Intra-Individual Cross-Over Blinded Dose Comparison Of Single Versus Double Dose Of Gd-DTPA In Contrast-Enhanced Magnetic Resonance Angiography Of The Carotid Arteries

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Purpose: Interest in noninvasive carotid imaging has increased in the recent years. Three-dimensional contrast enhanced Magnetic Resonance Angiography (CE MRA) of carotid arteries is unique in the sense that the arterial venous recirculation time is very short in the brain and the blood-brain barrier prevents extraction of the gadolinium chelate. For these reasons, it is difficult to avoid jugular venous enhancement. Unfortunately, jugular venous signal can obscure visualization of the adjacent carotid artery. The problem can be resolved by acquiring an absolutely precisely timed, or a time-resolved, sequence, so that images from the arterial phase are acquired before venous enhancement occurs. Clinical practice today usually uses a double dose (0.2 mmol/kg bw) of contrast agent for CE MRAs. However, there are some experimental indications that a single dose would be sufficient. Therefore, the aim of this study was to perform a intra-individual comparison of single-dose Gd-DTPA-enhanced MRA and double-dose Gd-DTPA-enhanced MRA in terms of quality of visualization of carotid vessel segments.

Subject and Methods: This study was planed as an open label single-center trial aimed at the intra-individual comparison of double-dose and single-dose CE-MRA in the carotid arterial territory. We included 11 volunteers (Mean age 32 ± 15 years; mean weight 71 ± 16 kg). Each volunteer was scanned twice, once with a single and once with a double dose of Gd-DTPA (Magnevist, Berlex, Montville, NJ). The order of the investigations was randomized, and both volunteers as well as observers were blinded in regard of the contrast agent dosage. Both MRAs were performed on the same 1.5 T clinical MR scanner (TwinSpeed, GE, Milwaukee, WI) with the use of neurovascular phased array coil (USA Instruments, Aurora, OH). Images were acquired with a 3D FSPGR sequence (TR: 5.6ms; TE: 1.4ms; FA: 40º; 60 slices; slice thickness: 1.8mm; matrix; 256x 256; FoV 26cm x 26cm; NEX: 1). SmartPrep was used for contrast agent bolus timing. Before the contrast agent injection, a mask was acquired that was subtracted from the contrast enhanced images in order to suppress the stationary background. Contrast agent dosage and injection speed were determined according to table 1.

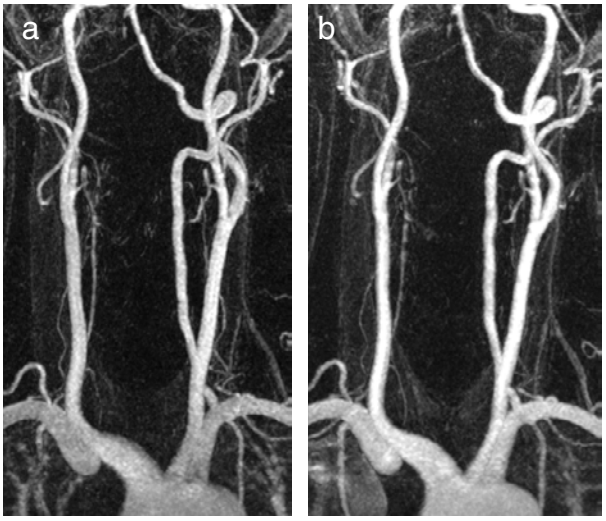

Figure 1: Carotid MRA of a 66 year old male volunteer with a hypo-plastic right vertebral artery. Single dose (a) provides a lower signal to noise ratio than double dose (b). However, vessel conspicuity and diagnostic confidence do not differ between the two scans.

Figure 2: Carotid MRA of a 20 year old female volunteer. The single dose image (a) does not show any major artifacts, while the double dose images (b) demonstrates some minor venous opacification of the left subclavian vein. In addition, the pulmonary vasculature is opacified in the double dose image.

Results: From the total 308 segments imaged observer 1 found 298 segments and observer 2 204 segments evaluable. The unevaluable segments were at least partially out of the field of view. In all of the evaluable segments, the signal intensity was higher for the double dose group. This difference was statistically significant. In the remaining segments, both observers rated the median image quality for both dosage groups as 4 (excellent). **Figure 1** demonstrates the results from both acquisitions in a 66 year old, male volunteer. The results showed a significant correlation between the both observers in the number of artifacts for both dosage groups (r=0.94 (single dose); r=0.91 (double dose); $p < 0.05$ (both doses)) and no statistically significant difference in the number or severity of artifacts for both observers (p=0083). The two types of artifacts observed during our study were venous opacification and insufficient contrast enhancement. Also if evaluated separately, none of these artifact groups showed statistically significant differences between the dosage groups.

Conclusion: In this study, we investigated the influence of the contrast agent dosage on the signal intensity characteristics and the diagnostic capabilities of contrast enhanced Magnetic Resonance Angiography of the carotid arties. Our results demonstrate that a double dose of contrast agent increases the signal to noise ratio in the images, but it does not improve image quality. Moreover, the subjective analysis of artifacts did not show any significant difference in number or severity of artifacts between the two contrast agent groups. In conclusion, this suggests that a single dose of Gd-DPTA for a MRA of the neck provides sufficient image quality, and that a double dose is not necessary.

Table 1: Single dosage and injection rate determination

Patient weight [kg]	Gd-DTPA dose [mL]	Rate of Administration [mL/sec]	Infusion Time [sec]
< 60	12.5	1.25	10
61-85	15	1.5	10
> 85	20	2.0	10

References: 1. Ho, V. B., Foo, T. K., Czum, J. M., Marcos, H., Choyke, P. L., and Knopp, M. V. Contrast-enhanced magnetic resonance angiography: technical considerations for optimized clinical implementation Top.Magn Reson.Imaging 01: 283-99.

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