ABSTRACT

Purpose. To compare the morphology of the distal femur between Caucasian and Japanese women.

Methods. 30 Caucasian women aged 41 to 84 (mean, 67) years and 70 Japanese women aged 54 to 86 (mean, 70) years who underwent total knee arthroplasty for osteoarthritis were randomly selected. Morphologic measurements of the distal femur were compared using lateral radiographs. Both race and height influenced the morphology. To adjust for the influence of height on morphology, each measurement was divided by the patient’s height and the ratios were compared.

Results. Caucasian women were generally taller and heavier (p<0.001) and had higher body mass index (p=0.03) than the Japanese women. Each morphologic measurement of the distal femur was significantly longer in the Caucasian women. In both groups, anteroposterior width of the condyle correlated more with height than weight. In women of equal height, the anteroposterior and metaphyseal widths of the femur and the anterior and resected condyles were longer in Caucasian women, but the posterior condyle was longer in Japanese women.

Conclusion. Both the size of the femur and the anterior and posterior condyles are significantly larger in Caucasian than Japanese women.

Key words: arthroplasty, replacement, knee; Asian continental ancestry group; continental population groups; European continental ancestry group; femur

INTRODUCTION

Morphology of the distal femur helps elucidate the causes of osteoarthritis, the outcome of osteotomy for osteoarthritis, and the optimal design and procedure for total knee arthroplasty (TKA). The ratio of anteroposterior width to mediolateral width of the distal femur differs between Caucasian and Japanese populations, such that mismatch of the prosthesis may occur. We aimed to compare the morphology of the distal femur between Caucasian and Japanese osteoarthritic women using lateral radiographs.
Correlations between the AP width of the condyle/shaft and height/weight were measured using the Pearson correlation coefficient ($r$). Both race and height influenced the morphology of the distal femur. Therefore to adjust for the influence of height on morphology, each measurement was divided by the patient’s height and the ratios were compared.

Measurements were made by 2 observers. One of them made measurement 3 times. Intra-observer and inter-observer reliability were assessed using the intraclass correlation coefficient. The 2-tailed Student’s $t$ test was used for comparison of the groups. A $p$ value of $<0.05$ was considered significant.

RESULTS

Caucasian women were generally taller and heavier ($p<0.001$) and had higher body mass indices ($p=0.03$) than the Japanese women (Table). 70% of the Caucasian and 50% of the Japanese patients were obese. 28 Caucasian and 66 Japanese women had FTA of $>175^\circ$. There were 13 (1+12) grade-3 and 87 (29+58) grade-4 osteoarthritis cases. The intra-observer and inter-observer intraclass correlations were 0.96 (95% confidence interval [CI], 0.92–0.98) and 0.89 (95% CI, 0.77–0.95), respectively.

Each morphologic measurement of the distal femur was significantly greater in the Caucasian women (Table). In both groups, AP width of the condyle correlated more with height ($r=0.71$) than weight ($r=0.57$) [Fig. 2]. The correlation coefficient between AP width of the femur and height was just 0.5.

The height-adjusted ratios of the half metaphyseal femur ($p<0.001$), the whole condyle ($p=0.03$), the anterior condyle ($p<0.001$), and the resected condyle ($p=0.004$) were significantly greater in the Caucasian women (Table). However, the height-adjusted ratio of the posterior condyle was significantly smaller in Caucasian women ($p=0.02$). The height-adjusted ratio of the remaining condyle was not significantly different between the 2 groups ($p=0.74$).

DISCUSSION

The size and shape of the distal femur differ between Caucasians and Japanese.6–9 Osteoarthritis and patellofemoral pain syndrome is more common in women.15–19 The AP width divided by the mediolateral width of the femur was greater in Caucasians than Japanese, but the differences in height, weight, and
body mass index were not analysed.\textsuperscript{9} In Japanese people, the width of the femur (at the articular level) and the AP length of the medial condyle correlated better with height than weight.\textsuperscript{20} In our study, height correlated better with the AP width of the condyle and therefore each measurement was divided by the patient’s height to adjust for the influence of height on morphology.

In our patients of equal height, the AP and metaphyseal widths of the femur and the anterior and resected condyles were longer in Caucasian women, but the posterior condyle was longer in Japanese women. As the width of the anterior flange of most prostheses is 8 to 10 mm, the resected condyle can be shorter than the anterior flange. The resected posterior condyle is usually equal to the posterior flange, according to the independent cut theory.\textsuperscript{13} Thus in Japanese patients after TKA, the AP width of the distal femur and hence the pressure on the patellofemoral joint may be excessive.

In normal knees, full flexion is accompanied by impingement between the posterior femur and the posterior horn of the medial meniscus.\textsuperscript{21} A significant correlation was noted between operative restoration of the posterior condylar offset (the depth of the posterior condyle) and the maximal flexion in the posterior cruciate ligament–retaining TKA.\textsuperscript{22} Increased flexion in the knee joint may require a

### Table

Comparison of morphologic measurements in Caucasian and Japanese women

<table>
<thead>
<tr>
<th>Parameters</th>
<th>Caucasian women</th>
<th>Japanese women</th>
<th>p value (2-tailed Student’s t test)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Height (cm)</td>
<td>162±5 (152–173)</td>
<td>148±6 (138–157)</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>Weight (kg)</td>
<td>74±2 (69–78)</td>
<td>59±9 (42–78)</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>Body mass index (kg/m(^2))</td>
<td>28.0±0.8 (26.2–29.9)</td>
<td>26.8±3.5 (19.4–35.7)</td>
<td>0.03</td>
</tr>
<tr>
<td><strong>Measurement of the distal femur</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Anteroposterior width of the shaft (mm)</td>
<td>32.2±2.2</td>
<td>28.3±2.8</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>Height-adjusted ratio (%)</td>
<td>19.7±1.5</td>
<td>19.0±1.9</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>Anteroposterior width of the condyle (mm)</td>
<td>70.7±4.6</td>
<td>62.4±4.5</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>Height-adjusted ratio (%)</td>
<td>43.6±2.3</td>
<td>42.1±2.9</td>
<td>0.03</td>
</tr>
<tr>
<td>Half metaphyseal width of the shaft (mm)</td>
<td>18.1±1.4</td>
<td>14.4±1.5</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>Height-adjusted ratio (%)</td>
<td>11.2±0.9</td>
<td>9.7±0.9</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>Length of the anterior condyle (mm)</td>
<td>25.7±3.6</td>
<td>19.4±2.6</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>Height-adjusted ratio (%)</td>
<td>15.8±2.1</td>
<td>13.1±1.6</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>Length of the posterior condyle (mm)</td>
<td>45.1±3.4</td>
<td>42.9±3.8</td>
<td>0.009</td>
</tr>
<tr>
<td>Height-adjusted ratio (%)</td>
<td>27.8±2.0</td>
<td>29.0±2.7</td>
<td>0.02</td>
</tr>
<tr>
<td>Length of the resected condyle (mm)</td>
<td>7.6±3.1</td>
<td>5.0±2.6</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>Height-adjusted ratio (%)</td>
<td>4.6±1.9</td>
<td>3.4±1.7</td>
<td>0.004</td>
</tr>
<tr>
<td>Length of the remaining condyle (mm)</td>
<td>63.3±3.7</td>
<td>57.4±4.2</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>Height-adjusted ratio (%)</td>
<td>39.0±2.1</td>
<td>38.7±2.8</td>
<td>0.74</td>
</tr>
</tbody>
</table>

Figure 2  Anteroposterior width of the femoral condyle correlates more to (a) height than (b) weight and in both Caucasian and Japanese women.
longer posterior condyle to avoid impingement of the tibia on the posterior femur.

Further studies to compare the medial and lateral condyles independently are needed to elucidate the kinematics of knee joints and the optimal design and procedure for successful TKAs in each race.

ACKNOWLEDGEMENTS

We thank Dr Hiroaki Minehara, Dr Masaki Ueno, Dr Kouji Naruse, Dr Mamoru Fujita, Dr Jun Aikawa, Dr Motoi Miyabe, and Ms Yuko Oonuki for assistance in preparing the manuscript.

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