Dynamic Contrast Enhanced MRI/MRA

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Target Audience: Clinicians (Residents, Fellows, and Attending Level) whose practice includes Body MRI, basic scientists interested in abdominal or angiographic applications of fast imaging, and basic scientists interested in modeling of DCE data.

Purpose:

- Understand the need for dynamic contrast enhanced MRI and MRA in the Body
- Understand how time resolved MR enables quantitative modeling of perfusion in the body
- Understand current clinical strategies for obtaining time-resolved information in the body, including repeated breath-holds, parallel imaging and view-sharing based acceleration
- Understand how developing strategies in time resolved imaging such as non-Cartesian acquisitions, non-Cartesian parallel imaging, and compressed sensing impact the developing field of body dynamic contrast enhanced imaging.

The goal of this session will be to cover dynamic contrast enhanced MRI and MRA, from present standard clinical practice, to some major developing approaches in the field.

Routine MR imaging in the liver, kidneys, and pancreas has long included images obtained at multiple time-points after contrast injection, which allows characterization of multiple lesions, with time-points selected to help characterize the enhancement curve for maximal clinical utility. Similarly, MR angiography applications require imaging at selected times after contrast bolus injection, to best visualize the desired vasculature. At the heart of these approaches is the fact that multiple temporal “looks” at organs of interest are possible with MR, without attendant radiation concerns that similar approaches would raise with CT. This clinical standard is the simplest dynamic contrast enhanced imaging.

However, this standard effectively means very few frames of an imaged volume are obtained to characterize the enhancement in an organ. Over the past few years, view-sharing and parallel imaging based approaches to multiple imaging techniques that provide high frame rate imaging. These go by multiple acronyms dependent on manufacturer, such as TRICKS (1) (GE, Time-Resolved Imaging of Contrast KineticS), TWIST (2,3) (Siemens, Time-resolved angiography With Stochastic Trajectories), and 4D-Trak (4) (Philips, 4D Time-Resolved Angiography using Keyhole). These technologies have made possible high frame rate time resolved imaging, though data are drawn from relatively wide temporal windows. These technologies have made it possible to assess pathologies that require high frame rates to characterize and would have previously required catheter angiography, such as arteriovenous malformations.

Motion corruption remains a major problem within images and between images, and intermittent breath-holds create data holes. Large temporal footprints and a need for accurate quantitative modeling of the data still leave open a need for further improvements in speed. Also, abdominal imaging provides a particular challenge as motion corruption can affect view sharing, and multiple breath-holds are needed for qualitative comparison of timeframes for quantitative modeling of data. Thus increasingly, multiple investigators are going back to imaging physics and relying on non-Cartesian acquisitions, non-Cartesian parallel imaging (5–8), and model based and compressed sensing approaches (8,9–12) to try and obtain ultra-fast images of abdominal structures to improve the quality of dynamic contrast enhanced imaging, and provide quantitative modeling of these data.

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