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Comparative study on the treatment of unstable distal radius fractures: variable-angle volar locking plate versus non-locking volar distal radius plate

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Abstract

Background: Distal end radius fractures constitute 10% of all human skeletal fractures. Such fractures mainly affect the elderly population and they involve low energy trauma. The purpose of this study was to evaluate the use of variable angle locking plate versus non locking volar plate for the management of unstable distal end radius fractures. Methods: In our study there were 20 patients with unstable distal end radius fractures who underwent ORIF using variable angle locking plate (10 patients) and Non locking plate (10 patients). Patients aged between 23 and 62 years old with mean age 39.50±14.24 for variable angle plate and 38.70±12.76 for Non locking volar plate. 15 patients were males (8 operated by variable angle plate and 7 operated by non locking plate) while 5 were female (2 opertaed by variable angle palate and 3 operated by non locking plate). Results: The functional results were assessed according to Quick DASH score. For variable angle plate group: 6 patients (60%) had excellent results (scores between 0 to 11), 3 patients (30%) had good results (scores between 12-22) and only one patient (10%) had fair results (scores between 23-33), no patients had poor results with a mean DASH score of 14.5. For Non locking plate group: 3 patients (30%) had excellent results, 6 patients (60%) had good results and only one patient (10%) had fair results, no patients had poor results with a mean DASH of 15.9 . Radiological results were evaluated according to Castaign radiological assessment score. For Variable angle plate group: 6 patients (60%) had excellent results (scores between7-8), 4 patients (40%) had good results (scores between5-6) and no patients had fair or poor results. The score ranged from 5 to 8 in the studied patients' group with a mean of (6.8). For Non locking plate group: 2 patients (20%) had excellent results (scores between7-8), 7 patients (70%) had good results (scores between5-6) and 1 patient (10%) had fair results (scores between3-4), no patients had poor results. The score ranged from 4 to 8 in the studied patients' group with a mean of (6). Conclusion: Variable angle volar locking plate and Non Locking volar plate both are effective tools for management of unstable fracture of distal end radius however Variable angle plate achieves more satisfactory results in complex articular fractures.

Key words: unstable distal radius fractures, variable, angle volar locking plate, non-locking volar distal radius plate.

1. Introduction

Fractures of the distal radius are one of the most common fractures that can be seen. Treatment of these fractures varies from closed reduction and casting in minimally displaced fractures to open reduction and internal fixation (ORIF) in more complex fractures. ORIF restore the wrist's anatomy and help in faster rehabilitation with good clinical outcomes. [1]

Maintenance of articular congruity and stable fixation reduce the incidence of osteoarthritis. Volar plating is currently favored for comminuted distal end radius fracture patterns and osteoporotic bones. [2]

Many new plates have been developed for the internal fixation of distal radius fractures [3, 4]. The locking plate technique overcomes the difficulty with the dorsal fragments and failure when a palmar plate is used for displaced distal radius fractures [5]. However, non-locking palmar plates are still used regularly for the fixation of these fractures. Although some studies [6, 7] have shown good to excellent results for various methods, the choice of the best option still remains controversial. [8]

Variable angle locking plates are biomechanically sound for the management of intra-articular fractures of the distal radius in a cadaveric study. Sascha Rausch et al, found that these plates have higher construct stiffness and superior properties under cyclic loading than monoaxial fixed angle plates. [9]

These plates enable insertion of screws at variable angles and allow secure subchondral placement of distal screws which is more difficult in fixed angle plates. [(10)]

The aim of this work was to evaluate the use of variable-angle volar locking plate in comparison with non-locking volar distal radius plate in the management of unstable distal radius fractures.

2. Patients and Methods

The study originally included 22 patients suffering from unstable fracture of distal end radius. All patients were operated from August 2019 to April 2021. Two patients were excluded from the results because they were lost in the follow up period (6 months). This left a total of 20 patients who fulfilled the inclusion criteria and completed at least 12 months follow up period.

Ten patients were managed by Variable-angle plate while other patients managed by Non-locking volar distal radius plate (conventional plate).

2.1Inclusion criteria:

(A)Patient related criteria:

1.Patients fit for surgery.
2.Patients above age of 18 years.

(B)Fracture related criteria:

1. Dorsal angulation greater than 20 degrees
2.Radial height less than 5 mm
3. Radial inclination less than 10 degrees
4. Positive ulnar variance greater than 2 mm
5. Articular incongruity greater than 1 mm.
6. Dorsal comminution >50%

2.2. Exclusion criteria

1. Open fractures
2. Pathological fractures.
3. Patients whose are unfit for surgery.
4. Associated injuries that increase the risk of surgery or prevent compliance with subsequent rehabilitation protocols (i.e., severe head injuries, spinal cord injury).
5. Amputated wrist.

2.3. For all included patients, the following were done

1. Detailed clinical history.
2. Detailed clinical examination.
3. Plain X-ray wrist joint and forearm AP and lateral views.
4. Routine Laboratory investigation.

3.Methods

3.1 Methods of Diagnosis:

1. Personal data

Name, Age, Sex, Address, Occupation, Dominant hand and Date of admission.

2. Complaints

- Pain
- Swelling of the wrist
- Limited range of movement of the wrist
- Parasthesia
- Affection of other regions.

3. History

A. History of trauma

- Time of injury
- Side affected
- Type of trauma
- Mechanism of trauma
- Time before the start of definitive treatment

B. Medical and surgical history

C. Medications and allergies

4. Clinical examination.

- 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.

2. Method of radiological evaluation:

1. Postero-anterior and Lateral views were taken to assess the following:

- Fracture type according to AO classification.
- Dorsal angulation.
- Radial shortening
- Dorsal displacement
- Palmar tilt.
- Associated ulnar fractures.
- Articular gaps and step-offs.
- Associated carpal dislocations or instabilities.

2. PA and lateral x-rays for the contralateral wrist were also taken for correlation of normal measurements and angles.

3. CT scan was also done.

3. Method of treatment

The study included 20 patients presented as either “fresh” Distal radius fractures (DRFs) or that had been managed in cast but with re-displacement/unaccepted reduction.

These fractures were treated by ORIF using Variable angle volar 2.4-mm distal radius locking plate in ten of cases while other cases treated by conventional volar non locking plate.

Anaesthesia:

17 patients were operated under general anesthesia , on the other hand only 3 patients were operated under regional anaesthesia

Surgical technique

The patient was palced supine on the operating table (Figure 1) , Prophylactic IV antibiotics were given immediately before operation and tourniquet was applied.

The surgical field was under complete aseptic condition.

Fig. (1) position of the patient on operating table.

Fracture reduction

After exposure and debridement of the fracture site, the fracture was reduced and provisionally fixed under C-Arm using k-wires. Extra articular fractures were reduced by simple traction and slight palmar flexion of the wrist and manual manipulation. In intra articular fractures large fragments were manipulated, reduced and preliminary fixed by wires.

Fig. (2) provisional fixation of fracture fragments.

Plate position

Variable angle plate :

The plate should be positioned on the distal radius proximal to the Watershed line. If placed properly, K-wires inserted in it to insure the position. The plate is designed to be elongated in its ulnar side as the volar surface of the ulnar column is more distal than radial column. The position of plate is confirmed by C-arm (Figure 2).

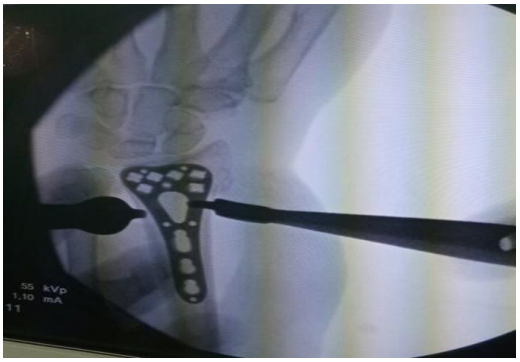


Fig. (3) Plate adjustment on the volar surface of lunate facet.

Non Locking volar plate

At first the plate should be bent to adapt to the normal configuration of distal radius. Distal end of plate should be placed far enough proximally to avoid insertion of screws into articular surface.

A screw was inserted in the oval hole of the plate which permits fine adjustment of the plate position either proximally or distally.

Then screws placed in diaphyseal bone to allow the plate to act as a butress for distal fragment.

Afterwards insertion of distal screws was done and ulnar screw insertion was considered first to ensure that there is no joint trespass (radial screws obstruct view of ulnar screws).

Fig. (4) Insertion and positioning of distal screws.

After each screw insertion, screw position was confirmed by C-arm to ensure there's no joint penetration by screw and oblique views was done especially 20° tilted lateral view.

At last final image was taken to ensure optimum position of plate and screws (Figure 4).

Fig (5) Final position of plate and screws.

Table (1) Quick DASH Score [11]

QUICKDASH ITEMS I - no difficulty; 2 - n1ild difficulty; 3 - moderate difficulty: 4 = severe difficultv : 5 = unable					
I) Open jar	1	2	3	4	5
2) Pain intensity	1	2	3	4	5
3) Tingling intensity	1	2	3	4	5
4) Sleep	1	2	3	4	5
5) Socialize	1	2	3	4	5
6) Wa sh back	1	2	3	4	5
7) Forceful recreation	1	2	3	4	5
8) Heavy chores	1	2	3	4	5
9)carry a bag	1	2	3	4	5
I0) limited in work	1	2	3	4	5

Quickdash score	Level of difficulty	Function of outcome
1	UP TO 11	Excellent
2	12-22	Good
3	23-33	Fair
4	34-44	Poor
5	45-55	Disable

Table (2): Castaign radiological score [12]

Castaign score	Score
Frontal tilt	
20-30°	2 point
I0-20°	
Sagittal tilt	
15-8	2 point
8-0	1 point
<0°	1 point
Radio-ulnar joint line	
From -2 mm a 0 mm	2 point
From 0 mm a 2 mm	1 point
From -2 or more than 2 mm	0 point
Radio-ulnar joint line	
Stage 0 (regular joint-line)	2 point
Stage I (regular joint-line)	1 point
Stage 2 (arthritis with joint-line narrowing)	0 point

3. Results

In case of variable angle plate : 6 patients (60%) had excellent results (scores between 0 to 11), 3 patients (30%) had good results (scores between 12-22) and only one patient (10%) had fair results (scores between 23-33), no patients had poor results with a mean DASH score of 14.5 **(Table 3).**

In case of Non locking plate : 3 patients (30%) had excellent results, 6 patients (60%) had good results and only one patient (10%) had fair results, no patients had poor results with a mean DASH of 15.9 **(Table 3).**

Table (3) Distribution of the studied patients, group regarding the final clinical score.

Quick DASH score		Variable angle plate		non locking volar plate		Total	
		N	%	N	%	N	%
Fair		1	10	1	10	2	10
Good		3	30	6	60	9	45
Excellent		6	60	3	30	9	45
Total		10	100	10	100	20	100
Chi-square	**X2**			2.000			
	P-value			0.368			

The range of movement of the wrist was evaluated at the end of follow up period **(Table 4).**

Group of variable Angle Plate :

- **Dorsiflexion:** At end of follow up, was 63±10.06 (range 40 – 75). one patients had limited dorsiflexion below 45°.
- **Palmar flexion:** At the end of follow up, was 70.7±6.18 (range 60 – 80).
- **Supination:** At end of follow up, was 77.8±4.76 (range 70 – 85).
- **Pronation:** At the end of follow up, was 75.7±5.19 (range 67 – 85) .
- **Radial deviation:** At the end of follow up, was 16.6±2.59 (range 13 – 20). Two patients had limited radial deviation below 15°.
- **Ulnar deviation:** At the end of follow up, was 37±2.05 (range 34 – 40).
- **Group of Non Locking Volar plate :**
- **Dorsiflexion:** At end of follow up, was 65.5±8.96 (range 50 – 75).
- **Palmar flexion:** At the end of follow up, was 71.5±10.06 (range 45 – 80). One patient had limited palmar flexion below 50°.
- **Supination:** At end of follow up, was 75.9±10.25 (range 55 – 85).
- **Pronation:** At the end of follow up, was 73±4.22 (range 65- 80).
- **Radial deviation:** At the end of follow up, was 17.2±3.19 (range 11 – 20). Three patients had limited radial deviation below 15°.
- **Ulnar deviation:** At the end of follow up, was 36.6±2.32 (range 32 – 40).

At the end of the follow up period, according to Castaign radiological assessment score [9],

In case of Variable angle plate : 6 patients (60%) had excellent results (scores between7-8), 4 patients (40%) had good results (scores between5-6) and no patients had fair or poor results **(Table 5).** The score ranged from 5 to 8 in the studied patients' group with a mean of (6.8).

In case of Non locking volar plate : 2 patients (20%) had excellent results (scores between7-8), 7 patients (70%) had good results (scores between5-6) and 1 patient (10%) had fair results (scores between3-4), no patients had poor results **(Table 3).** The score ranged from 4 to 8 in the studied patients' group with a mean of (6).

Table (4) Range of movements (in degrees) in the studied patients group at the end of the follow up.

	Variable angle plate	Non locking volar plate
	Mean±SD	**Mean±SD**
Pronation	75.7±5.19	73±4.22
Supination	77.8±4.76	75.9±10.25
Ulnar deviation	37±2.05	36.6±2.32
Radial deviation	16.6±2.59	17.2±3.19
Dorsiflexion	63±10.06	65.5±8.96
Palmar flexion	70.7±6.18	71.5±10.06

Table (5) Distribution of the studied patients, group regarding the final radiological score**.**

Castaign score		Variable angle plate		Non locking plate		Total	
		N	%	N	%	N	%
Fair		0	0	1	10	1	5
Good		4	40	7	70	11	55
Excellent		6	60	2	20	8	40
Total		10	100	10	100	20	100
Chi-square	**X2**			3.818			
	P-value			0.148			

There was statistically low significant correlation between fracture type according to AO classification and both Quick DASH and Castaign scores in Non locking plate group with p-value <0.05, while there was no statistically significant correlation in Variable angle plate group with p-value >0.05 **(Table 6, 7).**

Table (6) Relation between fracture type and final functional score.

AO Fracture type	Quick DASH score							
	Fair		Good		Excellent		Chi-square	
	N	%	N	%	N	%	X2	P-value
Variable angle								
23-A2	0	0	0	0	1	10		
23-A3	1	10	0	0	1	10		
23-c1	0	0	0	0	2	20	10.833	0.211
23-c2	0	0	1	10	2	20		
23-c3	0	0	2	20	0	0		
Non locking volar								
23-A2	0	0	0	0	2	20		
23-A3	0	0	0	0	1	10		
23-c1	0	0	4	40	0	0	20.000	0.010*
23-c2	0	0	2	20	0	0		
23-c3	1	10	0	0	0	0		

Table (7) Relation between fracture type and final radiological score.

AO classification	Castaign score							
	Fair		Good		Excellent		Chi-square	
	N	%	N	%	N	%	X2	P-value
Variable angle								
23-A2	0	0	0	0	1	10		
23-A3	0	0	1	10	1	10	5.139	0.273
23-c1	0	0	0	0	2	20		
23-c2	0	0	1	10	2	20		
23-c3	0	0	2	20	0	0		
Non locking volar								
23-A2	0	0	0	0	2	20		
23-A3	0	0	1	10	0	0	20.000	0.010*
23-c1	0	0	4	40	0	0		
23-c2	0	0	2	20	0	0		
23-c3	1	10	0	0	0	0		

Group of variable angle plate :

One patient had superficial wound infections (33.3%) that were resolved with regular dressings and antibiotic administration for two weeks .Another one suffered from delayed wound healing (33.3%). This resolved completely after 4 weeks.

One patient had a tourniquet palsy (33.3%) which was resolved after 5 weeks of physiotherapy. **(Table 8).**

Group of Non locking plate :

One patient had parasthesia in hand along median nerve distribution (50%) and underwent carpal tunnel release during follow up period. Another one had a tourniquet palsy (50%) and underwent course of physiotherapy for 4 weaks and then resolved. **(Table 8).**

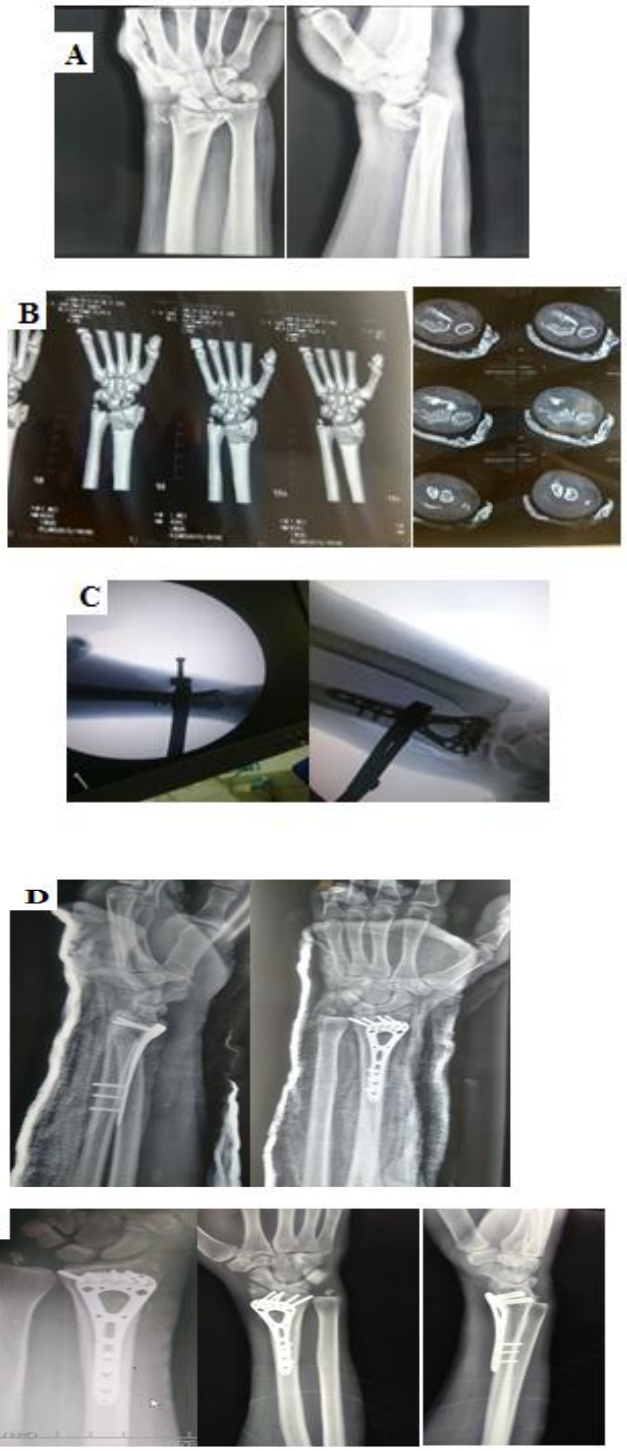
Table (8) Distribution of the studied patients group according to complications.

Complication	Variable angle		non locking volar		Total	
	N	%	N	%	N	%
Superficial wound infection	1	33.3	0	0	1	20
Tourniquet palsy	1	33.3	1	50	2	40
Delayed wound healing	1	33.3	0	0	1	20
Carpel tunnel syndrome	0	0	1	50	1	20
Total	3	100	2	100	5	100

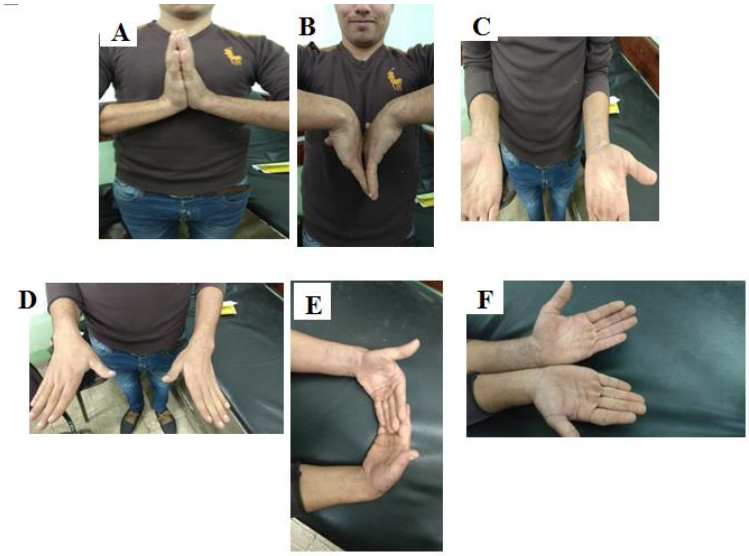
Case presentation

Case NO. 1

A 32 years old male patient sustained a type AO 23C2 fracture of the left distal radius and an ipsilateral fracture of the tibial shaft after a RTA. He was managed with a Variable angle locking plate and fixation of the tibia 2 days after injury.



A. Preoperative x-ray
B. Preoperative CT
C. Intraoperative images
D. Immediate postoperative x-rays
E. At the end of follow up

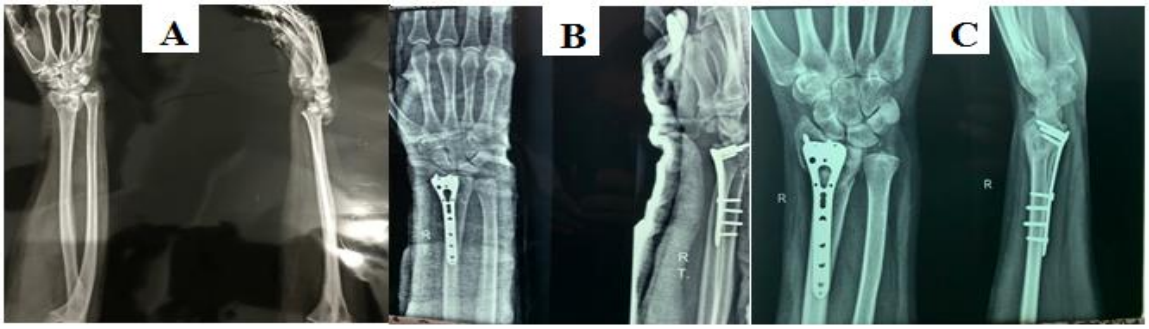


Range of motion :

A. Dorsiflexion B. Palmar flexion C. Supination D. Pronation E. Ulnar deviation
F. Radial deviation

Case NO. 2

A 45 years old female patient sustained a type AO 23C1 fracture of the right distal radius after falling on outstretched hand. She was managed with a variable angle locking plate after 3 days of injury. She was complicated with delayed wound healing which resolved completely at one month.



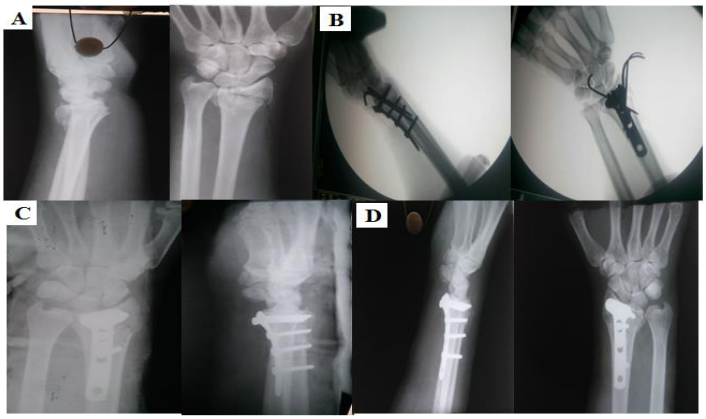
A. Preoperative X-rays B. Immediate postoperative C. At the end of follow up

Range of motion :

A. Dorsiflexion B. palmar flexion C. Supination D. Ulnar deviation E. Radial deviation

Case NO. 3

A 42 years old male patient sustained a type AO 23C1 fracture of the left distal radius after falling from height. He was managed with ORIF by using conventional plate (non locking volar plate) 7 days after injury.



A. Preoperative X-rays B. Intraoperative views C. Immediate postoperative D. At the end of follow up

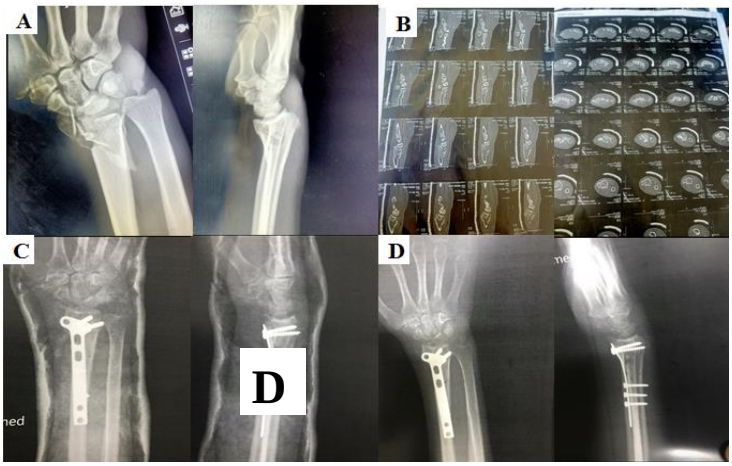
Range of motion :

A.Dorsiflexion B. palmar flexion C. Ulnar deviation

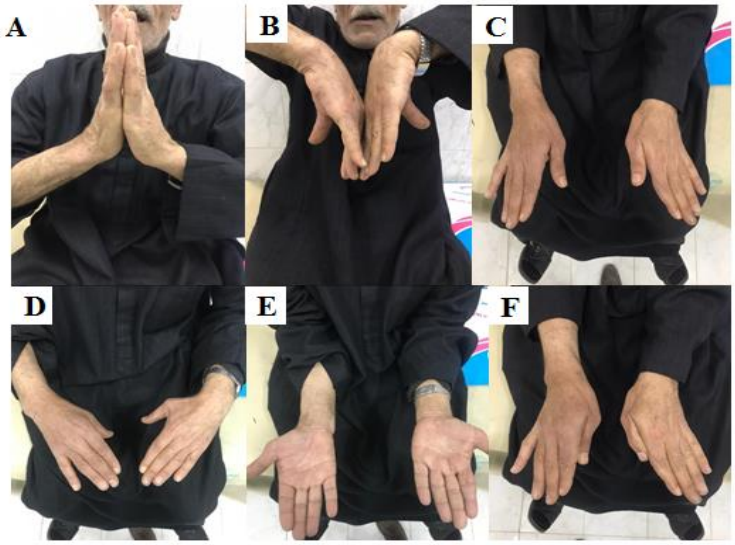
D. Radial deviation

Case NO. 4

A 60 years old male patient sustained a type AO 23C3 fracture of the right distal radius after direct trauma with blunt object. He was managed with ORIF by using conventional plate (non locking volar plate) 3 days after injury.



A. Preoperative X-rays B. preoperative CT C. Immediate postoperative D. At the end of follow up



Range of motion :
A. Dorsiflexion B. palmar flexion C. Ulnar deviation D. Radial deviation E. supination F.pronation

4. Discussion

At the end of the follow up period , according to Quick DASH scoring system in the group of VALP 6 patients (60%) had excellent results (scores between 0 to 11), 3 patients (30%) had good results (scores between 12-22) and only one patient (10%) had fair results (scores between 23-33), no patients had poor results with a mean DASH score of 14.5 .While in the group of NLP 3 patients (30%) had excellent results, 6 patients (60%) had good results and only one patient (10%) had fair results, no patients had poor results with a mean DASH of 15.9 and this was stastically insignificant between the two groups

Comparing to results of VALP in our study Figl et al, reported excellent results in 37.5% of patients, good results in 67%, and fair results in 1%. [13] Jagodzinski et al, reported a mean DASH (disabilities of the arm, shoulder, and hand) score of 18.2 in patients treated with VALP. [14]

In a study made by Kenny Kwan et al, on 75 patients had distal radius fractures managed by 2.4mm distal radius plates, they found that an excellent or good result was obtained in 96% of patients according to modified Green and O'Brien score. In our results the sum of excellent and good results of VALP was 90 % which is comparable to their results. [15]

Comparing to results of NLP in our study Osti et al, reported that Mayo wrist score was excellent in 10 (33%) patients, good in 14 (47%), fair in 5 (17%), and poor in 1 (3%). According to the Gartland and Werley score, 13 (43%) patients achieved an excellent result, 16 (53%) a good result, and 1 (3%) a fair result. He also reported a mean DASH of 14.9±17.6 . [16]

According to study made by Schmelzer-Schmied et al, he achieved excellent or good results according to the Gartland and Werley score in 85% of cases operated by NLP with a mean DASH score of 14 (SD=6.4) which can be comparable to our study. [17]

The range of movement of the wrist was evaluated at the end of follow up period for both groups. For VALP group Dorsiflexion ranged from 40 to 75 with a mean of 63±10.06. While palmar flexion ranged from 60 to 80 degrees with a mean of 70.7±6.18 Supination ranged from 70 to 85 degrees with a mean of 77.8±4.76, while pronation from 67 to 85 degrees with a mean of 75.7±5.19. Radial deviation ranged from 13 to 20 degrees with a mean of 16.6±2.59, while ulnar deviation from 34 to 40 with a mean of 37±2.05.

For NLP group Dorsiflexion ranged from 50 to 75 with a mean of 65.5±8.96. While palmar flexion ranged from 45 to 80 degrees with a mean of 71.5±10.06 Supination ranged from 55 to 85 degrees with a mean of 75.9±10.25, while pronation from 65 to 85 degrees with a mean of 73±4.22. Radial deviation ranged from 11 to 20 degrees with a mean of 17.2±3.19, while ulnar deviation from 32 to 40 with a mean of 36.6±2.32.

These values for both groups correspond well with the functional daily requirements.

By comparing the results of our study and the study done by Khatri K et al, our study was found to have comparable results. They used variable angle locking plate in 23 unstable distal end radius fractures. 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°±8.08, the mean extension was 76.95°±5.70, the mean pronation was 77.65°±6.01, and the mean supination was 81.86°±6.28. [18]

Spiteri et al, 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. [19]

Vlcek et al, 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. [20]

By comparing our results to results of Schmelzer-Schmied et al, as regards NLP mean flexion was 57 (SD=7.7), mean extension was 60 (SD=11), mean supination was 73 (SD=4.5), mean pronation was 72 (SD=6.2), mean radial deviation was 18 (SD=5.23) and mean ulnar deviation was 21 (SD=4.5). These results were comparable to our results. [17]

In the study made by Osti et al, they compared functional and radiological outcomes after treatment of unstable distal radius fractures with locking and conventional non locking plates .The group of NLP specified no residual wrist pain in 76% of patients. Average grip strength was 23.7610.9 kg, which is 87% of the noninvolved side. He reported mean wrist extension 89, mean flexion 87, mean radial deviation 89, mean ulnar deviation 85 and mean forearm rotation 97. The results of their study indicate that neither functional nor radiological results correlate with locking or non locking palmar plate fixation. [16]

At the end of the follow up period, according to Castaign radiological assessment score [12], In the group of VALP : 6 patients (60%) had excellent results (scores between7-8), 4 patients (40%) had good results (scores between5-6) and no patients had fair or poor results**.** The score ranged from 5 to 8 in the studied patients' group with a mean of 6.8.

- **Radial Inclination:** mean inclination angle was 21.36°±2.53.
- **Palmar tilt:** mean palmar (sagittal) tilt was 10.32°±2.26.

In the group of of NLP: 2 patients (20%) had excellent results (scores between7-8), 7 patients (70%) had good results (scores between5-6) and 1 patient (10%) had fair results (scores between3-4), no patients had poor results**.** The score ranged from 4 to 8 in the studied patients' group with a mean of 6.

- **Radial Inclination: mean inclination angle was 19.56°±3.53.**
- **Palmar tilt: mean palmar (sagittal) tilt was 8.92°±2.01.**

By comparing the results of our study and the study done by Khatri K et al, as regards results of VALP our study was found to have comparable results. Radial length mean was 11.84mm ±2.04, radial inclination mean was 22.89°±2.64, and the volar angulation mean was 5.21°±5.72. [(18)]

Sim JC et al. 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. [21]

Masood K et al, evaluated the use of VALP in 42 patients with distal radius fracture and found that radial inclination mean was 21.09° and volar tilt mean was 11.22°. Our results were comparable to these results and those of Fowler JR et al, with radial inclination mean was 21° which is similar to our result and volar tilt mean was 3° which is less than our results. [22, 23]

Teunis et al, 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. [24]

Gruber et al, noticed a statically 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. [25]

Koshimune et al, evaluated the use of locking versus no locking plates for unstable distal radius fracture in elderly and reported mean palmar tilt was 18, mean radial length was 6 and mean radial inclination was 13.5 for NLP group. Their study has shown that there was no significant difference between the two groups on any pre- and postoperative radiographic assessment and both groups obtained good reduction and results. [26]

Osti et al, reported mean palmar tilt was 15.27, mean radial inclination was 16.63 and mean radial shortening was 8.95 for the group of NLP. [16]

In our study there was high significant correlation between the functional result and the radiological results in both groups of VALP and NLP. Patients with excellent radiological result achieved excellent functional end result, patients with good radiological result achieved excellent and good functional results and no patient with poor radiological result achieved excellent functio0al result.

There are many studies support our results as in Kale et al. They found that radiological parameters have an effect on functional outcome in their study at six month of follow up. The more the number of radiological parameters affected the poorer is the functional outcome. [27]

It is also shown that permanent radial shortening and loss of the palmar angle were associated with prolonged wrist pain as in Karnezis IA study. They found that residual articular incongruity correlates with persisting loss of wrist dorsiflexion and wrist dysfunction contradicts the view that loss of articular congruity is associated with late development of articular degeneration but not with early wrist dysfunction. [28]

Correlation between the functional outcome and the radiographic appearance of the wrist after a fracture of the distal radius remains debated. Also there are many studies reporting that there is no correlation between radiological and functional outcome. [29]

This controversy may be due to the wide spectrum of injury patterns, different methodologies used by different investigators, and the number of possible parameters studied. Also patient's demand and age play an important role in the difference of these results.

In our study group of VALP had complication rate of 30%. One patient had superficial wound infections that were resolved with regular dressings and antibiotic administration for two weeks. Another one suffered

from delayed wound healing. This resolved completely after 4 weeks. One patient had a tourniquet palsy which was resolved after 5 weeks of physiotherapy.

Group of NLP had complication rate of 20%. One patient had carpel tunnel syndrome and underwent carpal tunnel release during follow up period. Another one had a tourniquet palsy and underwent course of physiotherapy for 4 weaks and then resolved.

Comparing our results with the results of Khatri K et al, the complication rate for the VALP was 21.7% in the form of hardware prominence, loss of reduction, and tendon irritation. (18)

Raman Mehrzad, and David C. Kim results are comparable to ours in their VALP study group regarding to nerve affection, tendon injuries and hardware complications such as screw loosening, pain related to hardware and tendon rupture. In our study there is no patient developed a tendon irritation or rupture. (30)

Kenny Kwan et al, reported that variable angle plates are much smaller, they can be placed more distally allowing sub-chondral fixation and reduced tendon and soft tissue irritation. (15)

Comparing between fixed angle and variable angled plates, Raman Mehrzad, and David C. Kim reported that fixed angle plate is positioned in a single location in order to provide optimal support of the subchondral bone across the articular surface. If the plates positioned too proximal or angled to one side, subchondral support may be compromised, leading to dorsal migration of the distal fragment and prominent hardware, loosening, and/or tendinitis. (30)

The position of variable angle plates proximal to watershed line permits giving a subchondral support by using the screws with the desired angle this limits irritation of tendons.

In a non-matched paired study on 53 patients, Kamano et al. found no significant differences between the palmar locking and non-locking system in unstable fractures of the distal radius in the elderly. They reported that complications of the palmar non-locking plate fixation ranged from 0% to 13.2%. (31)

Schmelzer-Schmied et al, reported complication rate of 14% in NLP group. One patient had Carpel tunnel syndrome as in our study and one patient developed reflex sympathetic dystrophy. (17)

Michael Osti et al, reported overall complication rate for both groups of locking and non locking plates was 25%. Impairment of the superficial branch of the radial nerve, resulted in dysesthesia, preferential at the extensor side of the thumb, in 6 patients. Implant malposition compelled early implant removal in 4 patients, 3 patients developed reflex sympathetic dystrophy, and 2 patients developed carpel tunnel syndrome. (16)

5. Conclusion

Variable angle volar locking plate and Non Locking volar plate both are effective tools for management of unstable fracture of distal end radius however Variable angle plate achieves more satisfactory results in complex articular fractures

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