Aligning Success: Insights from 85,000 CT Scans on Trochlear Groove Positioning with Kinematic Alignment

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INTRODUCTION: Patellar maltracking remains a significant cause of postoperative pain and dissatisfaction after total knee arthroplasty (TKA). Key contributors include femoral component internal rotation and trochlear groove (TG) malpositioning. While the CPAK classification aids in evaluating coronal alignment, it does not account for three-dimensional anatomy. As newer alignment philosophies like kinematic alignment (KA) gain traction, the risk of patellar maltracking may increase, especially when using implants designed for mechanical alignment. This study evaluates TG orientation in both axial and coronal planes after virtual KA-based placement of a standard femoral component in 85,000 patients undergoing primary TKA.

METHODS: We analyzed over 85,000 CT scans of patients with end-stage arthritis. For each patient, we calculated CPAK classification, lateral distal femoral angle (LDFA), medial proximal tibial angle (MPTA), hip-knee-ankle (HKA) angle, and posterior condylar to transepicondylar axis (PCA to TEA). Using KA principles, we virtually implanted a femoral component with a 6° built-in valgus TG. TG orientation was then measured relative to the native mechanical axis and quadriceps line of force (QLF), with 3.2° lateral to the axis considered ideal for tracking.

RESULTS: Mean values were: LDFA 87.1°, MPTA 85.7°, HKA 176.7°, and PCA to TEA 3.2°. In the coronal plane, 35.6% had TG medial to the QLF, and 10.7% were within 3° medial to the native axis. CPAK types 2 (8%), 3 (53%), and 6 (5%) showed the highest internal rotation and medial TG orientation. Over 25,000 cases required >3° valgus tilt and internal rotation; 1,408 exceeded 5°.

DISCUSSION AND CONCLUSION: Current implants may not suit KA techniques. A significant proportion of patients demonstrated TG malpositioning and internal rotation beyond thresholds linked to maltracking. These findings highlight the need for revised classification systems and implant designs that account for 3D alignment to optimize outcomes in TKA.