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Percutaneous Pinning Versus Volar Locking Plate Fixation in the Treatment of Intra_articular Distal Radius Fracture in Adults above 18 Years of Age

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Abstract

Background and objectives: Distal radius fractures account for more than 20% of all fractures seen in the emergency department, unstable distal radial fractures can be managed by several treatment options including cast immobilization, percutaneous pinning, plate fixation and external fixation, the aim of the study is to compare percutaneous pinning and volar locking plate in the treatment of distal radius fracture AO C1 subtype.

Methods: Thirty patients were included and divided into 2 equal groups, group 1 underwent volar locking plate fixation and group 2 underwent percutaneous k wire fixation, the functional and radiological outcomes were assessed by DASH and Stewart's score respectively and range of motion was measured.

Results: Plate group has significantly higher mean flexion at 3 and 12 months than those of the pin group, DASH score at 3 and 6 months was significantly higher in pin group (28.43 and 10.59 respectively) than plate group (20.47 and 16.75 respectively) but no significant difference was showed between the pin and plate groups at 12 months (14.58 vs 13.23 respectively)**.** When the difference between preoperative and 12 months radiographs was measured ulnar variance, radial inclination, and palmar tilt were significantly higher in the plating group, however, the Stewart's score distribution between both groups showed no significant differences.

Conclusions: While there was no functional outcome difference at one year of follow up between patients treated with either treatments modality, patients requiring faster recovery and return to function can be offered open reduction and volar locking plate fixation.

Keywords: Distal radius fracture; C1 AO type; Kirschner wire; Volar locking plating.

Introduction

More than 20% of all fractures seen in the emergency unit are distal radius fractures[1]. The vast majority of distal radius fractures treated with close reduction and casting achieved satisfactory stability; however, intraarticular and unstable fractures can affect the dynamics and congruency of the wrist joint[1]. The American Academy of Orthopaedic Surgeons recommends surgical fixation for distal radius fractures with post-reduction loss of radial length of 3mm or more, dorsal tilt more than 10 degrees, or intra-articular gap or step of 2 mm or more[2]. Treatment options for unstable distal radius fractures including plate fixation, external fixation, cast immobilization and percutaneous pinning[3]; however, restoring the radial length, radial inclination, and palmar inclination should be the ultimate goal of distal radial articular

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surface repair[4]. For a long period, percutaneous pinning has been demonstrated as a successful way of maintaining proper reduction with little complications[5]. It provides rapid, simple, minimally invasive, cost-effective, and cosmetically acceptable fixation of fractures[6]; however, in osteoporotic bone it is not effective in providing support as it is not a load-bearing device[7]. Several studies showed the advantages of using fixed angle plates in the treatment of distal radius fracture, which made this treatment modality more common in the last two decades[8]. The benefits of plate fixation are direct reduction, stable rigid fixation, immediate mobilization and early functional recovery[9]; however, tendon rupture and metallic complications reported as complications of volar locking plate use[10]. There are numerous classification systems for distal radius fracture, although till now there is no gold standard, uncontroversial and globally agreed upon classification, however, The AO Foundation/Orthopaedic Trauma Asso -ciation (AO/OTA) fracture classification was the only one that provided inter- and intra-observer reliability and only in the assessment of the three main types[10]. The aim of our study is to compare the functional and radiological outcomes of AO class C1 distal radius fracture managed by close reduction and percutaneous k wire fixation and open reduction and internal fixation using volar locking plate.

Patients and methods

Local ethics committee approval from Kurdistan Board of Medical Specialties and written informed consent was obtained for the study. This study comprised 30 patients with distal radius fracture C1 AO type treated in Erbil governmental hospitals (Rozhawa and Rozhalat emergency hospitals), They were divided into two equal groups (15 patients in each). Group I underwent close reduction, and percutaneous pinning, close reduction was done then a 1.5-cm incision was made at the radial styloid, the superficial radial nerve branches were mobilized, then two K wires 1.6-mm in diameter were placed from the radial styloid diverging from each other to engage the far ulnar cortex of the radius proximal to the fracture. A third or a fourth K wire was inserted if considered necessary. We applied a below elbow splint for 2 weeks. At six weeks the cast and pins were removed[11]. Group II managed by open reduction and internal fixation using the Henry approach and a 2.4-mm LCP distal radius plate with locking screws. An 8 cm incision was made and dissection carried on between the radial artery and flexor carpi radialis, an L-shaped incision was made to elevate the pronator quadratus. The fracture was reduced, we positioned the volar plate under fluoroscopic guidance and inserted a screw into the oblong or gliding hole, the distal holes were drilled and screws were inserted. The wound closed in layers and a splint was applied. At 1 week active wrist motion is begun. The patients wore a removable Orthoplast splints for 6 weeks[11]. Inclusion criteria were C1 AO class patients, age between 18 to 60 years old, isolated injury and closed fracture, exclusion criteria were patient younger than 18 years and older than 60 years, all AO classes other than C1, open fracture, associated neurovascular injury, pathologi-cal fracture, concomitant injury to the ipsilateral upper limb and previous fracture of the involved wrist. We used the disability of arm shoulder and hand score (DASH) to determine the functional outcome at 3,6 and 12 months[12]. the extension, flexion, supination, pronation, and ulnar and radial deviation ranges were measured with a goniometer at 3 and 12 months postoperatively. We expressed range of motion as a percentage of the contralateral uninjured wrist. In radiologic-al assessments, radial inclinatio, palmar tilt, radial length, ulnar variance, and

intraarticular step and gap were valued preoperatively and at 3 and 12 months postoperatively using radiographs and assessed by Stewart's radiological assessment criteria[13]. Data were analyzed using the Statistical Package for Social Sciences (SPSS, version 25). We utilized the Chi-square test of association for proportions comparison. Fisher's exact test was used when the expected count of more than 20% of the cells of the table was less than 5. The Student's t-test of two independent samples was employed so as to compare two means. We chose the Mann Whitney test in this study so as to compare the mean ranks of the two groups. A p-value of ≤ 0.05 was considered statistically significant.

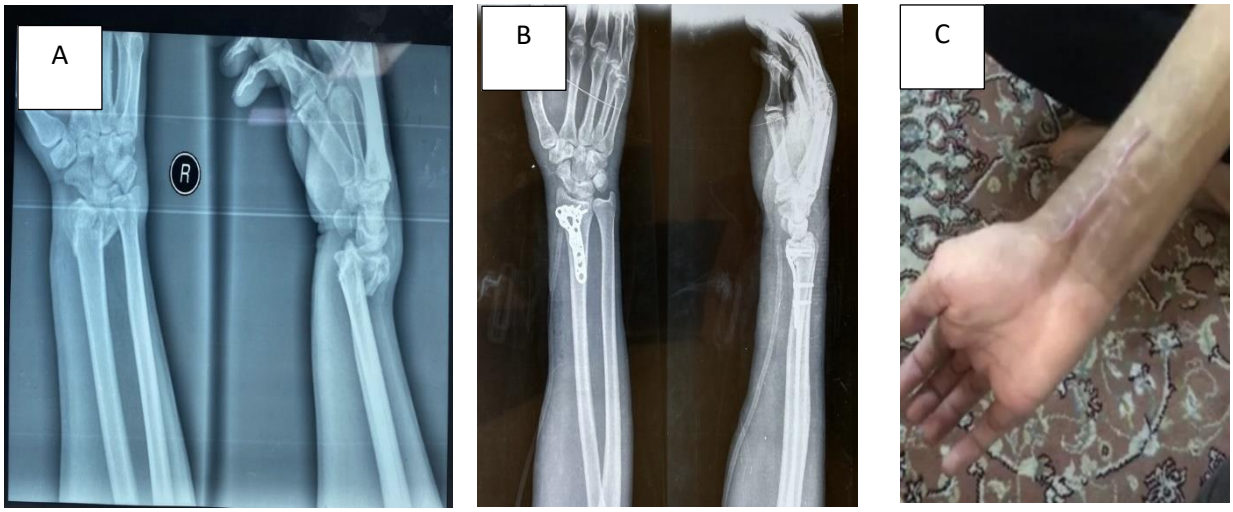

Figure 1:

A. Preoperative radiographs of AO C1 distal radius fracture in a 28 years old male
B. Postoperative radiographs of the same patient treated by volar locking plate
C. Photograph showing the surgical site at 3 months

Figure 2:

A. Preoperative radiographs of AO C1 distal radius fracture in a 37 years old female.
B. Postoperative radiographs of the same patient treated by k-wire

Results

There were no significant differences between the two groups in terms of age, sex, involved side and the mechanism of injury as presented in Table (1).

Table (1): Basic characteristics of the studied sample.

	Pin		**Plate**		**Total**		
	No.	**(%)**	**No.**	**(%)**	**No.**	**(%)**	**p-value**
Age (years)							
< 30	6	(40.0)	5	(33.3)	11	(36.7)	
30-39	4	(26.7)	3	(20.0)	7	(23.3)	
40-49	1	(6.7)	4	(26.7)	5	(16.7)	
≥ 50	4	(26.7)	3	(20.0)	7	(23.3)	0.641*
Mean (±SD)	36.0	(±13.59)	37.53	(±12.38)			0.749**
Gender							
Male	10	(66.7)	8	(53.3)	18	(60.0)	
female	5	(33.3)	7	(46.7)	12	(40.0)	0.456†
Involved side							
Right	7	(46.7)	7	(46.7)	14	(46.7)	
Left	8	(53.3)	8	(53.3)	16	(53.3)	>0.999†
Mechanism of injury							
Falling on outstretched hand	6	(40.0)	6	(40.0)	12	(40.0)	
Occupational	4	(26.7)	2	(13.3)	6	(20.0)	
Fall from height	4	(26.7)	5	(33.3)	9	(30.0)	
Road traffic accident	1	(6.7)	2	(13.3)	3	(10.0)	0.833*
Total	15	(100.0)	15	(100.0)	30	(100.0)	

*By Fisher's exact test. †By Chi square test. **By t test

The mean flexion in the plate groups was 74.36% at three months, and 89.49% at 12 months; both were significantly (p-value < 0.001) higher than those of the pin group (70.29% and 86.28% respectively). No other significant differences were detected apart from supination at three months which was significantly (p-value < 0.001) higher in the plate group than the pin group (89.40 vs. 84.51 respectively) as it is evident in Table (2).

Table (2): Parameters of the range of motion of the two study groups.

	Pin			**Plate**			
Parameters†	**Mean**	**(±SD)**	**Mean rank**	**Mean**	**(±SD)**	**Mean rank**	**p-value***
Flexion 3 M	70.29	(±1.25)	8.20	74.36	(±1.29)	22.80	< 0.001
Flexion 12M	86.28	(±1.62)	9.53	89.49	(±1.83)	21.47	< 0.001
Extension 3M	73.36	(±1.57)	15.23	74.29	(±4.31)	15.77	0.868
Extension 12M	88.31	(±1.73)	13.43	89.19	(±1.69)	17.57	0.198
Pronation 3M	87.41	(±1.38)	15.70	87.42	(±1.10)	15.30	0.901
Pronation 12M	97.42	(±1.57)	18.00	96.28	(±1.93)	13.00	0.119
Radial Dev. 3M	70.86	(±5.36)	15.33	69.65	(±2.47)	15.67	0.917
Radial Dev. 12M	89.58	(±2.19)	14.60	89.80	(±2.60)	16.40	0.573
Supination 3M	84.51	(±1.91)	8.37	89.40	(±1.99)	22.63	< 0.001
Supination 12M	97.60	(±1.51)	15.23	97.63	(±1.48)	15.77	0.868
Ulnar Dev. 3M	68.70	(±1.84)	12.93	69.72	(±1.36)	18.07	0.109
Ulnar Dev. 12M	89.93	(±1.85)	13.53	90.83	(±2.22)	17.47	0.220

* By Mann Whitney test comparing the mean ranks of the two groups. M = Month. †Value of any parameter = (range of motion of affected arm / range of motion of the contralateral side) * 100

The DASH score at three and six months, it was significantly higher in the pin group than the plate group (p-value < 0.001 and p-value = 0.041 respectively). At 12 months, the difference was not significant (p-value = 0.739), as it shown in Table (3).

Table (3): DASH score of the two study groups.

	Pin			Plate			
	Mean	**(±SD)**	**Mean rank**	**Mean**	**(±SD)**	**Mean rank**	**p-value***
DASH score 3M	28.43	**(**±1.55)	22.93	20.47	**(**±2.51)	8.07	< 0.001
DASH score 6M	20.59	**(**±5.53)	18.77	16.75	**(**±3.92)	12.23	0.041
DASH score 12M	14.58	**(**±8.95)	16.03	13.23	**(**±5.71)	14.97	0.739

*By Mann Whitney test. †

Regarding the radiological findings there were no significant differences between the two study groups except for the radial inclination at 12 months where the mean in the plate group was 23 degrees compared with 19.67 degrees in the pin group (p-value< 0.001). No significant differences were detected in the distributions of Stewart's score categories between the pin and the plate groups at 3 months (p-value = 0.700), and 12 months after the operation (p-value = 0.591), as it shown in table (4).

Table (4): Stewart's radiographic score by type of operation and time of follow-up.

Stewart's score categories	**Pin**		**Plate**		**Total**		
	No.	**(%)**	**No.**	**(%)**	**No.**	**(%)**	**p-value**
After 3 months							
0	5	(33.3)	4	(26.7)	9	(30.0)	
1	9	(60.0)	11	(73.3)	20	(66.7)	
2	1	(6.7)	0	(0.0)	1	(3.3)	0.700*
After 12 months							
0	4	(26.7)	4	(26.7)	8	(26.7)	
1	9	(60.0)	11	(73.3)	20	(66.7)	
2	2	(13.3)	0	(0.0)	2	(6.7)	0.591*
Total	15	(100.0)	15	(100.0)	30	(100.0)	

*By Fisher's exact test.

The mean difference in palmar tilt (12 months minus pre-operative readings) was 25 in the plate group which was significantly higher than the mean difference (24) in the pin group (p-value = 0.003). The same pattern is for radial inclination (mean of difference was 7 vs. 3.67 respectively) and the difference was significant (p-value < 0.001) The mean of difference of ulnar variance (pre-operative minus 12 months readings) was significantly (p-value = 0.027) higher in the plate group (2.73) than that of the pin group (2.13). The other differences were not significant, as it shown in Table (5).

Table (5): Correction achieved as assessed by X-Rays.

	Pin			Plate			
Diff.*	**Mean**	**(±SD)**	**Mean rank**	**Mean**	**(±SD)**	**Mean rank**	**p-value**
Diff. Palmar tilt 12M-Pre Op.	24.00	(±0.53)	11.20	25.00	0.93)	19.80	0.003
Diff. Radial inclination 12M-Pre Op.	3.67	(±1.11)	8.00	7.00	(±0.85)	23.00	< 0.001
Diff. radial Length 12M-Pre Op.	1.53	(±1.19)	14.37	1.87	(±1.06)	16.63	0.462
Diff. Ulnar variance preop - 12M	2.13	(±1.30)	12.20	2.73	(±1.16)	18.80	0.027
Diff. gap Pre – early post op.	2.46	(±1.18)	14.43	2.80	(±3.00)	16.57	0.480
Diff. step Pre – early post op.	1.46	(±0.91)	14.1	1.73	(±0.59)	16.9	0.344

Diff. = difference between values at different times (before and after the operation).M = Month

The mean (± SD) duration of surgery was 42.5 ± 11.3 minutes in the pin group which was significantly (p-value < 0.001) less than that of the plate group (72.1 ± 10.0 minutes). Results showed that 3 patients (20%) of the pin group developed complications while only1 patient (6.7%) of the plate group developed complications (p-value = 0.598). Regarding the type of complications in the pin group, 2 patients developed pin site infection and 1 patient developed a superficial branch of radial nerve injury, while 1 patient in the plate group developed Carpal tunnel syndrome (p-value = 0.500).

Discussion

Our study displayed no significant difference regarding range of motion between the two groups apart from the supination at 3 months and the flexion at 3 and 12 months being both significantly higher in plate group; however, other researchers didn't report a significant difference[14-15]. Regarding the functional outcome, the DASH score at 3 and 6 months was significantly higher in the pin group but no significant difference was showed at 12 months, similar results reported by Hull et al[6]. Both volar plate and K wire fixation yield same functional results at final follow up, this fact justifies the usage of the rapid, less invasive and cheap k wire fixation instead of the invasive and expensive surgery of volar plating that requires more anesthesia and runs the possible need for another surgery for implant removal. About the radiological findings, there are no significant differences between the two study groups apart from the radial inclination at 12 months being significantly higher in the plating group, no significant differences were found by Goehre F et al[16]; however, Bahari et al found better radiological outcomes in plating group[17]. When the difference between preoperative and 12 month radiographs was measured, palmar tilt, radial inclination, and ulnar variance were significantly higher in the plating group. Nadine et al found that the mean correction was only significant in ulnar variance in favor of the plate group[15]. In

terms of radiological outcomes, the volar plate group achieved significantly better correction in three parameters and this can be explained by the fact that the K wire fixation relies on indirect reduction and is not rigid as compared to volar plating which reduces its efficiency in achieving and maintaining near anatomical reduction, on the other hand, the volar plating technique offers direct visualization of the fracture that results in near anatomical restoration of these radiological parameters and it has higher biomechanical characteristics which enable it to provide a stable and rigid fixation that gives the advantage of maintaining the reduction achieved at operation time; however, in our study, no significant differences were detected in the distributions of Stewart's score categories between the pin and the plate groups at all follow-up periods, similar results were found by Yetkin et al[14]. Although the operations were done by 7 different orthopedic surgeons, the mean duration of operation was significantly lower in the pin group (42.5 minutes) than that of the plate group (72.1 minutes). The overall rate of complications was higher in the pinning group up to 20% of patients but the difference was not statistically significant, pin group complications were pin site infection and superficial branch of radial nerve injury, while one patient developed Carpal tunnel syndrome in the plating group, a complication that can be theoretically avoided by decompressing the canal at the same surgical session; however, other study have found reduced number of complications in the plate group[18].

Conclusions

It can be concluded that while there is no functional outcome difference at one year of follow up between patients treated with K wire or volar locking plate, patients requiring faster recovery and return to function can be offered open reduction and volar locking plate fixation.

Conflicts of interest

There were no conflicts of interest.

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