Medial Compartment Decompression by Fibular Osteotomy to Treat Medial Compartment Knee Osteoarthritis: A Pilot Study

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abstract

Compared with high tibial osteotomy and total knee arthroplasty, the authors found a simpler surgical procedure, partial fibular osteotomy, could effectively relieve knee pain and also correct the varus deformity for patients with medial compartment knee osteoarthritis (OA). From January 1996 to April 2012, a total of 156 patients with medial compartment OA were treated by proximal fibular osteotomy in the authors’ hospital. A 2-cm–long section of fibula was resected 6 to 10 cm below the fibular head. A total of 110 patients with follow-up of more than 2 years were included in the study, including 34 males and 76 females with an average age of 59.2 years. Anteroposterior and lateral weight-bearing radiographs, the femorotibial angle (FTA) and lateral joint space, and the American Knee Society Score (KSS) and the visual analog scale (VAS) score of the knee joint were evaluated preoperatively and at final follow-up, respectively. At final follow-up, mean FTA and lateral joint space were 179.4°±1.8° and 6.9±0.7 mm, respectively, which were significantly smaller than those measured preoperatively (182.7°±2.0° and 12.2±1.1 mm, respectively; both \( P < .001 \)). Mean KSS at final follow-up was 92.3±31.7, significantly higher than the mean preoperative score of 45.0±21.3 (\( P < .001 \)). Mean VAS score and interquartile range were 2.0 and 2.0, significantly lower than the preoperative data (7 and 1.0, respectively; \( P < .001 \)). The authors found that proximal fibular osteotomy can significantly improve both the radiographic appearance and function of the affected knee joint and also achieve long-term pain relief. This procedure may be an alternative treatment option for medial compartment OA.

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Knee osteoarthritis (OA) is a chronic, progressive degenerative disease with accompanying joint pain, stiffness, and deformity. Knee OA is a common joint disease, with an incidence of 30% of the population older than 60 years. The initiation and progression of knee OA involves mechanical, structural, genetic, and environmental factors. Knee varus deformities, characterized by a mechanical femorotibial axis of less than 180° on full-leg standing anteroposterior (AP) radiographs and narrowed medial joint space, are common in patients with knee OA and affect 74% of patients with idiopathic OA. Although it has been reported that even in healthy knees the medial compartment bears 60% to 80% of the load, no one has precisely documented what contributes to this uneven load distribution. The current belief is that the load is distributed along the mechanical axis, which is generally medial to the center of the knee.

High tibial osteotomy and total knee arthroplasty are the 2 methods used for treating knee OA. High tibial osteotomy can correct lower extremity alignment, relieve pain, and improve function significantly. However, for younger, active patients or patients with moderate OA, it may not be the treatment of choice. Based on previous image and clinical studies, the authors believe that the lateral support provided to the osteoporotic tibia by the fibula-soft tissue complex may lead to the nonuniform settlement and degeneration of the plateau bilaterally. This may result in the load from the normal distribution shifting farther medially to the medial plateau and consequently lead to knee varus, aggravating the progression of medial compartment OA of the knee joint. Using this logic, the authors have performed a proximal fibular osteotomy to relieve the increased loading force on the medial compartment for treatment of medial compartment OA of the knee joint. The goal of this retrospective study was to evaluate the radiographic and clinical outcomes of patients with medial compartment OA treated by partial fibular osteotomy with a mean follow-up of 49.1 months.

### Materials and Methods

Institutional review board approval was obtained for this study (No. Ke2014-004-1). All patients agreed to participate in this study and gave informed consent.

### Study Population

Inclusion criteria included patients with moderate to severe symptomatic medial compartment OA of the knee, who had an indication for a surgical procedure, and who were able to give informed consent for the surgery (Figure 1). Exclusion criteria included patients with posttraumatic knee OA or inflammatory joint disease and patients with a history of previous operations or fractures. Patients in whom conservative management has failed and who have radiographic evidence of significant varus are good candidates for partial fibular osteotomy. Between January 1996 and April 2012, a total of 156 patients with medial compartment OA were candidates to receive fibular osteotomy. Forty-six patients were excluded for the following reasons: lost to follow-up (n=21), fear of adverse effects from the procedure (n=10), and nonprocedure-related reasons (n=15).

### Outcome Measures

The primary outcome measure was the difference in femorotibial angle pre- vs postoperatively, with a minimum 2-year follow-up. The degree of correction was an important factor in patient outcome and gave an objective measurement. The method of measurement was that of Wang et al (Figure 2), in which the angle α stood for the femorotibial angle (FTA) and the line EF stood for the lateral joint space of the knee joint.

**Figure 1:** Preoperative anteroposterior (A) and lateral (B) radiographs of a 64-year-old woman showing a severe degree of medial compartment osteoarthritis and knee varus deformity.

**Figure 2:** Diagrams of the femorotibial angle and lateral knee joint space measurement. Line OA is the femoral shaft anatomical axis; line OB is the tibial shaft anatomical axis; and angle α is the femorotibial angle (A). Line CD runs through the tops of the medial and lateral condyles of the tibia; point E is the outer one-sixth point of line CE; and line EF is perpendicular to line CD and stands for the distance of the lateral knee joint space (B).

**NOTE:** Fibular osteotomy represents a unique way to treat knee osteoarthritis that cannot be fully explained by biomechanical studies to date. I have personally seen this procedure, examined patients both before and after surgery, and watched patients walk just hours after the surgery. The short-term outcomes I witnessed, along with the mid-term results being published from this institution, cannot be ignored. However, I do think this necessitates additional clinical trials in other countries to further validate the results. This pilot study provides a sound framework for further research.—Craig Hogan, MD, University of Colorado Hospital, reviewer.
Data regarding age, sex, laterality, severity of OA, radiographic FTA and lateral joint space, and preoperative American Knee Society Score (KSS) were recorded for all patients at baseline and at each follow-up visit.

**Surgical Technique**

Under epidural anesthesia, the patients were placed in the supine position with the lower limb tourniquet inflated. First, the fibular head was marked. To avoid injury to the common fibular nerve and tibial attachments of the soft tissue structures crossing the knee joint, a lateral incision of 3 to 5 cm was made at the proximal third of the fibula. The fascia was then incised in line with the septum between the peroneus and soleus, the muscles were separated, and the fibula was exposed. A 2-cm section of the fibula was removed 6 to 10 cm below the fibular head with the use of an oscillating saw or fret saw. Following resection, the fibula ends were sealed with bone wax. The muscles, fascia, and skin were sutured separately after the incision had been irrigated with a large volume of normal saline. Postoperatively, the patients were ambulated as soon as pain could be tolerated.

**Follow-up**

Patients were followed up by 3 of the authors (C.-X.L., B.-C.C., Y.-Z.Z.) at 1, 3, 6, and 12 months postoperatively and then annually thereafter. Weight-bearing AP and lateral radiographs of the affected knee were taken at each follow-up (Figure 3).

**Statistical Analyses**

Statistical analyses were performed using SPSS version 19.0 statistical software for Windows (IBM, Armonk, New York). Continuous variables were expressed as mean±SD and dichotomous variables were expressed as percentages. Two-tailed t test was applied to analyze the FTA and lateral joint space data. The nonparametric test (Wilcoxon’s signed rank test) was applied to analyze the VAS and KSS data. A P value less than .05 was considered to be significant.

**RESULTS**

A total of 110 patients, including 34 males and 76 females (62 right knees and 48 left knees), were available for a mean follow-up of 49.1 months (range, 24-189 months) and were included in this study. These patients had an average age of 59.2 years (range, 47-69 years) at the time of surgery. Preoperatively, all patients reported limited range of knee motion, varus deformity, and severe knee pain, especially after increased weight bearing or athletic activities. Preoperative AP radiographs of the affected knees revealed narrow joint space in the medial compartments and sclerosis around the femorotibial joints (Figure 1). The patients had experienced OA for a range of 19 to 82 months. After partial fibular osteotomy was performed, 4 patients reported numbness in the ipsilateral lower leg, including 2 common peroneal nerve palsies and 2 superficial peroneal nerve injuries, all of which resolved within 3 to 10 months. The fibular osteotomy was performed at the level of the femoral neck in 3 of these patients and 6 to 10 cm below the fibular head in 1 patient. Sixteen patients reported weakness in the lower legs, and all returned to normal strength by 4 weeks. There were no superficial or deep infections. Four patients subsequently underwent total knee arthroplasty at a mean of 12.4 months (range, 7-17 months) after the osteotomy due to residual pain and unsatisfactory knee function.

At final follow-up, 110 patients with an average age of 63.5 years (range, 50-73 years) were evaluated clinically and radiographically. On postoperative AP radiographs, bone defects of the proximal fibula were observed in all patients. Radiographic measurements obtained preoperatively and at final follow-up are listed in Table 1. At final follow-up, mean FTA and lateral joint space were 179.4°±1.8° and 6.9±0.7 mm, respectively, which were significantly lower than the data measured preoperatively (P<.001). The lateral joint space was narrower and the medial joint space was wider than demonstrated on preoperative radiographs. Mean KSS at final follow-up was 92.3±31.7, which was significantly larger than the preoperative score (45.0±21.3; P<.001; Figure 4). Mean VAS score and interquartile range at final follow-up were 2.0 and 2.0, respectively, which were significantly lower than the preoperative data (7 and 1.0, respectively; P<.001; Table 2).
**DISCUSSION**

High tibial osteotomy is a commonly used method to treat knee varus deformities due to OA. It aims to improve the mechanical axis passing from the center of the hip, through the knee joint, to the center of the tibiotalar joint in the coronal plane. Osteotomies performed proximal to the tibial tubercle may interfere with function of the patellar tendon. This patellofemoral disturbance is common in patients who have previously undergone proximal tibial osteotomies. In the authors’ experience, a simple fibular osteotomy can relieve knee pain and correct varus deformity as effectively as high tibial osteotomy.

Bone mass decreases as part of the normal aging process. Varying degrees of settlement of bone mass exist in the load-bearing joints, such as the knees, hips, ankles, and spine. In the proximal tibia, the lateral support of the fibula to the lateral tibial plateau routinely leads to nonuniform settlement, which is more severe in the medial plateau than in the lateral plateau. The slope of the tibial plateau arising from nonuniform settlement results in a transverse shearing force, with the femoral condyle shifting medially during walking and sports. Furthermore, side-slip aggravates the nonuniform settlement of the tibial plateau, especially in the medial plateau. Accordingly, a cycle of increasing the load distribution in the medial compartment and nonuniform settlement occurs. There is also evidence that tibiofemoral articular stress distribution is related to the progression of knee OA. Based on these assumptions, the current authors hypothesized that the lateral supramedial slope of the tibial plateau is a key factor that leads to nonuniform settlement of the bilateral plateau and the medial shift of the mechanical axis, resulting in degeneration and varus deformities of the knee joint.

This study confirms the safety and efficacy of partial fibular osteotomy in the treatment of medial compartment OA. Proximal osteotomy of the fibula weakens the lateral fibular support and leads to a correction of the varus deformity, which can subsequently shift the loading force from the medial compartment more laterally, leading to decreased pain and a satisfactory functional recovery. Mean Knee Society scores improved by 47.3 points in the final analysis. According to VAS scores, pain levels decreased significantly from severe to mild.

Although proximal fibular osteotomy is a simple procedure, care should be taken to avoid potential peroneal nerve injury. In this study, 4 (3.6%) patients reported numbness in the ipsilateral lower leg due to common peroneal nerve palsy (n=2) and superficial peroneal nerve injury (n=2). Based on this anatomical study and their own clinical experience, the authors recommend a posterolateral approach via the space between the peroneus longus and brevis muscle and soleus muscle to lessen the risk of iatrogenic nerve injury at a level of 6 cm before the fibular bed.

Limitations of this study include its small sample size. Although proximal fibular osteotomy may reduce knee pain significantly in the varus osteoarthritic knee and improve the radiographic appearance and functional recovery of the knee joint. It may delay or even negate the need for total knee arthroplasty. It is a safe, simple, and effective procedure that is an alternative to total knee arthroplasty for medial compartment OA of the knee joint. Care must be taken to avoid potential nerve injuries.

**REFERENCES**


