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Mechanical alterations of the bone-cartilage unit in a rabbit model of early osteoarthritis

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## **Abstract**

### **Introduction**

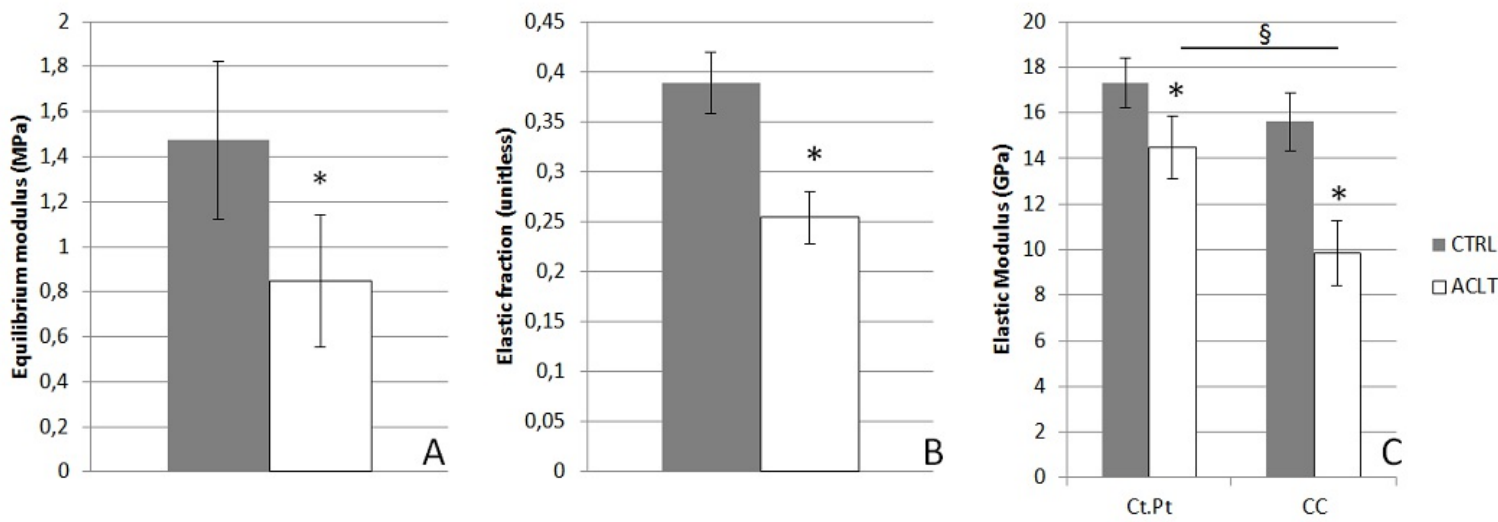
Mechanical modifications of loads by increased focal stress or excess overall load are factors that lead to OA (1). Whether the changes in the osteochondral junction occurring in OA are a cause or a consequence of hyaline cartilage damage is still debated. Especially, calcified cartilage and cortical plate play a strong role on stress distribution in the joint (2). The aim of this study was to assess mechanical properties along with microstructural modifications of the hyaline cartilage (HC), calcified cartilage (CC) and cortical plate (Ct.Pt), in an anterior cruciate ligament transection (ACLT) model.

### **Methods**

Medial femoral condyles of six healthy rabbits (control group) and of six ACLT rabbits 6 weeks after OA induction were explanted. The zone of interest (ZOI) for all experiments was defined as the weight bearing areas of the samples. Biomechanical properties were measured using nanoindentation. Microstructural changes were evaluated using biphotonic confocal microscopy (BCM) and environmental scanning electron microscopy (ESEM).

### **Results**

All rabbits of the ACLT group displayed early OA. The results indicate an overall decrease in the mechanical properties of the HC, CC and Ct.Pt in the ACLT group (figure 1). The average equilibrium modulus and elastic fraction of the HC decreased by 42% and 35%, respectively, compared with control group. The elastic moduli of the CC and Ct.Pt decreased by 37% and 16%, respectively, compared with control group. A stiffness gradient between CC and Ct.Pt appeared in the ACLT group. Evaluation of the grey levels in ESEM images revealed that there was a higher mineral content in Ct.Pt compared with CC in both groups. The irregularity of the cement line, quantified by its tortuosity in BCM images, was accentuated in the ACLT group compared with the control group.



**Figure 1** Evolution of equilibrium modulus (A) and elastic fraction (B) of hyaline cartilage and evolution of elastic moduli of Ct.Pt and CC (C). \*: p-value <0.05 between the control and ACLT groups, §: p-value <0.05 between cortical plate (Ct.Pl) and calcified cartilage (CC).

## Discussion

ACL rupture in rabbits alters their gait and induces abnormal joint kinematics. In the ACLT model, weight-bearing stress was modified in the ZOI. This disruption of the stress pattern induced alterations of the tissues composing the bone-cartilage unit. In term of mechanical properties, HC was the most affected followed by CC and then Ct.Pt. This supports the hypotheses that OA initiates in the HC.

## Acknowledgments

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## References

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