ORIGINAL RESEARCH

To Explore the Clinical Application Value of the Ilizarov Bone Handling Technique in the Treatment of Tibial Bone Defects Caused by Osteomyelitis Segmental Resection

Qiang Guo, MM; Shan Yun, MD; Zhigang Lang, MM

ABSTRACT

Objective • To study the application value of Ilizarov bone handling technology in the treatment of tibial bone defect caused by osteomyelitis segmental resection.

Methods • 78 patients with tibial bone defects after osteomyelitis segmental resection admitted to our hospital from January 2018 to August 2019 were retrospectively analyzed and assigned to the Ilizarov bone handling group (38 cases) and the fibular segmental transplantation group (40 cases). The perioperative indexes between the groups were compared (external fixation time, complete weight-bearing time, and intraoperative bleeding volume). The ankle function and knee function of patients were assessed before and 6 months after treatment and the occurrence of postoperative complications were counted.

Results • The external fixation time and full weight-bearing time in the Ilizarov bone handling group were significantly shorter than those in the fibular segment transplantation group, and the intraoperative bleeding was less, with statistically significant differences ($P < .05$). Compared to the pre-treatment period, Baird's scores and HHS scores of the patients in both groups increased significantly after 6 months of treatment, and both scores in the Ilizarov bone handling group were significantly higher than those in the fibular segment transplantation group, and the differences were statistically significant ($P < .05$). The postoperative complication statistics showed that the complication rate of the Ilizarov bone handling group was significantly lower than that of the fibular segment transplantation group ($P < .05$).

Conclusion • The Ilizarov bone transfer technique is less invasive than the fibular bone grafting technique used in the treatment of patients with osteomyelitis segmental resection-induced tibial bone defects, with the former having the advantages of less traumatization, faster recovery of the patients, better recovery of knee and ankle functions, and fewer complications, which is of high value for clinical application. (*Altern Ther Health Med.* 2024;30(10):297-301).

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INTRODUCTION

Osteomyelitis is a serious bone-destroying inflammatory disease caused by a bacterial infection that can occur in all age groups and has long been of great concern to the medical community because of its potentially serious consequences. Patients usually experience severe pain, high fever, localized redness and swelling, and dysfunction of the eroded bone during the acute onset of the disease, which is often debilitating. The main treatment options for osteomyelitis include antibiotic therapy and surgery, which usually involves the removal of the infected bone tissue to control the infection and promote recovery. However, this surgical treatment is often accompanied by the development of tibial bone defects, which adds to the complexity of osteomyelitis treatment.[1,2]

Tibial bone defects are a serious complication that, if not treated effectively, may lead to impaired joint function, persistent pain, and even patient disability. In recent years, with the incidence of osteomyelitis gradually increasing, the number of patients with tibial bone defects due to surgical treatment has significantly increased. This phenomenon has attracted widespread attention from the medical community, prompting clinicians and researchers to seek better treatments to address this complex clinical challenge.

Currently, there are various methods for treating tibial bone defects, including fibular segmental grafting, allograft bone grafting, etc. However, in practice, these methods encounter several challenges, such as surgical complexity, longer postoperative rehabilitation periods, and increased risk of complications.[3,4] In recent years, the application of the

Ilizarov bone handling technique in the treatment of tibial bone defects has gradually emerged. This technique, with its unique treatment modalities, including the application of external fixation devices and a stepwise bone handling approach,[5,6] is considered to have significant clinical advantages in the treatment of tibial bone defects. Recent studies have already pointed out that the Ilizarov bone handling technique has demonstrated significant advantages in terms of the speed of patient recovery and the incidence of postoperative complications when compared with conventional fibular segmental grafting treatment.[7]

Therefore, this study retrospectively included 78 cases of tibial bone defects due to osteomyelitis treated with the Ilizarov bone handling technique or fibular segmental grafting from January 2018 to July 2019 and analyzed the clinical effects of the two treatment modalities to evaluate their application value in the treatment of tibial bone defects due to osteomyelitis and to provide the medical community with more innovative and precision guidance for the medical community. This study will provide an important basis for improving the recovery and quality of life of patients, as well as optimizing treatment strategies, and will also provide new insights for future clinical practice and research, and promote further exploration in the field of osteomyelitis and associated complications.

METHODS

Participants

This study utilized a retrospective cohort design scheme to collect data and information based on the hospital's electronic medical record system and consecutively included a total of 78 patients with tibial bone defects due to osteomyelitis segmental resection from January 2018 to July 2019. Patients were categorized into the Ilizarov bone handling group (38 cases) and fibular segmental grafting group (40 cases) based on the type of treatment received.

Selection criteria

Inclusion criteria. (1) Age between 10 and 65 years; (2) No defect in the proximal tibia; (3) Normal level of white blood cells in the test; (4) Informed about this study and voluntarily lent their clinical data for this study; (5) No autoimmune disease.

Exclusion criteria. (1) The presence of a defect on the healthy side of the fibula; (2) The presence of malignant tumors or a history of cancer; (3) Imperfect clinical information or the inability to provide necessary clinical information and data; (4) Severe knee and ankle dysfunction.

The study was approved by the hospital ethics committee, and all participants signed an informed consent form.

Surgical method

Ilizarov bone handling group. After induction of anesthesia, the necrotic tissue and surrounding inflammatory tissue of the patient are thoroughly removed, the external fixation device is installed, the spacing of each ring is adjusted according to the length of the patient's bone defect, and the spacing of the rings is adjusted to ensure that the distance between the osteotomy line and the site of piercing the needle is at least 10 mm, a full ring is placed in the upper and lower end of the patient's calf, and a full needle with the diameter of 2.0 mm is pierced in the distal and proximal metaphyses of the fibula, and it passes through the distal fibula to the proximal end. The distal end was positioned 20 mm below the fibular plateau, at least 10 mm from the ankle joint surface, and the crossing angle was maintained at no less than 30°. The Kirschner pin was adjusted to the appropriate degree using the retractor.

Fibular segment transplantation group. Take the middle and upper part of the fibula on the healthy side of the patient and select the fibula with the supply of peroneal artery for transplantation, cut in the middle and upper part of the fibula, separate the fibula, and select the osteotomy of the outer ankle at the level of 10 cm or more for spare, and pay special attention to the protection of the peroneal nerve behind the tendon of the biceps tendon in the process of bone extraction. The length of the fibula is usually 1-3 cm longer than the length of the bone defect. After the scar is removed from the bone defect, the remaining hardened bone is removed, the medullary cavity is penetrated, and the fibula is placed in the bone defect. Finally, both ends were fixed with screws, and then the peroneal artery and vein were anastomosed, and the surgical incision was closed with a drain.

Postoperative treatment. In the Ilizarov bone transfer group, bone transfer was started at 4 ~ 7 d postoperatively, and the transfer speed was controlled at 1 mm/d. During the period, patients were closely observed for limb sensory abnormalities and skin and soft tissue abnormalities, and bone transfer was terminated as soon as abnormalities appeared, and then started again when the abnormalities were lifted, and bone healing was monitored using X-ray during the period. As for the fibula segment transplantation group, the drainage tube was removed in 2-3 d after the operation, and the external fixation frame and internal fixation were removed according to the recovery of the patients.

Observation indexes

Perioperative indexes. Several perioperative indexes were compared between the two groups of patients, including postoperative complete weight-bearing time, external fixation time, intraoperative bleeding volume, etc.

Joint function assessment. The ankle joint function and knee joint function were assessed before and 6 months after treatment using the Baird scoring system and the HHS scoring system, which covers all aspects of the ankle joint, including pain, swelling, joint stability, range of motion and function, and the HHS scoring system, which covers all aspects of the hip joint, including pain, function, gait, and range of motion. Both scores are positively scored, with higher scores suggesting better ankle function, a higher degree of rehabilitation, better hip function, and less pain.

Complication statistics. In addition, this study will also record the occurrence of complications after the patients receive surgical treatment.

Statistical Analysis

Excel 2019 was used for data entry, and Statistic Package for Social Science (SPSS) 25.0 statistical software (IBM, Armonk, NY, USA) was used to statistically analyze the data. Measurement data satisfying normal distribution were described by ($\bar{x} \pm s$), and the t test was used for comparison between groups; continuous variables not normally distributed were described by median and quartiles, and the Wilcoxon rank sum test was used for comparison between groups. Count data were described by frequency and percentage, and comparisons between groups were made using the χ^2 test. The difference was considered statistically significant if $P < .05$.

RESULTS

Comparison of general data

There was no statistically significant difference upon comparing the length of bone defects, age, gender, and length of bone defects between the two groups ($P > .05$), suggesting that the two groups were comparable at baseline (Table 1).

Comparison of perioperative indicators between the two groups

Comparing the perioperative indexes of the two groups (Table 2), it was found that intraoperative bleeding was less in the Ilizarov bone handling group, the time of external fixation and the time of complete weight-bearing were significantly shorter, and the difference was statistically significant ($P < .05$).

Comparison of HHS and Baird scores of patients in two groups

A comparison of the Baird score and HHS score of the two groups of patients before treatment and after 6 months of treatment revealed that there was no significant difference between the two groups of patients ($P > .05$); both scores increased significantly after 6 months of treatment, and the scores of the Ilizarov bone handling group were significantly higher than those of the fibular segmental transplantation group. The difference between the two groups was statistically significant ($P < .05$) (Table 3).

Comparison of the statistical results of complications between the two groups

The Ilizarov bone handling group had fewer events of infection, circulatory disorders, and poor fixation than the fibular segmental grafting group, and the complication rate was significantly lower, with a statistically significant difference between the two groups ($P < .05$) (Table 4).

Table 1. Comparison of General Data of Each Group

Item		Ilizarov bone handling group (n = 38)	Fibular segment transplantation group (n = 40)	χ^2/t	*P* value
Sex	Male	26 (68.42)	29 (72.50)	0.010	.922
	Female	12 (31.58)	11 (27.50)		
Age		40.52 ± 6.31[a]	40.01 ± 6.03	0.365	.716
BMI		20.90 ± 2.48[a]	20.10 ± 2.36	0.768	.209
Side (example, left/right)		18/20	25/15	0.351	.468
Length of bone defect (cm)		10.36 ± 2.61	10.58 ± 2.67	0.368	.714

[a]Suggesting that the two groups were comparable at baseline.

Table 2. Comparison of Perioperative Indicators Between the Two Groups

Group	n	Intraoperative bleeding (ml)	External immobilization time (m)	Time to complete weight bearing (m)
Ilizarov group	38	113.69 ± 23.58[a]	12.63 ± 1.58[a]	23.97 ± 3.06
Fibula group	40	148.97 ± 30.64[a]	16.03 ± 2.07[a]	20.69 ± 2.87
t	-	5.678	8.179	4.877
P value	-	.001	.001	.001

[a]The difference was statistically significant.

Table 3. Comparison of HHS and Baird Scores Between the Two Groups

Group	n	HHS scores		Baird scores	
		pre-treatment	After 6 months	pre-treatment	After 6 months
Ilizarov group	38	60.52 ±6.87	90.69 ± 7.94[a]	61.52 ± 6.03	88.97 ± 7.85[a]
Fibula group	40	61.06 ± 7.01	81.64 ± 7.52[a]	61.85 ± 6.18	82.63 ± 6.97[a]
t	-	0.343	5.163	0.239	3.765
P value	-	0.732	0.001	0.812	0.001

[a]The difference between the two groups was statistically significant.

Table 4. Comparison of the Statistical Results of Complications Between the Two Groups

Group	n	Infection	Circulatory disorders	Poor fixation	Complication rate
Ilizarov group	38	1 (2.63)	1 (2.63)	0 (0.00)	2 (5.26)
Fibula group	40	3 (7.50)	2 (5.00)	3 (7.50)	8 (20.00)
t	-	2.466	0.765	7.792	9.845
P value	-	.116	.382	.005	.01

[a]The difference between the two groups was statistically significant.

DISCUSSION

Tibial osteomyelitis is a serious infectious disease usually caused by purulent bacteria infecting a wound. Clinical treatments include debridement, antibiotic therapy, and surgical intervention. However, in some cases, it is difficult to achieve satisfactory results by only relying on debridement and antibiotic treatment, and surgical resection of the patient's infected bone tissue is needed to control the progression of the disease.[8,9] Although osteotomy can effectively eradicate osteomyelitis, the bone defect may have a serious impact on the patient's limb function. Currently, methods commonly used to treat bone defects in the tibia include fibular segmental grafting treatment and Ilizarov bone handling treatment. However, fibula segmental grafting may be more suitable in dealing with smaller bone defects, but in the case of patients with large bone segmental defects, large bone grafts may face the risk of ischemia-oxidative necrosis, which does not achieve the goal of rapid restoration of the function of the affected limb, and the area of the bone grafting will leave a new bone defect in the process of bone harvesting.[10-12]

In recent years, the Ilizarov bone transfer technique has been gradually highlighted as a good application in the treatment of tibial bone defects caused by osteomyelitis segmental resection. Compared with the fibular segmental grafting technique, Ilizarov bone handling technique has multiple advantages: first, it conforms to the principle of minimally invasive surgery, with less overall surgical trauma, which reduces the patient's pain and recovery time; second, the minimally invasive osteotomy process combined with a firm external fixation frame eliminates the need for internal fixation, avoids the trauma of removing internal fixation in a second surgery, and reduces the burden of medical treatment; moreover, the Ilizarov technique is applied by applying a constant force to the tibial bone. Ilizarov technique stimulates the regeneration of bone tissue by applying continuous and slow tension,[13] which promotes the formation and repair of new bone; most importantly, after fixation of the affected limb in an external fixator, patients can get out of bed earlier, which not only helps bone regeneration, but also prevents adverse events such as venous thrombosis of the lower limbs and pressure ulcers due to prolonged bed rest, and accelerates the rehabilitation of the patient's knee and ankle joint functions.[14]

In this study, it was found that the perioperative indexes, ankle joint function score and knee joint function score after 6 months of treatment, and the incidence of postoperative complications of patients in the Ilizarov bone handling group were significantly better than those in the fibular segmental transplantation group (P <0.05). It was confirmed that in the treatment of patients with osteomyelitis segmental resection resulting in tibial bone defects, the Ilizarov bone transfer technique can reduce surgical trauma, reduce postoperative complications, accelerate the recovery of patients, and effectively restore the function of the knee and ankle joints of the affected limbs. This is consistent with the findings of Sun J[15] and Zhou N[16], and this study confirms that the Ilizarov bone handling technique has good application value in the treatment of patients with tibial bone defect caused by osteomyelitis segmental resection.[17-20]

However, the Ilizarov bone handling technique needs to be considered for the management of complications along with its wide application.[21,22] To minimize patient discomfort, the medical team needs to establish an effective management strategy, including early diagnosis, treatment of infections, maintenance and adjustment of external fixation frames, and individualized treatment according to the size and location of the bone defect to ensure that each patient receives an optimal treatment outcome.[23] Future studies can also further optimize the surgical techniques of the Ilizarov bone handling technique, including the design and application of external fixation frames to reduce potential complications; and explore new biomaterials and bioengineering methods to promote bone tissue regeneration and healing, thereby providing more options for future treatments.

Study Limitations

Although this study achieved some valuable findings, there are some shortcomings: first, this is a single-center study and thus may be subjected to selective bias. Second, the sample size of this study was relatively small, and a larger multicenter study is needed to validate our findings. Finally, this study did not include long-term follow-ups which could help to evaluate which method has the best long-term efficacy.

CONCLUSION

In conclusion, the treatment outcome of the Ilizarov bone transfer technique in patients with tibial bone defects after segmental resection for clinical osteomyelitis is remarkable, having obvious advantages of less traumatization, fewer postoperative complications, and quicker recovery of joint function. These findings provide a more effective and safer treatment option for patients with osteomyelitis and are of wide application value.

ETHICAL COMPLIANCE

This study was approved by the ethics committee of the Sichuan Orthopedic Hospital.

AUTHOR DISCLOSURE STATEMENT

The authors have no potential conflicts of interest to report relevant to this article.

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QG and ZL designed the study and performed the experiments, QG and SY collected the data, ZL and SY analyzed the data, and QG and ZL prepared the manuscript. All authors read and approved the final manuscript.

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