

## Original Article

# Comparative study of the efficacy of open reduction and internal fixation versus closed reduction and external fixation in treating distal radius fracture

Weixuan Duan<sup>1\*</sup>, Xiaojuan Han<sup>2\*</sup>, Jianchuan Wang<sup>1</sup>

<sup>1</sup>Seven Department of Orthopedics, Affiliated Zhongshan Hospital of Dalian University, Dalian, Liaoning Province, China; <sup>2</sup>Department of Anesthesiology, The First Hospital of Shanxi Medical University, Taiyuan, Shanxi Province, China. \*Equal contributors and co-first authors.

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**Abstract:** Objective: To compare the efficacy of open reduction and internal fixation versus closed reduction and external fixation in treating distal radius fracture. Methods: A total of 77 patients with distal radius fracture were retrospectively analyzed. There were 40 patients in the open reduction and internal fixation group (observation group) and 37 patients in the closed reduction and external fixation group (control group). The fracture symptoms, healing time of fracture, postoperative evaluation of wrist function, disabilities of the arm, shoulder and hand (DASH) score and life quality for 3 months after operation were compared. Results: In terms of fracture symptoms, the patients in the observation group had better improvements in pain, swelling and ecchymosis over the patients in the control group. The differences were statistically significant ( $P<0.05$ ). Healing time of the patients' fracture in the observation group was less than that of the patients in the control group ( $P<0.05$ ). As for the recovery of wrist function, the observation group showed better recovery of the palmar tilt angle, ulnar deviation angle and radius height than the control group ( $P<0.05$ ). What's more, the excellent and good scores of DASH scale was higher in the observation group than in the control group ( $P<0.05$ ). Lastly, with regard to postoperative life quality, physical function, physical role functioning, social functioning, emotional role functioning and bodily pain of the patients in the observation group were all significantly better than those of the patients in the control group ( $P<0.05$ ). Conclusion: Open reduction and internal fixation is better than closed reduction and external fixation in treating distal radius fracture. When treated by open reduction and internal fixation, patients with distal radius fracture have shorter healing time and good postoperative life quality. Therefore, it is worthwhile to popularize and apply open reduction and internal fixation in clinical practice.

**Keywords:** Open reduction and internal fixation, closed reduction and external fixation, distal radius fracture, comparison of efficacy

## Introduction

In the upper limb, the distal radius is a site where fracture easily occurs. The incidence of distal radius fracture is responsible for about 16.67% of all kinds of fractures and distal radius fracture easily occurs among elderly patients, especially female patients [1-3]. About 25% of patients with distal radius fracture have comminuted fracture [4]. The increase of population aging leads to high incidence of osteoporosis that weakens patients' bone strength, thus increasing the risk that patients will have fractures [5, 6]. At present, clinical treatments that

are used to treat distal radius fracture are open reduction and internal fixation with steel plates and closed reduction and external fixation [7-9]. However, the efficacy of these two treatments and the choice of therapeutic protocols remain controversial in clinic. It is believed that closed reduction takes the advantage of a simple operation, little injury and specific reduction efficacy, which is recommended by the clinic [10, 11]. Nevertheless, it also has some shortcomings. For instance, when closed reduction is used, reduction loss easily occurs after the reduction is fixed, which will lead to joint malformation [12]. The advantage of open reduction is that

internal fixation can be reinforced to make the function of joints recover well, and that patients' fracture can be clearly observed [13, 14]. However, due to the invasive operations, open reduction can cause joint injury and breakage of the flexor tendon [15, 16]. Since the advantages and disadvantages of these surgeries are currently inconclusive, the two treatments were retrospectively analyzed and the efficacy of each was compared in this study to provide some references for clinical therapeutic protocols.

### Materials and methods

#### *General data*

A total of 77 patients with distal radius fracture, who were diagnosed in the orthopedics department of the Affiliated Zhongshan Hospital of Dalian University from January 2017 to December 2018, were enrolled in this analysis. There were 33 males and 44 females, aged from 40 years old to 75 years old, with an average age of  $64.0 \pm 8.9$  years old. Among them, 40 patients were treated with open reduction and internal fixation with steel plates (observation group). In the observation group, there were 18 males and 22 females, with an average age of  $62.9 \pm 8.5$  years. The other 37 patients were treated by closed reduction and external fixation (control group), including 15 males and 22 females, with an average age of  $63.4 \pm 8.7$  years. This study was approved by the Ethics Committee of Affiliated Zhongshan Hospital of Dalian University. All the patients signed an informed consent form.

#### *Inclusion criteria and exclusion criteria*

**Inclusion criteria:** Patients who conformed to the diagnosis of a simple closed fracture of the distal radius according to guidelines for the diagnosis and treatment of osteoporotic fracture in China in 2015 [17]; patients who had a new fracture caused by trauma; patients whose radius was shortened more than 3 mm by using manual reduction; patients with complete clinical data, patients who cooperated with the follow-up visit.

**Exclusion criteria:** Patients with open and pathological fracture; patients with serious cardiac diseases, liver diseases, renal diseases, etc.; patients with mental diseases or cerebrovascu-

lar diseases, as well as patients with a poor life quality; fracture combined with nerve injury; patients whose follow-up visit was difficult to be carried out, or patients who had an inconvenience in the follow-up visit.

#### *Methods*

**Observation group:** The operation plan is as follows: 2% lidocaine was used for brachial plexus block anesthesia by axillary approach. After the patients were anesthetized successfully, the operative sites were disinfected and were covered with sterile cloths. The site of the patients' fracture was confirmed by X-ray film or CT film. The patients' injured limb was placed in an abduction position with the margo volaris upward. The palmaris was used as the approach for the operation. A 3 cm longitudinal incision was made at the proximal end to distal transverse line of the wrist. After the patients' skin was incised, the superficial fascia and deep fascia were separated till the tendon sheath of flexor carpi radialis was exposed. The radial artery and flexor carpi radialis were pulled bilaterally after they were separated, and the pronator quadratus was exposed in view, then a longitudinal incision was made in the radial side. After the pronator quadratus was incised, it was pulled toward the ulnar side. Lastly the surface of the radius and the site of fracture were fully exposed. The hematocoele at the site of fracture was cleared away, then the fracture end was pulled, rotated and pried to be restored. After the fracture end was restored, it was fixed by Kirschner wires temporarily. Then the prepared steel plates were placed in the palmaris of the distal radius. After this, the position of the steel plates was adjusted. Next the condition of the reduction was observed under X-ray of C-arm machine. If the reduction was good, then the fracture end was fixed by locking screws. After this, irrigation solution was used to wash and then the wound was sutured, then the exterior of the wound was sutured layer by layer, and the operation ended.

**Control group:** The operation plan is as follows: the patients were anesthetized by local infiltration anesthesia with 2% lidocaine. The site of the patients' fracture was confirmed by X-ray film or CT film. The patients' injured limb was in an abduction position with the opisthenar upward. The elbow of the patients was held and fixed by assistants, then the doctors pulled and

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**Table 1.** Comparison of general data and baseline data

Item	Observation group (n=40)	Control group (n=37)	$\chi^2/t$	P
Gender (male/female)	18/22	15/22	0.156	0.693
Age	64.00±8.90	62.90±8.50	0.532	0.596
Fracture reason			0.623	0.891
Fall over	22	18		
Traffic accident	10	11		
Fall from height	6	5		
Others	2	3		
General health perceptions	73.95±3.27	74.38±3.06	0.592	0.556
Mental health	89.05±2.87	89.05±2.84	0.006	0.995
Physical functioning	70.32±5.35	71.00±5.75	0.534	0.595
Physical role functioning	60.32±6.20	60.30±6.10	0.020	0.984
Social functioning	68.32±3.35	68.08±3.33	0.320	0.750
Emotional role functioning	60.48±9.65	60.84±9.95	0.162	0.871
Bodily pain	34.12±4.28	34.22±4.18	0.095	0.925
Vitality	85.05±2.87	80.05±2.84	0.006	0.995

pressed the patients' wrist to restore the alignment of the fracture. After finishing this step, the condition of the reduction was observed under X-ray of C-arm machine. If the reduction was good, then the site of fracture was fixed by external fixation with plaster. The site of fracture was reexamined after a week. If there was displacement in the site of fracture, a second reduction could be carried out. The plaster couldn't be removed until poroma appeared. The fracture symptoms of the patients in two groups were evaluated two weeks after the operation and the efficacy of healing of the patients was observed three months after the operation.

### Observation indicators

In terms of fracture symptoms, pain, swelling and ecchymosis of the patients were observed two weeks after they were treated by reduction operation. The above three indicators were evaluated according to quantitative grades; the grades were respectively 0, 1, 2 and 3, the scores were respectively 0, 2, 4 and 6 points. To ensure the accuracy of the patients' scores, the above operations were done by the same doctor.

After the patients' fracture was healed, the efficacy of the patients was evaluated and the healing time was recorded three months after they were operated on. The evaluation content

of the efficacy included palmar tilt angle, ulnar deviation angle and radius height. The disabilities of the arm, shoulder and hand (DASH) score was used to evaluate the function of the patients' wrist. The four grades in the evaluation content of the efficacy: Excellent: Good wrist function, normal wrist shape and no pain. Good: Slightly limited wrist function and occasional pain. Moderate: Partly limited wrist function and a feeling of weakness and a little pain. Poor: Seriously limited wrist function, disability and a feeling of severe pain. Total effective rate = (excellent + good)/the sum of cases.

Indicators of follow-up visit: The patients were visited, the MOS 36-item short-form health survey was used to evaluate the patients, including general health perceptions, mental health, physical function, physical role functioning, social functioning, emotional role functioning, bodily pain and vitality.

### Statistical methods

SPSS 17.0 statistical software was used to analyze the data. Continuous variables were expressed as mean  $\pm$  standard deviation ( $\bar{x} \pm sd$ ). If variables accorded with normal distribution and homogeneity of variance, paired t-test was used to compare the patients in groups before and after they were treated. Independent t-test was used to compare between groups, expressed by t. The count data was analyzed by Pearson chi-square test and Fisher exact probability method, expressed as chi-square. When  $P < 0.05$ , the difference was statistically significant.

## Results

### General data and baseline data

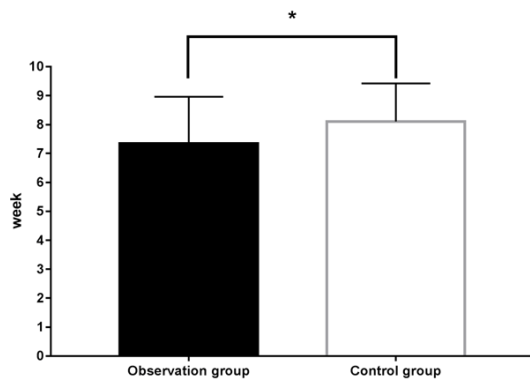
In terms of age, gender, disease type and indicators in MOS 36-item short-form health survey. There was no significant difference between the two groups ( $P > 0.05$ ). The results are shown in **Table 1**.

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**Table 2.** Comparison of fracture symptom scores

	Pain	Swelling	Ecchymosis
Before treatment			
Observation group	5.30±1.16	4.50±1.34	3.70±1.24
Control group	5.24±1.09	4.59±1.24	3.51±1.44
t	0.221	0.154	0.038
P	0.826	0.878	0.969
After treatment			
Observation group	1.54±1.42 <sup>#</sup>	1.57±1.42 <sup>#</sup>	1.35±1.34 <sup>#</sup>
Control group	2.25±1.30 <sup>#</sup>	2.75±1.26 <sup>#</sup>	2.10±1.28 <sup>#</sup>
t	2.201	3.870	2.512
P	0.031	<0.001	0.014

Note: Compared within the same group before treatment using paired t test, <sup>#</sup>P<0.05.



**Figure 1.** Comparison of healing time of the patients' fracture. \*P<0.05.

### *The comparison of fracture symptom scores of the patients in the two groups 3 weeks after operation*

There was no difference in fracture symptom scores of the patients in the two groups before they were treated ( $P>0.05$ ). Both groups recovered better after the reduction in terms of pain, swelling and ecchymosis, compared with those before the reduction. The difference was statistically significant ( $P<0.05$ ). The patients in the observation group had better improvements in pain, swelling and ecchymosis than the patients in the control group, with statistically significant differences ( $P<0.05$ ). See **Table 2**.

### *The comparison of healing time of the patients' fracture*

In the observation group, the healing time of the patients' fracture was  $7.34\pm1.62$  weeks, which was less than that of the patients in the

control group ( $8.11\pm1.31$  weeks). The difference was statistically significant ( $t=2.260$ ,  $P=0.026$ ). See **Figure 1**.

### *The comparison of recovery of the patients' hand function*

Between the two groups, there were no differences in palmar tilt angle, ulnar deviation angle and radius height of the patients before they were operated on ( $P>0.05$ ). After the operation, the patients in the observation group recovered better with regard to palmar tilt angle, ulnar deviation angle and radius height than those in the control group ( $P<0.05$ ). See **Table 3**.

### *The comparison of excellent and good score of DASH scale of the patients in the two groups*

The total effective rate of the observation group was higher than that of the control group. The difference was statistically significant ( $P<0.05$ ). See **Table 4**.

### *The comparison of life quality of the patients in the two groups three months after they were operated on*

As for the life quality of the patients three months after they were operated on, there were statistical differences in physical function, physical role functioning, social functioning, emotional role functioning and bodily pain ( $P<0.05$ ), which were better in the observation group than those in the control group. There were no statistical differences in general health perceptions, mental health and vitality between the two groups ( $P>0.05$ ). See **Table 5**.

## Discussion

With the development of biomechanics, the clinical efficacy of open reduction and internal fixation has gradually been accepted [18]. The principle of it is that first of all, the site of fracture is incised, then complete reduction is carried out at the site of fracture according to the anatomical site; next, the site of fracture is fixed with steel plates, which greatly reduces the possibility of displacement [19]. Patients can do wrist exercise after they are treated by open reduction and internal fixation, which is beneficial to the recovery of wrist function [20]. Open reduction and internal fixation can not

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**Table 3.** Comparison of recovery of the patients' hand function

	Palmar tilt angle (°)	Ulnar deviation angle (°)	Radius height (°)
Before treatment			
Observation group	-7.79±2.80	4.02±1.42	5.35±1.63
Control group	-7.72±2.62	3.90±1.29	5.11±1.51
t	0.405	0.396	0.675
P	0.686	0.693	0.502
After treatment			
Observation group	8.87±3.35 <sup>#</sup>	22.24±3.82 <sup>#</sup>	10.40±1.19 <sup>#</sup>
Control group	5.53±2.84 <sup>#</sup>	18.74±4.60 <sup>#</sup>	7.89±1.29 <sup>#</sup>
t	4.695	3.68	8.871
P	<0.001	<0.001	<0.001

Note: Compared within the same group before treatment, <sup>#</sup>P<0.05.

**Table 4.** Comparison of excellent and good rate of DASH score

	Observation group (n=40)	Control group (n=37)	X <sup>2</sup>	P
Excellent	28	14	9.564	0.023
Good	9	13		
Moderate	3	8		
Poor	0	2		
Total effective rate (%)	92.50	72.97	5.223	0.022

Note: DASH, the disabilities of the arm, shoulder and hand.

**Table 5.** Comparison of life quality of the patients in three months after the operation

	Observation group (n=40)	Control group (n=37)	t	P
General health perceptions	75.10±3.28	75.19±3.29	0.119	0.906
Mental health	91.50±3.34	90.22±2.85	1.084	0.750
Physical functioning	90.05±2.81	74.19±3.17	23.203	<0.001
Physical role functioning	76.73±6.46	65.85±6.15	7.764	<0.001
Social functioning	85.35±5.46	73.35±5.46	9.627	<0.001
Emotional role functioning	79.65±6.22	66.81±9.87	6.878	<0.001
Bodily pain	37.18±4.03	32.14±4.28	5.139	<0.001
Vitality	91.50±3.34	90.22±2.85	1.804	0.750

only restore the site of fracture, but also remove local blood stasis. In addition, doing wrist exercise in a timely manner can help to reduce swelling and ecchymosis and alleviate pain and discomfort. Therefore, in this study, postoperative pain, swelling and ecchymosis of the patients in the observation group showed better improvement than those of the patients in the control group. Open reduction and timely exercise can facilitate the healing at the site of fracture. The healing time of the patients' fracture in the observation group was significantly less

than that of the patients in the control group, which is consistent with the result of the above study.

In a comparative study of the efficacy of the two treatments, previous studies used randomized controlled trials, and it was found that when it comes to these two treatments, internal fixation was significantly better than external fixation in recovering ulnar deviation angle, but there was no significant difference in patients' other indicators [21]. In a retrospective study, it was found that the DASH score of patients in the observation group was higher than that of patients in the external fixation group three months and six months after they were operated on with no significant difference in patients' other efficacy indicators [22]. In another randomized controlled study, patients in the observation group recovered better in their wrist function than patients in an external fixation group three months after operation [23]. However, some studies suggest that when patients with distal radius fracture are treated by non-operative closed reduction and external fixation, their operation results might be satisfactory although

imaging results appeared to be unsatisfactory [24]. Another study concluded that the operation of closed reduction and external fixation was of good efficacy benefiting from simple manipulation and minimal trauma; and although it could lead to fracture healing malformation, it can reduce occurrence of malformation by finding and adjusting the site of fracture in a timely manner under X-ray [25]. In this study, the observation group showed better improvement in palmar tilt angle, ulnar deviation angle and radius height than the control group.



Meanwhile, the excellent and good score of the DASH scale of the patients in the observation group was higher than that of the patients in the control group.

With the development of technology, the concept of treating diseases is changing. The concept, "preventing diseases before they appear", is attracting more and more attention. Life quality rating scales are used to evaluate patients in many clinical studies, among which the MOS 36-item short-form health survey is very popular [26]. This study found that there were statistical differences in physical function, physical role functioning, social functioning, emotional role functioning and bodily pain, in terms of life quality of the patients in the two groups three months after they were operated on. But there were no statistical differences in general health perceptions, mental health and vitality between the two groups. The reason may be that the patients in the observation group recovered fast so that they could do wrist exercise as early as possible; however, the treatment time of the patients in the control group was too long for a fast recovery, thus their wrist exercise was restricted, which impacted the physiology, psychology and social functions of the patients. Therefore, postoperative guidance should be carried out for the patients in the control group to alleviate the patients' physiological and psychological burden. The result of this study is consistent with results of previous studies [27].

The sample size of this study is currently insufficient, which needs to be further expanded. Moreover, due to the short follow-up visit time, it is necessary to increase in order to investigate the effect of the two treatments on the patients' life quality.

In summary, open reduction and internal fixation is better than closed reduction and external fixation in treating distal radius fracture. When treated by open reduction and internal fixation, patients with distal radius fracture have shorter healing time and good postoperative life quality relatively. Therefore, it is worthwhile to popularize and apply open reduction and internal fixation in clinic.

### Disclosure of conflict of interest

None.

**Address correspondence to:** Weixuan Duan, Seven Department of Orthopaedics, Affiliated Zhongshan Hospital of Dalian University, No. 6 Jiefang Road, Zhongshan District, Dalian 116001, Liaoning Province, China. Tel: +86-0411-62893000; Fax: +86-0411-62893000; E-mail: duanweixuan011@163.com

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