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Analysis of the Effect of Interlocking Intramedullary Nail Fixation on Treating Bone Nonunion After Extremity Trauma Fracture

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Abstract: *Objective:* To analyze the effect of interlocking intramedullary nail fixation on treating bone nonunion after extremity trauma fracture. *Methods:* 80 patients with bone nonunion after extremity trauma fracture were selected and divided into two groups according to different treatment methods, each group having 40 cases. The control group performed compression plate fixation, and the observation group performed interlocking intramedullary nail fixation. A comparison of surgical indexes, bone metabolism indexes, and surgical effects was done. *Results:* The observation group had shorter operation time and postoperative hospitalization time, the levels of various bone metabolism indexes were higher than those of the control group one month after operation, and the total effective rate of the operation was higher than that of the control group ($P < 0.05$). *Conclusion:* Interlocking intramedullary nail fixation is more effective in the treatment of post-traumatic fracture of the extremities with bone nonunion.

Keywords: Traumatic fracture of extremity; Bone nonunion; Interlocking intramedullary nail fixation

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1. Introduction

Extremity trauma fracture is a high-prevalence disease in orthopedics, which can cause more complications, such as bone nonunion. Generally, in extremity trauma fractures, the fracture site can be reset and healed after internal fixation treatment, but some patients have poor healing, i.e., bone nonunion occurs [1]. For the clinical treatment of bone nonunion after extremity trauma fracture, compression plate fixation is the most common therapy with a more satisfactory effect but a long postoperative recovery time. The interlocking intramedullary nail fixation utilizes the principle of elastic fixation, which is highly stable [2]. In this paper, we will analyze the therapeutic effect as well as the effective rate of this therapy in the post-traumatic fracture of the extremities with bone nonunion, including a total of 80 patients in the study.

2. General information and methods

2.1. General information

A total of 80 cases of patients with bone nonunion after extremity trauma fracture were screened (admission date was from January 1, 2022 to December 31, 2023), and divided into 40 cases in the control group and 40 cases in the observation group according to the different treatment methods. In the control group, there were 23 male patients and 17 female patients, with ages ranging from 24 to 63 (45.05 ± 8.17) years old, of which 13 were fibula fractures, 11 were ulnar-radial fractures, and 9 and 7 were femur and humerus fractures, respectively. In the observation group, the ratio of male to female was 25:15, the age range was 22–64 (45.11 ± 8.40) years, and the fibula, ulnar-radial, femur, and humerus fractures corresponded to 14, 10, 10, and 6 cases in that order. $P > 0.05$ when comparing the data of the two groups.

2.2. Inclusion and exclusion criteria

Inclusion criteria: (1) clear trauma history and diagnosed as bone nonunion after extremity trauma fracture after relevant examination; (2) treated with open reduction and internal fixation, with an interval of more than 9 months between the last time and the current time of treatment; (3) patients with good communication and cooperation; and (4) patients with complete general information.

Exclusion criteria: (1) belonging to pathological fracture; (2) patients with other serious diseases; (3) patients with other bone diseases or serious infection of fracture end; (4) patients with mental diseases.

2.3. Methods

After the admission of the two groups of patients, they were subjected to routine examination and combined with the actual situation, a reasonable selection of fixation materials was done to ensure that there was no allergy, the specific treatment methods are as follows:

The compression plate fixation surgical treatment was implemented for 40 patients in the control group. The patient was assisted to lie supine on the surgical bed and a routine anesthesia operation was carried out. A 10 cm size incision was performed at the fracture end, separating the skin tissue layer by layer; after the separation of the broad fascia and the surrounding tissues, periosteotomy treatment and appropriate peeling were carried out to prevent excessive damage to the periosteum, revealing the discontinuous end of the bone in the field of vision, the original internal fixation was cleared away. After the scar at the fracture end was treated accordingly, it was polished, rinsed, and reset, and then the plate was placed in parallel and fixed with cortical bone screws. The incision was sutured, and the operation was completed.

40 patients in the observation group underwent interlocking intramedullary nail fixation. The position and anesthesia method were the same as that of the control group, the length of the incision was about 8 cm, and the fracture ends were separated layer by layer to reveal the fracture ends. After some cleaning, the sclerotic bone was removed with a bone knife, and the fracture ends were polished to the trapezoidal cross-section after marrow expansion. The intramedullary nails were examined after reset and they were grooved with hollow drills, and then inserted to determine the accurate position; the locking nails were taken to lock the proximal and distal ends, and then they were fixed, cleaned, and sutured.

2.4. Observation indexes

(1) Comparison of surgical indicators: The surgical indicators included operation time and postoperative hospitalization time.

(2) Comparison of bone metabolism indexes: The indexes included epidermal growth factor (EGF), osteocalcin (BGP), osteoprotegerin (OPG), alkaline phosphatase (ALP), applying enzyme-linked

immunosorbent assay test before and one month after surgery.

(3) Comparison of surgical effects [3]: The surgical effect three months after the operation was judged by the fracture healing. If there is no compression pain and percussion pain at the fracture end, the fracture is healing well, and the fracture line is under 1 cm, it is excellent, i.e. "highly effective"; there is slight pain at the fracture end, the fracture is healing relatively well, a cloudy scab is formed, and the fracture line is under 2 cm and below, it is good, i.e. "effective"; severe pain at the fracture end, poor healing, no bone scab, fracture line above 2 cm, it is poor, i.e. "ineffective." Total effective rate = highly effective + effective.

2.5. Statistical methods

SPSS version 25.0 statistical software was used to analyze the comparative data. Measurement data were measured using mean ± standard deviation (SD), indicated by *t*-test; count data were measured using [n (%)], indicated by χ^2 test; and $P < 0.05$ was used to indicate that the comparative data were statistically significant.

3. Results

3.1. Surgical indicators

As shown in **Table 1**, the operation time and postoperative hospitalization time of the observation group were shorter than that of the control group, $P < 0.05$.

Table 1. Surgical indicators (mean ± SD)

Group	Number of cases (*n*)	Surgical time (minutes)	Post-operative hospitalization (days)
Control group	40	139.56 ± 15.17	14.18 ± 3.20
Observation group	40	126.15 ± 13.34	11.15 ± 2.27
t	-	4.198	4.884
P	-	0.000	0.000

3.2. Bone metabolism indexes

As presented in **Table 2**, compared with the preoperative bone metabolism indexes of the two groups of patients, the difference was not significant, $P > 0.05$; and in comparison with one month after the operation, the levels of all bone metabolism indexes of the observation group were higher than those of the control group, $P < 0.05$.

Table 2. Bone metabolism indexes (mean ± SD)

Group	Number of cases (*n*)	EGF (pg/ml)		BGP (ng/L)		OPG (μg/L)		ALP (mmol/L)	
		Preoperative	One month after surgery	Preoperative	One month after surgery	Preoperative	One month after surgery	Preoperative	One month after surgery
Control group	40	0.65 ± 0.13	0.87 ± 0.13	44.15 ± 5.27	53.36 ± 5.14	2.49 ± 0.41	3.32 ± 0.28	93.15 ± 7.45	145.59 ± 8.57
Observation group	40	0.68 ± 0.11	0.95 ± 0.12	44.29 ± 5.14	59.54 ± 5.57	2.45 ± 0.38	4.59 ± 0.36	93.24 ± 7.18	161.45 ± 10.18
t	-	1.114	2.860	0.120	5.157	0.453	17.612	0.055	7.538
P	-	0.269	0.005	0.905	0.000	0.652	0.000	0.956	0.000

3.3. Surgical effects

As shown in **Table 3**, the total surgical effectiveness rate of the observation group was higher than that of the control group, $P < 0.05$.

Table 3. Surgical effects [n (%)]

Group	Number of cases (*n*)	Ineffective	Effective	Highly effective	Total effective rate
Control group	40	9 (22.50)	17 (42.50)	14 (35.00)	31 (77.50)
Observation group	40	2 (5.00)	11 (27.50)	27 (67.50)	38 (95.00)
χ^2	-	-	-	-	5.165
P	-	-	-	-	0.023

4. Discussion

Bone nonunion after extremity trauma fracture refers to the situation in which the fracture end is not healed nine months after extremity trauma fracture surgery, the pain is more intense, the healing of the fracture place is greatly affected, and the limb function cannot be restored for a while. Bone nonunion requires prompt fixation treatment, applying pressure to the fracture end. In the past, the effect of the compression plate internal fixation therapy was still ideal, but it produced the effect of stress masking, affecting fracture healing and recovery of limb function [4]. Interlocking intramedullary nail fixation therapy is less invasive and has fewer complications, which makes it more effective in the treatment of bone nonunion. This study showed that the observation group had a shorter operation time and postoperative hospitalization time than the control group, indicating that interlocking intramedullary nail fixation therapy is faster compared with compression plate fixation, which is more conducive to the patient's postoperative recovery and achievement of the discharge standard.

Bone nonunion affects the blood supply to the end of the bone, and subsequently, the bone repair ability is reduced. In severe cases, the bone completely loses its repair ability, which means that the bone scab cannot be formed naturally, the fracture recovery is delayed, and the limb function recovery is also poor. Among the bone metabolism indexes, EGF is a key index to promote tissue repair, BGP affects bone healing, OPG regulates the proliferation and differentiation of mesenchymal cells, which in turn promotes the proliferation of chondrocytes and osteoblasts, and the level of ALP reflects the metabolic status of the fracture site [5,6], and these levels have a direct impact on the healing of fractures. The result data in this article showed that the bone metabolism index levels of patients in the observation group were higher than those of the control group one month after surgery, indicating that the surgical method of the observation group is conducive to improving the level of bone metabolism, which is favorable to the recovery of limb function [7]. Comparing the surgical results of the two groups, the total effective rate of 95.00% in the observation group is higher than that of the control group, which shows that the treatment efficacy of the observation group is better. In the past, the internal fixation therapy of the compression plate could fix the fracture end, however, it is necessary to fix the two ends of the fracture, greatly influencing the blood flow to the fracture end, which is inconducive to the healing of the fracture. In addition, the bending stress is relatively large, and the rehabilitation training is hindered in the later stage; moreover, when performing the fixation with the steel plate, its effect will be gradually weakened in the period of fracture resorption [8], which is prone to secondary fracture. The principle of interlocking intramedullary nail fixation therapy is elastic fixation and good biomechanics; after the pressure is applied, it can prevent the displacement or rotation of the bone, which can help the healing of the fracture. In addition to its good flexibility [9], high adaptability, and no effect on the subsequent rehabilitation exercise, the treatment technique

can also prevent excessive impact on the blood supply of the fracture end tissues; there is less pain and there are sufficient nutrients to promote the healing of the fracture, and gradually restore the bone metabolism [10]. Overall, the healing effect is ideal, with light trauma and less impact, it stimulates the formation of bone scabs, the fracture ends can have a rapid and good recovery, and limb function is gradually enhanced.

5. Conclusion

In summary, it can be seen that the application of interlocking intramedullary nail fixation in the treatment of post-traumatic fracture of the extremities with bone nonunion has high efficiency and is worthy of promotion.

Disclosure statement

The authors declare no conflict of interest.

References

[1] Yan X, Ji F, Xian Y, 2023, Clinical Effect of Locked Intramedullary Nail Fixation for the Treatment of Post-Traumatic Fracture of the Extremities with Bone Nonunion and Its Effect on the Activity of the Extremities. China Modern Drug Application, 17(16): 60–63.

[2] Chen G, Xue Z, Li H, et al., 2022, The Effect of Locking Intramedullary Nailing or Plate Fixation Implanted with Autogenous Bone and Artificial Bone in the Treatment of Post-Traumatic Fracture of the Extremities with Osteoarthritis. Clinical Medicine, 42(10): 5–7.

[3] Yu H, 2022, Effect of Internal Fixation with Locked Intramedullary Nails on the Treatment of Bone Nonunion After Extremity Trauma Fracture. Jilin Med, 43(8): 2214–2216.

[4] Li Z, Liu H, 2022, Clinical Effect of Locked Intramedullary Nail Fixation for Treatment of Bone Nonunion After Traumatic Fracture of Limbs and Its Effect on Limb Activity. Clinical Medicine Research and Practice, 7(24): 62–64.

[5] Xu W, Yu T, Jiang S, et al., 2021, Application of Locked Intramedullary Nail Fixation in the Treatment of Bone Nonunion After Extremity Trauma Fracture. Chinese Disability Medicine, 29(22): 41–42.

[6] Dang H, Guo Y, 2021, Analysis of the Role of Compression Plate and Locking Intramedullary Nail Fixation in the Treatment of Post-Traumatic Fracture of Extremities with Bone Nonunion. Guizhou Medicine, 45(1): 73–74.

[7] Zheng Y, 2022, Clinical Study on the Treatment of Bone Nonunion After Limb Fracture by Combination of Kidney Tonifying and Bone Catching Formula with Locked Intramedullary Nail Internal Fixation. New Chinese Medicine, 54(4): 90–93.

[8] Xia L, Wang X, Chu H, et al., 2023, Comparison of the Effects of Internal Fixation with Locked Intramedullary Nails and Locked Plate on Postoperative Limb Function in Patients with Long Bone Diaphysis Fractures of the Upper Limb. Chinese Journal of Clinical Physicians, 51(12): 1468–1470.

[9] Wu J, Wang P, 2023, Technique and Analysis of Unarmed Distal Locking of Femoral Interlocking Intramedullary Nails. Chinese Journal of Modern Surgery, 27(1): 79–80.

[10] Hao B, Jia P, Wang Y, et al., 2022, Comparison of the Efficacy of Femoral Angle-Stabilizing Locking Intramedullary Nailing and Proximal Anti-Rotation Intramedullary Nailing in the Treatment of Cis-Rotor Intertrochanteric Fractures. Chinese Journal of Orthopaedics, 42(18): 1212–1219.