



Radiological Assessment of Distal-End Radius Fracture Using Sarmiento's Modification of Lindstorm Criteria Following Fixation with 2.7 Mm Volar Locking Compression Plate

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Abstract

Introduction: Fractures of the distal end of the radius accounts to around 15 % of all fractures diagnosed and dealt with in the emergency rooms. In the phrases of Dr. Abraham Colles "This fracture takes place about an inch and a half of above the carpal extremity of the radius and there's a 17% lifetime chance for distal radius fractures". The majority of these injuries are closed injury.

Aim: To measure the radiological outcomes in patients with displaced distal radius fractures managed with 2.7

mm volar LCP fixation using Sarmiento's Modification of Lindstorm Criteria.

Materials and Methods: A descriptive study was conducted in BGSGIMS located in Bangalore. All displaced distal radius fractures of skeletally mature patients who underwent volar locking plate fixation 2.7 mm volar locking compression plate fixation in the duration of November 2022 to October 2024. These 50 patients, who were admitted, operated and assessed at Department of Orthopedic Surgery, BGSGIMS HOSPITAL, Bangalore. X-rays of the wrist in the PA

view and true lateral views, taken Pre-operatively, Immediate post-operative, Six weeks and Three months were assessed and classified based on AO and Melone's classification. The radiological outcome was scored based on the Sarmiento's Modification of Lindstorm Criteria.

Results: The study comprised of 19 (38%) Females and 31 Males (62%). The mean age was 46.95 ± 13.93 years with range being 24-74 years. Fall either on an outstretched arm or from height was the most common mode of injury (65%). High energy trauma as a cause for distal radius fractures showed greater incidence in individuals <60 years. AO Type A2 was the most common fracture type encountered during this study. No statistically significant difference ($p=0.93, 0.874, 0.716$) in radial shortening, decrease in palmar angulation and loss of radial deviation was seen till the final follow up. Majority had a Good outcome in 52% followed by excellent in 28 % .and fair in 20% using Sarmiento's Modification of Lindstorm criteria.

Conclusion: The fracture reduction achieved in the immediate postoperative period was maintained throughout the follow up duration. The use of 2.7 mm volar locking plate showed good to excellent postoperative radiological outcomes in majority of the cases. However, a randomized controlled study is necessary to successfully highlight the advantages of this plate over other methods of fixation.

Keywords: Volar locking compression plate fixation, Radiological outcomes, High energy trauma.

Introduction

Fractures of the distal end of the radius accounts to around 15% of all fractures diagnosed and dealt with in the emergency rooms. In the phrases of Dr. Abraham

Colles "This fracture takes place about an inch and a half of above the carpal extremity of the radius and there's a 17% lifetime chance for distal radius fractures". The majority of these injuries are closed injury.^{1, 15}

A bimodal age distribution is seen, with differing trends in males and females. In females, the probability of these fractures rises with age, especially from the age of 40 years and onwards in people below the age of 40 years, the incidence is more in males.^{1, 16} In young people, these fractures usually result secondary to high velocity injury such as a motor vehicle accident or fall on an out stretched hand. While in the elderly, the fracture commonly occurs from low-energy or moderate trauma, like a fall from standing height. This is due to the fragile bone in older adults as a result of osteoporosis.³

Management for distal radius fractures has evolved significantly over the years. Closed Manipulative Reduction (CMR) and below elbow cast application has been the main treatment¹. However, the outcomes are often less than satisfactory with loss of reduction, limitation of function and disabilities. Several studies have shown that after a distal radius fracture, patients function more effectively when the anatomy is restored.¹³

Despite this fracture being very common, we lack evidence to support a single reparative technique as against the use of others. It is difficult to compare "Fractures of the distal radius" because of the many different specific patterns of lesions. In addition, different plates are used for fixation, different outcome tools are used and the fractures also vary in their complexity.^{4,5}

Though we have yet to reach a consensus regarding a gold standard for surgical treatment, recent bio-mechanical studies have shown volar LCP's have much

more rigidity and stability in comparison to traditional volar or dorsal plates.^{4, 12}

There has been an exponential increase in the use of LCP's with more than 30 different volar plating systems in use. Studies have been done on the 2.4 mm and the 3.5 mm LCP but there is a lacuna with regard to literature on the 2.7 mm volar LCP^{3,4,5,6}. The current study is being undertaken to retrospectively assess the postoperative radiological outcomes in a 2.7 mm volar LCP system used for internal stabilization of distal radius fractures.

Materials and Methods

A descriptive study was conducted in BSGGIMS institute located in Bangalore. All displaced distal end radius fractures of skeletal mature patients managed with 2.7 mm volar locking compression plate fixation in the duration of June 2018 to December 2019. These 50 patients, who were admitted, operated and assessed at Department of Orthopedic Surgery, BSGGIMS Bangalore.

X-rays of the wrist in the PA view and true lateral views, taken pre operatively, immediate post-operative, six weeks and three months were assessed.

The radiological outcome was scored based on the Sarmiento's Modification of Lindstorm Criteria which comprised of recording and grading palmar tilt, radial angulation, articular congruency and radial length.

Inclusion Criteria

Radiologically diagnosed with distal end radius fracture with:

1. AO Classification Type – A2,A3,B AND C
2. MELONE'S Classification Type –II, III, IV
3. Fractures operated within one week of injury

Exclusion Criteria

- Age more than 75 years
- Age less than 18 years
- Poly trauma patients with Injury Severity Score of more than 16 were excluded

After approaching and priming participants regarding the study, each provided their written informed consent. Participants were assured privacy and confidentiality. Patients were counselled that participation was voluntary and they could discontinue at any time without prejudice. No honorarium was paid and data was kept confidential with restricted access.

Results

All patients underwent the surgical procedure under regional anaesthesia and within a week after the injury. The Modified Henry's approach was used and all surgeries were performed by the same team of surgeon. The limb was immobilized in a short arm plaster splint until suture removal on the tenth post operative day. Active finger movements were initiated early followed by wrist mobilization after three to four weeks. Check X-rays of the wrist in the antero-posterior and true lateral views were taken in the immediate post-operative, six weeks and three months.

The patient demographics are elaborated in [Table 1]. The study comprised of 19 (38%) females and 31 males (62%). The mean age was 46.95 ± 13.93 with range being 24-74 years. Fall (65%) either on an outstretched arm or from height was the most common mode of injury. High energy trauma as a cause for distal radius fractures showed greater incidence in individuals <60 years. AO Type A2 was the most common fracture type encountered during this study.

Post operative check X-rays were analysed at immediate post operative, six weeks and three months. The mean immediate post operative radial shortening, loss of radial deviation and decrease in palmar tilt were 4.08 ± 2.23 , 5.91 ± 4.01 and 4.11 ± 3.29 respectively. The corresponding values at last follow up were 4.71 ± 2.31 , 7.9 ± 5.13 and 4.91 ± 3.32 respectively [Table 2]. No statistically significant difference ($p=0.93, 0.87, 0.71$) in radial shortening, decrease in palmar angulation and loss of radial deviation was seen at the final follow up.

These parameters were then graded and scored using the Sarmiento's Modification of Lindstorm Criteria to assess the radiological outcome which showed that majority had a Good outcome in 52% followed by excellent in 28 %. And fair in 20%.



Figure 1: Preoperative X-ray in Anteroposterior and True lateral views showing distal radius fracture

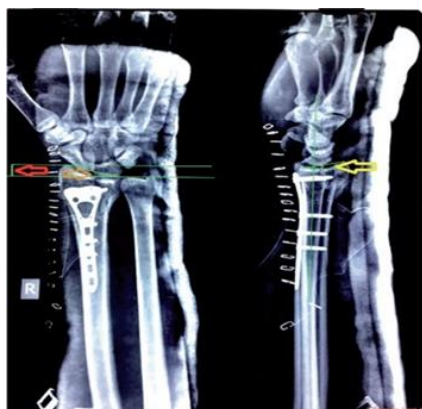


Figure 2: Immediate postoperative X-ray in antero-posterior and true lateral views after open reduction and

internal fixation with 2.7 mm volar LCP with measurements of radial length (red), radial deviation (orange) and palmar angulation (yellow)



Figure 3: Six weeks follow up X-Ray in antero-posterior and true lateral views after open reduction and internal fixation with 2.7 mm volar LCP with measurements of radial length (red), radial deviation (orange) and palmar angulation (yellow)

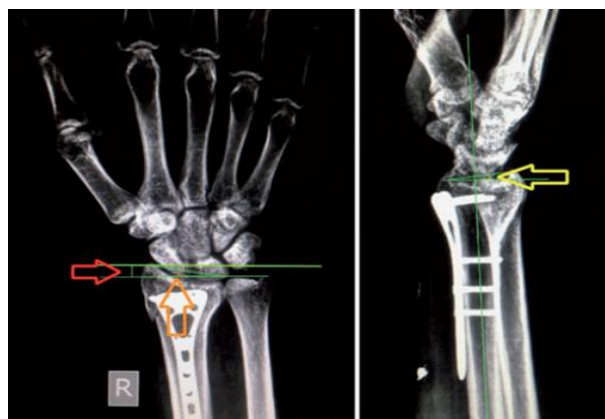


Figure 4: Three months follow up X-ray in antero-posterior and true lateral views after open reduction and internal fixation with 2.7 mm volar LCP with measurements of radial length (red), radial deviation (orange) and palmar angulation (yellow)

Table 1: Summary of patient demographics, mode of injury and fracture classification (n=50)

Patient	Age (years)	Gender	Mode of injury	AO type	Melones Type
1	50	Female	Fall on outstretched arm	A2	Type II
2	57	Female	Fall on outstretched arm	B1	Type II
3	34	Male	Fall from height	A2	Type II
4	56	Male	Fall from height	C1	Type III
5	47	Female	Fall on outstretched arm	A2	Type II
6	56	Female	Motor Vehicle Accident	C3	Type III
7	34	Male	Fall from height	B1	Type II
8	26	Male	Motor Vehicle Accident	A3	Type II
9	24	Male	Motor Vehicle Accident	C1	Type III
10	42	Female	Fall on outstretched arm	B1	Type II
11	70	Female	Fall on outstretched arm	A3	Type II
12	42	Male	Motor Vehicle Accident	A2	Type II
13	34	Male	Motor Vehicle Accident	B2	Type II
14	39	Male	Fall on outstretched arm	C1	Type II
15	74	Female	Motor Vehicle Accident	C1	Type III
16	60	Female	Fall on outstretched arm	A2	Type II
17	61	Male	Fall on outstretched arm	A2	Type II
18	53	Female	Fall on outstretched arm	A2	Type II
19	46	Male	Motor Vehicle Accident	C3	Type V
20	34	Male	Fall on outstretched arm	C1	Type III
21	34	Male	Fall from height	B1	Type II
22	26	Male	Motor Vehicle Accident	A3	Type II
23	24	Male	Motor Vehicle Accident	C1	Type III
24	42	Female	Fall on outstretched arm	B1	Type II
25	70	Female	Fall on outstretched arm	A3	Type II
26	42	Male	Motor Vehicle Accident	A2	Type II
27	34	Male	Motor Vehicle Accident	B2	Type II
28	39	Male	Fall on outstretched arm	C1	Type II
29	74	Female	Motor Vehicle Accident	C1	Type III
30	60	Female	Fall on outstretched arm	A2	Type II
31	61	Male	Fall on outstretched arm	A2	Type II
32	53	Female	Fall on outstretched arm	A2	Type II

33	46	Male	Motor Vehicle Accident	C3	Type V
34	34	Male	Fall on outstretched arm	C1	Type III
35	34	Male	Fall from height	B1	Type II
36	26	Male	Motor Vehicle Accident	A3	Type II
37	24	Male	Motor Vehicle Accident	C1	Type III
38	42	Female	Fall on outstretched arm	B1	Type II
39	70	Female	Fall on outstretched arm	A3	Type II
40	46	Male	Motor Vehicle Accident	C3	Type V
41	34	Male	Fall on outstretched arm	C1	Type III
42	34	Male	Fall from height	B1	Type II
43	26	Male	Motor Vehicle Accident	A3	Type II
44	24	Male	Motor Vehicle Accident	C1	Type III
45	42	Female	Fall on outstretched arm	B1	Type II
46	70	Female	Fall on outstretched arm	A3	Type II
47	42	Male	Motor Vehicle Accident	A2	Type II
48	34	Male	Motor Vehicle Accident	B2	Type II
49	39	Male	Fall on outstretched arm	C1	Type II
50	74	Female	Motor Vehicle Accident	C1	Type III

Table 2: The average immediate post-operative, 6 weeks and final follow up radiographic parameters (n=50)

	Radial Shortening (mm)	Loss of radial deviation (degrees)	Loss of palmar tilt (degrees)
Average immediate post-operative value	4.08±2.23	5.91±4.01	4.11±3.29
Average value at 6 weeks follow up	4.28±3.23	6.99±4.53	4.21±3.44
Average value at 3 month follow up	4.71±2.31	7.9±5.13	4.91±3.32
P value (immediate v/s 3 month follow up)	0.93	0.87	0.71

Table 3: The radiological outcome based on Sarmiento's modification of Lindstrom Criteria (n=50)

	Frequency (Percentage)
Excellent	14 (28%)
Good	26 (52%)
Fair	10 (20%)
Poor	0

Discussion

It is a well-known fact that fracture of the distal radius requires accurate restoration of the anatomy and articular congruity.⁵ The co-relation between incongruity and post traumatic arthritis is well established. Reduced grip strength, loss of range of motion as well as instability has been noted due to misalignment.⁶ Internal stabilization of distal radius fractures provides a better restoration of the radial length as well as the volar tilt in comparison to external fixation.⁸ Locking plates provide a better technique to fix osteoporotic bones.⁷

Our study has proved that there is an insignificant difference in the radial height, radial inclination and the palmar tilt in the immediate post operative and the last follow up. This highlights the fact that the fracture reduction that was achieved in the immediate post operative period is maintained throughout the follow up duration.

The results are in concordance with other studies conducted using a volar LCP fixation although not the 2.7 mm volar LCP as used in our study. Rozental TD et al., and Konstantinidis L et al., found good post operative radiological outcomes with use of LCP for distal radius fracture.^{4,5}

A few studies have been conducted in the Indian subcontinent Pradhan U et al, in their study concluded that treatment with open reduction and internal fixation for intra articular fractures of distal end of radius provides good radiological results.⁶

Volar plate fixation also provides an overall decreased rate of complications when compared to external fixation. Moirangthem V et al., in their retrospective analysis of volar plating of distal radius fractures stated that with proper patient selection and accurate surgical techniques, volar plating continues to be a useful method

of treatment for distal end radius fractures with minimal complications and allowing early return of patients to normal activities.⁷

Khan MS et al., also found the use of volar LCPs for intra-articular distal radius fracture to show good results especially in comminuted distal radius fractures.⁸

The 2.7 mm volar LCP is designed for fixation of complex fracture patterns especially in comminuted fractures and in the presence of osteoporosis. The smaller size of the plate and the locking screws help in addressing individual fracture fragments more precisely compared to the age old 3.5 mm system. Since the plates are much smaller, they can be placed more distally allowing sub-chondral fixation and reduced tendon and soft tissue irritation. The placement of multiple screws helps in fixation of fractures in all three columns of distal radius keeping in mind the three column theory of fracture fixation.¹⁴

The advantage of our study was that all the cases were operated at a single centre and by the same experienced orthopaedic surgeon keeping the idea and method of fracture fixation constant. The follow up examination was also done by the same team of orthopaedic surgeons. Moreover, none of our participants were lost to follow up. We believe this study has effectively demonstrated that the use of 2.7 mm volar locking plate for distal radius fracture fixation achieves good results in terms of radiological outcomes.

Conclusion

The use of 2.7 mm volar locking plate showed good to excellent postoperative radiological outcomes in majority of the cases. The fracture reduction achieved in the immediate postoperative period was maintained throughout the follow up duration. Therefore, the use of 2.7 mm volar locking plate for distal radius fracture

fixation is a useful tool in the management of these fractures. However, a randomised controlled study is necessary to successfully highlight the advantages of this plate over other methods of fixation.

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