Vacancy for PhD Candidate at Universitat Pompeu Fabra (UPF), Barcelona & children Hospital Sant Joan de Deu, Spain

- Computational model of guided growth in immature skeleton for custom-made correction of deformities -

Keywords: Skeletal Growth in Children; Long-bone; Growth Plate Mechanobiology; Finite Element Modelling; Computational Biology; Medical Image Analysis; Patient-Specific Modelling; Pediatric Orthopaedics

PhD Project Abstract

Limb deformities in children motivate frequently pediatric orthopedic consultations, because of angular (genus valgus / varus), torsional (internal / external torsion) or longitudinal (leg length discrepancy) bone growth disorder, or combinations thereof. We currently apply guided growth techniques with implants that temporarily block the physis. These techniques correctly solve genu valgus but are not as effective for genu varus or leg length discrepancy and are not effective for torsional or combined deformities. In addition, these techniques often lead to complications such as the emergence of deformities in other planes or the change of epiphyseal joint shape.

The objective of the present PhD project is to create a computational model of physical growth that allows to customize the treatment of a specific deformity through individualized designs of implant and the ability of the devices to correct the deformity with the greatest efficiency and the shortest time. It is part of a larger scale project that combines the physeal surgery in experimental animal (pig) and computer developments for the simulation model of physial growth, in collaboration with the children Hospital Sant Joan de Deu (SJDD), Barcelona.

The computational model development stands for the core of the proposed PhD thesis at BCN MedTech. It will combine image analysis and mechanobiological theories of epiphyseal bone growth, through finite element modelling, to simulate different growth guidance systems made of plates or screws. The model will be uniquely calibrated and validated against it ability to recreate and correct deformities against the experimental animal model. Eventually, it will be transferred to the physiological characteristics of the human bone, leading to a pipeline of models and simulations to properly plan the surgical correction of growth deformities in patients.

Job Description

- ***PhD Thesis:*** Computational model of guided growth in immature skeleton for custom-made correction of deformities.
- ***Type of Contract:*** full time, 48 months
- ***Doctorate programme:*** Information and Communication Technologies, UPF (https://www.upf.edu/web/etic/doctorat).
- ***Starting date:*** October-November 2021
- ***Hiring lab:*** Biomechanics & Mechanobiology (BMMB) and Computer Assisted Surgery (CAS) Labs, at BCN MedTech (https://www.upf.edu/web/bcn-medtech/). The BMMB and CAS labs are two of the eight Research Areas of BCN MedTech, settled at UPF in 2015.

The CAS lab develops advanced methods for medical image analysis and processing, including intelligent region detection and growth for segmentation or for statistical shape or neural network modelling methods in patient-specific modelling. In particular, these techniques allow both complex geometry and personalized organ modelling where only partial information is available or when information from different image modalities need to be combined. Such competencies are cornerstone one to provide correct organ morphological contexts for further biomechanics and mechanobiological analyses.

Research at BMMB focuses on the load-bearing organs and tissues of the human body in health and disease, and it targets (i) the interactions between tissue multiphysics and biological processes, (ii) the multiscale regulation of organ functional biomechanics, (iii) the identification of mechanistic risk factors associated with different diseases and disorders, based on synthetic data and on the virtual augmentation of real world data. Numerical methods that combine different modelling and simulation techniques are used to describe both the tissues at the organ level, and the tissue-cell interactions at the tissue and cellular levels. Models are usually developed to admit real world biological and/or clinical data as inputs, in addition to mechanical data from motion analyses where relevant. Theoretical and numerical concepts are tested against in vivo and in vitro data, allowing mechanistic interpretations of both experimental and clinical evidences, in addition to model validations. On the one hand, emphasis is given in the study of the multiscale transfer of mechanical effects from the system level to the cell level in different scenarios, e.g. simulated treatments, organ/tissue condition or cell cultures; relative to a chosen reference state. On the other hand, advanced tissue models are used to link observable phenotypes to possible mechanisms of spatiotemporal tissue regulation that will depend on the prediction of different cell microenvironments. Both top-down and bottom-up approaches are adopted, to eventually apprehend the regulation of highly multifactorial diseases and disorders.

- Direct collaboration with the Pediatric Orthopaedic and Traumatology Service of the SJDD Children Hospital (https://www.sjdhospitalbarcelona.org/en/children/orthopaedics-traumatology)
- ***PhD project Supervisors:***

  Jérôme Noailly (BCN MedTech - https://www.upf.edu/web/bcn-medtech/entry/-/-/115532/adscripcion/j%C3%A9r%C3%B4me-bernard-noailly),

  Miguel Ángel González Ballester (BCN MedTech - https://www.upf.edu/web/bcn-medtech/entry/-/-/105610/adscripcion/miguel-angel-gonzalez),

  César Galo García Fontecha (SJDD - https://www.sjdhospitalbarcelona.org/en/cesar-galo-garcia-fontecha)

Application: Please send: · Full CV · motivation letter · two reference letters · Academic transcripts to jerome.noailly@upf.edu **by August 31th, at the latest**.

Benefits

48 months full time contract with full social security coverage under the umbrella of an Official DTIC PhD grant. Highly international working environment. Close collaboration with the Children Hospital Sant Joan de Deu, Barcelona. Full support for research implementation, participation to congresses and short International secondments.