Technical Considerations in Whole Body MR

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Introduction: In the last several years MRI techniques have been increasingly applied to the imaging of extended fields of view. One reason for doing this has been to image an anatomic region of clinical interest larger than the typical maximum FOV allowable at a fixed MR table position. Perhaps the prototypical application has been imaging of the peripheral vasculature using multiple table positions or "stations" with time-of-flight or contrast-enhanced techniques [1]. Other reasons for extended FOV imaging have included the detection of disease suspected of being systemic rather than localized, whole body screening, and the wish to reduce the amount of contrast agent used in an exam by imaging it across a broad region. The purpose of this presentation is to identify technical issues and approaches in imaging an extended FOV and describe prospects for future developments.

Technical Issues: In conventional MRI in which a fixed, limited FOV (e.g. <40 cm) is imaged, acquisition parameters are selected specifically for that FOV. This includes the transmit and receiver coils, the number of X, Y, and Z samples to provide a targeted resolution, and potentially any shimming, tuning, or retrospective corrections for other system non-idealities. As the longitudinal extent of the object of interest increases, it becomes likely that a parameter set chosen for a "small" FOV is no longer optimal for the extended FOV. These issues are further complicated in the imaging of a dynamic phenomenon, such as in tracking the progression of an intravenously administered contrast material.

Technical Approaches: An effective way to image an extended FOV with MRI is to use a discrete set of small FOVs which collectively encompass the targeted region. For the specific case of contrast-enhanced peripheral MRA, typically three to five stations are used from the abdomen to the pedal vessels. Current commercial packages allow considerable flexibility in choosing parameters on an FOV-specific basis. The challenge is to move quickly enough from station to station to capture the arterial phase while imaging long enough at each station for adequate spatial resolution.

Another technical approach is to acquire MRI data *during continuous motion* of the patient table through the MR scanner gantry. This offers possible advantages of a seamless image of the extended FOV, elimination of the overhead of time in moving from one station to the next, elimination of any overlap of fixed FOVs, and the potential to dynamically change the table velocity. However, imaging during continuous motion raises a host of additional technical options and challenges beyond those of the fixed station approach. One has a choice of a 2D [2] or 3D [3] approach, and within both of these classes the manner in which k-space is sampled, whether it be standard Fourier, radial, or some variant.

Another key aspect of imaging during continuous table motion is the inconsistency of the data. That is, the raw data used to form the image at a specific longitudinal level along the extended FOV is generally acquired at varying levels of magnitude, phase, or system-based spatially-dependent non-ideality. These variations can more severely compromise image quality when compared to imaging without table motion.

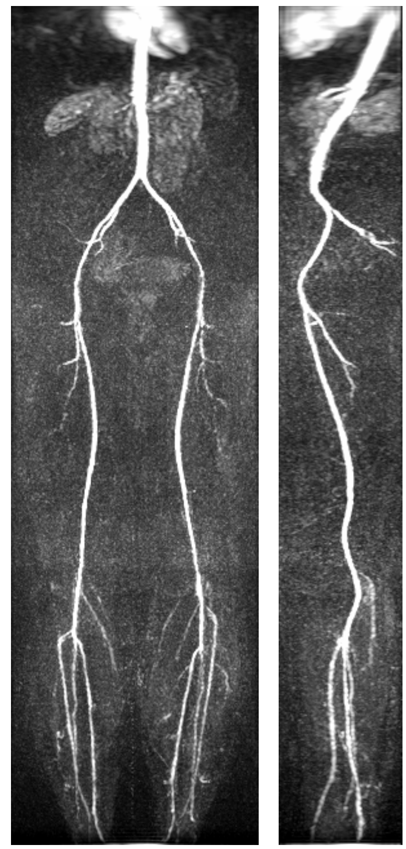

Fig 1. Coronal (left) and sagittal (right) MIP images of a peripheral runoff angiogram done using continuous table motion and a whole body receiver coil.

Discussion: Whole body MRI has become a technical reality. The ultimate clinical role will be determined only after consideration of other whole body imaging methods and their advantages, such as the high sensitivity of whole body PET and the high net acquisition speed of multi-slice CT. It is expected that the fundamental strengths of MRI of flexibility of contrast and k-space coverage, and the potential for real-time control will make it useful for imaging the cardiovascular system (e.g. Figure 1).

References: [1] Meaney JF, Radiology 211:59 (1999); [2] Fautz HP, Proc 9th ISMRM, 233 (2001); [3] Kruger DG, MRM, 47:224 (2002)