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Manual reduction with traditional small splints for distal radius fracture in older patients

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ABSTRACT

Objective: To investigate the effect of manual reduction with traditional small splints fixation for distal radius fractures in older patients in the emergency department.

Methods: Older patients (aged at least 60 years) with distal radius fractures were enrolled in this study. The patients were randomly divided into the treatment group and the control group. The treatment group was treated with manual reduction and small splints fixation. The control group was treated with manual reduction and resin plaster fixation. Before treatment, after reduction, and 3 months after treatment, the palmar tilt angle, ulnar deviation angle, and radial length were recorded. Before treatment and 3 months after treatment, the Cooney wrist joint scores were recorded. The time of fracture healing and related adverse events during the treatment were recorded.

Results: Before treatment and after reduction, there were no statistically significant differences between the two groups in palmar tilt angle, ulnar deviation angle, or radial length ($P>0.05$). Three months after treatment, the palmar tilt angle, ulnar deviation angle, and radial length of the treatment group were better than those of the control group ($P<0.05$). The Cooney wrist scores of the treatment group was significantly higher than that of the control group three months after the treatment ($P<0.05$). The time of fracture healing of the treatment group was shorter than that of the control group, but the difference was no statistically significant ($P>0.05$).

Conclusions: Compared with resin plaster fixation, traditional small splints fixation for distal radius fractures in older patients have the advantages of less loss of fracture reduction and faster functional recovery. Besides, the method is simple and low cost thus, it needs to be promoted.

KEYWORDS: Traditional small splint; Distal radius fracture; Older patients; External fixation

1. Introduction

Distal radius fracture is a common type of fracture in the emergency department, accounting for 75% of forearm fractures and 1/6 of emergency orthopedic patients[1,2]. Distal radius fracture occurs mainly at the age of 60-75 years, and the incidence of female patients are about six times of male patients[3-6]. With the aggravation of aging in the world, the incidence of distal radius fracture in older patients is higher and higher. Therefore, the treatment of distal radius fracture in older patients gets more concerns from medical staff. Although the treatments tend to be diversified and individualized[7-11], manual reduction and physical fixation is still an important method for the treatment of distal radius fractures[12], and it is simple operated, low cost, and easily accepted by patients.

In China, splint has been used as an external fixation material for more than 3000 years, which is an important part of traditional Chinese medicine. The small splint is simple to make since it is made of wood chips, bamboo chips, or bark. The wrist splints are generally 15-25 cm in length, and 3 mm in thickness. The splint is wrapped with yarn covers, and on the body side, the splint is covered with a felt pad. Four splints compose a group. The efficiency of this technique has been approved through a long history of clinical practice[13-16]. The purpose

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of this study is to compare the effect of the traditional splint and resin plaster fixation on distal radius fracture and to explore the current value of traditional splints fixation.

2. Patients and methods

2.1. Patients

From January 2019 to December 2020, older patients with distal radius fractures were recruited from the Emergency Department of the Second Hospital of Tangshan. All of them voluntarily chose conservative treatment.

The minimum sample size was calculated by the following formula: N=2*[(U_α+ U_β) s/δ]^2, where δ is the required discrimination, s is the estimated value of the overall standard deviation, the U_α and U_β are U values of the α and β test levels. Final number of subjects was determined to be 92, including the number of possible withdrawals and loss in the experiment. All the recruited patients were given serial numbers according to the order of admission. All the serial numbers were divided into the treatment group and the control group by computer random processor. The number of patients in the two groups was equal. The treatment group was fixed by small splints, and the control group was fixed by resin plaster.

2.2. Exclusion and inclusion criteria

Exclusion criteria: (1) Patients with distal radius fracture complicated with vascular or nerve injury; (2) Patients with severe skin disease in the wrist who could not tolerate closed reduction and external fixation; (3) Patients with severe cardiovascular and cerebrovascular diseases, epilepsy, or mental illness; (4) Patients with old distal radius fracture.

Inclusion criteria: (1) All the patients were over 60 years old; (2) The selected patients were diagnosed as distal radius fractures by X-ray or CT; (3) All of them were unilaterally closed fractures; (4) The occurrence time of fracture was less than 3 d.

2.3. Ethical approval

This study was approved by the Hospital Ethics Committee of Tangshan Second Hospital (TSEY-LL-2021009). Subjects were protected according to the Helsinki Declaration adopted by the World Medical Association in 1964. The selected patients voluntarily participated in the study and signed the informed consent.

2.4. Treatment methods

All patients' fracture was first treated with manual reduction, and then the patients in the treatment group were fixed by small splints, while the patients in the control group were fixed by resin plaster. All patients were instructed for rehabilitation after fixation.

2.4.1. Manual reduction

Before manual reduction, patients were given brachial plexus anesthesia or local anesthesia in the fracture site. Then, the patient took the sitting position or supine position. The operator and an assistant stood by both ends of the forearm of the affected limb. The assistant held elbows of the patient, and the operator held the patient's hands. They slowly and forcefully stretched patient's limbs for 2-3 min. Thereafter, the operator used single-hand traction, and applied manipulation at the fracture location with the other hand. The fracture was pressed reduce displacement. For osteoporotic fracture or severe comminuted fracture, it is necessary to press gently to avoid aggravating fracture fragmentation due to excessive force[17].

2.4.2. Small splints fixation

After the reduction, the fracture site was wrapped by a cotton pad longer than the small splint. If the fracture is angularly displaced to the dorsal side, the splint on the dorsal side is fixed 1-1.5 cm longer than the transverse carpal line, and the small splints on the palmar, radial, and ulnar sides are fixed to the transverse carpal line. If the fracture is angularly displaced to the palmar side, the splint on the palmar side is fixed 1-1.5 cm longer than the transverse carpal line, and the small splints on the dorsal, radial, and ulnar sides are fixed to the transverse carpal line. If the fracture of the distal radius is severely comminuted, the splints are fixed over the wrist joint to avoid the loss of reduction when the wrist joint moves. The small splints were fixed with three binding belts. The tightness of the binding belt was defined as moving up and down the splint by 1 cm. Patients took regular X-ray exam, and performed functional training. Then, the splints were removed after 4-6 weeks.

2.4.3. Resin plaster fixation

An appropriate size resin plaster was selected according to the length and width of the patient's wrist, and then the resin plaster was fixed close to the wrist skin. According to the angular displacement of the fracture, the palmar flexion or extension molding was made. At the same time, a gauze bandage or elastic bandage was used to wrap and fix the resin plaster that began to harden and set for about 5-10 min. To speed up the setting time of the resin plaster, it can be immersed in water before use, thereafter, excess water should be removed. Generally, after 2 weeks of fixation, the wrist would be changed to the functional position. The patients took regular X-ray exam, and performed functional training. Then the splints were removed after 4-6 weeks.

2.5. Observation indicators

Before treatment, after reduction, and 3 months after treatment, the fracture reduction status was recorded, including changes of palmar tilt angle, ulnar deviation angle, and radius height. Before treatment and 3 months after treatment, the Cooney functional scores were recorded. Cooney's functional scores include 25 points for pain, 25 points for function, 25 points for flexion angle, 25 points for holding power. The total scores range from 0-100 points. The higher the scores, the better the functional recovery[18]. The fracture healing time was recorded as well[19,20].

2.6. Statistical analysis

SPSS17.0 statistical software was used to analyze data. The indicators of age, fracture healing time, external fixation duration, palm angle, ulnar angle, radius height, Cooney score were measured. Descriptive data were expressed as frequency and percentage. Continuous variables were expressed as mean±SD. Student's t-test and, *Chi*-square test, and Wilcoxon rank-sum test were used to compare the difference between the two groups. The significant level of this study was set at α=0.05.

3. Results

3.1. Baseline data

A total of 92 cases were randomly divided into the treatment group and the control group, with 46 cases in each group. One person in the treatment group was excluded due to emigration. One person in the control group was removed because he abandoned conservative treatment and changed to surgical treatment. Finally, 45 cases in each group met the evaluation criteria. There were no significant differences between the two groups in gender, age, location, AO classification, or duration of external fixation (P>0.05). The fracture healing time in the treatment group was shorter than that in the control group, but the difference was no statistically significant (P>0.05). There was 1 case of Sudeck's atrophy, 2 cases of the shoulder and elbow stiffness, 3 cases of radial dorsal nerve compression in the treatment group, and 3 cases of Sudeck's atrophy, 2 cases of the shoulder and elbow stiffness, 2 cases of median nerve compression in the control group. There was no significant difference in the complications between the two groups (P>0.05) (Table 1).

3.2. Change of fracture reduction

Before and after reduction, there were no significant differences between the two groups in terms of palmar tilt angle (t=0.133, P>0.05), ulnar deviation angle (t=0.363, P>0.05), or radius height (t=0.439, P>0.05). Three months after treatment, there were significant differences between the two groups of the palmar tilt angle (t=3.134, P<0.05), ulnar deviation angle (t=4.502, P<0.05), and radius height (t=3.518, P<0.05). While the palmar tilt angle (t=7.309, P<0.05, for the control group; t=7.145, P<0.05, for the treatment group), ulnar deviation angle (t=8.649, P<0.05, for the control group; t=4.413, P<0.05, for the treatment group), and radius height (t=9.91, P<0.05, for the control group; t=4.292, P<0.05, for the treatment group) three months after treatment were all worse than those after reduction in both groups, and the differences were statistically significant (Table 2).

3.3. Change of wrist function

Before treatment, there was no significant difference in Cooney wrist scores between the two groups (P>0.05). Three months after treatment, the Cooney wrist scores in the treatment group was higher than that in the control group, the difference was statistically significant (P<0.05) (Table 3).

Table 1. Demographic and baseline information of the study patients.

Items	Treatment (n=45)	Control (n=45)	χ^2/t/Z	P-value
Gender (male/female, n)	11/34	14/31	0.498	0.480
Age (mean±SD , years)	67.71±6.03	69.13±5.29	1.188	0.240
Location (right/left, n)	28/17	30/15	0.194	0.659
AO classification (A/B/C, n)	12/16/17	18/13/14	1.143	0.253
Fracture healing time (mean±SD, week)	12.77±1.84	13.44±1.96	1.672	0.099
External fixation duration (mean±SD, week)	4.35±0.62	4.42±0.71	0.498	0.620
Complications [n (%)]				
Sudeck's atrophy	1 (2.22)	3 (6.67)		
Stiffness of shoulder and elbow	2 (4.44)	2 (4.44)	0.090	0.764
Nerve compression	3 (6.67)	2 (4.44)		

Table 2. The comparison of reduction indicators in the two groups.

Group	N	Before treatment	After reduction	3 months after treatment
Palmar tilt angle (degree)				
Control	45	2.65±2.11	9.31±1.70^{a}	7.03±1.22^{ab}
Treatment	45	2.71±2.16	9.92±1.62^{a}	7.81±1.14^{abc}
Ruler deflection angle (degree)				
Control	45	7.03±3.31	18.81±1.95^{a}	15.01±2.21^{ab}
Treatment	45	6.76±3.74	19.01±2.04^{a}	17.07±2.13^{abc}
Radius height (mm)				
Control	45	3.55±2.15	10.72±1.38^{a}	7.02±2.09^{ab}
Treatment	45	3.34±2.38	10.31±1.20^{a}	8.65±2.30^{abc}

^{a}: Compared with before treatment, P<0.05. ^{b}: Compared with after reduction, P<0.05. ^{c}: Compared with the control group, P<0.05.

Table 3. Cooney wrist scores of the two groups.

Group	*N*	Before treatment	3 months after treatment
Control	45	33.63±5.90	74.01±6.12
Treatment	45	35.29±5.61	77.63±6.40
t	-	1.368	2.742
P-value	-	0.175	0.007

4. Discussion

Distal radius fracture is one of the common fracture types in older patients. Because of the decrease of bone mass and the increase of brittleness in older patients, comminuted fracture often occurs after trauma. Besides, older patients repairability is weakened, which is likely to cause future dysfunction. Most scholars think that conservative treatment of distal radius fracture in older patients can achieve ideal outcome[21-23], but others believe that surgical treatment is a better choose, which is conducive to early recovery of wrist function[25,26]. However, surgical treatment is costly and more risky, so most patients are reluctant to choose it. No consensus or standard is reached on the choice of conservative or surgical treatment of distal radius fractures in older patients till now[24]. Plaster or splints for external fixation is the most common treatment for distal radius fracture, and their advantages over surgery are simple operation, low risk of secondary injury.

The traditional small splints fixation belongs to elastic fixation. The splints is competent to prevent fracture displacement through the holding force of its own, so the fracture site can maintain a stable state[27]. Small splints fixation can achieve “dynamic and static combination”, indicating the combination of fixation and functional exercise. “Static” means that the splints are fixed at the distal end of the radius, and the holding force maintains the stability of the fracture site. “Dynamic” means that the hand and wrist can carry out effective functional training, increase the blood supply of the broken end of the fracture, and ensure the energy supply for fracture healing[28,29]. For the small splints fixation, the contraction of the muscle can make the fracture end produce longitudinal pressure, keep the fracture end in close contact, which is conducive to fracture healing. Besides, the longitudinal pressure makes the fracture site stable and firm, thus effectively avoid the loss of fracture reduction. Early functional exercise can avoid joint stiffness, muscle atrophy, nonunion and other complications[30]. In this clinical study, the Cooney wrist scores of the treatment group are higher than that of the control group, the difference is statistically significant, which shows that the fixation effect of the traditional splint is satisfying, and the patients can carry out effective functional training under its fixation so that the patients can recover their functions as soon as possible.

In this study, both groups had symptoms of nerve compression. By timely adjusting the location and tightness of the external fixation and with the help of neurotrophic treatment, and finally, the symptoms relieved. For the complications of Sudeck’s atrophy or shoulder and elbow stiffness, the best prevention and treatment is early functional training.

The palmar angle, ulnar angle, and radius height of three months after treatment were all worse than those after reduction, which indicated that there was a loss of fracture reduction in the process of conservative treatment. To avoid the loss of fracture reduction, the external fixator should be checked regularly, and X-ray should be taken to determine the fracture’s situation. If obvious fracture displacement is found, the fracture should be reattached or the external fixation should be adjusted. After 3 months of treatment, the ulnar deflection angle and radius height of the patients in the treatment group were better than those in the control group, indicating that the treatment of distal radius fracture with small splints fixation has the advantage of less loss of fracture reduction, and its stability and effectiveness of fixation are better than that of resin plaster. Compared with plaster and its derivatives in the treatment of distal radius fracture, the traditional splint has the characteristics of fast functional recovery and good fixation effect, which is consistent with other research conclusions[31-34]. Therefore, the traditional splints fixation is simple, fast, and reliable for the treatment of distal radius fractures in older patients, so it needs to be promoted today.

Conflict of interest statement

The authors report no conflict of interest.

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Authors’ contributions

W.L.Y. proposed the study and wrote the first draft. Z.H.W. and Z.J.Z. analyzed the data. All authors contributed to the design and interpretation of the study and to further drafts.

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