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Logistic Multiple Regression Analysis of CT Image Evaluation of Wrist Arthroscopy-assisted Small Incision Treatment on Postoperative Healing and Wrist Function of Patients with Distal Radius Fractures

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Keywords:

CT images; Distal radius fractures; Wrist arthroscopic treatment; Small incision; Postoperative healing; Wrist function

1. Abstract

1.1. Objective: To assess the postoperative healing of patients with distal radius fractures treated with wrist arthroscopy-assisted small incision and its effect on wrist function using CT images combined with Logistic multiple regression analysis.

1.2. Methods: 166 patients with distal radius fracture were randomly divided into control group (open reduction and internal fixation) and study group (wrist arthroscopy-assisted small incision treatment), with 83 cases for each group. All patients underwent postoperative CT examination, Logistic multiple regression analysis was used to assess the recovery of wrist function, and the postoperative healing of the two groups was also assessed and compared.

1.3. Results: The operation time of the study group was longer than that of the control group, and the intraoperative blood loss and hospitalization time were less than those of the control group ($P < 0.05$); the fracture wound healing time in study group was shorter than that in control group, and disabilities of the arm, shoulder, and hand (DASH) score at 3 and 6 months after operation in study group was lower than that in control group ($P < 0.05$); the pain severity, psychological status, independent ability, and life comfort score at 1, 3, and 6 months after operation in both groups were higher than those before treatment, and the score in study group was higher than that in control group ($P < 0.05$); CT image found that the palmar inclination angle and ulnar deviation angle in study group were greater than those in control group ($P < 0.05$). Logistic multiple regression analysis showed that operation time and blood loss could be used as independent factors affecting postoperative fracture healing and wrist joint function recovery in both groups ($P <.0.05$).

1.4. Conclusion: Through the detection and evaluation of CT images, it was found that the wrist arthroscopy-assisted small incision treatment in patients with distal radius fractures could shorten the postoperative wound healing time, reduce the postoperative pain of patients, and contribute to the recovery of wrist joint function.

2. Introduction

Distal radius fracture is one of the most common fractures in the human body due to the occurrence of cancellous distal radius within 3 cm of the radiocarpal joint and dorsally displaced fractures, and its incidence accounts for 6.7% to 11% of various fractures, mostly in middle-aged and elderly people, and more women than men [1]. The causes of distal radius fractures are indirect violence, elbow extension, forearm pronation, wrist extension, and hand support injury during falls. If not treated promptly, symptoms such as fracture malunion and wrist dysfunction may occur [2]. Traditional open reduction and internal fixation surgery is mainly used to treat distal radius fractures in clinical practice, but factors such as intraoperative blood loss, fracture instability, and possible complications are gradually not adopted [3]. Therefore, there is a need to explore a minimally invasive surgical technique to replace traditional surgery to treat distal radius fractures.

With the development of endoscopic technology and minimally invasive concept at present, wrist arthroscopy has become a new minimally invasive technique for the treatment of distal radius fractures in recent years [4]. This surgical treatment is a series of operations such as reduction of articular surface fractures and percutaneous needle and nailing under wrist arthroscopy. Because of its minimally invasive treatment and short recovery time, it can effectively achieve the purpose of fracture reduction. At this stage, it is mainly used to treat patients with carpal fractures, synovectomy, ligament repair, and wrist dysfunction [5].

Therefore, 166 patients with distal radius fractures admitted to the hospital were selected as the study subjects. The postoperative healing time and postoperative related functional indicators of arthroscopy-assisted small incision treatment were compared with those of traditional open reduction and internal fixation using CT images. It was to explore the effect of arthroscopy-assisted small incision treatment on postoperative healing and wrist joint function in patients with distal radius fractures, and to provide a reference for clinical practice

3. Materials and Methods

3.1. General Information and Grouping

166 patients with distal radius fracture admitted to the hospital from April 2019 to January 2022 were selected as study subjects and randomly divided into two groups: study group andcontrol group. The control group consisted of 83 patients, 55 females, aged 31 ~ 66 years, with mean age of (53.18 ± 5.29) years; 28 males, aged 43 ~ 71 years, with mean age of (55.54 ± 6.29) years; causes of fracture: traffic accidents in 33 cases, smashing injuries in 28 cases, and falling in 22 cases. The study group consisted of 83 patients, 39 females, aged 33 ~ 71 years, with mean age of (55.18 ± 3.29) years; 44 males, aged 30 ~ 69 years, with mean age of (45.54 ± 6.29) years; causes of fracture: traffic accidents in 43 cases, smashing injuries in 20 cases, and falling in 20 cases. There were no significant differences in baseline data such as age, male to female ratio, and cause of fracture between two groups ($P > 0.05$). All patients signed the informed consent form. The treatment methods and detection methods used were clinically known safe methods. The general information and clinical data collected were only used for study and analysis and not for other purposes. If there was any discomfort during the treatment, the doctor in charge was informed in a timely manner to decide the next treatment plan. During the whole treatment and observation cycle, the doctor was informed of the changes in the condition in a timely manner. During the treatment, other drugs and other treatment methods for the disease should not be used without permission. If other drugs and treatment methods were used, the doctor should be informed.

Inclusion criteria: (1) Patients diagnosed as distal radius fracture by X-ray examination; (2) Patients with closed fresh fracture caused by trauma; (3) Patients were able to receive long-term follow-up after surgery; (4) Patients have good understanding and communication ability; (5) Patients without heart dysfunction.

Exclusion criteria: (1) Patients with coagulopathy; (2) Patients with old fractures; (3) Patients with mental illness; (4) Patients with other chronic diseases; (5) Female patients during pregnancy and lactation.

All patients had a detailed understanding of the content and purpose and signed an informed consent form.

3.2. Treatment

The control group underwent open reduction and internal fixation surgery. After anesthesia, the patient was placed in supine position, the upper limb was placed on the side table, and a balloon tourniquet was tied to the patient's upper arm for routine disinfection and draping. Then, an incision of about 7 cm was made in the palmar approach of the forearm, and the nerve interface between the extensor carpi longus palmar muscle and the radial artery was incised and entered. The pronator quadratus muscle and joint capsule were separated, the fracture site was exposed to maintain the palmar inclination deviation and reduction, followed by temporary fixation with 1 ~ 2 Kirschner wires according to the situation, an isometric bone plate was implanted into it, and the bone plate was fixed after drilling. C-arm machine was required to observe the smoothness of the articular surface, as well as the position and length of the internal fixation. After confirmation, the patient was given locking screw to fix, and irrigation at the incision site and repair of the joint capsule were performed.After hemostasis, normal saline was used for disinfection and cleaning. Then, stitched the skin. The study group was treated with arthroscopic assisted small incision for surgery. The anesthesia position was consistent with that of control group, and then a small incision of about 1 cm was cut on the volar skin to reduce the epiphyseal fracture of the radius, and Kirschner wires were temporarily fixed. Then take the dorsal carpal approach and insert a Smith&Nephew 2.7mm wrist arthroscope (the United States). The arthroscope was placed into the joint, a miniature camera was connected behind the arthroscope, the intra-articular condition could be clearly displayed on the screen of the television, and the intra-articular condition could be carefully observed through the arthroscope. The site of the lesion could be directly and accurately found, and the articular surface fracture of the distal radius could be explored. This is followed by clean-up, using forceps to remove fine cartilage or debris. The gapof fragments was reduced by prying reduction with a probe and Kirschner wire combined with pushing, and the Kirschner wires were temporarily fixed.

After operation, the wrist joints of patients in both groups were fixed with plaster cast to play a role in fixation. Because the incision of traditional surgery is large, the patients in the control group can be given detumescence, analgesia, and other treatments. After the operation, the corresponding rehabilitation training can be performed according to the healing condition and pain degree of the patients; the patients can be instructed to perform the simple rehabilitation activities of fingers and palms. At 14 days after operation, the patients can receive rehabilitation training of wrist joint function according to their own conditions; at 20 days after operation, they can perform simple arm activities, avoiding causing pain due to excessive force. One month after surgery, the range of motion of the arm and wrist can be gradually increased to better restore wrist function. The patient's wound healing and the patient's mobility was observed to arrange for discharge and regular reexamination. According to the reexamination to remove the Kirschner wires. Subsequently, according to the recovery of reexamination, the fixed plaster cast was removed, and the patient was told to perform appropriate strength exercise to gradually restore the wrist function. The patients in the two groups were followed up at 3 and 6 months after operation to understand the postoperative wound healing and improvement of wrist joint function. The patients were followed up at 1, 3, and 6 months after operation to investigate whether the quality of life was improved after operation.

3.3. CT Examination

A 128-row multi-slice spiral CT machine (Siemens, Shanghai Huanxi Medical Technology Co., Ltd.) was used for postoperative wrist examination. Before the scan, the patient was instructed to relax. Then, the relevant scanning parameters were set, with the voltage of 125 kV, current of 0.15 A, slice thickness of 3.5 mm, and reconstruction slice thickness of 0.8 mm. The standard scanning operation was performed according to the process, the relevant data were obtained, and the data were uploaded to the post-processing workstation for image processing, so as to obtain the best image and meet the needs of clinical diagnosis.

3.4. Outcome Measures and Evaluation Criteria

(1) The operation time, intraoperative blood loss, and hospital stay were compared between the two groups.

(2) The time of fracture healing was evaluated by CT images, and the surgical wound healing of the two groups was observed.

(3) The disabilities of the arm, shoulder, and hand (DASH) scale [6] was used to score the upper limb function at 3 and 6 months after surgery, which contained two parts, one was to assess the upper limb activity, and the other was to score the discomfort symptoms of upper limb, and a high score indicated a poor recovery of upper limb function.

(4) QOL-100 scale [7] was used at 1, 3, and 6 months after surgery to assess the quality of life level after surgery (pain degree, psychological status, independent ability, life comfort).

(5) The palmar inclination angle and ulnar deviation angle of the distal radius were measured by CT images, and the change of angle was used to indicate the effect of postoperative wrist function recovery [8].

3.5. Statistical Processing

All the data were arranged and the corresponding database was established. All the databases were entered into SPSS 26.0 for data processing. Normal test was performed on the measurement data, which was expressed as ($\bar{x} \pm s$), and the multiple-group test for compliance with normality was F. Independent sample t test was used for the data between groups, and paired sample t test was used for the data within groups. The rate was expressed as %, and the test was χ^2; multivariate analysis was performed by Logistic regression analysis. When $P < 0.05$, the difference between the data was considered statistically significant.

4. Results

4.1. Comparison of Operation Time and Postoperative Hospital Stay

The results showed that the operation time of study group was longer than that of control group, the blood loss of study group was significantly less than that of control group, and the hospital stay of study group was shorter than that of control group ($P < 0.05$) (Table 1) (Figure 1).

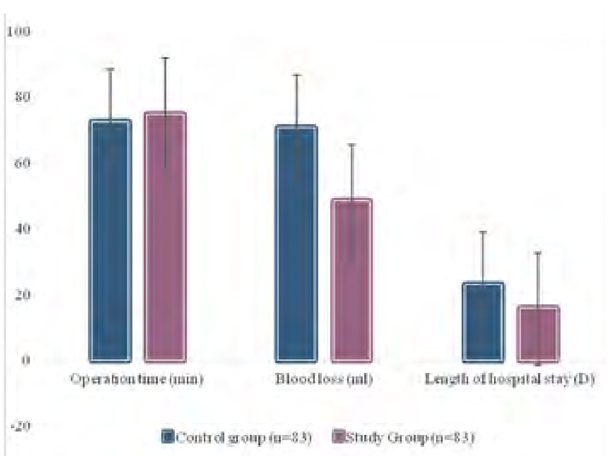

Figure 1: Comparison of operation time and hospital stay between the two groups

Table 1: Comparison of operation time and hospital stay between two groups.

Group	Operation time (min)	Blood loss (ml)	Hospital stay (d)
Control group (n = 83)	72.21±1.58	70.32±15.73	22.78±1.16
Study group (n = 83)	74.47±1.29	48.21±10.12	15.41±1.22
t	0.347	2.625	2.116
P	0.004	0.001	0.014

4.2. Comparison of Healing Time of Postoperative Fracture Wound

The comparison of healing time of postoperative fracture wound between the two groups showed that the wound healing time in study group was shorter than that in control group (P < 0.05) (Table 2). The specific wound healing of patients in the two groups is shown in Figure 2. After observation, it was obvious that the wound healing of patients in study group was better, the edge was smoother than that in control group, and the width of wound was smaller.

4.3. Comparison of upper limb function scores between two groups

Table 3 shows the statistical data of DASH scale in comparing the recovery of upper limb function between the two groups at 3 and 6 months after operation. The results showed that the DASH scores in the study group were lower than those in the control group at 3 and 6 months after operation (P < 0.05), indicating that the recovery of upper limb function in study group was better than that in control group (Figure 3).

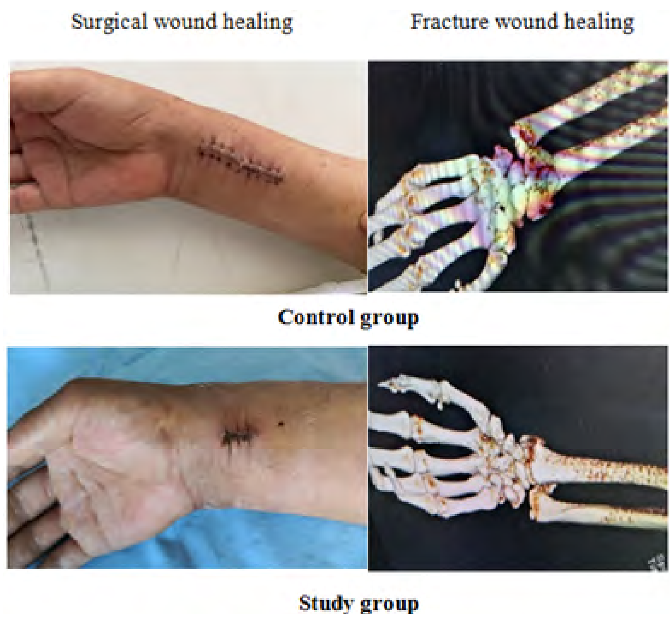

Figure 2: Comparison of surgery and fracture wound healing between two groups.

Table 2: Comparison of healing time of fracture wound between two groups.

Group	Healing time of fracture wound (weeks)
Control group (n = 83)	72.21±1.58
Study group (n = 83)	74.47±1.29
t	4.471
P	0.044

Table 3: Comparison of DASH score between two groups.

Group	3 months after operation	6 months after operation	*t*	*P*
Control group (n = 83)	13.55±2.48	9.24±3.08	5.512	0.002
Study group (n = 83)	10.63±1.11	5.73±2.68	6.417	0.001
t	4.102	4.043		
P	0.002	0.001		

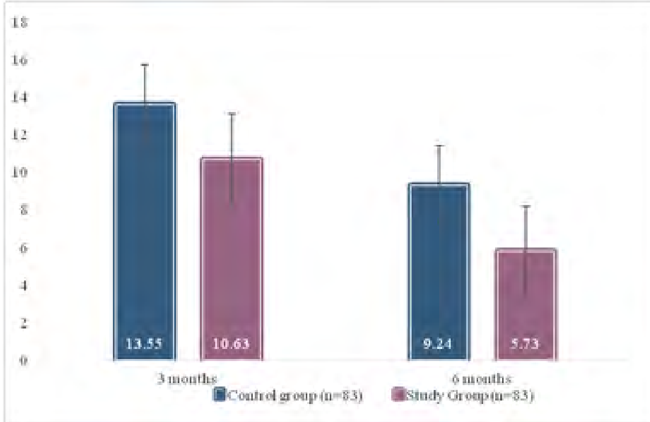

Figure 3: Comparison of DASH score between two groups.

4.4. Comparison of Postoperative Quality of Life Between Two Groups

Comparison of Wound Pain Between Two Groups

Table 4 shows the comparison of quality of life at 1, 3, and 6 months after operation between the two groups. In terms of pain severity, the scores of the two groups were gradually reduced, and the change of scores in study group was also superior to that in control group (P < 0.05) (Figure 4).

4.5. Comparison of Psychological Status Between Two Groups

Table 5 shows the statistics of quality of life at 1, 3, and 6 months after operation in the two groups. The results showed that the scores of psychological status in the two groups were significantly improved, and the change degree of scores in the study group was higher than that in the control group (P < 0.05).

4.6. Comparison of Spontaneous Ability Between Two Groups

Table 6 shows the statistics of quality of life at 1, 3, and 6 months after operation in the two groups. The results showed that the scores of spontaneous ability in the two groups were significantly improved, and the change degree of scores in the study group was higher than that in the control group (P < 0.05) (Figure 5).

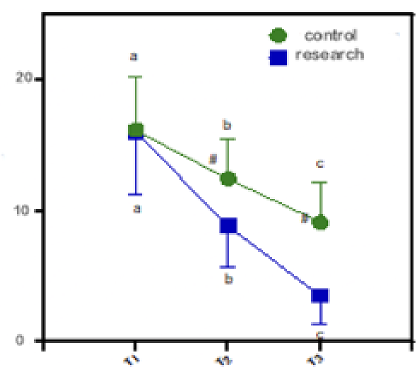

Figure 4: Comparison of wound pain severity at different time points between two groups. T1 is 1 month after treatment, T2 is 3 months after treatment, T3 is 6 months after treatment.

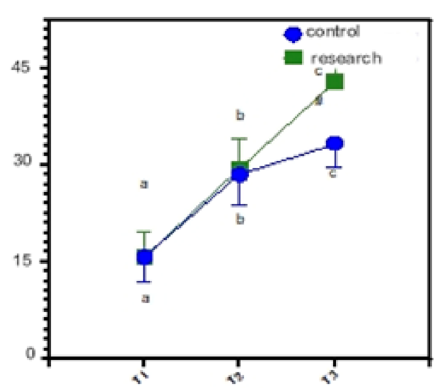

Figure 5: Comparison of spontaneous ability at different time points after operation between two groups. T1 is 1 month after treatment, T2 is 3 months after treatment, T3 is 6 months after treatment.

Table 4: Comparison of pain severity between two groups.

Group	1 month after treatment	3 months after treatment	6 months after treatment	*t*	*P*
Control group (n = 73)	15.25±3.26	8.74±1.61	3.44±1.61	2.61	0.01
Study group (n = 73)	13.55±1.42	5.14±1.62	1.01±0.61	2.41	0
t	3.415	1.346	1.475		
P	0.041	0.004	0.002		

Table 5: Comparison of psychological status between two groups.

Group	1 month after treatment	3 months after treatment	6 months after treatment	*t*	*P*
Control group (n = 73)	13.41±2.56	19.99±2.35	25.07±2.48	2.48	0.01
Study group (n = 73)	18.77±1.56	25.50±2.71	36.00±1.07	0	0
t	2.413	2.145	1.562		
P	0.022	0.021	0.01		

Table 6: Comparison of spontaneous ability.

Group	1 month after treatment	3 months after treatment	6 months after treatment	*t*	*P*
Control group (n = 73)	21.22±6.33	33.25±5.14	48.48±5.74	4.61	0.01
Study group (n = 73)	22.55±6.11	44.46±3.21	59.12±6.21	2.4	0
t	2.746	4.563	5.412		
P	0.021	0.014	0.01		

4.7. Comparison of Postoperative Life Comfort Between Two Groups

Table 7 shows the comparison of quality of life at 1, 3, and 6 months after operation between the two groups. By observing, the improvement of life comfort score month by month was found, the change degree of score in study group was higher than that in control group ($P < 0.05$) (Figure 6).

4.8. Comparison of the Postoperative Palmar Inclination Angle and Ulnar Deviation Angle of Distal Radius Between Two Groups

By a follow-up of 6 months after operation, the palmar inclination angle and ulnar deviation angle of distal radius were analyzed and compared between the two groups by CT images (Figure 7). The results showed that the changes of palmar inclination angle and ulnar deviation angle in the study group were superior to those in the control group ($P < 0.05$) (Table 8).

4.9. Logistic multiple regression analysis affecting postoperative fracture healing and wrist joint function recovery in two groups

After Logistic multiple regression analysis, excluding confounding factors, it was screened that the operation time and blood loss were the reasons affecting the postoperative fracture healing and wrist joint function recovery in the two groups. The number of patients with long operation time (> 73 min) and less bleeding (< 50 mL) who had good postoperative fracture healing and wrist function recovery was significantly higher than that of patients with poor recovery. The two independent influencing factors of operation time and blood loss were obtained ($P < 0.05$) (Table 9).

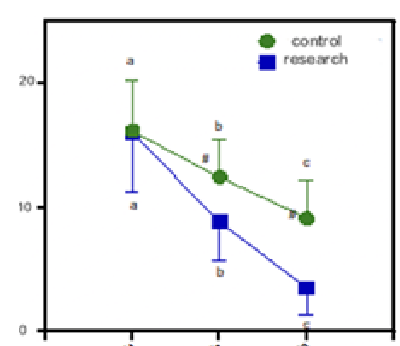

Figure 6: Comparison of life comfort at different time points after operation between two groups. T1 is 1 month after treatment, T2 is 3 months after treatment, T3 is 6 months after treatment.

Control group Study group

Figure 7: Display of CT image of wrist joint.

Table 7: Comparison of life comfort between two groups.

Group	1 month after treatment	3 months after treatment	6 months after treatment	*t*	*P*
Control group (n = 73)	61.43±10.03	66.74±9.33	68.04±2.33	1.514	0.017
Study group (n = 73)	60.12±11.04	68.01±9.01	72.45±5.61	1.402	0.001
t	5.075	3.601	2.043		
P	0.025	0.014	0.001		

Table 8: Comparison of palmar inclination angle and ulnar deviation angle of distal radius between two groups.

Group	Palmar inclination angle	Ulnar deviation angle
Control group (n = 83)	6.21±1.58	12.78±3.16
Study group (n = 83)	8.47±1.29	15.41±3.22
t	0.347	2.116
P	0.004	0.014

Table 9: Logistic multiple regression analysis results affecting postoperative fracture healing and wrist joint function recovery in two groups.

Group	Operation time		Bleeding volume	
	>73min	<73min	<50ml	>50ml
Good recovery (n = 123)	81.30%	18.70%	80.49%	19.51%
Poor recovery (n = 43)	53.49%	46.51%	27.91%	72.09%
t	12.347		11.116	
P	0.0041		0.002	

5. Discussion

The wrist joint is one of the joints more used in life, and distal radius fractures will bring many discomforts to the patient's wrist, and have a strong sense of pain, and the hand and wrist can't perform normal rotation and activities, which brings a great impact on the patient's physiology and life [9]. Therefore, the recovery of wrist joint function in patients after surgery is important, and the fixation of the distal radius fracture site is one of the effects affecting the recovery of wrist function by distal radius fracture treatment surgery [10].

The application of wrist arthroscopy-assisted small incision in the treatment of patients with distal radius fractures can better evaluate the joint injury when removing intra-articular hematoma and foreign body. Arthroscopy can directly reach the joint fracture, clearly show the anatomical reduction, correct the shortening of distal radius, restore the articular surface smoothness, have less soft tissue damage, have a short postoperative healing time, and have a significant effect on the recovery of wrist joint function [11]. The conclusion was consistent with the results of this exploration. By comparing the operation time and hospital stay between the study group and the control group, it was found that although the operation time of the study group treated with small incision with wrist arthroscopic assisted was longer than that of the control group, the discharge time of the study group was shorter than that of the control group. By comparing the upper limb function scores of the two groups at 3 and 6 months after operation, it was found that the DASH scores of the study group were lower than those of the control group at 3 and 6 months after operation, indicating that the upper limb function recovery of the study group was higher than that of the control group. It shows that small incision treatment with wrist arthroscopic assisted has less wound and less blood loss, shortens the hospital stay of patients and the overall recovery cycle of wrist joint function, and has a significant effect on the recovery of wrist function. Some relevant scholars have concluded that [12] wrist arthroscopy-assisted treatment using probe and Kirschner wire insertion and extraction for reduction combined with displacement to restore the fracture gap, temporary fixation of Kirschner wire, can enhance the stability of the fracture. Through CT scan images to obtain and analyze the fracture healing time, palmar inclination angle and ulnar deviation angle of the distal radius in the two groups, it was found that the fracture healing time of the study group treated with small incision with wrist arthroscopic assisted was shorter than that of the control group; the palmar inclination angle and ulnar deviation angle of the distal radius in the study group were also superior to those of the control group, indicating that the use of small incision with wrist arthroscopy-assisted can shorten the fracture healing time, restore the palmar inclination angle and ulnar deviation angle of the distal radius as soon as possible, and achieve the purpose of enhancing the stability of the fracture site. A large number of studies have also shown that [13-17] the traditional open reduction surgery has excessive intraoperative blood loss, causing subsequent inflammation and bring long recovery cycle to patients, and some may require a second operation, which brings life and physiological maladjustment to patients [18-22]. The use of small incision with wrist arthroscopy-assisted for treatment can reduce expose the fracture site and reduce the damage to patients. This experiment also achieved the same results. By comparing the quality of life at 1, 3, and 6 months after operation between the two groups, it was found that the scores of psychological status, independent ability, and life comfort in the two groups were significantly increased, and the score changes in the study group were higher than those in the control group. In terms of the degree of pain, the scores in the two groups were gradually decreased, and the score changes in the study group were also superior to those in the control group. Wrist arthroscopy-assisted small incision treatment can reduce the degree of pain, restore the patient's autonomy as soon as possible, and improve the patient's life comfort. After Logistic multiple regression analysis, it was found that the operation time and blood loss could be used as independent factors affecting postoperative fracture healing and wrist joint function recovery in the two groups. However, there is a lack of relevant studies, and further targeted studies are needed.

6. Conclusion

In conclusion, through the detection of CT images and other auxiliary methods, it was found that the use of small incision with wrist arthroscopy-assisted in the treatment of patients with distal radius fractures can reduce the postoperative wound pain, shorten the fracture wound healing cycle, and improve the quality of life of patients. It has a significant effect on improving the wrist joint function of patients and has clinical application value.

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