Three-Dimensional High Spatial Resolution Magnetic Resonance Angiography of the Supra-aortic Arteries at 3.0 Tesla: A Contrast Dose Reduction Study

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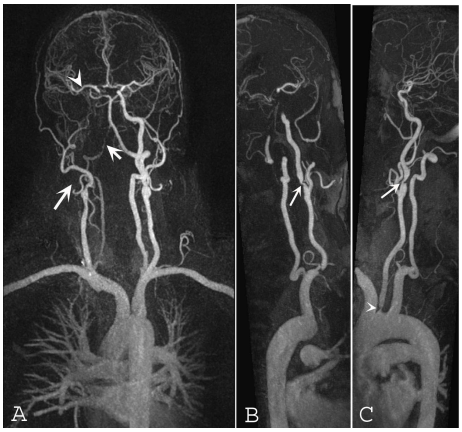
Background and Purpose:
In clinical practice, contrast-enhanced MR angiography (CE-MRA) of the supra-aortic arteries is performed using 0.1-0.2 mmol/kg of gadolinium (1,2). Recent reports link gadolinium-based contrast agents with nephrogenic systemic fibrosis (NSF) in renal failure patients. Current evidence suggests that risk of NSF is related to gadolinium dose (3), so dose minimization is desirable.
We aimed to prospectively compare the diagnostic image quality resulting from three dose regimens for high-spatial resolution 3D contrast-enhanced MR angiography of supra-aortic arteries at 3.0T.

Methods and Materials:
100 consecutive patients were randomized into three groups (A, n=40; B, n=40; C, n=20) and underwent 3D high-spatial resolution CE-MRA of supra-aortic arteries at 3.0T (TIM Trio, Siemens) using an identical acquisition protocol. A fast spoiled gradient-echo (GRE) sequence with parallel acquisition (GRAPPA x 4) generated 120 partitions (voxel dimensions 0.7 x 0.7 x 0.8 mm^3) in 21 seconds. The contrast injection protocols were 1) 25 mL (0.15 ± 0.01 mmol/kg) , 2) 15 mL (0.1 ± 0.01 mmol/kg) , 3) 7.5 mL (0.05 ± 0.004 mmol/kg) of Magnevist (Berlex Laboratories, Wayne, NJ) at a rate of 2 ml /sec. Supra-aortic arterial territory was divided into 34 segments and assessed for delineation of arterial segments, venous contamination, and severity of stenosis (4-point scales) by two readers. Signal-to-noise ratio (SNR) and contrast-to-noise ratio (CNR) was also evaluated. Statistical analysis was performed using Kruskal-Wallis, Wilcoxon, ANOVA, and kappa test.

Results:
Reader 1 and 2 identified arterial delineation as sufficient for diagnosis or excellent in group A for 1311 (96.4 %) and 1313 (96.6%) segments, in group B for1321 (97.6 %) and 1319 (97.4%) segments, and in group C for 658 (97.5 %) and 662 (98.1%) segments, respectively (good inter-observer agreement). Reader 1(2) identified venous contamination in 24 (21), 15 (11), and 11(9) segments, and arterial stenosis in 52(48), 27 (25), and 31(29) segments in groups A, B, and C, respectively (excellent inter-observer agreement). No significant difference existed between arterial delineation and venous contamination scores for each reader between the three groups (P>0.05). SNR and CNR values were significantly lower in group C compared to groups A and B.

Conclusion:
High spatial resolution CE-MRA of the supra-aortic arteries at 3.0T can be performed with a gadolinium dose at least as low as 0.05 mmol/kg, without compromising image quality compared to 0.1 mmol/kg and 0.15 mmol/kg. Although further work is warranted, these initial results suggest that adoption of low-dose protocols in clinical practice may diminish sensitivity to contrast dose-dependent complications and result in cost savings.

References:
1. Unterweger M, et al. Eur Radiol 2005;15(9):1797-805
2. Jourdan C, e al. J Magn Reson Imaging 2007;25:557-563
3. Sadowski EA, et al. Radiology 2007; 243(1):148-57



Low dose: Coronal full thickness MIP (A), and oblique sagittal thin MIP (10 mm) images (B and C) on low-dose CE-MRA in a 67 year old male show occlusion of the right internal carotid artery (ICA) at its origin (A, arrow), tight stenosis of the proximal left ICA (B and C, arrow), and tight stenosis of the origin of the left common carotid artery (C, arrowhead). Right middle cerebral artery is reconstitutedfrom the circle of Willis (A, arrowhead). Note is made of severely diseased right vertebral artery (A, small arrow