KINEMATIC VS MECHANICAL ALIGNMENT IN MEDIALLY-STABILISED TKA: A MATCHED-PAIRS KINEMATIC ANALYSIS

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Introduction

Mechanical alignment (MA) in total knee arthroplasty (TKA) is widely considered the gold standard, yet up to 25% of patients express dissatisfaction postoperatively [1]. Recently kinematic alignment (KA) emerged as an alternative technique in TKA, which endeavors to maintain the patient-specific knee alignment. Nevertheless, its efficacy in terms of improving biomechanical knee function and restoring the original soft tissue envelope remains uncertain [2]. Therefore, the aim of this study was to conduct a paired comparison of MA and KA using a physiological knee simulator.

Methods

Seven bilateral pairs of cadaveric lower limbs (86±5yrs) were subjected to passive knee flexion (10°-120°) and a squatting motion (35°-100°). The latter was performed with a 50N constant force spring on each hamstring and a quadriceps force actively controlled to maintain a constant vertical reaction force of 110 N at the ankle [3]. Subsequently, specimen-specific cutting jigs based on computed tomography (CT) scans were used to perform a medially-stabilised TKA (GMK Sphere, Medacta, Switzerland), with KA and MA being performed in the left and right specimens of each donor, respectively. Thereafter, all postoperative knees were retested with the same protocol. A six-camera motion capture system (Vicon, Oxford, UK) measured tibiofemoral kinematics using a pre-defined CT-based anatomical coordinate system while synchronized rosette strain gauges [3] affixed to the anteromedial (AM) and anterolateral (AL) regions of the tibia, 3cm below the joint line, measured bone strain. Tibial abduction and internal tibial rotation as well as AM and AL maximum principal strains were expressed in function of knee flexion angle. A generalized mixed model was used to compare tibiofemoral kinematics and bone strain between KA and MA TKA in relation to their respective native condition ($p<0.05$).

Results

Both MA ($p>0.66$) and KA ($p>0.91$) restored the native frontal plane kinematics during passive flexion (Fig.1). Only the tibial internal rotation demonstrated by MA knees was significantly different from native in early flexion (10°-43°, $p<0.44$). For squatting, internal rotation in KA ($p<0.01$) was significantly different from its native condition across the entire range flexion range. However, for ab-/adduction both alignment strategies resulted in kinematic behaviour similar to native (p>01) for abduction. In terms of bone strain, both KA and MA demonstrated similar AM strain. Nevertheless, for KA significant differences occurred from native between 79° and 100° ($p<0.04$). In terms of AL strain, none of the alignment strategies significantly differed from native ($p>0.5$).

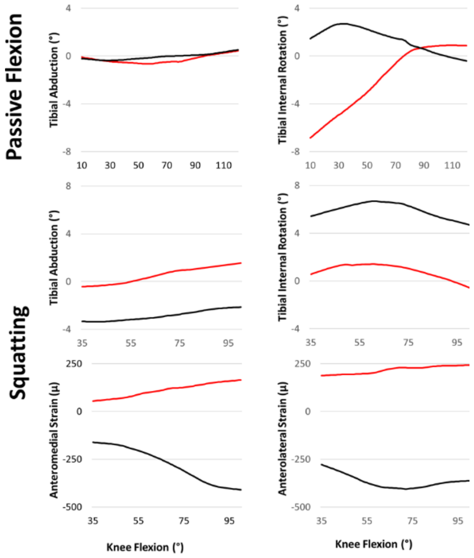

Figure 1: Average pre-to-post-operative changes in tibial abduction, tibial internal rotation, anteromedial strain and anterolateral strain for left knees (black) and right knees (red) during passive flexion (top) and squatting (middle and bottom).

Discussion

Our findings, measured during passive flexion and squatting, indicated that there were no substantial biomechanical benefits that could be attributed to one of the two alignment techniques in terms of tibiofemoral kinematics. However, the results showed that the internal rotation of MA during squatting was more consistent with its native condition compared to KA. Additionally, analyzing bone strain revealed that although both MA and KA produced comparable magnitudes, MA had a tendency to decrease bone strain, whereas KA tended to increase strain during squatting.

References

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3. Peersman et al, Clin Orthop Relat Res, 478:1990-2000, 2020.