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Observation on Curative Effect of Minimally Invasive Osteotomy Combined with Ilizarov Technique in the Treatment of Knee Osteoarthritis with Varus Deformity

Yong Di*, Guohua Wu, Guangpu Zhang, Xiaoyu Guo, Liqing Li

Langfang Aidebao Hospital, Langfang 065800, Hebei Province, China

***Corresponding author:** Yong Di, 13731616432@189.cn

Abstract: This paper aims to analyze the clinical efficacy of minimally invasive osteotomy combined with Ilizarov technique in the treatment of knee osteoarthritis with varus deformity. 80 patients with knee osteoarthritis and varus deformity who were treated in our hospital from January 2022 to May 2023 were selected, all of whom were affected by one knee. They were randomly divided into groups, including the study group and the control group, each with 40 patients. Patients in the control group were treated with fibula-tibial osteotomy and internal fixation, and patients in the study group were treated with minimally invasive osteotomy combined with Ilizarov technique. The operation time of the patients in the study group was significantly longer than that of the control group ($P < 0.05$). The intraoperative blood loss of the patients in the study group was significantly more than that of the control group ($P < 0.05$). The hospitalization expenses of the patients in the study group were significantly more than those of the control group ($P < 0.05$). The postoperative femorotibial angle and mechanical axis offset distance in the study group were significantly smaller than those in the control group ($P < 0.05$). The postoperative New York Hospital for Special Surgery (HSS) scores of the study group were significantly higher than those of the control group ($P < 0.05$). The postoperative visual analogue scale (VAS) score of the study group was significantly lower than that of the control group ($P < 0.05$). The range of motion of the knee joint in the study group was significantly greater than that in the control group ($P < 0.05$). The incidence of tendon injury, infection, and nerve injury in the study group (2.50%) was significantly lower than that in the control group (30.00%) ($P < 0.05$). Minimally invasive osteotomy combined with Ilizarov technique can be applied in the treatment of knee osteoarthritis with varus deformity, although the operation time is longer, with more intraoperative blood loss and higher treatment cost, but it has no effect on the femorotibial angle and mechanical axis deviation of the patient. It can significantly improve the movement distance, knee joint function, and knee joint range of motion, and significantly reduce the postoperative pain of patients, reduce the incidence of complications, and thus has high clinical application value.

Keywords: Minimally invasive osteotomy; Ilizarov technique; Knee osteoarthritis; Varus deformity

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1. Introduction

Knee osteoarthritis is a common orthopedic disease, and its main incidence group is middle-aged and elderly people [1]. The disease can cause joint pain, swelling, limited mobility, and lower limb dysfunction in patients, which is an important factor affecting patients' quality of life [2]. Clinical studies have shown that the incidence of knee osteoarthritis is related to many factors and resulted from the joint action of multiple factors [3]. The inner side of the knee joint is the main weight-bearing part, hence the incidence of knee osteoarthritis is more common in the inner compartment of the knee joint [3]. This characteristic of knee osteoarthritis makes patients prone to shortening of the tibial distance during the disease progression, resulting in a higher risk of genu varum [4]. For patients with knee osteoarthritis, once combined with varus deformity, it will lead to aggravation of the condition, affecting the function of the knee joint, and causing great harm [5]. Therefore, it is necessary to promptly treat knee osteoarthritis and varus deformity. Our hospital (Langfang Aidebao Hospital) has actively developed Ilizarov technology since 2021. Shaftov Vladimir Ivano, former president of the Russian Ilizarov Center, academician of the Russian Academy of Medical Sciences, and meritorious worker of the Russian Federation, and Professor Wei Qi came to our hospital regularly to carry out teaching rounds, outpatient guidance, and other work (**Figures 1** and **2**). At the same time, in April this year, the China-Russia Langfang Ilizarov Center for Trauma Repair and Orthopedic Reconstruction officially landed in Aidebao Hospital, as shown in **Figures 3** and **4**. The application of Ilizarov in orthopedics in our hospital has been greatly improved through extensive technical cooperation. This article analyzes the clinical efficacy of minimally invasive osteotomy combined with Ilizarov technique in the treatment of knee osteoarthritis with varus deformity, in order to provide a guideline for improving the treatment of such patients.

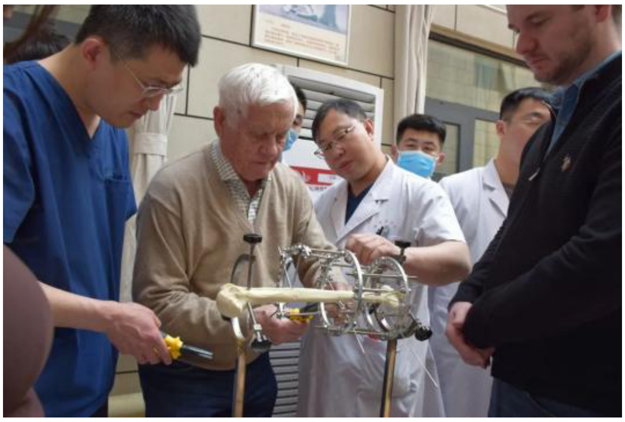

Figure 1. Shaftov Vladimir Ivanovich technical teaching training

Figure 2. Shaftov Vladimir Ivanovich technical teaching rounds

Figure 3. China-Russia Langfang Ilizarov Trauma Repair and Orthopedic Reconstruction Center signed a contract

Figure 4. Unveiling of China-Russia Langfang Ilizarov Trauma Repair and Orthopedic Reconstruction Center

2. Materials and methods

2.1. Demographic of study population

A total of 80 patients with knee osteoarthritis and varus deformity who were treated in our hospital from January 2022 to May 2023 were selected, all of whom were affected by one knee. They were randomly divided into groups, including the study group and the control group, each with 40 patients. There were 24 males and 16 females in the study group, aged 44–76 years, with an average of 55.52±2.06 years old. Among them, there were 22 cases of left knee joint disease and 18 cases of right knee joint disease. There were 23 males and 17 females in the control group, aged 46–77 years, with an average age of 56.74±2.13, the course of disease was 3–14 years, with an average duration of 6.13±3.46 years, and there are 25 cases of left knee lesions and 15 cases of right knee lesions. There was no statistically significant difference in the data of the two groups of patients $P > 0.05$.

Inclusion criteria included patients who meet the diagnostic criteria for knee osteoarthritis and varus deformity, patients suitable for surgical treatment, patients who can communicate in normal language, and patients who have signed the "Informed Consent Form."

Exclusion criteria were patients with surgical treatment contraindications, blood coagulation disorders, and anesthesia contraindications, patients with gouty arthritis, systemic lupus erythematosus, Sjogren's syndrome, and other diseases that can cause joint lesions, patients with other knee diseases such as acute joint injury, patients with knee osteophytes, patients with severe infection, liver, and kidney dysfunction, patients with severe diseases such as hypertension and stroke, and patients who quit the study halfway.

2.2. Treatment methods

The patients in the control group were treated with tibial osteotomy and internal fixation. They were given spinal anesthesia or general anesthesia, placed in the supine position, and put on a tourniquet. An incision was made from the posteromedial tibial plateau below the joint line to the medial tibial tuberosity, about 5cm in length. The goosefoot was separated to expose the superficial medial collateral ligament, the distal part of the superficial medial collateral ligament was peeled off, and a blunt retractor was inserted along the gap between the tibia and the superficial medial collateral ligament to the rear of the tibial osteotomy to protect the neurovascular. After the medial border of the patellar ligament has been identified, a subperiosteal dissection is performed from the tibial tuberosity to the posteromedial tibia. Two guide pins were inserted at 3.5–4.0cm below the medial joint line. The direction of the guide pins is adjusted obliquely upward until 1cm below the lateral tibial joint edge, towards the top of the fibular head. After the C-arm fluoroscopy showed that the position of the guide pins was appropriate, the osteotomy was performed along the two guide pins with a pendulum. During the osteotomy, it was necessary to confirm that the osteotomy line was parallel to the tibial posterior tilt in the coronal position, and a 1cm lateral hinge was reserved. After the osteotomy, a spreader is used to spread the knee to correct the varus of the knee joint. During the operation, a long metal rod was used to position the line of force of the lower limbs to ensure that the metal rod passed 62.5% of the lateral platform of the tibia. After the correction is satisfactory, a locking plate is placed for fixation. When the opening distance of the osteotomy is greater than 10mm, bone grafting is recommended.

Patients in the study group were treated with minimally invasive osteotomy combined with Ilizarov technique. They were treated with general anesthesia, placed in a supine position, and the entire length of the lower limbs were sterilized and draped. Before the operation, the qualified Ilizarov annular external fixator and accessories were assembled in advance. The external fixator consisted of a set of semi-rings and a set of full rings. It is a group with a distance of about 5cm, of which the proximal knee joint ring group is a 3/4 C ring, the anteromedial, anterolateral, posterior medial, and posterior lateral directions of the rings are connected by 4 adjustable screw rods. The articulator was installed at the proximal end of the screw rod, and it was connected and fixed with the proximal knee joint ring group. The external fixator is placed over the patient's limb and adjusted to match the varus deformity. Under the fluoroscopy of the C-arm X-ray machine, the position is determined, and then the needle is threaded. The first 2.0mm diameter full needle was inserted at the level of the tibial plateau near the knee joint and fixed on the ring. During the placement process, care should be taken to avoid the common peroneal nerve and the upper tibiofibular joint. A second full needle was inserted at the superior ring of the ankle and the inferior tibiofibular joint was stabilized. The position of the external fixator and the operative limb was adjusted to a suitable position. All the needles were inserted and fixed on the remaining rings in the same way. One and a half needles were inserted respectively at the rings of the two groups and fixed on the rings to ensure the stability of the rings. After the external fixator is installed in place, a 1cm incision was made on the anterolateral side of the calf about 2cm below the tibial tuberosity. The subcutaneous tissue and periosteum were separated with hemostatic forceps, and the multi-hole osteotomer was placed against the pre-osteotomy plane of the tibia, and an electric drill was used to minimally invasively arrange the drill holes and cut the osteotomy, the external fixation ring was tightened to connect the screw rod, and the success of the osteotomy was confirmed through fluoroscopy. The bone needle was bent, the excess part of the tail end was cut off, the protective cap was installed, and regular bandaging was performed.

Both the control group and the study group were routinely performed osteotomy of the fibula proximal to the ankle joint greater than 10cm.

2.3. Evaluation indicators

Surgical treatment was evaluated through the operation time, intraoperative blood loss, and hospitalization expenses of the patients. Before operation and 3 months after operation, 64-slice 128-slice spiral CT was used to measure the femorotibial angle and mechanical axis offset distance of patients. Before operation and 3 months after operation, the knee joint function of the patients was evaluated by using the New York Hospital for Special Surgery (HSS) knee score, which mainly included 30 points for pain, 18 points for joint range of motion, and 18 points for walking, 22 points for function, 10 points for flexion deformity, 10 points for joint muscle strength, and 10 points for instability. The higher the score, the better the recovery effect of the knee joint function of the patient [5]. The visual analogue scale (VAS) was used to evaluate the patient's pain severity, with a score ranging from 0 to 10 points. The higher the score is, the more severe the pain is [6]. The range of motion of the knee joint was measured before and after 3 months. The incidence rates of complications, such as tendon injury, infection, and nerve injury were counted.

2.4. Statistical methods

The research data were analyzed using the SPSS software version 21.0, in which the measurement data and count data were represented by (n, %) and ($\bar{x}$±s) respectively, and the t test and x^2 test were given correspondingly. $P < 0.05$ indicates that the comparison results are statistically significant.

3. Results

3.1. Comparison of surgical treatment

Based on **Table 1**, the operation time of the study group was significantly longer than that of the control group, and the difference was statistically significant at $P < 0.05$. The intraoperative blood loss of the study group was significantly longer than that of the control group, and the difference was statistically significant at $P < 0.05$. The hospitalization expenses of the patients in the study group were significantly more than those of the control group, and the difference was statistically significant at $P < 0.05$.

Table 1. Comparison of surgical treatment of two groups of patients

Group	Operation time (min)	Intraoperative blood loss (ml)	Hospital expenses (10,000 yuan)
Study group (n = 40)	68.06 ±**7.38**	23.18 ±**5.39**	3.48 ± 0.25
Control group (n = 40)	37.13 ±**3.16**	9.25 ±**2.08**	2.53 ± 0.18
t value	17.562	12.625	17.857
P value	>0.05	<0.05	<0.05

3.2. Comparison of the femorotibial angle and the offset distance of the mechanical axis

As shown in **Table 2**, the preoperative femorotibial angle and mechanical axis offset distance of the two groups of patients were similar, and there was no statistically significant difference in $P > 0.05$. The postoperative femorotibial angle and mechanical axis offset distance of the study group were significantly smaller than those of the control group, $P < 0.05$ indicated that the difference was statistically significant.

Table 2. Comparison of femorotibial angle and mechanical axis offset distance between the two groups of patients

Group	Femorotibial angle (°)		Mechanical axis offset distance (mm)	
	Preoperative	postoperative	Preoperative	Postoperative
Study group (n = 40)	184.42±7.06	154.86±4.05	31.56±4.12	0.95±0.12
Control group (n = 40)	184.62±7.15	172.63±5.13	31.68±3.89	9.15±0.35
t value	0.443	12.748	0.325	17.923
P value	>0.05	<0.05	>0.05	<0.05

3.3. Comparison of knee joint function

Table 3 shows that the preoperative pain, joint range of motion, walking function, flexion deformity, joint muscle strength, instability, and other HSS scores of the two groups of patients were similar, and there was no significant difference between the two groups with $P > 0.05$. The HSS scores of each item in the study group after operation were significantly higher than those of the control group, and the difference was statistically significant at $P < 0.05$.

Table 3. Comparison of knee joint function (points)

Group/ Treatment	Pain		Range of motion		Walking function		Buckling deformity		Joint muscle strength		Instability	
	Before	After	Before	After	Before	After	Before	After	Before	After	Before	After
Study group (n = 40)	10.28±1.75	25.16±2.15	9.25±1.12	16.15±1.25	8.43±1.75	12.38±1.17	4.38±1.06	8.73±0.17	6.07±1.15	8.33±0.27	6.16 ±1.09	8.12 ±0.21
Control group (n = 40)	10.26±1.74	20.49±2.08	9.15±1.27	13.54±1.22	8.58±1.83	10.24±1.68	4.59±1.15	7.25±0.28	6.48±1.29	7.43±0.12	6.23 ±1.13	7.79 ±0.17
t value	0.342	10.543	0.136	10.793	0.495	5.953	0.226	30.162	0.637	20.054	0.125	6.273
P value	>0.05	<0.05	>0.05	<0.05	>0.05	<0.05	>0.05	<0.05	>0.05	<0.05	>0.05	<0.05

3.4. Comparison of the degree of pain and range of motion of the knee joint

The preoperative VAS score and the range of motion of the knee joint in the two groups were similar, and there was no statistically significant difference between the two groups when compared ($P > 0.05$). The postoperative range of motion of the knee joint in the study group was significantly greater than that in the control group, and the difference was statistically significant at $P < 0.05$, as shown in **Table 4**.

Table 4. Comparison of pain degree and knee joint range of motion between the two groups of patients

Group	VAS score (points)		Knee range of motion (°)	
	Preoperative	postoperative	Preoperative	postoperative
Study group (n = 40)	6.58 ±1.13	2.01 ±0.36	56.54 ±5.07	84.48 ±5.15
Control group (n = 40)	6.43 ±1.17	3.47 ±0.54	55.83 ±5.24	71.06 ±4.65
t value	0.094	11.463	0.876	8.727
P value	> 0.05	< 0.05	> 0.05	< 0.05

3.5. Comparison of the incidence of complications

According to **Table 5**, the incidence of tendon injury, infection, and nerve injury in the study group (2.50%) was significantly lower than that in the control group (30.00%), and the difference was statistically significant at $P < 0.05$.

Table 5. Comparison of the incidence of complications between the two groups of patients

Group	Tendon injury	Infection	Nerve damage	Total incidence
Study group (n = 40)	1	0	0	1 (2.50)
Control group (n = 40)	4	5	3	12 (30.00)
x^2 value	-	-	-	4.863
P value	-	-	-	<0.05

4. Discussion

At present, for the clinical treatment of knee osteoarthritis with varus deformity, the conventional therapy is tibial osteotomy and internal fixation [7]. This operation method is currently considered to be a relatively effective treatment method clinically, and it is also a "knee-preserving" operation therapy [8]. After tibial osteotomy and internal fixation in patients with knee osteoarthritis and varus deformity, the proximal tibial bone can be remodeled, the tension of the soft tissue on the outside of the knee joint can be improved, and the line of force of the lower limbs can be corrected, so as to achieve the therapeutic effect [9,10].

Internal fixation of tibial osteotomy has the advantages of simple operation, less trauma, shorter operation time and relatively lower treatment cost [11-13]. This may be related to the skill of the surgeon in osteotomy and internal fixation. However, in the long-term research and observation, it was found that the long-term curative effect of patients treated with tibial osteotomy and internal fixation was not satisfactory. Due to the lack of internal fixation or external fixation support during the surgical treatment, patients had more complications in the later stage of the treatment, and the improvement effect of joint function has limitations [14,15]. Therefore, it is very important to explore a more effective treatment method.

In this study, in order to achieve this goal, the author adopted minimally invasive osteotomy combined with Ilizarov technique to treat patients with knee osteoarthritis and varus deformity. Compared with tibial osteotomy and internal fixation, the long-term efficacy of minimally invasive osteotomy combined with Ilizarov technique has significant advantages. The author believes that it is mainly due to the fact that the minimally invasive osteotomy combined with Ilizarov technique will not affect the subsidence of the patella or the structure of the patellar ligament. This surgical method improves the safety of osteotomy and will not cause major damage and impact on the ligament structure around the knee joint [16-18]. It is convenient for the firm fixation and accurate correction of the patient by external fixation, and the damage to the soft tissue can be reduced during the operation, which is conducive to the promotion of postoperative rehabilitation [19,20]. Therefore, with minimally invasive osteotomy combined with Ilizarov technique for treatment, the postoperative pain degree of the patient and the complications are significantly less, and the recovery of knee joint function is better.

To sum up, minimally invasive osteotomy combined with Ilizarov technique in the treatment of knee osteoarthritis with varus deformity can be applied, although the operation time is longer, with more intraoperative bleeding and higher treatment cost, but its effect on the femorotibial angle, the mechanical axis offset distance, knee joint function, and knee joint range of motion can be significantly improved, and it also can significantly reduce postoperative pain and the incidence of complications, which has high clinical application value.

Disclosure statement

The authors declare no conflicts of interest.

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