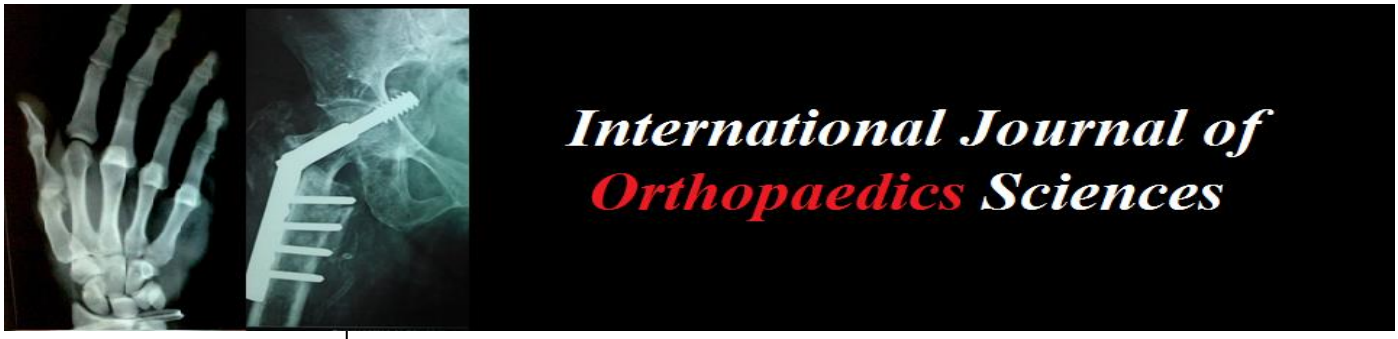

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Radiological follow up of volar locking plating of distal radius fracture

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Abstract
Introduction: Fracture of the distal end radius constitutes one of the most common skeletal injuries treated by an orthopaedic surgeon. This study was aimed to assess the clinical and radiological outcome of the intra-articular fracture distal end radius treated with variable angle mini-fragment volar plate fixation.
Methodology: In the prospective study, patients presenting with distal end radius fracture and then operated with mini-fragment volar locking distal radius plating were included. All patients were evaluated by a senior orthopaedic surgeon at 3, 6 and 24 weeks post-operatively, during which patients underwent a physical examination of the wrist and forearm motion and grip strength, followed by radiological evaluation. Range of movement and complications were noted for all patients at each follow up visit.
Results: 64% of the patients were below the age of 40 years. Approximately three fourths of all patients were classified as Frykmann distal radius fracture type VIII. The mean radial inclination, length and tilt were maintained throughout the follow up period. The range of dorsiflexion, palmarflexion, supination and pronation improved significantly at each follow up. 8% had superficial skin infection, 4% had serous discharge and loss of reduction each and 84% did not report any complications.
Conclusions: Primary volar mini-fragment variable angle plate fixation of freshly displaced distal radius fracture provides complete union, with immediate mobilization, better functional outcomes, minimizes chances of delayed/malunion.

Keywords: Distal radius, open reduction internal fixation, volar locking plate

Introduction
Fracture of the distal end radius constitutes one of the most common skeletal injuries treated by an orthopaedic surgeon. These injuries account for one sixth of all fractures evaluated in an emergency room [1]. Wide arrays of techniques can be used to treat such fractures, which include closed reduction, percutaneous fixation and open methods of reduction and stabilization; many of which have been increasingly advocated as successful treatments. Orbay introduced the volar locking plates in 2000 and they have become increasingly popular for treating distal radial fractures in recent years [2]. Volar plates provide biomechanical stability, enable fixation of comminuted bone, and promotes early return to activities of daily living [3]. Additionally, recent availability of various anatomically designed volar plates has helped to prevent soft tissue complications. However, there is limited literature, specially from Indian settings, which support the use of these plates and evaluate the functional outcome of the patients. This inadequacy of literature was emphasised by the Cochrane Musculoskeletal Registry as well [4]. This study was aimed to assess the clinical and radiological outcome of the intra-articular fracture distal end radius treated with variable angle mini-fragment volar plate fixation.

Methodology
Study design
In the prospective study, patients presenting to casualty and outpatient clinical of Department of Orthopedics, AJ Institute of Medical Science with distal end radius fracture between June 2017 and June 2018 were included. All patients above the age of 20 years in which volar plating was done were included. Patients with open fracture with neurovascular and tendon

injuries, pathological fractures, multiple fractures or other associated fractures were excluded from the study. Patients were explained the purpose of the study and a separate informed written consent for being included in the study was obtained from them. The study was approved by the institutional ethics committee.

Operative technique and postoperative rehabilitation

All patients underwent open reduction and internal fixation with mini-fragment volar locking distal radius plate (Synthes India Pvt.) by a senior orthopaedic surgeon. Prophylactic antibiotics were administered and a tourniquet was used in all cases. The radius was reached via volar approach. Under direct vision, the radial aspects of the fracture were reduced, plate was applied and was held temporarily with Kirschner wires. Reduction was confirmed with the help of an image intensifier. After that the plate was fixed to the proximal fragment, which was again confirmed with an image intensifier. The wrist was immobilized with a below elbow slab and wound inspection was done on post-operative day 3, 6 and 10. All dressings were removed two weeks post-operatively. Below elbow slab was removed on the third week and then mobilized. None of the patients required bone grafting or bone substitutes. At the time of suture removal, all patients displayed full range of finger movements. Physiotherapy program along with muscle strengthening exercises were started for all patients. Weight bearing was started after 6 weeks. All patients were evaluated by a senior orthopaedic surgeon at 3, 6 and 24 weeks post-operatively. During each follow up visit, patients underwent a physical examination of the wrist and forearm motion and grip strength, followed by radiological evaluation.

Data collection and analysis

Using a pre-designed case report form, patients' demographic and clinical information was noted. Patients were classified according to Frykmann classification of distal radius fractures [5]. Radiological evaluation of patients included posterior-anterior view, lateral view, oblique view, tilted lateral view, traction views and contralateral wrist X-ray. A reference line was drawn along the central longitudinal axis on both anterio-posterior and lateral views. Based on the previously published literature, volar tilt of 5 degrees to 20 degrees, radial height of 5 mm to 12 mm, radial inclination of 15 degrees to 30 degrees, and articular step of 2 mm were considered as acceptable parameters of reduction [6]. Range of dorsiflexion, palmarflexion, supination and pronation were noted for all patients at each follow up visit. Intra-operative, immediate and late post-operative complications were noted for all patients. Data were coded and analysed in SPSS software (Windows version 21). Quantitative data were expressed as mean and standard deviation and qualitative as numbers and percentage. Repeat measure analysis of variance was used to compare the means of radiological parameters noted at different follow up visits. Statistical significance was considered at 5% error.

Results

During the study period, 87 patients underwent mini-fragment volar plate fixation. Twelve of these patients could not be followed up for the full duration and were excluded. Final analysis included 75 patients. 64% of the patients were below the age of 40 years. Only one fifth of all patients were females (Table 1). Right hand was dominant in 88% of the patients and it was the injured site in 76% of the patients. Fall was the most common mode of injury (56%) and rest had road traffic accident. Approximately three fourths of all patients were classified as Frykmann distal radius fracture type VIII. Post-operative radiological parameters were noted at 3 weeks, 6 weeks and 24 weeks follow up (Table 2). There was a decrease in the mean radial inclination and radial length during the follow up period, but the difference was not statistically significant. Additionally, the radial tilt was maintained throughout the follow up period as well as the difference between radial tilt at 3, 6 and 24 weeks was not statistically significant. The range of dorsiflexion improved subsequently at each follow up and there was a significant increase in range of dorsiflexion. Similarly, range of palmarflexion increased significantly at each follow up. Furthermore, we found a significantly improved range of supination and pronation at each follow up. For all patients, intra-operative and immediate and late post-operative complications were noted. Of 75 patients, 8% had superficial skin infection, 4% had serous discharge and loss of reduction each and 84% did not report any complications. Regular dressing with antibiotic cover cared for superficial skin infection and serous discharge and loss of reduction was managed by removal of the implant and re-plating with bone graft.

Table 1: Distribution of patients according to their demographic and clinical characteristics

Variables	N (%)
Age distribution	
20 to 30 years	24 (32%)
31 to 40 years	24 (32%)
41 to 50 years	15 (20%)
> 50 years	12 (16%)
Gender distribution	
Females	15 (20%)
Males	60 (80%)
Dominant hand	
Left	9 (12%)
Right	66 (88%)
Injured side	
Left	18 (24%)
Right	57 (76%)
Mode of injury	
Fall	42 (56%)
Road traffic accident	33 (44%)
Frykmann classification	
VI	6 (8%)
VII	12 (16%)
VIII	57 (76%)

Table 2: Radiological parameters during the follow up period

Radiological parameter	Follow up visit		
	3 weeks	6 weeks	24 weeks
Radial inclination	22.12 ± 3.23	21.28 ± 2.88	21.60 ± 2.93
Radial length	10.81 ± 1.33	10.66 ± 1.24	10.48 ± 1.47
Radial tilt	9.68 ± 2.67	9.84 ± 2.12	9.72 ± 1.99
Range of dorsiflexion	30.60 ± 3.18	43.40 ± 4.50	70.60 ± 6.18
Range of palmarflexion	33.80 ± 2.61	47.80 ± 5.02	74.20 ± 6.24
Range of supination	33.80 ± 2.61	47.80 ± 5.02	74.20 ± 6.24
Range of pronation	33.20 ± 2.45	41.60 ± 3.14	68.80 ± 4.15

*all numbers are mean and standard deviation

Table 3: Distribution of patients according to the complications

Complication	N (%)
Superficial skin infection	6 (8%)
Serous discharge	3 (4%)
Loss of reduction	3 (4%)
None	63 (84%)

Discussion

Distal radial fractures are complex and are fraught with complications. In an attempt to stabilize these fractures, a plethora of treatment options exist. Modern plating techniques have been advocated to restore anatomical alignment and allow early mobilization. The benefits of early mobilization have recently been questioned and there is still debate as to the best way to manage these injuries. Open reduction and internal fixation has been advocated in displaced fractures because it helps in restoring the normal anatomy of the distal radius and ulna better. However, the literature is limited which prove that locked volar plates are better tolerated and allow early movement [7]. Soft tissue problems arise after use of either dorsally and radially placed plates and may include tendon irritation and rupture [8]. Volar plates overcome these shortcomings by being placed under the cushioned cover of pronator quadratus. Also, the screws do not cross the dorsal cortex, thus avoiding irritation to the extensor tendons [9].

Orbay and Fernandez followed distal radial fractures for 12 months and reported excellent range of finger movements with flexion and extension of 57 degrees and 59 degrees respectively and radial and ulnar deviation of 17 degree and 27 degrees respectively [10]. By allowing early wrist motion, volar plates enhance hand and finger functions. Furthermore, Rizzo *et al*. found that volar plates resulted in better anatomical restoration as compared to external fixators, although the final range of movements were similar in the two groups of patients [11]. Improvement in range of movement and grip strength is achieved by most patients by 6 months post-operatively, though in some cases improvement may progress till 18 months [12]. Furthermore, McQueen and Caspers demonstrated that restoring the exact anatomy is not necessary for better functional outcomes [13]. In our study patients, radial inclination, tilt and length were maintained throughout the follow up period of 24 weeks, while the range of movement improved significantly when measured at subsequent follow up visits.

There were a few limitations of our study. Firstly, although all measurements were performed by the same author, all values were captured manually. This author was not involved in patient surgery or care, thus keeping observer bias to the minimum. Second limitation was the low sample size, and losing 12 patients to follow up. In future, incentivising patients for regular follow up can help overcome this shortcoming. Lastly, we did not assess the pain score at each follow up visit, which has been identified as a key predictor of satisfaction among patients recovering from distal radial fracture [14].

Conclusion

Primary volar mini-fragment variable angle plate fixation of freshly displaced distal radius fracture provides complete union, with immediate mobilization, better functional outcomes, minimizes chances of delayed/ malunion. Future randomized studies are required to compare the clinical outcomes achieved by volar plating and by other surgical techniques.

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