COMPUTATIONAL ANALISYS OF THE ANTERIOR CRUCIAT LIGAMENT WHEN CLIMBING A STEP

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The human body is a complex mechanic structure and the knee joint (KJ) is one of the most complex and demanded joint due to it has to carry very high loads and his structure must to enable triaxial movements without lose both, the stability and the control motor [1].
The Anterior Cruciate Ligament (LCA) deficiency is one of the most common injuries of the KJ and affect about one of 3000 people around the world every year. Moreover, a LCA deficiency commonly leads to more than one causes that produces articular surfaces damage or osteoarthritis [3-5].
Many studies about the KJ had been carried out in both *in-vivo* and *in-vitro* and it showed a high variability by both person and age [6-9].
The aim of this work is to take a first step towards developing a procedure to quantify the subject specific LCA health with a non-invasive technique.
This protocol is based on two steps, the motion capture and then the numeric simulation with the finite element method.
For the motion capture we designed an experiment of climbing a step, to record the movements of the KJ with fotogravimetry using the well-known protocol Plug-in Gait developed by Vicon Motions Systems. We record the trajectories of the markers placed over the skin of the patient lower limb and extracted the curves of the knee kinematics.
This data was transform to extract both, the flexion-extension an internal-external rotation curves, to use as boundary condition for the finite element model of the patient's tibiofemoral joint.
On the second part, we developed a 3D finite element model of the KJ starting from the model released by the OpenKnee project [11] to run on FEBio [12]. With this model we analyze the effect on the results of changes on several variables like the constitutive models for the ligaments, included a fibril reinforced matrix model, and the mesh densities for de LCA. Moreover, we determine the kinematics of the LCA and the common stress and strain distribution on this complex structure when climbing a step.
The obtained results were compared against available data from literature [1] and showed a good agreement. Furthermore, this procedure enable to work on the study of specific mechanic properties of soft tissues for each patient with this protocol as starting point in order to obtain more reliable results.

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