

# A Prospective study to evaluate the Surgical Outcome of distal Radius fractures treated with Locking Compression Plate

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## Abstract

**Background:** Distal radius fractures crush the mechanical foundation of the man's most elegant tool, the hand. No other fracture has a greater potential to devastate hand function, and no other metaphysis of bone is embraced by more soft tissues. The objective of the study was to assess functional outcome of fractures of lower end radius treated with surgical management with locked compression plate (LCP) followed by early mobilization of wrist joint.

**Methods:** The present study was a prospective observational study conducted in BIRRD Trust Hospital, Tirupati for one year. This study included 20 patients who sustained fractures of lower end radius. Information such as sex, age, details of injury, duration, and progression were obtained through an interview. Final outcome was evaluated by QUICK DASH evaluation questionnaire.

**Results:** 65% of the patients were males and 35% were females. Most of the patients were aged between 18 to 30 years (35%). In this study during third follow-up, most of the patients had QUICK DASH scores of 25 or less (65%). Excellent outcome was noted in 13 patients. Of these, 9 (69.23%) patients reported fall on their outstretched hand as mechanism of injury compared to 4 (30.77%) patient who had road traffic accident.

**Conclusions:** Good to excellent results in the majority of patients based on QUICK Dash functional outcome evaluation after locking plate fixation of the lower end distal radius with lower rate of complications. Hence locking plate fixation may be recommended for distal radius fractures requiring operative intervention with early mobilization of wrist joint.

**Keywords:** Distal radius fractures, QUICK DASH evaluation questionnaire, Clinical and radiological union.

## 1. Introduction

Distal radius fractures crush the mechanical foundation of the man's most elegant tool, the hand. No other fracture has a greater potential to devastate hand function, and no other metaphysis of bone is embraced by more soft tissues. Fractures of the distal radius are among

the most common fractures of the upper extremity and account for approximately one-sixth (16%) of all fractures seen and treated in emergency rooms.<sup>1-3</sup>

Fractures of the distal radius have traditionally been discussed with reference to the eponyms Colles, Pouteau, Smith and Barton. However, it is more important today to determine the nature of the fracture and to describe the pathology involved, than to link diagnosis and treatment to a specific name. The type, direction, and amount of displacement are the most important factors relating to treatment.<sup>4</sup>

It is now generally accepted that for the ventral Barton fractures and Smith fractures, internal fixation is indicated as these fractures are always articular and are associated with actual or potential subluxation or dislocation of the carpus with a distal fracture fragment.<sup>5</sup>

It is now realized that many patients after distal radius fractures definitively do not enjoy perfect freedom in all wrist movements and that they are not exempt from pain even after many months.<sup>6</sup>

Many fractures of the distal aspect of the radius are in fact relatively uncomplicated and are effectively treated with closed reduction and immobilization in a cast. However, fractures that are either comminuted and/or involve the articular surfaces can jeopardize the integrity of the articular congruence and/or the kinematics of these articulations. Various methods have been used historically to treat fractures of the distal radius. The first and by far the most frequently used method has been closed reduction and plaster cast immobilization. This treatment has been applied for many years, but it has recently received a lot of criticism, especially for the more complex fractures.<sup>7-9</sup>

Most orthopaedic surgeons today would agree that a patient with a mal-united fracture of the distal end of the radius who “enjoys perfect freedom in all motions and is exempt from pain,” is the exception, not the rule. The goal of the treating physician should then be to restore the functional anatomy by a method that does not compromise hand function. The fracture pattern, the degree of displacement, the stability of the fracture, and the age and physical demands of the patient determine the best treatment option. The distal radius fractures especially the high energy fractures are often associated with poor results and high complication rates.<sup>3</sup> The method of immobilization that maintains the reduction with the least amount of surgical morbidity is the ideal treatment. Unstable fractures of the distal part of the radius have shown an inherent tendency toward loss of reduction after non-operative treatment. External skeletal fixation has been popular for the treatment of displaced, unstable fractures of the distal part of the radius because it combines a minimally invasive procedure with reduction by ligamentotaxis.<sup>10</sup>

However, despite the frequency of distal radius fractures, the optimal treatment remains without consensus opinion. A doubling incidence of surgical treatment for distal radius fractures and a more than 13-fold increase in the incidence of open reduction and plate fixation were observed. Factors such as number of years in practice, practice type, and the particular type of training received contributed most heavily to whether the fracture received internal fixation.<sup>11</sup>

Overall, there is a trend toward increased distal end radius fractures toward open reduction and internal fixation has been identified with biomechanical and clinical studies suggesting treatment advantages of certain fixation methods over others but well-controlled patient trials are still missing to lend objective findings to management algorithms.

Considering the high frequency of distal end radius fractures and scarcity of data regarding the optimal treatment, the present study was undertaken to assess functional outcome of fractures of lower end radius treated with surgical management with LCP followed by early

mobilization of wrist joint. The objective of the study was to assess the functional outcome of fractures of lower end radius treated with surgical management with locked compression plate (LCP) followed by early mobilization of wrist joint.

## 2. Material and Methods

The present study was a prospective observational study that included 20 Patients who sustained fractures of lower end radius presenting at BIRRD Trust Hospital, Tirupati. Sample size was calculated considering the average of past three years hospital statistics on patients presenting with distal end radius which was 20.33 cases per year. Patients with unstable, intra-articular fractures of distal end of radius, Adults with more than 18 years of age, Patients presenting with type VI, VII, VIII of Frykman's classification and Patients medically fit for surgery were included in the study. Patients with more than 3 weeks duration of injury and Patients with open fractures were excluded from the study.

The information such as sex, age, details of injury, duration and progression were obtained through an interview. Patients were subjected to clinical and local examination. These findings were recorded on predesigned and pretested proforma. Investigations such as X-Ray, complete blood count, urine routine and microscopy were done. Computed tomography scan of wrist was obtained if required.

Patients were treated with open reduction and internal fixation using locking compression plate (LCP). All the surgeries were performed in an orthopaedic operation theatre under antibiotic cover. General Anaesthesia was administered to all the patients. All the surgeries were performed by registered orthopaedic consultants.

Following admission to the hospital, a careful history was elicited from the patients and/or attendants to reveal the mechanism of injury and the severity of trauma. All patients were thoroughly examined. Their general condition associated systemic diseases and associated injuries were noted. All the findings were duly recorded in the patient proforma. Standard radiographs in PA and lateral views were taken for confirmation of the diagnosis and also to know the type of fracture. Oblique views were also taken in a few patients who had complex comminuted fractures. The fracture fragments were analysed and involvement of radiocarpal and distal radioulnar joints were assessed and classified according to the Frykman's classification. The duration from the date of injury to date of operation ranged from 1-6 days (average 2.35 days). All cases are treated with a volar locking compression plate using a volar Henry's approach. Follow-up of patients was done at six weeks (1<sup>st</sup> follow-up), three months (2<sup>nd</sup> follow-up) and six months (3<sup>rd</sup> follow-up) following the surgery.

For all subjects, radiographs were performed at the end of six weeks, three months and six months follow-up. Patients were evaluated based on the following parameters at the time of discharge and all three follow-ups: Range of motion: Wrist-flexion, extension, supination, pronation, ulnar deviation and radial deviation, Elbow-flexion, extension, supination and pronation, Complications-Arthritis, pain and swelling, Clinical union and Radiological union. Final outcome was evaluated by QUICK DASH evaluation questionnaire. The QUICK DASH<sup>12</sup> consists of 11 items to measure physical function and symptoms in people with any or multiple musculoskeletal disorders of the upper limb. Based on the Quick DASH score the functional outcome among patients was graded as Excellent outcome-Score between 0 to 25,

Good outcome-Score between 25.1 to 50.0, Fair outcome-Score between 50.1 to 75.0 and Poor outcome-Score between  $\geq 75$ .

Data obtained was coded and entered into Microsoft Excel spreadsheet. The categorical data was expressed as rate, ratio and percentage. The continuous data was expressed as mean  $\pm$  S.D. Fisher's exact test was used to find the association between categorical data. A 'p' value of less than 0.05 was considered as statistically significant.

### 3. Results

A total of 20 cases who sustained fractures of lower end of radius were included in the study.

**Table 1: Distribution according to Age and sex o study population**

Socio-demographic factors		Frequency	Percentage
Sex	Male	13	65
	Female	7	35
Age (Years)	18-30	7	35
	31-40	3	15
	41-50	5	25
	51-60	5	25

Table 1 shows that 65% of the patients were males and 35% were females. The male-to-female ratio was 1.85:1. In this study most of the patients were aged between 18 to 30 years (35%). The mean age of the study population was  $39.05 \pm 12.08$  years.

In the present study 75% of the patients presented with right-sided fractures, majority of the patients that are 75% reported nature of trauma as fall on outstretched hand. 50% of the patients presented with grade VIII Frykman classification while 40% and 10% of the patients had grade VII and VI were noted respectively. Complications of arthritis were noted in 15% of the patients at first follow-up and 20% of the patients each at second and third follow-ups respectively. (Table 2)

In the present study maximum number of patients complained of pain at first follow-up (60%). During second and third follow up pain was present in 25% and 10% respectively. Swelling was present in 60% of the patients at first follow up while at second and third follow up it was noted in 20% and 5% of the patients respectively. Clinical union was noted among 85% of the patients at second follow-up and radiological union was noted among 65% of the patients at second follow up and in the remaining (35%), it was seen during third follow-up. (Table 2)

In this study during the third follow-up, most of the patients had QUICK DASH scores of 25 or less (65%). The mean scores were  $26.01 \pm 12.47$ . The final outcome was excellent in 65% of the patients while good and fair outcomes were noted among 25% and 10% respectively. (Table 2)

From Table 3 it was observed that the mean range of motion at first, second, and third follow-up is gradually increasing in different movements of the hand.

In this study excellent outcome was noted in 13 patients. Of these, 9 (69.23%) patients reported fall on outstretched hand as mechanism of injury compared to 4 (30.77%) patients

who had road traffic accidents. However, this difference was statistically not significant. Of the 13 patients with excellent outcomes, 8 (61.54%) patients had right-side fractures compared to 5 (38.46%) patients with left-side fractures. However, this difference was statistically not significant. Among the patients with excellent outcomes, the type of fracture was comparable that is, 7.69% had type VI, and 46.15% each had type VII and VIII. (Table 4)

**Table 2: Distribution according to characteristics of fracture**

Fracture characteristics		Frequency	Percentage
Laterality	Right	15	75
	Left	5	25
Nature of Trauma	Road traffic accident	5	25.00
	Fall on outstretched hand	15	75.00
Frykman Classification	VI	2	10.00
	VII	8	40.00
	VIII	10	50.00
Complications of arthritis	First Follow up	3	15.00
	Second Follow up	4	20.00
	Third Follow up	4	20.00
Pain	First Follow up	12	60.00
	Second Follow up	5	25.00
	Third Follow up	2	10.00
Swelling	First Follow up	12	60.00
	Second Follow up	4	20.00
	Third Follow up	1	5.00
Clinical union	First Follow up	0	0.00
	Second Follow up	17	85.00
	Third Follow up	3	15.00
Radiological union	First Follow up	0	0.00
	Second Follow up	13	65.00
	Third Follow up	7	35.00
QUICK DASH score	25 or less	13	65.00
	26 to 50	5	25.00
	51 to 75	2	10.00
Final outcome	Excellent	13	65.00
	Good	5	25.00
	Fair	2	10.00

**Table 3: Range of motions during first, second, and third follow-ups**

Follow up	Variables	Distribution (n=20)	
		Mean	SD
First	Dorsal flexion	73.50	3.66
	Plantar flexion	75.00	3.97
	Radial deviation	13.25	2.45
	Ulnar deviation	24.00	3.84
	Supination	74.25	4.06
	Pronation	75.50	3.20
Second	Dorsal flexion	77.50	3.44
	Plantar flexion	77.00	2.99
	Radial deviation	14.50	1.54
	Ulnar deviation	27.25	2.55
	Supination	76.00	3.84
	Pronation	77.50	3.03
Third	Dorsal flexion	79.25	1.83
	Plantar flexion	78.00	2.99
	Radial deviation	15.00	0.00
	Ulnar deviation	28.25	2.45
	Supination	78.00	3.40
	Pronation	78.50	2.35

**Table 4: Association between outcome and Mechanism of injury, Laterality, Type of fracture**

Variable		Outcome			Total No. (%)	P value
		Excellent No. (%)	Good No. (%)	Fair No. (%)		
Mechanism of injury	Fall on outstretched hand	9 (69.23)	2 (100)	4 (80)	15 (75)	0.999
	Road traffic accident	4 (30.77)	0 (0)	1 (20)	5 (25)	
Laterality	Right	8 (61.54)	2 (100)	5 (100)	15 (75)	0.208
	Left	5 (38.46)	0 (0)	0 (0)	5 (25)	
Type of fracture	VI	1 (7.69)	0 (0)	1 (20)	2 (10)	0.719
	VII	6 (46.15)	0 (0)	2 (40)	8 (40)	
	VIII	6 (46.15)	2 (100)	2 (40)	10 (50)	

#### 4. Discussion

Despite the high frequency of distal radius fractures, the optimal treatment remains without consensus opinion. A trend toward increased distal radius fracture open reduction and internal fixation has been identified, with biomechanical and clinical studies suggesting treatment advantages of certain fixation methods over others.

The main objectives of distal radius fracture treatment are re-establishment of anatomic integrity and functioning. The knowledge and understanding about wrist anatomy and functioning gained through the recent studies and high expectations of patients have led to the expanded borders of surgical treatment. Also, improvements in fixation of materials have provided excellent opportunities. However, to date, there is no consensus about the approach to distal radius fractures and the positioning of plate. This prompted us to evaluate functional outcome of lower-end radius fractures treated with surgical management with LCP followed by early mobilization of wrist joint.

The present one-year prospective study included a total of 20 patients who sustained fractures of lower end of radius from January 2022 to December 2022. In the present study, male preponderance was noted that is, of the 20 cases studied, 65% of the patients were males and 35% were females, and male to female ratio was found to be 1.85:1. These findings were comparable with a study by Kilic A et al who reported male preponderance with male to female ratio of 1.25:1.<sup>13</sup> In contrast, Shin EK, et al.<sup>14</sup> reported that most distal radius fractures occur in females with a male-to-female ratio of 1 to 4. Another study by Lozano-Calderon SA, et al.<sup>15</sup> who retrospectively compared percutaneous fixation (10 females out of 17 patients) or a volar plate and screws (17 females out of 23 patients) reported female preponderance. Several other studies by Anakwe RE et al,<sup>16</sup> Rohit A et al,<sup>17</sup> Chung KC et al<sup>18</sup> also reported female predominance. However, the male preponderance observed in the present study would be explained by the involvement in outdoor activities, riding vehicles, and heavy manual labour work.

In this study 35% of the patients were aged between 18 to 30 years and the mean age was  $39.05 \pm 12.08$  years. Shin EK, et al.<sup>14</sup> found that, the age distribution for injuries to the distal radius is typically bimodal with peaks in the 5 to 14-year age group and in elderly patients older than 60 years. A study by Williksen JH, et al.<sup>19</sup> to determine whether volar locking plates are superior to external fixation with adjuvant pins in the treatment of unstable distal radius fractures on 111 unstable distal radius fractures reported the mean age of the patients as 54 years (range, 20-84 years). Another study by Lozano-Calderon SA, et al.<sup>15</sup> which retrospectively compared percutaneous fixation or a volar plate and screws reported mean age of 55 years in percutaneous group and 51 years in ORIF volar plate group. However, the average age observed in the present study was comparable to the studies of Kilic A et al,<sup>13</sup> Chung KC et al.,<sup>18</sup> and Anakwe RE et al<sup>16</sup> who reported an average age of 45 years, 48.9 years, and 48 years respectively.

In the present study majority that is, 75% of the patients had right-sided fracture and the nature of trauma as fall from outstretched hand. Nearly half of the study population that is, 50% of the patients presented with grade VIII Frykman followed by grade VII (40%) and VI (10%).

In this study majority that is, 85% of the patients had clinical union at second follow up and at the same interval 65% of the patients had radiological union. In the remaining the clinical union was noted during third follow up that is clinical union in 15% and radiological union in

35%. The relatively large number of outcome measures available for evaluating wrist and hand function provides clinicians with a wide range of choice, thereby enabling them to use that outcome instrument that is the most appropriate and suitable. The choice of an outcome measure is determined by the clinical condition one wishes to assess; the resources available and the psychometric properties are often additional determining factors.<sup>20</sup> The functional outcome based on QUICK Dash score at the end of third follow up revealed nearly one two third of the study population with excellent outcome (65%) and good and fair outcomes were noted among 25% and 10% respectively while none of the patients had poor outcome. No significant association was found between mechanism of injury, side involved, and type of fracture suggesting that the outcome was independent of etiology, side involved and type of fracture.

Phadnis J et al<sup>21</sup> in 2011 reported the functional outcome of a large number of patients at a significant follow-up time after fixation of their distal radius with a volar locking plate reported 74% of the patients with good or excellent DASH and MAYO score. Statistical analysis showed that no specific variable including gender, age, fracture type, post-operative immobilization or surgeon grade significantly affected outcome. Complications occurred in 27 patients (15%) and in 11 patients were major (6%). The study demonstrated good to excellent results in the majority of patients after volar locking plate fixation of the distal radius, with complication rates comparable to other non-operative and operative treatment modalities and recommended this mode of fixation for distal radius fractures requiring operative intervention. Rozental et al. showed mostly good and excellent functional outcomes in 45 patients at 17 months mean follow-up.<sup>22</sup> Similar larger series<sup>23,24</sup> have reviewed the outcome of volar plate fixation in cohorts of 150 (24 months follow-up) and 114 (12 months) patients respectively. Like our study, these both showed good to excellent functional outcome using the DASH score. Rohit Arora et al.,<sup>24</sup> used modified Green and Obrein score and reported 31 excellent, 54 good, 23 fair, and 6 poor results. Minegishi H et al<sup>25</sup> in 2011 to evaluate the functional and radiological results of treating unstable distal radius fractures with the volar locking plates among 15 patients reported 5 patients with excellent outcome, 7 with good outcome, and 3 with fair outcome according to Cooney's Clinical Scoring Chart.

In this study, complication of arthritis was present in 15% of the patients. During second and third follow ups, 20% of the patients each had arthritis. Maximum (60%) patients had pain at first follow up which sub-sided during second (25%) and third follow up (10%). Similarly swelling was noted also present among maximum patients during first follow up which reduced and during second and third follow up it was seen in only 20% and 5% of the patients respectively. Phadnis J et al<sup>21</sup> in 2011 reported complications in 15% of the patients major complications among 6% of the patients. Minegishi H et al<sup>25</sup> in 2011 reported rupture of the flexor pollicis longus tendon occurred in 1 patient.

Locked volar plates are now greatly used as a treatment method for unstable distal radius fractures. They present a biomechanical advantage and a lower risk of tendon complications than shown by dorsal plates. The results from using this type of plate have shown varying incidence of complications. Loss of range of motion and grip strength were also observed but with few functional repercussions.

It is concluded that good to excellent results in the majority of patients based on QUICK Dash functional outcome evaluation after locking plate fixation of the lower end distal radius with lower rate of complications. Hence locking plate fixation may be recommended for distal radius fractures requiring operative intervention with early mobilization of wrist joint.

## 5. References



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