INTRODUCTION

With the high success rate of total knee arthroplasty (TKA), an increasing number of operations are performed in Asian-Pacific counties. It is postulated that the smaller build and stature of the Asian-Pacific population requires a different component size. However, due to the paucity of anthropometric data on the distal femur in this population, many prostheses designed for Caucasian knees have been introduced without specific modification. The aim of the current study was to analyze the precise anatomical data collected from a large group of patients undergoing total knee arthroplasty and to correlate the measurements to the dimensions of current total knee prosthetic systems.

MATERIALS AND METHODS

Morphologic data from the distal part of the femur in 561 knees in 471 patients undergoing total knee arthroplasty were analyzed. Four hundred and sixty-seven (467) knees (83.2 %) were in women (232 left and 235 right) and 94 knees (16.8 %) were in men (52 left and 42 right). The mean age and standard deviation was 73.9 ± 6.6 years (range, 39 - 91 years) for the 387 women and 75.3 ± 7.2 years (range, 44 - 91 years) for the 84 men. Ninety patients had a simultaneous or sequential bilateral total knee arthroplasty. The mean age of all patients was 74.2 ± 6.8 years. Average height was 147.4 cm (range, 130 - 168 cm) for women and 159.9 cm (range, 147 - 176 cm) for men. The primary diagnosis leading to knee arthroplasty were osteoarthritis in 445 patients (530 knees) and rheumatoid arthritis in 26 patients (31 knees). All the operations were performed by 4 surgeons using the LCS total knee system (Depuy) and following the standard technique. The knees were exposed through a medial parapatellar approach. The bone cut in the proximal tibia was made with the intramedullary alignment guide perpendicular to its long axis in the frontal plane. The bone cut in the distal femur was made to excise bone of the same thickness as the femoral component from the less affected side. Following these bone cuts, osteophytes were excised and soft tissue balance in extension was checked using the “spacer block technique”. Then the flexion gap was made equal to the extension gap using the balanced soft tissue sleeve as the guide for the positioning of the femoral component. The anterior bone cut on the cortex level was performed initially and the anterior-posterior (AP) and medial-lateral (ML) lengths of the distal femur were measured on the femoral resection surface. The AP length was measured on the lateral and medial condyles separately using a vernier caliper as shown in Figure 1. The maximum ML length was measured after the chamfer cut along the anterior edge of the posterior chamfer (Figure 2). Known dimensions from six prosthetic knee systems were compared with the morphologic data.

RESULTS

The scatter diagram of AP and ML lengths is presented in Figure 3. It demonstrates that the smaller components with an ML length of less than 55 mm were rarely required for the Japanese population. Femoral component size variation should focus on an ML length of 60 - 70 mm, as 432 of 561 knees (77.0 %) fell into this size range. When the findings were confined to women, 412 of 432 knees (95.2%) were included in this size range.

A wide variation in AP to ML ratio (range 0.7 to 0.95) was observed. The AP to ML ratio had a negative correlation with the ML length ($r^2 = 0.259, p < 0.0001$) indicating that small knees were longer in the AP direction (Figure 4). The AP to ML ratio for the small knees (ML length = 60 mm) was approximately 0.83 and for large knees (ML length = 75-80 mm) was approximately 0.75. The AP to ML ratio of currently popular prostheses had a wide variation and showed higher ratio for smaller knees and lower ratio for larger knees.

DISCUSSION

For the design of a femoral component with maximum stability it is essential to have anthropometric data of the distal femur at the resection level. Geometry of the distal part of the femur is more complex than that of the tibia and intraoperative measurement of the actual bone resection surface is essential for accurate evaluation. To our knowledge, this study is the first to evaluate morphologic dimensions in an Asian-Pacific population after bone preparation for prosthetic replacement. This study clearly demonstrated that a special smaller size femoral component is rarely required despite the short stature of patients. Preparation of the size variations should focus on an ML length of 60 – 70 mm. When the AP to ML ratio was analyzed, small knees had a larger AP to ML ratio indicating a narrower femur compared to big knees. It is surprising that the majority of current prostheses had the opposite tendency; namely higher AP to ML ratio for smaller knees and lower ratio for larger knees. No prostheses fulfilled the two important requirements for Japanese knees as demonstrated by this study; enough size variation between ML length of 60-70 mm and an increased AP/ML ratio for small knees. Design modifications based on the anthropometric data shown in the current study are necessary for the design of a knee prosthesis with maximum femoral stability and suitable for most of the Asian-Pacific population, which will probably be the most important market of the 21st century.