Paper #35

A Computer Model of Mid-Flexion Instability in Balanced Cruciate Retaining or Posterior Stabilized Total Knee Arthroplasty

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Introduction: Total knee arthroplasty (TKA) surgical techniques target equal flexion and extension gaps to produce a well-balanced knee. Some patients have mid-flexion instability despite stability at 0 degrees and 90 degrees of flexion. This study aims to determine the effects of TKA stability while changing femur implant size and position.

Methods: A computational analysis was performed simulating knee flexion of posterior stabilized (PS) or cruciate retaining (CR) TKA designs using previously validated software. Deviations from the ideal TKA implant position were simulated by adjusting tibiofemoral proximal-distal position and femur anterior-posterior position as well as implant size. Forces in ligaments connecting the femur and tibia were collected. Anterolateral and posteromedial bundles of the PCL were also measured for CR designs. Total tibiofemoral ligament load for mid-knee flexion of 15-75° was analyzed versus proximal-distal implant position, implant size, implant design, and knee flexion for PS and CR knees. PCL load was also analyzed for CR knees.

Results: Total tibiofemoral ligament load was significantly reduced by a more proximal tibiofemoral and anterior femur position ($p<.001$). Implant size did not have a significant effect on tibiofemoral ligament load ($p>0.1$). Implant design and knee flexion significantly influenced total tibiofemoral ligament load ($p<.001$), but the interactions with implant proximal-distal position were not significant ($p>0.2$), indicating that implant proximal-distal position had a similar effect across the 15°-75° knee flexion range for both studied PS and CR implant designs.

Conclusion: PS and CR TKA can be well-balanced at 0° and 90° knee flexion and have instability in mid-flexion. Elevating the joint line and shifting the femur anteriorly can cause the knee to be too loose in mid-flexion. If the knee is too tight in mid-flexion, resecting more distal and posterior femur, downsizing the femoral if necessary, and increasing the tibial insert thickness can provide stability.

Notes