*IOSR Journal of Dental and Medical Sciences (IOSR-JDMS)*
*e-ISSN: 2279-0853, p-ISSN: 2279-0861.Volume 14, Issue 1 Ver. III (Jan. 2015), PP 54-59*
*www.iosrjournals.org*

# Fixed Angle Volar Plate Osteosynthesis for Unstable Distal Radius Fractures

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***Abstract:*** *Background: There is much debate regarding the optimal treatment of displaced, unstable distal radial fractures and there has been a trend toward open reduction and internal fixation of these fractures.*

***Objectives:*** *The purpose of this study was to evaluate the efficacy of a fixed-angle locking plate applied through a single incision volar approach in maintaining the radiographic alignment and functional outcome of unstable distal radius fractures.*

***Methods:*** *This is a prospective study in which 30 patients with persistent displacement of distal radius fractures after an initial attempt at reduction, between the ages of twenty and seventy years who provided written informed consent to participate in the study were included, and were treated using the fixed-angle volar plate through a single incision volar approach from September 2012 to August 2014. Outcome measures included radiographic parameters, wrist range of motion, Disability Arm Shoulder and Hand (DASH) questionnaire and Modified Green and O'Brien scoring.*

***Results:*** *The mean DASH score changed from a pre-injury baseline of 2 points to 7 points at the end of 18 months. Based on Modified Green and O'Brien score, 27 patients (90%) had excellent to good outcome in the final result. Complications encountered were 1 case of transient regional pain syndrome, two cases of hypertrophic scar, one case of late carpel tunnel syndrome and one case of delayed union.*

***Keywords:*** *Intra-articular fractures, volar fixed angle plate, unstable distal radius fractures*.

## I. Introduction

The incidence of distal radius fractures is increasing together with the average age of population. Intra-articular incongruity is the most probable cause of unsatisfactory outcome of distal radius fractures in younger and more active patients thus, the main goal in the treatment of distal radius fractures should be restoration of articular congruence.[1] Conventional method of reduction and cast treatment for this fracture has resulted in unsatisfactory anatomical and functional results with varying degree of deformity and disability.[2] In case of intra-articular fractures ( i.e. when the radio-carpal joint is involved ), anatomical reconstruction is of utmost importance to obtain good functional results.[3] An intra-articular step of more than 2 mm inevitably leads to osteoarthritis and a functional deficit. Some authors even stated that an intra-articular step of 1mm is unacceptable. Incongruence at the distal radio-ulnar joint leads to a painful and function-limiting arthritis.[4,5,6] Mal-alignment at the metaphyseal area leads to a changed load distribution at the wrist joint, this leads to a loss of motion and the development of osteo-arthritis at the wrist joint.[6,7] Here corrective measures, even in the older non debilitated patient, can bring a gain of function and a reduction of pain.[8] Radial shortening, often seen after fractures of the distal radius, leads to a radio-ulnar incongruence, subluxation of the ulnar head at the distal radio-ulnar joint and painful impingement of the triangular fibro-cartilagenous complex.[6,9] The amount of metaphyseal comminution is related to the shortening and the tendency to lose radial length, even after adequate reduction. Radial shortening the most important factor to determine the outcome after fractures of the distal radius.[10]

Fixed angle volar plates for the fixation of distal radius fractures were introduced by Orbay and Fernandez.[11] By placing the plate on the volar aspect of the distal radius one can avoid the close contact between the plate and tendons, because on the volar side the distance between the flexor tendons and volar cortex is longer and the plate can be completely covered by repairing the pronator quadratus muscle. Distal locking screws of the fixed angle plate prevent the distal fragments from collapsing dorsally which makes early mobilization possible. Volar fixed angle plates are pre-contoured to the anatomical shape of volar side of the distal radius. The direction of the distal locking screws is fixed by the plate design. Volar fixed-angle plates have been successfully utilised in the fixation of osteopenic distal radius fracture in elderly patients.[12] Contraindications to the volar plating of the distal radius are fractures of pediatric patients with open physis, open fractures with inadequate soft tissue coverage, and distal articular shear fractures (frequently seen in dislocation of the carpus) where there is insufficient bone distally for capture with the screws.[13]

## II. Materials And Method

30 consecutive patients with persistent displacement of a distal radius fracture after an initial attempt at reduction, treated with fixed-angle volar plate through single incision volar approach over a period of 24 months. Displacement was defined as radiographic evidence of more than 15° of angulation in any plane, more than 2 mm of intra-articular step-off, or more than 2 mm of radial shortening. Age of the patients ranged from twenty yrs to seventy yrs. There were 21 female patients and 9 male patients in this study. We used the AO/ASIF classification of distal radius fracture using plain radiographs. Our indications for use of fixed-angle volar plate were type A2, type A3, type B1, type B3, type C1, type C2 and type C3 distal radial fractures. Patients with type A1 and B2 were not included in this study.

**Operative procedure:** The patient was placed in supine position with hand supported on hand table under brachial plexus block or general anesthesia. Through the distal limb of a modified Henry volar approach, the dissection was continued between the FCR and the radial artery.[14] The skin incision was centred over the FCR tendon and of approximately 8 cm length (Fig. 1). The skin was incised longitudenally along the course of flexor carpi radialis (FCR) tendon. The FCR sheath was opened and tendon retracted to the radial side. Underneath the FCR sheath lies the flexor pollicis longus (FPL) tendon . This was retracted towards ulna revealing the Pronator Quadratus (PQ) muscle. The pronator quadratus muscle was elevated from its radial origin and reflected towards ulna to expose the distal radius. Each fragment was identified, disimpacted and reduced. Kirschner wires were used for provisional fixation depending upon fracture pattern. Plate was applied to the volar surface. The volar surface of the distal radius is flat. Application of flat implant on this surface automatically corrected any malrotaion of fracture fragments.

Plate was placed as distally as possible, to engage the strong subchondral bone but still proximal enough to be out of the joint by not projecting beyond or above the watershed line (Fig. 2). Drill guide was placed into a distal hole and a K-wire drilled through the guide and its placement was checked with fluororoscopy. First non-locking cortical screw was placed through the oval slot in the plate. The position of the plate relative to the articular surface was then adjusted by sliding the plate proximal or distal under fluoroscopy.

To assess the position of the distal locking screws relative to the articular surface and the dorsum of the radius, a K-wire was placed through the distal holes. The fracture reduction, plate position, and the location of the K-wire relative to the joint was assessed under fluoroscopy. Care was taken not to angulate the distal K-wires. One of the four distal holes was first targated. Screw length was measured by using the mark on the drill and the scale on the drill guide. Locking head screws were placed in the distal holes, depending on the fracture pattern; number and position of screws was decided. One by one the remaining proximal holes selected and locking head screws applied.

Finally proper joint reconstruction, screw placement and screw length ensured using multiple radiographic views. It was verified that the distal screws were not in the joint by using additional views such as a 10° dorsally tilted, 20° inclined lateral, and 45°pronated oblique view. Also, the length of screws checked with image intensifier from several different projections in order to avoid the screw penetration through the dorsal cortex, which may cause extensor tendon irritation and rupture.

Plaster splint was applied for 1 week postsurgery, during this period active finger, elbow and shoulder movements were encouraged. Patients were encouraged to perform active flexion and extension movements of affected wrist after 7 days postsurgery. Ulnar deviation, palmer deviation and active rotational exercises were started two weeks postsurgery. Patients were followed up every three weeks for first 12 weeks after surgery, then every six weeks for next three months, then every 12 weeks for next six months, then finally at the end of 18 months postsurgery (Figure 3 A,B,C).

## III. Results

The mean age of patients was 51.6 years (range 20-70 years). There were 21 females and 9 males. The mean time from injury to operation was 5 days (range 1-11 days). Fall from standing height accounted for 23(76.66%) fractures, road traffic accidents accounted for 5(16.67%) fractures and fall from height accounted for 2(6.67%) fractures. Right side was involved in 17 (56.67%) patients and left side was involved in 13 (43.33%) patients. According to AO/ASIF classification there were A2(n=7), A3(n=6), B1(n=2), B3(n=3), C1(n=7), C2(n=4), and C3(n=1) fracture. None of the injured wrists presented static carpal instability or unstable lesions of the distal radio-ulnar joint. The mean time to clinical union was 7.1 weeks (range 5-10). Mean time to complete cortical bridging or radiological union was 7.5 weeks (range 6-12). All 30 patients were followed up for an average duration of 18 months. The mean DASH score changed from a pre-injury baseline of 2 points to 7 points at the end of 18 months. Based on the functional assessment criteria i.e. Modified Green and O'brien

Score, for the present study, the final outcome for all cases was excellent in 21 (70%) patients, good in 6 (20%) patients , fair in 2 (6.67%) patients and poor in 1(3.33%) patient. Thus excellent and good results were seen in 90%. One patient with poor result was type-C3 fracture having delayed union and limitation of wrist joint function. Comparing the immediate postoperative x-rays with those taken at final evaluation, all fixations were maintained throughout the follow-up period so that the final assessments were same as intraoperative alignments. There was no intraoperative and immediate postoperative complication. Late complication encountered were consisted of one case of transient regional pain syndrome, two cases developed hypertrophic scar, one case of late carpel tunnel syndrome and one case of delayed union.

## IV. Discussion

Fixed-angle volar plating represents a valuable treatment modality for the most frequent types of unstable fractures of the distal radius. The volar plate system used in our study was a locking plate system, and this must be one of the reasons for retaining good anatomical reduction. Volar plate fixation of unstable distal fractures has been described recently.[15-18] Our results are comparable to the final follow-up range of motion, radiological evaluation, and functional assessments presented in these recent reports. Conventonal method of reduction and cast treatment for distal radius fracture has resulted in unsatisfactory anatomical and functional results, varying degree of deformity and disability with secondary loss of reduction during treatment in 35% of cases. The angular stable plates make it possible to treat most fractures from the volar side. The screws, which are locked in the plate, are placed just proximal to the subchondral bone. The distal screws are locked to the plate, which stabilizes the screws against lateral movement (toggle) and resists loosening. The screws will act as a buttress for this dense bone and theoretically no secondary loss of reduction is witnessed. Percutaneous pinning along with closed reduction is suitable for fractures without intra-articular instability and without metaphyseal comminution. Most common complications of percutaneous pinning are pin track infection and iatrogenic lesion of superficial branch of the radial nerve, which may cause chronic regional pain syndrome (CRPS).[19] Pin tract infection was a major complication of external fixation. In our study there was no infection. There is usually a gradual loss of the initial distraction force through stress relaxation of soft tissues causing partial loss of immediate improvement in radial height, radial inclination, and volar tilt by the time of fixator removal.[20,21] Although distal radius fractures can be easily reached from dorsal approach and dorsally angulated metaphyseal fractures are easy to reduce and fix from the dorsal side, complications related to dorsal plating are numerous. Complications related to dorsal plates are tendon rupture or tenosynovitis leading to reoperation in up to 32%, and a collapse in up to 25%.[22,23] The relatively large distance between the flexor tendons and the plate and the protection of the pronator quadratus muscle, make flexor tendon problems extremely rare. The volar application of fixation implants and the avoidance of dorsal dissection with its associated devascularization of dorsal fragments would facilitate early functional use of the hand while minimizing the need for bone grafting. In current study 13.3% cases developed complications including one case of transient regional pain syndrome, two cases developed hypertrophic scar and one case of late carpel tunnel syndrome. Hypertrophic scar was excised at the time of implant removal, transient regional pain syndrome responded completely to physical therapy and sympathetic nerve blocks, carpel tunnel syndrome was managed by nerve release. In our study excellent and good results were seen in 90%. One patient with poor result was type-C3 fracture having delayed union and limitation of wrist joint function. These unstable high-energy fractures with considerable comminution (AO C3 fractures) require supplemental internal fixation with K-wires or multiple plates. These type of fractures should not be considard for isolated volar plating.[24] Limitations of this study include small sample size and absence of a control group.

## V. Figures And Tables

**Figure 1** Showing site of incision

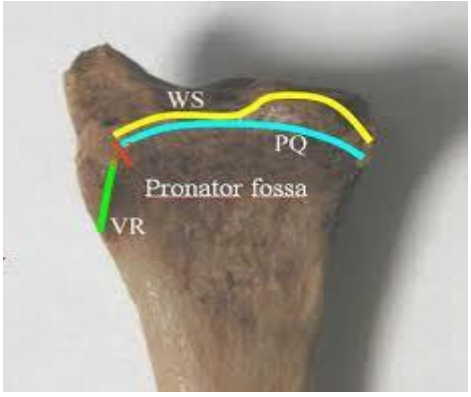
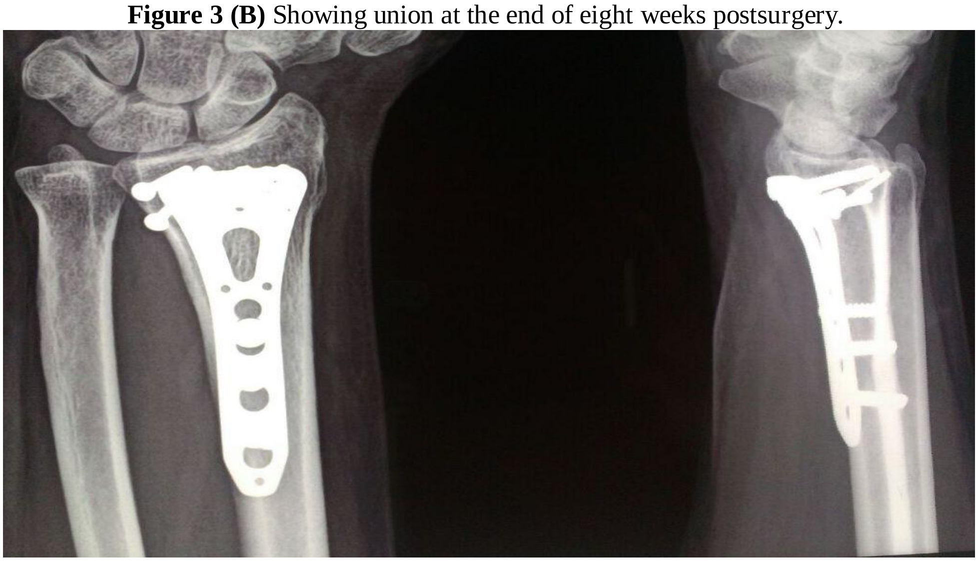



**Figure 2** showing watershed line (WS).

**Figure 3(A)** Showing intra-articular fracture.
**Figure 3 (B)** Showing union at the end of eight weeks postsurgery.



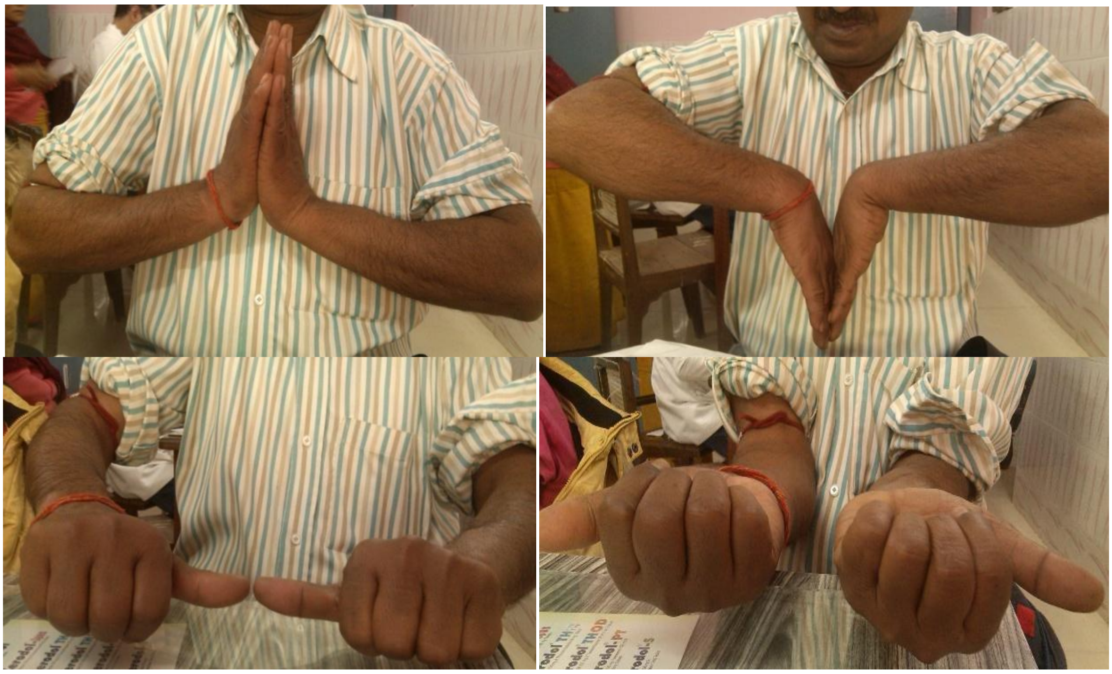


**Figure 3 (C)** Showing range of motion at the end of eight weeks postsurgery.

## VI. Conclusion

Our study findings suggests that application of a fixed-angle volar locking compression plate with single incision volar approach for displaced distal radial fracture is a safe alternative and should be the standard of care in treating displaced, unstable fractures of the distal radius. Internal fixation of displaced distal radial fractures with implants featuring fixed-angle plate with locking screw fixation can result in good to excellent outcomes with a limited number of complications.

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