

## DISPLACED INTRA ARTICULAR DISTAL RADIUS FRACTURES IN ADULTS: A COMPARISON BETWEEN TREATMENT WITH K-WIRES VERSUS VOLAR ANATOMICAL PLATE

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### ABSTRACT

**Objective:** The purpose of this study is to compare the functional outcomes of percutaneous Kirshner wires versus volar anatomical locking plates in the treatment of intra-articular distal radius fractures and detect complications postoperatively. **Patients and Methods:** This is a retrospective comparative study conducted at Tishreen University Hospital in Lattakia-Syria during tow year (February 2019–February 2021). The study included two groups of patients were compared: group 1 consisted of 34 patients (54.8%) who underwent fixation with percutaneous K-wires, whereas group 2 consisted of 28 patients (45.1%) who underwent internal fixation with volar anatomical locking plates. **Results:** The most frequent age group was 51–65 years (45.1%), and the median age was 51.2 years. Right side was affected in 39 patients (62.9%), and females represented 59.6% of the patients. Low-energy injury was present in 38 patients (61.2%). The most common type of fracture according to the AO classification was type C1 (41.9%). Functional results seem to favor patients treated with volar plates during the initial months following the procedure, but there were no significant differences between the two types of treatment at 12 months. At the end of follow-up, the mean qDASH score was 12 for the volar plate group and 14 for the k-wires group. Sex (male) and fracture type B1 were significantly associated with excellent and good functional results. Superficial pin tract infection, secondary displacement, and complex regional pain syndrome were the most frequent complications in group 1, whereas superficial skin necrosis, chronic swelling, and carpal tunnel syndrome were more frequently in group 2. **Conclusion:** Open reduction and internal fixation with a volar anatomical plate in the management of intra-articular distal radius fractures provide better functional results during the initial months and earlier return to work with less complications.

**KEYWORDS:** Distal radius, fractures, qDASH scoring.

### INTRODUCTION

The most common fracture in adults is a distal radius fracture (DRF). It represents 17.5% of all fractures seen in the emergency department.<sup>[1]</sup> However, the most effective method of treatment remains controversial and unclear.<sup>[2]</sup> The distribution of these injuries is bimodal, with young adults being affected by high-energy mechanisms and elderly adults being affected by low-energy falls and osteoporosis.<sup>[3]</sup> As the population is ageing, the specific incidence of distal radius fractures is expected to increase in the coming years.<sup>[4]</sup> There are many classification systems for these fractures, and the majority of them are based on the fracture's location, a number of articular fragments, the direction of

displacement, and the involvement of the ulna.<sup>[5]</sup> Previously, many of these fractures were managed conservatively. However, the high incidence of malunion associated with conservative management resulted in poor clinical outcomes, such as pain and disability.<sup>[6]</sup> Closed reduction and fixation with percutaneous K-wires has historically been the most common surgical treatment for distal radius fractures, as it is a relatively quick and inexpensive method.<sup>[7]</sup> Open reduction and internal fixation with volar anatomical locking plates is increasingly being used as an alternative to K-wires fixation, offering stability and allowing for early movement of the wrist and hand.<sup>[8]</sup>

Therefore, the purpose of our study is to compare the

functional outcomes of two totally different methods: the percutaneous Kirshner wires versus volar anatomical locking plates in the treatment of intra-articular distal radius fractures.

## PATIENTS AND METHODS

This study is a retrospective comparative of a group of patients with intra articular distal radius fractures who attended the orthopedic department at Tishreen University Hospital in Lattakia-Syria during a two-year period (February 2019–February 2021). The inclusion criteria were: patients aged 18–65 years of both genders; fracture type B or C according to AO classification. The exclusion criteria were: pathologic fractures, open fractures, history of previous wrist surgery, concomitant upper extremity fractures, congenital upper limb deformities, and the presence of associated vascular and neurological primary injuries.

A history and physical examination were performed as part of the workup. Patients were divided to group1 who undergone closed reduction with percutaneous K-wires fixation, and group2 who undergone open reduction and internal fixation with a volar anatomical locking plate.

Patients were classified according to AO classification, and they were followed up at regular intervals in the post-operative period by performing X-ray images of all patients, which were taken in anteroposterior, lateral, and oblique views to assess for union status and evaluate any complication if occurred. The functional outcomes were assessed at 3, 6, and 12 months postoperatively with the following parameters: wrist range of motion, grip strength, and disabilities of the arm shoulder and hand (Quick DASH).

Range of motion of the wrist was measured using a standard goniometer. The grip strength of the injured side was compared to the grip strength of the contralateral side using a modified sphygmomanometer.<sup>[9]</sup>

Grading as per qDASH score was used. Score <5 was excellent, 6-15 was good, 16-35 was moderate and >35 was poor.<sup>[10]</sup>

**Ethical consideration:** All patients were provided a complete and clear informed consent after discussion about the study. This study was performed following the Declaration of Helsinki.

## Statistical Analysis

IBM SPSS version20 was used for Statistical analysis. Basic Descriptive statistics included mean, median, standard deviation(SD), percentage and Frequency. To compare two independent groups, the independent t student test was used. The chi-square test was used to examine the relationships and comparisons between the two groups. With p-value of <0.05, the results were considered to be significant.

## RESULTS

The baseline characteristics of the participants were as shown in (Table 1). Ages range from 18 years to 65 years (median 51.2 years). Patients were divided into three groups: 18-35 (17.7%), 36-50 (37.1%), and 51-65 (45.2%). 59.6% of the patients were females, and 40.3% were males. Right side was affected in 39 patients (62.9%), and left side in 23 patients (37.1%). According to AO classification system, fractures were classified to B1 (9.6%), B2 (3.2%), B3 (14.5%), C1 (41.9%), C2 (30.6%), and there were no cases of type C3. The fractures had occurred as result of low-energy injury in 38 patients (61.2%) and high-energy injury in 24 patients (38.7%).

**Table 1: The study population's demographic characteristics.**

Variable	Result
<b>Sex</b>	
Male	25(40.3%)
Female	37(59.6%)
<b>Age group</b>	
18-35	28(45.2%)
36-50	23(37.1%)
51-65	11(17.7%)
<b>Affected side</b>	
Right	39(62.9%)
Left	22(37.1%)
<b>Classification of fracture</b>	
Type B1	6(9.6%)
Type B2	2(3.2%)
Type B3	9(14.5%)
Type C1	26(41.9%)
Type C2	19(30.6%)
Type C3	0(0%)
<b>Cause of injury</b>	
<b>Low-energy injury:</b>	
Fall from standing	27(43.5%)
Sport injury	11(17.7%)
<b>High-energy injury:</b>	
Fall from height	11(17.7%)
Motor vehicle accidents	13(20.9%)

The operative time ranged between 15 minutes and 35 minutes in group 1, with a mean time  $25.1 \pm 6.3$ , whereas in group 2, the operative time was longer and ranged between 45 minutes and 90 minutes with a mean time  $63.9 \pm 14.1$  (p: 0.0001). The mean duration of splinting was  $6.1 \pm 1.7$  weeks in group 1, whereas in group 2, the duration was shorter with a mean time  $1.8 \pm 1.4$  weeks (p: 0.0001). The median time to union in group 1 was  $6.7 \pm 1.3$  weeks, whereas the union time was longer in group 2 with a mean time  $8.3 \pm 1.7$  weeks (p: 0.0001). In group 1, the mean time to returning to work was  $4.2 \pm 1.1$  months, whereas in group 2, the time was shorter with a mean time  $1.9 \pm 0.9$  months (p: 0.0001).

**Table 2: The study population's operation characteristics by comparison of the two group.**

Variable	<b>Group 1</b> 34(54.8%)	<b>Group2</b> 28(45.1%)	P value
<b>Operation time(minute)</b>	25.1±6.3	63.9±14.1	0.0001
<b>Splinting duration(week)</b>	6.1±1.7	1.8±1.4	0.0001
<b>Duration of union(week)</b>	6.7±1.3	8.3±1.7	0.0001
<b>Return to work(month)</b>	4.2±1.1	1.9±0.9	0.0001

At 3 and 6 months postoperatively, there was a significant difference in wrist flexion between the two groups. However, wrist flexion of group 1 was 74.7°±15.6 and wrist flexion of group 2 was 77.5°±19.7 at 12 months postoperatively. At 3 months, wrist extension in group1 was 24.4°±12.9 and in group2 was 50.8°±13.2, which was statistically significant (p value =0.0001). Whereas wrist extension in group 1 was 64.4°±15.9 and in group 2 was 68.9°±17.7 at 12 months postoperatively. At 3 months' follow up, ulnar deviation in group1 was 13.8°±4.1 and 19.8°±5.4 in group2. It gradually increased to 34.8°±11.9 in group1 and 36.4°±12.1 in group2 at 12 months' follow up. Radial deviation in group 1 was 4.2° ±0.83 and radial deviation in group 2 was 10.4°±3.4 at 3 months, which is statistically significant. It gradually increased to 19.8°±10.4 in group1 and 21.1°±13.4 in group2 at 12 months' follow up. Pronation and supination in both groups had significantly different at 3 and 6 months follow up but there were no such different at 12 months

follow up. The evaluation of the recovered grip strength by the operated side compared to the contralateral side showed a percentage of %44.1±22.9 for group1 and %68.5±19.2 for group2 at 3 months postoperatively, which is statistically significant. It gradually increased to %84.4±15.3 in group 1 and %85.5±15.8 in group 2 at 12 months postoperatively. Group1 had qDASH Scores of 31.5±17.2 at 3 months postoperatively whereas group2 had qDASH scores of 21.5±14.5 in the same period. Group2, comparatively had less qDASH Scores than group1 at all follow up evaluations. Bu` t the significant difference was found to be at 3 and 6 months. However, over all period of time, there was a gradual reduction in qDASH scores in both groups. In group1, the results after 12 months were excellent in 9 (26.4%), good in 10 (29.4%), satisfactory in 13 (38.2%) and poor in 2 (5.5%), whereas the results in group2 were excellent in 8 (28.5%), good in 10 (35.7%), satisfactory in 9 (32.1%) and poor in 1 (3.5%).

**Table 3: The study population's functional outcomes by comparison of the two groups.**

Variable	<b>Group 1</b> 34(54.8%)	<b>Group2</b> 28(45.1%)	P value
<b>ROM:</b>			
<b>Flexion</b>			
3 months	38.8±12.5	55.3±16.2	0.0001
6 months	51.6±14.4	62.2±18.8	0.01
12 months	74.7±15.6	77.5±19.7	0.9
<b>Extention</b>			
3 months	24.4±12.9	50.8±13.2	0.0001
6 months	48.8±13.9	64.6±13.9	0.0001
12 months	64.4±15.9	68.9±17.7	0.2
<b>Ulnar deviation</b>			
3 months	13.8±4.1	19.8±5.4	0.0001
6 months	19.5±5.7	25.5±6.8	0.0001
12 months	34.8±11.9	36.4±12.1	0.5
<b>Radial deviation</b>			
3 months	4.1±2.9	10.4±3.4	0.0001
6 months	9.9±4.5	13.6±5.2	0.004
12 months	19.8±10.4	21.1±13.4	0.6
<b>Pronation</b>			
3 months	41.3±15.5	61.8±16.1	0.0001
6 months	67.8±14.5	78.6±13.9	0.004
12 months	83.8±16.4	84.8±15.5	0.8
<b>Supination</b>			
3 months	39.1±14.9	61.8±16.1	0.0001
6 months	70.4±14.5	78.6±13.9	0.02
12 months	85.1±17.7	87.8±16.2	0.8
<b>Grip strength</b>			
3 months	44.1±22.9%	%68.5±19.2	0.0001

6 months	65.8±16.4%	79.6±16.9%	0.002
12 months	%84.4±15.3	%85.5±15.8	0.7
<b>qDASH score</b>			
3 months	31.5±17.2	21.5±14.5	0.02
6 months	21.6±11.5	16.8±9.8	0.04
12 months	14.13±9.1	12.4±7.8	0.4
<b>qDASH score (after 12 months)</b>			
Excellent	9(26.4%)	8(28.5%)	0.4
Good	10(29.4%)	10(35.7%)	
satisfactory	13(38.2%)	9(32.1%)	
Poor	2(5.8%)	1(3.5%)	

According to the qDASH scores, males were associated significantly with excellent and good clinical outcomes as compared to females (p: 0.02). Patients aged 18–35 years were associated with excellent and good functional

outcomes as compared to other groups, but without significant differences (p: 0.08). In addition to that, B1 was found to be associated significantly with excellent outcomes compared to other types (p: 0.0001).

**Table 4: Comparison of functional outcomes according to demographic characteristics of patients.**

Variable	qDASH			
	Excellent	Good	Satisfactory	Poor
<b>Sex</b>				
Female	9(24.3%)	11(29.7%)	14(37.83%)	3(8.1%)
Male	8(32%)	9(36%)	8(32%)	0(0%)
<b>Age group(years)</b>				
18-35	5(45.4%)	6(54.5%)	0(0%)	0(0%)
36-50	10(43.4%)	7(30.4%)	6(26%)	0(0%)
51-65	2(7.1%)	7(25%)	16(57.1%)	3(10.7%)
<b>Classification of fracture</b>				
Type B1	5(83.3%)	1(16.6%)	0(0%)	0(0%)
Type B2	1(50%)	1(50%)	0(0%)	0(0%)
Type B3	3(33.3%)	4(44.4%)	2(22.2%)	0(0%)
Type C1	8(30.7%)	9(34.6%)	9(34.6%)	0(0%)
Type C2	0(0%)	5(19.2%)	11(42.3%)	3(15.7%)

There were early complications in 7 patients ( 20.5%) in group 1, including superficial pin tract infection in 4 cases and secondary displacement in 3 cases, whereas in group 2, early complications developed in 3 patients (10.7%), including superficial skin necrosis in 2 cases and secondary displacement in one case. There were late

complications in 15 patients (44.1%) in group 1, and both complex regional pain syndrome and chronic swelling were the most frequent complications, whereas in group 2, complications developed in 9 patients (32.1%), chronic swelling and carpal tunnel syndrome were the most frequent complications.

**Table 5: Comparison of postoperative complications of the study population.**

Complication	Group 1	Group2
<b>Early complications</b>		
Infection	4(11.7%)	0(0%)
Superficial skin necrosis	0(0%)	2(7.1%)
Secondary displacement	3(8.8%)	1(3.5%)
<b>Late complications</b>		
Chronic swelling	4(11.7%)	2(7.1%)
Complex regional pain syndrome	4(11.7%)	1(3.5%)
Malunion	3(8.8%)	1(3.5%)
Nonunion	0(0%)	1(3.5%)
Degenerative arthritis	2(5.8%)	0(0%)
Carpal tunnel syndrome	2(5.8%)	2(7.1%)

**DISCUSSION**

The fractures of the distal radius, despite being the most

common upper extremity fractures continue to pose a therapeutic challenge.

This study showed the main findings. First, fractures were more frequently in females, and there were plenty of fracture cases being peak well into middle age and elderly. Second, Fall from standing was the main cause of fractures. The most frequent type of fracture was type C1. Surgical procedure duration was significantly longer in group 2, and the mean time for union was also longer with a significant difference. The mean time of splinting was longer in group 1, and the mean time to return to work was shorter in group 2. Third, during follow-up periods, the functional outcome was favorable in group 2 compared to group 1 at 3 and 6 months, but at 12 months there were no significant differences. Males, age group 36-50 years, and fracture type B1 were associated with excellent results. Majority of complications in group 1 were superficial pin tract infection, secondary displacement and Complex regional pain syndrome, whereas in group 2 superficial skin necrosis, secondary displacement, chronic swelling, and carpal tunnel syndrome were the most frequent complications.

These findings are comparable with a study conducted by Tronci *et al.* (2013) who did a comparative study between ORIF with angular stability plate and percutaneous Kirschner wires in the treatment of distal radius articular fractures on 77 patients. Females represented the majority of patients, and the most frequent type of fracture was type C2. Left side was more affected (57.1%). DASH scores at the end of follow-up period were 13 in the k-wires group versus 9 in the volar plate group.<sup>[11]</sup>

Phadnis *et al.* (2012) demonstrated in a study conducted on 183 patients with distal radius fractures who underwent internal fixation with volar locking plate that the majority of patients were females, with a mean age 62.4 year. An average time for union was 8.4 weeks. The qDASH scores were good or excellent in 133 patients (74%), satisfactory in 41 (23%) and poor in six patients (3%).<sup>[10]</sup>

In summary, open reduction and internal fixation with a volar anatomical plate provide better functional results during the initial months and allow earlier return to work with less complications, but there were no significant differences between the two types of treatment at 12 months postoperatively.

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