

Post-doctoral Position in Ultrasound Imaging

PERFUSION - Kidney PERFusion mapping by ultrafast UltraSound Imaging for noninvasive diagnosis Of chronic Nephropathy

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

Locations: CEA SHFJ 4 Place du Gal Leclerc 91401 Orsay and Necker Hospital 75015 Paris

Opening: January 2020 funded by a Bettencourt-Schueller Biomedical Engineering Seed Grant for one year that might be extended another year.

Partners of the project: Dr. Jean-Luc Gennisson (jean-luc.gennisson@u-psud.fr, BIOMAPS) and Pr. Jean-Michel Correas (jean-michel.correas@aphp.fr, Service de radiologie adulte, Hôpital Necker, 75015, Paris)

Summary of the project:

Goal of the project

To define a new kidney perfusion mapping by using ultrafast ultrasound imaging for non-invasive diagnosis of chronic nephropathy. This research will combine two recent ultrasound techniques developed by us these last years: elastography and ultrasensitive Doppler, in order to define a new vascularization outflow and resistivity mapping of transplanted kidney.

Project overview

Renal transplantation represents the best treatment option in the case of severe Chronic Kidney Disease. It strongly improves quality of life and life expectancy compared to dialysis. After transplantation, 5 to 8% of the grafts are lost during the first year due to early surgical or immunological complications. After this period, the rate of graft loss is about 3% per year and the leading cause of long-term graft loss is Chronic Allograft Nephropathy (CAN, or chronic rejection). Its prevalence is particularly high: in the literature, CAN is observed in about half of patients in the first years after transplantation and can start early after transplantation. Then early diagnosis of CAN is necessary to limit the ineluctable degradation of renal function.

A new early diagnostic test for CAN

Doppler ultrasound (US) is an imaging method of choice for the study of renal transplant, but it does not diagnose CAN. The absence of an early diagnostic test for CAN is a major obstacle to the development and evaluation of new therapeutic options that can prevent, slow down or stabilize renal fibrosis. It is therefore necessary to develop a non-invasive imaging technique for the early diagnosis of CAN. In the present project we proposed to adapt 2 new ultrasound techniques that we have developed these past years: **US Elastography** and **Ultrasensitive Doppler**, to map a new kidney perfusion index and improve significantly CAN diagnosis. Both techniques are based on ultrafast US imaging. This new US imaging concept was born in Paris in the early 2000's and was adapted to elastography in 2004, in order to catch transient phenomena in the tissues and to Doppler imaging in order to increase its sensibility.

Innovative aspect of the project.

In the present project, we will use both techniques to develop a new approach of kidney perfusion quantification. By using elastography technique, we will be able to recover precisely stiffness of kidney tissue. This is quite important since, the stiffness, and it has been proven in others organs such as liver, is linked to fibrosis stage. Which is of great importance to know the well behavior of a transplanted kidney. By using ultrasensitive Doppler imaging, we will be able to detect very small flow within capillaries of kidney. Moreover, thanks to the high spatiotemporal resolution of the technique, the quantification of the resistivity index can be retrieved at the same time in each pixel of the image. Thanks to the research package available on our ultrasound devices, we will program and optimize the two corresponding ultrasound sequences for kidney imaging. Then an algorithm based on this acquired ultrasonic raw data will be developed to automatically calculate resistivity index maps, outflow maps

and perfusion index maps and possibly implemented for real time application into our ultrasonic devices.

The combination of both techniques will allow us to map new perfusion information of transplanted kidney such as outflow and internal pressure. By knowing the variation of micro-arteries stiffness (elastography) during one cardiac cycle as well as the speed of blood flow locally (ultrasensitive Doppler), it is then possible to map the internal pressure in the kidney. This information coupled with the mapping of resistivity index in the whole kidney could give us a true innovative biomarker of kidney perfusion and it could be of great importance for CAN.

Skills needed and information:

The successful candidate will hold a Ph.D and will be mostly in charge to build and implement new US sequences on an Aixplorer ultrafast US device. These new US sequences should be implemented to speed-up the acquisition rate and to optimize the setup sensibility and efficiency. Then implementation of new algorithms to build resistivity maps and estimate internal pressure 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 Jean-Michel Correas at Necker Hospital. Financial conditions are based on the Paris-Saclay University postdoctoral grants, and depend on the years of experience of the candidate.

Contacts: Applicants interested in this project can send a CV, motivation letter, and eventually recommendation letters to Jean-Luc Gennisson and Jean-Michel Correas.