

Research Article

Comparison of Clinical Effects of Intramedullary Nail Internal Fixation and Traditional Steel Plate Internal Fixation in the Treatment of Zhang-Hou Fracture

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Abstract

Objective: The objective of this study was to analyse and compare of the clinical effects of two surgical methods in the treatment of Zhang-Hou fracture; **Method:** A total of 34 patients with Zhang-Hou fracture diagnosed in our hospital from 2020.08 to 2022.06 were reviewed. Among them, 17 patients were treated with tibial intramedullary nail internal fixation and 17 patients with traditional steel plate internal fixation. The blood loss, operation time, fracture healing time, excellent rate of affected limb function and postoperative complications were compared between the two groups. **Result:** The operation time, intraoperative blood loss and fracture healing time were shorter in the intramedullary nail group, and the excellent rate of limb function in the intramedullary nail group was higher than that in the plate group 6 months after operation, but there was no significant difference between the two groups 12 months after operation. All the patients in the intramedullary nail group hadn't serious complications after operation. Among the 17 patients in the plate group, 1 patient had wound infection and 1 patient had delayed fracture healing. **Conclusion:** In the clinical treatment of Zhang-Hou fracture, tibial intramedullary nail internal fixation not only has the advantages of short operation time, less trauma and quick recovery after operation, but also has better functional recovery of the affected limb and less postoperative complications. However, clinicians' learning curve of tibial intramedullary nail internal fixation is relatively long.

Keywords

Zhang-Hou Fracture, Tibial Intramedullary Nail, Steel Plate Internal Fixation

1. Introduction

Zhang-Hou fracture is composed of lower 1/3 spiral fracture of the tibia combined with posterior ankle fracture

[1]. This kind of fracture is mostly due to the fixation of foot and ankle during exercise, and the lower limb contin-

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ues to move forward and rotates to the outside because of inertia, resulting in spiral fracture of lower tibia. The fracture of the posterior malleolus is mainly due to the avulsion fracture caused by the traction of the inferior tibiofibular ligament during exercise, or the fracture caused by the forward force of the tibia and the shearing of the talus [2]. At present, tibial intramedullary nail internal fixation and traditional steel plate internal fixation are mainly selected for its fracture. In recent years, there are few reports about Zhang-Hou fracture at home and abroad, and there is no unified understanding of the clinical treatment of Zhang-Hou fracture. Therefore, this study will explore the comparison of the clinical effects of two surgical methods in the treatment of Zhang-Hou fracture.

2. Information and Methods

2.1. General Information

A total of 34 patients with Zhang-Hou fracture diagnosed in our hospital from 2020.08 to 2022.06 were reviewed. Among them, 17 cases were treated with tibial intramedullary nail internal fixation and 17 cases were treated with traditional steel plate internal fixation. The preoperative general data between the two groups was no significant difference.

2.2. Inclusion Criteria and Exclusion Criteria

- 1) Inclusion criteria: clearly diagnosed as inferior tibial 1/3 spiral fracture and posterior malleolus independent fracture; patients with fresh fracture; patients with unilateral fracture.
- 2) Exclusion criteria: patients with open fracture; patients with pathological fracture; old fracture (injury time ≥ 14 days); complicated with severe medical diseases or lower limb dysfunction.

2.3. Surgical Methods

- 1) Internal fixation of tibial intramedullary nail: The surgeon rule out the contraindications of operation and anesthesia according to the preoperative examination of the patient. The patient is taken with supine position after successful anesthesia and disinfected, paved sterile sheet. We used three K-wires to fix the fracture of posterior malleolus. The surgeon take about 3cm longitudinal incision in the patella, gradually separate muscle, enter the articular cavity, drill into the K-wire along the sleeve, confirm the entry point under the perspective of the C-arm machine, pull out the K-wire, place the guide needle, stop the guide needle at the proximal end of the fracture, select and implant the

appropriate size interlocking intramedullary nail. The fracture of posterior malleolus was fixed by hollow nail. Suture the wound layer by layer and wrap it with aseptic dressing.

- 2) Traditional plate and screw internal fixation: The surgeon rule out the contraindications of operation and anesthesia according to the preoperative examination of the patient. The patient is taken with supine position after successful anesthesia and disinfected, paved sterile sheet. The fracture of posterior malleolus was fixed with K-wire and hollow nail was inserted percutaneously. The surgeon take the broken end of the tibial fracture as the center, take the length of the 15cm longitudinal incision, gradually separate the muscle, expose the broken end of the fracture, remove blood stasis, select the appropriate size of anatomical locking plate, screw in several locking screws and cortical screws. Under the fluoroscopy of C-arm machine, it is confirmed that the reduction effect is satisfactory and the position of plate and screw is suitable. Suture the wound layer by layer and wrap it with aseptic dressing.

2.4. Observation Index

- 1) Operative related indexes: operation time, fracture healing time; intraoperative blood loss;
- 2) Excellent rate of functional recovery 6 months and 12 months after operation (evaluated according to Johner-Wruhs scale of tibial effect);
- 3) Postoperative complications: wound infection, fracture nonunion, internal fixation loosening and so on.

2.5. Statistical Method

The data were processed by SPSS26.0. The measurement data were expressed by mean \pm standard deviation ($\bar{x} \pm s$), and the vertical sample t-test was performed between groups. The paired t-test was performed within groups, and the counting data was expressed as percentage (%). The $P < 0.05$ indicates that the difference is statistically significant.

3. Results

3.1. Comparison of Operation-Related Indexes Between the Two Groups

The intraoperative bleeding in the intramedullary nail group was less than that in the plate group, and the operation time and fracture healing time in the intramedullary nail group were significantly shorter than those in the plate group ($P < 0.05$). See Table 1.

Table 1. Comparison of operation-related indexes among two groups of patients.

	bleeding volume (ml)	Operation time (min)	Fracture healing time (w)
Intramedullary nail group	102.2±13.2	105.9±9.0	15.6±1.2
Steel plate group	125.5±14.0	135.4±12.9	17.5±1.5
t	-5.004*	-7.706*	-4.004*

Note: *: $P < 0.05$

3.2. Comparison of the Excellent Rate of Postoperative Function Between the Two Groups

The postoperative functional scores of 17 patients in the intramedullary nail group were excellent and the excellent rate was 100%. Six months after operation, the functional scores of 17 patients in the steel plate group were excellent in 11 cases, good in 2 cases, poor in 4 cases, and the excellent rate was 76.47%. The comparison was statistically significant ($\chi^2=4.53$, $P=0.0332$). 12 months after operation in the steel plate group, 15 cases were excellent, 1 case was good and 1 case was poor. The excellent and good rate was 94.12%, and the comparison was not statistically significant ($\chi^2=1.03$, $P=0.310$).

3.3. Postoperative Complications in Two Groups

All the 17 patients in the intramedullary nail group hadn't complications such as wound infection and nonunion, while in the plate group, there were 1 patient with wound infection and 1 patient with delayed fracture healing.

4. Discussion

Zhang-Hou fracture was proposed by academician Zhang Yingze and Professor Hou Zhiyong in the third Hospital of Hebei Medical University. Because the posterior malleolar fracture is not connected with the tibial fracture line, it will lead to the missed diagnosis of posterior malleolar fracture [3]. The main reason of the missed diagnosis is that clinicians are inexperienced or neglect the examination of posterior malleolus fracture. At present, the clinical treatment of Zhang-Hou fracture is mainly tibial intramedullary nail internal fixation and traditional steel plate internal fixation. The traditional steel plate internal fixation requires open reduction [4-7] and periosteum peeling off [8], which destroys the blood flow of the broken end of the fracture and soft tissue, increases the risk of postoperative wound infection and delays the fracture healing time. The tibial intramedullary nail internal fixation didn't destroy the blood supply and soft

tissue around the fracture [9, 10], and the fixation was reliable [11], which reduced the occurrence of postoperative complications. And the intramedullary nail has better biomechanical advantages [12, 13], which makes the functional recovery of the affected limb faster [14].

In this study, the operation time, intraoperative blood loss and fracture healing time in the intramedullary nail group were less than those in the steel plate group, indicating that the tibial intramedullary nail had less trauma and faster recovery after operation. There was no significant difference in the functional evaluation of the affected limb between the intramedullary nail group and the steel plate group 12 months after operation, indicating that better functional recovery of the affected limb could be achieved in the two groups in the long term. 6 months after operation, the functional evaluation of the affected limb in the intramedullary nail group was better than that in the steel plate group, mainly because the patients in the steel plate group were unable to exercise in the early stage after operation, which affected the functional exercise of the affected limb. 17 patients in the intramedullary nail group had no serious complications after operation. 1 patient with wound infection and 1 patient with delayed bone healing occurred in the steel plate group, mainly because the operation of steel plate internal fixation was traumatic and destroyed the blood flow around the fracture.

In the clinical treatment of Zhang-Hou fracture, compared with traditional plate internal fixation, tibial intramedullary nail internal fixation has the advantages of shorter operation time, less trauma, faster postoperative recovery and less complications [15]. However, clinicians' learning curve of tibial intramedullary nail internal fixation is relatively long.

5. Conclusion

In the clinical treatment of Zhang-Hou fracture, tibial intramedullary nail surgery has advantages such as short surgical time, minimal intraoperative trauma, fast postoperative recovery, and fewer complications, which are worthy of clinical promotion and application.

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Conflicts of Interest

All authors declare that there is no conflict of interest.

References

- [1] Zhang YZ, Hou ZY, Zhang Q, et al. Injury types and grading of lower tibial 1/3 spiral fracture combined with posterior malleolar fracture [J]. Hebei Medical Journal, 2007(12): 1337-1338.
- [2] Zhang YZ, Hou ZY, Zhang Q, et al. Study on the relationship between lower tibial 1/3 spiral fracture and ankle joint injury [J]. Journal of Hebei Medical University, 2007(05): 364-365+402.
- [3] Ye ZY, Huang DL, Wang J, et al. Study on the Efficacy of Semiextended Positioning Intramedullary Nailing Combined with Hollow Screw Fixation in the Treatment of Spiral Fracture of the Distal Third of the Tibia Combined with Posterior Ankle Fracture [J]. Progress in Modern Biomedicine, 2022, 22(13): 2509-2513.
- [4] Lim S, Song HK, Kim TH, et al. Comparison of suprapatellar intramedullary nailing versus minimal invasive locked plating for proximal tibia fractures. Arch Orthop Trauma Surg. 2023 Jul 19.
- [5] Schaffer NE, Wilson JL, Yee MA, et al. Intramedullary Nail for a Distal Tibia Fracture. J Orthop Trauma. 2020 Aug; 34 Suppl 2: S37-S38.
- [6] Cheng L, Li YH, Chu Y, et al. Intramedullary nailing via suprapatellar approach versus locked plating of proximal extra-articular tibial fractures: a randomized control trial. Int Orthop. 2021 Jun; 45(6): 1599-1608.
- [7] Wang DE, Hu W, Li H, et al. Comparison of efficacy between LISS plate and expert tibial intramedullary nail in treatment of middle and lower tibial fractures [J]. ChinJBoneJointInjury, 2022, 37(06): 589-593.
- [8] Song MY. Clinical application of tibial intramedullary nail and locking compression plate in the treatment of middle and lower tibial fracture [J]. Heilongjiang Medicine Journal, 2021, 34(06): 1435-1437.
- [9] Chen J, Wu L, Zhao H, et al. Comparison of suprapatellar versus infrapatellar approach for intramedullary nailing of the tibia shaft fractures: A systematic review and meta-analysis. Asian J Surg. 2023 Jul 19: S1015-9584(23) 01052-7.
- [10] Franke J, Hohendorff B, Alt V, Thormann U, Schnettler R. Suprapatellar nailing of tibial fractures-Indications and technique. Injury. 2016 Feb; 47(2): 495-501.
- [11] Dan M R, Radu S F, Ioan C M, et al. Extraction of Broken Interlocking Tibial Nails: A Review of Surgical Techniques and Practical Management [J]. Applied Sciences, 2023, 13(3).
- [12] Yang CY, Tay ST, Kuo LT. Suprapatellar vs infrapatellar approaches for intramedullary nailing of distal tibial fractures: a systematic review and meta-analysis. J Orthop Traumatol. 2023 Apr 11; 24(1): 14.
- [13] Yang L, Sun Y, Li G. Comparison of suprapatellar and infrapatellar intramedullary nailing for tibial shaft fractures: a systematic review and meta-analysis. J Orthop Surg Res. 2018 Jun 14; 13(1): 146.
- [14] Zhang HR, Sun YG, Cao LC. Effect of suprapatellar approach tibial intramedullary nail internal fixation on postoperative pain visual analogue scale and knee joint function in patients with middle and lower tibial fracture [J]. China Medical Engineering, 2022, 30(02): 123-125.
- [15] Methods In Medicine CAM. Retracted: Comparison of the Effects of Intramedullary Nailing and Plate Fixation on Lower-Extremity Deep Vein Thrombosis after Tibial Fractures. Comput Math Methods Med. 2023 Jun 28; 2023: 9842947.