INTRODUCTION
Correct alignment of the components is important for long-term survival of total knee arthroplasty (TKA). However, there is as yet not consensus regarding ideal rotational alignment in the coronal and the sagittal plane. Malalignment in axial rotation (especially combined internal rotation) may lead to patellar dislocation or loosening. Anatomic references for axes of the tibial rotational alignment have been reported from computed-tomography or MRI. These analyses comprised 2-dimensional evaluations that are affected by scanning direction, since the anteroposterior axis is affected by level of selection of the 2D-image. In addition, the mechanical axes were ignored since only the knee joint was scanned.

In TKA, coverage of the tibial baseplate on the tibial bone cut is critical since maximal implant coverage on the cutting surface minimizes the stress applied to the bone-implant interface. However, sometimes there is a conflict between optimal rotational alignment and optimal tibial baseplate coverage. No single method provides consistent coverage.

This study evaluated the effect of the rotational alignment on the tibial tray overhang after TKA using 3-dimensional patient-specific bone model in Japanese and Caucasians.

METHODS
Patients
Preoperative CT scans from hip to ankles were obtained from 23 Caucasians and 24 Japanese patients before TKA. All patients had end-stage osteoarthritis of the knee. There were no significant differences between 2 groups concerning mean age and knee deformity at the time of surgery.

Patient-Specific Computer Model
CT scans of each patient were segmented to generate 3-dimensional femoral and tibial bone geometry using MIMICS (Materialise, Leuven, Belgium). The following bony landmarks were defined: transepicondylar axis of the femur (TEA), posterior notch of the tibia at the attachment of the posterior cruciate ligament (Notch), medial edge and medial 1/3 of the patellar tendon attachment on the tibial tuberosity (Med and 1/3 Med). The center of hip, knee and ankle joints were defined using previously published methods.

RESULTS
The difference between Axis 2 and Axis 3 relative to the TEA was –2.3 ±5.9° (–14.3 to 8.9) and 4.0 ±5.7° (–7.0 to 13.8) (external rotation being positive). The incidence of the overhang was significantly different based on alignment method: 10.6 % (Axis 1), 48.9 % (Axis 2) and 55.3 % (Axis 3) (p<0.05, Fisher’s exact probability test). To reduce overhanging, the tray required downsizing or adjustment in mediolateral direction by more than 3 mm in 61 % (Axis 2) and 88 % (Axis 3).

There were no significant differences in the difference of angle relative to TEA and in rates of overhanging between Caucasian and Japanese patients (Table 1).

Table. 1: Comparison between Caucasian and Japanese patients

<table>
<thead>
<tr>
<th>Difference of angle to TEA</th>
<th>Caucasian</th>
<th>Japanese</th>
</tr>
</thead>
<tbody>
<tr>
<td>Axis 2</td>
<td>–1.9±5.6° (–13.4 to 7.3)</td>
<td>–2.7±6.2° (–14.4 to 8.9)</td>
</tr>
<tr>
<td>Axis 3</td>
<td>4.5±5.7° (–7.0 to 13.4)</td>
<td>3.5±5.7° (–6.8 to 13.8)</td>
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DISCUSSION
Some reports have studied ideal rotational alignment of the tibia. However, there is no clear consensus and the effects of tibial tray rotation on coverage of the tibial baseplate are less known. Matching the shape of the footprint of the tibial tray to the resected surface of knee has been reported as a factor for long-term survivorship in TKA. Surgeons should therefore optimize both coverage and the alignment.

Aligning perpendicular to the TEA generated the least overhang. Using tibial landmarks alone does not result in optimum coverage. Tibial landmarks that have been reported to define the anteroposterior direction don’t pass through the midpoint of the surface of the tibial cut which has an asymmetric shape. It is difficult to achieve the best coverage using the tibial landmarks with current generation designs of the tibial baseplate. A image-based navigation system would be useful in more accurately aligning the tibial tray.

Previous studies reporting on ideal alignment for the tibial tray have used 2-dimensional evaluations on healthy subjects (without osteoarthritis) or without measurement of the mechanical axes which does not replicate the results of real surgery. In this study, virtual surgery was performed with 3-dimensional model of actual patients before TKA including the mechanical axes.

Some weaknesses of our model are that the soft tissue attachments were defined with 2-dimensional, not 3-dimensional evaluation. One implant condition (symmetric design and 5° posterior slope) was simulated. Despite these limitations, our method would better simulates actual surgical conditions and is useful as a preoperative planning tool.

REFERENCES