IN-VITRO KINEMATICS OF POSTERIOR CRUCIATE-RETAINING TOTAL KNEE ARTHROPLASTY AT HIGH FLEXION

**ABSTRACT INTRODUCTION:**

The effect of posterior cruciate ligament (PCL) retention on knee joint function after total knee arthroplasty (TKA) continues to be a controversial issue, particularly at high flexion angles (>120°). There is an interest in enhancing flexion after TKA to accommodate activities such as going into and out of the bathtub (135°), playing golf (>120°), or kneeling (~160°). It has been suggested that the PCL promotes femoral rollback, which increases the range of flexion, and provides posterior stability. However, no information is available regarding knee kinematics (i.e. femoral translation and tibial rotation) and the role of the PCL in a cruciate retaining (CR) TKA at flexion angles greater than 120°. The objective of this study is to investigate knee kinematics (posterior femoral translation and tibial rotation) of a CR TKA designed to accommodate high knee flexion using a robotic technology. Furthermore, the PCL force in the CR TKA at high flexion is to be examined.

**METHODS:**

**Specimen Preparation:** Five post-mortem human knee specimens (age 79±6 years) were thawed overnight at room temperature. Prior experimentation, radiographic images of each specimen were taken to exclude specimens with previous injuries. Each knee included approximately 25cm of bone above and below the joint, leaving all soft tissues around the knee joint intact.

**Kinematic Analysis:** Each specimen was preconditioned ten times prior to its installation on the robotic testing system. The native knee was tested first. Its passive path as well as the kinematics (femoral translation and tibial rotation) under combined muscle loads (400N quadriceps and 200N hamstrings) were determined. An orthopaedic surgeon then performed a CR-Flex TKA (Zimmer Inc., Warsaw, IN) on the same specimen. This component has a 2mm extended femoral posterior contact surface compared to conventional TKA to enhance knee flexion. A new passive path and a new knee kinematics under the same loading were determined. The PCL was then excised and the last kinematics was repeated. The PCL force in the CR-Flex TKA was obtained using the principle of superposition.

**Statistical Analysis:** A one-way repeated measure Analysis of Variance (ANOVA) was performed to detect whether knee state had a significant effect on femoral translation. Newman Keuls test was done to detect statistical significance between knee states. Significant level was set to p-values less than 0.05.

**RESULTS SECTION:**

**Posterior femoral translation:** The lateral femoral condyle of all knees was positioned posteriorly at full extension. With increasing flexion, the intact knee lateral condyle gradually translated posteriorly reaching a peak value of 29.18±6.71 mm at 150° of flexion (Fig 1A). Peak posterior femoral translation of the lateral condyle (Fig 1A) for the CR-Flex TKA was recorded at 150° of flexion (21.56±8.40 mm).

The medial femoral condyle of the intact knee translated posteriorly with increasing flexion, reaching a maximum value of 23.22±9.70 mm at 150° of flexion. The CR-Flex TKA progressively translated posteriorly with increasing flexion (Fig 1B), reaching a maximum of 10.49±10.04 mm at 150° of flexion.

**PCL force in the CR-Flex TKA:** Under combined muscle load, PCL force increased from full extension to 90° flexion, peaked at 90° (63.72±37.00N), and decreased with further increase in flexion (Fig 2). At 150° of flexion, the PCL force was 27.74±15.10N.

**DISCUSSION:**

This study directly compared the kinematics of the intact knee and the CR-Flex TKA on the same knee from full extension to 150° of flexion. The TKA partially restored intact knee femoral translation (74% in the lateral and 67% in the medial condyles) at high flexion angles. For all knees and throughout the entire range of flexion the lateral femoral condyle translated more posteriorly than the medial femoral condyle signifying the presence of internal tibial rotation.

The PCL force measured in the CR-Flex TKA design showed a similar trend as the PCL force found in the intact knee although the PCL force in the TKA was of lower magnitude. This signifies the importance of the PCL in the mid flexion range.

The posterior soft tissue compression may play an important role in promoting further posterior femoral translation in high flexion. The TKA may not completely restore this soft tissue compression. Further investigation is necessary to characterize the interaction of the posterior soft tissue with the TKA at high flexion.

**REFERENCES:**