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Changes In Tibial Insert Design Can Alter Knee Kinematics And Tibiofemoral Stress Distributions In Total Knee Arthroplasty

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Faculty Disclosure Information

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There are no disclosure with regard to this presentation.

Introduction

About 20% of patients remain unsatisfied even after modern total knee arthroplasty [1].

However, despite new tibial insert designs that aim to improve patient satisfaction, it is uncertain whether expected effects are achieved.

In addition, few studies have demonstrated differences in clinical outcome between different implant design.

Purpose

Purpose of this study was to develop musculoskeletal computer simulation to simultaneously investigate knee kinematics and stress distribution in post-TKA models.

Methods

Musculoskeletal computer simulation using computed tomography data of volunteer was developed to analyze knee biomechanics during squat (0°–120°) [2–6].

We compared biomechanical changes between posterior cruciate ligament (PCL)-retaining (CR)-TKA and CR-TKA without anterolateral (AL)-PCL, because AL-PCL can be damaged during tibial bone resection.

If PCL were damaged intraoperatively, surgeon would use cruciate-sacrificing (CS) tibial insert with high anterior lip or PCL-substituting (PS) components with post-cam mechanism.

Femoral components had single radius of curvature design.

AP movement of medial and lateral femoral condyles against tibial insert and peak equivalent stresses on tibial insert were measured.

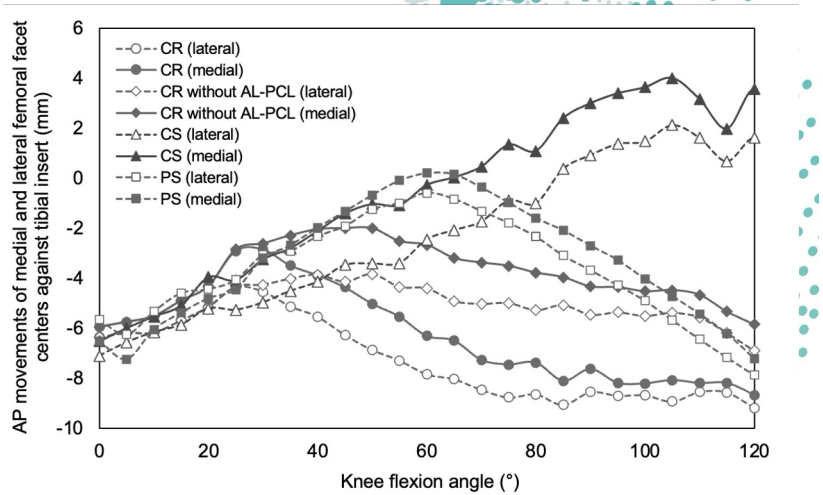
Results

CR model showed little femoral anterior movement during mid-flexion, and then suitable medial pivot motion and roll-back of femoral component.

CR model without AL-PCL showed relatively larger femoral anterior movement than CR model with intact PCL, and also had attenuated medial pivot motion and roll-back.

In CS model, femoral component moved anteriorly until high anterior lip of tibial insert exerted effect, and it then rolled back.

PS model exhibited same type of anterior femoral movement as CS model during mid-flexion. However, PS femoral component was forcibly rolled back when post-cam mechanism was active at knee flexion of 60° or more.



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Results

Regarding to equivalent stresses on tibial insert, PS model due to its post-cam mechanism exhibited higher equivalent stress on tibial insert throughout squat than other TKA models.

In CR model, TF contact stress increased at mid-flexion because increased PCL tension caused femoral roll-back.

TF contact stress in CS model increased significantly during deep knee flexion.

Discussion

- ✓ This study using musculoskeletal computer simulation revealed that simply by changing type of tibial insert can alter not only knee kinematics, but also stress distribution, even with same femoral component design in same knee.
- ✓ CR design showed good knee kinematics with little paradoxical femoral anterior movement.
- ✓ However, CR-TKA with partial PCL damage caused femoral anterior movement during mid-flexion.
- ✓ After PCL dysfunction, switching to CS tibial insert with high anterior lip could not reduce mid-flexion instability. In contrast, change to PS components resulted in mechanical femoral roll-back against tibia, but also increased stress distribution on tibial polyethylene.

Conclusion

Even with same TKA design concept, different models produced different biomechanical results.

There is close relationship between knee kinematics and stress distribution after TKA.

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