Tibiofemoral Articular Contact Kinematics Of The Knee After A Posterior Cruciate Substitute Total Knee Arthroplasty - A Comparison Between Caucasian And Asian Patients

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Introduction: Recent research revealed morphological distinctions between Caucasian and Asian knees [1], implying a possible ethnics specific total knee arthroplasty (TKA) design for Asian patients. There are studies reporting that Asian patients had higher revision rate, but lower maximal knee flexion after TKA compared to Caucasian patients [2,3]. However, there are little data reported on the in-vivo kinematics function of Asian patients after contemporary TKA. The objective of this study was to compare the tibiofemoral articular contact kinematics between a Western and an Asian patient cohorts after a posterior substituting (PS) TKA during a single leg, weight-bearing lunge using a dual-orthogonal fluoroscopic system. The contact kinematics of both patient groups were compared with those of normal, healthy knees.

Methods: Eight Caucasian patients (9 knees, age, 66-78; 6 males and 2 females; BMI, 25.1-32.5 kg/m2) and nine South Korean patients (13 knees, age, 61-74; 9 females; BMI, 23.2-30.1 kg/m2) were included in this study. Each patient was randomly recruited with IRB approval and given an informed consent before testing. All patients received a PS-TKA (Nexgen LPS-Flex, Zimmer). One year after operation, each patient performed a single leg, weight-bearing lunge from full extension to maximal flexion in approximately 15° increments. The knee motion was captured by a dual-fluoroscopic system [4]. Three-dimensional CAD models of the TKA components and the paired fluoroscopic images at each knee position were imported into a virtual dual fluoroscopic system constructed in a solid modeling software (Rhinoceros, Robert McNeel and Associates) to reproduce the actual knee position through a 2D/3D registration technique. Tibiofemoral contact areas were determined and the centroids of the contact areas on the tibia plateau surfaces were used to represent the contact locations (Fig. 1). Contact points in medial and lateral compartments along the flexion path were compared to those of healthy knees (8 knees, age, 23-49; 5 males and 2 females; BMI, 19.9-29.3 kg/m2). For comparison of tibiofemoral articular contact kinematics between groups, the values of the contact points were normalized to the anteroposterior (AP) and mediolateral (ML) dimensions of the polyethylene tibia insert in patients and of the tibia plateau in healthy subjects. Anterior and medial locations from the tibial center were
recorded as positive values. Differences between groups were examined using the Independent T-test. Statistically significant differences were indicated when $p < 0.05$.

**Results:** In the medial compartment, the mean contact points of PS-TKAs in both South Korean and Caucasian patients were located at 27-33 % medially from the center of the polyethylene insert (Fig. 2A). The mean ranges of AP translation were from 9.5% at extension to -9.9% at maximum flexion in South Korean patients and from -6.8% at extension to -9.6% at maximum flexion in Caucasian patients (Fig. 2B). Significant differences of AP translation were observed at 0° and 15° of knee flexion between the two patient groups ($p < 0.05$). South Korean patients showed similar AP translation with the normal subjects.

In the lateral compartment, the mean contact points of both South Korean and Caucasian patients were located at 27-33 % laterally from the center of the polyethylene insert (Fig. 2C). Significant differences of ML translation were observed at 0 and 90° of knee flexion between the two patient groups ($p < 0.05$). However, contact points of both patient groups were significantly more laterally located than the healthy knees.

**Discussion:** We found that the South Korean patients have more lateral contact positions compared to the Caucasian population after the PS-TKAs during the single leg, weight bearing lunge, even though contact centers in both populations shifted laterally compared to the healthy knees. In addition, South Korean patients showed different contact movements in AP direction from the Caucasian patients at full extension to 30° of flexion. The contact kinematics in AP direction of the South Korean patients are more close to those of the healthy knees. The differences of contact kinematics between the South Korean and Caucasian patients could be due to different morphological and physiologic soft tissue conditions. How these kinematics and morphological variations affect clinical outcomes between the Western and Asian patients warrants further investigation.

**Significance:** A quantitative understanding of articular contact kinematics after TKA in various populations with different life styles may help to improve current TKA designs and surgeries.
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