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ORIGINAL RESEARCH

Comparison of clinical efficacy of open reduction and internal fixation for different types of male distal radius fractures

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Abstract

To compare the effects of open reduction and internal fixation (ORIF) on male patients with distal radius fracture (DRF) combined with ulnar styloid process fracture of different types (Hauck II and Hauck I). Male patients with DRF and associated ulnar styloid process fractures who were treated at our hospital between March 2021 and March 2022 were randomly assigned to a Hauck I type (Group A, n = 44 cases) and Hauck II type (Group B, n = 44 cases). Both groups of patients underwent ORIF procedures, with self-locking locking compression plates used during surgery, and their surgical conditions (including time and bleeding volume), Visual Analog Scale (VAS) scores, wrist joint functionality (assessed using the Mayo score and range of motion), and quality of life scores were compared. At the last follow-up, Group A exhibited significantly greater wrist joint range of motion and WHO-QOL-BREF (The World Health Organization quality of life) scores compared to Group B ($p < 0.05$). However, no statistically significant differences ($p > 0.05$) were observed when comparing surgical conditions (time, bleeding volume), duration of hospital stay, fracture healing rates, incidence of complications, VAS scores (1 day, 2 days, 3 days post-surgery) and Mayo scores at the last follow-up between Group B and Group A. Male patients suffering from distal radius fractures combined with ulnar styloid process fractures can benefit from ORIF. Specifically, Hauck I patients demonstrate superior wrist joint mobility and a higher quality of life compared to Hauck II patients.

Keywords

Open reduction and internal fixation surgery; Hauck Type II; Hauck Type I; Male; Distal radius fracture; Surgical situation; VAS score; Recovery of wrist joint function

1. Introduction

Clinical statistics indicate that among patients with distal radius fractures (DRF), male patients account for most of the cases [1, 2]. The common symptoms observed in patients with these fractures include swelling, localized pressing pain and reduced wrist joint mobility, with the common causes of DRF comprising traffic accidents and falls [3]. Currently, the primary treatment for these patients is open reduction and internal fixation (ORIF). Clinical studies have shown that distal radius fractures often co-occur with ulnar styloid fractures [4, 5]. In clinical practice, ORIF is the primary approach for treating distal radius fractures. However, the therapeutic outcomes of ORIF may vary for patients with different types of ulnar styloid fractures [6, 7]. Hauck has classified ulnar styloid fractures into two distinct types based on the location of the fracture line in relation to its attachment point to the triangular fibrocartilage complex (TFCC). Type I denotes ulnar styloid tip fractures, where the fracture line is distal to the TFCC attachment point, while Type II corresponds to ulnar styloid base fractures, where the fracture line may be proximal to the TFCC attachment point. Herein, we designed this study to primarily perform a comprehensive investigation into the impact of ORIF in male patients with DRF exhibiting different ulnar styloid fracture types (Hauck Type II and Hauck Type I) and systematically assess the efficacy of various treatment modalities based on comparative analyses of patients admitted to our hospital from March 2021 to March 2022.

2. Material and methods

A total of 44 Hauck I (Group A) and 44 Hauck II (Group B) cases were randomly selected from a cohort of male patients with DRF combined with ulnar styloid process fractures who were admitted to our hospital from March 2021 to March 2022.

The study inclusion criteria were: (1) X-ray, CT (Computed Tomography) and other imaging examination diagnosed distal radius fracture combined with ulnar styloid fracture; (2) fit for open reduction and internal fixation surgery; (3) could cooperate and accepted the proposed surgical procedures; (4)

were fixed with self-locking locking compression plates during the surgery (1 piece). Patients who had severe infections or malignant tumors, coagulation disorders and multiple fractures were excluded from this study.

The baseline characteristics of the patients are shown in Table 1.

2.1 Methods

During the ORIF procedure, anesthesia was administered through a brachial plexus block. The Henry approach was followed from the palmar aspect, which involved the mobilization of the flexor carpi radialis from the rasceta to the proximal radius towards the ulnar side. The pronator quadratus was dissected to expose the fracture site and enable its realignment. To temporarily stabilize the fractured end of the radius, we utilized a Kirschner wire. Subsequently, we employed a C-arm X-ray machine to assess the adequacy of the realignment, following which the fractured end was secured with a locking compression plate and screws. The closed or open reduction of the ulnar styloid fracture was also monitored using the X-ray machine. Once satisfactory alignment was achieved, the ulnar styloid fracture was fixed in place using Kirschner wires.

Postoperatively, nursing staff were responsible for changing medications every 2–3 days and monitoring the condition of the incision and the surrounding skin. The patients were scheduled for wrist joint evaluations in the anteroposterior position on the 1st day post-surgery, as well as at 1 month, 3 months and 1 year following the procedure. Under the guidance of a physician, the patients initiated passive wrist joint flexion and extension exercises 3 days post-surgery, progressing to active flexion and extension exercises 2 to 3 weeks after the procedure, which aimed to prevent joint stiffness and promote the absorption of any residual lumps.

2.2 Indexes

Surgical conditions, including operative duration and bleeding volume (assessed by blood absorbed on gauze), were documented. Additionally, the length of hospital stay (LOS) was recorded. The fracture healing rate was calculated, defined as the absence of a discernible fracture line on X-ray films 9 months post-surgery, with the formula: Fracture healing rate = (number of patients with fracture healing/total number of cases) $\times$ 100%.

The incidences of postoperative complications, such as incisional infections and loosening of internal fixation, were recorded. The assessment of internal fixation loosening involved weight-bearing X-ray examinations to determine if there was substantial displacement ($>$5 mm) at the fracture site and the incidence rates of these complications were calculated.

Patient pain levels were assessed using the Visual Analogue Scale (VAS), where higher scores denoted lower pain levels.

Patients' recovery from wrist fractures was assessed using the Mayo scale, which comprised five items, namely pain, wrist joint mobility, grip strength and daily activity performance. Each item was scored on a 25-point scale, with higher scores indicating better recovery.

Wrist joint mobility was evaluated from six different angles: palmar flexion, dorsiflexion, ulnar deviation, radial deviation, pronation and supination. The measurement protocol involved patients being in a relaxed state with the joint in a neutral position, and the range of joint motion was measured using a protractor or ruler. These procedures were conducted five times, and the average value was recorded. Objectivity and professionalism were maintained throughout the measurement process for data reliability.

The WHO-QOL-BREF scale was used to assess the quality of life of patients both before the operation and at the last follow-up. All patients were followed up for an average of 17 months (range, 12 to 24 months after surgery). This scale comprised four items: physical condition, mental condition, environmental condition, and social relationships. Each item was rated on a scale of 100 points, with higher scores indicative of a higher quality of life.

2.3 Statistics

Statistical analyses were conducted using the SPSS software version 20.0 (Statistical Package for Social Sciences, IBM (International Business Machine), Armonk, NY, America). Measurement data are expressed as mean $\pm$ standard deviation ($\pm$s), and categorical data are presented as percentages (%). The t-test and chi-square (χ^2) test were used for the analysis of continuous and categorical data, respectively. Significance was determined at $p < 0.05$.

3. Results

3.1 Comparison of surgical conditions, LOS and healing rate of fracture

In Group B, the surgical duration for patients averaged 58.62 $\pm$ 6.94 minutes, with a recorded bleeding volume of 141.59 $\pm$ 36.23 milliliters. The mean LOS was 16.98 $\pm$ 3.25 days, and the fracture healing rate was 93.18%. The detailed comparison between Group B and Group A is presented in Table 2.

3.2 Comparison of postoperative complication incidence

The incidence of complications in Group B was significantly lower, at 6.82%, compared to the 9.09% observed in Group A. Statistical analysis ($\chi^2 = 1.047$, $p = 0.306$) confirmed these findings. Further information is shown in Table 3.

3.3 Comparison of VAS scores

In Group B, the VAS scores recorded at 1 day, 2 days and 3 days after the operation were 3.52 $\pm$ 0.84, 2.84 $\pm$ 0.72 and 2.13 $\pm$ 0.67, respectively. The detailed comparisons between the investigated groups are shown in Table 4.

3.4 Comparison of Mayo scores

Analysis of the Mayo scores between the two groups showed that both groups exhibited significantly higher Mayo scores on the last follow-up compared to their preoperative scores ($p <$ 0.05). Notably, in Group B, the Mayo scores for pain (21.15 $\pm$ 2.56), wrist joint mobility (21.23 $\pm$ 2.84), grip strength (21.45

TABLE 1. Comparison of basic information (n (%), ($\bar{x} \pm s$)).

Baseline characteristics	Group A (n = 44)	Group B (n = 44)	t/χ^2	p
Position				
Left	18	20	0.185	0.666
Right	26	24		
ASA stages				
Grade II	32	31	0.055	0.813
Grade III	12	13		
Causes of injury				
Falls	18	21	0.414	0.519
Traffic accident	17	15	0.196	0.657
Fall from high	5	3	0.550	0.458
Exercise	4	5	0.123	0.724
Age	59.11 ± 10.42	59.61 ± 10.68	0.222	0.825
Interval between injury and operation	12.64 ± 3.24	12.14 ± 3.37	0.710	0.480
Weight (kg)	68.59 ± 5.72	68.23 ± 5.67	0.296	0.767
Average length of education (yr)	10.82 ± 3.51	10.57 ± 3.37	0.340	0.734
Radius shortened length (mm)	6.39 ± 2.21	6.28 ± 2.37	0.225	0.822

TABLE 2. Comparison of surgical conditions, LOS and healing rate of fracture ($\bar{x} \pm s$, n).

Variables	Number	Surgical time (min)	Intraoperative bleeding volume (mL)	Length of stay (d)	Healing rate of fracture (%)
Group A	44	58.34 ± 6.39	15.11 ± 0.62	12.71 ± 1.05	43 (97.73)
Group B	44	58.62 ± 6.94	15.20 ± 0.63	12.98 ± 1.05	41 (93.18)
t/χ^2	-	0.196	0.675	1.195	1.047
p	-	0.844	0.501	0.236	0.306

TABLE 3. Comparison of complication incidence between the investigated groups (n (%)).

Variables	Number	Infection of incision	Loosening of internal fixation	Incidence
Group A	44	2 (4.55)	2 (4.55)	4 (9.09)
Group B	44	2 (4.55)	1 (2.27)	3 (6.82)
χ^2	-	-		1.047
p	-	-		0.306

TABLE 4. Comparison of VAS scores (n (%)).

Variables	Number	1 day after operation	2 days after operation	3 days after operation
Group A	44	3.59 ± 0.87	2.80 ± 0.73	2.18 ± 0.69
Group B	44	3.52 ± 0.84	2.84 ± 0.68	2.11 ± 0.65
χ^2	-	0.383	0.266	0.490
p	-	0.702	0.791	0.626

± 2.21) and ability to perform daily activities (21.52 ± 2.18) were all significantly higher than those in Group A ($p < 0.05$). Further details are shown in Table 5.

3.5 Comparison of mobility of wrist joint

At the last follow-up, the measurements for wrist joint mobility in Group A were as follows: palmar flexion: 13.82 ± 1.95°, dorsiflexion: 56.85 ± 6.98°, ulnar deviation: 21.68 ± 2.84°, radial deviation: 22.39 ± 2.61°, pronation: 84.61 ± 7.62°, and supination: 81.85 ± 9.25°, which were all higher than those observed in Group B (Table 6).

3.6 Comparison of WHO-QOL-BREF scores

At the last follow-up, the WHO-QOL-BREF scores in both groups significantly exceeded their preoperative scores ($p <$ 0.05). Specifically, during the last follow-up, the WHO-QOL-BREF scores in Group A, encompassing physical condition (86.19 ± 4.23), mental condition (86.58 ± 3.94), environmental condition (86.36 ± 4.52) and social relationship (86.45 ± 3.54), were all significantly higher than those recorded in Group B ($p < 0.05$). Additional details are shown in Table 7.

4. Discussions

In clinical practice, a significant proportion of fracture cases occur at the upper extremity fractures, with a predominance observed in male patients [8, 9]. Among these fractures, DRF is particularly common and can have detrimental effects on wrist functions. Fractures often result in reduced palmar inclination and ulnar deviation, which are key anatomical changes contributing to wrist joint dysfunction and a subsequent negative impact on patients' quality of life [10]. Currently, ORIF is widely used to treat DRF [11, 12]. Clinical studies have shown that early implementation of ORIF in DRF patients can accelerate patient recovery from fracture, as well as the restoration of normal physiological wrist functions [13, 14]. However, when DRF coexists with other fractures, such as ulnar styloid process fractures, patients may experience additional symptoms, including distal ulnar joint dislocation and ligament injuries [15, 16]. The ulnar styloid process plays a crucial role in maintaining the stability of the ulnar radioulnar joint, and if a fracture occurs in this region, it can lead to instability, further exacerbating the severity of wrist injuries [17–19].

In recent years, an increasing number of clinical studies focusing on DRF have revealed that the efficacy of ORIF is significantly influenced by the type of ulnar styloid fracture [20, 21]. Therefore, this study investigated the outcomes of ORIF in male patients with different DRF types, specifically Hauck II and Hauck I fractures. The results indicated no statistically significant differences between male patients with Hauck I DRF and those with Hauck II DRF following ORIF treatment in various parameters, including surgical conditions (time, bleeding volume), LOS in hospital, healing rate of fracture, complication incidence, VAS scores (1 day, 2 days, 3 days after operation), Mayo scores on the last follow-up ($p > 0.05$). Patients with Hauck I and Hauck II fractures who underwent ORIF treatment exhibited no significant differences in surgical conditions, postoperative complications or postoperative pain, demonstrating comparable recovery outcomes [22]. This similarity in outcomes might have been attributed to the use of self-locking locking compression plates in both groups, along with screws employed to secure these plates, which enhances stability, achieves optimal fixation, minimizes the risk of internal fixation loosening, enhances fracture end fixation and effectively contributes to the overall recovery process [23, 24].

This study results revealed that during the last follow-up, patients in Group A exhibited significantly better wrist joint mobility compared to Group B, with higher values for palmar flexion (13.82 ± 1.95), dorsiflexion (56.85 ± 6.98), ulnar deviation (21.68 ± 2.84), radial deviation (22.39 ± 2.61), pronation (84.61 ± 7.62), and supination (81.85 ± 9.25) ($p < 0.05$), which have contributed to male patients with DRF who underwent ORIF experiencing substantial improvements in wrist joint mobility ($p < 0.05$). Notably, patients with Hauck I fractures were found to have greater improvements compared to those with Hauck II fractures, and this discrepancy can be attributed to the location of the fractures [25, 26] as Hauck II fractures, occurring near the triangular fibrocartilage complex of the ulnar joint, led to severe damage to the structure, resulting in reduced ulnar joint stability and challenging fracture recovery. Comparatively, Hauck I fractures, located farther from the triangular fibrocartilage complex, caused less structural damage and had a milder impact on ulnar stability. Consequently, these fractures had a lesser effect on the stability of the ulnar joint itself, leading to superior post-surgery restoration of wrist joint mobility [27, 28].

Moreover, it is worth highlighting that patients with Hauck I fractures exhibited significantly better quality of life during the last follow-up compared to those with Hauck II fractures ($p < 0.05$). Although all DRF patients experienced enhanced quality of life following ORIF, those with Hauck I fractures demonstrated a more substantial improvement, which can be attributed to their superior post-surgery recovery of wrist functions and mobility, leading to fewer disruptions in their daily lives [16, 29, 30].

5. Conclusions

In conclusion, among male patients who underwent ORIF for both distal radius and ulnar styloid process fractures, those with Hauck I fractures showed improved wrist joint functions and a higher quality of life compared to those with Hauck II fractures. Nevertheless, it is also important to recognize the study's limitations, such as the high proportion of male patients and the relatively short follow-up period. Thus, it would be advisable to include a more diverse patient population and extend the study duration in future studies to yield more comprehensive and scientifically robust findings, which could help strategize more effective treatment approaches to improve patient outcomes.

AVAILABILITY OF DATA AND MATERIALS

The authors declare that all data supporting the findings of this study are available within the paper and any raw data can be

TABLE 5. Comparison of Mayo scores ($\bar{x} \pm s$).

Indicators	Time	Group A (n = 44)	Group B (n = 44)	t	p
Pain					
	Before operation	13.43 ± 3.12	13.52 ± 3.06	0.136	0.891
	Last follow-up	20.83 ± 1.84	21.15 ± 2.56	0.673	0.502
	t	13.551	12.685	-	-
	p value	$p < 0.001$	$p < 0.001$	-	-
Mobility of wrist joint					
	Before operation	13.64 ± 3.52	13.38 ± 3.64	0.340	0.734
	Last follow-up	20.35 ± 2.81	21.23 ± 2.84	1.461	0.147
	t	9.882	11.278	-	-
	p value	$p < 0.001$	$p < 0.001$	-	-
Grip strength					
	Before operation	13.12 ± 3.16	13.43 ± 3.23	0.455	0.650
	Last follow-up	20.68 ± 2.31	21.45 ± 2.21	1.597	0.113
	t	12.811	13.592	-	-
	p value	$p < 0.001$	$p < 0.001$	-	-
Ability in daily activities					
	Before operation	13.45 ± 3.26	13.21 ± 3.18	0.349	0.727
	Last follow-up	20.83 ± 2.24	21.52 ± 2.18	1.464	0.146
	t	12.376	14.297	-	-
	p value	$p < 0.001$	$p < 0.001$	-	-

TABLE 6. Comparison of mobility of wrist joint ($\bar{x} \pm s$ (°)).

Group	Number	Palmar flexion	Dorsiflexion	Ulnar deviation	Radial deviation	Pronation	Supination
Group A	44	13.82 ± 1.95	56.85 ± 6.98	21.68 ± 2.84	22.39 ± 2.61	84.61 ± 7.62	81.85 ± 9.25
Group B	44	11.91 ± 1.62	53.54 ± 6.15	18.82 ± 2.36	20.91 ± 2.15	81.35 ± 7.21	77.89 ± 9.34
t	-	4.997	2.360	5.137	2.903	2.061	1.998
p	-	$p < 0.001$	0.020	$p < 0.001$	0.004	0.042	0.048

TABLE 7. Comparison of WHO-QOL-BREF scores ($\bar{x} \pm s$).

Indicators	Time	Group A (n = 44)	Group B (n = 44)	t	p
Physical condition					
	Before operation	69.37 ± 3.31	69.64 ± 3.57	0.367	0.713
	Last follow-up	86.19 ± 4.23	78.64 ± 3.56	9.058	$p < 0.001$
	t	20.772	11.841	-	-
	p value	$p < 0.001$	$p < 0.001$	-	-
Mental condition					
	Before operation	69.43 ± 3.26	69.72 ± 3.41	0.407	0.684
	Last follow-up	86.58 ± 3.94	79.59 ± 3.39	8.920	$p < 0.001$
	t	22.245	13.615	-	-
	p value	$p < 0.001$	$p < 0.001$	-	-
Environmental condition					
	Before operation	69.83 ± 3.34	69.86 ± 3.41	0.041	0.966
	Last follow-up	86.36 ± 4.52	78.69 ± 3.24	9.148	$p < 0.001$
	t	19.509	12.451	-	-
	p value	$p < 0.001$	$p < 0.001$	-	-
Social relationship					
	Before operation	69.57 ± 3.69	69.68 ± 3.71	0.139	0.889
	Last follow-up	86.45 ± 3.54	79.14 ± 3.67	9.509	$p < 0.001$
	t	21.896	12.024	-	-
	p value	$p < 0.001$	$p < 0.001$	-	-

obtained from the corresponding author upon request.

AUTHOR CONTRIBUTIONS

MZ and TM—designed the study and carried them out; MZ, BH and TM—supervised the data collection, analyzed the data, interpreted the data, prepared the manuscript for publication and reviewed the draft of the manuscript. All authors have read and approved the manuscript.

ETHICS APPROVAL AND CONSENT TO PARTICIPATE

Ethical approval was obtained from the Ethics Committee of The First Affiliated Hospital of Wannan Medical College (Yijishan Hospital) (Approval no. 2019-01). Written informed consent was obtained from a legally authorized representative for anonymized patient information to be published in this article.

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CONFLICT OF INTEREST

The authors declare no conflict of interest.

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