



# Proximal fibular osteotomy: a new surgery for pain relief and improvement of joint function in patients with knee osteoarthritis

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## Abstract

**Objective:** To explore the effects of proximal fibular osteotomy as a new surgery for pain relief and improvement of medial joint space and function in patients with knee osteoarthritis.

**Methods:** From January 2015 to May 2015, 47 patients who underwent proximal fibular osteotomy for medial compartment osteoarthritis were retrospectively followed up. Preoperative and postoperative weight-bearing and whole lower extremity radiographs were obtained to analyse the alignment of the lower extremity and ratio of the knee joint space (medial/lateral compartment). Knee pain was assessed using a visual analogue scale, and knee ambulation activities were evaluated using the American Knee Society score preoperatively and postoperatively.

**Results:** Medial pain relief was observed in almost all patients after proximal fibular osteotomy. Most patients exhibited improved walking postoperatively. Weight-bearing lower extremity radiographs showed an average increase in the postoperative medial knee joint space. Additionally, obvious correction of alignment was observed in the whole lower extremity radiographs in 8 of 47 patients.

**Conclusions:** The present study demonstrates that proximal fibular osteotomy effectively relieves pain and improves joint function in patients with medial compartment osteoarthritis at a mean of 13.38 months postoperatively.

## Keywords

Proximal fibular osteotomy, medial compartment osteoarthritis, ratio of knee joint space

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## Introduction

Osteoarthritis is the most common cause of disability in the older population. Disability is caused by pain and limitations in mobility. Total knee arthroplasty (TKA), which aims to relieve pain and improve joint function and mobility, is the main surgical alternative in this patient population. However, TKA is expensive and complex, and some patients need a second knee revision after the first surgery.<sup>1,2</sup> Although high tibial osteotomy (HTO) is the first-choice treatment for young patients with osteoarthritis of the medial compartment of the knee, there are some potential disadvantages after surgery.<sup>3–6</sup> In 2015, Zhang et al. reported that proximal fibular osteotomy (PFO) relieves pain and improves joint function in human knee osteoarthritis.<sup>2</sup> This new surgery is simple, safe and affordable. Pain relief after surgery occurs in almost all patients. PFO may delay or replace TKA in a subpopulation of patients with knee osteoarthritis. In the present study, we carefully evaluated the short-term efficacy of PFO in terms of pain relief and improvement of joint function in a cohort of patients from our hospital.

## Patients and methods

From January 2015 to May 2015, 47 consecutive patients who underwent PFO at our hospital were followed retrospectively ( $n = 47$ ; mean age,  $63.96 \pm 7.48$  years; age range, 48–78 years; 35 female, 12 male). The inclusion criteria were knee pain with difficulty walking due to medial compartment osteoarthritis or genu varus. The diagnosis of osteoarthritis was made by a clinician according to the American College of Rheumatology criteria.<sup>7</sup> The exclusion criteria were genu valgus, acute major trauma, inflammatory joint disease, malignant tumours, and abnormal renal or liver function. Approval from the Institutional Review Board of the Second Hospital of

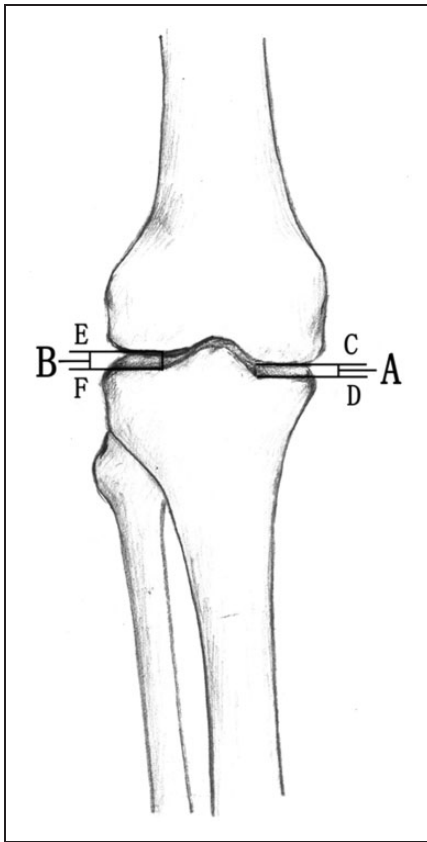
Shanxi Medical University was obtained, and all patients provided informed consent prior to implementation of the study procedures (IRB File No. 2015–026).

The patients were placed in the supine position after administration of anaesthesia. An approximately 5-cm longitudinal incision was made over the lateral skin of the proximal fibula, and the fibula was exposed between the peroneus muscle and soleus muscle. PFO was performed by removing a 2- to 3-cm length of fibula at a site 6 to 10 cm from the caput fibulae. Full weight bearing and free mobilization were allowed postoperatively.

Knee pain was assessed using a visual analogue scale. Knee ambulation activities were recorded using the knee and function subscores of the American Knee Society score preoperatively and at a mean of 13.38 months postoperatively.

Preoperative and postoperative weight-bearing and whole lower extremity radiographs were obtained in all patients to analyse the alignment of the lower extremity and the ratio of knee joint space (medial/lateral compartment).

Briefly, the medial joint space was determined by a vertical line (A) between two horizontal lines (C and D) that were drawn from the lowest point of the medial condyle of the femur and medial plateau of the tibia, respectively. The lateral joint space was determined by a vertical line (B) between two horizontal lines (E and F) that were drawn from the lowest point of the lateral condyle of the femur and lateral plateau of the tibia, respectively. The ratio of the knee joint space (medial/lateral) was determined by the ratio of A/B (Figure 1). The hip-knee-ankle angle was measured based on the whole lower extremity radiograph. Line A was drawn from the centre of the femur to the centre of the knee, and line B was drawn from the centre of the knee to the centre of the ankle. The hip-knee-ankle angle was the intersection angle  $\alpha$  between lines



**Figure 1.** Measurement of ratio of knee joint space. The medial joint space was determined by a vertical line (A) between two horizontal lines (C and D) that were drawn from the lowest point of the medial condyle of the femur and medial plateau of the tibia, respectively. The lateral joint space was determined by a vertical line (B) between two horizontal lines (E and F) that were drawn from the lowest point of the lateral condyle of the femur and lateral plateau of the tibia, respectively. The ratio of the knee joint space (medial/lateral) was determined by the ratio of A/B.

A and B (Figure 2). Data collection and assessment were performed by two independent observers who were not involved in the surgery.

Data are shown as mean  $\pm$  SD. Paired and unpaired *t* tests were used to compare the differences in outcome scores between

two groups. Differences were considered significant at  $P < 0.05$ .

## Results

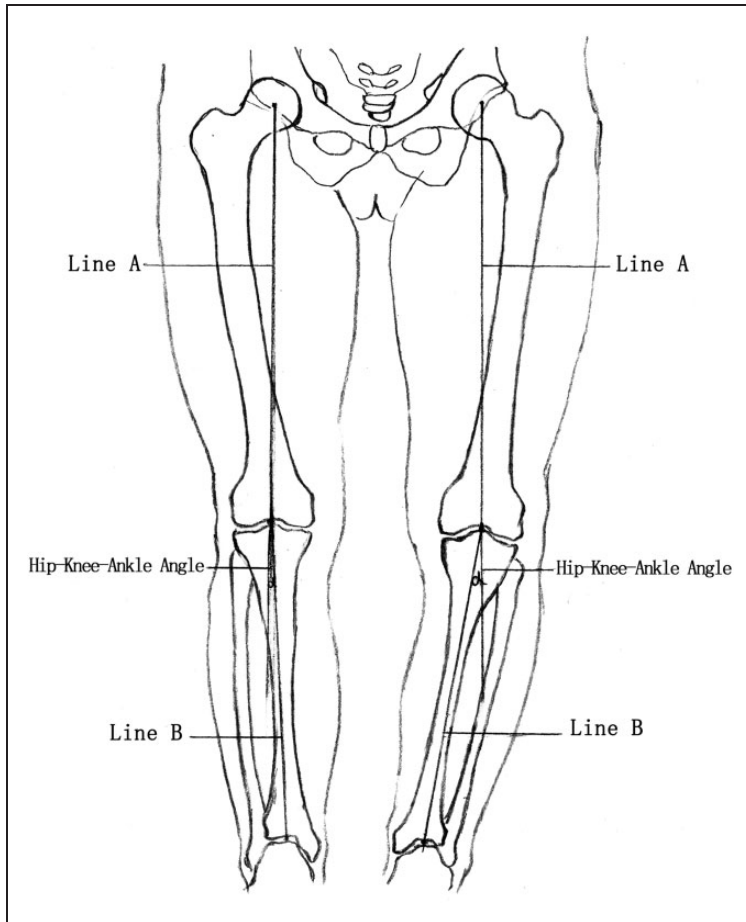
One of 47 patients who underwent PFO was lost to follow-up, leaving 46 patients who were followed for a minimum of 12 months. The mean duration of follow-up was 13.38 months (range, 12–18 months). The average duration of unilateral PFO was  $32.23 \pm 9.13$  minutes. No postoperative complications were observed, including wound infection, delayed healing or nerve damage.

Notably, medial pain relief was observed in all patients after PFO. The mean visual analogue scale scores significantly decreased from  $8.02 \pm 1.50$  preoperatively to  $2.74 \pm 2.34$  postoperatively. Preoperatively, the mean knee and function subscores of the American Knee Society score were  $44.41 \pm 8.90$  and  $41.24 \pm 13.48$ , respectively. Postoperatively, they significantly improved to  $69.02 \pm 11.12$  and  $67.63 \pm 13.65$ , respectively (Figure 3).

Radiographs of the weight-bearing lower extremity showed an average increase in the medial knee joint space postoperatively compared with preoperatively. The ratio of the knee joint space (medial/lateral compartment) improved significantly from  $0.40 \pm 0.28$  preoperatively to  $0.58 \pm 0.30$  postoperatively (Figure 4). Additionally, an obvious correction of alignment in the whole-lower-extremity radiographs was observed in 8 of 47 patients (Figure 5).

## Discussion

Knee osteoarthritis is one of the most common joint disorders, and it causes severe pain and immobility. TKA is very effectively relieves pain and improves knee function in patients with late-stage knee osteoarthritis. However, TKA is expensive and complex, and some patients need a second revision.<sup>1,2</sup> HTO has been the

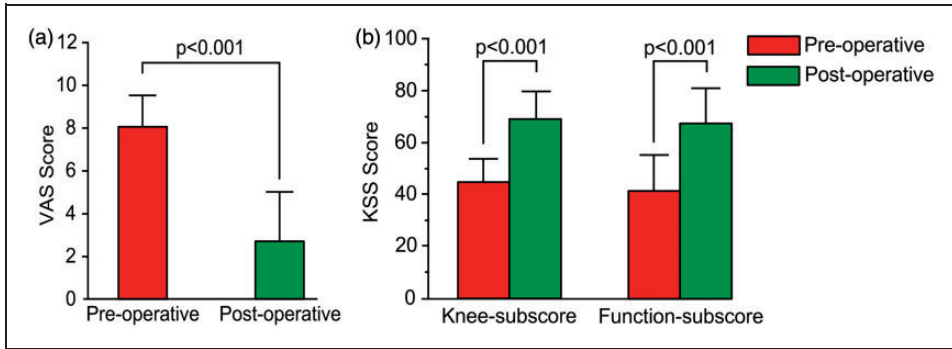


**Figure 2.** Measurement of the hip-knee-ankle angle. Line A was drawn from the centre of the femur to the centre of the knee, and line B was drawn from the centre of the knee to the centre of the ankle. The hip-knee-ankle angle is the intersection angle  $\alpha$  between lines A and B.

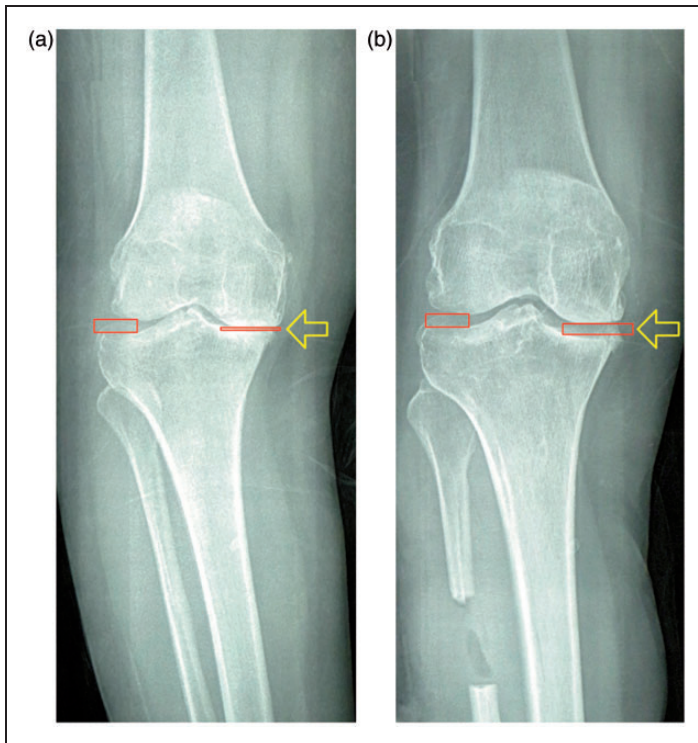
surgical treatment of choice for young patients with osteoarthritis of the medial compartment of the knee, and it is aimed at correcting alignment and delaying the time until TKA is required.<sup>3,4</sup> However, HTO also has some disadvantages, including a delayed time to full weight bearing and risks of nonunion or delayed union, peroneal nerve paralysis and wound infection.<sup>5,6</sup>

PFO has emerged as a new surgery to relieve pain and improve joint function in patients with knee osteoarthritis as reported by Zhang et al. in 2015. The most striking

findings in the present study included medial pain relief and an increase in the medial joint space. The majority of patients in our study had significant pain relief immediately after PFO, although the mechanism was unclear and the follow-up was short. Interestingly, the pain relief continued to improve, and some patients even reported no pain at the last follow-up. Postoperative ambulation (i.e. walking) was also obviously improved when compared with the pre-operative state. PFO also improved the axial alignment of the lower extremity in



**Figure 3.** (a) The visual analogue scale indicated a significant difference between the preoperative and postoperative scores ( $P < 0.001$ ). (b) American Knee Society scores broken down by knee subscores and function subscores. There were significant differences in the postoperative and preoperative scores.

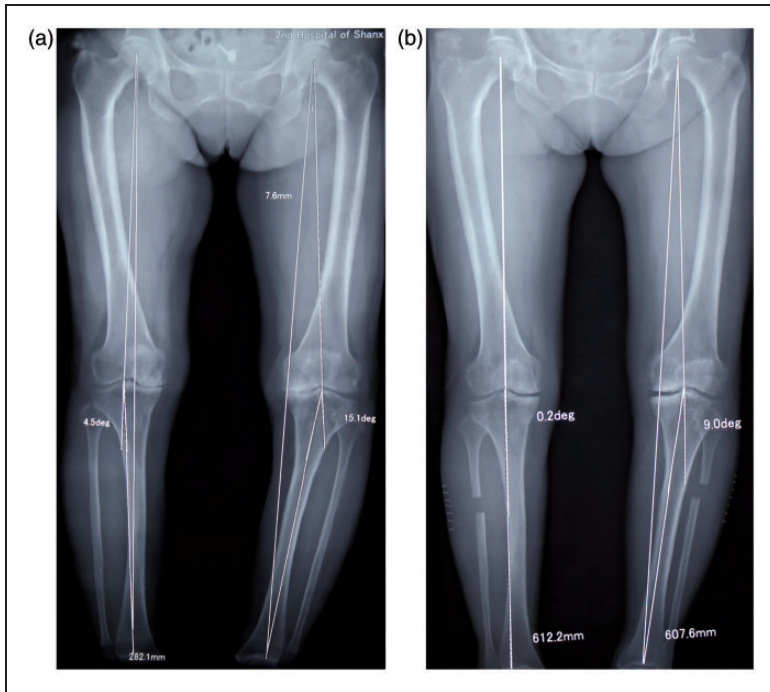


**Figure 4.** Obvious improvement in the joint space ratio (medial/lateral compartment) after PFO. (a) Preoperative image. (b) Postoperative image.

some patients, especially in those with severe genu varus.

Compared with TKA or HTO, PFO is a simple, safe, fast and affordable surgery that

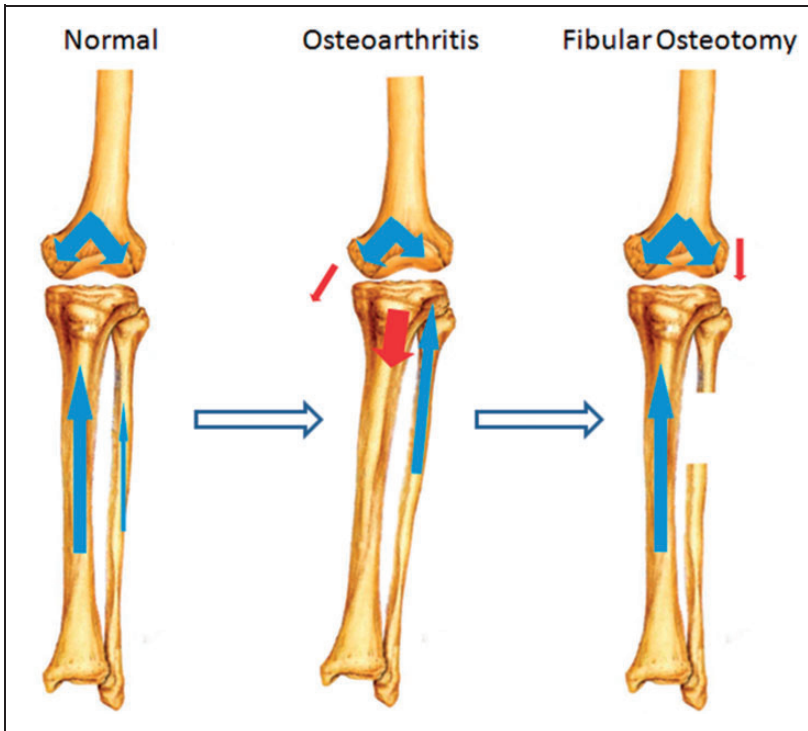
does not require insertion of additional implants. As such, PFO is a suitable surgical option in most developing countries that lack financial and medical resources.



**Figure 5.** Improvement in the axial alignment of the lower extremity in a 79-year-old woman with a 20-year history of bilateral knee pain. (a) Weight-bearing radiograph of the whole lower extremity showed bilateral genu varus (hip-knee-ankle angle: right knee, 4.5°; left knee, 15.1°) before proximal fibular osteotomy. (b) Obvious correction of alignment (hip-knee-ankle angle: right knee, 0.2°; left knee, 9.0°) after proximal fibular osteotomy.

This novel surgery can potentially become an alternative treatment method for osteoarthritis of the medial compartment of the knee, especially for patients who cannot undergo TKA because of medical comorbidities. However, several limitations to this study must be noted. First, although the short-term results are encouraging, the follow-up time was relatively short, and whether these outcomes will remain unchanged at a longer follow-up time is unclear. Therefore, a longer follow-up study is warranted. In addition, the mechanism of the efficacy of PFO is unclear. One possible explanation of why PFO relieves pain and improves the joint space is that it removes the fibula support that may cause genu varus. The fibula supports one-sixth of the

body weight; thus, PFO may rebalance or redistribute the load on the lateral and medial tibia plateau after surgery (Figure 6).<sup>8</sup> Another possible mechanism is nonuniform settlement as proposed by Yang et al. They stated that the lateral support provided to the osteoporotic tibia by the fibula–soft tissue complex may lead to nonuniform settlement and degeneration of the plateau bilaterally, which may cause the load from the normal distribution to shift farther medially to the medial plateau, consequently leading to knee varus and aggravating the progression of medial compartment osteoarthritis of the knee joint.<sup>9</sup> Because only eight patients in our study exhibited obvious correction of alignment, the reason for this phenomenon



**Figure 6.** Possible mechanism of pain relief and joint space improvement after proximal fibular osteotomy. Left: Equal loads were distributed on the medial and lateral tibia plateau in the normal condition. Middle: A greater load was shifted to the medial tibia plateau. Right: The abnormal load was corrected after proximal fibular osteotomy.

remains unclear. Furthermore, the long-term side effects of PFO on other joints of the lower extremity, such as the hip and ankle, remain unknown. Therefore, the biomechanics of pain relief, increases in the medial joint space, and correction of alignment in patients who have undergone PFO need further study. Finally, the absence of a control group is another main limitation; however, a placebo control is difficult to include when performing this surgery because of the inability to exclude a placebo effect.

In summary, our preliminary data clearly demonstrate that PFO is a simple, safe, fast and affordable surgery to relieve pain and improve joint function and the medial joint space in human knee osteoarthritis.

PFO may be a promising alternative in most developing countries because of their financial and healthcare delivery limitations. It may also constitute a promising alternative surgery for osteoarthritis of the medial compartment of the knee, especially for patients who cannot undergo TKA because of certain medical comorbidities. Furthermore, these patients can still undergo TKA in the future if it becomes necessary.

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### Declaration of conflicting interests

The authors declare that there is no conflict of interest.

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