Modélisation et Simulation Multi Echelle, MSME UMR 8208

Post-doctoral position in theoretical and numerical bone biomechanics and acoustics

Biomechanical modeling of the bone-implant interface: acoustics and multiscale analysis

Keywords: Biomechanics, bone, implant, interface, acoustics, modeling, numerical simulation,.

Implants are often employed in orthopaedic and dental surgeries. However, risks of failure, which are difficult to anticipate, are still experienced and may have dramatic consequences. Failures are due to degraded bone remodeling at the bone-implant interface, a multiscale phenomenon of an interdisciplinary nature which remains poorly understood. The objective is to provide a better understanding of the biomechanical properties of the bone-implant interface. To do so, we aim at studying the evolution of the biomechanical properties of bone tissue around an implant during the remodeling process.

New modeling approaches will be developed in close synergy with the experiments. The aim is to derive a multiscale constitutive relation for the rough bone-implant interface. An approach based on analytical modeling and on numerical simulation will be developed to understand the mechanical behavior of this complex interphase in the static (mechanics) and in the dynamic (acoustic) regimes.
Models describing the interaction between an ultrasonic wave and rough interfaces will be developed and used to solve the inverse problem (estimation of the interface properties) from the analysis of its ultrasonic response. The influence of the roughness of the implant surface on the ultrasound propagation will be studied using the phase-screen approximation.
Another aim is to provide a reliable multiscale "movie" of evolution of the system. At the nanoscale, fluid flows in the canalicular system will be modeled using molecular dynamics and electrical effects will be taken into account because these phenomena are known to strongly affect bone healing. Homogenization theories will be developed to 'take a picture at a time'. Bone tissue constitutive laws will be determined based on generalized continuum theories in order to account for the microstructure and high strain field in bone around an implant. The results will be used to design effective loading clinical procedures of implants and to optimize implant conception, leading to the development of therapeutic and diagnostic techniques.

The candidate will have a PhD in mechanics, acoustics or applied mathematics. No particular knowledge in Medicine or Biology is required but the candidate is expected to be interested by multidisciplinary approaches. He/she will validate the numerical results experimentally using the results obtained by our group. The salary will be commensurate with the experience of the candidate.
The work will be done in the MSME laboratory in Créteil but this project involves mobility at the European level. The candidate will work within a multidisciplinary team of 15 persons (including engineers, biologists and clinicians), all studying the biomechanical properties of the bone-implant interface founded by the European Research Council (ERC Consolidator Grant 2015).

Contact:
If you are interested, send a curriculum vitae, a cover letter describing previous research experience and interests, the names and contact information of two references. Please, submit via email with "ERC BoneImplant PD1" on the subject line to Guillaume Haiat (Guillaume.haiat@univ-paris-est.fr).

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