Original Article

Outcome of treatment of distal radial fractures with volar locking plate

Ranjeet Hakepatil*, Shrikant Gore**

*Assistant Professor, **Professor and HOD, Department of Orthopaedics, Government Medical College, Latur, Maharashtra, INDIA.
Email: drranjeet_hpatil@yahoo.com

Abstract

Background: Fractures of distal end radius continues to be most common skeletal injuries of upper extremity and remains a challenge for the orthopaedic surgeons. The purpose of this prospective study was to assess the efficiency of volar locking plate fixation with regards to functional outcome and complications. **Methods:** Patients with distal radial fractures from June 2013-Sept 2015 in Dept of orthopaedics, Govt Medical College, Latur were admitted and treated in the form of volar locking plate. (Total 40 patients) The modified Green and O'Brien wrist score system was used for analysis of functional outcome. **Results:** Out of 40 patients, 17 (42.5%) were male and 23 (57.5%) were female patients. According to Frykman's classification, there were 5 (12.5%) patients of Type I, 13 (32.5%) patients of Type II, 3 (7.5%) patients of Type III, 3 (7.5%) patients of Type IV, 4 (10%) patients of Type V, 4 (10%) patients of Type VI,3 (7.5%) patients of Type VII and 5 (12.5%) patients of Type VIII. At final functional assessment, 29 patients (72.5%) achieved excellent, 9 patients (22.5%) achieved good results and 2 patients (5%) achieved fair results. All of the patients returned to their regular employment. Complications in the form of stiffness was seen in 2 (5%) of the patients, malunion was seen in 2(5%) of the patients, neurovascular complication was seen in 1 (2.5%) of the patient, superficial infection was seen in 1(2.5%) of the patient and tenosynovitis was seen in 2(5%) of the patients. **Conclusion:** Volar locking compression plating system is an effective treatment modality for functional and anatomical restoration of distal end radius fractures.
Keywords: volar locking plate, distal radial fracture.

***Address for Correspondence:**
Dr. Ranjeet Hakepatil, Assistant Professor, Department of Orthopaedics, Government Medical College, Latur, Maharashtra, INDIA.
Email: drranjeet_hpatil@yahoo.com
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INTRODUCTION

Distal radial fractures are very common injuries accounting for 16% of all fractures treated in emergency room and represent 74.5% of all fractures of the forearm.[1] These fractures tend to suffer secondary displacement after conservative treatment. And as distal radius is important in the kinematics of radiocarpal and radioulnar joints, open reduction of articular surface and restoration of radial length, volar angulation and radial inclination are prerequisites for good clinical outcome.[2] Distal radius is foundation of wrist joint and indispensable part of ligamentous support so reconstruction of articular congruity and stable fixation is important to reduce the incidence of post-traumatic osteoarthritis and early functional rehabilitation. Closed reduction and cast immobilization, kirschner wire (k-wire) fixation, external fixation, and open reduction and internal fixation (ORIF) have been evaluated as primary treatment of distal radial fractures.[3] Loss of reduction is a common problem associated with cast immobilization. Other complications attributed to cast immobilization include soft tissue, necrosis, compartment syndrome, neurovascular injury. Complications attributed to k-wire fixation include cutaneous nerve and vessel injury, attrition rupture of tendons, chronic regional pain syndrome (CRPS), pin migration, pin fracture, irritation, and loss of reduction.[4] The advantages of volar locking plates over dorsal plates and external fixators have been described in recent literature. External fixators oblige immobility across the joint, which may result in potential muscle atrophy, disuse osteopenia and tightening of the joint capsule. This complicates rehabilitation and functional outcome,

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especially for those patients with osteoporosis. Dorsal plates carry the risk of tenosynovitis and tendon rupture due to the proximity of the plate to the extensor tendons. These complications have been reported to necessitate the removal of the dorsal plate in 11 to 33% of cases.[5] Volar plates diminish the aforementioned risks and have improved the outcome in treating distal radius fractures. Furthermore, and critical to reaching the goal of safe, early postoperative range of motion, volar locking plates introduce improvement in the stability of the fracture repair. With better understanding of the principles of locking compression plating system, this procedure has become an indispensable tool in the management of distal end of radius fractures. The objective of this prospective study was to a) To assess the efficiency of volar locking plate fixation in the management of fractures of distal end of radius and b) To assess the functional results in patients treated with volar locking plates.

MATERIALS AND METHODS

Forty patients with fractures of the distal end of radius were treated with open reduction and internal fixation with locking compression plating system. There were 17 males and 23 females. Most of the patients were between the age group of 40-60 yrs. The dominant wrist (Right) was affected in 13 cases and 27 patients had injury to left wrist. None of the cases of our study had any median nerve involvement or any tendon injury. All the patients were evaluated with x-rays in posteroanterior and lateral views. Our inclusion criterions included volar barton fractures, palmarly displaced extra-articular fractures (smith), and dorsally displaced articular and extra-articular fractures. Regional anaesthesia and upper arm tourniquet was used in all of the cases. Radial artery was marked with skin marker before inflation of tourniquet. A standard Henry's approach was used in all of the cases. Fracture reduction achieved by inserting a bone spike or an osteotome, over the dorsal cortex; to completely disimpact the distal fracture fragment. Fracture reduction was also facilitated by ligamentotaxis by applying traction to the fingers while reducing the fracture manually by the surgeon. A k-wire was placed in the radiocarpal joint to mark the distal end of radius, so that plate could not slide far distally. A C-arm was used to confirm reduction of the fracture fragments, optimal position of the plate and optimum length of the screws. All the distal screws were placed under subchondral bone for maximal stability; remaining screws in the shaft were placed. A 30° lateral C-arm image was obtained to ascertain that all the screws were placed in subchondral position and, not in the joint. BE POP dorsal slab was given postoperatively. Intravenous antibiotic (Inj.Cefotaxime 1gm) was given for two days postoperatively followed by oral antibiotic (Tab Cefotaxime 500 mgs bid) for three more days. Postoperative first check dress was done on day 2, followed by postoperative check x-ray. Posteroanterior and lateral x-rays of the wrist were taken. Sutures were removed on 10th postoperative day, dorsal slab was removed and wrist mobilization exercises were begun. Range of the movements recorded. Patients were followed at an interval of 6 weeks, 3 months, 6 months and 1 year postoperatively. The modified Green and O'Brien wrist score was used for the analysis.

Table 1: Clinical scoring system of Green and O'Brien modified by Cooney (1987)

	Score (Points)	Findings
Pain	25	None
	20	Mild, occasional
	15	Moderate, tolerable
	0	Severe or intolerable
Functional status	25	Returned to regular employment
	20	Restricted employment
	15	Able to work but unemployed
	0	Unable to work because of pain
Range of motion	25	Full
	15	75-99% of normal
	10	50-74% of normal
	5	25-49% of normal
	0	Less than 25% of normal
	Or evaluation dorsiflexion-palmar flexion arc of injured hand	
	25	120 or more
	15	91-119^0
	10	61-90^0
	5	31-60^0
	0	30^0 or less
Grip strength	25	Normal
	15	75-99% of normal
	10	50-74% of normal
	5	25-49% of normal
	0	0-24% of normal
	Final result	Excellent 90-100
		Good 80-89
		Fair 65-79
		Poor 65

RESULTS

There were 40 patients treated with volar locking plate in this study. Following observations were made. There

were 17 (42.5%) male and 23 (57.5%) female patients in our study. The patients in the age group of 20-39 years were 11 (27.5%), in the age group of 40-60 years were 19 (47.5%) and in the age group of more than 60 years were 10 (25%). All fractures were classified according to Frykman's classification. There were 5 (12.5%) patients of Type I, 13 (32.5%) patients of Type II, 3 (7.5%) patients of Type III, 3 (7.5%) patients of Type IV, 4 (10%) patients of Type V, 4 (10%) patients of Type VI, 3 (7.5%) patients of Type VII and 5 (12.5%) patients of Type VIII. Complications in the form of stiffness was seen in 2(5%) of the patients, malunion was seen in 2 (5%) of the patients, neurovascular complication was seen in 1 (2.5%) of the patient, superficial infection was seen in 1 (2.5%) of the patient and tenosynovitis was seen in 2(5%) of the patients. The average final wrist range of motion was 61° extension (range 45°-70°), 62° flexion (range 45°-70°), 75° pronation (range 70°-80°) and 76° supination (range 70°-80°). Modified Green and O'Brien scoring system was used for assessment. At final functional assessment, 29 patients (72.5%) achieved excellent, 9 patients (22.5%) achieved good results and 2 patients (5%) achieved fair results. All of the patients returned to their regular employment.

Table 1: Complications

Sr no	Complication	No of cases	Percentage(%)
1	Stiffeness	02	5
2	Malunion	02	5
3	Nonunion	0	0
4	Neurovascular complications	01	2.5
5	Superfiscial infection	01	2.5
6	Tenosynovitis	02	5

Table 2: Frykman's Classification Wise Distribution

Frykman's Type	No Of Patients
I	05
II	13
III	03
IV	03
V	04
VI	04
VII	03
VIII	05

Table 3: According to Green and Obrien clinical wrist scoring system modified by Cooney

Sr No	No Of Patients	Percentage (%)
Excellent	29	72.5
Good	09	22.5
Fair	02	05
Poor	00	00

DISCUSSION

A fracture of the distal end of radius continues to be one of the most common skeletal injuries of the upper limb. These fractures are frequently articular injuries resulting in disruption of both the radiocarpal and distal radio ulnar joints. Restoration of normal alignment and articular congruity has proved to be essential to achieve good functional results and for prevention of late osteoarthritis.[2] Comminuted intra-articular fractures are highly unstable. After an anatomical joint reduction is achieved, the articular segment must be connected to the shaft while appropriate alignment is maintained. Achieving adequate stability for fracture-healing is difficult in the presence of metaphyseal or meta-diphyseal communition. The application of cast in these patients would lead to loss of reduction and a poor functional outcome. Open reduction and early fixation with locking plate allows restoration of normal anatomy, stable fixation, early mobilization, and early return to previous activity.[3] Palmar plating avoids violating the extensor compartment and should virtually eliminate the complications of extensor tendon irritation and rupture. Also, in the volar approach, there is more space between the volar cortex and flexor tendons and pronator quadratus prevents soft tissue complications like flexor tendon injuries.[2] The volar plate should not be positioned distal to the watershed line to avoid flexor tendon injuries .Distal to the watershed line, radius slopes in a dorso-distal direction and becomes more prominent palmarly. The course of Flexor pollicis longus is close to the palmar rim of distal radius. Thus, volar plates positioned distal to the watershed line can exert pressure on flexor tendons and cause injury. The watershed line is defined as a transverse ridge that closures the concave surface of the volar radius distally.[6] With locking plates stability is maintained at angular-stable screw-plate interface. As a result of this stable monobloc of the locking internal fixator, the pullout strength of locking head screws is substantially higher. Because the screws are locked to the plate, it is difficult for one screw to pull out or fail unless all adjacent screws fail. The increase in stability with locking plates is most helpful in poor quality bones; osteoporotic bones.[7] For maximal support of the bone, distal screws must be placed just under the subchondral bone. However, it is possible for the drill to penetrate into the radiocarpal joint, and a 30° lateral radiograph can be used to assess whether the screws have penetrated through the articular surface of the radius. It is often difficult to measure the length of the screws so, it is better to verify radiographically the length after the first screw is inserted. Appropriate placement of the plate is important to avoid impingement of the ulnar portion of the plate on the distal radioulnar joint. Also as since only

single plate is needed and the plate does not depend on a tight fit to the bone for stability, substantially less soft tissue dissection may be required, thus preserving the local blood supply and enhancing fracture-healing. In our series of 40 patients, 17 were male patients and 23 were female patients. In our series, one of the patients had superficial infection, antibiotics were given and the patient recovered uneventfully. Two of the patients had extensor tenosynovitis, in these patients implants were removed earlier. Stiffness was observed in two of the patients as those were poorly motivated patients who have not followed postoperative physiotherapy. Stiffness is uncommon with this technique but it must be watched for and should be treated aggressively in the early stages. Guidelines for the acceptable reduction are a) radial shortening < 5mm, b) radial inclination >15°, c) saggital tilt on lateral projection between 15° dorsal tilt and 20° volar tilt, d) articular incongruity < 2mm of sigmoid notch of distal radius. Malunion was observed in two of the patients. None of the patient from our series suffered nonunion. Neurovascular complication in the form of median nerve neuropraxia was observed in one of the patients; which was treated with steroids, physiotherapy and patient recovered completely after 4 weeks. Modified Green and O'Brien scoring system was used for assessment. At final functional assessment 29 patients (72.5%) achieved excellent, 9 patients (22.5%) achieved good results and 2 patients (5%) achieved fair results. We conclude that, good anatomical reduction is necessary for optimum results. By above considerations, volar locking compression plating system is an effective treatment modality for functional and anatomical restoration of distal end radius fractures.

Table 4: Comparative analysis of Range of Movements

Author	Extension	Flexion	Pronation	Supination
Orbay[8]	59°	57°	80°	78°
Wong And Chan[2]	59°	55°	82°	98°
Kilic & Kabukci Voglu[9]	40°	55°	86°	83°
Present Study	61°	62°	75°	76°

Table 5: Comparative analysis of results

Results(In %Age)	Leung And Yuan Ku Tu[10]	Present Study
Excellent	54	72.5
Good	15	22.5
Fair	27	5
Poor	4	0

CASES

Figure 1: Dorsiflexion

Figure 2: Supination

Figure 3: Palmar Flexion

Figure 4: Pronation

Figure 5: pre-op x ray ap view

Figure 6: pre-op x ray lat view

Figure 7: post-op x ray pa view

Figure 8: post-op x ray lat view


Figure 9: Dorsiflexion


Figure 10: Palmar Flexion


Figure 11: Supination


Figure 12: Pronation


Figure 13: pre-op x ray ap view


Figure 14: pre-op x ray lat view


Figure 15: post-op x ray pa view


Figure 16: post-op x ray lat view

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