Abstract

This dissertation presents a study of biomechanical load in the knee joint during isokinetic test. The first part of the dissertation is focused on the analysis of muscle torques acting in the knee joint to flex and extend the knee under load exerted on the limb by the isokinetic dynamometer. Despite the wide use of isokinetic tests in medical clinics, reference material for this type of examination describing the load in the range of motion of the knee joint, was very limited in the literature. Within this doctoral dissertation, isokinetic tests of healthy knee joints were used to describe the shape of the isokinetic curve reference model. A set of parameters describing the isokinetic curve was proposed and presented based on 340 tests of elite football players who did not sustain any injury around the knee joint 12 months before and after the isokinetic test. Subsequently, the reference model was used to describe a change in the knee torque isokinetic curve 6, 12, and 24 months after the surgery, among the patients treated due to the medial meniscus tear. The analysis showed that parameters of the isokinetic curve among patients after the surgery change to those designated by the reference model, which can suggest a gradual progress and ability to perform more dynamic movements. However, among operated patients 24 months after the surgery, the test result still differs from the reference model.

The aim of the second part of the dissertation was to develop and validate a semi-individualised mechanical model of knee extension that could be applied to calculate the tibiofemoral force acting on the articular surface of the tibia during the isokinetic test. There were used medical records of a sample of six patients who underwent magnetic resonance imaging diagnostics and isokinetic tests performed 1 year after knee arthroscopic meniscus repair procedures. A mathematical model using kinetostatic equations and literature data was developed and subsequently validated by comparatory analysis to the one previously described by Nisell. Significant differences between values calculated with the developed model and those calculated with the Nisell model were confirmed for the normal and shear tibiofemoral force. Moreover, the work also contains a chapter on the analysis of the change in tibiofemoral force during rehabilitation process 6, 12, and 24 months after the surgery, among patients treated due to medial meniscus tear, in which differences in the values of tibiofemoral force values were analysed with respect to the patient's sex, as well as to other activities of daily living.

02.12.2022.

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