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MECHANICAL CHARACTERIZATION OF CRUCIATE AND COLLATERAL LIGAMENTS OF HUMAN KNEE

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SUMMARY

Human knee ligaments mechanical characterization is fundamental to understand a native knee behavior. Moreover, nowadays this knowledge is essential to numerically model a native knee and to validate it before the different applications that can be possible in the clinical field, in pre-operative, operative or post-operative steps, related to a specific patient.
Unfortunately, very few data are nowadays available in literature and often these data oversimplify the real behavior of native ligaments, thus the use of oversimplified models and material properties let often to obtain not trustable knee models.
For these reasons, we want to characterize collateral and cruciate ligaments from a cadaveric knee with the use of mechanical tensile tests performed for different speeds.

INTRODUCTION

To better understand knee biomechanics and to be able to develop accurate numerical models of the human knee, the knowledge of the mechanical characteristics of cruciate and collateral ligaments is fundamental.
However, very few data are currently available in literature and often these analyses are mainly focus on collateral ligaments only at one single deformation speed setting.
Therefore, the aim of this study is to provide such information, characterizing the mechanical behavior of cruciate and collateral ligaments of human knee.

METHODS

Medial and lateral collateral ligament and anterior and posterior cruciate ligaments from fresh frozen cadaver leg were analyzed in this study. Each ligament was accurately dissected from the specimen without removing the femur and the tibial bony attachment.
Tensile testing for each ligament was performed on a standard 3-ton tensile testing machine.
The bony attachments of each ligament were connected to the machine using flat roughened clamps (Figure 1).
Three different crosshead speeds were considered: 0.1m/s, 0.2m/s, 0.4m/s.
For each speed, five repetitions for the same ligament were executed. Axial force and deformation were recorded continuously for each test.

Figure 1: Machine setting.

RESULTS AND DISCUSSION

The average Force/Deformation curve and standard deviation for each analysed speed for the posterior cruciate ligament (PCL) is reported in Figure2.

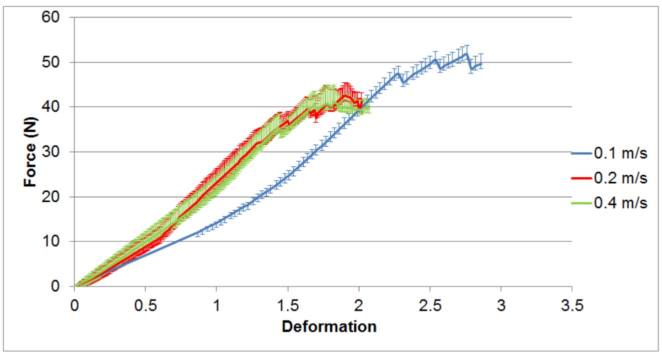

Figure 2: PCL Force/Deformation curves depending on the used crosshead speed.

Figure 3 shows the behaviour for the four analysed ligaments for the same used crosshead speed (0.1 m/s).

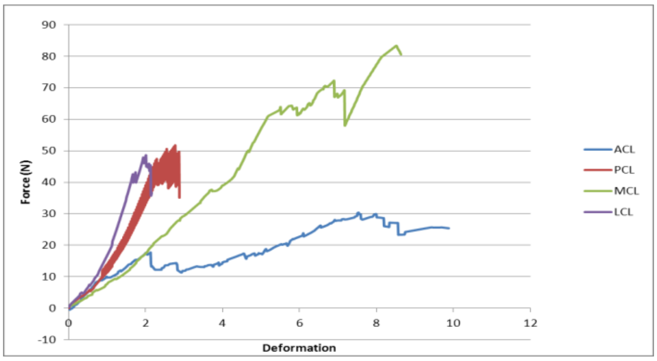

Figure 3: Ligaments Force/Deformation curves depending on the same used crosshead speed.

CONCLUSIONS

In this study the mechanical behavior in terms of Force/Deformation of several ligaments from a native knee was determined from experimental test. Results show that mechanical behavior is speed dependent and that the four ligaments present different mechanical behavior.