

**Session:** Recent Innovations in Cardiac MR

**Title:** Magnetic Resonance Angiography – Not so Fast: Recent Advances in CE-MRA

Ulrike I. Attenberger, MD

Associate Professor of Radiology,

University Medical Center Mannheim

Medical Faculty Mannheim, Heidelberg University, Mannheim, Germany

ulrike.attenberger@medma.uni-heidelberg.de

### **Who will benefit from this information?**

Radiologists

### **How was a problem determined?**

Recent advances in contrast enhanced MRA (CE-MRA) have been driven by advances in MR hardware and novel acquisition techniques. With the increased incorporation of high field strength imaging into the clinical routine and the development of techniques, such as parallel imaging, the ability to obtain rapid, high resolution CE-MRA is greater than ever. This lecture will present the current status of CE-MRA imaging with regard to potential applications, benefits, limitations, and potential solutions.

Prior to the advent of Nephrogenic Systemic Fibrosis (NSF) in early 2000, CE-MRA was considered a promising imaging alternative to conventional modalities due to its non-invasiveness and lack of ionizing radiation. The latter is especially important for patients requiring long-term follow-up, as with chronic peripheral arterial occlusive disease. However, NSF renewed interest in non-enhanced MRA (NE-MRA) techniques, and increased attempts to solve past limitations of these techniques such as long acquisition times and insufficient spatial resolution. Innumerable publications on new technical developments for improving NE-MRA techniques are present in the literature. However, the clinical value of these techniques is not yet definitely established, and there are still limitations to these techniques. Constant inflow and cardiac gating are requisite for adequate image quality and are hampered by arrhythmias and poor cardiac output. NE-MRA acquisitions are also relatively time-consuming, a potential limitation in critically ill patients. These technical limitations, especially with an older, more debilitated patient cohort - requiring fast, robust imaging techniques - necessitate a re-evaluation of low dose CE-MRA techniques. Low dose CE-MRA and NE-MRA techniques must thus be compared in terms of their efficacy and feasibility in the clinical routine.

### **Examples of how this issue have been addressed:**

CE-MRA presents several advantages over NE-MRA techniques allowing for high spatial resolutions with voxel sizes  $< 1\text{mm}^3$  and acquisition times of 15-25 sec. Dedicated multi-element coils improve SNR/CNR even in small vessels. Continuous table movement techniques facilitate large field-of-view imaging.

Time-resolved CE-MRA techniques help overcome limitations from flow alterations due to hyperemia or significant stenoses. The additional acquisition of high-resolution T1-w fs sequences in steady-state after the arterial phase MRA provides additional helpful information such as detection of deep venous thrombosis and abscesses. Initial results are presented.

With the advent of NSF, low-dose CE-MRA techniques must be employed without detrimental effects on image quality and diagnostic accuracy must be prioritized. The optimal combination of technical pre-requisites such as field strength, coil selection and time-resolved MRA allow a reduction in the overall contrast dose to  $< 0.1\text{ mmol/kg bw}$ .

All the factors mentioned above have potential to make CE-MRA a robust, fast, safe, and cost-effective diagnostic tool with high diagnostic accuracy.

### **What will learners be able to do differently because of this information?**

- Learners will recognize technical requirements of contrast-enhanced MRA (i.e. signal-to-noise-ratio, scan time, spatial resolution, voxel size) and potential methods by which to achieve successful vascular imaging, such as:
  - parallel imaging
  - view-sharing
  - higher field strength
  - multi-element coils

The overall impact of these techniques on diagnostic accuracy will be described and illustrated in case based examples. A review of recent publications will be given.

- Learners will understand contrast-agent dose optimization strategies. The effect of higher field strength imaging and advanced coils in terms of their potential for contrast agent dose reduction will be discussed.
- Alternative acquisition techniques for peripheral MRA improving its robustness and broadening its diagnostic spectrum and will be introduced and their potential implications on patient care will be illustrated by case examples.

### **Suggested Reading:**

Kramer H et al, Invest Radiol 2008.  
Lim RP et al, JMRI 2008.  
Attenberger UI et al, Radiology 2010.  
Haneder S et al, Eur Radiol 2011.