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Comparative Study on the Efficacy of Closed Reduction and Kirschner Wire Fixation versus Open Reduction and Plate Fixation in the Treatment of Hand Surgery Fractures

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Abstract: *Objective*: To investigate the therapeutic advantages of closed reduction and Kirschner wire fixation versus open reduction and plate fixation in patients with hand surgery fractures. *Methods*: The sample was collected from May 2021 to May 2025, consisting of 80 patients with hand surgery fractures. These patients were randomly divided into two groups using the red and blue ball method: the plate fixation group (40 cases, treated with open reduction and plate fixation) and the Kirschner wire fixation group (40 cases, treated with closed reduction and Kirschner wire fixation). The therapeutic effects between the two groups were randomly compared. *Results*: The Kirschner wire fixation group outperformed the plate fixation group in all indicators except for hand function scores ($p < 0.05$). There was no statistically significant difference in hand function scores between the two groups ($p > 0.05$). *Conclusion*: Compared with open reduction and plate fixation, closed reduction and Kirschner wire fixation for patients with hand surgery fractures achieves a more pronounced therapeutic effect, with advantages such as less trauma, shorter operation time, less bleeding, and a lower incidence of complications. It is suitable for hand surgery fractures with good stability. Open reduction and plate internal fixation have greater advantages in complex fractures and cases requiring high stability, and are worthy of promotion and application.

Keywords: Closed reduction and Kirschner wire fixation; Open reduction and plate fixation; Hand surgery fractures

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1. Introduction

Hand surgery fractures are a relatively common type of clinical injury, typically caused by traffic accidents, machinery-related injuries, falls from heights, and sports injuries. Due to the complex anatomical structure and delicate functionality of the hand, improper treatment after fractures can easily lead to joint stiffness, malunion, and functional impairment, significantly impacting the patient's quality of life and ability to work [1]. Therefore, selecting a reasonable and effective treatment method to achieve stable fracture fixation and restore hand function

as early as possible is crucial in hand surgery. Currently, the treatment principle for hand surgery fractures is to achieve good fracture reduction and sufficient stability while minimizing soft tissue damage, thereby facilitating early functional exercise for the patient. Closed reduction and Kirschner wire fixation offer advantages such as simple operation, minimal trauma, short surgical time, and minimal soft tissue disruption, making them particularly suitable for stable fracture types. However, their fixation strength is relatively limited, and some cases may experience pin tract infections or inadequate fixation [2]. Open reduction and internal fixation with plates enable precise reduction under guidance, providing strong fixation that helps maintain fracture stability and promotes early functional activity in patients. This method is particularly suitable for complex or unstable fractures. However, it involves relatively significant surgical trauma, extensive soft tissue dissection, and a higher risk of postoperative infection and scar formation [3]. Although the two surgical approaches mentioned above each have their own advantages, in specific clinical practice, there remain significant differences and certain controversies regarding the effects of different surgical methods on surgical trauma, fracture healing, complication rates, and postoperative hand function recovery, and there is a lack of unified clinical selection criteria [4]. Based on this, this study aims to explore the comparative efficacy of closed reduction and Kirschner wire fixation versus open reduction and plate fixation in the treatment of hand surgery fractures, with the report as follows.

2. Materials and methods

2.1. Clinical data

The sample collection period spanned from May 2021 to May 2025, with the sample comprising patients with hand surgery fractures. A total of 80 cases were included and randomly divided into two groups using the red and blue ball method: the plate fixation group (40 cases, treated with open reduction and plate fixation) and the Kirschner wire fixation group (40 cases, treated with closed reduction and Kirschner wire fixation). The Kirschner wire fixation group included 40 patients, consisting of 23 males and 17 females, with ages ranging from 18 to 65 years old, an average age of 38.45 years, and a standard deviation of 10.26 years. The plate fixation group also included 40 patients, with 25 males and 15 females; patient ages ranged from 19 to 67 years old, with an average age of 39.12 years and a standard deviation of 11.08 years. Statistical analysis revealed no statistically significant differences in general clinical data such as gender composition and age between the two groups ($p > 0.05$).

2.1.1. Inclusion criteria

(1) Patients diagnosed with hand surgery fractures through imaging examinations;
(2) Patients with fresh fractures, where the time from injury to surgery is ≤ 14 days;
(3) Patients meeting surgical indications;
(4) Patients aged ≥ 18 years;
(5) Patients with complete clinical data and a follow-up period of ≥ 6 months;
(6) Patients and their families are informed and consent to surgical treatment.

2.1.2. Exclusion criteria

(1) Patients with severe open fractures or extensive soft tissue defects;
(2) Patients with severe nerve or vascular injuries requiring simultaneous repair;
(3) Patients with pathological fractures or old fractures;

(4) Patients with infectious diseases or obvious local infections before surgery;
(5) Patients with incomplete follow-up data or lost to follow-up.

2.2. Methods

The plate fixation group underwent open reduction and internal fixation with plates. Patients were placed in a supine position, and an appropriate surgical incision was selected based on the fracture site. The skin and soft tissues were incised layer by layer to fully expose the fracture end, and anatomical reduction was performed under guidance. After satisfactory reduction, an appropriately sized mini-plate and screws were selected for internal fixation to ensure stable alignment of the fracture ends. Postoperative routine anti-infection treatment and functional rehabilitation guidance were provided.

The Kirschner wire fixation group underwent closed reduction and internal fixation with Kirschner wires. Patients were placed in a supine position, and under brachial plexus block anesthesia, manual reduction was performed under C-arm X-ray fluoroscopy guidance. After satisfactory reduction, Kirschner wires of appropriate diameter were percutaneously inserted for fixation to ensure stable fracture ends. During the surgery, repeated fluoroscopy was performed to confirm proper fracture alignment and the correct positioning of Kirschner wires, with appropriate exposure of the needle tips and bending for fixation. After the operation, patients were given routine anti-infection treatment and instructed to engage in progressive functional exercises based on the stability of their fractures.

2.3. Observation indicators

(1) Perioperative indicators
The operative time and intraoperative blood loss of patients in both groups were recorded and compared.
(2) Fracture healing
The fracture healing time (in weeks) of patients in both groups was compared, and fracture healing was assessed using imaging examinations. Fracture healing was defined as the blurring or disappearance of the fracture line and the restoration of osseous continuity.
(4) Postoperative hand function recovery
During postoperative follow-up, the Total Active Motion (TAM) or relevant functional scores were used to evaluate the hand function recovery of patients, and the functional recovery levels of patients in both groups were compared.
(5) Incidence of postoperative complications
The incidence of postoperative complications in patients in both groups was counted and compared.

2.4. Statistical methods

In this study, SPSS 22.0 statistical software was used for data processing. Measurement data were analyzed using the *t*-test and expressed as mean ± standard deviation ($\overline{x} \pm s$). Count data were analyzed using the χ^2 test and described in terms of case numbers and percentages [n (%)]. A p-value < 0.05 was considered statistically significant.

3. Results

3.1. Comparison of perioperative-related indicators

The operative time and intraoperative blood loss in the Kirschner wire fixation group were significantly lower than those in the plate fixation group ($p < 0.05$). See **Table 1**.

Table 1. Comparison of perioperative-related indicators between the two groups ($\overline{x} \pm s$)

Group	Number of cases (n)	Operative time (min)	Intraoperative blood loss (mL)
Kirschner wire fixation	**40**	42.35 ± 6.28	18.62 ± 4.15
Plate fixation	40	68.47 ± 7.92	46.83 ± 6.27
t-value	-	16.322	23.487
p-value	-	0.000	0.000

3.2. Comparison of fracture healing time

The fracture healing time in the Kirschner wire fixation group was shorter than that in the plate fixation group ($p < 0.05$). See **Table 2**.

Table 2. Comparison of fracture healing time between the two groups ($\overline{x} \pm s$, weeks)

Group	Number of cases (n)	Time to fracture healing (weeks)
Kirschner wire fixation group	40	6.84 ± 1.12
Plate fixation group	40	8.16 ± 1.35
t-value	-	4.726
p-value	-	0.000

3.3. Comparison of postoperative hand function recovery

There was no statistically significant difference in hand function recovery between the two groups ($p > 0.05$). See **Table 3**.

Table 3. Comparison of hand function recovery 6 months postoperatively between the two groups ($\overline{x} \pm s$, °)

Group	Number of cases (n)	Total active motion (TAM) score (°)
Kirschner wire fixation group	40	228.45 ± 15.26
Plate fixation group	40	231.62 ± 14.87
t-value	-	0.943
p-value	-	0.348

3.4. Comparison of postoperative complications

The incidence of postoperative complications in the Kirschner wire fixation group was lower than that in the plate fixation group ($p < 0.05$). See **Table 4**.

Table 4. Comparison of postoperative complications between the two groups [n (%)]

Group	Number of cases (n)	Incision/ Pin tract infection	Implant loosening	Delayed union	Malunion	Overall complication rate (%)
Kirschner wire fixation	40	2 (5.00)	1 (2.50)	0 (0.00)	0 (0.00)	3 (7.50)
Plate fixation	40	4 (10.00)	2 (5.00)	2 (5.00)	1 (2.50)	9 (22.50)
χ^2-value	-	-	-	-	-	4.500
p-value	-	-	-	-	-	0.034

4. Discussion

Fractures in hand surgery represent one of the common conditions encountered in orthopedics and hand surgery. Due to the intricate anatomical structure of the hand, the presence of numerous joints, and the dense arrangement of tendons, nerves, and blood vessels, improper management of fractures can readily lead to joint stiffness, functional impairment, and even permanent disability, significantly impacting patients' daily lives and work capacity [5]. Therefore, minimizing surgical trauma and promoting early functional recovery, while ensuring stable fracture healing, constitute key objectives in the treatment of hand fractures. Currently, closed reduction with Kirschner wire fixation and open reduction with internal plate fixation are the two primary surgical approaches employed in clinical practice for managing hand fractures. Open reduction with internal plate fixation enables anatomical reduction under direct visualization, offering strong fixation stability, particularly suitable for complex or unstable fractures. However, it involves greater surgical trauma, extensive soft tissue dissection, and a relatively higher risk of postoperative complications. In contrast, closed reduction with Kirschner wire fixation is characterized by its minimally invasive nature, offering advantages such as simple operation, minimal soft tissue injury, and rapid postoperative recovery. Nevertheless, its fixation strength is relatively limited, imposing stringent requirements on fracture type selection [6]. Consequently, the rational selection of surgical approach while ensuring optimal outcomes remains a focal point of clinical attention.

The results of this study show that the operation time and intraoperative blood loss in the Kirschner wire fixation group were significantly lower than those in the plate fixation group ($p < 0.05$). The reason is that closed reduction and Kirschner wire fixation do not require extensive incision of the patient's skin or dissection of soft tissues. During the operation, reduction is achieved solely through manual manipulation, and fixation is completed by percutaneously inserting Kirschner wires under fluoroscopic guidance, simplifying the operational process and significantly reducing the operation time. Meanwhile, since there is no incision exposure during the operation, extensive damage to the patient's muscles, fascia, and periosteum is avoided. The bleeding during the operation mainly comes from needle tract injuries, resulting in a significant reduction in blood loss. In contrast, open reduction and internal fixation with plates require full exposure of the patient's fracture site, anatomical reduction, and plate contouring for fixation, inevitably increasing soft tissue damage and intraoperative bleeding, involving more operational steps, and prolonging the operation time. The reduction of perioperative trauma not only facilitates postoperative recovery but also reduces the risk of inflammatory reactions and complications to a certain extent, laying a good foundation for subsequent fracture healing and functional recovery [7]. The results of this study show that fractures in both groups healed successfully, but the fracture healing time in the Kirschner wire fixation group was significantly shorter than that in the plate fixation group ($p < 0.05$). The reason is that

closed reduction and Kirschner wire fixation can achieve stable fixation without disrupting the local blood supply at the fracture site, maximally preserving the integrity of the patient's periosteum and surrounding soft tissues, which is conducive to blood supply to the fracture site and callus formation, thereby promoting fracture healing. In addition, Kirschner wire fixation is relatively flexible and aligns with the concept of "biological fixation." It can stabilize fractures while allowing for minor physiological stress stimulation, further promoting the bone healing process [8]. Although open reduction and internal fixation with plates provide strong mechanical stability, the surgical procedure inevitably involves stripping the periosteum and soft tissues of patients, which has a certain impact on local blood perfusion and can delay the fracture healing process to some extent. During the 6-month postoperative follow-up in this study, no statistically significant difference in TAM scores was observed between the two groups of patients ($p > 0.05$), suggesting that both surgical methods can achieve favorable hand function recovery outcomes during the mid-term follow-up phase. The reason for this is that open reduction and internal fixation with plates provide more reliable fracture stability, enabling patients to engage in functional exercises early after surgery, which aids in the recovery of joint mobility. Although closed reduction and Kirschner wire fixation offer less stability, their minimally invasive advantage reduces scar formation and soft tissue adhesion, creating favorable conditions for later recovery. Furthermore, both groups of patients in this study received standardized rehabilitation guidance and functional exercises after surgery, which also minimized the impact of different surgical methods on final functional recovery to some extent. Therefore, under the premise of reasonable fracture type selection and adequate postoperative rehabilitation intervention, both surgical methods can achieve satisfactory hand function recovery outcomes. The results of this study indicate that the incidence of postoperative complications in the Kirschner wire fixation group was significantly lower than that in the plate fixation group ($p < 0.05$). The reason lies in the fact that closed reduction and Kirschner wire fixation, due to its smaller incision and milder soft tissue injury, significantly reduces the risk of postoperative incision infection. Moreover, it preserves good local blood supply, which is more conducive to the smooth healing of the patient's fracture. Although there is a risk of pin tract infection, it is generally a mild local infection that can be effectively controlled through standardized treatment. In contrast, open reduction and internal fixation with a plate involves a larger incision and a wider range of soft tissue dissection in patients, which correspondingly increases the risks of postoperative infection, scar formation, and impaired blood supply. This is also one of the reasons for delayed fracture healing or even malunion in patients. Additionally, plate fixation is a rigid fixation method. If stress concentration occurs or postoperative functional exercises are not performed properly, it can also lead to complications related to internal fixation.

5. Conclusion

In summary, compared to open reduction and internal fixation with a plate, closed reduction and Kirschner wire fixation for patients with hand surgery fractures can achieve a relatively significant therapeutic effect. It offers advantages such as minimal trauma, short surgical time, less bleeding, and a low incidence of complications, making it suitable for hand surgery fractures with good stability. Open reduction and internal fixation with a plate have greater advantages in complex fractures and cases with high stability requirements, and are worthy of promotion and application.

Disclosure statement

The author declares no conflict of interest.

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