International Journal of Science and Research (IJSR)
ISSN (Online): 2319-7064
Index Copernicus Value (2016): 79.57 | Impact Factor (2015): 6.391

Functional Outcome of Fracturedistal End Radius Treated with Volar Locking Plates: A Prospective Study

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Abstract: ***Background: Diverse options are available for treatment of closed distal radius fractures .However most of these treatment modalities are unable to provide early functional rehabilitation. Locking compression plates provides angular and axial stability and facilitates early functional rehabilitation.Advantages of volar approach to distal radius including avoidance of devascularization of distal fragments and damage to extensor tendons associated with dorsal approach. Methods: From March 2016 to May 2017, twenty patients with distal radius fractures were treated with open reduction and internal fixation using volar locking compression plates at our institute.All patients had radiographic and clinical follow-up performed atone , three,six months and one year. Results: At final evaluation all patients showed good range of motion of wrist-average dorsiflexion 62.7^0,palmar flexion 54.8^0,radial inclination 15^0,ulnar inclination 25.5^0,pronation 69^0,supination 68.3^0. Radiologically, average volar tilt in our study was 6^0,average radial inclination was 21.2^0, average radial length 3.6mm and articular congruity 0.5 mm. Conclusions: It is a safe and effective method with minimum tissue damage,good primary stability of fracture and facilitates early active motion from first post-operative day without compromising fracture reduction.***

Keywords: Volar locking plates, Distal radius fractures, colles fracture

1. Introduction

Distal radius fractures are referred to as Colles, Barton or Smith fractures depending on the involvement of radiocarpal joint surfaces and direction of displacement of fracture fragments[1].

As distal radius is important in kinematics of radio-carpal and radio-ulnar joints, for good clinical outcome, open reduction of articular surface and restoration of radial length, volar angulation and radial inclination are prerequisites. Reconstruction of the articular congruity and stable fixation reduces incidence of post-traumatic osteoarthritis and allows early range of movement.

Distal radius fractures are more common in elderly individuals.

Recently the development of locking-plate technology has changed the way in which many fractures are managed. Locking compression plates utilize threaded screw heads that lock into plate holes when screws are tightened providing angular and axial stability and minimizing possibility of screw loosening there by facilitating early functional rehabilitation. Volar approach has several advantages including, more special volar aspect of the distal radius and avoidance of dorsal dissection with associated devascularization of distal fragments and damage to extensor tendons, thereby facilitating early functional use of hand while minimizing need for bone grafting.

The purpose of this study is to present our experience in treating twenty displaced distal radius fractures with volar locking plate and immediate functional rehabilitation from first day post-op.

2. Review of Literature

In 1783 Pouteau was first to describe the fracture of lower end radius[2].

In 1814 Abraham Colles described fracture of lower end radius and published it in the Edinburgh Medical and Surgical Journal.[2].

In 1989, Lafontaine, Hardy and Delince identified five predictors of instability in a study conducted by them: a patient over sixty years, an intra-articular fracture, dorsal comminution, dorsal angulation of more than 20° and an associated ulnar fracture [3].

In 2005KK Wong, KW Chavan reported thirty patients of dorsally displaced distal radius fractures fixed by volar locking compression plating. Functional assessment by Gartland and Werley showed 80% excellent and 16 % good and 4% poor results[4].

In 2006 Orbay JL,Touhami A., mentioned in article published in Clinical Orthopaedics 2006 that there are several theoretical advantages to approaching and fixing the radius through a volar approach; more space is available, the flexor tendons are further from the bone and pronator quadratus is interposed[5].

In 2008, a study done at orthopaedic department of Mid Staffordshire NHS foundation trust which included thirty-nine patients with distal end radius fracture treated with volar locking plate showed mean volar tilt of 9 degrees and according to Gartland and Werley system all patients achieved excellent to good results[6].

3. Objectives

1) To study twenty patients with fracture distal end radius fracture treated at our hospital with volar locking plates.
2) To access the functional outcome in these patients by checking range of motion and radio graphical evaluation. Thereby coming to conclusion if this mode of treatment is effective in getting good functional outcome in patients with these fractures.

Anatomy

Normal radiographic relationships [7]

- Radial inclination: averages 23 degrees (range- 13 to 30 degrees)
- Radial length: averages 11 mm (range - 8 to 18 mm).
- Palmar (volar) tilt: averages 11 to 12 degrees (range- 0 to 28 degrees).

4. Materials and Methods

From March 2016 to May 2017, 20 patients with distal radius fractures were treated with open reduction and internal fixation using volar locking compression plates at our institute.

Preoperative radiographic evaluation showed an average deformity of 16.8degrees of dorsal/volarangulation , average radial inclination of 14.25 degrees, average radial shortening of 2.5mm.

All procedures were performed under general anesthesia.

Figure 1: Intra-operative image showing placement of volarlocking plate

Open reduction was performed with the aid of manual traction and manipulation of the fragment and confirmed under the image intensifier. The plates used were 3.5 mm T-shaped AO titanium locking compression plates depending on fracture configuration.

Figure 2: Intra-operative fluoroscopy image showing adequate reduction and fixation.

Post-op management -

- Immediately after surgery below elbow slab was applied on day 0
- From day1, slab removed, dressing done and active finger, wrist motion and forearm rotation were encouraged.
- Post-operative patients were followed up weekly for four weeks and then once in a month for the next three months and thereafter at 6 months and lastly one year.
- Final radiological results were reviewed at final evaluation. Volar tilt, radial inclination, radial length and articular congruency were measured and compared with pre-op data.

5. Results

Preop Radiograph:

Sl. No.	*D/V angulation (degrees)*	*Radial inclination (degrees)*	*Radial angulation (degrees)*	*Loss of Articular congruity (mm)*
1	D-10	10	0	2
2	D13	11	1	3
3	D-15	13	3	3
4	D-10	23	5	1
5	v-15	12	1	3
6	v-19	14	3	3
7	v-13	11	2	2
8	D-16	16	4	2
9	V-12	17	1	3
10	D-21	13	2	1
11	D-23	11	3	1
12	V-19	16	0	3
13	V-16	17	3	3
14	D-23	21	3	2
15	V-19	11	5	2
16	V-16	16	3	1
17	D-23	12	2	3
18	D-19	17	1	1
19	V-13	13	3	2
20	V-21	11	5	2
Average	16.8	14.25	2.5	2.15

In our study pre-op radiograph evaluation showed average dorsal/volar angulation of 16.8 degrees(ranging from 10-23degrees),average radial inclination of 14.25 degrees(ranging from 10-23degrees),average radial shortening of 2.5mm(ranging from0-5mm)and average loss of congruity of 2.15mm(ranging from 1-3mm).

Figure 3: Pre-operative anteroposterior and lateral Xrays

Post-op radiograph:

Sl.No.	*Volar Tilt (degrees)*	*Radial inclination (degrees)*	*Radial height (mm)*	*Articular congruity (mm)*
1.	6	22	4	0
2.	8	24	3	0
3.	8	22	0	0
4.	10	18	2	1
5.	6	20	4	0
6.	10	26	6	1
7.	6	20	3	1
8.	6	22	6	1
9.	8	20	5	1
10.	8	18	3	0
11.	11	22	3	0
12.	6	26	3	0
13.	8	20	4	1
14.	8	22	5	0
15.	8	22	3	1
16.	6	23	0	0
17.	10	18	0	1
18.	10	20	3	1
19.	6	20	3	0
20.	11	22	4	1
Average	8	21.35	3.2	0.5

Volar tilt, radial inclination ,radial length and articular congruity were the various parameters which were used to access the radiographic correction of fracture.

- The average volar tilt in our study was 8degrees (ranging from 6-10 degrees)
- The average radial inclination was 21.5 degrees (ranging from 18-26 degrees)
- The average radial length 3.2 mm (ranging from 0-6mm) and articular congruity 0.5 mm (ranging from 0-1mm).

It was also observed that there was not much loss of reduction in all cases on final X-ray evaluation as compared with first post-operativeX–ray.

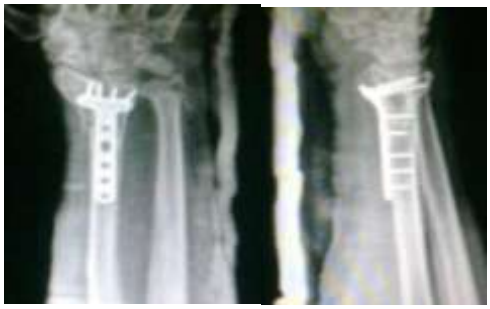

Figure 4: Immediate post-operative Xray.

Range of motion-

Sl. No.	*Dorsi-flexion (degrees)*	*Palmar flexion (degrees)*	*Radial inclination (degrees)*	*Ulnar inclination (degrees)*	*Pronation (degrees)*	*Supination (degrees)*
1.	62	54	12	30	76	71
2.	73	64	13	24	72	69
3.	62	52	15	23	74	66
4.	50	55	18	30	63	59
5.	68	59	17	19	62	62
6.	70	57	20	30	67	68
7.	69	65	12	27	69	73
8.	62	53	16	28	72	76
9.	61	45	15	24	73	71
10.	50	44	12	20	62	68
11.	70	53	20	20	64	61
12.	62	63	16	19	69	67
13.	58	55	15	27	73	76
14.	60	60	14	26	75	72
15.	70	64	20	22	73	62
16.	52	52	12	27	67	66
17.	54	56	13	28	68	71
18.	70	54	12	21	72	73
19.	64	44	16	24	68	64
20.	68	60	20	27	67	69
Avg	62.75	55.45	15.4	24.8	69.3	68.2

At final evaluation all patients showed good range of motion of wrist-

- Average dorsiflexion 62.75 degrees (ranging from 50-73 degrees)
- Palmar flexion 55.45 degrees (ranging from 52 -65 degrees)
- Radial inclination 15.4degrees (ranging from 12 -20 degrees)
- Ulnar inclination 24.8 degrees (ranging from 19 -30 degrees)
- Pronation 69.3degrees (ranging from 62-76 degrees)
- Supination 68.2 degrees (ranging from 59-76 degrees).

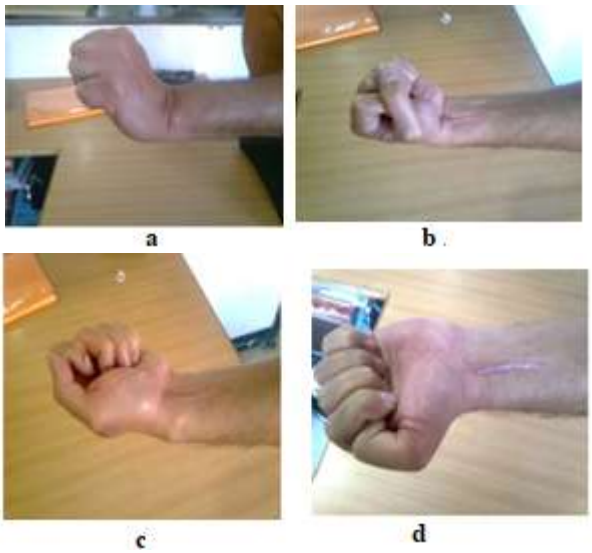

Figure 5: Clinical images showing range of motion at final follow-up.

a) Dorsiflexion
b) Palmarflexion
c) Ulnar inclination
d) Radial inclination

6. Discussion

Distal radius fractures accounts for up to 10 to 20% fractures of skeletal system.

Diverse options available in managing these fractures including closed reduction with plaster cast immobilization, pins and plaster, open reduction and internal fixation[8] ,external fixation devices[9]. However none of these treatment modalities are unable to provide early functional rehabilitation.

The benefits of this method of volar locking compression plating includes early return of function, improved final motion, virtual elimination of extensor tendon problems[10].

Dorsal approach requires dissection of extensor retinaculum. The extensor pollicislongus tendon commonly exposed to mechanical attrition by plate and screws. In volar approach space on the volar aspect of distal radius provides more room for implant placement and pronator quadratus act as barrier to minimize irritation to flexor tendons.

7. Conclusion

1) We found that volar locking compression plating is successful in stabilizing distal radius fractures giving excellent to good results.
2) It is a safe and effective method of treating distal radius fractures facilitating early active motion from first post-operative day without compromising fracture reduction.
3) We have clearly shown that active mobilization can be started from the day one post-op achieving early return of function and improved final functional range of motion.

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