

Patient-Specific Femoral Rotation in Robotic TKA: Can Flexion Stress Testing Replace Traditional Tensioning Devices?

Peter Keyes Sculco, Rami Sorial, Sabine Montenegro, Massoud Akbarshahi

INTRODUCTION:

Patient-specific soft tissue management is essential for achieving a balanced flexion gap in Total Knee Arthroplasty (TKA). Mechanical tensioning devices have been used alone or with robotic-assisted TKA (ra-TKA) to provide soft tissue laxity data for planning bone resections. However, these devices typically assess the tension at 90 degrees and require a predefined tibial cut before femoral rotation can be assessed, potentially limiting possibilities of optimizing implant positioning. This study investigates the feasibility of using ra-TKA-assisted flexion stress testing (FST) to guide femoral component rotation for patients with medial and lateral bone wear. Specifically, we examined the correlation between posterior condylar angle (PCA) rotation values derived from the mechanical tensioning device and those theoretically calculated using the FST approach.

METHODS:

A retrospective review of 138 ra-TKA patients (Age=69.44±7.48, F=58%) by a single surgeon was conducted. Standard ra-TKA surgical workflow was followed. Soft tissue assessment using FST was performed by distracting the collateral ligament in the opposite direction of the deformity in flexion at 90 degrees. A mechanical tensioning device was used to quantify the flexion balance and set femoral rotation relative to the PCA. Data from the FST obtained from the robot was used to derive the theoretical femoral rotation angle aimed at achieving a rectangular flexion gap. The cohort was categorized by pre-operative wear pattern and the tensioner-driven and FST-driven rotational angles were compared using Pearson's coefficient and Intraclass Correlation Coefficient (ICC).

RESULTS:

In patients with medial wear pattern (n=111), the tensioner-driven femoral rotation was 5.67±3.71°. FST-driven femoral rotation was calculated to be 5.47±3.21° (p=0.324), showing strong reliability and correlation (ICC=0.794, R²=0.65) between the two methods (Figure 1).

In contrast, for patients with lateral wear (n=27), the mechanical tensioning device specified greater external rotation (3.84±2.59°), while FST-derived rotation was significantly lower at 0.19±2.48° (p<0.001) external rotation, with poor reliability (ICC=0.368, R²=0.56) across the methods (Figure 2).

DISCUSSION AND CONCLUSION:

Stressed test in flexion was an accurate and reliable predictor of balance in patients with medial wear. However, FST showed poor reliability in predicting balance for cases with lateral wear which might be due to the differences in loading of the lateral ligament between the two methods. The results indicate the possibility of using FST method for setting the femoral rotation angle in cases with medial OA.

Additional work is required to evaluate the robustness of this method across multiple surgeons and patient demographics.

