

Unenhanced Body MRA: Is it Good Enough?

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Contrast-enhanced MR-Angiography (CE-MRA) has evolved into the standard, non-invasive imaging modality for vascular imaging of the body. It allows for high spatial resolution with submillimeter voxel sizes, a large field of view and it can be acquired in 15-25s. It relies on the administration of Gd-based contrast agent of which typically 0.2mmol/kg is administered. At 3.0T, the administered dose can be cut down to 0.1mmol/kg without impairing image quality. Until the advent of nephrogenic systemic fibrosis, CE-MRA was considered safe and well tolerated even in patient with heavily impaired renal function. However, with the advent of nephrogenic systemic fibrosis (NSF) and continuous improvements in scanner hardware and software the interest in non-enhanced MRA-techniques has markedly increased. Among the most important improvements are parallel imaging, the widespread availability of clinical 3T scanners as well as the availability of new sequence techniques such as EKG-gated Fourier Fast Spin-echo (FSE) or arterial spin labelling in combination with balanced steady state free precession (SSFP) sequences.

Non-enhanced time-of-flight (TOF) MRA is a standard sequence in daily clinical routine. TOF-MRA has also been used for body and peripheral MRA but has been by and large abandoned for these applications due to long measurement times and insufficient spatial resolution. Phase-contrast (PC) MRA is another abandoned non-enhanced MRA technique which is nowadays mostly used for venous imaging of the brain or as localizing sequences.

First reports on new, EKG-gated non-enhanced MRA techniques have been published by Katoh (1) for the renal arteries and Miyazaki (2) for the peripheral arteries. Since then a huge number of publications has described new techniques, technical improvements and initial clinical results of non-enhanced MRA techniques. A comprehensive and current overview of the topic has been recently published by Lee and Miyazaki in Radiology (3).

Non-enhanced MRA techniques are based on the following physical principles:

1. EKG-gated imaging (FSE, SPACE), with acquisition of systolic and diastolic images which are subtracted in a second step to yield images with arterial contrast only.
2. arterial spin labelling in combination with FSE (time-SLIP)
3. bSSFP sequences with or without breathhold, EKG-gating and with or without arterial labelling.

The exact clinical value of these techniques has not been fully evaluated. There are however some problems compared to CE-MRA. All approaches are rather time-consuming which may limit their use in patients not able to lay still. In addition, as EKG-gating and constant inflow into the imaging plane are a prerequisite for imaging image quality can be impaired in patients with arrhythmia or with low cardiac output.

This lecture will present the current status of non-enhanced imaging with regard to potential applications, benefits and limitations.

Suggested Reading

1. Katoh M, Buecker A, Stuber M, Gunther RW, Spuentrup E. Free-breathing renal MR angiography with steady-state free-precession (SSFP) and slab-selective spin inversion: initial results. *Kidney Int* 2004; 66:1272-1278.
2. Miyazaki M, Takai H, Sugiura S, Wada H, Kuwahara R, Urata J. Peripheral MR angiography: separation of arteries from veins with flow-spoiled gradient pulses in electrocardiography-triggered three-dimensional half-Fourier fast spin-echo imaging. *Radiology* 2003; 227:890-896.
3. Miyazaki M, Lee VS. Nonenhanced MR angiography. *Radiology* 2008; 248:20-43.