Low Dose, Supraortic 3D Time-Resolved MR Angiography at 3T: Comparison with High Spatial Resolution 3D Contrast-Enhanced MR Angiography

Y-J. Lee[1], J-Y. Byun[1], S-L. Jung[1], W-J. Yoo[1], Y-J. Kim[1], K-J. Ahn[1], and B-S. KIM[1]
[1]Department of Radiology, The Catholic University of Korea, Seoul, Seoul, Korea, Republic of

PURPOSE : To evaluate the effectiveness of low-dose, contrast-enhanced, time-resolved, threedimensional (3D) magnetic resonance (MR) angiography (TR-CEMRA) at 3T in the assessment of supraaortic vessel, and to intra-individually compare it with high-resolution contrast enhanced MRA (HR-CEMRA)

METHODS : Clinical protocol of supraortic MR angiography in authors' institute consists of T2 weighted image of the brain, Time-of-Flight MR angiography of circle of Willis and carotid bifurcation, respectively, supraaortic HR CE MRA, and TR-MRA. Since March to April 2009, supraaortic MR angiography was performed for 90 patients for the evaluation of supraaortic vascular disease, and 45 consecutive patients of them underwent TR-CEMRA and HR CEMRA at 3T. Clinical indication for supraaortic MRA of these patients included ischemic attack or stroke (n=35), known atherosclerotic disease on follow-up (n=9), and Moyamoya disease (n=1). Gadolinium-based contrast medium was administered at a constant dose of 1ml for TR-CEMRA, and 0.1mmol/kg for HR-CEMRA. For HR-CEMRA, 3D gradient echo sequence was performed with centric ordering of k-space acquisition at following parameters; acceleration factor (GRAPPA) 2, TR 3.2 msec, TE 1.2 msec, flip angle 25°, voxel size $1.0 \times 0.8 \times 0.6$ mm^3 (after interpolation). For TR-CEMRA, TWIST sequence was performed at following parameters; acceleration factor (GRAPPA) 3, TR 2.6 msec, TE 1.0 msec, flip angle 19°, 29 phases at 2.3 sec/frame, voxel size $1.3 \times 0.9 \times 1.6$ mm^3 (after interpolation). Two readers retrospectively evaluated image quality using a four point scale (from 0=excellent to 3=non-diagnostic). Evaluation of stenosis done from 15 predetermined arterial segment, and graded into 3 categories (less than 50% stenosis, 50-99% stenosis, occlusion or nonvisualization) for two datasets.

RESULTS : The overall image quality for low dose TR-CEMRA was in the diagnostic range (median 0, range 0-3). In scoring of image quality, the kappa coefficient revealed good inter-observer agreement for HR-CEMRA (k = 0.66) and TR-CEMRA (k = 0.62). For the evaluation of arterial stenosis, TR-CEMRA correlated with HRCE MRA in both readers (r = 0.679 for reader 1 and r = 0.628 for reader 2, respectively, p<0.001). Of the 675 supraaortic arterial segments evaluated for stenosis or occlusion, TR-CEMRA agreed with HR-CEMRA in 618 segments (91.6%) by reader 1 and 605 segments (89.6%) by reader 2. On TR-CEMRA, stenosis was overestimated in 39 segments (5.8%) and underestimated in 18 segments (2.7%) by reader 1, and in 40 segments (5.9%) and 30 segments (4.4%) by reader 2, respectively. In grading of stenosis, the kappa coefficient revealed moderate interobserver agreement (k = 0.596) for TR-CEMRA and good (k = 0.688) for HR-CEMRA

CONCLUSION : TR-MRA can be achieved by administration of small contrast dose (1cc, 0.1mmol), and yields rapid and important functional and anatomical information in the evaluation of supraaortic arteries. Due to limited spatial resolution, TR-MRA is has tendency to overestimated the stenosis or occlusion of smaller intracranial arteries.
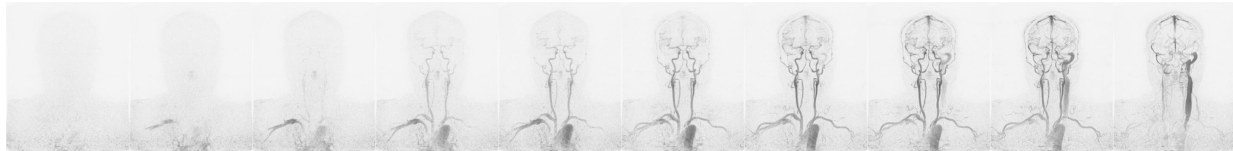

Figure 1. Selected MIP display images of TR-CEMRA, acquired with injection of 1cc of Gadobutrol followed by 20cc of saline.

HR CEMRA (R1)

		1	2	3	Total
T R C E M R A	1	566	15	2	583
	2	24	37	1	62
	3	8	7	15	30
	Total	598	59	18	675

HR CEMRA (R2)

		1	2	3	Total
T R C E M R A	1	558	27	2	587
	2	28	35	1	64
	3	2	10	12	24
	Total	588	72	15	675

Table 1. Comparision of stenosis grade between TR-CEMRA and HR-CEMRA in reader 1 (R1) and reader 2 (R2).

Figure 2. Comparision of image quality between TR-CEMRA and HR-CEMRA in two readers.

References:
1. Korosec FR et al., Time-resolved contrast-enhanced 3D MRA. Magn Reson Med 1996;36:345-351
2. Lim RP et al., 3D Time-resolved MRA of the carotid arteries with time-resolved imaging with stochastic trajectories: comparison with 3D contrast-enhanced bolus-chase MRA and 3D time-of-flight MRA. AJNR 2008;29:326-336
3. Krishnam MS et al., Low-dose, time-resolved, contrast-enhanced 3D MRA in cardiac and vascular diseases: correlation to high spatial resolution 3D CE MRA. Clin Radiol 2008;63:744-755