

# DISTAL RADIUS FRACTURES: LONG TERM FUNCTIONAL AND RADIOLOGICAL RESULTS OF PERCUTANEOUS PINNING FIXATION

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## ABSTRACT

**Objective:** To evaluate, functionally and radiologically, the long term outcomes of the management of distal radius fracture treated by closed reduction and percutaneous pinning fixation. **Methods:** From 84 patients submitted to percutaneous fixation of the distal radius fracture, we evaluated 34, with a medium follow-up of 85.7 months (from 18 to 168 months). Of the 34 patients, 23 were women, and the ages ranged from 28 to 88 years (median 65 years). We analyzed the range of movement, strength, pain and the results of the DASH questionnaire. Radiological evaluation was also carried out, to evaluate healing time and angles of the distal radius. **Results:** The fractures healed in an average of 41 days. The mean values for wrist flexion, extension, radioulnar deviation, pronation and supination were

within the functional parameters for ROM of the wrist. Most of the patients (76.5%) presented no pain during the examination, and 23 patients presented a DASH value of zero. There was one case of loss of reduction, which was re-operated two weeks after the initial surgery, and one patient developed a sympathetic dystrophy associated with a distal radioulnar joint disturbance. **Conclusion:** Percutaneous pinning fixation for distal radius fracture results in a long term follow-up with excellent range of movement, little or no pain, acceptable radiographic parameters, and low complication rate, and is an efficient and low cost method.

**Keywords** - Radius Fractures; Kirschner Wires; Fracture Fixation.

## INTRODUCTION

Fractures of the distal extremity of the radius are a constant subject of studies that seek to define which surgical method would present best results and fewest complications relating to the procedure. These are fractures that have a broad spectrum of presentations and likewise a range of procedures for treating them, going from conservative methods like plaster casts to surgical procedures for unstable fractures: percutaneous pinning and volar and dorsal plates of a wide variety of models, with or without locking, with or without external fixators and with or without associations with other methods<sup>(1, 2)</sup>.

With the advent of locked plates, several studies have compared their use with the use of other fixation

methods for these fractures, and good results have been reported in the literature<sup>(3,4)</sup>. In the same way, because this is a more invasive method, it involves a great number of complications than seen in other, more conservative procedures such as percutaneous pinning. Complications such as plate breakage, tenosynovitis, tendon adherence and even torn tendons (both flexors and extensors) have been described in the literature<sup>(5-8)</sup>.

On the other hand, percutaneous pinning after closed reduction of the fracture continues to be a procedure that is widely disseminated and accepted among orthopedists and hand surgeons. It presents the advantage of being less invasive, with lower complication rates and lower procedure costs; it is relatively

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simple to perform and the pins can easily be removed after consolidation<sup>(9-13)</sup>.

The objective of the present study was to conduct long-term functional and radiographic analysis on patients with a fracture of the distal radius who were treated with closed reduction and percutaneous fixation, and to describe the complications encountered during the follow-up period.

This study was approved by the Ethics Committee of the Orthopedics Hospital of Belo Horizonte.

## MATERIAL AND METHODS

Between 1996 and 2008, 84 patients were operated to treat unstable fractures of the distal extremity of the radius, by means of percutaneous fixation using Kirschner wires. Only 39 of them made return visits for evaluations. Some patients had died, while others were experiencing locomotion problems and yet others had changed address or telephone number. All of these patients were therefore excluded from the present study.

Twenty-three women and eleven men were evaluated, with a minimum length of follow-up of 18 months and a maximum of 168 months (mean of 85.7 months). Among these, 11 patients were evaluated with more than 10 years of follow-up (Table 1).

**Table 1** – Length of postoperative evolution among the patients operated to treat fractures of the distal extremity of the radius by means of percutaneous fixation.

Length of evolution	
18 months	6 patients
4 to 6 years	10 patients
7 to 10 years	7 patients
More than 10 years	11 patients

The patients' mean age at the time of the examination was 65 years (range: 28 to 88 years), and 25 of them were more than 60 years of age.

In eighteen patients the fracture was in the dominant side.

All the patients were assessed by one of the authors (HF), who did not participate in the treatment. All the patients were operated by the same surgeon (AGPJ).

The assessment methods used were the range of motion (ROM), grip strength, radiographic study, pain evaluation and functional analysis (DASH).

The ROM was measured using a goniometer, and measurements were obtained for flexion, extension,

pronation, supination, radial deviation and ulnar deviation.

Grip strength was measured in both hands, using a Jamar dynamometer, and the mean was taken from three consecutive measurements.

The pain evaluation was done by means of a visual analogue scale.

The functional evaluation was done by means of the DASH test ("Disabilities of the Arm, Shoulder and Hand").

The radiographic study was done on radiographs that were obtained before the reduction, just after the fixation, during the treatment and at the time of revision, in the posteroanterior and lateral views. The time taken to achieve consolidation and the angles of radial and volar tilt were assessed.

The fractures were classified using the universal and AO systems (Table 2).

**Table 2** – Universal and AO classifications for the fractures.

Universal classification		AO classification	
Type	Number	Type	Number
IV A	1	A 2	5
II B	11	A 3	5
IV B	15	B 1	3
IV C	5	C 1	4
		C 2	6
		C 3	9

Two cases did not have an initial X-ray

## SURGICAL TECHNIQUE

All the patients were operated under anesthetic blockage of the brachial plexus. Fracture reduction was achieved in all cases by means of traction and counter-traction performed by two auxiliaries. After manipulation of the fracture by the surgeon, the reduction was checked using an image intensifier. For fracture fixation, 1.5 mm Kirschner wires were used.

The preferred position layout for the wires consisted of two wires introduced through the styloid process of the radius, crossing the fracture focus proximally, and another dorsal wire, through the ulnar notch of the radius. Other configurations were used mainly in cases of more severe comminution that would require use of more wires. We used two pins in five cases, three pins in 23 cases and four pins in six cases (Figures 1A, 1B, 1C, 2A, 2B and 2C). The wires were bent over and cut close to the skin, a dressing was applied over the wires and a

short splint was installed to assist in immobilizing the wrist. A clinical control was done on the first postoperative day to check on the sensitivity and perfusion. One week after the operation, new radiographs in the posteroanterior (PA) and lateral views were obtained and the dressing was changed. This procedure was repeated two weeks after the operation, when the patient was then instructed to start hand therapy. The splint was kept in place until around six weeks after the operation, but the pins were removed after around four weeks. At this point, the hand therapy was intensified. The length of time with the pins and splint varied mainly according to the patient's age, type of fracture, image on control radiographs and bone quality.

## STATISTICAL ANALYSIS

The statistical analysis on the study data was performed by a biostatistician at the Federal University of Minas Gerais. The t test was applied to analyze statistical differences in ROM. For the DASH and grip strength variables, the Anderson Darling test was used; and for the analysis on the types of fracture according to the AO classification, the Kruskal-Wallis test was applied. The p value was set at  $p < 0.05$ .

## RESULTS

With regard to the ROM results, we divided the patients into two groups: less than 60 years and greater than 60 years, and this can be seen on Table 3.



**Figure 1** – Patient aged 54 years. (A) – X-ray showing unstable reducible extra-articular fracture. (B) – After reduction and fixation with three Kirschner wires. (C) – 4.6 years later, showing consolidated fracture with good reconstitution of the angles of the distal extremity of the radius. Asymptomatic patient.



**Figure 2** – Patient aged 79 years. (A) – X-ray showing unstable reducible Intra-articular fracture. (B) – X-ray after reduction and fixation with four Kirschner wires. (C) – 10 years later, showing consolidated fracture with satisfactory distal angles of the radius. Asymptomatic patient.

**Table 3** – Comparison between the patients' ROM and age.

	< 60 years				> 60 years				95% CI P-value		
	N	Mean (degrees)	SD	Median (degrees)	N	Mean (degrees)	SD	Median (degrees)	Lower	Upper	
Flexion	9	71.11	10.86	69.00	25	59.20	12.83	61.00	2.122	21.700	0.019
Extension	9	75.44	5.81	74.00	25	70.72	9.83	72.00	-2.401	11.850	0.186
RD	9	20.00	3.12	20.00	25	18.20	4.08	18.00	-1.260	4.860	0.240
UD	9	36.11	5.97	38.00	25	32.00	5.28	32.00	-0.210	8.432	0.061
Pronation	9	81.44	9.00	85.00	25	84.22	4.61	85.00	-7.840	1.689	0.198
Supination	9	81.56	16.03	87.00	25	81.28	10.99	85.00	-2.990	6.000	0.280

SD: standard deviation; RD: radial deviation; UD: ulnar deviation; CI: confidence interval

Among the variables analyzed, we only found a statistically significant difference for flexion, such that patients aged less than 60 years presented mean flexion of 71.11°, versus 59.20° among patients over 60 years.

Twenty-six of the 34 patients (76.5%) did not present any pain at the time of the examination, while seven patients had low-intensity pain associated with activities in which force was applied and one patient presented moderate-intensity pain, even when resting.

The fractured wrists were evaluated using radiographs with two views (PA and lateral). We observed bone consolidation after a period ranging from 27 to 67 days, with a mean of 41 days. The angles of volar tilt (lateral radiograph) and radial tilt (PA radiograph) were measured. The results found were compared with the immediate postoperative radiographs, and these data are shown in Tables 4 and 5. No statistically significant differences were found in relation to these data.

The grip strength was analyzed and we divided the patients into two groups: those who had fractured the dominant side and those who had fractured the non-dominant side. The mean strength in the group that had fractured the dominant side was 24.74 kgf, with standard deviation of 9.53, while the strength in the group that had fractured the non-dominant side was 22.62 kgf, with standard deviation of 9.24. The

statistical analysis did not demonstrate any significant difference between the groups.

Regarding the functional evaluation using DASH, we observed that the mean was 2.18, with a standard deviation of 4.78. This value was lower than the mean reported in a study on healthy volunteers (10.1 with standard deviation of 14.7).

The DASH values were analysed in two different categories: comparison of DASH values between individuals older and younger than 60 years; and DASH compared with the type of fracture using the Universal classification.

The analysis on the DASH values comparing between the age groups did not show any statistical significance. The patients younger than 60 years presented a mean of 2.04 with standard deviation of 5.51, while the group older than 60 years had a mean of 2.23 with standard deviation of 4.62.

The DASH values were analysed in compared with the type of fracture using the Universal classification (types II and IV) showed values of 4.85 with standard deviation of 7.02 for the extra-articular fractures (type II) and 0.99 with standard deviation of 2.69 for the intra-articular fractures (types IV and V). Despite the difference of almost four points on the scale, this difference did not show statistical significance (Table 6).

The complications observed among the patients in

**Table 4** – Comparison between the angles of radial tilt immediately after the operation and at the final evaluation.

	Immediately after operation				Final evaluation				95% CI P-value		
	N	Mean (degrees)	SD	Median (degrees)	N	Mean (degrees)	SD	Median (degrees)	Lower	Upper	
Radial tilt	33	22.00	4.76	22.00	34	22.74	3.96	23.50	-1.397	2.867	0.493

**Table 5** - Comparison between the angles of volar tilt immediately after the operation and at the final evaluation.

	Immediately after operation				Final evaluation				95% CI P-value		
	N	Mean (degrees)	SD	Median (degrees)	N	Mean (degrees)	SD	Median (degrees)	Lower	Upper	
Volar tilt	33	-2.03	10.44	0.00	34	-3.82	11.70	2.50	-3.625	7.212	0.511

**Table 6** – Comparison of DASH values between types II and IV B and C of the universal classification.

	Type II				Type IV B and C				95% CI P-value		
	N	Mean	SD	Median	N	Mean	SD	Median	Lower	Upper	
DASH	11	4.85	7.02	0.83	20.00	0.99	2.69	0.00	0.000	5.829	0.123

the study included one case of loss of reduction, which was reoperated after two weeks of evolution such that the fracture was fixed again using percutaneous wires; and one patient who developed sympathetic reflex dystrophy associated with changes to the distal ulna, which was resolved after controlling the dystrophy and performing the Bowers procedure (hemi-resection arthroplasty of the distal ulna).

## DISCUSSION

Our study demonstrated that percutaneous fixation with Kirschner wires in fracture of the distal extremity of the radius produces excellent functional and radiological results after a long follow-up period. The data analyzed showed that only flexion had a statistically valid difference in comparisons of the results between the groups, but this difference was very small in clinical practice.

All the ROM data showed amplitudes within the functional patterns, for flexion, extension and radial and ulnar deviations<sup>(14)</sup>. Oshige et al<sup>(15)</sup> and Huard et al<sup>(16)</sup> advocated using plates because of the great advantage in using this method so the patient could start physical therapy earlier. Several studies have already proven that late evaluations on patients do not show ROM differences between patients operated using plates and percutaneous pinning<sup>(17,18)</sup>. In addition, another study showed that, among patients who were operated using a plate, when they were divided into two groups with rehabilitation starting after two or six weeks of immobilization, they did not present any difference in any of the parameters evaluated, in assessments three and six months after the operation<sup>(19)</sup>.

Our patients presented low levels of pain, and most of them did not present any pain in the final evaluation. Osteosynthesis with plates is more associated with late postoperative pain than percutaneous wires<sup>(17)</sup>.

The values from the DASH test among our patients were lower than those shown in other studies<sup>(20)</sup>. We believe that these values were directly connected with the pain levels and profile of our patients<sup>(21)</sup>.

In analyzing the radiographic data on our patients immediately after the operation and at the end of the follow-up, we saw that there was no statistically valid variation in the parameters analyzed, thus showing

that, on average, the initial reduction was sustained. The critics of percutaneous fixation using Kirschner wires, say that the great problem would be precisely the lack of stability of the method, which would lead to loss of the reduction in the initial phases of consolidation<sup>(22)</sup>. Our study did not demonstrate such complication and we attribute this to the type of assembly that we used in most of our cases. Several patterns for placement of Kirschner wires have been described in the literature, with differences in how they are applied and the number used<sup>(23)</sup>. In our study, 67.6% of the cases were treated using three crossed bicortical Kirschner wires: two through the radial styloid process and one introduced dorsally through the ulnar edge of the radius. This configuration proved to be more rigid when pins of diameter 1.5 to 2.0 mm were used<sup>(24)</sup>. Another study demonstrated that, although the configuration that we used was biomechanically more stable, the clinical and radiological results from simple crossed wires (in the radial styloid plus one in the ulnar border of the radius) are similar, which also confirms our results, given that this configuration was used in 14.7% of the cases<sup>(25)</sup>.

Another biomechanical study demonstrated that the difference in deviation of the fracture, comparing percutaneous pinning with volar plates, was only 1.5 mm<sup>(26)</sup>. Thus, even if there is a slight loss of reduction, thus leading to a reduction that is not exactly anatomical, this reduction will not have a direct implication regarding good results from long-term follow-up, or a high DASH value<sup>(27,28)</sup>.

We believe that the complication rate among our patients, is in accordance with other authors<sup>(29)</sup>. We had three cases of superficial infection of the Kirschner wires that were resolved through changing the dressings and administering oral antibiotics, one case of sympathetic reflex dystrophy and one case of loss of reduction with the need for a new procedure. We did not have any case of lesions of sensory branches of the radial nerve, as also shown by other studies, and by anatomical studies that demonstrated that occurrences of such lesions caused by Kirschner wires would be unusual<sup>(30)</sup>. Likewise, we did not have any case of tendon rupture, either of flexor or

of extensor type. These tears, which generally are not associated with percutaneous pinning, occur more frequently when volar or dorsal plates are used. They are related to the mechanical friction produced by plates and screws, which leads to tenosynovitis that, if undiagnosed, culminates in tendon ruptures<sup>(31-36)</sup>.

A study conducted by Koval et al<sup>(37)</sup>, in which the tendency for new surgeons to treat fractures of the distal radius with plates was analyzed, showed that the use of this technique increased from 42% to 81% between 1999 and 2007, but without any evidence of improvements in the results. One of the important factors when analyzing a surgical indication is its cost, especially in a country in which access to

the latest materials is extremely expensive. Thus, use of Kirschner wires becomes an attractive technique because it is inexpensive, considering that each wire costs 8 to 10 reais ( 5 or 6 dollars) on average. On the other hand, locked plates with screws cost from 1800 to 5000 reais (1000 to 3000 dollars) or more.

## CONCLUSION

We conclude that using percutaneous fixation with Kirschner wires for fractures of the distal radius results in excellent ROM over the long term, with little or no pain, acceptable radiographic parameters and a low complication rate, in addition to being an inexpensive and efficient method.

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