The Effect of the Posterior Cruciate Ligament on Total Knee Arthroplasty Load Balance

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INTRODUCTION

• The role of the posterior cruciate ligament (PCL) in total knee arthroplasty (TKA) continues to be debated.
• Currently, both cruciate-retaining and posterior-stabilized designs are implanted with excellent clinical results.
• Recently biomechanical studies have been undertaken to explore the PCL’s effects on TKA soft-tissue balancing and flexion-extension gap kinematics1,2.

PURPOSE

The objective of this in-vitro study was to determine the effects of the PCL on TKA load balance.

METHODS

• Fresh-frozen cadaveric knees were tested (n=12).
• Each femur was rigidly clamped to a frame that fixed the knee at five discrete flexion angles (0°, 30°, 60°, 90°, and 100°) while allowing the tibia to remain unconstrained in rotation and in varus / valgus.
• Cemented cruciate-retaining TKA (NexGen, Zimmer) was performed on each knee.
• An instrumented tibial load cell (TLC) was inserted into the knee joint3 (Figure 1).
• Measurements were made (without actuated muscle loads) prior to ligamentous balancing, after ligament balancing (PCL/MCL-recessed), and after arthroscopic PCL resection (PCL-sacrificed).
• All coronal plane balancing was performed on the medial side. Sagittal-plane balance included recession of the PCL from its femoral origin.

RESULTS

• Medial and lateral compressive forces were compared using two-way repeated measures ANOVAs (α = 0.05) and post-hoc Student-Newman-Keuls tests.
• All results were expressed as the ratio between medial and lateral loading.
• Medial and lateral loads were unbalanced in the PCL intact knee at 0°, 60° and 90° (p<0.05) (Figures 2 - 4).
• Following MCL release with PCL-resection, the force distribution between the compartments was improved at 0° and 90°.
• Complete PCL-sacrifice resulted in load balance between the medial and lateral compartments for all three angles shown (Figures 2, 3 and 4).
• The data for 30° and 110° flexion (not shown) were similar to 60° and 90° respectively.

DISCUSSION

• With recession of the PCL from its femoral origin, the PCL’s anterolateral fibers are preferentially sectioned.
• The anterolateral fibers see greatest in situ forces at high flexion angles4 therefore, at 0°, PCL-recession has little effect on force distribution.
• It is likely the medial release is responsible for successful coronal plane balance in extension.
• At 90°, PCL-recession successfully balances the coronal plane force distribution.
• In mid-flexion (60°), medial release and PCL-recession is insufficient to balance the loads. It is not until the posteromedial bundle of the PCL is released (with complete PCL-sacrifice) that balance is obtained.

CONCLUSIONS

• Cruciate-retaining TKA’s are limited by the PCL’s anisometric properties and are not able to balance loads throughout a full range of motion.
• Intra-operative balancing at only 0° and 90° may not be sufficient to ensure load balance throughout the complete range of motion.

REFERENCES


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