TRANSEPICONDYLAR AXIS IN NORMAL, VARUS, AND VALGUS KNEE

INTRODUCTION: Correct rotational alignment of the femoral component is one of the most important factors in successful total knee arthroplasty. The posterior condyles have been used as a femoral rotational alignment landmark. The laboratory studies have shown that slight external rotation of the femoral component relative to a line connecting the posterior aspects of the femoral condyles places the patellar groove in a favorable position in a normal knee. On the other hand, many surgeons pointed out that the posterior aspect of the femoral condyle does not serve as a reliable rotational landmark for a valgus knee because the lateral femoral condyle is abnormally small. However, detailed geometric measurements of valgus knees have not been available yet. This study was designed to evaluate femoral condylar geometry in normal, varus, and valgus knees using magnetic resonance imaging (MRI). The reliability of the posterior condylar axis as a rotational landmark for varus and valgus knees was evaluated compared with the transepicondylar axis and the anteroposterior (AP) axis.

SUBJECTS AND METHODS: Thirty knees in 27 normal volunteers (mean age: 66.2 years), 30 knees in 30 symptomatic patients with osteoarthritis and varus deformity (mean age: 67.0 years), and 11 knees in 10 symptomatic patients with osteoarthritis and valgus deformity (mean age: 68.8 years) were evaluated by MRI. The normal knee group did not have any knee symptoms and plain radiographs did not show any osteoarthritic changes (Figure 1). They had a normal physical examination and normal range of motion. Patients in the varus knee group and in the valgus knee group had signs and symptoms of osteoarthritis. Standing radiographs showed complete loss of the medial joint space in the varus knee group (mean femoro-tibial angle: 185.0°) and showed complete loss of the lateral joint space in the valgus knee group (mean femoro-tibial angle: 163.8°). T1 weighted MR imaging was performed according to the following protocol on a 0.5-Tesla Shimadzu SMT-50A MRI system (Shimadzu Co. Ltd, Kyoto, Japan) and all subjects were secured during the scanning process to prevent movement. Transverse images of the knee joint were obtained with a repetition time (TR) of 500 ms and an echo time (TE) of 20 ms. In the transverse view, sections through the most prominent part of both femoral condyles were used for measurement. The transepicondylar axis was defined as a line between the most medial and most lateral prominences of the epicondyles, while, the posterior condylar axis was a line connecting the posterior aspects of the femoral condyles. The anteroposterior (AP) axis was a line connecting the deepest part of the patellar groove anteriorly and the center of the intercondylar notch posteriorly (Figure 1). The angle between the transepicondylar axis and the posterior condylar axis and the angle between the line perpendicular to the AP axis and the posterior condylar axis were measured. One factor analysis (ANOVA) and Fisher’s PLSD as a post-hoc test were used for analysis of data.

RESULTS: Transepicondylar line showed 6.0° ± 3.6 (mean ± standard deviation) of external rotation in the normal knees and 6.0° ± 2.3 of external rotation in the varus knees relative to the posterior condylar axis (Figure 2). However, transepicondylar axis of the valgus knee showed 11.7° ± 2.8 of external rotation (Figure 3). This angle was significantly larger than that of the normal knees and the varus knees. The line perpendicular to the AP axis showed 6.3° ± 2.4 of external rotation in the normal knees, 6.6° ± 2.5 of external rotation in the varus knees, and 9.1° ± 3.8 of external rotation in the valgus knees relative to the posterior condylar axis. The external rotation angle was significantly larger in the valgus knees than in the normal and in the varus knees.

DISCUSSION: This is the first study that showed detailed geometry of the femoral condyle in varus knees. The results of this study showed that the posterior part of the lateral condyle in varus knees was severely distorted and the posterior condylar line was internally rotated relative to the transepicondylar axis in 11.7 degrees. These results confirmed that, in valgus knees, slightly external position of the femoral component relative to the posterior condyles caused internally rotated femoral component postoperatively. On the other hand, the transepicondylar axis or AP axis of the varus knees was approximately 6° externally rotated as in the normal knees. These results suggest that there is no hypoplasia of the posterior part of the medial condyle in varus knees and that degenerative changes of the posterior part of the medial condyle are minimal even in advanced varus knees. The posterior condyles can be used as a rotational landmark in varus knees, but not in valgus knees. However, the large range of the measured angle suggests that the shape of the distal femur varies among individuals and the posteroomedial articular cartilage might be destroyed in more severely deformed knees. All these rotational indices should be used to achieve correct rotational alignment.

Figure 1. (A) Standing AP radiograph of a normal knee. (B) Magnetic resonance imaging of the transverse view of the distal femoral condyle of a normal knee. The transepicondylar axis (TE), the posterior condylar axis (PC), and the anteroposterior axis (AP).

Figure 2. (A) Standing AP radiograph of a varus knee. (B) Magnetic resonance imaging of the transverse view of the distal femoral condyle of a varus knee. The transepicondylar axis had 6.0° external rotation relative to the posterior condylar axis in the varus knee.

Figure 3. (A) Standing AP radiograph of a valgus knee. (B) Magnetic resonance imaging of the transverse view at the distal femoral condyle of a varus knee. The transepicondylar axis had 11.7° external rotation relative to the posterior condylar axis in the valgus knee.