Cardiovascular MR

CV-I *T1 map and more*
(3 speakers, 90 min)

CV-II ***Flow and motion***
(4 speakers, 90 min)

CV-III *Cardiac: Ischemic Heart*
(3 speakers, 90 min)

Hsu-Hsia Peng, PhD
彭旭霞 副教授

CV-II

Time Table

Saturday, May 21, 2022
Room 203

Time	Topics	Speakers	Moderators
15:30-15:50 (20mins)	Physics of 4D Flow MRI	Michael Markl	Hsu-Hsia Peng Whal Lee
15:50-16:10 (20mins)	Strain Analysis by Cardiac MRI	Liang Zhong	Hsu-Hsia Peng Whal Lee
16:10-16:30 (20mins)	Kinetic Energy in Cardiac MRI	Hsu-Hsia Peng	Hsu-Hsia Peng Whal Lee
16:30-16:50 (20mins)	AI in Cardiac MRI	Albert Hsiao	Hsu-Hsia Peng Whal Lee
16:50-17:00 (10mins)	Q&A		

Cardiac Flow and Motion

Organizer: Hsu-Hsia Peng

Overview:

4D flow MRI has been used for the quantitative measures of flow in various cardiovascular diseases, including challenging congenital heart diseases. Recent advances in 4D flow MRI include shortened imaging times and improved dataset pre- and postprocessing, which increase the feasibility of 4D flow MRI in clinical practice. Cardiac strain, assessing global and regional myocardial deformation, has been used to detect abnormality in left ventricular and atrial function in many cardiac diseases. In this session, the physics, applications, and artificial intelligence in the field of cardiac flow and motion will be discussed. The audience can capture the fundamental technology and advanced applications in this field.

Physics of 4D Flow MRI

Michael Markl, PhD, USA

- Vice Chair for Research, Northwestern University
- Professor of Radiology (Basic and Translational Radiology Research) Feinberg School of Medicine, Northwestern University
- Lester B. and Frances T. Knight Professor of Cardiac Imaging, McCormick School of Engineering, Northwestern University
- Major interest / achievement: Cardiovascular Imaging, biomedical Engineering

Physics of 4D Flow MRI

- **Synopsis:**

- The intrinsic motion sensitivity of magnetic resonance imaging (MRI) can be used acquire and quantify blood flow in-vivo. Advances in imaging techniques allow the use of 4D flow MRI to measure, visualize and quantify 3D blood flow with full volumetric coverage of cardiac chambers or cardio- or neurovascular regions (e.g. thoracic aorta, large cerebral vessels). This presentation will 1) Introduce methodological aspects related to the measurement, visualization and quantification of 3D blood in the human body based on 4D flow MRI; 2) Provide examples of clinically relevant questions and how 4D flow can be used to improve cardiovascular diagnostics; and 3) Discuss recent 4D flow MRI developments and future perspectives

- **Key References:**

- Nayak KS, Nielsen JF, Bernstein MA, Markl M, P DG, R MB, Saloner D, Lorenz C, Wen H, B SH, Epstein FH, J NO and Raman SV. Cardiovascular magnetic resonance phase contrast imaging. *J Cardiovasc Magn Reson. 2015;17:71.*
- Markl M, Kilner PJ and Ebbers T. Comprehensive 4D velocity mapping of the heart and great vessels by cardiovascular magnetic resonance. *J Cardiovasc Magn Reson. 2011;13:7.*

Strain Analysis by Cardiac MRI

Liang Zhong, PhD, Singapore

- Associate Professor, Cardiovascular Sciences Academic Clinical Programme Singapore, Duke National University of Singapore.
- Associate Professor, Cardiovascular Metabolic Disorder Programme Singapore, Duke National University of Singapore
- Lead of Cardiovascular System Imaging and Artificial Intelligence Lab, National Heart Centre Singapore
- Major interest / achievement: Cardiovascular Imaging, computational modeling, mechanics and physiology, AI

Strain Analysis by Cardiac MRI

- ## Synopsis:

- Myocardial strains are defined as a fractional change in length of a myocardial segment relative to its baseline length. Myocardial strains are more sensitive than ventricular ejection fraction (EF) to identify sub-clinical ventricular dysfunction in diverse heart diseases. Among all the strain parameters, longitudinal strain is more reproducible than radial and circumferential strain and rotation and hence is recommended as routine measurements to detect reduction in ventricular function prior to conventional EF falls. Methods for myocardial strains beyond left ventricle will be presented.

- ## Key References:

- Leng S, Tan RS, Zhao XD, Allen JC, Koh AS, Zhong L. Validation of a rapid semi-automated method to assess left atrial longitudinal phasic strains on cine cardiovascular magnetic resonance imaging *J Cardiovasc Magn Reson* 2018;20:71.
- Leng S, Dong Y, Wu Y, Zhao X, Ruan W, Zhang G, Allen JC, Koh AS, Tan RS, Yip J, Tan JL, Chen Y, Zhong L. Impaired cardiovascular magnetic resonance derived rapid semi automated right atrial longitudinal strain is associate with decompensated hemodynamics in pulmonary arterial hypertension *Circulation Cardiovascular Imaging* 2019; 12(5):e008582
- Leng S, Geng H, He J, Kong L, Yang Y, Yan F, Xiu J, Shan P, Zhao S, Tan RS, Zhao XD, Koh AS, Allen JC, Hausenloy DJ, Mintz GS, Zhong L, Pu J. Long-term prognostic value of cardiac MRI left atrial strain in ST-segment elevation myocardial infarction *Radiology* 2020;296:299-309.

Kinetic Energy in Cardiac MRI

Hsu-Hsia Peng, PhD, Taiwan

- Associate Professor, Department of Biomedical Engineering and Environmental Sciences, National Tsing Hua University
- Major interest / achievement: Cardiovascular imaging, magnetic resonance imaging, biomedical imaging

Kinetic Energy in Cardiac MRI

- ## Synopsis:

- 4D flow-derived measurements of intracardiac kinetic energy (KE) provides new insights into cardiac hemodynamics and may improve assessment and understanding of cardiovascular diseases. Myocardial motion velocity measured by tissue phase mapping Tissue phase mapping (TPM) has emerged as a reliable measurement of three-dimensional voxel-wise myocardial motion velocities for evaluating regional cardiac function. The TPM-derived KE can also been used to estimate abnormal energetic mechanism of myocardium. In this talk, we will introduce the applications of KE in evaluation of intraventricular flow, aortic flow, and myocardium in cardiovascular manifestation.

- ## Key References:

- Garg P. et al, Left ventricular blood flow kinetic energy after myocardial infarction - insights from 4D flow cardiovascular magnetic resonance. J Cardiovascular Magn Reson. 2018; 20: 61.
- Kanski M. et al, Left ventricular fluid kinetic energy time curves in heart failure from cardiovascular magnetic resonance 4D flow data. J Cardiovasc Magn Reson. 2015; 17: 111
- Chang MC, Left ventricular regional myocardial motion and twist function in repaired tetralogy of Fallot evaluated by magnetic resonance tissue phase mapping. European Radiology. 2018; 28:104-114.

AI in Cardiac MRI

Albert Hsiao, MD, PhD, USA

- Radiologist
- Associate Professor,
  Department of Radiology
  Halıcıoğlu Data Science Institute
  University of California San Diego
- Major interest / achievement: Artificial intelligence, 4D Flow, congenital heart disease, cardiac magnetic resonance imaging, cardiac computed tomography, hemodynamics

AI in Cardiac MRI

- ## Synopsis:

- In this talk, we will discuss several current applications of artificial intelligence to the acquisition, quantitative analysis and interpretation of cardiac MRI. Regarding acquisition, this will include methods of scan automation, acceleration and image quality enhancement. We will also present methodologies for automating analysis of routine cardiac cine SSFP images and advanced sequences such as 4D Flow, and ultimately highlight the impact of artificial intelligence on diagnosis and interpretation.

- ## Key References:

- Blansit, K., Retson, T., Masutani, E.M., Bahrami, N., Hsiao, A., Deep Learning-based Prescription of MR Cardiac Imaging Planes. Radiology: Artificial Intelligence (2019).
- Masutani, E.M., Bahrami, N., Hsiao, A., Deep-Learning Singleframe and Multiframe Super-Resolution for Cardiac MRI. Radiology (2020).
- You, S., Masutani, E., Alley, M.T., Vasanawala, S.S., Liau, J., Roberts, A., Taub, P., Hsiao, A., Deep Learning Automated Background Phase Error Correction for Abdominopelvic 4D Flow MRI. Radiology (2021).