

**CRUCIATE LIGAMENT REMOVAL
CONTRIBUTES TO ABNORMAL KNEE MOTION
DURING POSTERIOR STABILIZED TOTAL KNEE ARTHROPLASTY**

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INTRODUCTION

Total Knee Arthroplasty (TKA) is performed to relieve the pain of osteoarthritis. When posterior stabilized knee prostheses are implanted, the cruciate ligaments are removed and mechanical interaction between the femoral and tibial components is intended to stabilize the anterior-posterior motion of the knee. However, these implants result in abnormal anterior translation of the femur relative to the tibia (Siston, 2006). This motion can lead to accelerated wear of the prosthesis and alter the moment arms of the muscles. The causes of this abnormal motion are unknown. We measured passive kinematics of the knee during surgery to answer two specific questions: Does posterior cruciate ligament removal introduce abnormal anterior translation of the femur? Does prosthesis implantation change the kinematics from the cruciate deficient case?

METHODS

We measured passive knee kinematics in 10 male subjects undergoing primary total knee arthroplasty for the treatment of osteoarthritis. Prostheses used were NexGen Legacy Posterior Stabilized Knees from Zimmer Inc. Institutional Review Boards approved the protocol and subjects gave informed consent.

We used a surgical navigation system to record the passive kinematics of the knee during surgery (Siston, 2006). Sterilized infrared-reflective trackers were affixed directly to the femur and tibia, and a stylus was used to digitize anatomic landmarks to establish the anatomic reference frames. The origin of the femur frame was the anterolateral edge of the posterior cruciate ligament attachment, and the origin of the tibia frame was the center of the anterior cruciate ligament attachment.

We measured the anterior-posterior translation of the knee throughout the range of flexion. We defined anterior position of the femur relative to the tibia by projecting the origin of the femur frame onto the anterior axis of the tibia frame. By this definition, anterior position is zero when the origin of the femur frame is directly above the origin of the tibia frame. The surgeon moved the knee through its range of motion three times. We calculated the flexion angle and anterior position of the femur relative to the tibia throughout the range of motion. We fit a fifth order polynomial to the resulting curves of anterior femur position vs. flexion angle (Fig. 1). We then measured the anterior translation, the forward distance traveled by the femur on the tibia (Fig 1, arrow). The anterior translation was recorded at four surgical stages: (1) Intact, before removing the ligaments, (2) No ACL, after removing the anterior cruciate

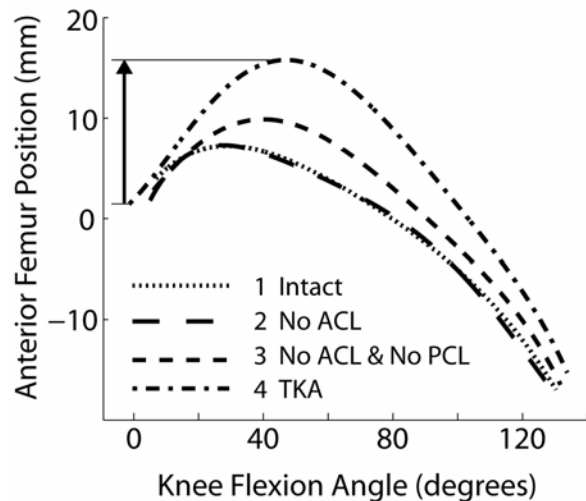


Figure 1: Anterior femur position throughout the range of knee flexion for one subject at the four surgical stages (see methods). Arrow indicates anterior femur translation.

ligament, (3) No ACL & No PCL, after removing the posterior cruciate ligament, and (4) TKA, after implanting the prosthesis. Surgical stages were compared with paired student's *t*-tests (stage 1 vs. 2, 1 vs. 3, 3 vs. 4) with Bonferroni correction for multiple comparisons.

RESULTS AND DISCUSSION

Removing the anterior cruciate ligament did not change the anterior motion of the femur (compare surgical stages 1 and 2 in Fig. 2). Removing the posterior cruciate ligament doubled the distance of anterior translation relative to the intact stage (compare surgical stages 1 and 3 in Fig. 2). Implanting the prosthesis increased the anterior translation of the femur relative to the cruciate deficient stage (compare surgical stages 3 and 4 in Fig. 2). Anterior translation after prosthesis implantation was three times that of the intact knee.

The increased anterior femur translation in early flexion following posterior stabilized

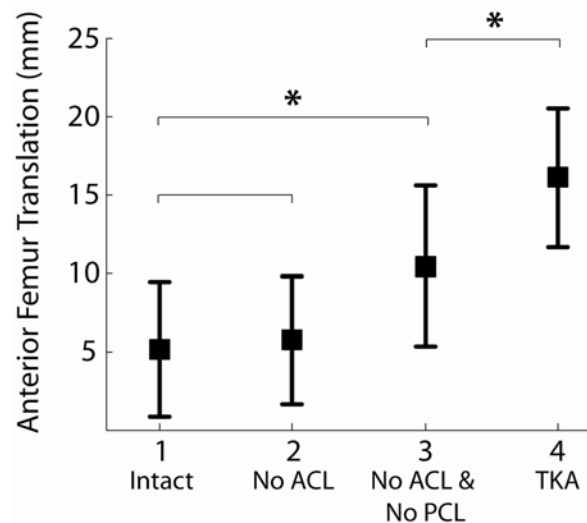


Figure 2: Anterior femur translation at the four surgical stages (mean \pm SD). * $\alpha=0.05$

total knee arthroplasty observed here in passive motion also occurs in voluntary movement, during the stance phase of gait (Dennis, 2003) and in the swing and stance phases of stair climbing (Andriacchi, 2003).

The abnormal anterior translation observed following posterior stabilized total knee arthroplasty was caused largely by removing the posterior cruciate ligament. Normal motion was not restored by the posterior stabilized prosthesis.

REFERENCES

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ACKNOWLEDGEMENTS

National Defense Science and Engineering Graduate Fellowship