Influence of the injection rate on vessel signal and image quality in first pass imaging with gadofosveset (Vasovist®)

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Background

Due to the interaction with serum albumin the intravascular contrast agent gadofosveset is characterized by a 4-5 times higher relaxivity than standard extracellular Gd-chelates at 1.5T (1). However, only 75%-85% of gadofosveset bind to albumin. The non–bound molecules reveal a similar relaxivity as standard extracellular Gd-chelates. This implies that a maximal enhancing effect can only be achieved when the interaction between the injected gadofosveset and serum albumin takes place immediately. There are ongoing discussions at this time whether gadofosveset should be injected at a slow injection rate to allow for protein binding or whether a faster injection rate should be chose to achieve a compact bolus. Therefore, the aim of this study was to investigate the influence of different injection rates on the signal of gadofosveset-enhanced first pass MRA.

Material and Methods

In this IRB-approved prospective study 21 healthy volunteers (19-46 years, all male) were included. The volunteers were assigned to one of three age- and body-weight-matched groups. All volunteers measurements were performed at 1.5T (Siemens MAGNETOM Avanto) using a time-resolved echo-shared angiographic technique (TREAT) sequence (TR/TE – 1.96/0.68, flip angle 20°, BW 1030 Hz/px, voxel size 2x2x5mm³, parallel imaging GRAPPA 2 temporal resolution 1.7s/3D-volume). A large FOV covering the thorax and the abdomen was chosen so visualize differences in flow dynamics. The TREAT sequence was started 5s after automated contrast injection using an automated power injector. To investigate the influence of the injection rate on the enhancement three different injection rates were applied. Group 1 (n=7, mean age 29.9±7.6, mean weight 80.6kg) was injected gadofosveset (Vasovist®, BayerHealthCare) at an injection rate of 1ml/s, group 2 (n=7, mean age 30.4±4.5, mean weight 78.9kg) at an injection rate of 2ml/s and group 3 (n=7, mean age 32.0±6.7, mean weight 78.9kg) at an injection rate of 4ml/s. All volunteers were given a standard dose of 0.03mmol/kg B.W. gadofosveset (mean dose group 1 – 9.7ml, group 2 – 9.5ml and group 3 – 9.5ml).

Using ROIs, the maximal signal enhancement and hereof derived the contrast-to-noise ration (CNR) was measured in the pulmonary trunc (PT), the aortic arch (AoAr), the abdominal aorta above (SupAo) and below (InfAo) the origin of the renal arteries as well in both kidneys (Kid) and in the lung parenchyma (Lung) and the contrast to noise ratio was calculated. A subtraction method was used to measure the noise correctly despite the application of parallel imaging. The number of purely arterial abdominal frames (no enhancement from renal vein, IVC or portal vein system) was determined as well as the time difference between peak arterial enhancement at different levels and the difference between peak aortic and renal enhancement. A visual assessment of the temporal MIP-images was performed with all MRA data sets with regards to image quality using a 4 point ordinal scale (4-very good, 3-good, 2-moderate, 1-non-diagnostic). T-tests were used for statistical analysis.

Results

20/21 MRA exams yielded at least good image quality with a median score of 4 in all three groups. In one volunteer the sequence was started too late. In the visual assessment no subjective difference in image quality could be perceived (Figure 1). No significant differences could be found for the CNRs either even though there was a trend to slightly lower CNRs with the slower injection rates (Table 1). The time between maximal enhancement of the TP and the AoAr was higher with the slow injection rate of 1ml/s, while there were no differences in the time between maximal enhancement of the AoAr and the SupAo (0.4-1.2 frames) or InfAo (0.6-1.7 frames) with all three injection rates. With the slow injection protocol of 1ml/s a longer purely arterial phase of 6.2 frames was achieved compared to 4.5 frames with higher injection rates (p = 0.045). The time between maximal aortic signal intensity and maximal renal enhancement was equal (3.0-3.3 frames) for all injection protocols.

Conclusion.

With a slower injection rate a significantly longer purely arterial imaging window can be achieved. With regard to the maximal signal intensity neither a high injection rate with a compact contrast agent bolus nor a slower injection rate with a potentially higher rate of albumin-bound gadofosveset achieve superior results.

References

Rohrer, M., H. Bauer, et al. (2005). Invest Radiol 40(11): 715-24.

Flow	PT	AoAr	SupAo	InfAo	Kid
1ml/s	365±134	412±72	310±26	253±38	180±21
2ml/s	486±151	494±136	328±23	234±91	166±31
4ml/s	424±162	509±189	344±57	285±57	196±57

Table 1 – Median CNR achieved over the field of view at the above defined sites.

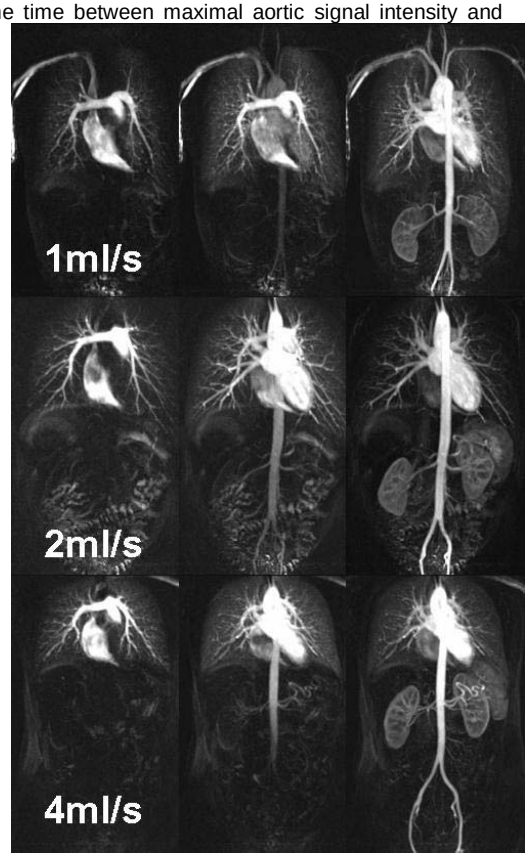

Figure 1
Exemplary frames of three volunteers with injection rates ranging from 1ml/s to 4ml/s. With all injection rates a gradual filling of the aorta and strong vascular enhancement can be appreciated. Visually, no significant differences can be appreciated.