THE EFFECT OF TIBIAL SLOPE ON THE BIOMECHANICS OF CRUCIATE-RETAINING TOTAL KNEE ARTHROPLASTY: A MUSCULOSKELETAL SIMULATION STUDY

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Introduction/Aim: More posterior tibial slope (PTS) can prevent flexion gap tightness in cruciate-retaining Total Knee Arthroplasty (TKA) and help achieving better knee function. However, the influence of PTS on knee function during activities of daily living (ADLs) is scarcely documented. The aim of this study was to investigate the effect of PTS and surgical referencing technique on tibiofemoral joint (TFJ) kinematics, quadriceps force, and patellofemoral joint (PFJ) force during ADLs.

Materials and Methods: We used a previously validated musculoskeletal model of cruciate-retaining TKA [1] to simulate a squat activity. A baseline case with the original post-operative PTS (0°) was simulated, plus four PTS cases (-3°, +3°, +6°, +9°) obtained using anterior tibial cortex-referencing (ACR, Fig. 1a) technique and four using centre of tibial plateau-referencing (CPR, Fig. 1b) technique.

Results: More PTS with ACR technique caused a larger and more anterior excursion of the TFJ contact point on the lateral side, and more posterior, on the medial side, in extension (Fig. 2). More PTS with the CPR technique caused the contact point in extension to shift gradually more posterior on both medial and lateral sides, and in flexion to shift gradually more posterior mainly on the lateral side. The peak quadriceps force decreased on average by 1.7 and 1.2 % BW for every degree of more PTS, with the ACR and CPR techniques, respectively. The peak PFJ contact force decreased more importantly with more PTS with the CPR technique rather than with the ACR technique (-3.9 vs. -1.5 % BW/degree more PTS, Fig. 3).

Discussion: The ACR technique loosens the TFJ, thus leading to more unstable TFJ kinematics and anterior shift on the lateral side. More PTS also reduces the quadriceps force to squat. More PTS with the CPR technique resulted in stable and more posterior TFJ kinematics, and a greater reduction of the PFJ contact force, due to preservation of patellar height.

Conclusions: TFJ stability should be maximally preserved to improve knee function. More PTS with the ACR technique has severe consequences on knee kinematics and function, whilst CPR technique results in more effective reduction of quadriceps and PFJ forces, while preserving TFJ stability.

References: [1] Marra MA, Vanheule V, Fluit R, et al. A Subject-Specific Musculoskeletal Modeling Framework to Predict In Vivo Mechanics of Total Knee Arthroplasty. ASME. *J Biomech Eng.* 2015;137(2):020904-020904-12

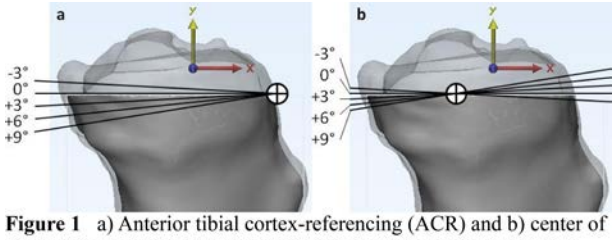

Figure 1 a) Anterior tibial cortex-referencing (ACR) and b) center of tibial plateau-referencing (CPR) techniques used to simulate varius degrees of tibial slope. Rotation centers highlighted by crossed circles.

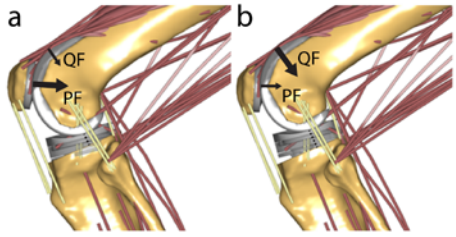

Figure 3 Conceptual representation of the quadriceps-femur (QF) and patella-femur (PF) load sharing with +9° of tibial slope with a) anterior tibial cortex (ACR) and b) center of tibial plateau (CPR) referencing techniques. The position of the patella relative to the femur is higher with ACR than with CPR. In a), due to the lower femur position (dashed lines), little quadriceps force is transmitted directly through the femur, and the PF force is higher. In b) the patella is lower and a greater quadriceps force is transmitted directly through the femur, which reduces the PF force notably.

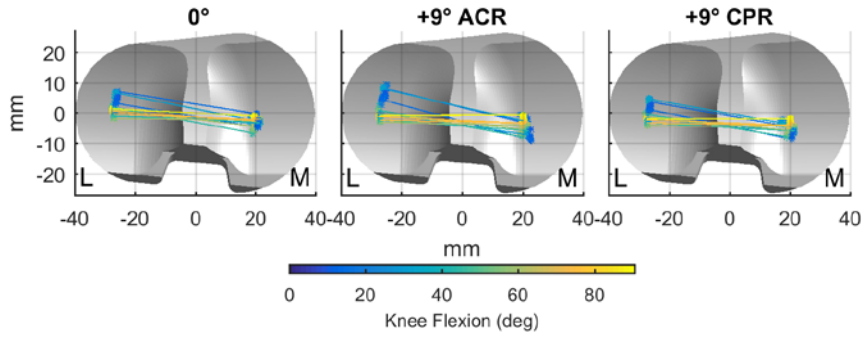

Figure 2 Kinematics of the tibiofemoral (TF) contact point during squat at baseline (0°, left), and +9° posterior slope using ACR (middle) and CPR (right) techniques. Contact points on the lateral (L) and medial (M) side of the tibial plateau are connected together and color-coded according to the knee flexion angle.