Internship position

FULGUR - vers une planiFication individUalisée de La charGe d'entraînement adaptée aux propriétés mUsculaires pour Réduire l'incidence des blessures en sprint

towards an individualized planning of the training adapted to muscular properties to reduce the incidence of injuries in sprint

BIOMAPS – Université Paris-Saclay, CNRS, INSERM, CEA

Locations : Laboratoire d'imagerie biomédicale multimodale à Paris Saclay, CEA SHFJ 4 Place du Général Leclerc 91401 Orsay – INSEP, 11 Avenue du Tremblay, 75012 Paris
Opening: February 2023 for 5-6 months funded by an ANR Grant "Investissement d'avenir".
Contact : Dr. Jean-Luc Gennisson (jean-luc.gennisson@universite-paris-saclay.fr, BIOMAPS)
Partners of the project:
INSEP, Supersonic Imagine, Université de Nantes.

Summary of the project:

Goal of the project

To define new elastography parameters by using ultrafast ultrasound imaging to prevent muscular injuries. This research will focus on a recent ultrasound technique developed by us these last years: elastography, in order to quantify mechanical properties of muscle and define new parameters to estimate trauma.

Project overview

During the Olympics, running fast is the most prevalent motor task, 100-m dash being the one of the most-expected event. Yet, the achievement of such running sprints requires both extreme athletic capabilities together with robust musculoskeletal system in order to limit the risk of injury. Lower limb muscle injury is indeed the main cause of training or competition interruption on the international stage. In this context, France presents the unique feature of being historically strong in velocity-oriented sports and recognized for the quality of research work done for the understanding of sprint running performance. This research program will be conducted in strong collaboration with French Federations of Athletics, Rugby and Ice Sports (bobsleigh). FULGUR gathers world's leading experts in muscle biomechanics, strength and conditioning research, clinical imaging, health behaviors, and machine learning applied to very high sport performance in order to pursue a threefold objective:

• To appraise sprint mechanics at center of mass and joint segments level in a view to quantify specific-structure workload at these scales in ecological conditions;

• To determine individual musculoskeletal profile of elite athlete to propose tailored strengthening programs in order to optimize running propulsion efficiency;

• To estimate the level of injury risk and suggest individualized prevention contents based on a multi-factorial approach.

These goals will be supported by transverse tasks aiming at refining muscle mechanics and motion capture analysis based on ultrasound imaging and machine learning. These tasks will aim to advance the analysis of skeletal muscle dynamics 2D ultrasound analyses and to implement markerless motion capture methods in the field. Led by the flagship French laboratory focused on very high sport performance, these works originate from long-term collaborations between high-end athletic and multi-disciplinary scientific staffs. Thanks to a strong evidence-based methodological approach and minimal time-cost for top-level athletes, all the efforts put in FULGUR will convert to the ultimate goal of fast-track knowledge and tech transfer towards sport performance stakeholders. Tailored-made sprint, strength and prevention training will be co-built with coaches and staffs during panel meetings in a view to optimize sprint performance and reduce the exposure of top-level French sprinters, rugby 7 players and bobbers to muscle injury. The knowledge inferred from this project will have direct

implications in every discipline that elicits all-out sprints and accelerations (e.g. team sports, racket sports). Regular meetings with coaches and heads of federal R&D departments will result in a strongly anticipated strategy to enhance the potential of knowledge transfer and performance optimization (annual expertise meetings, innovative videos including dynamic infographics, short technical sheets, expert education programs for coaches). This approach is expected to strongly contribute to upgrade scientific skills of French performance stakeholders from Tokyo 2020 to Paris 2024 and beyond.

Innovative aspect of the project in our transverse task.

In the transverse task we manage, our team will focus on fascia. Such small tissues are often at the origin of muscle injuries. In ultrasound imaging it is possible to visualize and localize fascia, but it is very difficult to estimate their mechanical properties due to their geometry. The hypothesis of our work will be that mechanical properties such as elasticity and viscosity change previously to injuries. We will then adapt our ultrafast ultrasound device to estimate these properties in real time. As fascia are very thin, the propagation of shear waves, that gives access to mechanical properties, is complicated. In fact, due to the small thickness of fascia shear waves are guided.

In the present work we will develop the theory of guided shear wave, in order to correct from the geometrical effect, the shear wave speed quantification. Such development will be done in numerical simulation as well as in phantom experiments before to go *in vivo*. The theory will be then directly implemented in the ultrasound device to get real time feed back of our measurement in collaboration with supersonic imagine. A first cohort of volunteers will be measured at University of Nantes to validate our measurements before to test it on athletes.

Skills needed and information:

The successful candidate will be mostly in charge to build and implement new algorithms to calculate data obtained on an Aixplorer ultrafast US device. The implementation of new algorithms to build elasticity and viscosity maps should be also developed. This project requires a good knowledge of the physics of US as well as some programming facilities (Mainly Matlab but some C++ capacities should be needed). Skills in biomechanics and biophysics are also welcome, especially in elastography methods or Doppler methods. Candidate should be skilled to interact with radiologists, physicists and engineers: a clear taste of interdisciplinary research is needed. This work will be realized in collaboration with Antoine Nordez at University of Nantes, Thomas Frappart at Supersonic Imaging and Gaël Guilhem at INSEP. Financial conditions are based on the Paris-Saclay University internship rules.

Contacts: Applicants interested in this project can send a CV, motivation letter, and eventually recommendation letters to Dr. Jean-Luc Gennisson: jean-luc.gennisson@univeristy-paris-saclay.fr