Time Resolved Contrast Enhanced MRA of Head and Neck: Initial experience at 3.0T with an eight channel Neurovascular Coil

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Background: At 1.5T, SNR is a limiting factor for time-resolved, ultra-short TR MRA of the extracranial carotid circulation (1). The increased available SNR at 3.0T holds promise for higher performance, in terms of speed and spatial resolution (2). We report what, to our knowledge, is the first experience with time-resolved, 3D CEMRA using a dedicated neurovascular coil at 3.0T.

Purpose: To implement and evaluate a protocol for Time Resolved CEMRA of the carotids at 3.0 T, using an eight channel neurovascular coil and parallel acquisition.

Materials and Methods: 8 healthy volunteers and 4 clinical patients with suspected cerebrovascular disease (5M, 7F, 41-73 years old) were scanned with an ultra-fast 3D MRA sequence. Three of the four patients had angiographic correlation with the MRA findings. All studies were performed on a 3 T MR system (Siemens Magnetom Trio), using an 8 channel neurovascular coil. Imaging parameters were; (TR/TE: 2.2/1 ms, FA 20º, FOV 400 mm, slice thickness 3 mm, 24 partitions, matrix: 384 x310, voxel size 1.3 x1 x3 mm^3, BW 1090 Hz/pixel, GRAPPA x3). 4 ml gadodiamide (Omniscan, Amersham Health Inc.) were injected at a rate of 3 ml/s followed by 30 ml of saline at a rate of 3 ml/s. Coronal time-resolved MR angiography within 20-22 seconds breathhold was implemented, and 10 consecutive measurements each 2.1 seconds apart were acquired. Magnitude subtraction, in the image domain, of the first (unenhanced) data set from all subsequent data sets was performed online, as was on-axis MIP reconstruction.

For qualitative assessment, a pure arterial phase was selected from the time-resolved MRA data and coronal thin MIP (5 by1 mm) images were generated and reviewed throughout the volume. Depiction of the arterial vasculature from aortic arch up to the intracranial circulation was evaluated subjectively on a 1-5 scoring scale based on visibility and definition of vessel wall and overall image image quality (non visible 1; visible but not sufficient for diagnosis 2; sufficient for diagnosis 3; good 4; excellent 5). 19 arterial segments were scored including: 1: aortic arch, 2: brachiocephalic trunk, 3,4: bilateral subclavian A. 5,6: bilateral common carotid A. 7,8: bilateral external carotid A. 9,10: bilateral internal carotid A.11,12: bilateral ACA. 13,14: bilateral MCA. 15,16: bilateral vertebral A.17: basilar A. 18,19: bilateral PCA.

Results: All studies were performed safely and without complication. All 19 segments were visualized in all subjects (100%) with mean visibility score=3.87. The result showed 11 segmental pathologies including 6 segments with mild stenosis and 5 segments with high grade stenosis. An arteriovenous fistula fed by the external carotid (fig 1), and one internal carotid artery aneurysm were identified as incidental findings in our healthy volunteers. Complete occlusion of the proximal left internal carotid with retrograde filling distally was demonstrated in one patient (fig 2).

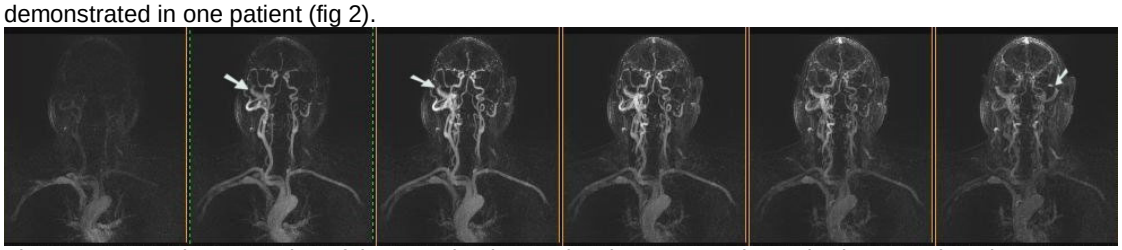

Figure-1. Dynamic MIP series of time resolved MRA (each 2.1 second apart), shows early enhancement of right transverse sinus, fed by external carotid artery due to an AVM (arrows). There is 8 seconds delay between the left and right transverse sinus enhancement.

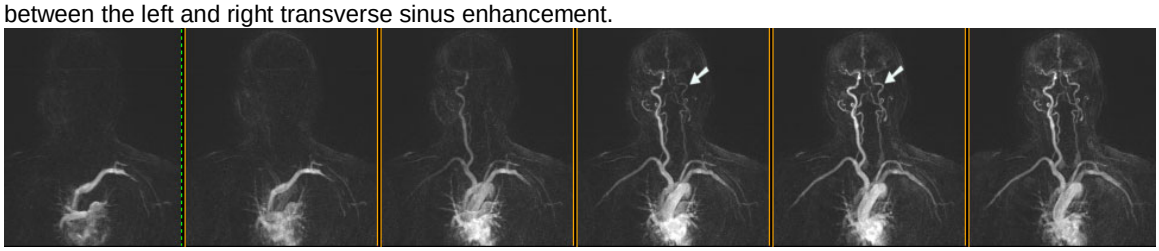

Figure-2. Dynamic MIP series of time resolved MRA shows occlusion of left internal carotid artery and then retrograde filling of distal part of the artery (arrows).

Conclusion: Time resolved CEMRA at 3.0 T is feasible and the initial results are extremely promising. The higher SNR gain at 3.0 T can be used effectively to improve performance and to support aggressive parallel acquisition protocols, as in the present study. Although further clinical studies are required to establish the range of applications of the technique, initial results support the argument that it should be applied routinely to detect dynamic physiologic changes which may not be evident in non-time-resolved MRA.

References:

1. Lenhart M et al. Investigate Radiology, 2002.
2. Bernstein M et al. MRM, 2001.