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Original article

Distal radius articular fractures: a comparison between ORIF with angular stability plate and percutaneous Kirschner wires

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Abstract. *Purpose of the study:* To analize and compare vantages and disadvantages in long-term of two different techniques to treat distal radius articular fractures: ORIF with plate versus percutaneous pinning with K-wires. *Materials and Methods:* We reviewed 77 distal radial articular fractures treated surgically from 2005 to 2009. Fractures were divided in two homogeneous groups according to patient age, gender, fracture-type and follow-up. The first group was treated with ORIF using angular stability volar plate, while the second one with closed reduction, K-wires percutaneous pinning and ante-brachial plaster casting. Functional outcomes were assessed with MAYO and DASH score, wrist range-of-movement and handgrip. Radiographic parameters were calculated in the post-operative and long-term x-rays. *Results:* ORIF group showed better mean DASH and MAYO score, range of movement and handgrip strength compare to K-wires group. Expecially in type C fractures and in younger patients (<65 years). Minor differences were observed in type B fractures. About complications: two cases of surgically-treated medial nerve compression in ORIF group and one in K-wire group, one case of algodystrophy in K-wire group. Referring to radiographic parameters, long term values show data positive for ORIF. *Conclusions:* Though several studies about these techniques has been performed, but no scientific evidence proves the superiority of one surgical treatment. C-type need to be treated with plate in young patients or in elderly patients with high functional demand. Elderly patients with low functional demand can achieve satisfactory results also with percutaneous pinning, especially in B-type fractures. (www.actabiomedica.it)

Key words: wrist, plate, percutaneous, pinning

Introduction

Distal radius articular fractures are consistently on the increase due to the rise in average life expectancy (1). In recent years, the treatment of displaced articular fractures has been characterized by a progressive increase in surgical versus non-operative treatment, due to increased functional demands by patients, who tend to be elderly, and reduced time to functional rehabilitation (2). In particular, the high frequency of open surgical treatment was due to the introduction of angular stability plates.

These devices bring some advantages: a steady fixation also in patients with poor bone structure, which reduces the problem of screws loosening significantly (3), faster rehabilitation and functional recovery time.

The aim of our study is to compare the treatment of articular wrist fractures with two totally different methods: the K-wire percutaneous pinning and a cast, versus open reduction and internal fixation with angular stability volar plate. This comparison was performed according to clinical and radiographic criteria in order to assess costs and benefits of both methods

and the possible superior quality of one technique compared to the other.

Materials and methods

Our sample series consisted of 77 wrist fractures treated surgically at the Department of Orthopaedic Surgery of Modena in the period from March 2005 to June 2009. The fracture classification was made according to that of the AO Foundation (4), which, in our opinion, is the most complete and exhaustive. The criteria of inclusion used in this study were radio-articular fractures of type B and type C1 - C2.

This study also includes fractures previously treated with closed reduction in the emergency room with unsatisfactory outcome, in particular those that belong to group B (AO classification).

Type A extra-articular fractures were excluded because they do not affect our study, while high-complexity fractures (C3) were excluded because none of them were treated at our center with the K-wire method (Table 1). Moreover, fractures with associated lesions of the ipsilateral upper extremity were excluded too. Radiographically, the inclusion criteria were two: a displacement above 15° on the lateral plane and radial shortening greater than 5 mm in the frontal plane (5).

After the application of the afore-mentioned criteria, patients were split into two case series homogeneous for number of treated fractures, age and gender. Instead, non-homogeneous data were follow-up time and the AO-type of fracture distribution.

Table 1.

Inclusion criteria
- Articular fractures: B e C1-C2 type
- Age>18 years
- Isolated lesions
- Rx: >15°displacement on lateral plane
- Rx: >5mm radial shortening on frontal plane

Exclusion criteria
- Politrauma
- A and C3 type fractures
- Exposed fractures and neuro-vascular lesions
- Ipsilateral upper extremity associated lesions

The indication for treatment with K wires was mainly dictated by the age and the general clinical condition of the patients. There was no randomization.

To the first group a treatment protocol was applied (Table 2), that involved internal fixation using an angular stability volar plate (Aptus Mikai®), according to Henry's volar approach (6). This plate is characterized by extreme flexibility, various sizes of presentation and the presence of screws with angular stability, with a multi-directional range of 30° for the epiphyseal screws. The functional rehabilitation began 15 days after surgery and removal of the volar wrist support was performed after 15-20 days.

A treatment protocol was applied also to the second group (Table 3). This protocol envisaged the closed reduction and stabilization of the fracture using fluoroscopy with 2 or 3 K-wires, introduced by the radial styloid and if necessary one K-wire for the stabilization of the ulnar styloid and/or the distal radio-ulnar joint. Subsequently, a brachiometacarpal plaster cast placement was performed. Wires and cast were removed after 30 days and rehabilitation could start.

There were three different surgeons.

All patients were assessed through an evaluation summary scheme developed in our center (Figure 1). Each patient was crosschecked to a clinical control, paying attention in particular to the joint function and grip strength (by analogue hydraulic dynamometer - Jamar®) compared to the contralateral wrist, by calculation of the Mayo score. The degree of personal sat-

Table 2 - Treatment protocol – plate group
- Volar Henry's approach
- Reduction and internal fixation with angular stability plate
- Immobilization with volar wrist support for 15 days
- Functional rehabilitation 15 days after surgery

Table 3 - Treatment protocol – K-wire group
- Closed reduction and percutaneous K-wire fixation
- 2-3 K-wires introduced from radial styloid
- eventually 1 K-wire for distal stabilization of radio-ulnar joint
- Brachio-metacarpal plaster cast
- Wires and cast removal after 30 days and then functional rehabilitation

ARTICULAR FRACTURES DISTAL RADIUS				
PATIENT	Age	Sex	Date birth	
Traumatic mechanism				
AO-classification				
Time (days) fractures-treatment				
Range of movement		Fractured-side	Unfractured-side	
	Flexion			
	Estension			
	Ulnar deviation			
	Radial deviation			
	Pronation			
	Supination			
Grip strenght (dynamometer)		Fractured-side	Unfractured-side	
	Dominant side			
Scores	Dash	Mayo wrist		
Complication				
Time plate removal				
Pronator quadratus reconstruction				
Functional rehabilitation				
Return to job				
Personal satisfaction degree				
Ulnar distal fracture				
RADIOGRAFIC VALUTATION				
Time consolidation fracture (days)				
Lateral plane		pre-op	post-op	follow up
	Dorsal tilt			
	Dorsal shift			
Frontal plane		pre-op	post-op	follow up
	Radial height			
	Radial angle			
	Radial shift			

Figure 1.

isfaction was asked for and the Dash score questionnaire was assembled.

The radiographic study included the preoperative assessment of the degree of displacement on the frontal and lateral plane and the evaluation of postoperative recovery of the lateral radial tilt and radial height in the frontal plane (Figure 2-3). We checked the preservation of these parameters at follow-up by

Figure 2.

Figure 3.

studying the x-ray performed after one, three and twelve months.

Data were statistically analyzed using SPSS® italian version 18.0 (SPSS Inc., USA) supported by Excel sheet (Microsoft Inc., USA): *t* Student test with 95% IC was used to compare the groups of patients and statistical significance was set at $p < 0.05$.

Results

In group 1 (ORIF technique) were included 38 patients (30 F – 8 M) for a total of 39 surgical treatments, including one case of bilateral fracture. The average age was 62.1 years (min 28 – max 81) with a mean follow-up of 24 months (min 8.4 – max 63.3). 17 cases were located on the right side, while 22 were on the left side. 38 patients (31 F – 7 M) were recorded in group 2 (pinning technique) for a total of 38 operations, a mean age of 61.2 (min 32 – max 83) and a mean follow-up of 38 months (min 8.9 – max 74.4). There were 16 cases on the right side and 22 cases on the left side.

For group 1, according to the AO classification, these cases consisted of: 1 - B1, 10 - B2, 8 - B3, 5 - C1 and 15 - C2 fractures; in group 2: 3 - B3, 11 - B2, 4 - B3, 10 - C1 and 10 - C2 fractures.

Table 4.

Range of Movement	Flexion	Estension	Ulnar deviation	Radial deviation	Pronation	Supination
Plate group	63	70	42	20	84	87
K-wire group	70	71	41	25	85	87

The evaluation of the range of motion showed satisfactory values with no significant difference between the two groups, but only a minimal benefit for group 1, as shown in Table 4. The mean value of Dash score was 9.0 ± 8.5 (range 25 - 0) for group 1 and 13.0 ± 17.1 (range 75.9 - 0) for group 2. The same evaluation for the type of fracture shows an average of 12.8 ± 8.1 (group 1) and 10.4 ± 9.0 (group 2) for type B fractures, and 5.5 ± 7.3 (group 1) and 15.4 ± 22.0 (group 2) for type C fractures (Table 5).

Based on Mayo score (Table 5) we had an average of 80.0 ± 8.8 points (min 60 – max 100) for group 1 and 77.4 ± 10.0 (min 55 - max 95) for group 2. Mean values for type B fractures were 75.8 ± 9.3 and 78.9 ± 10.2 (group 1 and group 2 respectively); for the type C fractures average values were 83.3 ± 6.5 (group 1) and 76.0 ± 9.9 (group 2).

The evaluation of the recovered grip strength by the operated side compared to the contralateral one showed a percentage of 83.1% for group 1 and 86.6% for group 2. Breaking down the data by type of fracture we get 76.6% (group 1) and 88.8% (group 2) for type B fractures, and 88.4% (group 1) and 84.7% (group 2) for type C fractures.

The degree of personal satisfaction showed a complete satisfaction for type C fractures treated with a plate, while the 13.2% of the patients (n=5) with type C fractures treated with wires were forced to change their jobs.

Table 5.

	Total mean values	Group B mean values	Group C mean values
DASH score			
Plate group	8.5	12	5.5
K-wire group	13	10	15.4
MAYO score			
Plate group	80	75.8	83.3
K-wire group	77	78.9	76

For the radiographic study we assessed fractures according to type. Postoperatively, the evaluation of dorsal tilt in degrees in group B showed an average value of 8.2 for plates, which declined to an average value of 5.2, one year later (7, 8). With regard to fractures treated with wires, average values for radial tilt postoperatively and after one year were 7.6 mm and 3.7 mm respectively. The evaluation of the radial height on the frontal plane showed similar average values between the two groups, postoperatively (11.5 mm for group 1 versus 11.3 mm for group 2) and after a one-year follow-up (10.3 for both groups). With regard to type C fractures, we noted dorsal tilt mean values postoperatively of 9.1 mm for group 1 and 4.8 mm for group 2. After one year, the values were 6.8° for the plates group and 1.9° for the wires group. The postoperative radial height values were 13.4 mm for group 1 and 12.4 mm for group 2. After a one-year follow-up these values declined to 12.0 mm for the plates group and 9.6 mm for the wires group.

Considering the two groups together we recorded no statistically significant differences between the averages of the Dash score ($p = 0.20$) and the Mayo score ($p = 0.30$); furthermore there was no significant difference with regard to range of motion ($p = 0.50$) and strength ($p = 0.44$).

Specific results have been noted from sub-group assessment. There is a statistically significant difference in the C-type fractures in favor of those treated with plates with regard to the Mayo score ($p = 0.01$), while for the Dash score $p = 0.07$. In contrast, there is no significance for fractures of the B sub-group ($p > 0.05$).

In the evaluation of radiological data, we recorded statistically significant values for the consistency of the reduction in time in favor of C-type fractures treated with plates for both the radial height ($p = 0.49$) and the radial tilt ($p = 0.03$) values. For these parameters, there were no statistical significant differences in subgroup B ($p > 0.05$).

With regard to complications, in group 1 we recorded: two cases of post-operative carpal tunnel syndrome and one post-operative hematoma both treated surgically, with no infection, no neurovascular injuries or screw mobilizations. We also performed plate removal in 3 cases (7.7%) due to intolerance. In group 2 we recorded: one cases of carpal tunnel syndrome resolved with medical treatment, one case of skin pressure sores of the wires, one case of algodystrophy, with no peripheral neurovascular deficits and no infection. Neither our center nor any other one has performed corrective osteotomy in any of these cases.

Discussion

Fractures of the distal radius are continuously increasing (9), due to the rise in life expectancy and the practice of high-risk sporting activities. The types of treatment are multiple and to date, there is no clear bibliographic confirmation of the superior quality of one treatment over another (10-13). In the last few years, the use of angular stability plates applied by means of volar access has been introduced: this approach made the significant reduction of the dorsal tendon problems possible, while angular stability solved the problem of migration of screws in osteoporotic bone (14).

The purpose of our study was to compare two different treatment methods: the more modern angular stability plates by volar approach, versus the traditional method of manual reduction and fixation with percutaneous K-wires.

Our attention is focused on B-type, C1 and C2 fractures according to AO classification, excluding type A and the more complex C3-type fractures for which we consider there is no evidence for treatment with wires. In the literature, we noted that the majority of comparative studies between these two methods involved only extra-articular fractures. Moreover, there are only two studies (2, 15) performed according to criteria similar to ours. Nevertheless, there are many studies that compare other techniques such as the dorsal versus volar plate (16), pinning versus external fixation (17), external fixation versus plates (18).

There are also several prospective and retrospective studies that take into consideration only one method (19-24).

The analysis of the data obtained showed essentially similar values in motion recovery. The mean Mayo and Dash scores are favorable for the plate group, although the difference is lower in type B fractures; while in type C fractures the difference is considerably higher. We reached similar conclusions as far as the degree of personal satisfaction is concerned.

Radiographic evaluation showed that postoperative values obtained and preservation of the reduction at follow-up is very similar between the two groups in type B fractures. In contrast for C-type fractures, the postoperative values and their preservation have been largely favorable to the fractures treated with plates, thus emphasizing a strong correlation between radiographic and clinical data.

The data collected in our study are essentially overlapping with those of the small literature that compares these two techniques (2;15): the volar angular stability plate allows better results in the C-type articular fractures, while there are no significant differences in the group of B-type fractures compared to those treated with K wires.

Conclusion

These results suggest that treatment of articular fractures of the distal radius with plates leads to better overall clinical and radiographic results in the long run, compared to percutaneous wire treatment. There was no advantage to plate fixation in the B-group fractures, but a statistical benefit was demonstrated in C-group fractures. The pinning technique also seems to give good results in less complex articular fractures. Therefore, this technique can be taken into account especially in cases where the functional requirements are not high and recovery time is not the first priority. This conclusion is also supported by statistical analysis of the data obtained. In addition, the significant difference in terms of costs between the two surgical treatments must also be considered.

Taking into consideration the clinical results obtained, the authors recommend deliberating carefully

on the use of plates as the surgical treatment choice for these fractures, which appear to be consistently increasing in the last few years.

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