

# Functional & Radiological Outcome and Complication After Volar Locking Plate Fixation for Dorsally Placed Unstable Fracture of the Distal End Radius

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## ABSTRACT

**Background:** Fractures of the lower end of the radius are most common fractures of the upper extremity, encountered in practice and constitute 17 % of all fractures and 75% of all forearm fractures. Management of DRFs has always been an area of intense research and innovation. The aim of this study to determine the radiological & functional outcome of distal end of the radius fracture treated by volar locking plate.

**Materials & Methods:** A prospective study on cases of the fractures of the distal end of the radius, attending the Government Bangur Hospital, Pali, Rajasthan. The fractures were classified according to Modified AO Classification. 20 cases were followed at regular intervals and final assessment was done at 3 months.

**Results:** In our study showed that the maximum male & female (n=8, n=4 respectively) were seen in 31-50 years of age group. Radial deviation was  $16.39 \pm 6.7^{\circ}$ , radial length was  $11.24 \pm 3.55$  mm and volar tilt was  $1.860 \pm 6.107^{\circ}$  in affected limb after procedure. According to GARTLAND & WERLEY<sup>5</sup> Criteria result obtained at 6 week were 1 patients (5%) in excellent followed by 13 patients (65%) was in good outcome.

**Conclusion:** The technique emphasizes that open reduction and internal fixation with volar plating has excellent functional outcome with minimal complications thus proving that it is the prime modality of treatment for distal radius fractures.

**Keywords:** Distal Radial Fracture, AO Classification, Functional Outcome, Radiological Outcome.

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## INTRODUCTION

Fracture of the distal radius continues to be one of the most common skeletal injuries treated by Orthopaedic or trauma surgeons.<sup>1</sup> There appears to be a bimodal age distribution of distal radial fractures consisting of a younger group who sustains relatively high-energy trauma to the upper extremity and an elderly group who sustains both high-energy injuries and insufficiency fractures.<sup>2</sup>

These fractures often are unstable, are difficult to reduce anatomically, and are associated with a high rate of complication. Restoration of normal alignment and articular congruity after a displaced fracture can be difficult but it is essential for a good functional result. It may cause pain, limitation of forearm motion, and decreased grip strength as a result of arthrosis of the radiocarpal and distal radioulnar joints.<sup>3</sup>

Management of DRFs has always been an area of intense research and innovation. It has changed more rapidly in the past decade than in any previous two decades. Whereas percutaneous pinning and external fixation remain the mainstays of treatment

throughout much of the world, with strong and somewhat idiosyncratic national trends attributable to the prominence of individual surgeons in those countries, volar fixed-angle plating has become popular and has dramatically shifted the landscape in several ways.

However, with the availability of locking screw technology, fractures that classically have been treated with a dorsal approach or with external fixation now can be addressed with a volar approach and a volar locking plate. Thus, the expanded indications for the volar approach now can include unstable intra- or extra-articular fractures of the distal radius with either an apex dorsal or an apex volar pattern.<sup>4</sup>

The volar fixed-angle plate has been proposed for use in osteoporotic elderly patients, as the stiffness of the construct provides the necessary subchondral support to maintain fracture reduction. The aim of this study to determine the radiological & functional outcome of distal end of the radius fracture treated by volar locking plate.

**MATERIALS & METHODS**

A prospective study on cases of the fractures of the distal end of the radius, attending the Government Bangur Hospital, Pali, Rajasthan. The fractures were classified according to Modified AO Classification. 20 cases were followed at regular intervals and final assessment was done at 3 months. This study was conducted with detailed clinical and radiological analysis after surgical management of fractures of distal end of radius.

**Inclusion Criteria**

- 1) Adult between age groups of 20 to 60 years with fracture lower end of radius
- 2) All patients having isolated fracture distal end of radius.

**Exclusion Criteria**

1. Open fracture
2. Pathological fracture
3. Distal radius fracture associated with other injury around the wrist joint
4. Patients with comorbid conditions preventing surgical intervention
5. Patients with more than 3 weeks duration of injury
6. Patients with local tissue condition making the surgery inadvisable

**Preoperative Evaluation**

All the patients were subjected to clinical examination. Radiographic evaluation of affected & normal side was done at the time of injury with the antero-posterior and lateral views. The radiographs were assessed in terms of loss of palmar tilt or presence of dorsal tilt, radial shortening and loss of radial inclination. Fractures were classified according to the AO Classification into type A (extra-articular), type B (partial articular) or type C (complete articular).

**Surgical Procedure**

All surgeries were performed on an elective basis under standard aseptic precautions. Surgery was performed under general or regional anaesthesia.

**Incision and Exposure**

Painting and draping was done, under all aseptic precaution. The skin was incised longitudinally along the course of the flexor carpi radialis (FCR) tendon. The FCR tendon was retracted to the radial side to expose the ulnar corner of the distal radius. The FCR tendon may also be retracted to the ulnar side to expose the radial styloid and scaphoid fossa. Great care was taken to avoid pressure on the median nerve. Underneath the FCR the flexor pollicis longus (FPL) is tendon were retracted ulnarly to reveal the pronator quadratus (PQ) muscle. The pronator quadratus muscle was elevated from its radial origin and reflected ulnarly to expose the distal radius.

**Fracture Reduction and Plate Fixation**

Open reduction was performed with the aid of intrafocal leverage, traction by an assistant/distractor, and provisional fixation by temporary Kirschner wires followed by definitive volar buttress or locking plate and screws. Image intensifier was used in theatre to assist the evaluation of fracture reduction and fixation. Final position of the plate and screws was checked under IITV to ensure proper reduction and fixation

**Closure and Slab Application**

After reduction and plate fixation layer by layer closure were done with the help of suture material. Aseptic dressing and above elbow slab was applied.

**Post-Operative Regimen**

The limb was kept elevated in above elbow plaster slab. Every six hourly monitoring of blood pressure, pulse rate, temperature and respiratory rate was done for the first 24 hours. Intramuscular analgesics diclofenac were given as per patients need. Intravenous ceftazidime 1 gm i/v were continued for 3 days.

**Dressing and Suture Removal**

Standard aseptic dressing of the suture site was done and any local skin and stitch line margins were looked for any erythema and signs of necrosis on 5<sup>th</sup> and 10<sup>th</sup> post-operative day and sutures were removed on 14<sup>th</sup> day if healthy.

If any discharge is found from the suture site then that was sent for microbiological examination and appropriate antibiotics was started as per culture reports.

**Slab Duration**

The plaster slab was removed after 2 weeks followed by a removable splint for 4 weeks. Patient was encouraged to remove the splint regularly and mobilize wrist.

The patient was asked to come for follow up at 2 weeks, 6 weeks and at 12 weeks. Final evaluation of result was done at 12 weeks for functional and radiological outcome.

**FINAL EVALUATION**

**Radiological**

Radiological assessment was done in terms of residual dorsal angulation, radial shortening and loss of radial inclination and the results were graded according to the Sarmiento's modification of Lind Storm Criteria. These parameters were assessed during the follow up of the patient to assess the quality of reduction and the ability of the technique to maintain the reduction.

**Clinical and Functional**

Functional evaluation of the patients was done at the last follow up according to the demerit point system of Gartland and Werley] with Sarmiento et al's modification.

**Sarmiento'S Modification of Lind Storm Criteria**

DEFORMITY	RESIDUAL DORSAL TILT		RADIAL SHORTENING	LOSS OF RADIAL INCLINATION
<b>EXCELLENT</b>	No or insignificant	0°	< 3 mm	< 5°
<b>GOOD</b>	Slight	1° to 10°	3 to 6 mm	5° to 9°
<b>FAIR</b>	Moderate	11° to 14°	7 to 11 mm	10° to 14°
<b>POOR</b>	Severe	Atleast 15°	Atleast 12 mm	>14°

**Table 1: Distribution Of Case According To Age & Sex**

Age Group	Sex		Total
	Male	Female	
≤ 30 yrs	4	0	4
31-50 yrs	8	4	12
>50 yrs	2	2	4
<b>Total</b>	<b>14</b>	<b>6</b>	<b>20</b>

**Table 2: Case Distribution According To Fracture Type**

Fracture type	No. of cases	Percentage
AO type A	1	5%
AO type B	8	40%
AO type C	11	55%

**Table 3: Mean ± SD Of Initial And Postoperative Radiological Parameters In Normal And Affected Upper Limb**

Parameters	Normal (Mean ± SD)	Affected (Mean ± SD)
Radial Deviation	16.10±4.4 (10 <sup>0</sup> -28 <sup>0</sup> )	16.39±6.7 (5 <sup>0</sup> -36 <sup>0</sup> )
Radial Length	10.34±2.064 (8-15mm)	11.24±3.55 (5-18mm)
Volar Tilt	11.46±6.654 (4 <sup>0</sup> -28 <sup>0</sup> )	1.860±6.107 (-8 <sup>0</sup> -16 <sup>0</sup> )

**Table 4: Mean ± SD Of Range of Motion of affected Upper Limb at Different Interval**

Range of Motion	6 Week	12 Week	P-value	Significance
Dorsi flexion	28.64±11.27	62.11±22.0	<0.0001	HS
Palmar flexion	32.30±12.30	67.12±13.97	<0.0001	HS
Radial Deviation	12.0±3.90	17.64±3.176	<0.0001	HS
Ulnar deviation	12.18±4.611	21.18±6.22	<0.0001	HS
Supination	40.8±10.21	63.56±11.42	<0.0001	HS
Pronation	38.3±9.17	63.24±12.81	<0.0001	HS

**Table 5: Functional Result According To GARTLAND & WERLEY Criteria**

Outcome	6 <sup>th</sup> Week	12 <sup>th</sup> Week
Excellent	1 (5%)	12 (60%)
Good	13 (65%)	6 (30%)
Fair	6 (30%)	2 (10%)
Poor	0 (0%)	0 (0%)

**Table 6: Distribution of Case Based On Presence of Tenderness and Pain on Movement**

Complication	6 week	12 week
Tenderness	12 (60%)	3 (15%)
Pain on Movement	8 (40%)	1 (5%)

**DISCUSSION**

In our study showed that the out of 20 operative cases 14 were males and 6 were females. Maximum male & female (n=8, n=4 respectively) were seen in 31-50 years of age group. Factors such as patient age, activity level, co morbidities, and functional demands are considered. For young, active patients, acceptable reduction is generally considered to be less than 10° dorsal tilt, less than 3 to 5 mm of radial shortening, and less than 2 mm of

**RESULTS**

Maximum male & female were seen in 31-50 years of age group (table 1). Majority of fracture AO type C (55%) followed by AO type B (40%), AO type A (5%) (table 2). Radial deviation was 16.39±6.7°, radial length was 11.24±3.55 mm and volar tilt was 1.860±6.107° in affected limb after procedure (table 3). The difference between these two means percentage of movement statistical highly significant in dorsiflexion, palmarflexion, radial deviation, ulnar deviation, supination & pronation (table 4).

According to GARTLAND & WERLEY<sup>5</sup> Criteria result obtained at 6 week were 1 patients (5%) in excellent followed by 13 patients (65%) was in good outcome while 6 patients (30%) was in fair group. At 12 week 12 patients (60%) had excellent result, 6 patients (30%) had good result and 2 patients (10%) had fair result (table 5). 60% cases had tenderness and 40% pain on movement present at 6 week postoperatively.

articular displacement. Younger patients have stronger bone, and thus, more energy is required to create a fracture in these individuals. Kevin C. Chung et al (2008)<sup>6</sup> found that the VLPS is successful in managing DRFs in older patients without increased complications compared to younger patients. For older patients without prohibitive surgical risks, internal fixation using the VLPS yields comparable outcomes to younger patients.

Majority of fracture AO type C (55%) followed by AO type B (40%), AO type A (5%) in our study. Extra-articular fractures require avoidance of malunion with angulation and shortening. Malalignment results in limitation of movement (Fernandez 1993).<sup>7</sup> Radial deviation was 16.39±6.7°, radial length was 11.24±3.55 mm and volar tilt was 1.860±6.107° in affected limb after procedure (table 3). The difference between these two means percentage of movement statistical differ highly significant i.e. P<0.0001 (HS) in range of motion. Three radiographic measurements are accepted in the anatomical evaluation of the distal end of the radius (Gartland and Werley 1951<sup>5</sup>, Lidstrom 1959<sup>8</sup>, Scheck 1962<sup>9</sup>, Cole & Oblatz<sup>10</sup>). These parameters are measured to determine the degree of displacement and impaction. These are volar/dorsal tilt, radial deviation and radial lengths. These parameters are measured radiologically as follows; The measurements are recorded against the longitudinal axis of the radius in AP view and lateral view the longitudinal axis defined

as a line through 2 points located in the middle of the diaphysis of the radius distance of 3 cm and 6 cm proximal to the radio carpal joint (Frieberg 1979).<sup>11</sup> Volar tilt (Palmar angulation): in the normal wrists the lower end of radius has a distinct concavity and the articular surface is directed slightly forward as well as downward. This is called volar tilt. The normal value is 11° (range -2 to 28°). It is recorded as plus angle (Sarmeinto 1975).<sup>12</sup>

The volar/dorsal tilt is measured in lateral roentgenograms. One line is drawn perpendicular to the longitudinal axis of the radius in the region of the fracture and another line is drawn joining the volar and dorsal margins of the distal articular surface of the radius. The angle formed by these lines is volar / dorsal tilt. The volar tilt is recorded as plus angle (degree) and dorsal tilt is recorded as minus angle (degree). If the articular surface is parallel to the perpendicular line it is recorded as neutral (0°).

According to Gartland & Werley<sup>5</sup> Criteria result obtained at 6 week were 1 patients (5%) in excellent followed by 13 patients (65%) was in good outcome while 6 patients (30%) was in fair group. At 12 week 12 patients (60%) had excellent result, 6 patients (30%) had good result and 2 patients (10%) had fair result in our study. More recent work has suggested that outcomes may be more dependent on patient factors, with elderly patients of lower functional demand more tolerant of persistent radiographic abnormalities. This is an important part of fractures management (Golden 1963<sup>13</sup>, Bohler 1929<sup>14</sup>), stressed the value of active functional training. To ensure best functions results therapy should be done by patient himself under proper medical supervision (Frykman 1967<sup>15</sup>, Collins 1993<sup>16</sup>). Therapy includes measures to reduce edema, maintain range of motion of uninjured joints mobilise soft tissue structures; assist in pain management, monitoring for compression of nerves (Collins 1993).<sup>16</sup>

In our study showed that the 60% cases had tenderness and 40% pain on movement present at 6 week postoperatively but only 15% cases had tenderness and 5% pain on movement present at 12 week postoperatively. Our results suggested with Bacorn (1953)<sup>17</sup> found that palmar flexion was the commonest movement to be restricted (45% and 95.5 respectively). Knirk & Jupiter (1986)<sup>18</sup> in a study on intra particular fractures found that supination is limited more commonly than any other movement. Frykman 1967<sup>15</sup> found an incidence of 19% and regard it an important cause of unsatisfactory functions results. For most authors resection of the distal ulna (Darrach procedure) is the treatment of choice for complaints resulting from loss of DRUJ integrity. Good results painless motion and improved cosmetic appearance have been reported after this procedure (Conney 1980<sup>19</sup>). Persistent pain and other symptoms associated with DRUJ disruption made many surgeons to feel that the DRUJ remains the low back pain of wrist.

## CONCLUSION

The technique emphasizes that open reduction and internal fixation with volar plating has excellent functional outcome with minimal complications thus proving that it is the prime modality of treatment for distal radius fractures. The procedure is applicable for AO types A, B and C fractures of the distal radius, in young patients with a good bone stock as well as in elderly osteoporotic patients. Given the apparent success of volar plate fixation of dorsally unstable distal radius fractures further investigation is warranted into implant design, the indication for supplementary fixation, and range of- motion protocols.

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