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Paper #167

Anteroposterior Translation of the Native Knee, but Not Rotational Kinematics, Is Preserved after Bicruciate-Retaining Total Knee Arthroplasty: A Biomechanical Cadaveric Study

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Summary:
Anteroposterior translation of the native knee, but not rotational kinematics, is preserved after bicruciate-retaining total knee arthroplasty.

Abstract:

Objective

Despite the great success of long term implant survival of total knee arthroplasty (TKA), nearly 20% of patients are still dissatisfied with their replaced knees. Loss of native kinematics after TKA is a possible explanation for this dissatisfaction. The concept of recently reintroduced bicruciate-retaining (BCR) TKA is an interesting approach to reproduce the native knee kinematics. However, the detailed kinematic data following BCR TKA is still limited and debatable. The purpose of this study is to compare the kinematics between native knees and knees that have undergone BCR TKA in cadaveric specimen. The null hypothesis is that BCR TKA would reproduce the native knee kinematics.

Methods

Six knees from 4 fresh frozen whole body cadavers stored at -20 °C were included in this study. Each knee does not have gross deformity, arthritic change, contracture, severe osteoporosis, or evidence of prior surgery. No specimen had a macroscopically damaged or degenerated ACL or PCL. The anteroposterior (AP) translation and the rotational kinematics of the femur throughout passive flexion of the native knees, knees after femoral replacement and knees after BCR TKA were assessed using navigation system. The kinematic analysis was performed twice for each knee by the same examiner, and the average values were used. The preliminary study using another three cadaveric whole body specimens demonstrated that intra-class coefficients (ICC) for intra-examiner reproducibility was almost perfect (0.89 for the native knees, 0.90 for the knees after BCR TKA). Analysis of variance followed by Dunnett's multiple comparison test was used to evaluate differences in the AP position and rotation angle of the tibia at every 10° from 0° to 130° of knee flexion between native knee and other conditions. The level of significance was set at $p < 0.05$ for all tests. This study was approved by the institutional review board (IRB).

Results

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The AP translation of the femur in the native knee was closely reproduced in the femoral replaced knee and BCR TKA. On the other hand, rotational kinematics of knees after BCR TKA was different from those of native knees. The relative tibial internal rotation angles in the early flexion phase were significantly larger in BCR TKA compared with native knee ($p < 0.05$). Interestingly, native rotational kinematics was preserved in the femoral replaced knee.

Conclusion

The AP translation of the native knee is preserved after BCR TKA. However, rotational kinematics of the native knee was not restored after BCR TKA. The hypothesis that the BCR TKA would reproduce the native knee kinematics was proven incorrect. Native rotational knee kinematics was lost when the proximal tibia was replaced, indicating that the tibial surface geometry is one of the determinants for native rotational knee kinematics. Further modification in tibial surface geometry makes the kinematics of the BCR TKA more close to the native knee.