15th International Symposium on Computer Methods in Biomechanics and Biomedical Engineering
and
3rd Conference on Imaging and Visualization
CMBBE 2018
P. R. Fernandes and J. M. Tavares (Editors)

Abstract ID-31

COMPUTER-AIDED SURGERY FOR THE MEDIAL PATELLOFEMORAL LIGAMENT RECONSTRUCTION: A PARAMETRIC FINITE ELEMENT MODEL

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Keywords: Patellofemoral Joint, Finite Element Methodology, 3D parametric FE Model, MPFL Reconstruction, Patellofemoral Contact Pressure, MPFL Stress

Summary: Lateral patellar instability has become an important clinical issue among young people, being the medial patellofemoral ligament (MPFL) tear its main cause. The most common clinical solution is the MPFL reconstruction through a surgical procedure that replaces the damaged ligament with a graft. This reconstruction has been described through several surgical techniques, with different insertion points and grafts, which have obtained good initial results. However, although stability is reestablished and pain seems to disappear, these techniques should also avoid any damage on the patellar cartilage over the years. The success of these techniques is also strongly influenced by the knee joint geometry, especially in the cases that show any kind of osseous abnormality. Therefore, the main goal of this work is the development of a parametric finite element (FE) model of the patellofemoral joint (PFJ) enabling us to simulate different surgical techniques for MPFL reconstructions in different patient-specific cases.

A 3D parametric FE model was developed based on the knee joint geometry (femur, femoral cartilage, patella and patellar cartilage). Related muscles and ligaments were also included. Four MPFL reconstruction techniques were considered for analyzing the stresses generated on the patellar cartilages and the ligaments: anatomical insertion, posterior non-anatomical insertion with osseous tunnel, anterior non-anatomical insertion with osseous tunnel and posterior non-anatomical insertion without osseous tunnel. These techniques were analyzed in five main knee flexion positions: 0°, 30°, 60°, 90° and 120°.

Important differences among these techniques were estimated. Additionally, the parametric model was validated by the simulation of several patient-specific cases. The computational predictions were compared with the clinical evaluation. A good correlation between both results was obtained. To conclude, the use of a 3D parametric FE model of the PFJ enables us to evaluate different types of surgical techniques for MPFL reconstruction, with regard to its consequence on the patellofemoral contact pressure and ligament stress.