Cardiovascular and Metabolism PhD Program

Mini-Symposium

"Imaging techniques in cardiovascular and metabolism research: Hot topics and challenges"

Organizer: Jessica Bastiaansen, Department of Radiology & Translational Imaging Center, University and University Hospital of Berne, Switzerland

When: 20 May 2022 from 9:00 – 13:00
Where: CHUV Lausanne, main building BH08, Auditorium YERSIN

Remote participation via

https://chuv.webex.com/chuv/j.php?MTID=m2f5d34a5943514c88c6cf540f8267bea

8:30 – 9:00	Welcome coffee
9:00 - 9:15	**Welcome** Jessica Bastiaansen, Department of Radiology & Translational Imaging Center, University and University Hospital of Berne, Switzerland
9:15 - 10:00	**Flow MRI applications for assessing cardiovascular structure and function** Eva Peper, QIS Lab, University Hospital of Berne, Switzerland *Unfortunately, Bram F. Coolen had to cancel last minute due to illness.*
10:00 - 10:45	**Advanced image acquisition and image reconstruction techniques for cardiac PET-MR imaging** Camila Munoz, Department of Biomedical Engineering, School of Biomedical Engineering & Imaging Sciences, King's College London, UK
10:45 – 11:00	**Coffee break**
11.00 - 11:45	**Advances in translational optoacoustics: From vascular to vasometabolic imaging** Angelos Karlas, Institute for Biological and Medical Imaging, Helmholtz Center Munich and Technical University of Munich, Germany
11.45 - 12.30	**Multienergy CT in cardiovascular diseases** Monica Sigovan, INSA-Lyon, Université Claude Bernard Lyon 1, UJM-Saint Etienne, CNRS, Inserm, CREATIS Lab, Lyon, France
14:00 – 16:00	**Afternoon workshops for PhD students with symposium speakers**

The meeting is free of charge, but for organization purposes please register by filling the form (https://tinyurl.com/CVM-May2022) prior to May 10, 2022. The UNIL-FBM doctoral school attributes 1.0 ECTS to PhD students who present a signed participation form for the mini-symposium (0.25 ECTS morning session, 0.75 ECTS afternoon session). For additional information, please contact Dr. Ulrike Toepel (Ulrike.toepel@unil.ch).

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Talk abstracts

Eva Peper, QIS Lab, University Hospital of Berne, Switzerland

Flow MRI applications for assessing cardiovascular structure and function

Unfortunately, Bram F. Coolen had to cancel last minute due to illness. The afternoon workshop for PhD candidates will kindly be hosted by Jessica Bastiaansen and Eva Peper with the materials previously provided by Bram Coolen. Thanks to all for your flexibility!

Camila Munoz, Department of Biomedical Engineering, School of Biomedical Engineering & Imaging Sciences, King's College London, UK

Advanced image acquisition and image reconstruction techniques for cardiac PET-MR imaging

Cardiac magnetic resonance (MR) and positron emission tomography (PET) imaging have been areas of active research for over three decades. Throughout this time, technical advances in scanner hardware, data acquisition, and image reconstruction techniques have resulted in the clinical adoption of cardiac MR and PET examinations for the assessment of a wide range of cardiovascular diseases. Conventional cardiac MR and PET imaging have focused on the depiction of the cardiac anatomy and characterization of myocardial function. In clinical practice, both PET and MR images are typically analysed qualitatively, by looking at areas of higher or lower signal intensity in the images as compared to surrounding healthy tissue. However, recently proposed techniques for MR-based tissue characterization and novel target specific PET radiotracers have encouraged a change in the way images are acquired and analysed, moving towards more objective, reproducible, and quantitative cardiovascular imaging. These advanced techniques have great potential to enable early detection of cardiovascular diseases, and accurate quantification of disease progression and therapy response. Moreover, the introduction of hybrid PET-MR systems in the early 2010s has opened new possibilities for the simultaneous acquisition of complementary information with both imaging modalities, showing promising results for a comprehensive assessment of the cardiovascular system, and potentially improving patient care. This chapter describes state-of-the-art and emerging methods for cardiac MR and PET-MR imaging, highlighting the trends of current research and discussing some their potential for clinical translation.

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Angelos Karlas, Institute for Biological and Medical Imaging, Helmholtz Center Munich

Advances in translational optoacoustics: From vascular to vasometabolic imaging

Vascular imaging may well visualize local pathology, such as an atherosclerotic plaque which affects the vessel wall structure and local blood flow but provides no insights into subsequent metabolic dysfunction of the targeted perfused tissue (e.g., skeletal muscle in the lower limbs). The latter is monitored by means of functional imaging techniques (e.g., contrast-enhanced ultrasound – CEUS, magnetic resonance imaging – MRI or positron emission tomography – PET) which visualize tissue perfusion/metabolism and measure tissue function in health and disease. Nevertheless, such techniques may require the administration of potentially harmful contrast agents (e.g., in PET), use of bulky and expensive equipment (e.g., in MRI) or provide only perfusion and not metabolic information for limited amount of time (e.g., CEUS for 3-5 minutes). Optoacoustic imaging, a novel molecular imaging technique, offers label-free imaging of both local vascular pathology and targeted tissue metabolic status with high portability. Herein, we are going to discuss: i) the principles of optoacoustic imaging, ii) the characteristics of usual systems and configurations and iii) several translational applications of optoacoustic imaging technologies. The presentation focuses on the unique potential of optoacoustics to perform detailed imaging of both vascular and tissue pathophysiology in an attempt to shift the paradigm from purely vascular to vasometabolic imaging.

Monica Sigovan, INSA-Lyon, Université Claude Bernard Lyon 1, UJM-Saint Etienne, CNRS, Inserm, CREATIS Lab, Lyon, France

Multienergy CT in cardiovascular diseases

Computed tomography (CT) has been established as an important imaging modality in the evaluation of cardiovascular disorders owing to a high speed of image acquisition, high spatial resolution, and dose efficient image reconstruction resulting from technological advancements.

Multi-energy CT is another important technological advancement that enables sampling of the attenuation data in the energy dimension. Consequently, the data from different energies (two or more) is used to analyze differences in the chemical composition of the objects being imaged; going beyond what is possible with conventional CT. Systems capable of sampling two X-ray spectra of different energies, called Dual Energy CT, have made their way to clinical practice. For cardiovascular imaging, the main focus of Dual Energy CT is the visualization and quantification of iodine-based contrast agents in the vasculature.

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In this talk, we will focus mainly on the multi-energy or Spectral CT, enabled by the relatively recent development of photon-counting (PC) detectors for CT. I will present the initial experience we have had in Lyon with the first preclinical and then the clinical prototype SPCCT system from Philips.

PC detectors are smaller than conventional energy integrating detectors, thus inherently lead to higher spatial resolution images. In addition, these detectors resolve the energy of each photon of the incident spectrum, then quantify and classify them according to this energy. This process permits a configurable sampling of the energy-dependent attenuation of the object being imaged. The system is thus capable of detecting the discontinuity of attenuation around specific K-edge energies. This is useful for separating exogenous contrast agents based on elements with K-edge energies higher than 40 keV, such as gadolinium or gold, from tissues and iodine contrast agents. Therefore, a K-edge contrast material that accumulates in macrophages could be extremely advantageous for specific imaging of vulnerable atherosclerotic plaques. Among the candidates for k-edge imaging, promising results have been reported using gold nanoparticles. In addition, gold nanoparticles are highly biocompatible, are extremely dense, and have low viscosity, which is important for in vivo applications.

Acknowledgement

Bram F. Coolen, Department of Biomedical Engineering and Physics, Amsterdam UMC

MRI applications for assessing cardiovascular disease: structure, function and metabolism

Postponed ….

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