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Anteroposterior Rotational References of the Tibia for Medial Unicompartmental Knee Arthroplasty in Japanese Patients

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ABSTRACT

Background: In unicompartmental knee arthroplasty (UKA), there is no consensus regarding how to determine the anteroposterior (AP) reference of the tibia. A number of surgeons in Japan perform the sagittal saw cut using the medial intercondylar ridge (MIR) of the tibia according to surgical manuals. However, there is no theoretical basis for this practice.
Methods: Preoperative computed tomography data from 32 lower limbs of 31 Japanese patients who received UKA were used. First, the angles between the surgical epicondylar axis and the MIR and the substitute AP (sAP) line connecting the medial border of the patellar tendon at the articular surface level and the medial intercondylar tubercle were measured. Next, the mediolateral (ML)/AP ratio of the tibial cut surface was measured when cut parallel to the MIR and sAP line. Finally, the ML/AP ratio of the tibial component was investigated in 4 contemporary UKA implants.
Results: The MIR and sAP line were externally rotated 94.9° ± 4.1° and 90.4° ± 3.6° relative to the surgical epicondylar axis, respectively. Compared with a cut parallel to the MIR, the mean ML/AP ratio of the cut surface was significantly larger, and the ML/AP ratio was closer to the ML/AP ratio of the components for a cut parallel to the sAP line.
Conclusion: Obtaining the tibial AP orientation is one of the key steps not only in total knee arthroplasty but also in UKA. The sagittal cut referencing the sAP line provides better AP rotation and fitting of the tibia in UKA than referencing the MIR.

Rotational alignment of the tibial component is important in both total knee arthroplasty (TKA) [1] and unicompartmental knee arthroplasty (UKA) [2,3]. The tibial anteroposterior (AP) line connecting the middle of the posterior cruciate ligament (PCL) to the medial edge of the patellar tendon (PT) attachment has been proposed for this alignment and is used in TKA [4,5]. However, it can be difficult to identify the tibial AP line in a modern mini-incision UKA because the PCL is barely visible or accessible in the small operating field. A manufacturer has suggested the medial intercondylar ridge (MIR) as an anatomical rotational reference of the tibial component, although without sufficient evidence [6–8]. According to these manuals, a number of surgeons in Japan including us perform the sagittal saw cut using the MIR as the tibial AP reference. To our knowledge, however, there is no theoretical basis for this practice. The MIR appears to be only one bony landmark for indicating the AP orientation on the tibial plateau, which can be identified as a linear peak connecting the medial intercondylar tubercle (MIT) and the medial brink of Parsons' knob [9,10] (Fig. 1A). However, it is not clear whether the MIR is perpendicular to the surgical epicondylar axis (SEA) or parallel to the tibial AP line [4,5].

In UKA, the tibial components must be sized and positioned properly so that the tibial cut surfaces are well covered without marked underhang or overhang and subsequent impingement of the surrounding soft tissues [11]. Rotational orientation of the

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Approval of institutional review board in our university hospital was obtained for this study (Approval No: 23-087).

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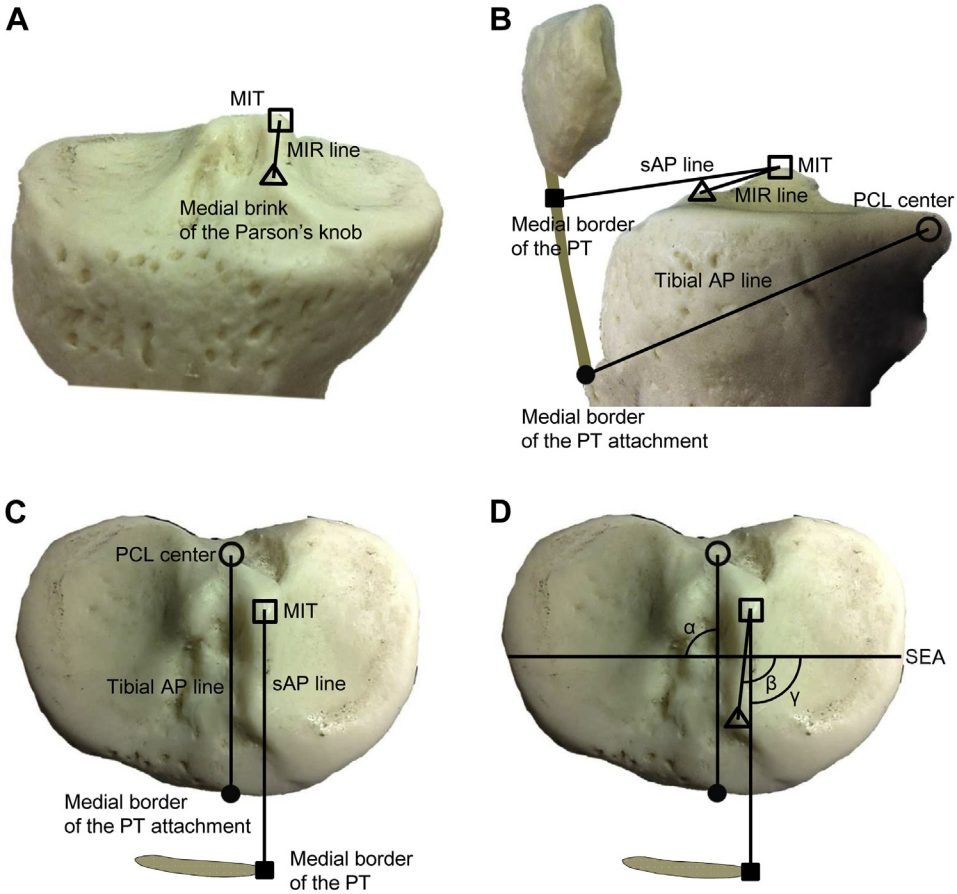

Fig. 1. Photographs showing the anatomical bony landmarks and the AP referencing lines on the tibial plateau. (A) Frontal view. The MIT, a medial brink of Parsons' knob, and the MIR line connecting the MIT and brink are shown. (B) Lateral view. The sAP line connecting the MIT and medial border of the PT at the articular surface level, the MIR line and tibial AP line connecting the PCL center and the medial border of the PT attachment to the tibia are shown. (C) Axial view. The tibial AP line and sAP line are shown. (D) The external rotation angle of the tibial AP line (α), MIR line (β), and sAP line (γ) relative to the SEA are shown. Open squares (□), MIT; triangles (△), brink of Parsons' knob; filled squares (■), medial border of the patellar tendon at the articular surface level; open circles (○), PCL center; filled circles (●), medial border of the patellar tendon attachment. AP, anteroposterior; MIR, medial intercondylar; MIT, medial intercondylar tubercle; PCL, posterior cruciate ligament; PT, patellar tendon; sAP, substitute AP; SEA, surgical epicondylar axis.

sagittal cut of the tibia can affect the coverage of the cut surface because external or internal rotational errors can result in a smaller mediolateral (ML) length of the tibial cut surface relative to the AP length. Underhang of the tibial cut surface may result in edge loading on the tibial polyethylene and insufficient bony support of the tibial component on the cut surface [12]. By contrast, medial overhang of the tibial component of 3 mm or more can significantly worsen the Oxford Knee Score and pain score [13]. A cadaveric study showed that a medial overhang of more than 2 mm increases the load to the medial collateral ligament, which is one possible cause of pain [14]. Actually, we have sometimes experienced medial overhang of the tibial component when the sagittal bone cut was performed parallel to the MIR.

In this study, we investigated whether the MIR is an appropriate reference for determining the AP orientation of the tibia in a medial UKA and, if not, whether there is an alternative AP reference of the tibia that is better than the MIR. First, we searched anterior anatomical landmarks to find alternative AP references when the MIT is used as a posterior landmark. After screening, we chose the medial border of the PT at the articular surface level as a good candidate for the anterior landmark and called this line made by these landmarks a substitute AP (sAP) line (Fig. 1B and C). We then compared the MIR and sAP line in terms of their angles relative to the SEA (Fig. 1D). We also examined whether the MIR or sAP line is a better AP reference for avoiding medial overhang.

Materials and Methods

Study Population

After obtaining approval from our institutional review board, we reviewed computed tomography (CT) data obtained for routine preoperative planning from 32 lower limbs in 31 Japanese patients. These patients were scheduled for consecutive primary UKA in our hospital between January 2015 and November 2015. All patients gave informed consent to allow use of their medical information for this retrospective study. The mean age of the patients was 73 years (range 59–87 years), and 10 knees were in men and 22 knees were in women. Twenty-eight knees were diagnosed with primary medial osteoarthritis (OA) and 4 knees with spontaneous osteonecrosis of the medial femoral condyle. In the radiographic assessment, the severity of OA according to the Kellgren–Lawrence classification [15] was grade 2 in 19 knees and grade 3 in the other 9 knees. Flexion contracture of the knee was less than 10°, and the hip–knee–ankle angle was less than 10° in all knees.

Image Technique

The CT scans were performed using a 64-row multislice CT system (LightSpeed VCT; GE Healthcare, Chalfont St. Giles, UK) in our hospital. The patients were positioned on the CT table in a