Cardiac MRI: How much myocardial damage is necessary to detect focal late gadolinium enhancement?

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Introduction: Within the last years the concept of late gadolinium enhancement (LGE) in cardiac magnetic resonance imaging (MRI) has been established in clinical routine for the assessment of myocardial viability. Whereas, myocardial infarction (MI) can be reliably visualized by LGE due to the fact that MI typically affects larger areas of myocardium, the detection of structural myocardial abnormalities in non-ischemic diseases is difficult, because non-ischemic diseases typically i) cause multifocal myocardial damages and ii) affect only a small amount of myocardium.

Purpose: Our study aimed to estimate how much myocardial damage is necessary to detect LGE in vivo in an experimental model of a multifocal myocardial pathology.

Material and Methods: Coronary microembolization (ME) was performed in 18 male minipigs to create multifocal myocardial damages. Therefore, a 2F microcatheter was placed into the distal portion of the left anterior descending coronary artery (LAD) under x-ray guidance and ME was performed by injection of microspheres (42µm in diameter, approximately 4500 micropheres per mL/min coronary flow). In vivo cardiac MRI was performed 4 hours (n=9) or 8 hours (n=9) after ME on a 1.5 T scanner (Siemens medical solutions, Erlangen, Germany) using an inversion recovery fast low angle shot (IR-turbo FLASH: TR 8 ms, TE 4 ms, TI 300-360 ms, FA 20°, slice thickness 5 mm, in-plane resolution 1.3 x 1.7 mm²) sequence after injection of 0.2 mmol/kg body weight Gd-DTPA to assess LGE. After in vivo imaging, the animals were euthanized and high resolution ex vivo images of the explantetd heart were acquired (IR-FLASH: TR 8 ms, TE 4 ms, TI 300-360 ms, FA 20°, slice thickness 3 mm, in-plane resolution 0.5 x 0.5 mm²). All experiments were followed by histomorphologic quantification of myocardial damage.

Results: Streaky LGE among normal appearing myocardium was observed in all animals ex vivo. 6 of 9 (67%) animals displayed LGE in vivo 4h, and 8h after ME in terms of areas of areas of weak LGE, respectively. Focal myocardial lesions exceeding 5% of myocardium per section could be detected by in vivo LGE in 86% 4h after ME, and in 80% 8h after ME**.**

Discussion: Our data suggest that focal myocardial lesions exceeding approximately 5% of myocardium per section can be detected by LGE in vivo. Whereas, in vivo imaging demonstrated contiguous areas of weak LGE (Figure 1a), high resolution imaging revealed streaky areas of LGE among normal appearing myocardium (Figure 1b). Thus, high resolution imaging is necessary to discover the true composition of multifocal myocardial damages.

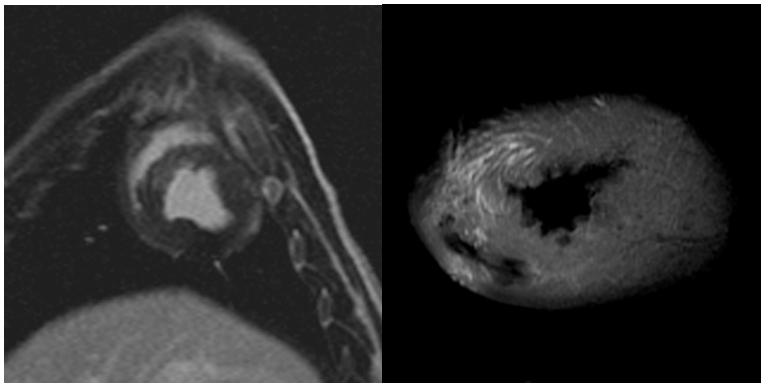

Figure 1: In vivo IR-turbo FLASH images (a; in-plane resolution 1.3 x 1.7 mm²) demonstrate weak septal LGE, whereas high resolution (b.; in-plane resolution 0.5 x 0.5 mm²) revealed streaky LGE among normal appearing myocardium.