

Volar locking plate fixation for unstable distal radius fractures- A prospective study of functional and anatomical outcome

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ABSTRACT

BACKGROUND:

Distal end radius fractures constitute one-sixth of all fractures treated in the emergency department. These fractures often are unstable, are difficult to reduce anatomically. Various modes of treatment include plaster application, External fixator, Plate fixation with locking compression plate. Recently, there has been an increasing interest in plate fixation, especially volar locking compression plate fixation of distal radius fractures. The purpose of this study is to evaluate the functional and anatomical outcome of unstable distal radius fractures treated by volar locking compression plate.

METHODS AND MATERIALS:

Forty-eight patients with unstable fractures of the distal radius treated with open reduction and internal fixation with volar LCP were taken under the study. Lafontaine 's criteria for instability were used to assess the fracture stability. Volar Henry approach was employed in all patients. Post-operative follow up at 6 weeks, 3 months, 6 months, 1 year and every 6 months later on as necessary. The assessment of functional results was made using the Demerit system of Gartland & Werly and Sarmiento's modification of Lidstrom's criteria was used for assessing anatomical outcome.

RESULTS:

Out of 48 patients, 34 were males and 14 females. 26 met with road traffic accidents and 22 have fallen on their outstretched hand. The assessment of functional results was made using

Gartland & Werley demerit system based on residual deformity, subjective evaluation, objective evaluation & complications. 22 cases had excellent results and 22 cases had good results and 4 cases had fair results at the end of 12 months.

CONCLUSIONS:

Volar LCP is an effective treatment option for unstable distal radius fractures which promotes anatomic realignment, prevents delayed collapse, allows early joint motion and results in successful functional and anatomical outcomes.

KEYWORDS:

Distal radius fracture, Lafontaine 's criteria, Demerit system of Gartland &Werly and Sarmiento's modification of Lidstrom's criteria.

INTRODUCTION:

Distal end radius fractures are often unstable and difficult to reduce anatomically and are associated with complications like distal radioulnar joint instability, malunion, post traumatic osteoarthritis. Extra articular malalignment can lead to decreased grip strength, limited motion, and carpal instability.

Plaster application was the choice treatment in the past which had compromising results. Pins were added to plaster to give more stability which resulted in improved outcome. However unstable fractures and osteoporotic fractures have becoming worse.

External fixator, based on ligamentotaxis has a risk of distraction of joint, development of finger stiffness and pin tract infections.

Locking compression plate (LCP) is a screw-plate system developed by combining the traditional plating techniques with the principles of AO internal fixator. These plates provide stable fixation, maintain the reduction, reconstruction of articular congruity and reduce the incidence of post-traumatic osteoarthritis. The use of pre contoured angular stable plate fixation is characterized by higher stability by improved pull out strength even in osteoporotic bone. These implants afford osseous fixation that allows early motion and rehabilitation.

The purpose of this study is to evaluate the functional and anatomical outcome of unstable distal radius fractures treated by volar locking compression plate.

METHODS AND MATERIALS:

It was a prospective observational study done in department of orthopedics, Narayana Medical College and Hospital, Nellore, Andhra Pradesh. The study was conducted on patients who underwent surgery between June 2020 to January 2022.

Forty-eight patients with unstable fractures of the distal radius treated with open reduction and internal fixation with volar LCP were included in the study. Lafontaine 's criteria for instability were used to assess the fracture stability.

Inclusion Criteria :

A fracture is deemed unstable if it fulfils three or more of the five criteria

- Dorsal tilt more than 20°,
 - Dorsal comminution,
 - Intra articular fracture,
 - Associated ulna fracture,
1. Age more than 60 years.
 2. All unstable fractures were included.

Exclusion Criteria :

1. Pathological fractures,
2. Open fractures,
3. Fractures with neurovascular injuries.

AO/OTA classification was used to classify the fractures.

Ethical committee approval was taken, and ethical committee guidelines were strictly followed.

A total of 48 patients who had a history of either motor vehicle accident or accidental fall and were radiologically diagnosed with fracture and underwent surgery for the same.

Surgical Technique :

- All the patients were operated under brachial plexus block and under tourniquet control.
- Volar Henry approach was employed in all patients.
- An incision was made between the flexor carpi radialis (FCR) tendon and the radial artery.
- This interval was developed, revealing the flexor pollicis longus (FPL) muscle at the proximal extent of the wound and the pronator quadratus muscle more distally.
- The radial artery was carefully retracted radially, while the tendons of the FCR and FPL were retracted medially.
- The pronator quadratus was divided at its most radial aspect, elevated medially, leaving a small cuff of muscle for later reattachment.
- The fracture site was visualized, reduction was achieved by manual traction, reduction clamps, provisional K wire fixation as deemed necessary.
- By using the image intensifier, the parameters of radial height, radial inclination, palmar tilt, ulnar variance were checked for appropriate reduction.
- Appropriate plate was chosen to complete the definitive fixation.

- Supplementary K wires were added when necessary.
- Distal radioulnar joint stability was assessed after plating and was fixed with a K wire in reduced position if found unstable, to be removed after 4 weeks.
- Wound was closed in layers.
- Below elbow plaster slab with the wrist in neutral position was applied till suture removal.

Post operative care:

- Active exercises of all the fingers, elbow and shoulder were carried out.
- After suture removal, volar slab was removed, and wrist mobilization exercises were taught.
- The patients were followed up at 6 weeks, 3months, 6 months, 1 year and every 6 months later on as necessary.
- The assessment of functional results was made using the demerit system of Gartland & Werly based on residual deformity, subjective evaluation, objective evaluation & complications.
- Sarmiento's modification of Lidstrom's criteria was used for assessing anatomical outcome.

Statistical analysis:

Results:

The age of the patients ranged from 22-66years. Out of 48 patients, 34(70.83%) were males and 14(29.16%) females. Involved side is right in 28 (58.33%) patients and left in 20 (41.66%) patients. In our study, there were 26(54.16%) patients had road traffic accidents and 22 (45.84%) patients have fallen on their outstretched hand. According to AO/OTA classification, 5 (10.41%) were of A3, 3(6.25%) were of B1, 13(27.08%) of B3, 16 (33.33%) were of C1, 4(8.33%) of C2, and 7 (14.58 %) of type C3. Fracture of ulnar styloid is seen in 24 patients. No fixation was done in them. DRUJ instability was assessed after fixation of the distal radius and was present in 6 patients who had a transfixing K wire across the DRUJ after reduction. This K wire was retained for 4 weeks. In the present study, 40 (83.33%) had union within 2-3 months and 8(16.66%) had union in 3-4 months. Bone grafting was not necessary in any of the patients. At 12 month follow up, the average dorsiflexion was 48.37 ± 16.88 degrees, palmar flexion 63.35 ± 10.43 degrees, pronation 82.37 ± 4.75 degrees, supination 75.85 ± 12.62 degrees. All patients had ulnar deviation (minimum 15°) within the normal functional range. 36 patients (75%) had radial deviation within the normal functional range (minimum 15°). There was no significant loss of grip strength.

Table 1: Age Incidence

Age (in Years)	No. of Cases	Percentage %
21-30	10	20.83%
31-40	14	29.16%
41-50	8	16.66%

51-60	9	18.75%
61-70	7	14.58%

Table 2: Functional outcome - Gartland & Werley Demerit system

Residual deformity	Prominent ulnar styloid	1
	Residual dorsal tilt	2
	Radial deviation of hand	2 or 3
Subjective evaluation	(Range 0 to 6 points)	
	Excellent: No pain, disability, or limitation of motion	0
	Good: Occasional pain, slight limitation of motion and no disability	2
	Fair: Occasional pain, some limitation of motion, feeling of weakness in wrist, no particular disability if careful, and activities slightly restricted	4
	Poor: Pain, limitation of motion, disability, activities more or less markedly restricted	6
Objective evaluation[1] (range 0 to 5 points)	Loss of dorsiflexion	5
	Loss of ulnar deviation	3
	Loss of supination	2
	Loss of palmar flexion	1
	Loss of radial deviation	1
	Loss of circumduction	1
	Pain in distal radio-ulnar joint	1
	Grip strength – 60 % or less of Opposite side	1
Complications (range 0 to 5 s)	Loss of pronation	2
	Arthritic change Minimal	1
	Minimal with pain	3
	Moderate	2
	Moderate with pain	4
	Severe	3
	Severe with pain	5
	Nerve complications (median)	1-3
Poor finger function due to cast	1-3	
Result	Excellent	0-2
	Good	3-8
	Fair	9-20
	Poor	>20
[1] The objective evaluation is based upon the following ranges of motion as being the minimum for normal function: dorsiflexion 45°; palmar flexion 30°; radial deviation 15°; ulnar deviation 15°; pronation 50°; supination 50°		

Table 3: Anatomical Outcome - Sarmiento's**Modification of Lidstrom's Criteria**

Excellent	No or insignificant deformity. Dorsal angulation $\leq 0^\circ$. Radial shortening <3 mm. Loss of radial deviation <4°.
Good	Slight deformity. Dorsal angulation 1 to 10 °. Radial shortening 3 to 6 mm. Loss of radial deviation 5-9°.
Fair	Moderate deformity. Dorsal angulation 11 to 14 °. Radial shortening 7 to 11mm. Loss of radial deviation 10-14°.

Poor	Severe deformity. Dorsal angulation > 15 °. Radial shortening > 12mm. Loss of radial deviation >15°.
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Table 4: Results at 12 months follow up

Range of motion		Radiographic criteria	
Dorsiflexion	48.37 ± 16.88 °	Radial length	10.47 ± 1.45mm
Palmar flexion	63.35 ± 10.43 °	Radial inclination	22.63 ± 3.78°
Pronation	82.37 ± 4.75 °	Palmar tilt	9.36 ±4.84°
Supination	75.85 ± 12.62 °	Ulnar variance	-0.23 ± 1.87 mm
Grip strength [vs Contralateral]	87.45 ± 5.35%		

Table 5: Outcome scores at 12 month follow up

Functional outcome		Anatomical Outcome	
Gartland & Werley Score		Sarmiento's modification of Lidstrom's score	
Excellent [0-2]	22 [45.83%]	Excellent	30(62.5%)
Good [3-8]	22 [45.83%]	Good	18 (37.5%)
Fair [9-20]	04[8.33%]	Fair	00
Poor [≥21]	00	Poor	00

Fig 1: Pre-operative radiographs, post-operative radiographs, and functional outcome at 14 months



DISCUSSION:

Distal radius fractures are the most frequently seen upper extremity fractures. The main objective of its treatment is the re-establishment of anatomic integrity and functioning. In unstable intra-articular fractures, re-establishment of inter-articular integrity of the wrist and maintaining the radial length are often not possible with closed methods. In such cases, where an open reduction is required, various surgical methods and fixation materials can be used.

Due to their intra-articular and unstable nature, most of the fractures from Frykman type III to type VIII are treated surgically. Locking compression plates are being preferentially used over conventional plates. Dorsal approach facilitates plating in buttress mode but there will be implant prominence and proximity to extensor tendons causing tenosynovitis and rupture and risk of delayed collapse. In recent years, volar approach has become more popular. The present study was done to assess the functional & anatomical outcome of operative management of unstable distal radial fractures using a volar LCP.

Volar approach allows reconstruction of the fractured fragments under vision, dealing with intra Volar locking plate fixation for unstable distal radius fractures articular comminution & displacement, restoration of the volar cortex which aids in the restoration of radial length. The Volar LCP gives stability to permit early wrist mobilization and better rehabilitation. The plate is positioned under pronator quadratus keeping it away from flexor tendons avoiding irritation.

Locking plates offer significant resistance to fracture gap motion. The locking screws provide angular stability which minimizes, the possibility of the late collapse of these unstable fractures.

In this study, 83.33% fractures attained union within 2 to 3 months and 16.66% in 3-4 months. Bone grafting was not performed in any of the patients. At the end of 12 months follow up, we had functionally 46% excellent, 46% good, 8% fair results and no poor result.

Patients, who obtained excellent results had no residual deformity. Range of motion was within the normal functional range. They had no arthritic changes. Radial length, radial inclination, tilt, articular step-off were within acceptable limits. Patients with good results had minimal residual deformity and slight limitation of motion. Rest of their findings were within acceptable parameters. Patients with fair results, had pain in distal radioulnar joint along with residual deformity. No fixation was done for the fracture of ulnar styloid process, and it did not have any significant effect on the outcome.

In 6 patients with demonstrable DRUJ instability assessed intraoperatively after fixation of distal radius with LCP, we have used a transfixing K wire to stabilize DRUJ and retained for 4 weeks. All of these patients had restricted and painful pronation at 6 weeks, but five patients developed full, painless rotations by 3 months. One patient continued to have persistently painful and unstable DRUJ with prominent distal ulna. We have done Darrach's excision at 6 months after which relieved her symptoms. We had a few complications in our study apart from the patient with DRUJ instability. 2 patients had superficial wound infection which was managed conservatively with IV antibiotics and dressings. 1 patient had flexor pollicis longus tendon irritation because of its proximity to a long volar plate, 2 patients had pain and one had discomfort. These symptoms were reduced after removing implant at 6 months once the union was achieved.

CONCLUSION:

Volar LCP is an effective treatment option in dealing with unstable distal radius fractures which facilitates and maintains anatomic realignment, prevents delayed collapse, allows early joint motion and results in successful functional and anatomical outcomes. The associated ulnar styloid fractures though not surgically managed do not affect the outcome. The complication rate with this surgical modality.

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