The Distance From The Skin Surface To The Extramedullary Cutting Guide Is A Practical Useful Reference Guide For Tibial Slope In Total Knee Arthroplasty

Tadashi Tsukeoka, Yoshikazu Tsuneizumi, Tae-Hyun Lee.
Chiba Rehabilitation Center, Chiba, Japan.

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Introduction: Although proper sagittal tibial alignment in total knee arthroplasty (TKA) is important for stability, range of motion, and contact pressure within the tibiofemoral joint [1-4], no gold standard anatomic landmark currently exists. Tibial crest has been advocated as a reliable landmark for tibial posterior slope in a few studies [5, 6]. The anterior tibial crest is the area which has the least soft tissue, and is an easily palpable and visible landmark. We therefore hypothesized that the distance between the extramedullary cutting guide and skin surface, just above the tibial crest could be a practical useful reference guide for tibial slope in TKA. The aim of this study was to determine (1) how accurate the predicted posterior slope cut using this distance as a reference guide and (2) whether obesity affected its accuracy.

Methods: Our study investigated 100 knees in 91 consecutive patients scheduled for TKA. The population consisted of 89 knees in 82 females and 11 knees in 9 males. Our study group included 78 patients with osteoarthritis (87 knees) and 13 patients with rheumatoid arthritis (13 knees). None of our patients had evidence of trauma, infection, tumor, or any congenital disorder. The mean age of all patients was 72.5 years (range, 53 years to 84 years). Mean weight, height and body mass index (BMI) of the patients were 59.7 kg (range, 39 kg to 97 kg), 152.7 cm (range, 131 cm to 173 cm), and 25.4 kg/m² (range, 17.3 kg/m² to 41.1 kg/m²), respectively. Preoperative high-resolution CT scans of all the affected lower limbs, including the whole tibia, were performed as a standard exam for TKA preoperative planning. Three-dimensional (3D) CT-based preoperative TKA planning software (ZedKnee ® LEXI Co., Ltd., Tokyo, Japan) was used to determine the tibial mechanical axis (MA) and perform the measurements. First, the coronal plane passing through the most anterior point of the predicted tibial cut surface (10 mm from the unaffected side) which is parallel to the tibial MA was created (Fig.1A and B). Then, the distance between this plane and the skin surface just above the tibial crest 20 cm distal to the predicted cut surface was measured (Fig.1C, d; positive value indicates the skin surface located posteriorly compared to the plane). The predicted posterior slope of the tibia was calculated based on this data when the distance between the extramedullary cutting guide and the skin surface 20 cm distal to the predicted cut surface was equal to the distance between the most anterior part of the tibia at the bone cutting level and the guide rod (Fig.1D; positive value indicates posterior slope cut). The correlation between BMI and the distance between the skin surface and the guide rod was examined. To measure the test-retest reliability, the measurements were repeated on 30 randomly selected subjects with two months intervening. We used Pearson’s correlation coefficients to correlate the distance between skin surface and the guide rod with BMI. The Mann-Whitney test was used to compare the difference in predicted tibial slope for men and women. A p-value of less than 0.05 was considered significant. This study was approved by our Institutional Review Board.
**Results:** The test-retest-reliability coefficient was excellent (0.986). The predicted posterior slope of the tibia when the distance between the skin surface 20cm distal to the bone cutting level and the guide rod was equal to the distance from the proximal tibia to the rod was shown in Figure 2. The mean (± SD) predicted posterior slope was -0.1º±1.1º (range, from -2.9º to 4.3º). Ninety five knees out of 100 knees were within 2º of deviation from the tibial MA, and all of the knees were within 3º of deviation except for one patient. The mean (± SD) distance from the coronal plane, which is parallel to the sagittal tibial MA and passing through the most anterior point of the predicted tibial cut surface, to the skin surface just above the tibial crest was 0.3mm±3.9mm (range, from -15mm to 10mm). A significant negative moderate correlation between BMI and the distance from the skin surface to the guide rod was found (r=-0.41, p=0.00003).

**Discussion:** In the present study, by making the distance from the skin surface to the guide rod equal to the distance between the cutting block and the guide rod, surgeon can place the cutting guide almost parallel to the tibial MA in the sagittal plane. It was reported that the difference between the anterior tibial crest and the sagittal tibial MA was 2º to 5º of predicted anterior slope in previous studies [5, 6]. The soft tissue was not considered in these studies. The most anterior point of tibia at the osteotomy height is located posterior to the tibial tubercle. In addition to this proximal anterior tibial cortex location, the thickness of the soft tissue in front of the tibial crest may lead to parallelize the guide rod to the sagittal tibial MA.

We found that the obesity affected its accuracy. It was demonstrated that patients with obesity were at the risk of postoperative malalignment in the previous studies [7, 8]. The only patient whose predicted posterior slope was more than 3º of deviation from the tibial MA (4.3º), has a BMI of 29.6 kg/m² and has 15mm thickness of the soft tissue in front of the anterior tibial crest. In the technique presented in this study, the problem can be solved if the pre-operative lateral radiograph of the whole lower leg is performed. This study had several limitations. First, anatomical features may differ with the ethnic origin of patients. Because all subjects in this study were ethnically Japanese, the findings might be difficult to directly extrapolate to a patient population of a different ethnic origin. Second, low percentage of male patients participated in this study, creating a skewed male/female ration. Further investigation including larger numbers of Caucasian subjects and male should be performed. However, this technique can be applied easily to all patients if the pre-operative lateral radiograph of the whole lower leg is performed.

**Significance:** The distance between the guide rod and the skin surface 20cm distal to the resection level can be a practical useful reference guide for the posterior slope of the extramedullary guide in TKA.
Fig. 1

A

200 mm

B

C

d

D

200 mm

a mm

a mm

Fig. 2

Number of knees

The predicted tibial posterior slope (°)

0 0 2 18 27 11 2 0 1

>4 >2 >3 2>2 2>1 2 0 1

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