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The Knee

Gender differences of the morphology of the distal femur and proximal tibia in a Korean population

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ABSTRACT

Purpose: We conducted this study to determine whether the sizes of distal femurs and proximal tibiae in Korean men and women are different, and to assess suitability of the sizes of prostheses currently used in Korea.
Materials and methods: We performed morphological analysis of proximal tibia and distal femur on 115 patients (56 male, 59 female) using MRI to investigate a gender difference. Tibial mediolateral dimension (tMAP), tibial medial anteroposterior dimension (tMAP), tibial lateral anteroposterior dimension (tLAP) femoral mediolateral dimension (fML), femoral medial anteroposterior dimension (fMAP), and femoral lateral anteroposterior dimension (fLAP) were measured. The ratio of tMAP and tLAP to tML (plateau aspect ratio, tAP/tML×100%), and that of fMAP and fLAP to fML (condylar aspect ratio, fAP/fML×100%) were calculated. The measurements were compared with the similar dimensions of four total knee implants currently used.
Results: The tML and tAP lengths showed a significant gender difference ($P<0.05$). The plateau aspect ratio (tMAP/tML) revealed a significant difference between male (0.74 ± 0.05) and female (0.68 ± 0.04, $P<0.05$). For morphotype of distal femur, males were found to have significantly large values ($P<0.05$) in the parameters, except for fLAP. With regards to the ratio of the ML width to the AP length, the women showed a narrower ML width than the men. Both genders were distributed within the range of the dimensions of the prostheses currently used prostheses.
Conclusions: Korean population revealed that women have smaller dimensions than male counterparts. In both genders, a relatively small size of prostheses matches distal femur and proximal tibia better among the implants currently used in Korea.

1. Introduction

The purpose of total knee arthroplasty (TKA) is to relieve pain, improve function, and maintain the improvement. In order to obtain desirable TKA results, it is critical to select a prosthesis that best matches the sizes of the resected surfaces of the distal femur and proximal tibia before implantation [1]. The sizes and the shapes of implants also play important roles, because prostheses that match patient morphotypes provide firmer fixation and better initial stability [2,3]. It has been an issue of debate whether the knee joints of men and women differ morphologically and whether gender specific prostheses are required [4–6]. Those who contend that gender differences exist and defend the need for a female-specific prosthesis report have reported morphologic differences between men and women [6–10]. Morphological measurements revealed female knee joints have anterior condyles that are less prominent and more diamond-shaped. Furthermore, women with the same anteroposterior (AP) length have been reported to have a narrower mediolateral (ML) width than men [6]. Given this finding, some have maintained that gender-specific prostheses are needed. In fact, a gender-specific knee joint replacement that reflects gender-associated femoral morphological differences (Gender solution, Zimmer Inc., Warsaw, IN) has been introduced. On the other hand, others have suggested that morphological differences exist but consider these differences insignificant, and have raised doubts over the need of gender-specific prostheses [11–13].

In addition to sex differences, anatomic differences have been identified between ethnicity. Most prostheses have been designed to match the morphotypes of western populations, and thus Asians, who tend to be smaller, are sometimes fitted with implants larger than needed [9,14–19]. Therefore, we conducted this study to determine whether the sizes of distal femurs and proximal tibiae in Korean men and women are different, and to assess suitability of the sizes of prostheses currently used in Korea.

2. Materials and methods

This research was approved by our institutional ethical review board. Subjects that underwent magnetic resonance imaging (MRI)

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of knee joints for diagnosis, among individuals that visited our institution complaining of knee joint pain from March 2004 to December 2008 were considered for enrollment, and of these, 115 patients without degenerative osteoarthritis were randomly selected (71 cases of internal knee derangement, 32 cases of soft tissue injury, seven cases with a cyst, and five cases of plica syndrome). The cohort included 56 men and 59 women of average age 31.2 years (25 to 35 years) and 36.2 years (20 to 45 years), respectively.

2.1. MRI technique

Before a 3.0 T MRI unit (Trio Tim system, Siemens, Erlangen, Germany) was installed at our hospital, a 1.5 T MRI unit (Sonata System, Siemens, Erlangen, Germany) was used, and after this installation both units were used. Images were obtained at an image thickness of 3 mm with an intervening interval of 0.3 mm. To obtain an axial image which runs parallel to knee joints, the patients were laid down in the supine position with their knee joints at 0° of an angle with facing the patellar forward for the imaging. A digitized picture archiving communication system (StarPACS, Infinitt, Seoul, South Korea) was used to measure the mophology in the axial images of proximal tibia 9 mm (three slices) below joint surfaces. Magnification was corrected automatically in the program. The measurement accuracy of PACS is reported to be better than 0.1 mm for a short distance [20]. Two independent orthopedic surgeons measured the entire data to secure objectivity against interobserver bias.

2.2. Measurement of proximal tibia

According to the definition of Kwak et al. [21], the mediolateral length of tibia (tML) was the length of the longest ML line in axial images of the proximal tibia. Anteroposterior length of tibia (tAP) was taken as the line drawn perpendicular to the tML line while passing through the midpoint of the resected surface. Medial anteroposterior length (tMAP) and lateral anteroposterior length (tLAP) were defined as the longest lines drawn parallel to the tAP line and perpendicular to the tML line, to the medial and the lateral condyles of tibia respectively from the resected surface (Fig. 1).

2.3. Measurement of distal femur

As condyles are more prominent in the mediolateral direction than TKA prostheses, measurements of the transepicondylar axis connecting the medial and lateral epicondyles (to determine ML length) might have larger values than replacements. Instead of defining transepicondylar axis as ML length, we decided to take measurement at the distal femur where the femoral component is inserted during TKA. The measurement was made in the axial MR image which is 9–10 mm above the lowest point of the medial femoral condyle (one to two slice(s) more distal to axial image showing the transepicondylar axis). Mediolateral length of distal femur (fML) was taken to be that of the longest line connecting the medial and the lateral dimensions while medial anteroposterior length (fMAP) and the lateral anteroposterior length (fLAP) of distal femur were defined as the longest line drawn perpendicular to the fML line, reaching the medial and the lateral condyles of femur respectively from the resected surface (Fig. 2).

2.4. Ratio of ML to AP

Based on definition of Hitt et al. [9], the ratios of tMAP and tLAP to tML (plateau aspect ratio, tAP/tML × 100%), and that of fMAP and fLAP to fML (condylar aspect ratio, fAP/fML × 100%) were calculated.

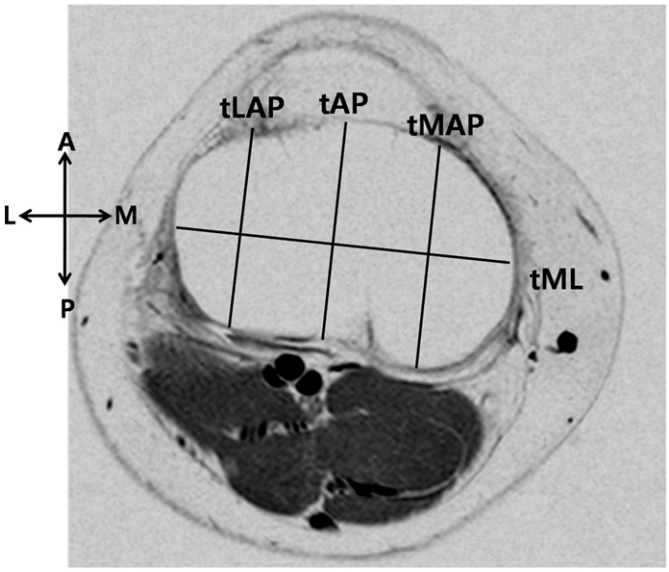

Fig. 1. Axial MRI image of the proximal tibia showing the mediolateral length of tibia (tML), the anteroposterior length of tibia (tAP), the medial anteroposterior length (tMAP), the lateral anteroposterior length (tLAP).

2.5. Comparison with size of prostheses commonly used in Korea

Four implant types, namely, the Scorpio (Stryker, Howmedica Osteonics), NexGen (Zimmer, Warsaw, Indiana), PFC-Sigma (DePuy-Johnson and Johnson, Warsaw, Indiana) and Emotion (Aesculap-B Braun, Melsungen, AG) implants, which are commonly used in Korea were studied to determine their ML and AP lengths (MAP and LAP), and ML to AP ratios were calculated.

2.6. Statistical analysis

Student *t*-test was performed to determine the significances of gender differences. Analysis of covariance (ANCOVA) was conducted to validate results after adjustment for age. Cohen's kappa analysis was used to determine levels of interobserver agreement. Values were interpreted as;

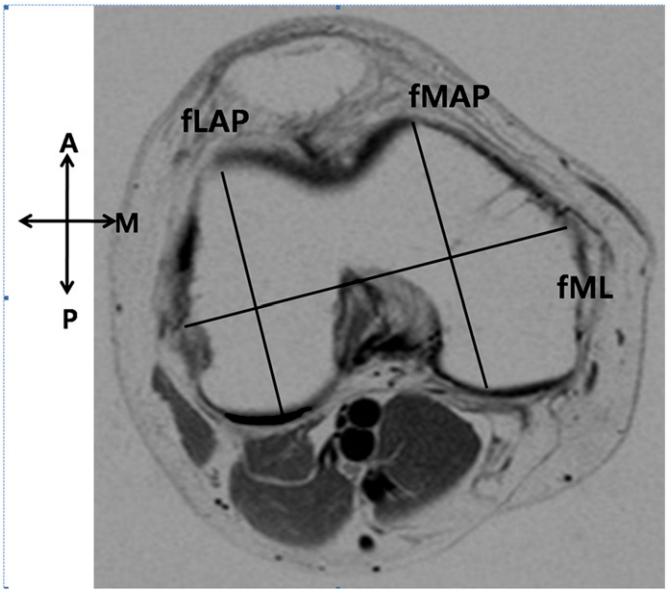

Fig. 2. Axial MRI image of the distal femur showing the mediolateral length of distal femur (fML), the medial anteroposterior length (fMAP), the lateral anteroposterior length (fLAP).