INTRODUCTION

• Up to 25% of patients are not satisfied after total knee arthroplasty (TKA).

• Planning and assessing TKAs on a patient-specific basis using musculoskeletal models might improve outcomes.

• Using musculoskeletal models, clinicians could iteratively perform TKAs to determine the optimal set of intraoperative decisions to best restore biomechanics to native for each patient.

• One common intraoperative decision is whether to perform releases to reduce the tension in overly tight soft tissue restraints and thus reduce high contact forces on the tibia [1].

• The extent to which releases alter soft tissue restraint mechanical properties, tibial contact forces, and knee laxities is unknown.

OBJECTIVES

(1) Characterize, ex vivo, how releases change the slack length and stiffness of a representative soft tissue restraint.

(2) Determine, using a validated multi-body knee model, how releases change tibial contact forces and knee laxities.

ACKNOWLEDGMENTS

NIH (T32-AG-213-26), THINK Surgical

REFERENCES


METHODS

1 Ex Vivo Testing:
• Tensioned 3 porcine flexor tendons to simulate an “overstuffed” TKA.
• Performed releases under tension in 5 puncture iterations (3).
• Determined slack length (unstretched length) and stiffness (slope of force-vs-displacement during ramp) for each release iteration.

2 Stochastic Modeling:
• Simulated releases in a validated 12-DOF knee model (4).
• Generated 1000 probabilistic models with randomly selected increases in slack length and reductions in stiffness of the superficial medial and lateral collateral ligaments (sMCL and LCL, respectively) based on ex vivo results.

3 Forces and Laxities:
• Determined changes in tibial contact forces during passive flexion from 0° to 90° flexion and changes in varus-valgus laxities ±10 Nm at 0°, 45°, and 90° flexion from the nominal model using forward dynamic simulations.

RESULTS

Figure 1. Scatter plots show changes in varus-valgus laxity and medial-lateral contact forces on the tibia at 0°, 45°, and 90° flexion due to simulated releases of the sMCL and LCL. Releases to both structures achieved the goal of reducing contact forces on the tibia, but consequently increased joint laxity.