Can We Predict Laxity In Robotic TKA Using Pre-Operative Force-Controlled Laxity Measurements?

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Soft-Tissue Balancing

- The prerequisite for optimal outcomes in TKA is restoring normal knee ligament balance and stability.

However, manual balancing methods commonly rely on subjective surgeon feel and experience and have been shown to produce variable results.
Study Purpose

The purpose of this study was to assess the accuracy and repeatability of a new TKA technique that uses robotically-controlled ligament tensioning and integrated 3D implant planning to achieve a targeted degree of soft-tissue balance.
Sixty consecutive robotic TKA patients (mean age 72±11, BMI 27.3±8.3) were included in this study.

After resecting the proximal tibia, a robotic ligament tensioning device was inserted into the knee and used to independently apply 80-11N of tension to the medial and lateral compartments.
Study Methods

- With the Active Spacer in the knee joint, a pre-operative gap profile was acquired throughout flexion as the limb was manually taken through a range of motion.

- The femoral implant was then planned to have a mediolateral balance within 1mm in extension and flexion, and a virtual gap algorithm displayed the predicted post-operative TKA gap profiles throughout the range of motion.
Study Methods

- A robotic cutting-guide was used to perform the femoral resections and a femoral trial component was inserted.

- The Active Spacer was then reinserted into the joint in place of the tibial insert, and the post-operative gap profile was acquired using the same loading profile as for the pre-operative gap acquisition.
Study Methods

- The predicted and post-operative gap profiles were respectively calculated and measured as the distance from the tibial resection to the closest point on the femoral implant.

- The mean and standard deviation of the medial and lateral prediction error were calculated for all knees.
Paired t-tests were used to identify significant differences between the predicted and measured post-operative gaps across the flexion arc.

The distribution of post-operative knee balance at 0, 10, 30, and 90 degrees of flexion was calculated in 1mm increments.
Results: Accuracy of Predicted vs. Actual Laxity Profiles

- Average discrepancy between the predicted and post-operative gaps was 0.4±1.1mm and 0.3±0.8mm for the medial and lateral gaps respectively.

- The maximum error was 2.7mm and 1.8mm while the RMS error was 1.3mm and 1.6 mm for the medial and lateral side respectively.

Differences between the predicted and the measured post-op gaps for both sides were not statistically significant for all flexion angles (p>0.8).
Results – Final Medial-to-lateral Balance Achieved

- 88-96% of knees balanced within 2mm mediolaterally depending on the flexion angle.

- Maximum imbalance was less than 3mm across all knees and flexion angles.
Discussion

- Knee balance could be accurately predicted and achieved to within 2mm using active ligament tensioning.

- This represents an improvement in accuracy when compared with manual instrumentation.

- Some of the variation between the predicted and actual post-op gaps is likely due to small variations in the planned vs actual bone resections, in the soft-tissue properties during the procedure, and in the pre- vs post-operative knee gap kinematic acquisitions.