Mechanical Engineering Colloquium

January 27, 2015

Macdonald Engineering Building (MD) 267 from 4-5 pm

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Bone Quantitative Ultrasound: towards an estimation of multiscale biomechanical properties

Abstract:

Bone is a complex multiscale anisotropic medium. At the scale of several hundred nanometres, mineralized bone is composed of elementary components such as hydroxyapatite, collagen molecules and water. At the scale of 1 to 10 µm, bone is constituted by the ultrastructure composed of fibrils and extrafibrillar spaces. At the scale of several hundred micrometers, the microstructure of cortical bone is constituted by cylindrical units called osteons whereas that of trabecular bone is made of an interconnected network of more or less disordered trabeculae.

First, Quantitative ultrasound (QUS) methods aiming at estimating trabecular bone quality will be considered. The coupling of numerical simulation tools with high resolution imaging techniques led to the estimation of the sensitivity of ultrasonic parameters to controlled modifications of bone properties by considering an in silico approach of osteoporosis.

Second, QUS methods applied to cortical bone will be presented. An experimental multimodal approach allowed a better understanding of ultrasonic propagation at 4 MHz. Finite element numerical simulation tools aiming at modelling the axial transmission configuration have been developed.

Third, the application of QUS technique to the determination of the osseointegration of endosseous implants will be studied. An ultrasonic device applied to dental implant, which is now under clinical transfer, will be described. Then, a more fundamental approach consisting in studying a dedicated animal model with a planar bone-implant interface will be studied. In particular, mechanical cleavage experiments will be carried out in order to retrieve the effective adhesion energy of the bone-implant interface.

Bio:

Guillaume Haiat graduated from the Ecole Polytechnique in 1998 (X95) in physical acoustics. He defended his PhD study at the French Atomic Energy Commission in 2004 in the domain of ultrasound non-destructive evaluation in the nuclear industry. Since 2004, he works in the domain of bone quantitative ultrasound and biomechanics. He is now a group leader in the National Center for Scientific Research (CNRS) and he is based Créteil, nearby Paris.