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Accuracy of blood suppression in vessel wall MRI of intracranial aneurysms: a phantom study.

E. L. Leemans[1,2], *B. M. W. Cornelissen*[1,2,3], *R. J. I. Bot*[1,4], *G. A. te Riet o/g Scholten*[3], *C. B. L. Majoie*[2]
B. F. Coolen[1], *H. A. Marquering*[1,2], *C. H. Slump*[3]
[1]AMC, Department of Biomedical Engineering and Physics, Amsterdam, Netherlands
[2]AMC, Department of Radiology and Nuclear medicine, Amsterdam, Netherlands
[3]University of Twente, MIRA institute, Enschede, Netherlands
[4]VU university, Biomedical Sciences, Amsterdam, Netherlands

Introduction: Vessel wall MRI is often used to evaluate intracranial aneurysm wall thickness. After contrast administration wall enhancement can be assessed. Both MR measures of the wall likely relate to aneurysm stability. However, to reliably assess the vessel wall, adequate blood suppression is important. Multiple black-blood vessel wall MR sequences have been developed for this goal. Most methods rely on flow sensitive signal attenuation but intra-aneurysmal flow is often chaotic with slow flows near the aneurysm wall. Therefore, the blood might be more difficult to suppress. The goal of this study is to assess the performance of vessel wall MR sequences in a controlled phantom setting with different aneurysm geometries and contrast agent concentrations.

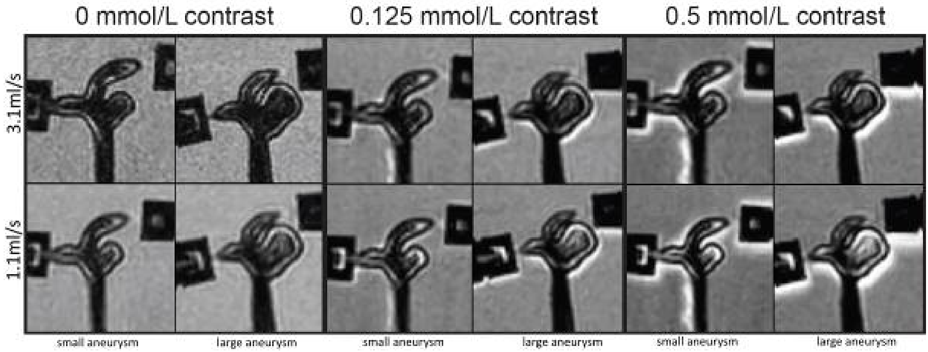
Methods: Two 3D printed vascular models were created based on 3T TOF-MRA data of an aneurysm with a diameter of 7.5mm. For the second model, the maximum aneurysm diameter was reduced to 3.5mm. The phantom was connected to a pulsatile flow pump. Imaging was performed at 3.0T. A 3D Vista vessel wall MR sequence was performed at three different contrast concentrations (0, 0.125 and 0.5mmol/l) and two flow settings (1.1ml/s and 3.1ml/s). Finally, a computational fluid dynamics (CFD) analysis was performed to evaluate flow characteristics in the aneurysm.

Results: Complete flow suppression was obtained for the parent artery. However, in both aneurysms at all scan conditions high signal intensity was observed (Figure 1). This signal increased with higher contrast agent concentrations. These intensities were predominantly near the aneurysm wall and in the centre of the aneurysm, corresponding with areas of low velocity on CFD. The presented set-up displayed leakage of contrast agent near the connectors, which only influenced the agar signal.

Conclusion: Our study shows that results of vessel wall imaging should be interpreted with care as a suboptimal blood suppression could lead towards artificial high intensities, which could be interpreted as an increased wall thickness or wall enhancement. As a result, aneurysms might be erroneously categorised as unstable. Further research should evaluate whether other MR sequences (e.g. DANTE, 3D TSE) have fewer slow flow artefacts.

Figure 1: MR images at a flow flow of 3.1ml/s (top row) and 1.1ml/s (bottom row) for all contrast concentrations. The small aneurysms is depicted at column 1,3 and 5 the large aneurysm at 2,4 and 6.

Figure 1:


0 mmol/L contrast
0.125 mmol/L contrast
0.5 mmol/L contrast
3.1ml/s
1.1ml/s
small aneurysm
large aneurysm
small aneurysm
large aneurysm
small aneurysm
large aneurysm