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# Deviation of femoral intramedullary alignment rod influences coronal and sagittal alignment during total knee arthroplasty

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ABSTRACT

*Background:* An intramedullary (IM) rod is used to resect the distal femur vertically to the femoral mechanical axis in the coronal plane in many cases of total knee arthroplasties (TKA). The valgus angle between the mechanical axis and the anatomical axis of the distal femur is estimated preoperatively. It is known the deviation of the IM rod in the femoral canal could influence the femoral component alignment. However, there is no published data regarding how many degrees of deviation to make with the IM rod. The purpose of this study is to measure each deviation of the IM rod using three-dimensional (3D) computer simulations.
*Methods:* Preoperative CT scans on 30 knees undergoing TKA were studied. The line connecting central points at 10 and 20 cm proximal from the intercondylar notch was defined as the anatomical axis and the point at which the anatomical axis intersects the surface of the distal femur was considered as the entry point of the IM rod. The medio-lateral (ML) and antero-posterior (AP) deviations between the anatomical axis and the IM rod were measured.
*Results:* The ML and AP deviations were 0.8 and 1.1° on average. The IM rod was deviated mediolaterally more than 1.0° in three knees (10%).
*Conclusion:* Surgeons should note the ML difference of the resection thickness of the distal femur for coronal alignment. If the ML difference varies greatly from the preoperative planning, they need to adjust at most 1.0° of valgus angle to achieve the appropriate coronal alignment.
Level of evidence III, Therapeutic.



## 1. Introduction

Total knee arthroplasty (TKA) is a successful procedure for end-stage osteoarthritis of the knee or rheumatoid arthritis due to the improvement of surgical techniques and materials [2,3,5–7,10,24,26–28,32,37,39,42,45,46]. It has been advised that femoral and tibial components should be positioned less than three degrees of varus or valgus malalignment [10,34,35,37]. It is generally recommended that the distal femur should be resected vertically to the femoral mechanical axis in the coronal plane [9,11,25,43] and an intramedullary rod (IM rod) is used during this procedure in many cases [1,22,23,38]. The valgus angle between the femoral mechanical axis and the anatomical axis of the distal femur can be estimated preoperatively using a radiograph of the whole femur or computed tomography (CT) data, and the resection angle of the distal femur is adjusted based on the valgus angle.

Surgeons know clinically that the deviation of the IM rod to the medial or lateral, and the anterior or posterior in the canal of the femur could influence the femoral component alignment [20,36,38]. However, to the best of our knowledge, there is no published data regarding how many degrees of deviation to make with the IM rod. The objectives of this study are to measure each deviation of the IM rod and the difference of the resection thickness of the distal femur using three-dimensional (3D) computer simulations.

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**Table 1**
Patient details.

| Patient details | Value, mean ± SD (range) |
|---|---|
| Age (years old) | 77.4 ± 3.4 |
| Gender (knees) | Male: 2; Female: 28 |
| Side | Right: 14; Left 16 |
| Kellgren–Lawrence Grading Scale (knees) | Grade 3: 3; Grade 4: 27 |
| Body mass index (kg/m$^2$) | 25.1 ± 3.4 (18.8–32.5) |
| Hip–knee–ankle (°) | 10.7 ± 6.1 varus (2–27 varus) |
| %MA (%) | 9.4 ± 22.9 (−58 to 48) |

MA, mechanical axis; SD, standard deviation.

## 2. Materials and methods

This study was approved by the institutional review board (No. 16080-189). Informed consent for participation was obtained from all patients. A total of 30 Japanese TKAs were recruited in this study. Patient details are described in Table 1. We excluded any deformity such as post-fracture or osteotomy influencing the femoral shaft morphology in our study.

The patients were placed in the supine position on the scanning table, and the affected knee was naturally extended without any feeling of internal or external rotation. Transverse CT scans were taken at levels ranging from the hip joint to the ankle joint at 1.25 mm intervals. CT images were acquired as digital imaging and communications in medicine (DICOM) data from the CT system server. Three-dimensional images of the lower extremity were reconstructed on the computer using the program 3D template (ver. 3.8, Kyocera Medical, Osaka, Japan) [10,12–15,17,33]. All measurements were done with the computer program.

The femoral mechanical axis was defined as the line connecting the center of the femoral head and the midpoint of the surgical epicondylar axis (SEA) [28]. The coronal plane was defined as the plane including the femoral mechanical axis and the SEA [28] (Figure 1). The line connecting central points at the level of 10 cm and 20 cm proximal from the intercondylar notch of the distal femur was defined as the anatomical axis of the distal femur [31] and the point at which the anatomical axis intersects the surface of

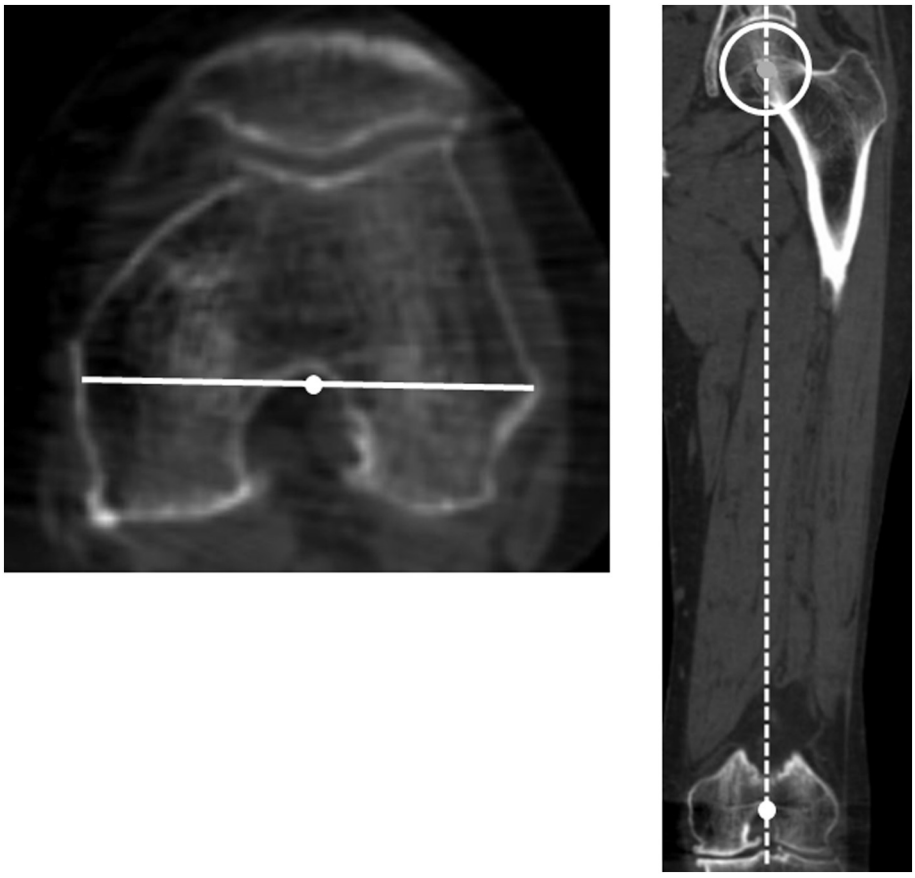

**Figure 1.** The femoral mechanical axis (*white broken line*) was defined as the line connecting the center (*gray point*) of the femoral head and the midpoint (*white point*) of the surgical epicondylar axis (SEA: *white solid line*). The coronal plane was defined as the plane including the femoral mechanical axis and the SEA.

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