Detection of Small Arteries Feeding the Spinal Cord: 0.5M Gd-DTPA versus 1.0M Gadobutrol CE-MRA

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Introduction

Visualization of spinal cord arteries is mostly hampered by their ultra-small diameters, which are approximately 1 mm. Improving contrast-to-noise (CNR) to better delineate such small vessels is therefore desirable. Recently a 1.0M Gd based contrast agent (Gadobutrol) has become available for clinical MRI. First contrast-enhanced (CE) MRA experience with this new agent was promising and showed a mean increase of 70 % in contrast-to-noise-ratio (CNR) of aortoiliac arteries (1). The purpose of the current study was to test whether the 1.0M Gd chelate showed improved image quality for visualization of the small spinal cord feeding arteries compared to the commonly used 0.5M Gd chelate.

Materials and methods

Eleven consecutive patients scheduled for elective TAAA repair were included. All scans were performed on a 1.5T clinical MRI system (ACS/NT R9.1,Philips Medical Systems) using a quadrature phased-array spine coil. To image the entire aorta, the FOV covered a region from the third thoracic vertebra (T3) to the first sacral vertebra (S1). The scanning protocol consisted of (i) a T2 weighted scan for anatomical reference, (ii) bolus timing, and (iii) multiphase CE-MRA consisting of two scans which lasted no longer than 40s each. CE-MRA acquisition parameters were: TR/TE/FA 5.9ms/1.9ms/30°; voxel size was 1.0x1.0x1.2 mm. All patients underwent CE-MRA twice: once with 45 mL 0.5M Gd-DTPA (Magnevist®, Schering, Berlin) administered at 3 mL/s and once with 22.5 mL 1.0M gadobutrol agent (Gadovist ®, Schering, Berlin) administered at 1.5 mL/s. CE-MRA images were analyzed by using multi-planar reformations (MPR) and maximum intensity projections (MIP). Vascular structures were considered to be arteries only if they were brightest in the first dynamic phase. Endpoints were differences in CNR and subjective image quality. CNR was calculated by determining signal values in regions of interest from in the aorta, segmental arteries (SA), Adamkiewicz' artery (AKA), anterior spinal artery (ASA) and the surrounding tissue, and the noise level which was obtained from the erector spinae muscle. In addition, all images were rated by two independent observers, who indicated their preference for the either the 0.5M or the 1.0M dataset in a blinded head-to-head comparison using the following criteria: vessel delineation, contrast between vessel and surrounding tissue, and heterogeneity of surrounding tissue.

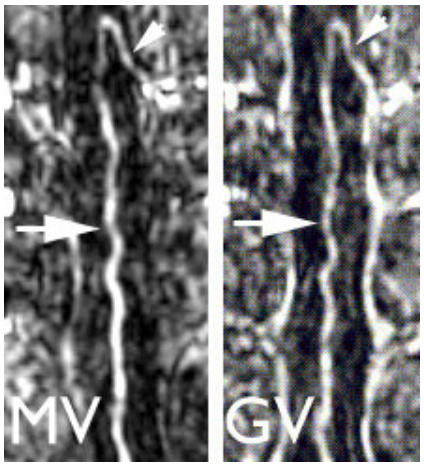

Fig. 1 MIP of AKA (arrowheads) and ASA (arrows) in Gd-DTPA (MV) and gadobutrol (GV) CE-MRA

Results

All acquisitions with both contrast agents were successfully performed without side-effects. In all patients the aorta, ASA, AKA and segmental arteries were successfully visualized (**figure 1**). Findings with regards to CNR are listed in the **table**. The 1.0M Gd chelate yielded slightly worse image quality (*P* = N.S.). In 7 out of 11 cases the observers preferred (identical) 0.5M Gd chelate images over 1.0M images. Theoretical signal amplification was calculated (2) for the applied gradient echo sequence as a function of the plasma concentration of contrast agent and is depicted in **figure 2.**

Artery	1.0 M Gd chelate	0.5 M Gd chelate	Difference
CNR Aorta	45.1 ± 8.3	49.9 ± 11.0	- 4.8 ± 14.4 (p=0.3)
CNR ASA	7.0 ± 2.9	7.7 ± 3.0	- 0.7 ± 2.9 (p=0.4)
CNR AKA	6.0 ± 3.5	8.0 ± 5.3	- 2.0 ± 3.8 (p=0.11)
CNR SA (AKA)	25.3 ± 9.6	33.6 ± 17.5	- 8.3 ± 16.3 (p=0.12)

Discussion and conclusion

Both 0.5M and 1.0M Gd chelates are useful in detecting the small arteries feeding the spinal cord. There were no significant differences in image quality between both agents. The improvement of image quality by using the 1.0M Gd chelate compared to the 0.5M Gd chelate in a previous study (1) of the pelvic arteries was not corroborated in the present study. Differences are the targeted vascular anatomy and the used dose of contrast agent. At lower arterial concentrations the stronger T1 relaxivity (r_1) effect of gadobutrol may be advantageous for signal enhancement compared to Gd-DTPA (**figure 2**). At higher concentrations and at ultra-high spatial resolution (with resultant increase in TE) however, the accompanying stronger T2* relaxivity (r_2*) effect of gadobutrol may lead to loss of CNR, yielding comparable results for both contrast agents. Maximal achievable signal enhancement (max. 20) is similar for both agents for the used MR protocol.

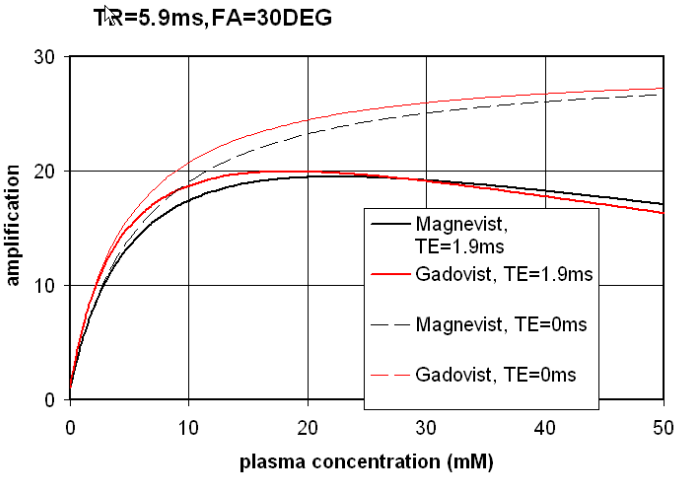

Fig. 2. Signal enhancement for Gd-DTPA and gadobutrol versus plasma concentration. A triple (single) dose corresponds to 18 mM (6 mM) plasma concentration.

References

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[2] Prince, M. (ed.). 3D contrast MR angiography. Springer Verlag Berlin 2002.