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EVALUATION OF A NEW PROTOCOL TO QUANTIFY THE KNEE JOINT HEALTH

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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].

To the best of our knowledge, there is no available tool for clinic uses to quantify the KJ health and to predict the impact of surgeries on the knee kinematics at long term. However, recently some scientist groups started to work on it [6].

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 was to take a first step towards developing a tool to quantify the KJ health coming up with a new protocol to analyze accurately the KJ movements. This protocol is based on three steps, first to all the motion capture, followed for the data analysis and finally the simulation with the finite element method.

For the motion capture we specified the exactly location of the markers over the skin of the patient lower limb and designed an experiment (MCex) to record the movements with fotogravimetry.

This data was used on a home-made OpenSim model (OSmodel) based on the discrete element model developed by Schmitz, Anne & Piovesan [10]. The OSmodel was specifically designed to represent the MCex and it is capable to reach the best match between the movements and the data available using an inverse kinematics algorithm. From this step, we extracted six time dependent curves, from which three are the relative translations and the others three are the relative rotations of the patient's tibiofemoral joint. The third step was to develop a 3D Finite Element Model of the KJ starting from the model released by the OpenKnee project [11] to run on FEBio [12] (FBmodel). This FBmodel used as boundary conditions the six curves obtained from the previous step. Different constitutive models for the ligaments were evaluated, included a fibril reinforced matrix model.

Finally, with this model we analyzed the different results for each model and its sensibility related to changes on main parameters. Moreover, for each case we determined the stress state of the ligaments and the pressure peak on the menisci.

The obtained results were compared against available data from literature [1] and showed a good agreement. In this case, we might validate this new protocol of knee joint health analysis.

Furthermore, it enable to work on the study of specific mechanic properties of soft tissues for each patient with this protocol as starting point and with the aim to obtain more reliable results.

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