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Early clinical effect of proximal fibular osteotomy on knee osteoarthritis.

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Abstract

Objective: The aim of this study was to investigate the early clinical effect of proximal fibular osteotomy on varus Knee Osteoarthritis (KOA).

Methods: We selected 92 patients with KOA, including 40 patients with proximal fibular osteotomy (observation group) and 52 patients with High Tibial Osteotomy (HTO) (control group), who were treated with osteotomy. The median time of follow-up was 25 months, and the clinical effects were compared between the two groups.

Results: The operation time, bleeding amount during operation and drainage volume after operation significantly decreased while the full weight-bearing time significantly shortened in the observation group compared with the control group ($p<0.05$). The pain VAS and femur–tibial angle significantly decreased and the JOA score of the knee joint significantly increased in the observation group compared with the control group ($p<0.05$). A significantly lower incidence of complications, including neurovascular injury, deep infection, lower-limb deep vein thrombosis, fracture, delayed union and deformity recurrence, was found in the observation group compared with the control group ($p<0.05$).

Conclusion: The short-term and long-term surgical effects of proximal fibular osteotomy on varus KOA are superior to those of HTO.

Keywords: Knee osteoarthritis, Proximal fibular osteotomy, High tibial osteotomy.

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Introduction

The pathological characteristics of Knee Osteoarthritis (KOA) include joint structure degradation and cartilage destruction and hyperplasia, with joint pain, dysfunction and joint deformity as the main clinical symptoms. KOA affects about 50% of >60-year-old individuals, especially women, and it is associated with post-menopausal osteoporosis and significant bone mass reduction; it is also an important reason of disability [1]. This condition is characterised by complex causes and long course, which lead to progressive exacerbation and ineffective conservative treatment. Surgical methods for KOA include arthroscopic debridement, High Tibial Osteotomy (HTO), proximal fibular osteotomy and unicompartment or artificial total knee arthroplasty. A single arthroscopic debridement can only alleviate symptoms of pain and is associated with high recurrence rates [2]; arthroplasty is mainly used in patients aged over 60 years and could cause serious trauma [3]; osteotomy can correct varus-valgus deformity, recover the normal alignment of the lower limbs, reduce the stress concentration on articular surfaces, effectively relieve pain, delay joint degeneration and prevent or delay joint replacement [4]. HTO includes valgus proximal tibial osteotomy and supracondylar femoral osteotomy, and its satisfaction rate in a 10-year follow-up period can reach up to 60% [5,6]. Proximal fibular osteotomy is based on the 'theory of differential settlement', which initiates KOA and promotes its progression [7]. This treatment approach is characterised by minimal trauma, few complications, definite effects and wide clinical applications [8]. The present study analysed the early clinical effect of proximal fibular osteotomy on varus KOA.

Materials and Methods

Object data

A total of 92 patients diagnosed with varus KOA for the first time in our hospital between January 2013 and January 2016 were selected. Included patients were (1) those whose unilateral lesions and varus deformity of Femur-Tibial Angle (FTA) are shown in a load-position X-ray film and (2) those showing indications of osteotomy, with available clinical information and who provided informed consent. Excluded patients were 1) those with valgus deformity of KOA or other types of knee arthritis, such as rheumatoid arthritis and traumatic arthritis; 2) those with severe symptoms or poor expected post-operative effect; and 3) those with bone tumour and severe osteoporosis or underlying diseases, such as hepatic and renal dysfunction.

The 92 patients were divided into two groups of operation method, namely, proximal fibular osteotomy (observation group, n=40) and HTO (control group, n=52). The observation group comprised 12 males and 28 females with an average age of 62.3 ± 13.5 y and an average course of disease of 1.5 ± 0.4 y; in terms of KOA grade, this group included 30 cases of grades I and II and 10 cases of grades III and IV. Meanwhile, the control group comprised 15 males and 37 females with an average age of 65.6 ± 17.2 y and an average course of disease of 1.8 ± 0.6 y; in terms of KOA grade, this group included 36 cases of grades I and II and 16 cases of grades III and IV. The baseline data between the two groups were comparable.

Research methods

Proximal fibular osteotomy was performed by the same surgical and nursing team, and the main processes were as follows. Under the epidural anaesthesia, the pneumatic tourniquet was used for haemostasis, and the fibular posterolateral approach was performed in the supine position. The subcutaneous tissues were exposed, the intermuscular space between the peroneus longus and brevis and soleus muscle was found, curved forceps were used for layer separation until the proximal fibula and then the subperiosteal dissection was performed. Two broad osteotomes were used to protect the soft tissues along the fibular medial surface. A 2 cm long fibula 6-10 cm away from the fibular head was cut off using a micro-oscillating saw and then washed thoroughly with 0.9% sodium chloride solution. The broken end was sealed by bone wax to reduce bleeding and pain. Combined with arthroscopic debridement, the synovial soft tissues and cartilage face were cleaned, loose bodies were removed, the meniscus was repaired and shaped, the lateral patellar retinaculum was released and osteophytes were removed. The negative pressure drainage tube was placed and then removed within 24 h. The pneumatic pump was used to prevent lower limb venous thrombosis, and lower limb functional exercise was guided.

The main processes of HTO were as follows. The periosteum was cut open along the anteromedial longitudinal incision of the proximal tibia and then stripped backwards until the posteromedial corner. The posterior neurovascular structures and anterior patellar ligament were protected, and two Kirschner wires were used to mark the articular surface of the tibial plateau. The osteotomy line should point to the upper part of the proximal tibiofibular joint, and the sagittal osteotomy should be parallel to the articular surface retroversion. The tibial cortex was sawed off from the tibial tubercle to the tibial medial surface, and the lateral bone cortex was cut off incompletely. Legs were stretched to open the osteotomy surface, and the open interval was the correction height measured before operation. The allograft bone was implanted into the lower limbs. The stretched height was measured, and one 5 hole AO 'T'-shaped titanium plate was used to fix and support. During operation, a C-arm X-ray film showed satisfactory lower limb alignment, sufficient length and proper location of internal fixation, as well as continuous lateral bone cortex. Then periosteum was sutured, the incision was closed layer by layer and one negative pressure drainage tube was placed in the articular cavity.

Observational indexes

The operation time, bleeding amount during operation, drainage volume after operation, full weight-bearing time, Visual Analogue Scale (VAS) pain, FTA and JOA score of the knee joint and surgical complications between the two groups were compared. VAS adopted the ranking method (0-10 scores); higher scores correspond to more serious pain. FTA was the lateral angle of the femoral lower axis and the tibial upper axis formed in the knee joint. Total JOA score was 100, including walking pain (0-30 scores), upstairs-downstairs pain (0-25 scores), flexion angle (0-35 scores) and swelling (0-10 scores); higher scores correspond to better joint function. The follow-up time for both groups was 6-40 months, and the median time was 25 months.

Statistical analysis

SPSS20.0 software was used for statistical analysis. Measurement data were presented as mean ± standard deviation, the independent-sample t-test was used for inter-group comparison and paired t-test was used for intra-group comparison. Enumeration data were presented as case or percentage, and Chi-square test was used for intergroup comparison. Statistical significance was considered at $p<0.05$.

Results

Comparisons of operation time, bleeding amount during operation, drainage volume after operation and full weight-bearing time

As shown in Table 1, the operation time, bleeding amount during operation and drainage volume after operation significantly decreased while the full weight-bearing time significantly shortened in the observation group compared with the control group ($p<0.05$).

Table 1. Comparisons of operation time, bleeding amount during operation, drainage volume after operation and full weight-bearing time.

Group	Operation time (min)	Bleeding amount (ml)	Drainage volume (ml)	Full weight-bearing time (d)
Control group	52.7 ± 12.3	66.9 ± 21.5	123.2 ± 54.7	1.4 ± 0.5
Observation group	35.6 ± 9.5	32.5 ± 10.4	64.9 ± 23.5	0.5 ± 0.2
t	3.659	4.521	4.867	4.123
P	0.032	0.021	0.016	0.027

Comparisons of VAS, FTA and JOA score of the knee joint

As shown in Table 2, the pain VAS and FTA significantly decreased and the JOA score of the knee joint significantly increased in the observation group compared with the control group ($p<0.05$).

Table 2. Comparisons of VAS, FTA and JOA score of the knee joint.

Group	VAS		FTA		JOA score	
	Before treatment	Follow-up	Before treatment	Follow-up	Before treatment	Follow-up
Control group	4.5 ± 1.2	1.2 ± 0.4	182.6 ± 2.3	175.3 ± 1.6	68.7 ± 11.3	82.4 ± 14.5
Observation group	4.6 ± 1.3	0.5 ± 0.2	183.4 ± 2.5	168.9 ± 1.3	66.5 ± 10.2	89.2 ± 13.6
t	0.096	4.125	0.152	4.965	0.263	4.754
P	0.934	0.019	0.867	0.007	0.769	0.012

Table 3. Comparison of incidence of operation (case (%)).

Group	Case	Neurovascular injury	Deep infection	Lower limb deep vein thrombosis	Fracture	Delayed union	Recurrence of deformity	Incidence of complications
Control group	52	3	1	1	3	2	3	13 (25.0)
Observation group	40	1	0	0	1	0	1	3 (7.5)
χ^2								4.819
P								0.028

Comparison of incidence of complications

As shown in Table 3, a significantly lower incidence of complications was found in the observation group compared with the control group ($p<0.05$).

Discussion

Blaimont et al. found that the surgical effects of HTO are superior, but the excessively high osteotomy plane increases the risk of tibial plateau fracture and proximal necrosis [9]. Hence, HTO is not recommended for the elderly or for patients with severe osteoporosis. Sprenger et al. [10] and Minzlaff et al. [11] observed satisfactory long-term effects of lateral tibial closing-wedge osteotomy on KOA patients with varus deformity. The main advantages of medial tibial opening-wedge osteotomy over lateral closing osteotomy are that the lateral fibular head does not need to be exposed, proximal fibula osteotomy is avoided, injuries of the peroneal nerve and lateral collateral ligament are reduced and the lateral soft tissue tension is retained. Koshino et al. [12] and Takeuchi et al. [13] confirmed that medial tibial opening-wedge osteotomy can obtain satisfactory mid- and long-term effects. Domical tibial osteotomy is mainly used for children with lower limb varus–valgus deformities. However, this approach is less stable than wedge osteotomy and renders normal alignment with the nail-track infection in the fixation of external fixator and other problems difficult to maintain. Krempen et al. [14] confirmed that domical tibial osteotomy has a certain application value. Early complications of HTO include infection, deep vein thrombosis, insufficient correction, intra-articular fractures, peroneal nerve injury, osteofascial compartment syndrome and knee stiffness, whereas late complications of this procedure include delayed union or non-union, deformity recurrence and internal fixation failure [15].

In proximal fibula osteotomy, the fibular head is pulled to the distal end through the soleus muscle and peroneus longus to form a lever structure, with the lateral tibial plateau as the fulcrum used to pry the medial femoral condyle to reduce the stress of medial plateau. Hence, the load of the knee joint is transferred from the medial plateau to the lateral plateau, and the distal femoral mechanical axis is rearranged to relieve the lateral soft tissue tension of the knee joint and remove KOA symptoms [16]. Some studies also argued that this procedure is associated with low intra-osseous pressure and pain relief [17]. The key to fibular osteotomy is the accurate fibular osteotomy height and length and the peroneal nerve protection. Performing fibular osteotomy in an area 4-7 cm away from the fibular head lowers the risk of peroneal nerve injury and produces satisfactory curative effects after operation [18].

HTO is used to directly correct varus deformity of the knee joint, and its indirect correction capacity is stronger than that of fibular osteotomy; therefore, HTO is more appropriate for patients with serious varus deformity than fibular osteotomy [19]. The present study showed that proximal fibular osteotomy decreased the operation time, bleeding amount during operation and drainage volume after operation while shortened the full weight-bearing time; decreased the pain VAS and FTA and increased the JOA score of the knee joint; and decreased the incidence of complications. These results suggest that the short-term and long-term surgical effects of proximal fibular osteotomy on varus KOA are superior to those of HTO, which has certain clinical promotion value. The long-term therapeutic effect of fibular osteotomy needs further follow-up observation.

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