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## Long term outcome of lower end radius fractures treated with locking plates

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### Abstract

**Introduction:** Fractures of distal end radius account for one sixth of all fractures that are seen and treated by orthopaedic surgeons. Increasing functional demand and improved methodologies of achieving and maintaining anatomical reduction, restoration of length, angulation and congruity of joint have generated renewed interest in addressing the anecdotal comments in more precise manner. Plating is a technique to restore and maintain the radial length and prevention of metaphyseal collapse. The focus of our interest in this study is to evaluate the outcome of plating in fractures of lower end of radius.

**Methods:** We reviewed 36 patients treated for distal radius fractures using a plate. All patients were treated by volar plating using Henry's volar approach for distal radius. Postoperative management included immediate finger movements, limb elevation and wrist immobilization for 4-6 weeks depending on fracture pattern and followed by wrist range of movement physiotherapy. Patients were followed for total 6 months-5 years. Radiographs of wrist joint were taken as well as movements in the form of dorsiflexion, palmarflexion, pronation, supination, radial deviation, ulnar deviation and hand grip were assessed at every follow up for all patients. At every follow up, patients were assessed using Gartland and Werley's Demerit Scoring System for the result of plating of distal radius fracture. Patients were also evaluated for radiological outcome at immediate postoperative and at final follow up, in the form of radial length, radial inclination and volar tilt.

**Results:** Fracture union had occurred in all patients at the mean time of follow-up of 9.5 weeks. On X-rays taken at the time of follow-up, 31 patients (86.10%) had achieved acceptable radial length that is radial shortening <5 mm at distal radioulnar joint. 5 patients (13.90%) had a radial shortening of 5 mm. The mean radial length was 9.61 mm. The mean radial inclination was on average 21.53° and the volar tilt was on average 4.22°. Our patients had mean dorsiflexion 66.22°, mean palmar flexion 56.86°, mean supination 74.61°, mean pronation 70.91°, mean radial deviation 14.94° and mean ulnar deviation 28° at final follow up. Out of 36 patients, total 32 patients (88.90%) had excellent and good outcome as per subjective evaluation in Gartland and Werley's demerit score system. Asymptomatic tenosynovitis was found most commonly than any other complications. Gartland and Werley's Criteria results yielded an excellent outcome in 21 cases (58.33%), a good outcome in 12 cases (33.33%) and a fair outcome in 3 cases (8.33%). The fair results were due to difficulty in getting primary reduction with the persistence of incongruity of the radio-carpal and the distal radio-ulnar joints, incomplete restoration of radial length.

**Conclusion:** Distal radius fractures in our study, are more common in young and middle aged (20 to 59 years) males who had sustained high velocity trauma (RTA). This favours that young male sustaining road traffic accidents are more prone to intra-articular, displaced distal radius fracture than extra articular fracture and elder patients, who have osteoporotic fracture. Locking plate used for fixation of intra-articular, displaced, lower end radius fracture, gives excellent to good result. This means that, plating in unstable intra-articular fracture of distal end radius using locked plates has become an effective tool in the management of difficult injuries. Anatomical restoration of articular congruency along with restoration of radial length and reduction of the dorsal tilt to volar, having great importance with regards to long term outcomes.

**Keywords:** Distal radius fracture, locking plate

### 1. Introduction

Fractures of distal end radius account for one sixth of all fractures that are seen and treated by orthopedic surgeons<sup>[1]</sup>. These fractures are characterized by varying degree of comminution with volar and dorsal displacement, articular spread & depression and involvement of major fragment with or without involvement of radio carpal radio ulnar joint.

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Having been recognized for nearly two centuries, fractures of the distal radius recently have become the focus of an intense resurgence in interest regarding optimal management [2]. Formerly considered relatively innocuous injuries incurred principally by the elderly, these fractures are now acknowledged as serious disruptions of wrist anatomy, with a considerable incidence of complications that affect a much larger segment of the populations. Heightened awareness of the widening scope of distal radius fractures has led to the emergence of a substantial change in concepts that rational treatment should incorporate [3,4].

Prominent among these concepts is that functional recovery closely parallels the accuracy of skeletal restoration. The overly optimistic attitude that a favourable outcome will eventuate, despite residual deformity must be tempered by the realization that the common factor predisposing to a suboptimal recovery is malunion. Moreover for the most frequently occurring intra-articular fractures, an increasing consensus exists that preservation of distal radial articular contours, that in many cases can be achieved only by open treatment, is an absolute prerequisite for successful recovery [5]. Residual joint incongruity of seemingly minimal extent is prone to the inevitable development of disabling arthritis. Furthermore it is increasingly evident that well conceived treatment for the diverse spectrum of distal radius fractures is contingent upon strict definition of specific fracture configuration. The extent to displacement, the degree of articular disruption, the stability and the reducibility of each fracture, as well as any concurrent injury to adjacent nerves, tendons or carpal structures must be assessed carefully in the planning of logical treatment. Clearly, optimal management requires an accurate recognition and repair of concomitant injuries and rehabilitation supervised by highly skilled therapists [6,7].

The comminuted intra articular fractures (A.O. C2 & C3) occur in younger population. Here, the treatment is quite difficult and the rate of complications is evidently high. Jupiter described it as pilon fracture of upper extremity [8]. Other methods include external pin fixation, plate fixation, percutaneous pinning, bone grafting, fragment specific fixation and arthroscopic fixation.

Increasing functional demand and improved methodologies of achieving and maintaining anatomical reduction, restoration of length, angulation and congruity of joint have generated renewed interest in addressing the anecdotal comments in more precise manner [9]. Plating is an outstanding technique because of its ability to restore and maintain the radial length and prevention of metaphyseal collapse. Loss of reduction is the most common complication which can be prevented with plate. The objective of the present study is to determine the results of plating of fractures of lower end of radius.

## 2. Methods

The study was conducted in the Shri Vinoba bhav Civil hospital, in the Department of Orthopaedics from the year June 2010 to December 2016. Outcomes of intra articular fracture lower end radius using locked plates as a type of implant for open reduction and internal fixation of the fracture fragments were included in the study. All patients sustained distal radius fracture grade III to grade VIII according to Frykman classification

A total of 36 patients were studied, there were 28 (77.80%) Males and 8 (22.20%) Female patients of Age 18-70 years (mean= 40.22 years). It was observed that out of 36 patients, 23 (63.90%) had been injured by RTA (Road Traffic

Accident), whereas 7 (19.40%) had sustained injury due to fall from height and remaining 6(16.70%) due to domestic fall at home. All the fractures were closed fractures. Out of 36 patients, 17 (47.20%) patients had isolated distal radius fracture and rest had associated ulna styloid fracture. The heights number of patient i.e. 23 (63.90%) under the current study was affected by the type III (Intra articular, displaced) fracture as per Gartland & Werley classification. Rest 12 patients (33.30%) had Type I (Extra articular) fracture while 1 patient (2.80%) having type II (Intra articular, UN displaced) fracture was recorded. It was found that 14 patients (38.90%) were operated within two days of occurrence the injury. Total 25 patients (69.44%) were operated within four days of the injury. Mean of time to operative intervention was 2.2 days (Range of 2-8 days). All patients received Open Reduction and Internal Fixation with Volar Locking Plate.

### 2.1 Surgical Method

A longitudinal incision is made slightly radial to the flexor carpi radialis tendon. The space between the flexor carpi radialis tendon and the radial artery is dissected exposing the pronator quadratus, which is detached from the lateral border of the radius and elevated from the radial metaphysis towards the ulna. The tendon of the flexor pollicis longus is visible more proximally in the wound and partial detachment of its radial attachment is necessary when applying longer plates to this part of the bone.

Volar fixed angle plating is a fixed angle plate to support subchondral bone and articular fragments. Reduce the radial styloid fragment (lateral column) and secure it to the shaft fragment with temporary kirschner wires. Reduce the medial column volar and dorsal fragments. Percutaneously pin the dorsal medial fragment to the shaft fragment with one or two kirschner wires entering the dorsomedial fragment distally aiming proximally into the radial shaft. If necessary, expose the dorsal medial fragment through a longitudinal approach between the third and fourth dorsal compartments. Apply a fixed angle locking plate and screws. If secure fixation is achieved with a locking plate, the kirschner wires can be removed. If the ulnar styloid is fractured and greatly displaced and the distal radioulnar joint is unstable, fix the styloid with one or two percutaneous kirschner wires.

### 2.2 Post-Operative Rehabilitation

During the fracture immobilization using a cock up slab rehabilitation should include: Immediate exercise of uninvolved joints, finger elbow and shoulder, Resistive exercise, Reduction of post-operative oedema, Ablation of pain prevents complex regional pain syndrome. Following suture removal at two weeks and plaster slab removal at three weeks it should include; Scar management, Immediate joint mobilization, Active and passive exercises, Muscle strengthening exercises.

Radiographs were done for three months at an interval of four weeks.

At the final follow-up, patients were assessed using Gartland and Werley's Demerit Scoring System for the result of plating of intrarticular fracture of lower end radius.

## 3. Results

All incisions healed by primary incision. There were no cases of Early Post Op complications. All patients were follow up for a period of 30-45 months with a mean of 35 months. We noted 14 patients (38.90%) fracture got united within 10 weeks of time. The range of reunion time varied from 6 weeks to 14

weeks. The average mean for the sample of 36 patients worked out to be 9.53 weeks. At the time of final Follow-up, the mean volar tilt was 4.22°, 9.61 mm mean radial length and 21.53° of average radial inclination. Wrist flexion activity was similar to opposite side in 14 cases, 31°- 60° in 20 cases while 2 patients had a decreased range of motion, upto 30°. Dorsal flexion was upto 90° in 24(66.66%) patients, with partial restriction with a range of 30°- 60° in 12(33.33%) patients. Supination and Pronation was upto opposite side in 34(94.44%) patients. According to Gartland and Werley assessment system, the

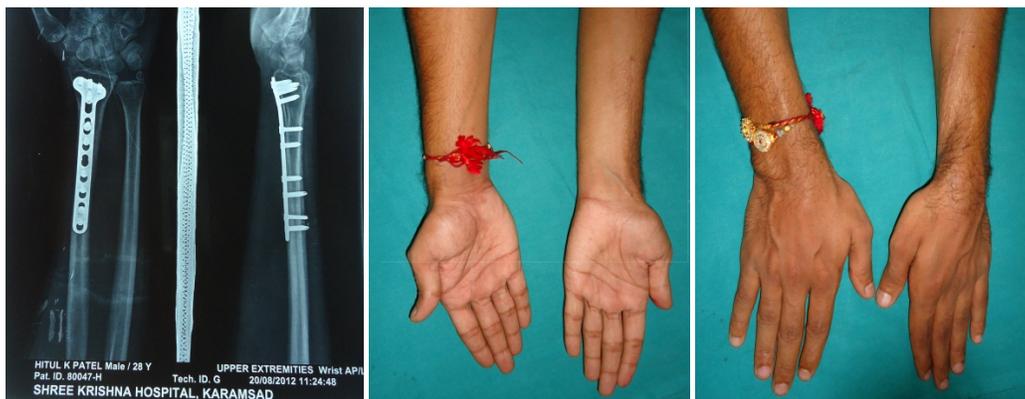
results were excellent in 21(58.30%) cases, good in 12(33.33%) cases, fair in 3(8.33) cases and poor in 0 cases at the time of final follow up.

**Case 1:** 28 Years, male patient present with history of fall from height and come with Gartland and Werley type II that is, intra articular, undisplaced lower end radius fracture on left side with ulnastyloid fracture. Patient was operated with locked volar plate and additional fixation by K-wire.



Pre-operative X-ray

Post-operative X-ray



Follow up X-ray

Supination

Pronation

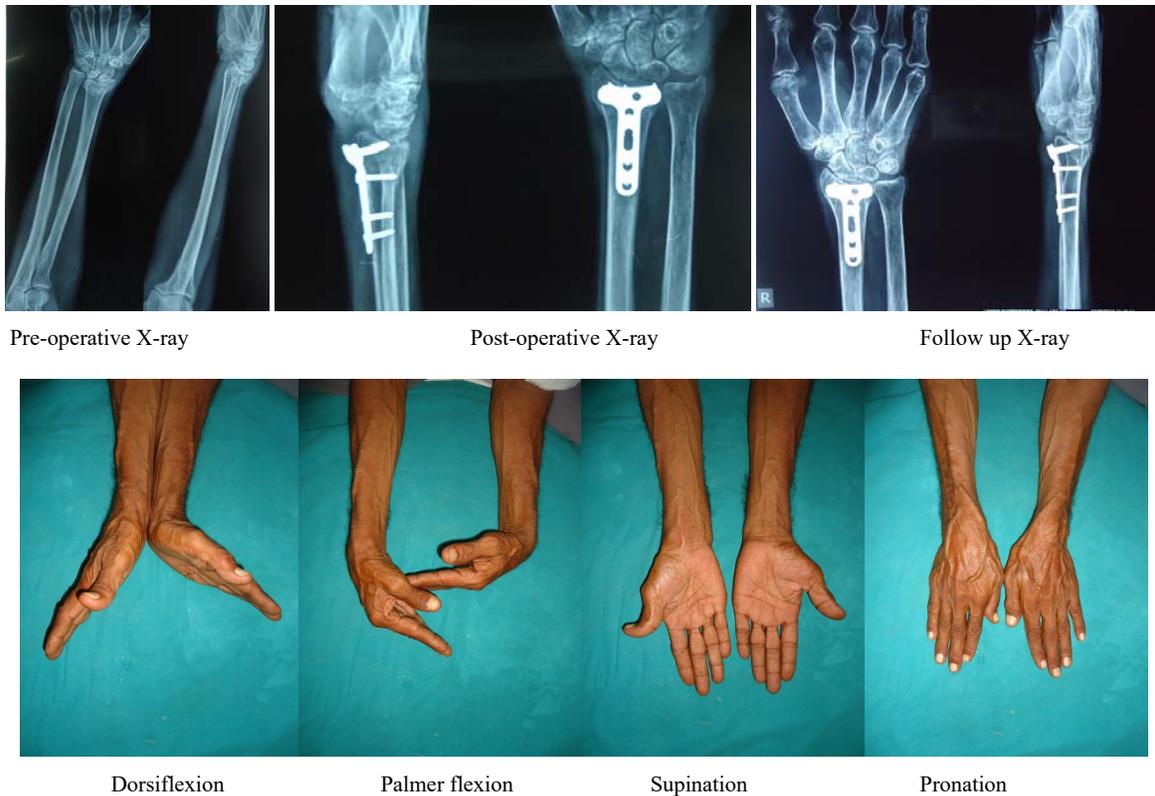


Dorsiflexion

Palmer flexion

**Fig 1**

**Case 2:** 65Years,male patient present with history of fall at home and come with Gartland and Werley type III that is, intra articular lower end radius fracture on right side with intact ulna. Patient was operated with locked volar plate.



**Fig 2**

#### 4. Discussion

Although distal radial fracture is the commonest of fracture and represents 20% of all fractures. There exist various classifications, treatment protocol and the correlation between radiographic and functional outcome.

These fractures as a rule are easily reduced by traction and manipulation. Frequently however, maintenance of reduction is not possible because there is significant metaphyseal comminution. The reduction can only be maintained by some form of fixation at the fracture site improving the end result.

On analyzing the result and comparing with other studies, interesting factors were unraveled. The data collected used for comparison with the data of studies mentioned below are obtained by regular follow up of the patients with the minimum duration of follow up being 4 months.

In our study, the major age group involved was 20 to 39 years of age, and second major was 40 to 59 years of age with mean age of 40.22 years. A study done by Schütz M *et al*, showed mean age of the patients was 52 years [10]. In our study, 77.80% of patients were male. These data shows distal radius fractures were more common in males of middle age group. In our study, most common mode of injury was road traffic accident that is, 23 patients (63.90%). This is suggestive of middle aged males are economically active and sustain distal radius fracture due to road traffic accidents than any other mode of injury.

In our study, 23 patients (63.90%) had Gartland and Werley type III distal radius fracture while 12 patients (33.30%) had Gartland and Werley type I distal radius fracture. These shows the majority of fractures were intra articular in nature. Sarmiento A *et al* also shows that intra-articular distal radius fractures were more common than extra articular type [11]. It was found that the majority of our patients, 25 patients

(69.44%) were operated within 2-4 days of injury. This is because fracture of distal radius cause massive swelling at local site following trauma, which need to be subsided before operative intervention takes place.

In our study, 21 patients (58.30%) had achieved radial length of more than or equal to 10mm, while 10 patients (27.80%) had radial length between 7 to 9 mm, that is 31 patients (86.10%) had no shortening. In our study, only 5 patients (13.90%) had radial length less than 6 mm that is shortening of more than 5 mm. Sarmiento A *et al* showed 75% patients had no radial shortening [11]. In our study mean radial length was 9.61 mm. In our study, 19 patients (52.80%) had achieved volar tilt of more than or equal to 6°, while 11 patients (30.60%) had volar tilt between 0 to 5°, that is 30 patients (83.40%) had volar tilt. In our study, only 6 patients (16.70%) had dorsal tilt. In our study mean volar tilt was 4.22°. Sarmiento A *et al* showed average volar tilt was 6° [11].

Our study contained 22 patients (61.10%) with radial inclination of more than 20°, while 9 patients (25.00%) had radial inclination between 15° to 20°, which is 31 patients (86.10%) had acceptable radial inclination. In our study, only 5 patients (13.90%) had radial inclination less than 15°. In our study mean radial inclination was 21.53°. Sarmiento A *et al* showed average radial inclination was 22° [11]. In our study, out of total 36 patients, 24 patients (66.67%) had achieved dorsi flexion more than 60° with mean dorsi flexion having 66.22° while study of Arora R, Lutz M had average *et al* 53.10° extension of wrist [2]. Study of Markus Figl *et al* showed average 54° extension of wrist [12]. In our study, out of total 36 patients, 14 patients (38.89%) had achieved palmer flexion more than 60° with mean palmer flexion having 56.86° while study of Arora R, Lutz M had average 45.80° flexion of wrist [2]. Study of Markus Figl *et al* had average 52° flexion of wrist

<sup>[12]</sup>. In our study, out of total 36 patients, 34 patients (94.44%) had achieved supination more than 60° with mean supination having 74.61° while study of Arora R, Lutz M had average 81.90° supination <sup>[2]</sup>. Study of Markus Figl *et al* had average 87° supination <sup>[12]</sup>. In our study, out of total 36 patients, 32 patients (88.89%) had achieved pronation more than 60° with mean pronation having 70.91° while study of Arora R *et al* had average 78.70° pronation <sup>[2]</sup>. Study of Markus Figl *et al* had average 86° pronation <sup>[12]</sup>. In our study, out of total 36 patients, 33 patients (91.67%) had achieved radial deviation more than 10° with mean radial deviation having 14.94°. Study of Markus Figl *et al* had average 26° radial deviation <sup>[12]</sup>. In our study, out of total 36 patients, 27 patients (75%) had achieved ulnar deviation more than 26° with mean ulnar deviation having 28°. Study of Markus Figl *et al* had average 32° ulnar deviation <sup>[12]</sup>.

We got 5 patients (13.90%) with no pain, no disability and no limitation of movements. They were rated *excellent* outcome of subjective evaluation in Gartland and Werley's demerit score for evaluation of distal radius fracture outcome. As per other studies, 42% patients had excellent outcome. Our 27 patients (75%) had occasional pain, no disability and slight limitation of movements. These patients were rated as *good* outcome of subjective evaluation in Gartland and Werley's demerit score for evaluation of distal radius fracture outcome. As per other studies, 36% patients had good outcome. Thus, our 32 patients (88.90%) had satisfactory results while according to Gartland *et al* study showed their 78% patients had satisfactory outcome <sup>[13]</sup>. Our 4 patients (11.10%) had fair to poor outcome whereas, Gartland *et al* other study had 22% fair to poor outcome <sup>[13]</sup>.

We have got 28 patients (77.77%) with various types of complications. Other studies of Dominique Knight *et al* showed 48% over all complication rate <sup>[14]</sup>. Out of which only 1 patient had wound complication in the form of hypertrophic scar as early complication of surgery. While 27 patients developed late complications out of which tenosynovitis was the most common complication (11 patients). This was clearly related to direct attritional damage of the tendon caused by the prominent edge of the plate or by protruding screw tips. Study of Rampoldi M *et al* showed tendon related complications were most frequently seen <sup>[15]</sup>. We need implant removal for 1 patient.

We observed that time required for fracture to be united was minimum of 6 weeks to maximum of 14 weeks, depending upon fracture pattern and bone stock available for a particular patient. Our average fracture union time was 9.53 weeks.

We got, in our study, 21 patients (58.30%) with excellent results and 12 patients (33.33%) with good results according to Gartland and Werley's demerit score system for evaluation of distal radius fracture treatment outcome. So, total 33 patients (91.63%) got satisfactory outcome. Markus *et al* showed 63.26% excellent results and 20.40% good result <sup>[12]</sup>. So total 83.66% patients got satisfactory outcome <sup>[12]</sup>. Gartland *et al* showed 52% excellent and 40% good outcome and therefore 92% had satisfactory outcome <sup>[13]</sup>. Another study by Carter PR, Frederick HA shows 95% excellent or good outcome <sup>[5]</sup>. Our study shows 3 patients (8.30%) got fair outcome, while Markus *et al* study showed 16.32% fair outcome <sup>[12]</sup>.

In our study, out of 23 patients with Gartland and Werley type III lower end radius fracture, we got 14 patients with excellent outcome and 7 patients with good outcome. Same way, in our study, out of 12 patients with Gartland and werley type I lower end radius fracture, we got 6 patients with excellent outcome and 5 patients with good outcome.

The fair results were due to difficulty in getting primary reduction with the persistence of incongruity of the radio-carpal and the distal radio-ulnar joints, incomplete restoration of radial length and malalignment of distal radial fracture fragments.

Volar locked plating in distal radial fractures has the following advantage:-

- 1) It can be applied to differing patterns of the fracture.
- 2) Stable subchondral support to the intact radial shaft affords excellent fracture stability and prevents settling.
- 3) It allows early active wrist motion, so less stiffness of fingers and wrist joint.

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