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# The Necessity of Restoration of Radiologic Parameters by Closed Reduction in Elderly Patients with Distal Radius Fractures

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**Background:** The aim of this study was to evaluate the influence of distal radius fractures (DRFs) malalignment on the treatment outcomes in patients over age 65 years.





**Material/Methods:** We retrospectively reviewed the records on fresh DRFs treated with closed reduction from December 2014 to January 2018. After treatment, patients were evaluated for the determination of grip strength, the Visual Analog Scale (VAS) during wrist movement, the Patient-Rated Wrist Evaluation (PRWE), the Disabilities of the Arm, Shoulder and Hand (DASH) score, the appearance satisfaction, and active wrist range of motion (ROM).

**Results:** A total of 96 patients with complete data were included in our study. During follow-up, there were 75 patients (78.1%) with acceptable reduction and 21 patients (21.9%) with unacceptable reduction. Compared with those having acceptable alignment in the distal radius, patients with unacceptable alignment had weak grip strength, were unsatisfied appearance, and had severe flexion as well as ulnar deviation limitation at 6-month follow-up. A significant correlation was found between ulnar positive variance and grip strength ( $r=-0.35$ ,  $P=0.03$ ), as well as dorsal angulation and flexion movement ( $r=-0.31$ ,  $P=0.02$ ).

**Conclusions:** Conservative treatment should be used differently, even in elderly patients. For low-demand patients, it is not necessary to restore all anatomic radiographic parameters, as malalignment does not increase disability or pain score. However, for patients who are still healthy and active, satisfactory reduction is the first choice, as malalignment can lead to decreased grip strength, dissatisfaction with appearance, and certain wrist limitations.

**MeSH Keywords:** **Bone Malalignment • Manipulation, Orthopedic • Radius Fractures**

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## Background

Distal radius fractures (DRFs) are one of the most common wrist injuries, and their incidence has been reported to be increasing worldwide, especially in older patients [1]. Even though DRFs account for almost one-sixth of all fractures treated in emergency rooms, without proper treatment, they may lead to permanent impairment of the wrist and hand. The treatment methods of DRFs in clinical practice are diverse [2–4], but in patients with simple fractures, the most common method is manipulation, which includes closed reduction and plaster immobilization [5–7].

During the procedure of closed reduction, surgeons usually strive for an anatomic reduction, but obtaining an acceptable reduction can be very hard or even impossible in some cases. In addition, the outcome of reduction may be difficult to maintain by plaster immobilization [8]. Nevertheless, a clear consensus regarding a standard for closed reduction of DRFs does not exist [4]. It is generally recognized by us that the analysis of a single radiologic variable in isolation was not as clinically useful as a cluster of X-ray findings when dealing with a three-dimensional structure. Although the American Society for Surgery of the Hand (ASSH) set forth criteria to define the overall acceptable alignment of the distal radius, this criterion is not applicable to all people. In older patients, the restoration of this alignment was considered to be less necessary since the demands on the wrist are decreased in this population. For example, Gutierrez-Monclus et al. [9] investigated the relationship between radiographic parameters and functional outcomes in 180 patients older than 60 years and concluded that there was no significant correlation between acceptable alignment and short- or medium-term functional outcomes for extra-articular DRFs treated conservatively. Beumer et al. [10] observed 60 fractures healing in a malunited position, and concluded that reduction of DRFs is of minimal value in older and frail patients. However, it is noteworthy that those studies only investigated very elderly or low-demand patients. Making clinical decisions becomes difficult when one is confronted with an older patient who is still healthy and active but presents with some degree of residual deformity in the distal radius. The current literature offers little information for us in this situation.

The above observations inspired us to determine whether primary reduction of these fractures is worthwhile for older patients in contemporary society. The aim of this paper is to evaluate the influence of malalignment on the treatment outcomes in patients over age 65 years. Defining such a relationship is useful to verify if it is really necessary to achieve anatomic radiographic parameters in the primary reduction, and to clarify the meaning of repeat reduction in patients with loss of reduction during follow-up. The null hypothesis is that moderate

variation of radiographic parameters can still be associated with good treatment results for older patients.

## Material and Methods

### Study group

We retrospectively reviewed the records on fresh DRFs treated with closed reduction and immobilization that were performed from December 2014 to January 2018 in our hospital. The inclusion criteria were patients over age 65 years who presented with AO/ASIF type A2 or A3 fractures. We excluded patients with open fractures, bilateral wrist fractures, concurrent major traumas, or declining cognitive function. Patients were not excluded on the basis of bone quality. This study was approved by the Ethics Committee of the Third Hospital of Hebei Medical University.

### Treatment and follow-up

At the initial visit, all patients' demographic data were obtained, such as age, gender, and dominant extremity. X-ray imaging and clinical assessment were also performed before treatment. Fractures were categorized according to the AO/ASIF classification on the basis of radiographs taken in standard views [11]. Closed reduction was performed except for those who had little displacement of fractures or who expressed unwillingness. A short arm plaster or brace immobilization was used after reduction for 4 to 8 weeks according to the fracture healing. Routine follow-ups were performed postoperatively at 2, 4, and 6 weeks, and 3 and 6 months. At each visit, patients were asked to have X-ray imaging. At the 6-month follow-up, additional clinical assessment was also performed.

### Radiographic evaluation

According to the X-ray exams, we performed measurements for radial inclination, dorsal angulation, and ulnar variance. Based on measurements of X-ray images at the 6-month follow-up, an additional binary radiographic variable was applied to define the overall alignment using guidelines set forth by the ASSH. The overall alignment of the DRF was considered to be "unacceptable" if the radial inclination was  $<15^\circ$ , if the dorsal angulation was  $>10^\circ$ , or if there was  $>3$  mm of ulnar positive variance. Otherwise, the alignment of the DRF was designated as "acceptable".

### Clinical assessment

Patients were evaluated by the same observer for the determination of grip strength, the Visual Analog Scale (VAS) during wrist movement, the Patient-Rated Wrist Evaluation (PRWE) [12],

the Disabilities of the Arm, Shoulder and Hand (DASH) score [13], patient satisfaction with appearance, and active wrist range of motion (ROM). Grip strength of the injured wrist was measured with a dynamometer, and its value was compared with the contralateral extremity. The VAS score is a numerical rating scale, with 0 being no pain and 10 being the worst pain imaginable. Patients were asked to grade the appearance of the wrist as satisfactory or unsatisfactory. Active wrist ROM included the following movements: flexion, extension, radial deviation, ulnar deviation, pronation, and supination.

### Statistical analysis

Descriptive analysis of the patient population was performed using means and standard deviations for continuous variables and frequencies as well as percentages for categorical variables. The independent-samples *t* test or Mann-Whitney *U* test were used for continuous data, and the chi-square test was used to identify differences in frequency of categorical variables between groups. To identify the correlation between the radiographic parameters and treatment outcomes, Pearson correlation analysis was used. Probability value less than 0.05 was considered to be statistically significant. All statistical analysis was performed with the Statistical Package for Social Sciences software (version 17.0; SPSS, Inc., Chicago, IL, USA).

## Results

A total of 96 patients with complete data were included in our study. The mean age of these patients was  $70.5 \pm 6.2$  years. Among these patients, 9 were male and 87 were female. Forty-five fractures occurred in the dominant extremity, and the other 51 were in the non-dominant extremity. Sixty-one fractures were classified as A2 type fracture and 35 were A3 type fracture. Twenty-nine patients had associated ulnar styloid process fracture, and the other 67 patients did not. During follow-up, there were 75 patients with acceptable reduction and 21 patients with unacceptable reduction. Of the 21 patients, 3 rejected reduction, 7 had a poor reduction, and 11 suffered reduction loss (Table 1). The baseline comparison in the 2 groups showed no significant difference (Table 2).

The comparison of functional outcomes is presented in Table 3. Of the 75 patients in the acceptable reduction group, 65 patients (86.7%) were satisfied with the appearance, while 4 of the 21 patients (19.0%) in the unacceptable reduction group are satisfied with the appearance, and the difference between the 2 groups was statistically significant ( $P < 0.001$ ). In the acceptable reduction patients, the grip strength was significantly better than that in the unacceptable reduction patients ( $81.4 \pm 6.4$  vs.  $73.5 \pm 5.5$ ,  $P < 0.001$ ). However, there was

**Table 1.** Demographic data of older patients with distal radius fractures.

Variables	Values
Number of patients	96
Age (year)	$70.5 \pm 6.2$
Gender	
Male	9 (9.4%)
Female	87 (90.6%)
Dominant extremity	
Yes	45 (46.9%)
No	51 (53.1%)
Types of fracture	
A2	61 (63.5%)
A3	35 (36.5%)
Associated ulnar styloid process fracture	
Yes	29 (30.2%)
No	67 (69.8%)
Number of patients with unacceptable reduction	21
Rejected reduction	3 (14.3%)
Poor reduction	7 (33.3%)
Reduction loss	11 (52.4%)

no significant difference in VAS score, PRWE score, or DASH score between the 2 groups ( $P > 0.05$ ).

To investigate the effect of the distal radius alignment on the wrist ROM, comparisons were performed in 6 movements. The flexion movement in the acceptable reduction group was better than that in the unacceptable reduction group ( $70.6 \pm 11.2$  vs.  $61.6 \pm 8.4$ ,  $P < 0.001$ ). In addition, the ulnar deviation in the acceptable reduction group was better than that in the unacceptable reduction group ( $27.2 \pm 7.4$  vs.  $19.7 \pm 4.5$ ,  $P < 0.001$ ). Other movements showed no significant difference in ROM between the 2 groups ( $P > 0.05$ ). The comparison of active wrist ROM between the 2 groups is shown in Table 4.

As grip strength, flexion movement, and ulnar deviation were 3 continuous parameters that showed difference between groups, we further analyzed the association between these outcomes and radiographic parameters. A significant correlation was found between ulnar positive variance and grip strength ( $r = -0.35$ ,  $P = 0.03$ ). A significant correlation was also shown between dorsal angulation and flexion movement

**Table 2.** Comparison of basic data in patients with distal radius fractures.

	Acceptable reduction	Unacceptable reduction	P value
No. of patients	75	21	
Age (years)	70.1±6.4	71.8±5.1	0.27
Gender			
Male	6	3	0.38
Female	69	18	
Dominant extremity fracture			
Yes	33	12	0.33
No	42	9	
AO classification			
Type A2	48	13	0.86
Type A3	27	8	
Associated ulnar styloid process fracture			
Yes	23	6	0.85
No	52	15	
Osteoporosis			
Yes	61	17	0.97
No	14	4	
VAS score	3.8±1.3	4.3±1.5	0.14
PRWE score	56.7±8.3	59.1±7.4	0.23
DASH score	68.2±9.5	71.6±11.2	0.17
Casting time			
≤6 weeks	55	16	0.79
>6 weeks	20	5	

VAS – Visual Analog Scale; PRWE – Patient-Rated Wrist Evaluation; DASH – Disabilities of the Arm, Shoulder, and Hand.

**Table 3.** Comparison of grip strength, pain, and disability in patients with distal radius fractures at 6-month follow-up.

	Acceptable reduction	Unacceptable reduction	P value
No. of patients	75	21	
Grip strength*	81.4±6.4	73.5±5.5	<0.001
VAS score	0.7±0.2	0.8±0.3	0.08
PRWE score	20.1±4.3	19.8±5.2	0.79
DASH score	24.7±6.6	26.5±5.9	0.26
Appearance			
Satisfied	65	4	<0.001
Dissatisfied	10	17	

\* % of the contralateral extremity; VAS – Visual Analog Scale; PRWE – Patient-Rated Wrist Evaluation; DASH – Disabilities of the Arm, Shoulder, and Hand.

**Table 4.** Comparison of active wrist ROM in patients with distal radius fractures at 6-month follow-up.

	Acceptable reduction	Unacceptable reduction	P value
No. of patients	75	21	
Flexion	70.6±11.2	61.6±8.4	<0.001
Extension	65.7±10.5	66.3±13.2	0.83
Radial deviation	23.6±6.7	22.1±5.5	0.35
Ulnar deviation	27.2±7.4	19.7±4.5	<0.001
Pronation	81.4±14.9	77.6±14.2	0.30
Supination	83.4±15.2	79.8±17.4	0.36

ROM – range of motion.

**Table 5.** Association between radiographic parameters and treatment outcomes.

	Radial inclination	Dorsal angulation	Ulnar positive variance
Grip strength	-0.04 (P=0.36)	-0.22 (P=0.18)	-0.35 (P=0.03)
Flexion	-0.11 (P=0.47)	-0.31 (P=0.02)	-0.18 (P=0.16)
Ulnar deviation	-0.52 (P=0.17)	-0.18 (P=0.90)	-0.34 (P=0.53)

( $r=-0.31$ ,  $P=0.02$ ). Radial inclination did not have a significant correlation with grip strength, flexion, or ulnar deviation ( $P>0.05$ , Table 5).

## Discussion

In recent years, people have paid much attention to the diagnosis and treatment of fractures [14–17], especially DRFs. Both conservative and surgical treatments have been used to treat DRFs. Surgical treatment can make fractures well-aligned. However, for simple fractures, conservative treatment is still the first choice, especially in the elderly. In the past decades, some authors emphasized the importance of keeping parameters within the proposed range to avoid a poor functional outcome [18,19], and some authors reported that striving for an anatomic reduction is not necessary [9,20]. In the present study, we included patients over 65 years of age who presented with AO/ASIF type A2 or A3 fractures, and found that treatment of extra-articular fractures by closed reduction leads to a satisfactory outcome in most cases. In comparison with these having acceptable alignment in the distal radius, patients with unacceptable alignment showed weak grip strength, were unsatisfied with appearance, and had limited flexion and ulnar deviation at 6-month follow-up. Patients in the 2 groups showed no difference in VAS score, PRWE score, DASH score, or other wrist ROM, except for flexion and ulnar deviation.

The functional outcome is the most important indicator for patients. A previous study by Kumar et al. [21] showed that

there is a difference in patients younger vs. older than 60 years with extra-articular DRFs: in the younger patients there was a very strong link between poor outcomes and the presence of a malalignment of the distal radius, but patients over 65 years showed no statistically significant relationship between radiologic alignment and disability. In the present study, we used several indicators to assess the outcomes, including both pain and disability. Consistent with the previous results [21,22], overall malalignment of the distal radius was not demonstrated to have a statistically significant effect on self-reported pain and disability in patients over age 65 years.

Grip strength is a traditional measure of impairment, but does not necessarily reflect patient-reported pain and disability. Our results showed that patients with unacceptable alignment of the wrist showed weaker grip strength in comparison with those with acceptable alignment, and the grip strength was significantly associated with ulnar positive variance. This result was supported by other reports, showing that an increase in volar tilt causes a decrease in grip strength [19].

In terms of the wrist ROM, flexion and ulnar deviation were 2 parameters that were affected by unacceptable alignment of wrist, and a significant correlation was shown between dorsal angulation and flexion movement. The flexion limitation was considered to be affected by dorsal angulations, and the range of ulnar deviation may be affected by the comprehensive influence of all deformities. Anzarut et al. [23] studied 74 patients over the age of 50 years, all of whom were living independently prior to their fractures. They found that acceptable

dorsal angulation was not associated with better physical or mental health status, lesser degrees of upper-extremity disability, or greater satisfaction than was unacceptable for dorsal angulation at 6 months. Although flexion movement was reduced, residual extension, as the usual position of wrist function, was not affected by malunion. This could be why good function is independent of anatomy at union.

Although good functional results can be obtained despite a poor anatomical reduction, an excellent function is more likely when the anatomy has been properly restored. However, even with anatomic reduction, loss of reduction or redisplacement after conservative treatment is common [7,24,25]. Beumer et al. [10] reported that in 44 dorsally displaced fractures, 37 lost reduction during the following weeks of immobilization in plaster. It is likely that this high rate of reduction loss is due to the inclusion of many comminution fractures, such as type A3 or C3 fractures. For type A2 fractures, the incidence of reduction loss is relatively low, but good reduction and close follow-up is necessary for satisfactory radiologic alignment. To minimize the influence of reduction loss on outcomes, we only analyzed the radiography of patients at 6-month follow-up, when the fracture is united and the alignment can better represent the association with functional outcomes.

Strengths of this study include the strict inclusion criteria and the absence of significant differences in the general characteristics of the patient groups. However, there are several limitations that should be considered. First, to obtain a homogeneous group with respect to the treatment administered, only patients who showed extra-articular fractures were included in

the study. The results are not applicable to patients with intra-articular fractures or other complicated fractures. Second, this study only investigated the treatment effect following manipulation. The involvement of patients after surgical treatment may provide more valuable information. Finally, the exact degree of displaced alignment which can be accepted in the elderly with or without manipulation has not been established, and further studies on this are still needed.

## Conclusions

Treatment of extra-articular fractures by closed reduction leads to a satisfactory outcome in most cases. In comparison with those having acceptable alignment in the distal radius, patients with unacceptable alignment showed weak grip strength, were unsatisfied with the appearance, and had limited flexion and ulnar deviation at 6-month follow-up. Patients without satisfactory reduction did not show significantly worse outcomes in VAS score, PRWE score, or DASH score. Thus, for low-demand patients, it is not necessary to correct all radiographic parameters back to normal in the primary reduction or to perform repeat reduction for those with loss of reduction during follow-up. However, for patients who are still healthy and active, satisfactory reduction is the first choice, as malalignment can lead to decreased grip strength, dissatisfaction with appearance, and certain wrist limitations.

## Conflicts of interest

None.

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