Towards personalized analysis and treatment using dynamic imaging and musculoskeletal modelling

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Introduction

We have generated biomechanical tools which allows us to generate musculoskeletal models of the lower extremity.

1) We have generated MRI/CT-based automatic segmentation tools to define the geometries of the femur, the tibia and their cartilage layers. The cartilage segementation works on proton density weighted scans which is most often used in clinical practice.
2) The kinematic behavior of the knee was quantified in three ways. The first method was based on dynamic MRI. We developed algorithms which allowed accelerated dynamic MRI scanning of knee kinematics. The second method is utilizing dynamic CT scanning and automatic segmentation using AI algorithms to allow for fast dynamic imaging of joints. The third method to assess the kinematical behavior of the knee is based on multiple A-mode ultrasound transducers which are 3-D tracked using a motion capture system.
3) Techniques to determine the properties of the soft tissues are still under development and it seems more reliable to utilize laxity and intra-operative laxity measurements.

Currently we are applying these techniques to develop an anatomically shaped meniscus prosthesis, to improve patella-femoral treatment and to optimize robotic assisted total knee surgery.