernible advantage. The p<0.5 in the dorsal locking plate group and 0.7 in the volar locking plate group. Comparative analysis of the duration of surgical waiting periods The current study found that the average waiting time for dorsal plating surgery was 5.4±1.69 days, whereas for volar plating surgery it was 6.03±1.49 days. The comparison of surgical waiting periods across both groups yielded an insignificant effect, with a p<0.1. This finding is consistent with the results reported by Fasaro FJ Jr., Olysav DJ, Stauffer ES 54 and Dicicco, Jenkins, Ostrum RF (2000) 55. The study revealed that the tendency to RTA trauma was 56.7%, while FOOSH accounted for 43.3%. The high frequency of this occurrence can be attributed to the large number of patients in the age range of 20-30 yrs (n = 20), closely followed by those in the age range of 41-50 yrs (n = 14). Patients aged 60 or above (n = 06) experienced low-energy trauma ailment. Our study found that the degree of palmar flexion after 4 weeks was 18.8±4 in the dorsal plating group, compared to 16.8±3.6 in the volar plating group. The degree of palmar flexion rose progressively in both groups, reaching 71±13.1 degrees in the dorsal plating group and 71.8±8 degrees in the volar plating group after 9 months of follow-up. The plantar flexion measurements were comparable between both groups after 36 weeks, as indicated by a non-significant p<0.9. Dorsi flexion refers to the movement of the foot in which the toes are lifted towards the shin. In this study, the level of dorsi flexion was similar at 4, 8, 16, 24 and 36 weeks. In the group treated with dorsal locking plates, dorsiflexion increased from an average of 18.3±5.5 degrees at 4 weeks to 17.9±16 degrees at 36 weeks. In contrast, in the group treated with volar locking plates, dorsiflexion increased from an average of 18.8±8.8-71.5±11.8 degrees, respectively. Significant increases in dorsiflexion were observed in both groups. Lateral displacement from a central point. Within the scope of our investigation The volar locking plate group exhibited a somewhat greater radial deviation at 4 weeks, measuring 4.5±7.7 degrees, compared to the dorsal locking plate group, which measured 3.5±0.9 degrees. Radial deviation showed a substantial increase to 16.3±3.4 degrees and 16.1±3.6 degrees in both groups, respectively, after 36 weeks of follow-up. The radial deviation was comparable across both groups at 4, 8, 16, 24 and 36 weeks, with a p>0.05, indicating no significant difference. Ulnar deviation refers to the abnormal sideways movement of the hand towards the ulnar side of the forearm. In our study, we found that the ulnar deviation in the dorsal locking plate group was 5.9±1.6 degrees at 4 weeks and 24.1±5 degrees at 36 weeks. Similarly, in the volar locking plate group, the ulnar deviation was 6.23±1.88 degrees at 4 weeks and 23.6±5.7 degrees at 36 weeks. The comparison between the two groups showed no significant difference, as indicated by the inconsequential p<0.8 and 0.9, respectively. Pronation Our investigation found a significant rise in pronation after 4 weeks, with measurements of 17±4.84 degrees compared to 20.6±4 degrees. The temperature at 8 weeks was measured to be 37.8±8.7 degrees, compared to 40.6±7.7 degrees. The measurements at 16 weeks were 55.1±11.4 degrees compared to 57.6±10.7 degrees, while at 24 weeks the measurements were 17.1±11.1 degrees and 72.3±10.9 degrees, respectively. After 36 weeks of monitoring, both groups had a satisfactory range of motion, with pronation measuring 72.3±10.8 degrees and 72.6±10.5 degrees, respectively. SUPINATION In our investigation, the range of motion for supination was equally satisfactory in both the groups using dorsal locking plates and volar locking plates at 4 weeks (12 ± 2.8 degrees vs. 12.1 ± 2.5 degrees) and at 36 weeks (71.1 ± 9.1 degrees vs. 70.6 ± 9.8 degrees).The study is limited by a small sample size of patients and a short duration of follow-up. We suggest that a larger group

of patients with a longer follow-up period will provide more definite results. There was a lack of follow-up data about the functional outcome beyond the 9-month mark after the surgery. Expect some enhancement in the range of motion, grip strength and functional outcome. The assessment did not take into account the patient's initial functional level, adherence to physiotherapy and possible circumstances that could affect the recovery process. There is a lack of assessment of the potential long-term complications. The study did not incorporate radiological examination, although it being conducted at each follow-up.

CONCLUSION

The present study suggests that both dorsal locking plate and volar locking plate are effective treatment choices for intra-articular distal end radius fracture with a dorsal fragment. There were no notable disparities detected in radial length, palmar tilt and articular step-off. Dorsal plating enables direct observation of a component that has been moved towards the back, as well as providing support to prevent collapse in that area. The dorsal plate is a suitable choice for managing fractures of the distal end of the radius with dorsal displacement. The range of motion for palmar flexion, dorsi flexion, radial deviation, ulnar deviation, supination and pronation exhibited no significant differences between both groups over the 36-week follow-up period.

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