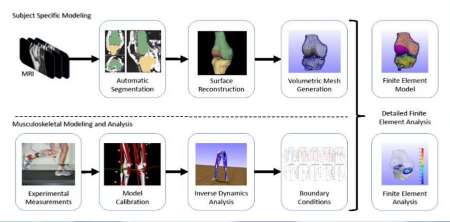

SafeACL

Ευρωπαϊκή Ένωση
Ευρωπαϊκό Ταμείο
Περιφερειακής Ανάπτυξης

ΕΣΠΑ 2014-2020
ανάπτυξη - εργασία - αλληλεγγύη

The Problem

An anterior cruciate ligament (ACL) tear is a devastating injury to an athlete and un- fortunately is one of the most common knee injuries in athletes involved in rapid de-celeration moves. Reconstruction of the ACL is commonly performed to restore stability to the knee and allow the patient to return to a healthy and active lifestyle. Revision ACL reconstruction is clinically challenging and associated with worse clinical out- comes than primary reconstructions, and a recent systematic review revealed a 13.7 % overall failure rate. In current clinical practice, the ACL reconstruction plan is selected from a standard menu of options rather than customized to the unique characteristics of the patient and the treatment selection process is normally based on subjective clinical experience rather than objective prediction of post-treatment function.

SafeACL Overall Objective

The aim of SafeACL project, is the development of a decision support system based on the integration of musculoskeletal computer models with imaging (MRI, X-ray, ultrasound) and motion analysis data (kinematics, kinetics) to simulate the surgery and to improve customization, objectivity, and effectiveness of treatments for ACL reconstruction. The SafeACL system will allow the physician to operate in a virtual environment using an individualized musculoskeletal model that will be able to predict the effect of the surgery. The therapist will be able to test a variety of surgical scenarios (bone channel location, initial graft trend, graft fixation methodology, relative movement between the bone canal and graft) before performing the actual surgery. As a result, the customized surgical plan will be fed into a surgical assistant system that will guide the surgeon to reproduce the selected invasive scenario during the actual surgery. With SafeACL, the orthopedic surgeon will be able to predict the outcome of a surgery in an innovative 3D environment (as opposed to two-dimensional images used in clinical practice), thus reducing surgical errors and post-operative complications of the patient.

The Project

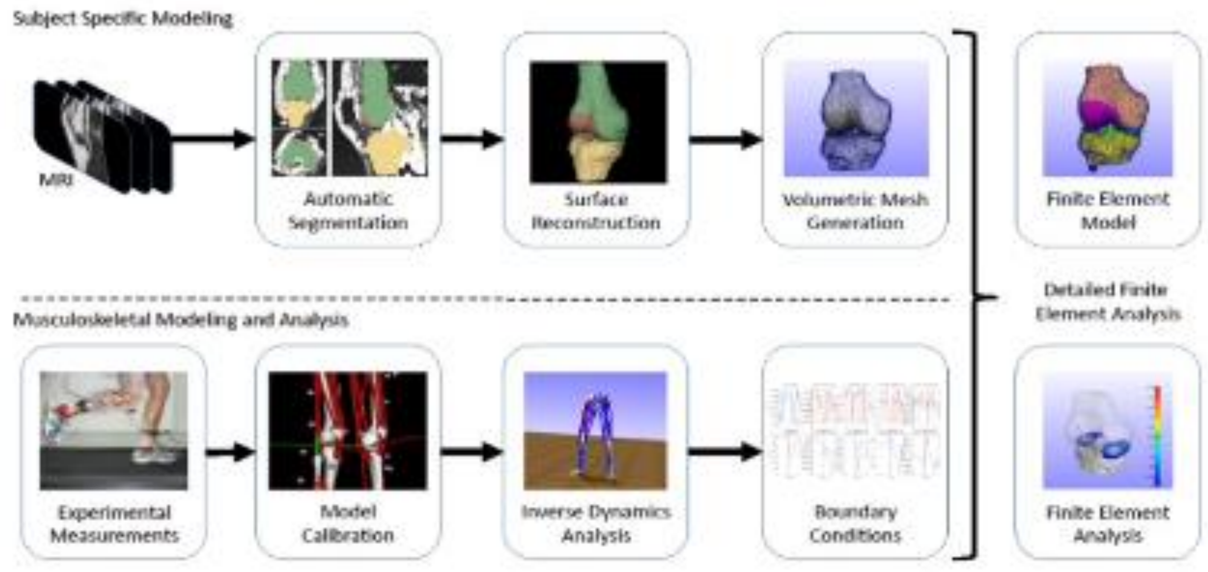

Figure 1. Overview of modeling and simulation pipeline for creating subject-specific detailed models of the knee that are used for finite element analysis of complex movements.

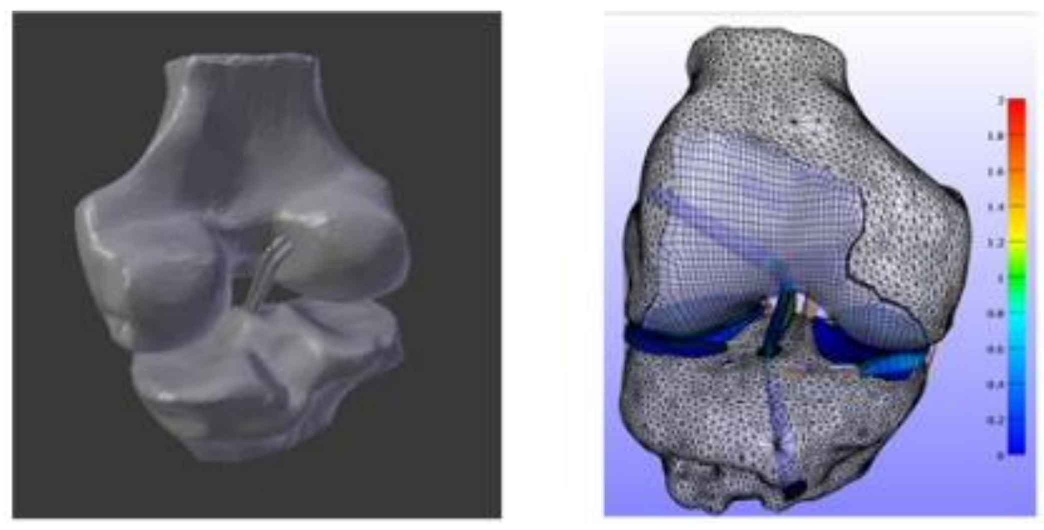

Figure 2. a) Modeling of ACL reconstruction options and (b) finite element analysis

The Approach

The development of the SafeACL medical decision support system will be implemented through a multidisciplinary approach aimed at developing state-of-the-art technology and exploiting the scientific knowledge of all the project partners. During the first work package (WP1), the parameters, architecture and interfaces of the SafeACL system will be determined. During the second work package (WP2) the validity of the human musculoskeletal models will be tested in dynamic athletic motions beyond walking using OpenSim's musculoskeletal modeling software (www.simtk.org) and experimental motion analysis data in normal participants, using state-of-the-art scientific equipment. Work package 3 (WP3) will develop an innovative three-dimensional image analysis technique that allows the extraction of the required parameters from clinical images for the production of personalized musculoskeletal models. Work package 4 (WP4) will develop personalized musculoskeletal and finite element models. Then, a software for the interactive connection between the models and the surgeon physician will be developed in work package 5 (WP5) using virtual reality algorithms and three-dimensional imaging techniques. The surgeon will be able to parameterize each patient's musculoskeletal model by simulating the intervention plan. In WP5, the surgical effect of surgical intervention on the patient's kinetic and kinematic model during daily and athletic activities will be assessed using individualized musculoskeletal models including the adjustments made to the knee joint after surgery. Predictions of the patient's postoperative functioning are purely mathematical and therefore not usable by surgeons. For this reason, an easy-to-use graphical environment will be created in work package 6 (WP6) to allow the orthopedic surgeon to interpret the results of surgical simulations. Finally, a detailed feasibility study, work package 7 (WP7), will be developed by a specialized subcontractor for the new system, focusing on its optimal commercial exploitation and business models of exploitation.

Expected Impacts

For Physicians: simulation of surgery in a virtual environment; selection of the best procedure for the surgery, for each patient; assisted surgery.

- For Patients: personalized surgery, quicker restoration of ACL function, better qual- ity of life, reduced chance of failure of the surgery operation.
- For the Research community: development of innovative personalized musculoskel- etal models, development of interactive virtual surgical environment.
- For the National Health System: improvement of the services and products provided, reduction of hospitalization and rehabilitation costs.

The Project Partners

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VVR

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