Changing a Paradigm: Comprehensive and Fully Self-Gated 3D Functional and Anatomical Assessment of the Whole Heart Using Magnetic Resonance Imaging and Compressed Sensing

In recent years, cardiac magnetic resonance imaging (MRI) has received an increasing interest for the clinical assessment of patients with suspected coronary artery disease (CAD). This non-invasive diagnostic tool offers excellent soft-tissue contrast, absence of ionizing radiation, and quantitative assessment of both cardiac morphology and function. The use of cardiac MRI in clinical practice, however, is challenged by the complexity of the workflows, long scan times, and high vulnerability to motion during acquisition.

Cardiac motion is generally addressed by using electrocardiogram (ECG) triggering to synchronize the image acquisition with the cardiac cycle, whereas navigator gating is commonly used to minimize respiratory motion in free-breathing whole-heart coronary MRA [1]. However, lengthy and unpredictable acquisition times remain a drawback. Respiratory self-navigation (SN) [2,3], conversely, enables 100% scan efficiency, but performs motion correction over a broad range of respiratory displacements, which can result in image artifacts.

Recent innovations in coronary MRA, which make use of advanced acquisition [4] and reconstruction schemes, such as Compressed Sensing (CS) [5], have the potential to challenge these existing paradigms and to enable high-resolution dynamic coronary imaging. Specifically, CS enables accelerated image acquisition by exploiting redundancies in either spatial or temporal dimensions and by only collecting a subset of the image data. Using these novel acquisition strategies to detect and estimate respiratory motion from the acquired data themselves, together with these iterative CS reconstruction methods, has enabled cardiac and respiratory motion-resolved whole-heart imaging during free-breathing [4].

This talk will present the CS framework developed at the CHUV and discuss its application in 5D (x-y-z-cardiac-respiratory dimensions) whole-heart and fetal cardiac MRI.

References

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