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Original Research Article

Outcome Assessment of the Management of Fractures of Distal End Radius with Open Reduction and Internal Fixation using Volar Locking Compression Plate

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Conflict of interest: Nil

Abstract

Aim: The aim of the present 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.

Material & Methods: This study is a prospective, time-bound, hospital-based study that was conducted in Department of Orthopaedics between the duration of 12 months. The study included a total of 50 cases of distal end radius fractures that were operated with open reduction and internal fixation with volar Locking Compression Plate (volar LCP). The fractures were classified according to Frykmann classification and were followed up at regular intervals. Functional outcome was assessed using the Gartland and Werley demerit scoring at each follow up visit.

Results: In the study, 26% were in 20 - 30 Years, 22% were in 31-40 years, 32% were in 41 - 50 Years and 20% were > 50 Years. Mean age of subjects was 40.5 ± 14.26 years. 46% were Female and 54% were male. 52% had injury in left and 48% had in right. In the study, mode of Injury in 32% was FOOH, 68 % was RTA. In the Study, Frykman/AO type I/A2 was 12%, II/A3 was 10%, III/B3 was 20%, IV/B2 was 10%, V/B3 was 16%, VI/C2 was 10% and VII/C2 was 22%. In the study, 52% got surgery done in 1 day, 32% in 2 days, 12% in 3days and 4% in 4 days. In the Study, 84% had follow-up after 6 months, 12% after 9 months and 4% after 12 months. In the study, Mean Palmar flexion (PF) was 71.67 ± 9.81, Dorsiflexion (DF) was 76.4 ± 10.02, Radial deviation (RD) was 14 ± 3.40, ulnar deviation (UD) was 22.6 ± 5.55, Supination was 81.49 ± 8.52, Pronation was 72.48±10.06 and G&W Score was 4.96 ± 3.14. In the Study, 4% had Arthritis and 4% had EPL Tendon rupture.

Conclusion: Based on the findings of this study it may be concluded that, locking plate fixation for distal radius fractures provided favourable outcome in patients requiring operative intervention with early mobilization of wrist joint.

Keywords: Distal End Radius, Comminuted, Intra-Articular, Open Reduction, Internal Fixation, Locking Compression Plate.

Introduction

The distal radius forms a cornerstone for kinematics of the radiocarpal and the radioulnar joints, near normal restoration of the radial length, volar angulation and radial inclination are important pre-requisites for obtaining good wrist function. [1] 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. [2,3,4]

Distal end radius fractures constitute 10% of all human skeletal fractures. Such fractures mainly affect the elderly population and they involve low energy trauma. [5,6] However, in young adults, high energy trauma such as that resulting from vehicular traffic accidents accounts for a substantial number of cases, the majority of which are unstable. 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. [7] Restoration of volar angulation, radial length, and radial

inclination are essential for good functional outcomes at the wrist joint. Maintenance of articular congruity and stable fixation reduce the incidence of osteoarthritis and also help with earlier rehabilitation. [1]

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. Various treatment modalities, including plaster cast application, Kirschner wire fixation, dorsal and volar plates, and external fixation, have been described for the management of these fractures , all have contributed to improved fracture stability and outcome. [8,9] In recent years, angle-stable, volar locking plates have been propagated and enthusiastically used for surgical fixation of distal radial fractures, especially in the osteoporotic bone. The underlying biomechanical principle of angle-stable locked plating is that uni-cortical, threaded screws fixed in the screw hole of the plate ("internal fixator") reduce shear forces, thereby preventing loosening of the surgical construct. Locking volar plates mechanically bridge the bone and bear the load through the locking construct, resulting in a lower incidence of failure. [10] The subchondral placement of distal screws is essential to prevent a loss of correction and to achieve good functional results. [9] This type of fracture can be better managed with the use of a variable-angle plate as it allows greater flexibility in terms of screw angle insertion and the engagement of periarticular fragments. [11] Considering the high frequency of distal end radius fractures and scarcity of data regarding the optimal treatment, the objectives of the study were 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.

Material & Methods

A Prospective study was conducted in the Department of Orthopaedics, Sri Krishna Medical College and Hospital, Muzaffarpur Bihar, India. All patients visiting the outpatient department and emergency department of the hospital were considered. 50 Patients diagnosed with distal end radius fractures who were operated during the time period of 18 months were included in the study. Patients were followed upto 12 months (Jan 2022 to December 2022). Only post traumatic fractures were included while pathological fractures were excluded.

Method of collecting data

All cases presenting to the outpatient and emergency department fulfilling the below mentioned criteria were recruited for the study.

Inclusion Criteria

1. Fractures of distal end radius of either side.
2. AO MULLER 23 A1, A2, A3, B1, B2, B3, C1, C2, C3.
3. For fixation of complex intra and extra articular fractures.
4. Age between 18-70 years.

Exclusion Criteria

1. Pathological fractures.
2. Polytrauma patients.
3. Skeletally immature patients.
4. Non-union and delayed union.
5. Fractures older than 2 weeks.

Surgical Procedure

The operations were performed under general anaesthesia in all cases and brachial block in 4 cases. The patient was placed supine on the operating table. The affected limb was elevated for 2-3 minutes and exsanguinated. Then a mid-arm pneumatic tourniquet was applied and the limb was placed on a side arm board. Forearm and hand were thoroughly scrubbed, painted with betadine and spirit and draped.

The incision for volar fixation of the distal radius is typically performed through the distal extent of the Henry's approach. An incision is made between the flexor carpi radialis (FCR) tendon and the radial artery. This interval is 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 is carefully retracted radially, while the tendons of the flexor carpi radialis (FCR) radially and flexor pollicis longus (FPL) ulnar side. After the pronator quadratus has been divided and elevated, the fracture is readily visualized, and reduction maneuvers can be accomplished under direct vision. After exposure and debridement of the fracture site, the fracture is reduced and provisionally fixed under fluoroscopy with K-wires, reduction forceps or suture fixation. Reduction aids should be placed so as not to interfere with placement ofthe plate. The appropriate plate is selected following fracture reduction. First, a standard cortical screw was applied to the most distal oval hole of the vertical limb of the plate in order to temporarily secure the plate to the proximal fragment. This allowed concomitant proximal and distal plate adjustment. After fixing the distal fragment with subchondral locking screws, radial length was gained, when necessary, by pushing the plate distally. The first standard screw can be either left in situ or

exchanged with another locking screw. The optimal placement of the distal screws is important. They must be inserted at the radial styloid, beneath the lunate facet, and near the sigmoid notch. The distal screws can be of either monocortical or bicortical engagement. More volar tilt can be achieved during distal screw placement when the wrist is volarly flexed as much as possible by an assistant. The final position of the plate was confirmed using fluoroscopy. Pronator quadratus muscle was used at the time of closure, to cover, in part, the implants that were applied to the anterior surface of the radius. Once stable fixation was achieved and hemostasis secured, the wound was closed in layers and sterile compression dressing was applied. The tourniquet was removed and capillary refilling was checked in the fingers. The operated limb was supported with an anterior below elbow POP slab with the wrist in neutral position.

Postoperative Care

Patient's vitals were monitored. Suture removal was done on 12th day post operatively. POP slab was removed and patient discharged. Patient was advised physiotherapy exercises on discharge.

Follow Up

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 the 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 EPL tendon irritation

• Clinical union

• Radiological union

Final outcome was calculated based on the Gartland and Werley demerit scoring system.

Statistical Analysis

Student's t-test was used to compare the results between patient groups, with statistical difference defined as 5% ($P \leq 0.05$).

Results

Table 1: Patient details

		Count	%
Age	20 - 30 years	13	26%
	31-40 years	11	22%
	41 - 50 years	16	32%
	> 50 years	10	20%
Sex	Female	23	46%
	Male	27	54%
Side involved	Left	26	52%
	Right	24	48%
Mode of Injury	FOOH	16	32%
	RTA	34	68%

In the study, 26% were in 20 - 30 Years, 22% were in 31-40 years, 32% were in 41 - 50 Years and 20% were > 50 Years. Mean age of subjects was 40.5 ± 14.26 years. 46% were Female and 54% were male. 52% had injury in left and 48% had in right. In the study, mode of Injury in 32% was FOOH, 68 % was RTA.

Table 2: Frykman/AO Type Distribution among subjects

		Count	%
Frykman/AO type	I/A2	6	12%
	II/A3	5	10%
	III/B3	10	20%
	IV/B2	5	10%
	V/B3	8	16%
	VI/C2	5	10%
	VII/C2	11	22%

In the Study, Frykman/AO type I/A2 was 12%, II/A3 was 10%, III/B3 was 20%, IV/B2 was 10%, V/B3 was 16%, VI/C2 was 10% and VII/C2 was 22%.

Table 3: Time from injury to surgery (days) and duration of follow-up

		Count	%
Time from injury to surgery (days)	1	26	52%
	2	16	32%
	3	6	12%
	4	2	4%
Duration of follow up months	6	42	84%
	9	6	12%
	12	2	4%

In the study, 52% got surgery done in 1 day, 32% in 2 days, 12% in 3days and 4% in 4days. In the Study, 84% had follow-up after 6 months, 12% after 9months and 4% after 12 months.

Table 4: Mean Deformity Distribution among subjects

	Mean	Median	SD
Palmar flexion (PF)	71.67	72	9.81
Dorsiflexion (DF)	76.4	80	10.02
Radial deviation (RD)	14	16	3.40
Ulnar deviation (UD)	22.6	20	5.55
Supination	81.49	80	8.52
Pronation	72.48	76	10.06
G&W Score	4.96	4	3.14

In the study, Mean Palmar flexion (PF) was 71.67 ± 9.81, Dorsiflexion (DF) was 76.4 ± 10.02, Radial deviation (RD) was 14 ± 3.40, ulnar deviation (UD) was 22.6 ± 5.55, Supination was 81.49 ± 8.52, Pronation was 72.48±10.06 and G&W Score was 4.96 ± 3.14.

Table 5: Complications

		Count	%
Complications	No complications	46	92%
	Arthritis	2	4%
	EPL Tendon rupture	2	4%

In the Study, 4% had Arthritis and 4% had EPL Tendon rupture.

Discussion

Intra-articular fractures of the distal radius represent a spectrum of therapeutic challenges to the trauma surgeons over the years. [12] Dorsal angulation of the fracture is a common complication of these injuries; secondary displacement is also seen after conservative management. [13] These injuries have been noted to develop mal-union in many occasions which provide a less satisfactory functional and cosmetic outcome. [14] The distal radius forms a cornerstone for kinematics of the radiocarpal and the radioulnar joints, near normal restoration of the radial length, volar angulation and radial inclination are important pre-requisites for obtaining good wrist function.[13] Dorsal plating of dorsally displaced fractures was an option in case of patients with these injuries but, the complication rate also remained high. [15,16] Double-plating was tried in many cases of unstable distal radius fractures and several complications of loss of reduction and osteoporosis were noted. [15,17] The volar approach was then developed in management of these fractures and it had several advantages of minimizing the complications of the dorsal approach such as deprivation of metaphyseal blood supply to the fragments, avoidance of dorsal dissection and complications of extensor tendons also a more spacious volar aspect of distal radius. [15,18,19]

In the study, 26% were in 20 - 30 Years, 22% were in 31-40 years, 32% were in 41 - 50 Years and 20% were > 50 Years. Mean age of subjects was 40.5 ± 14.26 years. 46% were Female and 54% were male. 52% had injury in left and 48% had in right. In the study, mode of Injury in 32% was FOOH, 68 % was RTA. In the Study, Frykman/AO type I/A2 was 12%, II/A3 was 10%, III/B3 was 20%, IV/B2 was 10%, V/B3 was 16%, VI/C2 was 10% and VII/C2 was 22%. In the study, 52% got surgery done in 1 day, 32% in 2 days, 12% in 3days and 4% in 4days. In the Study, 4% had Arthritis and 4% had EPL Tendon rupture. 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. Open reduction and internal fixation restore the wrist's anatomy and help in faster rehabilitation with good clinical outcomes. [20] Volar plating is currently favored for comminuted distal end radius fracture patterns and osteoporotic bones. [21] 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 palmar cortex is better contoured with respect to the dorsal cortex in terms of plate application.

The volar variable angle locking plate is not a panacea for distal end radius fractures. The inability to decipher the articular anatomy of the distal end radius and the poor reduction of the fracture will lead to poor results with this newer implant. Complications such as hardware prominence, loss of reduction, and tendon irritation are similar to those found with other volar plates. The overall complication rate in our study was 21.7%, which is comparable to that reported by Jagodzinski et al. in a bicentric study on distal radius variable angle locking plates. [22] They reported a complication rate of 19.6%, although the majority had screw misplacement, while Kawasaki et al. had no reported cases of screw misplacement. [23] In our study, there was only one case of screw misplacement because extra care was taken to prevent this complication since it could have resulted in longer fluoroscopy time. However, no effort was made to calculate the resultant extra fluoroscopy exposure. The smaller sample size in our study could also be the reason for only a single case of such a complication.

In the Study, 84% had follow-up after 6 months, 12% after 9months and 4% after 12 months. In the study, Mean Palmar flexion (PF) was 71.67 ± 9.81, Dorsiflexion (DF) was 76.4 ± 10.02, Radial deviation (RD) was 14 ± 3.40, ulnar deviation (UD) was 22.6 ± 5.55, Supination was 81.49 ± 8.52, Pronation was 72.48±10.06 and G&W Score was 4.96 ± 3.14.

Conclusion

Based on the findings of this study it may be concluded that, locking plate fixation for distal radius fractures provided favourable outcome in patients requiring operative intervention with early mobilization of wrist joint. Hence locking plate fixation may be recommended for distal radius fractures.

References

1. Wong KK, Chan KW, Kwok TK, Mak KH. Volar fixation of dorsally displaced distal radial fracture using locking compression plate. Journal of Orthopaedic Surgery. 2005 Aug;13(2):153-7.
2. Ark J, Jupiter JB. The rationale for precise management of distal radius fractures. The Orthopedic Clinics of North America. 1993 Apr 1;24(2):205-10.
3. Nagi ON, Dhillon MS, Aggarwal S, Deogaonkar KJ. External fixators for intra-articular distal radius fractures.Indian J Orthop2004;38:19-22.
4. Jupiter JB. Fractures of the distal end of the radius. JBJS. 1991 Mar 1;73(3):461-9.
5. Xavier CR, Dal Molin DC, Dos Santos RM, Dos Santos RD, Neto JC. Surgical treatment of distal radius fractures with a volar locked plate: correlation of clinical and radiographic results. Revista Brasileira de Ortopedia (English Edition). 2011 Sep 1;46(5):505-13.
6. Arora R, Gabl M, Gschwentner M, Deml C, Krappinger D, Lutz M. A comparative study of clinical and radiologic outcomes of unstable colles type distal radius fractures in patients older than 70 years: nonoperative treatment versus volar locking plating. Journal of orthopaedic trauma. 2009 Apr 1;23(4):237-42.
7. Green DP. Pins and plaster treatment of comminuted fractures of the distal end of the radius. JBJS. 1975 Apr 1;57(3):304-10.
8. Ring D, Jupiter JB, Brennwald J, Büchler U, Hastings II H. Prospective multicenter trial of a plate for dorsal fixation of distal radius fractures. The Journal of hand surgery. 1997 Sep 1;22(5):777-84.
9. Osada D, Viegas SF, Shah MA, Morris RP, Patterson RM. Comparison of different distal radius dorsal and volar fracture fixation plates: a biomechanical study. The Journal of hand surgery. 2003 Jan 1;28(1):94-104.
10. Lakshman K, Shivananda S, Radhakrishna AM. Surgical management of fractures of distal end radius with open reduction and internal fixation using volar locking compression plate. International Journal of Orthopaedics. 2021;7(4):101-1.
11. RossM, Heiss-DunlopW. In: Volar angle stable plating for distal radius fractures. Slutsky DJ, editor. ; 2010.
12. Fok MW, Klausmeyer MA, Fernandez DL, Orbay JL, Bergada AL. Volar plate fixation of intra-articular distal radius fractures: a retrospective study. Journal of wrist surgery. 2013 Aug;2(03):247-54.
13. Wong KK, Chan KW, Kwok TK, Mak KH. Volar fixation of dorsally displaced distal radial fracture using locking compression plate. Journal of Orthopaedic Surgery. 2005; 13(2):153-57.
14. Arora R, Lutz M, Deml C, Krappinger D, Haug L, Gabl M. A prospective randomized trial comparing nonoperative treatment with volar locking plate fixation for displaced and unstable distal radial fractures in patients sixty-five years of age and older. J Bone Joint Surg Am. 2011;93(23):2146–53.
15. Swan K Jr, Capo JT, Tan V. Distal radius plating options. Curr Opin Orthop. 2003; 14:238–44.
16. Campbell DA. Open reduction and internal fixation of intra-articular and unstable fractures

of the distal radius using the AO distal radius plate. J Hand Surg Br. 2000; 25:528–34.
17. Jakob M, Rikli DA, Regazzoni P. Fractures of the distal radius treated by internal fixation and early function. A prospective study of 73 consecutive patients. J Bone Joint Surg Br. 2000; 82:340–44.
18. Chan KW, Kwok TK, Mak KH. Early experience with locking compression plate in the treatment of distal radius fracture. Hong Kong J Orthop Surg. 2003; 7:88–93.
19. Leung F, Zhu L, Ho H, Lu WW, Chow SP. Palmar plate fixation of AO type C2 fracture of distal radius using a locking compression plate: a biomechanical study in a cadaveric model. J Hand Surg Br. 2003; 28:263–66.
20. Park JH, Hagopian J, Ilyas AM. Variable-angle locking screw volar plating of distal radius fractures. Hand Clin. 2010;26(3):373–80.
21. Margaliot Z, Haase SC, Kotsis SV, Kim HM, Chung KC. A meta-analysis of outcomes of external fixation versus plate osteosynthesis for unstable distal radius fractures. J Hand Surg Am. 2005;30(6):1185–99.
22. Jagodzinski NA, Singh T, Norris R, Jones J, Power D. Early results of a variable-angle volar locking plate for distal radius fractures: A bi-centre study. In Orthopaedic Proceedings 2012 Sep 1 (Vol. 94, No. SUPP_XLII, pp. 13-13). Bone & Joint.
23. Kawasaki K, Nemoto T, Inagaki K, Tomita K, Ueno Y. Variable-angle locking plate with or without double-tiered subchondral support procedure in the treatment of intra-articular distal radius fracture. J Orthop Traumatol. 2014;15(4):271–4.