Structure & function analysis from muscle MRI data

Lab

Research at IMT Atlantique involves nearly 800 people, including 290 teachers and researchers and 300 PhD students, and is on digital technology, energy and environment. It covers all disciplines (from the physical sciences to humanities and social sciences through those of information and knowledge) and covers all fields of science and information and communications technology.

The thesis will take place in the laboratory LaTIM (INSERM U1101), at Brest campus under the supervision of François Rousseau and Juliette Ropars.

Starting date: October 2020
Funding : IMT Atlantique - ANR Chaire IA & CHRU Brest

Description

Duchenne's disease is the most common neuromuscular disease in children. Muscle degeneration induces a generalized progressive muscle weakness. The evolution is towards a loss of gait before the age of 13 years, which is the evolutionary turn of the disease. To date, there is no curative treatment but several therapeutic trials are expected. It is essential to have markers of disease severity (biomarkers) in order to evaluate the efficacy of these promising treatments but also to guide targeted therapies (rehabilitation, surgery, drugs...). The non-invasive nature of magnetic resonance imaging (MRI) offers unique opportunities for in vivo investigation of muscle damage. Many parameters are quantifiable: muscle volume in 2D or 3D, fat infiltration, edema, metabolites, contractile portion... Several studies have shown that MRI data were associated with the severity of motor impairment. Although the disease does not affect the different muscles homogeneously, the most relevant muscles to be studied are not clearly identified. Similarly, the prognostic value of these MRI parameters has been poorly evaluated.
The aim of this thesis work will be to focus on the structure/function relationship of two muscle groups with a as yet poorly understood role in the course of Duchenne disease. MRI evaluation of the muscle involvement could have a significant impact on the understanding of the role of these two muscles in the motor skills of children but also on the development of reliable biomarkers of Duchenne's disease.

The central question of this work will be the analysis of MRI data for a better understanding of Duchenne disease and the links between anatomical biomarkers and motor functions. This work will benefit from data collected in children with Duchenne disease in the 2 years prior to and at the time of loss of walking compared to healthy children: MRI muscular imaging of the lower limbs, Quantified Gait Analysis, quantification of strength, functional scales. Quantified Analysis of Gait data (kinematics, kinetics and dynamic EMG) were analysed which showed a specific role for walking of the Anterior Tibialis and Gastrocnemius muscles during the course of the disease. The study of the relationship of the "in vivo" MRI exploration parameters with these functional data will allow a deeper understanding of the biomechanical factors of the loss of gait in children with Duchenne disease.

The following specific objectives are sought in this PhD work:

1) the development of morphometric methods to model the muscles studied before and after the loss of walking,

2) the use of deep learning methods for the discovery of dedicated biomarkers,
3) statistical analysis of the relationship between biomarkers and patient motor function.

This thesis in MRI image analysis is part of LaTIM's work on data analysis and numerical modeling of neuro-musculo-skeletal disorders. This work will focus on the development of MRI data analysis methods quantifying the evolution of disease monitoring and therapeutic efficacy (development of biomarkers). They will be carried out in close collaboration with the engineers, radiologists and clinicians of the Scientific Interest Group Be A CHILD), in particular through the co-direction with Juliette ROPARS Neuropaediatrician of the Reference Centre for Neuromuscular Diseases of Brest University Hospital.

Profile

- Master degree in image processing or applied mathematics
- Required skills: machine learning, image processing, programming (C++ & Python).

Net income/month : ~1500€

Contact

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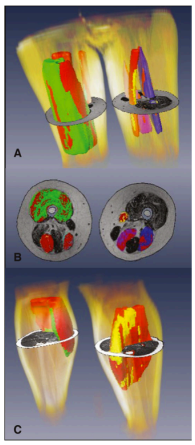
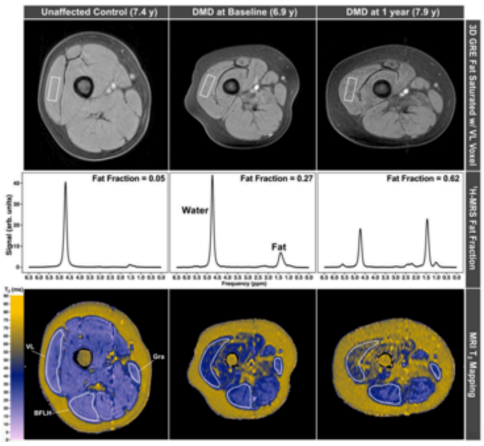
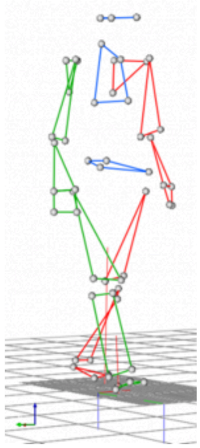
How to apply

Candidates are invited to email (to François Rousseau) a motivation letter and CV detailing in full your academic background, including all modules taken and grades assigned.







Bibliography

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2. Ropars J, Lempereur M, Vuillerot C et al. Muscle Activation during Gait in Children with Duchenne Muscular Dystrophy. PLoS One. 2016
3. Ropars J, Houx L, Brochard S, Rousseau F, Pons C, Lempereur M. Gait characteristics in children with Duchenne Muscular Dystrophy during the last 2 years of free ambulation: implications for rehabilitation. In press