THE EFFECT OF POSTERIOR TIBIAL SLOPE ON SIMULATED LAXITY TESTS IN CRUCIATE-RETAINING TOTAL KNEE ARTHROPLASTY

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Introduction/Aim: More posterior tibial slope (PTS) can potentially prevent flexion gap tightness in Total Knee Arthroplasty (TKA). However, the effects of more PTS on knee laxity remain unclear. The aim of this study was to investigate the effect of PTS on the anterior-posterior (AP) and varus-valgus (VV) laxity in TKA. We hypothesised that the effects also depend on whether an anterior tibial cortex-referencing (ACR) technique or a centre of tibial plateau-referencing (CPR) technique is used.

Materials and Methods: A previous validated musculoskeletal model of cruciate-retaining TKA was configured to simulate AP and VV laxity tests [1]. First the model was simulated without any external loads applied, with the knee spanning a 0-90° flexion range of motion (ROM). Subsequently, anterior and posterior loads of 70 N were applied alternately to the proximal tibia, and the resulting AP tibial displacement recorded throughout the knee ROM. Similarly, varus and valgus loads of 15 Nm were applied alternately to the tibia, and the resulting knee VV rotation recorded. The simulations were repeated with -3°, +3°, +6°, +9° of PTS both with the ACR and CPR techniques (Fig. 1). Laxity were calculated as the unloaded case curves minus the loaded case curves.

Results: More PTS with the ACR technique increased dramatically the anterior, varus and valgus laxities, throughout the knee flexion ROM. The anterior laxity was maximal (23 mm) at 60° of knee flexion in the +9° ACR case. Conversely, variations of PTS with the CPR technique hardly affected the AP and VV laxities.

Discussion: More PTS with the ACR technique compromises the overall knee stability, throughout the knee flexion-extension ROM and, most interestingly, also in extension. This is due to an increase of the flexion gap. In contrast, the CPR technique preserves the translational and rotational laxities of the knee, throughout the ROM. CPR could be achieved by pre-planning the PTS and by accurately executing the tibial cut or by using inserts with built-in PTS.

Conclusions: More PTS with the ACR technique has large effects on knee stability and laxity, therefore surgeons should avoid increasing PTS using the ACR technique and, instead, reference the tibial cut height and slope from the posterior one third of the tibia.

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

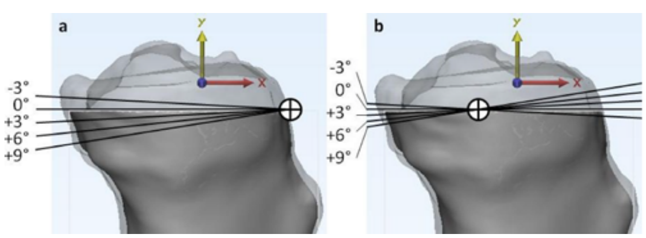

Figure 1 a) Anterior tibial cortex-referencing (ACR) and b) center of tibial plateau-referencing (CPR) techniques used to simulate varius degrees of tibial slope. Rotation centers highlighted by crossed circles. Note that a more posterior tibial slope with ACR causes all points on the tibial plateau posterior to the rotation centre to shift distally, whereas a more posterior tibial slope with CPR causes al points on the tibial plateau posterior to the rotation centre to shift distally and all points anterior to shift proximally, and vice versa for an anterior slope.

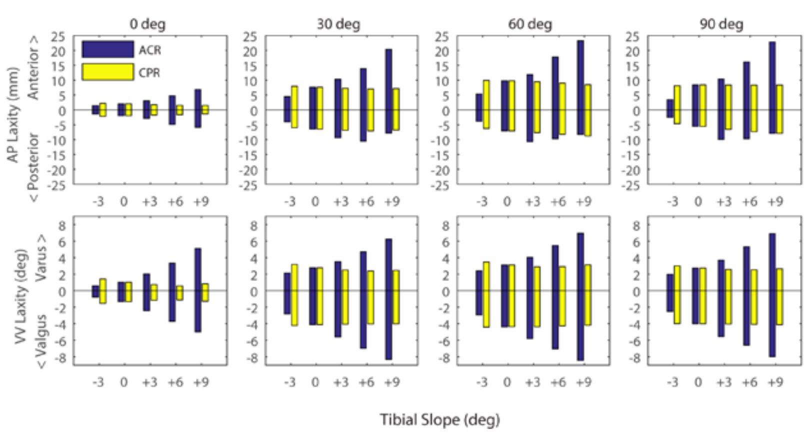

Figure 2 Anterior and posterior laxities (top row) and varus and valgus laxity tests (bottom row) at 0°, 30°, 60°, 90° of knee flexion with anterior (-3°), baseline (0°), and posterior (+3°, +6°, +9°) tibial slope, simulated with ACR (blue) and CPR (yellow) techniques. Note how slope variations using the ACR technique alter AP and VV laxities, both in extension and in flexion, whereas slope variations using the CPR technique leave the laxity patterns nearly unchanged.