High Resolution Contrast Enhanced 3D SPGR MRA Using Parallel Imaging Techniques in Carotid Artery Stenosis: Comparison With Conventional 3D-TOF MRA

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INTRODUCTION: 3D TOF MRA is a well established high resolution non-invasive way to assess carotid artery stenosis. Although accurate [1], this method is prone to artifacts such as in plane saturation, and is especially challenging to perform successfully in the uncooperative patient due to long acquisition times. Contrast enhanced MRA techniques have become increasingly popular as there are less flow related artifacts and the time of acquisition is short, such that it can be performed within a breath-hold [2]. With the advent of parallel acquisition techniques and multi-channel neck coils, spatial resolution can be significantly increased without sacrificing arterial phase resolution and prolonging examination time. Parallel imaging has been shown to be useful for improving spatial resolution in imaging of the intracranial circulation [3] and reducing time of imaging of carotid plaques [4]. To date, no studies have investigated the use of parallel imaging in contrast enhanced MRA for the evaluation of carotid stenosis. The purpose of this study is to compare conventional 3D TOF-MRA and 3D CE-MRA with parallel imaging to determine if parallel imaging can be used to improve the spatial resolution of dynamic CE-MRA and achieve submillimeter, isotropic voxels and compare the image quality with that of conventional 3D TOF-MRA.

MATERIALS AND METHODS: Prospectively, four consecutive patients presenting for carotid MRA underwent 3D TOF and 3D CE MRA with parallel imaging (acceleration factor 3) using multiple channel head and neck coils. Images were performed on a 1.5 T magnet (Avanto; Siemens medical systems, Erlangen Germany). Conventional 3D TOF imaging was performed using the following parameters: TR/TE 25/7.15/FA 25°; FOV 210 mm, voxel 0.7 x 0.5 x 0.9mm, 288x384 matrix, and a time of acquisition of 6 minutes 21 seconds. 3D CE-MRA with parallel imaging was performed using a 3D SPGR (FLASH) sequence with the following parameters: TR/TE 4.3/1.5/FA 25°, FOV 400 mm, voxel 0.8 x 0.8 x 0.8 mm, 384x512 matrix, and a time of acquisition of 24 seconds following intravenous injection of gadolinium (0.1-0.2 mmol/kg) and a 20 cc saline bolus via power injector. Optimal arterial phase timing was obtained using a time resolved sequence (TREAT) with a 3 cc bolus of intravenous contrast. Quantitative assessment was performed by calculating signal-to-noise ratio (SNR) and contrast-to-noise ratios (CNR) in the distal common carotid artery for each method of imaging using standard methods. Qualitative assessment was performed by two neuroradiologists blinded to the imaging method. Assessment criteria included image quality, noise, degree of stenosis using the NASCET criteria, and degree of confidence in diagnosis based on a 4 point scale, with consensus reading as the standard of reference.

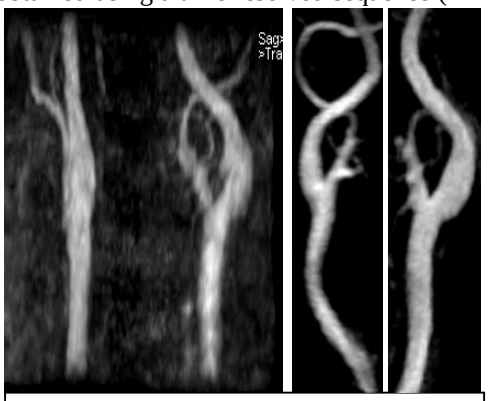

Fig 1. 3D MIP images of the same carotid bifurcations using conventional 3D-TOF (left) and CE-3D FLASH MRA with parallel imaging (right)

RESULTS: The spatial resolution of the CE-MRA with parallel imaging was increased to a achieve sub-millimeter isotropic voxel size comparable to that of the conventional 3D TOF sequence. SNR and CNR were higher for CE-MRA compared to 3D TOF as shown in Table 1. Qualitative parameters such as overall quality were better in the CE-MRA sequences but this was not statistically significant in our small group of patients. Image quality of the CE-MRA was rated the same or higher on all patients when compared with conventional non-contrast enhanced 3D-TOF imaging (Table 1, Fig 1).

TABLE 1	3D TOF vs. CE-MRA with Parallel Imaging		
	NC 3D-TOF	**3D CE- MRA**	**P-value**
SNR	106.6	139.4	$p \leq 0.75$
CNR	81.7	121.9	$p \leq 0.5$
Overall Quality	2.2	1.9	$p \leq 0.5$
*Note: Average Overall Quality on a scale of 1-4. (1=Excellent, 2=More than adequate for diagnosis, 3=Adequate for diagnosis 4=Nondiagnostic)			

CONCLUSION: Spatial resolution of CE-MRA can be improved with parallel imaging such that resolution is comparable to that of conventional 3D TOF imaging. Imaging the carotids with CE-MRA with parallel imaging can be performed faster and with less artifact that 3D TOF. This study demonstrated a trend toward improvement in signal to noise and overall image quality with CE-MRA performed with parallel imaging when compared to 3D TOF but further evaluation with a larger number of patients is needed.

REFERENCES:

1. Nederkoorn PJ et al. Stroke 2003, 34:1324
2. Chul-Ho S et al. Magn Reson Imaging Clin N Am 2003, 11:599-614
3. Gaa J et al. Acta Radiol 2004, 45: 327-32
4. Itskovich VV et al. J Magn Reson Imaging 2004, 19: 459-67