Laxity, Balance, and Alignment of a Simulated Kinematic Alignment Total Knee Arthroplasty

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INTRODUCTION:

Kinematic alignment (KA) and related personalized alignment strategies in total knee arthroplasty (TKA) target restoration of native joint line obliquity and alignment. In practice, deviations from exact restoration of the pre-arthritic joint surface are tolerated for either the femur or tibia to achieve ligamentous balance. It remains unknown however, what laxity, balance, and alignment would result if a pure resurfacing of both femur and tibia were performed in a KA TKA technique.

METHODS:

We used data from 382 robot-assisted TKA performed with a digital joint tensioner to simulate TKA with a pure resurfacing KA technique for both femur and tibia. All knees had the PCL retained. Knees were subdivided into 4 groups based on preoperative coronal alignment: valgus (<-3º, n = 32), neutral (±3º, n = 112), varus (3º - 10º, n = 203), and high varus (>10º, n = 35). Cartilage thickness profiles were derived from literature to account for wear. Medial and lateral laxity in extension and flexion, balance in extension and flexion, and coronal plane alignment were compared between groups using ANOVA testing.

RESULTS:

In simulated pure resurfacing KA TKA, only 11-31% of knees would have mediolateral extension ligament balance within ±1mm, all values increase with widening balance windows, Table 1. In total, 20-41% would have a medial flexion gap that is looser than the lateral flexion gap (Table 2) and between 17-56% of knees report greater medial laxity than lateral laxity in extension (Table 1). On average, femoral and tibial coronal resections would be 3.0±3.2º valgus and 2.3±3.1º varus respectively, resulting in over 45% of knees with a coronal hip-knee-ankle angle >3 degrees from mechanical neutral, Figure 1.

DISCUSSION AND CONCLUSION:

In simulations of pure resurfacing KA TKA, there was wide variability in the resulting laxity and alignment outcomes. Most knees had alignment and balance outcomes outside of normally accepted ranges. Techniques that deviate from pure resurfacing in order to achieve balance appear favorable.

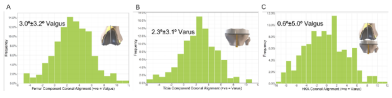

Figure 1 Resulting femoral (A), tibial (B) and tibio-femoral (C) coronal component alignment from a KA approach

Table 1 Breakdown of coronal balance distribution according to pre-operative coronal deformity

Balance (M – L)	Valgus (<-3°)	Neutral (±3°)	Varus (>3°)	High Varus (>10°)
± 1mm	31%	13%	19%	11%
± 2mm	63%	30%	43%	31%
± 3mm	81%	43%	57%	51%
M > L	56%	21%	13%	17%

Table 2 Breakdown of flexion balance distribution according to pre-operative coronal deformity

Balance (M – L)	Valgus (<-3°)	Neutral (±3°)	Varus (>3°)	High Varus (>10°)
± 1mm	29%	15%	23%	9%
± 2mm	47%	37%	42%	17%
± 3mm	72%	53%	61%	37%
M > L	41%	26%	22%	20%