AbstractID: 11950 Title: Functional Cardiovascular MRI: Assessment, Visualization and Quantification of 3D Blood Flow Characteristics

Magnetic Resonance Imaging (MRI) techniques provide a non-invasive method for the highly accurate anatomic depiction of the heart and vessels. Most MR-sequences demonstrate more or less significant sensitivity to flow and motion, which can lead to artifacts in many applications. The intrinsic motion sensitivity of MRI can, however, also be used to image vessels like in phase contrast (PC) MR-angiography or to quantify blood flow and motion of tissue. Such techniques offer the unique possibility to acquire spatially registered functional information simultaneously with the morphological data within a single experiment. Characterizations of the dynamic components of blood flow and cardiovascular function provide insight into normal and pathological physiology and have made considerable progress in recent years

To synchronize flow or motion sensitive measurements with periodic tissue motion or pulsatile flow, data acquisition is typically gated to the cardiac cycle and time resolved (CINE) anatomical images are collected to depict the dynamics of tissue motion and blood flow during the cardiac cycle. Visualization and quantification of blood flow and tissue motion using PC MRI has been widely used in a number of applications. In addition to analyzing tissue motion such as left ventricular function, time-resolved 2D PC MRI techniques have proven to be useful tools for the assessment of blood flow within the cardiovascular system.
Moreover, 3D spatial encoding offers the possibility of isotropic high spatial resolution and thus the ability to measure and visualize the temporal evolution of complex flow and motion patterns in a 3D-volume. In this context, ECG synchronized and respiration controlled flow sensitive 3D MRI using 3-directional velocity encoding (also termed 'flow sensitive 4D MRI') can be employed to detect and visualize global and local blood flow characteristics in targeted vascular regions (aorta, cranial arteries, carotid arteries, etc.). For the analysis and visualization of complex, three-directional blood flow within a 3D volume, various visualization tools, including 2D vector-fields, 3D streamlines and particle traces, have been reported. In addition more advanced data quantification strategies of directly measured (e.g. flow rates) or derived parameters (e.g. pressure difference maps, wall sheer stress, pulse wave velocity, etc.) are promising as new clinical markers for the characterization of cardiovascular disease.
This lecture will provide an overview of the MR imaging principles and advanced acquisition methods, data processing, flow visualization and quantification strategies, and clinical applications of flow sensitive MRI imaging.

Educational Objectives:
1. Understand the basic and advanced methods for flow measurements using MRI
2. Understand techniques for 3D flow visualization and quantification of blood flow and derived parameters
3. Understand the issues related to clinical applications of flow-sensitive MRI