An MRI Examination for Evaluation of Aortic Dissection Using a Blood Pool Agent

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Introduction: Aortic dissection follows a partial tear in the lining of the aorta and results in two lumens. Thrombus formation in the false lumen is associated with improved survival [1]. Contrast-enhanced computed tomography (CT) (first pass of an iodine-based contrast agent) is currently the imaging modality of choice. Areas of the false lumen without contrast enhancement are assumed to be thrombus but this may be inaccurate due to reduced and altered flow. Magnetic resonance imaging (MRI) and Gadofosveset clinical blood pool agent are able to acquire high-resolution images to depict anatomy, directly image thrombus, calculate the blood pool volume and quantitatively analyse flow [2]. The aims of this study were to i) investigate the use of direct thrombus MRI, 3D MRA using Gadofosveset blood pool agent, and quantitative flow analysis, to determine false lumen thrombus volume in patients with Type B aortic dissection, and ii) compare the volumes to those obtained by clinical CT.

Methods: Ten patients with Type B aortic dissection and false lumen thrombosis were identified. Each underwent MRI examination at 3.0T (Achieva Philips Healthcare) with a 6-element cardiac coil. After initial survey and reference scan, direct thrombus imaging was performed with an inversion recovery (IR) 3D TFE sequence using ECG-triggering and respiratory-navigation (FOV: 300x255x60mm^3 with 2x2x2.5mm^3 resolution, TFE-factor = 36, TR/TE = 3.2/1ms). The inversion time was set to null the blood signal (TI = 490ms). Afterwards the blood-pool agent (Gadofosveset) (dose 0.12ml/kg at 4ml/s) was injected and first-pass imaging performed by 3D CE MRA under breathhold, without cardiac gating (FOV = 420x280x135mm^3, resolution = 1.8mm^3, FA = 35º, TR/TE = 6.0/1.8 ms). The start of the MRA was determined by a dynamic 2D MRI bolus track sequence. Two-dimensional flow scans were performed at 4 aortic levels (FOV = 2x2x10mm^3, FA = 10º, TR/TE = 5.0/2.7 ms, 25 cardiac-phases, VENC = 200cm/s). For visualization of the blood-pool a respiratory-navigated ECG-triggered IR-3D SSFP sequence was used (FOV = 400x253x156mm^3, resolution = 1.5mm^3, FA = 20º, TI = 350ms, TR/TE = 4.0/1.3ms, TFE-factor = 22). The scan was preformed 10 min after injection to ensure good distribution of blood pool agent in the false lumen.

The volume of false lumen thrombus was extracted from the different datasets (first pass CT, first pass MRA and blood pool MRI) by an expert using manual segmentation (ViewForum, Philips Healthcare). Areas of low signal on blood pool images were correlated with direct thrombus images. Quantitative analysis (ViewForum, Philips Healthcare) derived volumetric and directional flow.

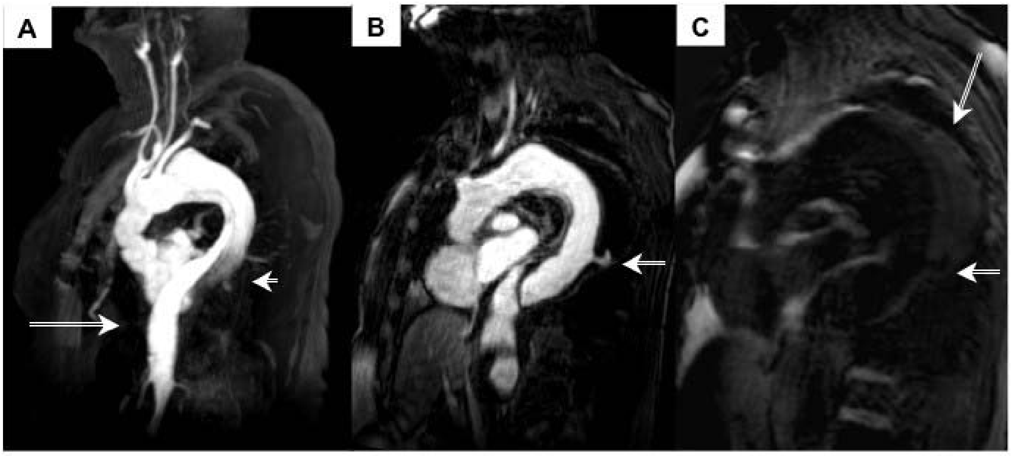


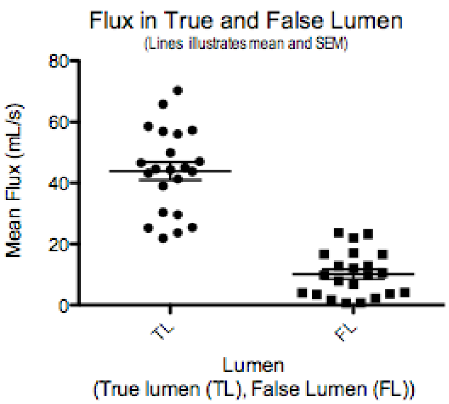
Figure 1.
A: First pass CE MRA (MIP) with Gadofosveset, demonstrating good true lumen perfusion (long arrow) and poor false lumen perfusion (short arrow) B: 3D Inversion Recovery SSFP blood pool imaging with visible distal entry tear (arrow). C: Direct thrombus (IR 3D-TFE sequence) imaging highlighting false lumen thrombus (long arrow) and distal entry tear (short arrow)

Results: Analysis was feasible in all ten patients. Evaluation of the true and false lumens showed altered and regurgitant flow. The mean stroke volume (mL) was 42.2 (17.48-55.6) in the true lumen and 10.41 (1.37-20.03) in the false lumen. The mean flux was significantly greater in the true lumen compared to the false lumen (43.92±2.920 vs 10.13±1.57(p<0.0001)) (Graph 1.).

Figure 1 illustrates poor enhancement of the false lumen on first pass CE-MRA (A) and positive correlation of areas with no filling on blood pool imaging with areas of positive enhancement on direct thrombus imaging (B&C).

Figure 2 shows false lumen thrombosis on CT (A). MRI (B&C) was able to demonstrate low false lumen flow and patency of both lumens on blood pool imaging.

Graph 1.



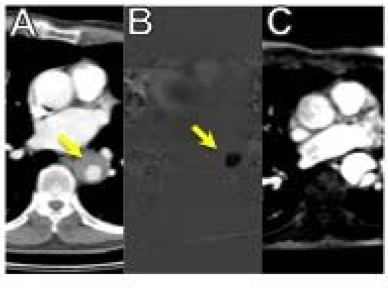


Figure 2.
A: First pass contrast-enhanced CT (iodine-based contrast) suggesting false lumen thrombosis (arrow); B: sQFlow analysis at the same location (VENC 200cm/s FH) illustrating very low flow in false lumen (arrow); C: Blood pool image (Gadofosveset) at 10 minutes demonstrating patency of the both the true and false lumens.

The volume of thrombus derived from first pass 3D CE MRA and CT were significantly greater than those obtained with blood pool imaging. The mean difference between first pass 3D CE MRA and blood pool imaging was 114.4 cm^3 ((95%CI 60.04-168.7), p=0.001), and between CT and blood pool imaging was 69.97 cm^3 ((95%CI 14.33-125.60), p=0.019). Thrombus location and morphology was confirmed by direct thrombus MRI in all patients.

Conclusion: Blood pool imaging together with direct thrombus MRI allows assessment of aortic anatomy and more accurate quantification of false lumen thrombosis compared with CT. Current clinical trials using false lumen thrombosis as a primary endpoint should consider multi-parametric MRI as the preferred diagnostic tool.

References: **[1]** Bernard Y et al. Am J Cardiol. 2001;87(12):1378-82 **[2]** Kelly J et al. Thromb Haemostat. 2003;89:773-82