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To evaluate the functional and radiological outcome of fracture distal end radius treated with volar plating

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Abstract

The aim of this study is to assess the radiological and functional outcomes of open reduction and internal fixation with volar locking plates in the treatment of unstable intra-articular distal radius fractures. In this study functional evaluation was performed using the modified Gartland–Werley scoring system and for the radiological assessment, radial inclination, volar tilt and radial height was compared pre and post operatively.

Keywords: Fracture, distal radius, gartland and werley score, radiological outcome, functional outcome, locking volar plate

Introduction

Distal end radius fractures are the most common fractures of the upper limb following fall on outstretched hand^[1]. The ideal management protocol of distal end radius fractures has changed dramatically over the previous two decades from the universal use of cast immobilization to highly sophisticated surgical interventions^[2]. Due to increased rate of complications such as malunion, subluxation/dislocation of distal radio-ulnar joint or late collapse of fracture with procedures such as closed reduction and cast immobilization, ligamentotaxis with external fixator and percutaneous pin fixation are no longer acceptable. Furthermore, these procedures often result in poor functional and cosmetic outcome^[3, 4]. Although various studies have demonstrated good results with different modalities of management, the choice of treatment still remains controversial. Internal fixation with volar plating using locking screw implants has been a move toward good functional outcome, which can rigidly stabilize cancellous and fragmented bone that is normally not amenable to screw fixation^[5]. Potential advantages of this technique include stable subchondral fixation, early postsurgical active wrist motion, and the restoration of articular and extra-articular alignment.

The purpose of this study is to study the radiological and functional outcomes of volar locking plate for treating unstable intra-articular distal radius fractures.

Materials and methods

Aim: To evaluate clinical and radiological outcome of fracture distal end radius treated with Volar locking plate.

Objective: To assess the functional outcome of fracture distal end radius treated with Volar plating using Gartland and Werley scoring system and to evaluate the radiological outcome using radiological parameters.

This study was conducted in Department of Orthopaedics, Sri Aurobindo Medical College & Post Graduate Institute, INDORE, from September 2019 to August 2020, Patients presenting in the OPD and in emergency with fracture distal end radius were included. The study group consisted of 25 patients with distal radius intra articular displaced fracture treated with a volar locking plate in our Institution.

Inclusion Criterion

- Intra-articular displaced fracture distal radius.

- Distal radius Metaphyseal comminution
- All skeletally mature patients >18 years.

Exclusion Criteria

- Open fracture with neurovascular injury.
- Multiple fractures in the same limb.
- Old fracture (>2 weeks duration).

Pre- Operative Planning

The details of history was taken. Clinical examination of patient including general examination and local examination was done. Co-morbidity of the patients were also noted. Then the patients were evaluated radiologically with anteroposterior and lateral radiographs of the wrist joint. Gartland and Werley scoring system was used for evaluating clinical function. Routine laboratory investigations were done such as complete operative profile and coagulation profile (such as prothrombin time, clotting time) were performed for all patients.

Surgical Technique – Modified Henrys Approach

The patients were treated with open reduction and internal fixation using 2.4-mm volar locking plates with the modified Henry approach. In volar plate fixation, the skin was incised longitudinally along the course of the flexor carpi radialis (FCR) tendon. The FCR tendon and flexor pollicis longus tendon were retracted medially, and the pronator quadratus muscle was also elevated from its radial origin and reflected medially to expose the distal radius fracture. Each fracture fragment was identified and reduced. After applying the plate and screws, reduction is checked under C-arm under AP and lateral views along with the screw length. If possible, the pronator quadratus was sutured. Then the wound was closed in layers.

Post Operative Protocol

Postoperatively, ice fomentation and limb elevation were advised. Active finger exercises were started the day after surgery. Dressings were done on post operative day 2 and 5 and sutures were removed on the 13th postoperative day. Rehabilitation began with active and passive exercises after suture removal. All patients were followed up at 1month, 3 months and 6 months. Strenuous use of the hand including heavy weight lifting was not allowed for 12 weeks after surgery.

Follow Up Protocol

At the time of follow-up, functional outcome was assessed by Gartland Werley score with an antero-posterior and lateral view radiographs of the wrist for evaluation of radiological parameters.

Radiographic evaluation was evaluated based on 3 criteria;

- 1) Radial inclination: is the angle between the articular surface of the radius and the radial styloid, measured on the posteroanterior (PA) view. The radial inclination ranges from 13° to 30° (although this range varies considerably between authors). Average radial inclination is around 23°. Acceptable reduction is thought to be greater than 15°.
- 2) Radial height: is the difference in length between the ulnar head and the tip of the radial styloid on the PA view, which should be 11 to 12 mm. Shortening of up to 5mm is associated with a satisfactory outcome.
- 3) Volar tilt (palmar inclination): at the articular surface of the radius, a tangent line is drawn from dorsal-to volar, followed by a line perpendicular to the long axis of the radius. The angle formed measures the volar tilt. Lateral view is used to measure volar tilt. Palmar or volar tilt ranges from 0 to 28°. Average is around 11°.

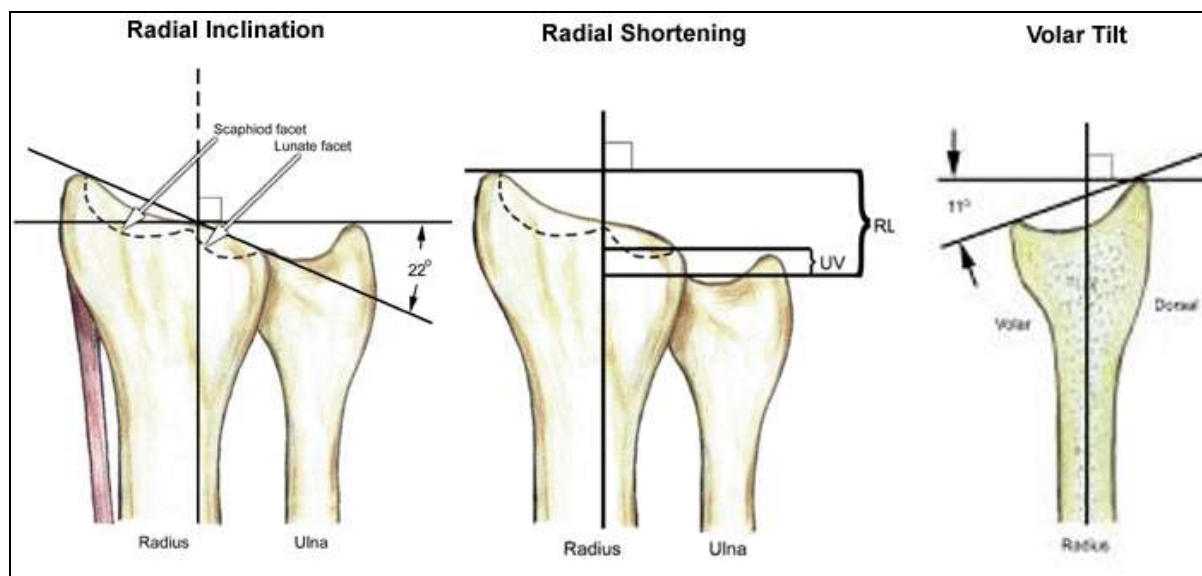


Fig 1: showing normal radial inclination, radial height and volar tilt.

Subjective functional assessment was performed using the Gartland–Werley scoring system. At each follow up visit, the patients were evaluated for any postoperative complications including infection, neuropathy, tendon injury, loss of

reduction, malunion, non union, chronic regional pain syndrome, and plate and screw loosening. The follow up period was at least 3 months.

	DESCRIPTION	Points			
Deformity	Prominent ulnar styloid	1	Complications	None or minimal	0
	Radial deviation	1-2		Slight crepitation	1-2
	Dinner fork deformity	1-3		Sever crepitation	3-4
	Maximum	6		Median nerve compression	1-3
				Pulp-palm distance 1 cm	3
Subjective evaluation	No pain, no limitation of motion	0	Pulp-palm distance > 2cm	5	
	Occasional pain, some limitation of motion, weakness, pain, limitation of motion	4	Pain in distal radio ulnar joint	1-3	
	Activities restricted	6	Maximum	15	
	Maximum	6			
			Excellent		0-2
Range of motion	Limitation of motion <20%	0	Good		3-7
	Limitation of motion <50%	2	Fair		8-18
	Limitation of motion >50%	6	Poor		19-33
	Stiffness of wrist	6	Table-1. Modified Gartland and Werley scoring system		
	Maximum	6			

Fig 2: Gartland and Werley scoring system

Results

We operated 25 patients of distal end radius fracture, with volar plating. The patients were in different age group with a mean age of 37.84 years, the youngest being 18 years of age

and the eldest being 58 years of age. According to their age distribution 28% were in the age group of <=30 years, 28% in age group of 31-40 years, 24% in age group of 41-50 years, 20% in age group of 51-60 years.

Table 1: showing distribution of patients according to age in the study group

Variables		Frequency	Percent
Age Group	<= 30 Yrs	7	28.0%
	31-40 Yrs	7	28.0%
	41-50 Yrs	6	24.0%
	51-60 Yrs	5	20.0%
Total		25	100.0%

Our study was of male preponderance comprising of 76% male patients and 24% female patients, due to involvement of more male patients in road traffic accidents.

the patients while the rest of the patients took 3 months for complete union to occur which was evident of follow ups.

Table 2: Showing distribution of patients according to sex in the study group.

Sex	Female	6	24.0%
	Male	19	76.0%
	Total	25	100.0%

There was slight predominance of left sided affection in our study comprising 52% patients in left sided wrist involvement.

Table 4: Showing time taken for fracture union in follow up period.

Time of Union	2 months	16	64.0%
	3 months	9	36.0%
	Total	25	100.0%

At 3 months follow up the majority of the patients were free of any complications. Only 2 patients (8%) reported CRPS and 3 patients (12%) reported stiffness.

Table 3: Showing distribution of patients according to side involvement.

Side	Left	13	52.0%
	Right	12	48.0%
	Total	25	100.0%

Table 5: Showing complications rate in follow up period.

Complications (IF ANY)	Crps	2	8.0%
	None	20	80.0%
	Stiffness	3	12.0%

The rate of bony union in all the operated cases vary patient to patient. Also, union time is a patient related outcome, however to some extent it also depends upon the fracture fixation. Complete union was achieved in 2 months in 64% of

The radiological assessment was done taking into consideration of the volar tilt, radial height and radial inclination. In our study the volar tilt increased from mean pre operative value of 7.24 to 14.0, radial height increased from a mean pre operative value of 5.20 to 9.80, and radial inclination increased from a mean pre operative value of 10.16 to 22.56.

Table 6: comparing radiological outcome in post operative period from pre operative period

Variables		N	Mean	Std. Deviation	Pair T-Test	P Value	Result
Pair 1	Pre Volar tilt	25.00	7.24	2.260	10.419	0.000	Sig
	Post Volar tilt	25.00	14.00	2.291			
Pair 2	Pre radial height	25.00	5.20	1.683	12.294	0.000	Sig

	Post radial height	25.00	9.80	1.258			
Pair 3	Pre radial inclination	25.00	10.16	2.688	19.134	0.000	Sig
	Post radial inclination	25.00	22.56	2.083			

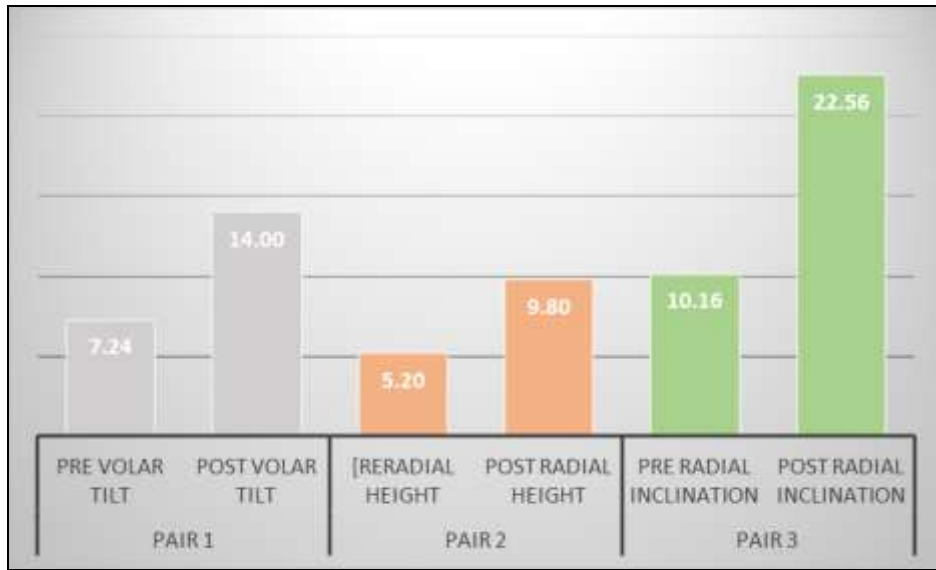


Fig 3: Bar diagram showing comparison between pre operative and post operative radiological parameters



Fig 4: X-ray showing pre operative radial height, volar inclination and radial inclination in a patient

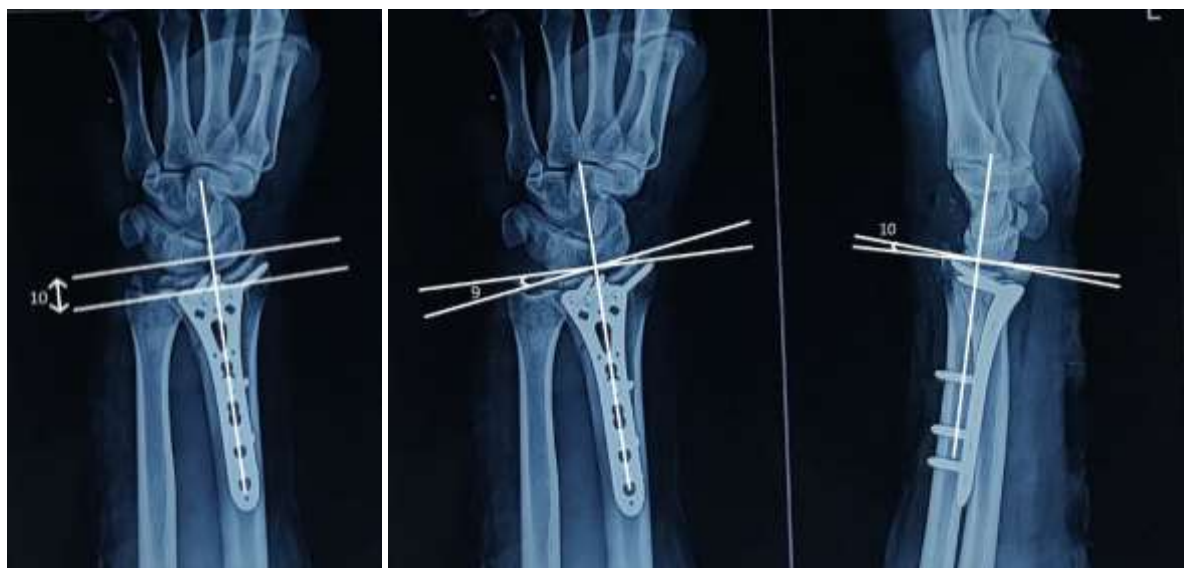


Fig 5: X-ray showing post operative radial height, radial inclination and volar inclination in the same patient

In present study, we evaluated functional outcome Pre and post operatively along with comparison at consecutive follow ups at different time intervals using Gartland and Werley Scoring system. Pre operatively the mean score was 27.52 and

at 1 months of follow up it decreased to 6.12 and it further improved to 1.12 at 3 months of follow up indicating excellent functional outcome.

Table 7: Pre-Post comparison of Mean Gartland and Werley Score at different Time Intervals

Gartland And Werley Score		N	Mean	Std. Deviation	Pair T-Test	P Value	Result
Pair 1	PRE	25.00	27.52	1.686	53.500	0.000	Sig
	1 month Follow-up	25.00	6.12	1.092			
Pair 2	PRE	25.00	27.52	1.686	68.165	0.000	Sig
	3 month Follow-up	25.00	1.12	0.781			
Pair 3	1 month Follow-up	25.00	6.12	1.092	18.898	0.000	Sig
	3 month Follow-up	25.00	1.12	0.781			

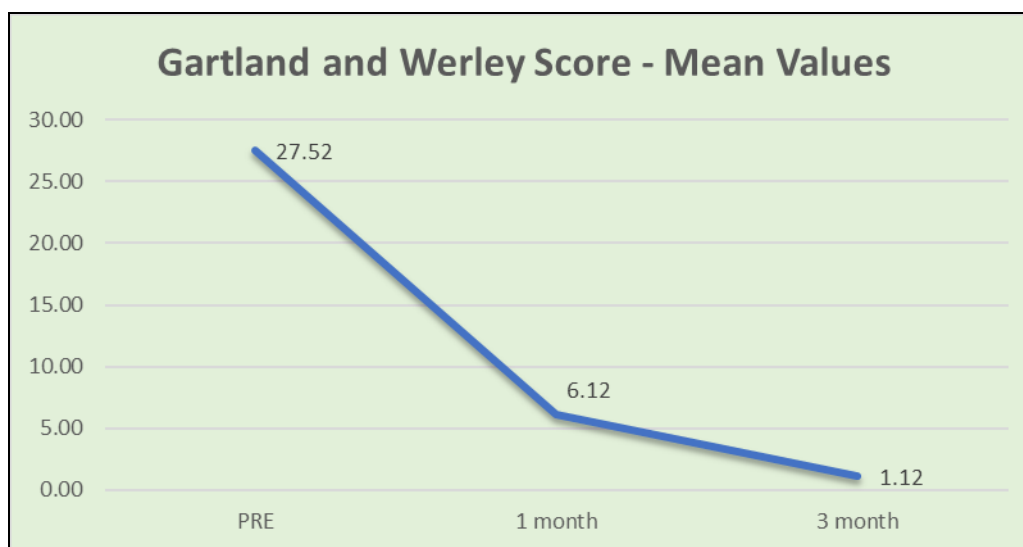


Fig 6: line diagram showing improvement in Gartland and Werley score from pre operative period to 3 months follow up

Discussion

An anatomical reduction of the articular surface with a stable fixation is the main goal in the treatment of intra-articular distal radius fractures. Improper reduction or residual intra-articular incongruity leads to secondary arthritis and poor functional outcome in the long term [6, 7]. Despite evolving and improving approaches, treatment goals remain unchanged: restoring the joint surface to protect the joint cartilage, achieving radial alignment and height to preserve normal kinematics of the joint, providing mobility for maintenance of finger-wrist and forearm functions, and ensuring stability to protect length alignment- joint surface congruency until recovery [8].

Plating allows direct visualization of fracture fragments and restoration of the anatomy, decreased morbidity by allowing early mobilization, and early return of wrist function. Locking plates address intra-articular and metaphyseal comminution and are very helpful in osteoporotic fractures preventing late collapse of fracture fragments. DRUJ instability was previously recognized as a poor prognostic factor in the management of distal radius fractures. However, studies suggest that anatomically reduced and rigidly fixed distal radius fractures with locking plates have no significant difference in the final functional outcome between patients treated with and without ulnar styloid fractures, despite the degree of displacement and the location of the fractures [9]. In our study there was no patient with DRUJ instability.

Our study included 25 patients with a mean age of 37.84 years, the youngest being 18 years of age and the eldest being 58 years of age. Chavhan AN *et al.* in there study included

patients with mean age of 42.8 years, the eldest being 75 years and youngest being 21 years [10]. In Rohit A *et al* mean age of the patients was 57 years with minimum age 17 years and maximum age of 79 years [11]. This variation shows bimodal distribution of fracture distal end radius in young age group due to high energy trauma and old age people due to trivial trauma.

Our study was of male preponderance comprising of 76% male patients and 24% female patients. Chavhan AN *et al.* in there study included 71.4% females as compared with 28.6% males [10]. In Margaret Fok WM *et al* study there were 56 (57.7%) male and 41 (42.3%) female while Tank Gyaneshwar study had female 52 (65%) and male was 28 (35%) in number [12, 13].

The complete union was achieved in 2 months in 64% of the patients while the rest of the patients took 3 months for complete union to occur. In a study by K. Murakami *et al* mean time of union was 2 months [14]. At 3 months follow up the majority of the patients were free of any complications. Only 8% reported CRPS and 12% reported stiffness. In study by Chandan K *et al* 3 patients had joint stiffness, 1 patient had paraesthesia in the distribution of radial nerve, none had impingement of tendons or median nerve complications [15].

The rating system of Gartland and Werley is sometimes difficult to apply accurately, particularly for the radiological and subjective demerit points. This fact might be the cause of the wide variance of results in groups with similar radiological and clinical findings. Neither reliability nor validity of the score has been reported. However, it is a popular score that is used in most of the present literature and

which includes subjective and objective parameters. In present study Pre and post-comparison at different time intervals were carried out using Gartland and Werley Scoring system. Pre operatively the mean score was 27.52 and at 1 months of follow up it decreased to a mean of 6.12 and it further improved to 1.12 at 3 months of follow up. In study by Chandan K *et al.* 73% patients had excellent result, 17% had good result and 10% had fair result using Gartland and Werley scoring system ^[15]. In our study 100% patients had excellent results.

The radiological assessment was also done using volar tilt, radial height and radial inclination. In our study the volar tilt increased from pre operative value of 7.24 to 14.0, radial height increased from a pre operative value of 5.20 to 9.80, and radial inclination increased from a pre operative value of 10.16 to 22.56. In our study the mean loss of radial inclination was 0.44°, the mean loss of radial height was 1.2mm, the mean loss of volar tilt was 3° in immediate post operative period. In a study by Gereli A *et al.* The mean loss of radial inclination was 1.3°, the mean loss of radial height was 1.2mm, the mean loss of volar tilt was 2.3° in immediate post operative period ^[16].

Conclusion

Distal end radius fractures are a very common entity encountered by orthopaedicians worldwide in the emergency department. Various modalities like cast/slab; percutaneous fixation with k-wire, external fixation & volar plating are available for fixation of fracture distal radius. This study demonstrates excellent results in all patients with volar locking plate fixation of the distal radius, with complication rates in 20% cases. It suggests that stabilizing the distal radius fracture with volar plating and screws in its management, is an effective method to maintain the reduction till union, even when the fracture is grossly comminuted/intra-articular/unstable. Thus, proving that it is the prime modality of treatment for distal radius fractures.

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