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# MANAGEMENT OF DISTAL RADIUS FRACTURES: SERIES OF 50 CASES

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**Abstract:**

**Background:** Distal radius fractures are among the most common injuries of the wrist that orthopedic surgeons will face in a trauma practice. In the past, these were treated by k-wires, external fixation or both. With advances in internal plate fixation, the trend has changed to treat the more unstable fractures by open reduction and internal fixation. The aim of our study was to find out the efficacy of a variable angle locking plate fixed by volar approach in maintaining the radiographic alignment of unstable intraarticular fractures as well as to report the clinical outcomes.

**Materials and Methods:** This prospective study was conducted from 1st May 2015 to 31st December 2016. 50 cases of intraarticular distal radius fractures were analyzed. Over 80% were C2/C3 fractures, based on the AO classification. 4 open fractures were noted.

**Results:** With an average follow up of six months the range of movement of the wrist was very satisfactory, and the mean grip strength was 81% of the opposite wrist. The Disabilities of the Arm, Shoulder, and Hand (DASH) score was 8. The complications rate was < 5%, including loss of reduction in two patients. 2 cases of tenosynovitis and 2 cases of flexor pollicis longus rupture were noted. Screw penetration into the radioulnar joint was observed in 2 case All fractures healed by 3 months post injury.

**Conclusions:** Irrespective of the direction and initial displacement, majority

of intraarticular fractures of the distal radius can be managed with a Variable angle volar plate through volar approach. Complications were due to technical errors in implant placement which can be corrected by the surgeon with more precision while operating.

**Key words:** Distal radius fractures, volar plate, internal fixation.

## Introduction

Few decades ago, distal radius fractures were often casually regarded as 'Colles' fractures'. The treatment was mainly manipulation and casting as proposed by Abraham Colles in 1841,<sup>1</sup> although these fractures would heal with deformity, the functional deficit would be acceptable. With better understanding of the various fracture types, classifications such as Frykman,<sup>2</sup> Melone<sup>3</sup> and AO<sup>4</sup> were developed. There was a need for a better method of treatment after careful study of the individual fracture pattern. Intraarticular fractures of the distal radius poses a challenge as compared with unstable extraarticular fractures.<sup>5</sup> Apart from being more difficult to reduce and stabilize with internal fixation, these fractures frequently result in malunion,<sup>6</sup> which results in a less satisfactory functional outcome, if not anatomically reduced.<sup>7</sup>

In the past, these types of fractures were treated by k-wires, external fixation or combination of both. With advances in internal plate fixation, there has been a trend by orthopaedic surgeons to treat the more unstable fractures by open reduction and internal fixation. Recent biomechanical studies have addressed the issue of stability from pin vs plate fixation and compared volar locked plate fixation vs volar and dorsal unlocked plate fixation. The volar plate provided the most rigid stability with least amount of fracture gap formation and fragment specific fixation has emerged as an option.<sup>8</sup> Open reduction and internal fixation (ORIF) using volar variable angle plates has also shown to be a valid treatment option for unstable, dorsally displaced distal radial fractures.<sup>9,10</sup>

The purpose of our study was to find out the efficacy of a variable

angle locking plate fixed through a volar approach in maintaining the radiographic alignment of unstable simple intraarticular fractures as well as to report the clinical outcomes.

## Materials And Methods

The study was conducted from 1<sup>st</sup> May 2015 to 31<sup>st</sup> December 2016. The study was approved by the institutional ethical committee. 50 patients of intraarticular fractures of the distal radius were treated with internal fixation using volar locked plate through a volar flexor carpi radialis (FCR) approach. All of the patients gave informed consent for surgical treatment. Three patients were lost to followup thus, we analyzed the remaining 47 patients. We excluded all distal radius fractures that presented with (1) dorsal Barton's fractures, (2) radiocarpal fracture dislocations, (3) dorsal articular impacted fractures (4) isolated radial styloid fractures, and (5) highly intraarticular comminution and /or bone loss. There were 21 female and 26 male patients. The average age was 50.3 years old (range, 18-70years old). More than 50% of the patients ( $n = 47$ ) sustained their injury after a simple fall on an outstretched hand. The remaining were road traffic accidents. One patient had bilateral fractures. (Table 1)

The fractures were classified according to the OTA Classification. There were 10 C1, 21 C2, and 16 C3 fractures (Table 2). Fracture displacement was volar in 09 fractures and dorsal in 38 fractures. Out of these 04 were open fractures, which were classified as Gustillo grade 1 (i.e., open fracture with clean wound < 1 cm in length). Standard anteroposterior (AP) and lateral Xray images were taken of both wrists, with the parameters measured by ruler in millimeters based

on Castaing.<sup>11</sup>

The preoperative radiographs showed an average dorsal tilt of 22° (range, 35°volar tilt to 60°dorsal tilt), an average radial inclination of 9.7° (range 10° to 35°), and an average radial shortening of 4.3 mm (range, 0 to 12 mm). Articular incongruity (stepoff or gap of the articular surface) averaged 4.0 mm (range, 1 to 10 mm). All fractures were treated by using a variable angle locking plate and a volar incision overlying the FCR tendon.

## Operative technique:

The volar approach for dorsally displaced distal radius fractures utilizes an incision that is centered longitudinally upon the flexor carpi radialis (FCR) tendon. This approach, popularized by Orbay et al. (2000, 2002, 2004) allows distal and radial exposure through the use of a distal and radial limb to the incision that begins at the junction of the FCR and the proximal wrist crease. This protects the palmar cutaneous branch of the median nerve and allows balanced exposure over the fracture site (Figure 1).

The superficial branch of the radial artery is identified and protected, and the anterior and posterior sheaths of the FCR are incised and the space of Parona is developed. The flexor tendons and median nerve are retracted ulnarly and the pronator quadratus fascia is incised on its radial and distal borders. The muscle is reflected ulnarly protecting the ulnarly based metaphyseal blood supply and the innervation by the anterior interosseous nerve. Depending upon the fracture deformity and need for further exposure, the brachioradialis tendon may either be elevated off the radial styloid or identified just proximal to its insertion and released using a Z step tenotomy (Orbay 2001).

Debridement of the fracture site is completed under manual traction and a provisional reduction is performed. The proximal radial metaphysis typically is displaced ulnarly to the distal fragments and a Homan retractor may be used to lift the ulnar border of the metaphysis to reduce the volar ulnar cortex. Following reduction of the volar ulnar cortex, traction and ulnar deviation of the wrist combined with a dorsal to volar translation of the lunate with some wrist flexion will assist the surgeon in maintaining the fracture reduction. Percutaneous k-wire fixation may be necessary as an adjunct to help to maintain the reduction.

A Volar plate, with locked distal fixation, is positioned and is provisionally fixed to the radius with a K-wire and fluoroscopic evaluation is examined to check the position of the plate and the trial reduction. The plate is then secured to the shaft with a cortical screw placed through the oblong hole to allow for positional adjustment if needed. Temporary percutaneous Kwire fixation may be used to maintain the articular reduction and cancellous bone graft may be used to facilitate the reduction and to add stability. The distal locking screws are then placed into the distal fracture fragment and are locked to the plate. Intraoperative fluoroscopy was used to obtain AP and lateral view <sup>[12]</sup> to confirm the absence of intraarticular screw penetration, and the dorsal horizon view to confirm the absence of screws emerging beyond the dorsal cortex. The time interval between the injury and surgical fracture fixation was on average 6.1 days (range, 0-12 days). Delayed open treatment was performed in 3 severely comminuted C3 fractures, which were initially treated with temporary external

fixation.

Distal radioulnar joint (DRUJ) instability was tested in all cases intraoperatively after the fixation of the distal radius. DRUJ instability was arbitrarily defined as an increase in the anteroposterior translation of 5-10 mm as compared with the uninjured wrist and a soft endpoint, when tested after the plate fixation of the distal radius. Twenty two patients were noted to have an associated ulnar styloid fracture. Only four patients were detected to have an unstable DRUJ intraoperatively, as judged by the surgeons' clinical appreciation which was managed with internal fixation and temporary radioulnar K-wire transfixation.

Postoperative exercises were started immediately with finger range of motion, elbow and shoulder motion, and anti-edema measures. Patients were encouraged to begin activities of daily living as soon as they were comfortable. Heavy lifting was not allowed until signs of fracture healing were radiographically confirmed (i.e 6-8 weeks postoperatively). The follow-up protocol was 1-2 weeks, 5-6 weeks, 3 months, 1 year, and 2 years. Clinical and radiographic assessments were performed at every visit. The clinical outcome was evaluated with the following parameters: range of motion of the wrist and fingers, grip strength, pain according to the Fernandez<sup>13</sup> pain score (Table 3) and the Disabilities of the Arm, Shoulder, and Hand (DASH) score.

Standard plain X-ray images of the wrist were taken and the following parameters, according to Castaing were measured: volar tilt, radial inclination, radial length and articular joint congruency. Pre and postoperative x-ray images were compared to assess the correction of the initial fragment

displacement and to recognize any postoperative loss of reduction. Bone healing was defined as the presence of bridging bony trabeculae across the fracture lines on both the AP and lateral views.

## Results

The minimum follow-up period was 6 months. For the majority of cases, full finger motion was achieved at the end of the first week, and satisfactory forearm rotation was achieved by 8 weeks postoperatively (Figure 2). At 1.5 years follow-up all patients had achieved full finger range of motion. The mean wrist motion was as follows: 56° of extension, 52° of flexion, 22° of ulnar deviation, 15° of radial deviation, 79° of pronation and 74° of supination. (Figure 3) The average grip strength was 81% compared with the patient's unaffected wrist.

31 patients had no pain, 12 patients had mild pain, and 4 patients had moderate pain according to the Fernandez pain score. Of the 16 patients that suffered with some residual pain, all except one had a C2 or C3 fracture pattern. Additional chondral damage or partial non recognized carpal ligament injuries might explain the persistence of discomfort. The average DASH score for all patients was 8. Radiographically, all fractures healed uneventfully with an average time to bone union of 14 weeks (range, 12-16 weeks). At final follow up, the average volar tilt was 6.7° (range, 2° of dorsal tilt to 15° of volar tilt), radial inclination averaged 20.2° (range, 12-28°), radial shortening averaged 0.7 mm (range, 0-2 mm), and articular congruity averaged 0.14 mm (range, 0-2 mm) (Table 4). The position of the plate was noted to be on average 1.1 mm (range, 0-3.5 mm) proximal

with respect to the watershed line. The complications rate was < 5%, including loss of reduction in two patients which was directly related to the surgeon's failure in placing the plate in a more distal position. 2 cases of tenosynovitis and 2 cases of flexor pollicis longus rupture were noted. Two cases of complex regional pain syndrome (CRPS) were also observed. There was no case of implant failure. Two patients had superficial wound infections that were resolved with regular dressings and antibiotic administration for two weeks. Screw penetration into the radioulnar joint was observed in 2 patients, which remained asymptomatic at follow-up (Figure 4). Another patient developed carpal tunnel syndrome, which was managed with a splint and the symptoms were resolved in three months. None of the patients had malunion, or nonunion.

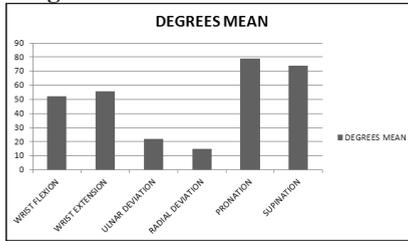
**Figure 1: Operative steps-Volar Approach**



**Figure 2: Complete Range of Movement at the wrist at 1 year follow-up**



**Figure 3: The mean wrist motion**



**Figure 4: DRUJ instability, 2 mm K-wire was pinned to the radius. The pin was left in place for a period of 4 weeks. Also Radiograph Showing Screw penetration**



**Figure 5: Pre and post-op radiograph of patient with unstable fracture**



**Table 2: The distribution of the severity of intraarticular fractures of distal radius based on AO classification<sup>4</sup>**

AO type C classification of distal radius	Description	No of patients
C1	Simple intra-articular fracture with simple metaphyseal involvement	10
C2	Simple intra-articular fracture with multifragmentary metaphyseal configuration	21
C3	Multifragmentary intra-articular fracture	16

**Figure 6: Pre and post-op xrays of Unstable Distal End Radius Fracture after plate fixation**



**Table 1: Clinical Profiles of Patient**

Clinical profiles	Values
Age in years (mean)	50.3
<b>Gender</b>	
Male	26
Female	21
<b>Mechanism of injury</b>	
Rta	31
Self fall	14
Assault	02
<b>Type of fracture (AO classification)</b>	
C1	10
C2	21
C3	16

**Table 3: Degree of residual wrist pain, described by the patients (Fernandez)<sup>14</sup>**

Degree of pain	Description
None	Absence of pain in carrying out all activities
Mild	Presence of pain only at the extreme(s) of the active range of motion of the wrist No physical or psychological disturbance was noted
Moderate	Presence of pain during heavy manual labor. Either physical or psychological disturbance or both was noted
Severe	Presence of pain occurring during activities of daily living and even at rest

**Table 4: Radiological Parameters**

Parameters	Normal values	Immediate post-op	At follow up
Radial length, mm	Average = 12 mm.	12.04	11.84
Radial inclination°	Average = 23°	23.08	20.2
Volar angulation°	Average = 12°	5.56	6.7
Ulnar variance mm	Neutral	-0.33	-0.29

## Discussion

The treatment of distal end radius fractures varies from closed reduction and casting in minimally displaced fractures to open reduction and internal fixation in more complex fractures. An anatomical reduction of the joint surface with rigid fixation is the main goal in the treatment of intraarticular fractures. Open reduction and internal fixation restore the wrist's anatomy and help in faster rehabilitation with good clinical outcomes.<sup>15</sup>

It has been shown that residual intraarticular incongruity leads to posttraumatic arthritis in the long term.<sup>16,17</sup> The current trend of management for irreducible fractures (C3 fractures) has shifted from bridging external fixation, pins, and bone grafting to open reduction and stable internal fixation.<sup>18,19,20</sup> Volar plating is currently favored for comminuted distal end radius fracture

patterns and osteoporotic bones.<sup>21</sup> The volar cortex of the distal end radius is often less comminuted than the dorsal cortex; therefore, anatomical reduction of the palmar cortex restores the radial shortening. Moreover, the volar cortex is better contoured with respect to the dorsal cortex in terms of plate application (Figure 5). There had been a shift in focus from the use of non-locking volar plates to locking volar plates as the latter provides secure and reliable fixation of complex fractures due to angular stability.<sup>22,23</sup> Kanabar et al reported that early mobilization in fractures treated with volar fixed locking plates does not lead to a decrease in the radiological parameters achieved at the final follow-up.<sup>22</sup> Gruber et al noticed a statically significant loss in parameters like radial inclination and volar tilt with the use of volar fixed-angle plates.<sup>24</sup> A few other studies

have also reported a reduction in the radiological parameters during the follow-up period with the use of volar fixed-angle plates.<sup>25</sup> The most significant change in parameters was seen in cases with comminuted distal end radius fractures (C2 and C3). The introduction of variable angle plates addressed this problem in many such cases. Various other studies reported the use of additional methods like Kirschner wire and/or dorsal plating in a few comminuted fracture patterns (AO type C3).<sup>26,27</sup> With the introduction of variable angle locking plates, there has been a decrease in the use of these additional methods of fixation. The adaptation of screw direction helps in engaging specific fracture fragments and avoiding intraarticular penetration (Figure 6). Stanbury et al. reported the superiority of variable angle volar locking plates over fixed-angle locking plates in capturing the distal radial styloid.<sup>28</sup> However, in our case series, three cases required additional measures to stabilize the unstable distal end radius fracture. Kirschner wire was used to engage small radial styloid fragments that could not be engaged with the plate screws. Plate position is important because an increase in the incidence of flexor tendon irritation and/or ruptures has recently been reported in distal plate application due to the prominence of the distal edge of the volar plate, leading to direct contact with the flexor tendons. Volar prominence of the plate is often associated with an insufficient fracture reduction and residual dorsal tilt of the dorsal fragment as well as with plate application distal to the watershed line. We had two cases of flexor tendon ruptures in our series.

The final functional outcome of the patients in our study was favorable compared with other reported series of

open reduction, internal fixation, and functional aftertreatment of complex articular distal radial fractures. In our study there were only two cases of screw misplacement because extra care was taken to prevent this complication.

Instability of the DRUJ is recognized as a poor prognostic factor in the management of distal radius fractures. However, recent studies have shown that if the distal radius fractures are anatomically reduced and rigidly fixed with locking plates, no significant difference is noted in the final outcome between patients with and without ulnar styloid fractures, despite the location of the fractures and the degree of displacement.<sup>29</sup> Even if the ulnar styloid fracture progresses to nonunion, no significant clinical difference has been noted when compared with patients with united ulnar styloid fractures.<sup>30,31</sup> We had nearly 50%(22) of patients associated ulnar styloid fractures, only four patients were found to have DRUJ instability intra-operatively, requiring temporary stabilization of the DRUJ. These patients were noted to have stable DRUJ at 6 weeks.

The drawback of our study is that there was no control group hence no conclusions can be made as in comparison with other types of treatment methods.

### Conclusion

We conclude that variable angle locking plates are a treatment method with a low complication rate. It helps in early mobilization without the fear of a decrease in radiographic indices and hence functional results. Thus it can be a useful modality for treating unstable distal end radial fractures. With the execution of good surgical techniques, including proper plate position and insertion of screws

and avoidance of past pointing, and proper patient selection, a satisfactory functional and radiological outcome can be obtained for a great majority of patients with complex intraarticular distal radius fractures by using a volar approach and a variable angle locking plate.

Despite the small sample size, the present study could provide a basis for any future prospective studies involving variable angle volar locking plates.

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