

Surgical Management of Unstable Distal Radius Fractures with a Variable-Angle Volar Locking Plate

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Abstract

Background: The distal radius is one of the most commonly fractured bones in the body accounting for 8 - 15% of all broken bones. The use of variable-angle locking plates is promoted for the management of these fractures. This study aimed to evaluate the radiological and clinical outcome of the management of unstable distal radius fractures using a variable-angle volar locking plate.

Methods: This was performed a prospective cohort study on 18 patients with unstable distal end radius fractures, admitted to Orthopedic Department in Zagazig University Hospital and El-Menshawey General Hospital in Tanta. All patients were operated from January 2019 to June 2019. The affected patients' age ranged from 24 to 65 years old with a mean of (37.06 ± 12.69). There were 12 males and 6 females. These fractures were treated by internal fixation (ORIF) using the variable-angle 2.4-mm distal radius locking plate.

Results: There was one patient had a tourniquet palsy which was resolved after one month of physiotherapy (5.56%). One patient suffered from delayed wound healing (5.56%). One patient had screw misplacement in the radio-ulnar joint that remains asymptomatic at the final follow up period (5.56%). At the end of follow up period, inclination angle (frontal tilt) ranged from 17° to 24° (mean was 20.36° ± 2.53), volar (sagittal) tilt ranged from 7° to 14° (mean was 10.32° ± 2.26). According to the disabilities of arm, shoulder, and hand scoring system (DASH score), 8 patients (44.44%) had excellent results with an average 3.55 ± 1.24, 8 patients (44.44%) had good results with average 9.70 ± 1.98. There was a statistically highly significant correlation between the radiological outcome and final clinical score.

Conclusions: The use of variable-angle locking plates in treating unstable distal end radius fractures is associated with excellent to good functional outcomes with a significant reduction of hardware complication.

Keywords: Distal Radius; Variable Angle; Locking Plate; Volar; Internal Fixation

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Introduction

The distal radius is one of the most commonly fractured bones in the body accounting for 8-15% of all broken bones [1]. Such fractures mainly affect the elderly population and they involve low energy trauma. However, in young adults, high-energy trauma such as that resulting from vehicular traffic accidents accounts for a substantial number of cases [2], which present as shear and impacted fractures of the articular surface of the distal radius with displacement of the fragments [3].

Certainly, the new low profile plates and locking systems have popularized the surgical option. Treatment modalities exist for surgical management of these fractures, including open reduction and internal fixation (ORIF) with volar or dorsal plates and screws, non-spanning external fixation (NSEF), closed reduction and percutaneous pinning (CRPP), spanning external fixators or a variation of each [4].

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 help for earlier rehabilitation [5].

Volar locking plates mechanically bridge the bone and bear the load through the locking construct, resulting in a lower incidence of failure. The subchondral placement of distal screws is essential to prevent a loss of correction and to achieve good functional results [6].

Experimental biomechanical evidence supporting their use with dorsally comminuted unstable distal radius fractures was recently published [7].

Goals in the application of a volar implant include the accurate and safe subchondral placement of screws, combined with the achievement of true radial column support. In using a fixed-angle plate, this may be difficult to achieve because of variations in the size of the radius as well as variations in the location of the fracture lines, particularly the volar fracture lines [8].

Variable-angle screws allow adaptation of the plate position to volar fracture lines in both a proximal-to-distal plane and a radial-to-ulnar plane. This adaptation in position can be achieved while still



minimizing the risk of screw perforation of either the distal radio-ulnar joint or the radio-carpal joint by directing screws away from the joint [9].

This study aimed to evaluate the results of management of unstable distal radius fractures using variable-angle volar locking plate.

Methods

We performed a prospective cohort study on 18 patients with distal end radius fractures who were treated operatively between January 2019 to June 2019 and then followed up for at least six months. The inclusion criteria for the study were as follows: Patients aged between 24 to 65 years with isolated closed intra-articular distal end radius fractures displaced more than 2 mm from the anatomic position, a dorsal inclination of the distal fragment of more than 20°, Radial height less than 5 mm. Radial inclination less than 10 degrees. Positive ulnar variance greater than 2 mm. Articular incongruity greater than 1 mm. Unstable extra articular fractures.

Exclusion Criteria

- Open fractures Gustilo and Anderson type II and III.
- Pathological fractures.
- Patients whose are unfit for surgery.

All patients were subjected to complete clinical and radiological examination preoperative and postoperative and follow up. Noticing any swelling or deformity. Examination of other regions that are subjected to trauma and detection of any associated injuries. Neurovascular status and tendons status.

Postero-anterior and Lateral views were taken to assess the following Fracture type according to Frykman's classification. Dorsal angulation. Radial shortening. Dorsal displacement. Palmar tilt. Associated ulnar fractures. Articular gaps and step-offs. Associated carpal dislocations or instabilities. PA and lateral x-rays for the contralateral wrist were also taken for correlation of normal measurements and angles. CT scan was also done.

The mean age of the patients was 37.06±12.69 years (range 24 to 65). There were 12 males and six females. There were 11 dominant and 7 non-dominant hands. The mode of injury was Fall on an out stretched hand in 10 patients, Road traffic accident in 4 patients, Fall from a height in 3 patients, Direct trauma in one patient. Associated medical diseases was 2 patients were diabetic. 1 patient were hypertensive. 1 patient was on renal dialysis. 1 patient had bronchial asthma. 13 had no associated medical diseases. The fractures were classified on the basis of the Frykman's classification. There were One patient Type I, Five patients type III, Three patients type IV, One patient type V, Five patients type VII, Three patients type VIII.

Post-operative and Rehabilitation

Post-operative treatment was described for patients with anti-edematous, NSAID when indicated only and anti-biotic. Hand elevation and early active fingers and MP exercises were encouraged.

All patients were immobilized in a splint for one week. The splint was removed at one week and patients were allowed to wear wrist brace. Patients were instructed to remove the brace and start gentle active wrist and finger exercises. A physiotherapist regarding the standard range of motion exercises for the wrist and fingers instructed the patients.

At the end of follow up, clinical results were evaluated according to

The Disabilities of the Arm, Shoulder, and Hand score (DASH score). Radiological evaluation was done according to Castaign radiological assessment score.

Results

Based on our inclusion criteria, 18 patients were available for analysis in the present prospective cohort study. The mean age was (37.06±12.69) years with a range (24-65) years old. There were 12 males and 6 females (Table 1).

At the end of the follow up period, according to the Disabilities of the Arm, Shoulder, and Hand scoring system (DASH Score) [10], 8 patients (44.44%) had excellent results (scores between 1.7-5) with average 3.55 ±1.24, 8 patients (44.44%) had good results (scores between 6.7-12.5) with average 9.70 ±1.98 and 2 patients (11.11%) had fair results (scores between 20-24.2) with average 22.10 ±2.97, no patients had poor results. The score ranged from 1.7 to 24.2 in the studied patients' group with a mean of (8.3±6.06) (Table 2).

There was a statistically insignificant correlation fracture type according to Frykman's classification system and the final clinical and radiological score (P=0.327), (P=0.189) (p-value >0.05) (Table 3).

Case: A 40 years old male patient sustained a type III fracture of the right distal radius and an ipsilateral fracture of the femur after an RTA. He was managed with a variable angle locking plate and fixation of the femur after 2 days of injury (Figures 1-3).

Discussion

In this study there were 18 patients with unstable distal end radius fractures who underwent ORIF using variable angle locking plate. The affected patients' age ranged from 24 to 65 years old with mean of (37.06±12.69). There were 12 males and 6 females.

Table 1: Demographic data of the studied group of patients.

	Frequency	
	No.	%
Range	24-65	
Mean	37.06	
S.D.	12.69	
Sex		
Male	12	66.67
Female	6	33.33

Table 2: Distribution of the studied patients, group regarding the final clinical score.

DASH score	N	%	Minimum	Maximum	Mean	Std. Deviation
Fair	2	11.11	20	24.2	22.1	2.97
Good	8	44.44	6.7	12.5	9.7	1.98
Excellent	8	44.44	1.7	5	3.55	1.24
Total	18	100				



Figure 1: Preoperative X-ray.



Figure 2: At the end of follow up x-ray.



Figure 3: Range of motion. A: Dorsiflexion; B: Palmar flexion; C: Ulnar deviation; D: Radial deviation and E: Supination.

The most common mode of trauma in this study was falling on outstretched hand (55.56%) and road traffic accidents (22.22%).

The minimum duration of follow-up in our study was six months. Distal end radius fractures achieve the majority of their grip strength and movement in six months as reported by MacDermid JC, et al. (2013) [11].

At the end of the follow up period, according to The Disabilities of the Arm, Shoulder, and Hand scoring system (DASH Score) [10], 8 patients (44.44%) had excellent results (scores between 1.7-5) with average 3.55 ± 1.24 , 8 patients (44.44%) had good results (scores between 6.7-12.5) with average 9.70 ± 1.98 and 2 patients (11.11%) had fair results (scores between 20-24.2) with average 22.10 ± 2.97 , no patients had poor results. The score ranged from 1.7 to 24.2 in the studied patients' group with a mean of (8.3 ± 6.06) .

Figl M, et al. (2009) reported excellent results in 36% of patients, good results in 51%, and fair results in 13% [12]. Jagodzinski NA, et al. (2012) reported a mean DASH (disabilities of the arm, shoulder, and hand) score of 18.2 in patients treated with VALP [13].

The range of movement of the wrist was evaluated at the end of follow up period. Dorsiflexion ranged from 40 to 75 degrees with a mean of $64.8^\circ \pm 9.73$. While palmar flexion ranged from 45 to 80 degrees with a mean of $71.28^\circ \pm 7.75$.

Supination ranged from 55 to 85 degrees with a mean of $77.28^\circ \pm 7.23$, while pronation from 65 to 85 degrees with a mean of $74.52^\circ \pm 4.53$. Radial deviation ranged from 11 to 20 degrees with a mean of $17.36^\circ \pm 2.61$, while ulnar deviation from 30 to 40 with a mean of $36.64^\circ \pm 2.38$. These values correspond well with the functional daily requirements.

By comparing the results of our study and the study done by Jagodzinski NA, et al. (2012) our study was found to have comparable results [13]. They assessed 61 patients with distal radius fractures with

Table 3: Relation between fracture type and final clinical and radiological score.

Frykman's classification	DASH score							
	Fair		Good		Excellent		Total	
	N	%	N	%	N	%	N	%
Relation between fracture type and final functional score								
Type I	0	0	1	12.5	0	0	1	5.6
Type III	1	50	2	25	2	25	5	27.8
Type IV	0	0	0	0	3	37.5	3	16.7
Type V	0	0	0	0	1	12.5	1	5.6
Type VII	1	50	4	50	0	0	5	27.8
Type VIII	0	0	1	12.5	2	25	3	16.7
Total	2	100	8	100	8	100	18	100
Chi-square	X ²	11.4						
	P-value	0.327						
Frykman's classification	Castaing score							
	Fair		Good		Excellent		Total	
	N	%	N	%	N	%	N	%
Relation between fracture type and final radiological score								
Type I	0	0	1	11.1	0	0	1	5.6
Type III	1	100	2	22.2	2	25	5	27.8
Type IV	0	0	0	0	3	37.5	3	16.7
Type V	0	0	0	0	1	12.5	1	5.6
Type VII	0	0	5	55.6	0	0	5	27.8
Type VIII	0	0	1	11.1	2	25	3	16.7
Total	1	100	9	100	8	100	18	100
Chi-square	X ²	13.667						
	P-value	0.189						

a minimum of six months follow-up. Functional assessment was made using the DASH score. Jagodzinski NA, et al. (2012) measured wrist range of movement and grip strength, and reviewed radiographs to assess restoration of anatomy, fracture union and complications [13]. All fractures united within six weeks. Mean ranges of movement and grip strength were only mildly restricted compared to the normal wrist. The mean DASH score was 18.2.

Khatri K, et al. (2016) used variable angle locking plate in 23 unstable distal end radius fractures [9]. According to Gartland and Werley excellent results were reported in 65.2% cases, while good results were present in 35% cases. The mean flexion was $71.91^\circ \pm 8.08$, the mean extension was $76.95^\circ \pm 5.70$, the mean pronation was $77.65^\circ \pm 6.01$, and the mean supination was $81.86^\circ \pm 6.28$. The results are not truly comparable with those of the current study as a different scoring system was used in the evaluation of the results. On other hand, there was a strong correlation between Green and O'Brien score that we used and the DASH score was found by Kwok IHY, et al. (2011) in their study [14].

Spiteri M, et al. (2017) found that postoperative range of motion was variable and grip strength was of 71% of the uninjured contralateral side with the use of variable angle volar rim plate in their study [15].

Vlcek M, et al. (2011) compared the performance of the variable angle locking plate to another fixed angle plate and reported an improved range of radial and ulnar deviation with the variable angle device but they use another plate system [16].

At the end of the follow up period, according to Castaing radiological assessment score (100), 8 patients (44.44%) had excellent results (scores between 7-8) with average score 7.25 ± 0.46 , 9 patients (50%) had good results (scores between 5-6) with average score 5.78 ± 0.44 and 1 patient (5.56%) had fair results (scores 4), no patients had poor results. The score ranged from 4 to 8 in the studied patients'



group with a mean of (6.33±1.03).

Inclination: At the end of follow up period, inclination angle (frontal tilt) ranged from 17° to 24° (mean was 20.36°±2.53).

Volar tilt: At the end of follow up period, volar (sagittal) tilt ranged from 7° to 14° (mean was 10.32°±2.26).

By comparing the results of our study and the study done by Khatri K, et al. our study was found to have comparable results. Radial length mean was 11.84 mm ± 2.04, radial inclination mean was 22.89°±2.64, and the volar angulation mean was 5.21°±2.72 [9].

Sim JC, et al. (2015) analyzed the results in 45 cases treated by variable-angle volar locking plate. At the end of follow up period the mean radial length was 11.8 mm (9.2-14.3), radial inclination was 22.0° (15.9-31.6), and volar tilt was 8.7° (1.3-15.8). Our results are comparable to these results [17].

Masood K, et al.(2016) found that radial inclination mean was 21.09° and volar tilt mean was 11.22° in their study. Our results are comparable to these results and those of Fowler JR, et al. (2013) with radial inclination mean was 21° which is similar to our result and volar tilt mean was 3° which is less than our results [18,19].

Teunis T, et al. (2017) made an evaluation of fracture position by radiographs one year after variable angle locked distal radius plating. In their prospective study they found a small (less than 2 mm or 2°) but statistically significant change in several measures. Accounting for inter-observer variability, this is probably within measurement error [20].

Gruber G, et al. (2008) noticed a statistically significant loss in parameters like radial inclination and volar in their study on 55 adult patients with intraarticular distal radius fractures using volar fixed angle plate [21].

Rozental TD, et al. (2006) also reported a reduction in the radiological parameters during the follow-up period with the use of volar fixed angle plate [22].

Statistical analysis of the results showed that no change in results with the type of fracture. These results are similar to the results of Karnezis IA, et al. (2005) as they found that no demonstrable correlation between fracture type and outcome in their study. Ng CY, et al. (2011) had similar results [23,24].

In contrast, Braziulis TR, et al. (2014) found that there was a strong correlation between fracture type and functional result [25]. According to AO classification system patients with type C fractures treated with a volar locking plate had a worse wrist function as compared with the patients type A and B fractures at the 6-month follow-up. The postoperative hand function was significantly associated only with the type C fracture, while age and gender had no significant impact. But they used different plate system with fixed angle screws [26].

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