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Original Article

Tibial Tubercle in Valgus Osteoarthritic Knees Is More Laterally Positioned Than in Varus Knees

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ABSTRACT

Background: The tibial tubercle (TT) is the most reliable landmark of the tibial component rotation in total knee arthroplasty. However, there is no report comparing the position of the TT between valgus and varus osteoarthritic knees.
Methods: Using preoperative computed tomography, we measured the TT-posterior cruciate ligament (PCL) distance representing the degree of lateralization of the TT and the angle between Akagi's anteroposterior (AP) axis and the dorsal condylar line (DCL) of the tibia in 36 valgus and 40 varus osteoarthritic knees and compared them.
Results: The mean TT-PCL distances in valgus and varus knees were 26.1 (18.2-36.8) and 17.2 mm (10.3-22.6), respectively, with a significant difference ($P < .001$). Twenty-four of 36 valgus knees (67%) had abnormal TT-PCL (>24 mm). The mean AP-DCL angles in valgus and varus knees were 103° (95.8°-114.8°) and 93.2° (85.3°-99.6°), respectively, with a significant difference ($P < .001$).
Conclusion: The TT in valgus knees was significantly more laterally positioned than in varus knees. Also, Akagi's AP axis in valgus knees was significantly more externally rotated relative to the DCL of the tibia than in varus knees. Attention is necessary to correct rotational alignment without posterolateral overhang of the tibial component during total knee arthroplasty, particularly for valgus knees.

Proper rotational alignment of the tibial component in total knee arthroplasty (TKA) is critical for a successful outcome. Clinical studies have shown that malrotation of the tibial component is associated with knee stiffness, pain, patellofemoral complication, and increased rates of revision surgery [1-3]. To avoid rotational error of the tibial component placement, the tibial tubercle (TT) is used as a reliable bony landmark [4,5]. Akagi et al [4,6] demonstrated that the line connecting the middle of the posterior cruciate ligament (PCL) and the medial border of the patellar tendon attachment at the TT is perpendicular to the surgical epicondylar axis (SEA) of the femur in an extended knee position from computed tomography (CT) for healthy knees, and a reliable and reproducible anteroposterior (AP) axis.

Approximately 10% of patients requiring TKA have a valgus deformity. Matsuda et al [7] reported that hypoplasia or erosion of the posterolateral femoral condyle existed in valgus knees, and the posterior condylar axis is more internally rotated in valgus knees than in normal and varus knees, relative to the SEA. Therefore, for valgus knees, systematic femoral component placement by 3° of external rotation relative to the posterior condylar axis can result in rotational malalignment, which causes patellofemoral complication [8-10], and so the femoral component should be placed parallel to the SEA because it approximates the flexion-extension axis of the knee and the femoral collateral ligaments' origin [11-13]. Although the anatomic features of the femoral condyles in valgus osteoarthritic knees have been demonstrated, they have not been fully evaluated in regard to the morphology of the proximal tibia. If the line connecting the middle of the PCL and the medial border of the patellar tendon attachment is perpendicular to the SEA for all knees

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Table 1
Patient Demographics.

	Valgus Group	Varus Group	*P* Value
Age (y), mean (range)	73 (59-81)	73 (64-86)	NS
Gender (male/female)	5/26	5/35	NS
Height (cm), mean (SD)	152 (9)	152 (8)	NS
Weight (kg), mean (SD)	57 (11)	60 (12)	NS

NS, not significant.

[4,6,14], the TT in valgus knees may be more laterally positioned than in varus knees, and consequently, Akagi's AP axis in the valgus knee would be more externally rotated than in the varus knee. However, there is no report comparing the position of the TT between valgus and varus osteoarthritic knees.

In 2012, Seitlinger et al [15] described a new measurement, the TT-PCL distance, which was defined as the mediolateral distance between the midpoint of the insertion of the patellar tendon and the medial border of the PCL parallel to the dorsal condylar line (DCL) of the tibia. This made it possible to quantify lateralization of the TT independent of the flexion of the knee. They defined a TT-PCL distance >24 mm as abnormal.

The purposes of this study were to retrospectively measure the TT-PCL distance and the angle between Akagi's AP axis and the DCL of the tibia from preoperative CT for valgus and varus osteoarthritic knees and compare them. Our hypotheses were that the TT-PCL distance in valgus knees was larger than that in varus knees and that Akagi's AP axis in valgus knees was more externally rotated relative to the DCL of the tibia than in varus knees.

Materials and Methods

After approval was obtained from the institutional review board, data were collected retrospectively. Between January 2011 and July 2015, 45 valgus knees of 38 patients underwent TKA at our institute. We excluded 2 knees of rheumatoid arthritis and 2 knees after high tibial osteotomy. In addition, 2 knees with ipsilateral congenital dislocation of the hip, 1 knee with ipsilateral hip joint osteoarthritis, and 2 knees after ipsilateral total hip arthroplasty were excluded. The remaining 36 osteoarthritic knees of 31 patients were assigned as the valgus group. There were 5 male and 26 female patients. We randomly selected 40 varus osteoarthritic knees of 40 patients who underwent TKA in our institute between January 2011 and July 2015, and designated them as the varus group (Table 1). There were 7 males and 33 females. There was no case with adjacent arthropathy in the varus group.

Single-leg weight-bearing full-length AP radiographs were obtained in all patients before surgery, and we measured the

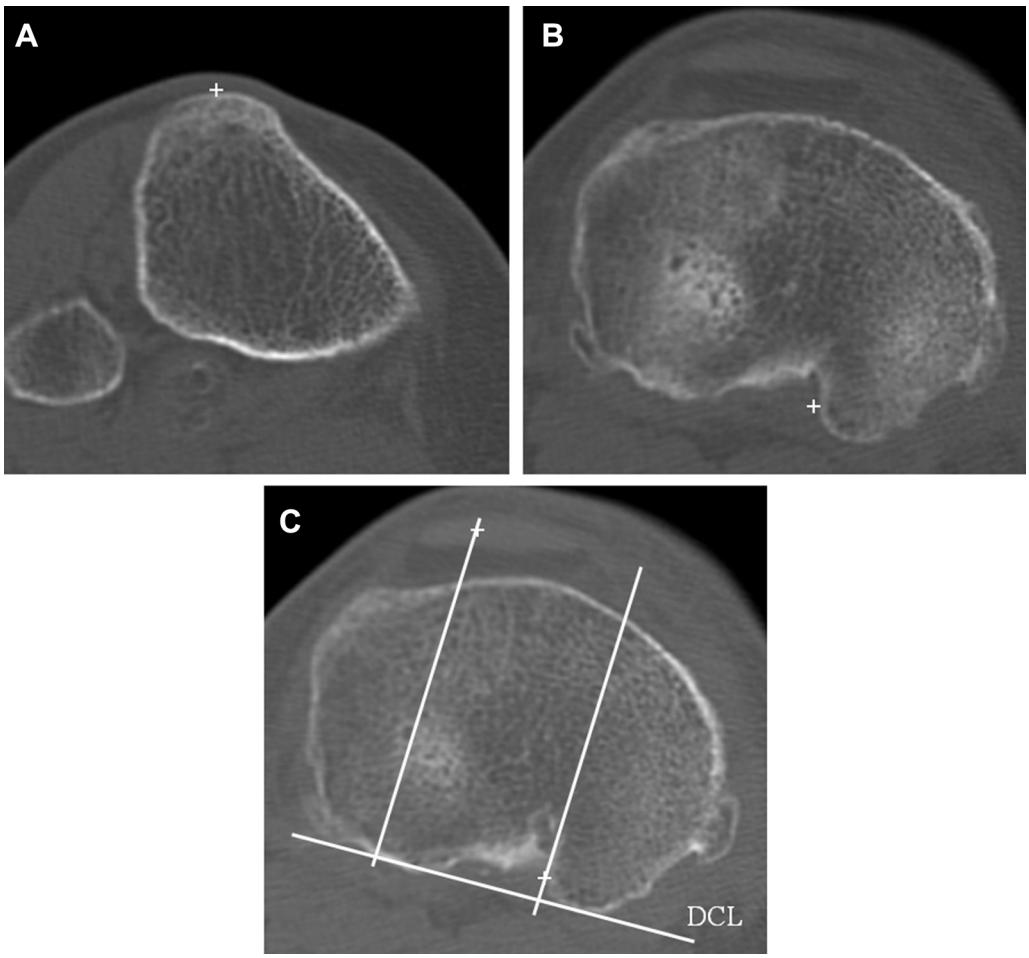

Fig. 1. The TT-PCL distance is the mediolateral distance between the midpoint of the insertion of the patellar tendon and the medial border of the PCL parallel to the DCL of the tibia. (A) First, the midpoint of the patellar tendon insertion at the TT is marked ("+" point). (B) Then, the medial border of the PCL is marked on the most inferior slice on which the PCL could still be identified ("+" point). (C) Finally, the DCL of the tibia removing the osteophytes is defined on the slice below the articular surface of the tibia plateau and above the fibular head. Both points for the TT and PCL are then transferred onto this slice, and the distance between the 2 points is measured parallel to the DCL. TT-PCL, tibial tubercle-posterior cruciate ligament; DCL, dorsal condylar line.