



Contents lists available at BioMedSciDirect Publications

International Journal of Biological & Medical Research

Journal homepage: www.biomedscidirect.com



Original Article

“Prospective study of management of unstable distal radius fracture with volar plate osteosynthesis.”

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ARTICLE INFO

Keywords:

Distal radius fracture

Volar plating

ABSTRACT

Introduction: - Fracture of the distal end radius constitutes one of the most common skeletal injuries treated by the orthopedic surgeon. Wide arrays of techniques have been described including closed reduction, percutaneous fixation and open methods of reduction and stabilization. Displaced extra- or intra-articular distal radius fractures require accurate reduction to allow a good outcome. We wished to assess the outcome of volar plate osteosynthesis to confirm satisfactory reduction and functional outcomes. **Material and methods:** - This is prospective study conducted in our medical institution between 2010 and 2012. Inclusion criteria included skeletally mature patients who presented to casualty with unstable intra and extra-articular fractures of the distal radius. Open reduction and internal fixation with a volar plate under general anaesthesia was done in all patients. During the follow-up, radiological and functional parameters were assessed and Gartland and Werley scoring was done. **Observation and results:** In our study, a total number of 29 patients have been included who underwent volar plate fixation, out of which 4 patients were lost for complete follow up. Radiological parameters were well maintained and functional parameters showed significant improvement during the follow-up period. The mean Gartland and Werley score for 25 patients at the end of 24 weeks of follow-up was 3. Complication rate was 8% and they were promptly recognised and managed. **Conclusion:** - Primary volar plate fixation of unstable distal radius fracture provides a stable construct which helps in early mobilization, there by better functional outcomes and minimizes chances of delayed/malunion. However our study concludes that good intra-operative reduction and fixation is mandatory in order to reduce complications.

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1. Introduction

Fracture of the distal end radius constitutes one of the most common skeletal injuries treated by the orthopedic surgeon. These injuries account for one sixth of all fractures evaluated in emergency room. The fractures can be either extra-articular types resulting in disruption of radiocarpal or radioulnar joints. Better understanding of the distal radius fractures has led to the changing concepts of the treatment [1]. Wide array of techniques have been described including closed reduction, percutaneous fixation and open methods of reduction and stabilization. This group of patients have high functional demands and are often still in active employment. Treating the growing number of these difficult injuries presents a

particular challenge for orthopedic surgeons. A fracture is defined as unstable if there is severe comminution, intra-articular extension, or large dorsal cortical comminution or defect [2]. A fracture also deemed unstable when reduction could not be maintained with a cast or splint. The unstable fractures are therefore less suitable for traditional method of closed reduction and cast application. Without supplemental skeletal fixation, re-displacement of the fracture commonly to its pre-reduction position is inevitable, resulting in malunion, limited range of motion, weakness, pain and post-traumatic arthritis. It must be recognized that articular fracture constitutes a diverse spectrum of injuries for which optimal management requires differing methods of treatment. Employment

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of simple technique for dissimilar injuries predictably yields a variable and often disappointing quality of recovery. Displaced extra-articular distal radius fractures require accurate reduction to allow a good outcome. Historically these fractures were treated with manipulation and casting, with or without Kirschner (K) wire fixation. Modern plating techniques have been advocated to restore anatomical alignment and allow early mobilization. Open reduction and internal fixation using a locking plate system is a valid treatment of displaced extra-articular and intra-articular distal radius fractures in adults [3-6]. The use of locked volar plates for distal radius fractures is increasingly popular although there is little in vivo data to suggest superiority over other techniques. Proposed advantages of locked volar plating include improved pull out strength even in osteoporotic bone [7] and a volar surgical approach that avoids the need for an extensive dorsal dissection. The plate is positioned in a well-padded area beneath pronator quadratus to avoid flexor tendon irritation and it is thought that patients tolerate volar wrist scars better than dorsal ones [8, 9]. Also volar plate osteosynthesis provides a rigid construct allowing for early mobilization and rapid functional recovery. We wished to assess the outcome of volar plate osteosynthesis to confirm satisfactory reduction and functional outcomes.

Materials and methods: This is prospective study conducted in our medical institution between 2010 and 2012. Ethical committee clearance was taken before the start of the study. Inclusion criteria included skeletally mature patients who presented to casualty with unstable intra and extra-articular fractures of the distal radius. Exclusion criteria included open fractures, fractures associated with neurovascular or tendon injuries, pathological fractures and multiple fractures. Investigations included plain radiographs of both the wrists (injured as well as healthy) in PA and lateral views. Fractures were classified by Frykman's classification [10]. In the casualty, fracture was immobilized in a well-padded below elbow POP slab. After getting medical fitness and a fully informed consent for surgery, they were treated by open reduction and internal fixation with a volar locking plate.

Surgical technique: -Surgery was performed under general anaesthesia. A proximal arm tourniquet was routinely used and prophylactic antibiotics administered before inflation. The surgical approach was through the sheath of the flexor carpi radialis tendon. 3.5 mm LCP T-plate was used for all the patients. The plate was applied to the volar aspect of the distal radius under direct vision and fixed proximally using the oblong hole to allow fine adjustment, the fracture was reduced and temporary fixation was maintained with K-wires. The reduction and plate position were routinely checked under image intensification. Distal locking screws were subsequently sited so as to reach but not penetrate the dorsal cortex. A measurement of 2 millimetres was routinely subtracted from the distal screw length measurement in order to avoid penetration of the dorsal cortex and to minimise the potential for extensor tendon irritation. Distal locking screws were positioned aiming to site them 2 mm below the joint line in order to provide subchondral support [11]. A final check was made for plate and

screw positions with image intensification using a standard postero-anterior view, two oblique views and a true lateral view of the wrist in order to ensure that the joint had not been penetrated [12].

After the surgery, the wrist was again immobilized in a below elbow POP slab and an arm pouch. Wound inspection was done on 3rd and 6th days. Sutures were removed on 10th post-operative day. After 3 weeks slab was removed and active and passive mobilization of the fingers, wrist and forearm was started. Subsequent follow-ups were done at 6 weeks and 24 weeks. The examination includes measurements of wrist and forearm motions and grip strength. The measurements were documented both as absolute values on the injured side and relative value as compared to the contra lateral or healthy side. The variables were compared on different follow up intervals and the mean of all available measurements is calculated and used as a reference value.

Functional assessment was done based on the demerit point system described by Gartland and Werley [13]. Radiological assessment is based on the measurement of variables: Radial inclination (RI), Radial length (RL) and Radial tilt (RT) during the follow-up period (Figure 3).

Observation and results: - In our study, a total number of 29 patients have been included who underwent volar plate fixation, out of which 4 patients were lost for complete follow up. Thus, the analysis has been done by measuring the following radiological and functional parameters for 25 patients: Radial Inclination (RI), Radial Length (RL), Radial Tilt (RT), Dorsiflexion (DF), Palmarflexion (PF), Supination (S) and Pronation (P). Gartland and Werley scoring has been used to assess the functional scoring of 25 patients. For statistical purposes the paired Student "t" test has been used and p value < 0.05 has been taken to be statistically significant.

Out of 25 patients, 8 patients were below 30 years, 8 patients were in 31-40 year age group, 5 patients were in 41-50 age group and 4 patients were above 50 years. Out of total of 25 patients, 5(20%) were females and 20(80%) were males. 6 patients (24%) had left side injury and 19(76%) had right side injury. 14 patients (56%) had sustained injury due to fall and 11(44%) had sustained injury due to RTA (road traffic accidents). Frykman classification for distal radius fractures was used in our study. Out of 25 patients, 19(76%) were of type VIII, 4(16%) were of type VII and 2(8%) were of type VI.

Mean Radial Inclination (RI), Radial Length (RL) and Radial Tilt (RT) at 3 weeks, 6 weeks and 24 weeks follow-up are enlisted in the Table 1 and there was no statistically significant variation in the any of the radiological variables during the course of follow-up.

Range of dorsiflexion, palmar-flexion, supination and pronation at 3 weeks, 6 weeks and 24 weeks follow-up are enlisted in the Table 1 and there was statistically significant improvement in these variables during the course of follow-up.

The mean Gartland and Werley score for 25 patients at the end of 24 weeks of follow-up was 3.

Out of 25 patients, 23 patients had no complications, 1 patient (4%) had superficial infection and 1 patient (4%) had loss of reduction during follow-up. These complications were promptly recognized and managed accordingly. Superficial skin infection was treated with regular dressing with antibiotic cover. Loss of reduction, which was noted at 3 weeks of follow-up, was managed by removal of the implant and re-plating with bone grafting.

Figure : Intra-operative pictures of volar plating of distal radius fracture.



Figure : Pre-operative, post-operative and 24 week's follow-up radiograph.



Figure : Measurement of Radial inclination (RI), Radial length (RL) and Radial tilt (RT).

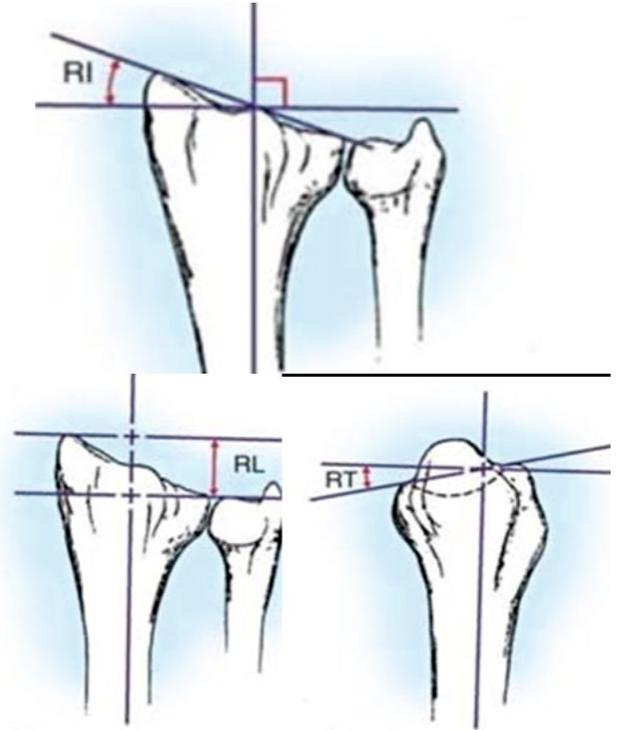


Figure : Follow-up clinical images showing functional improvement.



Table : Mean radiological and functional variables during the follow-up period

Parameters Follow-up	RI (degrees)	RL (millimetres)	RT (degrees)	DF (degrees)	PF (degrees)	SN (degrees)	PN (degrees)
3 Weeks	22.12	10.8148	9.68	30.60	33.80	29.20	33.20
6 Weeks	21.28	10.6667	9.84	43.40	47.80	37.80	41.60
24 Weeks	21.60	10.4815	9.72	70.60	74.20	66.40	68.80

Discussion: -No fracture in the body is as ubiquitous and fraught with potential complications as the complex fractures of the distal radius. Recognition of fracture pattern and proper fixation to secure and maintain reduction and prevent late collapse is the key to successful management. Anatomic restoration of these fractures is correlated directly to improved functional result of the affected wrist. 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. Leung et al. [14] demonstrated no statistical difference between axial loading transmission through the intact radius and a distal radius fracture fixed with a volar locking plate. In fact, the volar locking plate showed advantages over dorsal plating in the fixation of a dorsally unstable distal radius fracture. In addition, volar plate fixation is a valuable method because of the decreased risk of inducing dorsal soft-tissue complications. The palmar cortex is relatively flat, and the plate is better contoured for application from this aspect rather than on the dorsal cortex of the distal radius [15].

In our study, a total number of 29 patients have been included who underwent open reduction and internal fixation with volar plate, out of which 4 patients were lost for complete follow up. Thus, the analysis has been done by measuring the following radiological and functional parameters for 25 patients. In our study, the mean age distribution was 35 years with male preponderance. As per Frykman classification used for this study, type VIII was the commonest fracture pattern seen (76%). All 25 patients underwent open reduction and volar plate fixation. On follow-up analysis of radiological variables, there was no statistically significant decrease in radial inclination, radial length and radial tilt over the period of follow-up of 24 weeks. Jorge Orbay et al study on "Volar Plate Fixation of Distal Radius Fractures" also showed that RI, RL and RT were well maintained throughout the follow up period [11].

On follow-up analysis of functional variables, it was noted that the range of dorsiflexion, palmar flexion, pronation and supination improved over the period of follow-up and the improvement was statistically significant. Jupiter et al study on

"Operative Management of Distal Radius Fractures with 2.4-Millimeter locking plates" also showed significant improvement in range of palmar-flexion, dorsiflexion supination and pronation [16]. The mean Gartland and Werley score of 3 in our study was comparable to the scores in studies conducted by Jorge Orbay et al (score 4) and Jupiter et al (score 4).

Jupiter et al study had 28 complications (12%) with 2 patients having loss of reduction. Orbay et al study had 9% complication rate. In our study of 25 patients, 23(92%) did not have any complications, 1(4%) had superficial skin infections and 1(4%) had loss of reduction due to poor fixation. These complications were promptly recognized and managed accordingly. In all these studied, loss of reduction was seen in patients with osteoporotic and severely comminuted fractures which subsequently requires re-osteosynthesis and bone grafting. No implant failure, neurovascular injuries, tendon ruptures were seen in our study.

Conclusion: Primary volar plate fixation of unstable distal radius fracture provides a stable construct which helps in early mobilization, there by better functional outcomes and minimizes chances of delayed/malunion. However our study concludes that good intra-operative reduction and fixation is mandatory in order to reduce complications.

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