Molecular magnetic resonance imaging of pulmonary emboli with Gadofluorine

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PURPOSE

The aim of this study was to investigate the potential of a newly developed contrast agent (Gadofluorine, Schering AG, Berlin, Germany) for molecular targeted magnetic resonance imaging (MRI) of pulmonary emboli.

MATERIALS AND METHODS

Fresh clots from human blood were engineered ex vivo and delivered in the lungs of 6 swine. All studies were performed on a 1.5 Tesla whole-body MR system. For MR-imaging, firstly a previously described breath-hold magnetic resonance angiography (MRA) (TR 5.5 ms,TE 1.5 ms, FA 40°, 512 x 205 matrix, 0.9 x 1.7 x 1.7 mm voxel size) and a free-breathing inversion recovery sequence adjusted for black blood properties (IR) (TR 4.6 ms, TE 1.4 ms, 256 x 256 matrix, reconstructed to 0.6 x 0.6 mm spatial resolution) were performed without contrast media (1,2). Subsequently, a breath-hold magnetic resonance angiography (MRA) and a free-breathing inversion recovery sequence (IR) were performed without contrast media. After intravenous injection of 0.05 mmol/kg Gadofluorine the same sequences were repeated shortly after injection and after 30, 60 and 90 minutes. Due to the long half-life of Gadofluorine the same sequences were performed 24 hours after contrast media injection. MR images were analyzed by two investigators and signal-to-noise- as well as contrast-to-noise ratios between the thrombus and the surrounding tissue (blood pool and lung parenchyma) was assessed. Localization of thrombi was compared with 16-row multislice computed tomography. Finally, the animals were sacrificed and thrombi were removed for assessment of gadolinium concentration.

RESULTS

Before contrast media application, thrombi were not visible on MR images. After contrast media injection, pulmonary emboli were selectively visualized with high-signal intensity foci in the inversion recovery sequence. One embolus could be clearly delineated as a filling defect on early MRA (three minutes post injection) in one case. The contrast-enhanced MRA showed an excellent signal-to-noise- (34 $\pm$ 2) and contrast-to-noise ratio (28 $\pm$ 3) early after injection. A high gadolinium concentration in thrombi was found (76 $\pm$ 19 micromol/kg), resulting in a high CNR on MR images (CNR thrombus-pulmonary artery 23 $\pm$ 3 and CNR thrombus-lung tissue 20 $\pm$ 6 in the first IR sequence 10 minutes after injection of contrast media). In the following IR sequences CNR decreased over time significantly from 16 $\pm$ 6 and 14 $\pm$ 8, respectively, 90 minutes after injection of Gadofluorine to 8 $\pm$ 1 and 10 $\pm$ 3, respectively, on the following day.

CONCLUSION

Systemic application of Gadofluorine allows for selective visualization of fresh pulmonary thromboembolism in a swine model using the IR sequence. Emboli can still be visualized more than 24 hours after injection of contrast media. Although a relative high Gadolinium concentration was found, further investigation are needed to prove a specific binding. Especially the very long half life time have to be taken into account as diffusion into the clot based on high blood pool levels may also support Gd concentration within the clot.

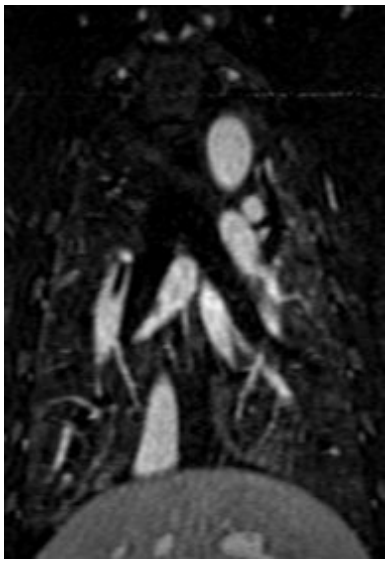

Fig. 1: Contrast enhanced MRA showing an embolus in the right descending pulmonal artery

Fig. 2: Inversion recovery sequence showing the same embolus with a bright signal in the surrounding black blood of the pulmonary artery

Ref.: 1. Spuentrup E et al., Circulation 2005
2. Spuentrup E et al., AJRCCM 2005