Contrast Enhanced MRA of the Carotids with sub-millimeter voxels: Initial experience at 3.0T with an eight channel Neurovascular Coil

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Background: At 1.5T, CEMRA is gaining widespread acceptance as a diagnostic tool in the extracranial carotid circulation (1). The increased available SNR at 3.0T holds promise for higher performance, in terms of speed, spatial resolution, or a combination of both (2). However, a suitable coil for carotid MRA at 3.0T has, until recently, not been available. We report what, to our knowledge, is the first experience with high resolution CEMRA using a dedicated neurovascular coil at 3.0T.

Purpose: To implement and evaluate a protocol for high-resolution CEMRA at 3.0 T using an eight channel neurovascular coil.

Materials and Methods: 8 healthy volunteers and 4 patients with suspected cerebrovascular disease (5M, 7F, 41-73 years old) were scanned with a fast 3D MRA sequence. Three of the four patients have angiographic correlation with the MRA findings. Imaging parameters were; TR/TE: 3/1.3 ms, FA 21º, FOV 400 x 350 mm, partition thickness 1.2 mm, matrix: 706 x460 , voxel size 0.9 x 0.6 x 1.2 mm³, BW 650 Hz/pixel, GRAPPA x2. All studies were performed on a 3 T MR system (Siemens Magnetom Trio), using an 8 channel neurovascular coil. Twenty five ml gadodiamide (Omniscan, Amersham Health Inc) was injected at a rate of 1.5 ml/s followed by 30 ml of saline at a rate of 1.5 ml/s. A coronal 3D imaging slab included the aortic arch, carotids and vertebro-basilar circulation in a 20 second breath-hold. Visualization of the arterial system from the aortic arch to the intracranial circulation was assessed independently by 2 neuroradiologists. A 1-5 scoring scale was used, based on the sharpness of specific vessel walls and overall image quality (non visible 1; visible but not adequate for diagnosis 2; adequate for diagnosis 3; good 4, excellent 5), and contaminating venous signal was scored on a scale of 0-3 (none 0, less than aorta 1, same as aorta 2, more than aorta 3). Vascular occlusive disease was recorded and scored based on a scale of 1-3 (vessel irregularity 1, mild stenosis (<50%) 2, significant stenosis (>50%) 3). 26 arterial segments were evaluated including; 1: aortic arch, 2: brachiocephalic trunk, 3,4: bilateral subclavians . 5,6: bilateral common carotids. 7,8: bilateral external carotids. 9,10: bilateral internal carotids.11,12:bilateral ACA. 13,14: bilateral MCA. 15: ACOM. 16,17: bilateral vertebrals.18: basilar. 19,20: bilateral PICA. 21,22: bilateral AICA. 23,24: bilateral SCA. 25,26: bilateral PCA.

Results: All studies were performed safely and without complication. All 26 segments in all subjects (100%) were visualized with a mean score= 3.64. Venous contamination was absent or minimal in all subjects and never interfered with diagnostic evaluation. Vascular pathology was found in 12 arterial segments, including 6 with mild stenosis and 6 with high grade stenosis. Also, one unsuspected internal carotid artery aneurysm was detected in a healthy volunteer. In the 3 patients with conventional angiography, the MRA findings were confirmed.

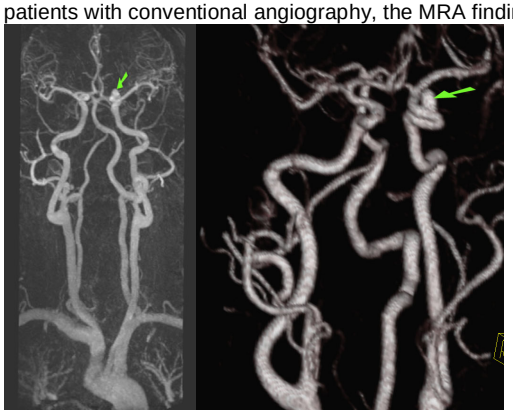

Figure-1. Coronal MIP and volume rendered images of CEMRA in an unsuspected volunteer shows left ICA aneurysm.

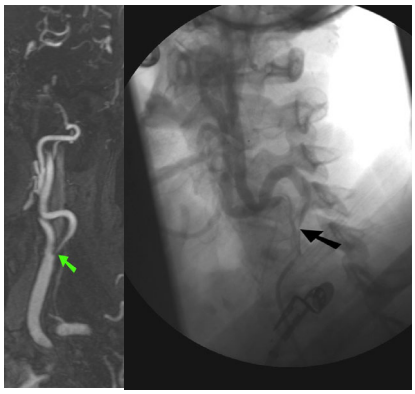

Figure-2. Coronal-oblique thin MIP, and conventional angiogram, shows left internal carotid artery high grade stenosis in patient with carotid atherosclerotic disease.

Conclusion: High resolution CEMRA at 3.0 T is extremely promising. Using a dedicated neurovascular coil, sub-millimeter voxels can be generated in a comfortable breath-hold. Signal gain at 3.0 T imaging is an important factor in further increasing spatial resolution for visualization of small vessel detail, and in enabling parallel acquisition to be used effectively. Further clinical studies are required to establish the accuracy of the technique in a broader clinical setting.

References:

1. Carr J et al. AJR, 2002.
2. Bernstein M et al. MRM, 2001.