In vivo and *ex vivo* plaque characterisation in the aortic arch of apoE -/- mice with high-resolution multi-parametric magnetic resonance imaging at 17.6 Tesla

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Purpose: High-Resolution plaque imaging in atherosclerotic apoE knock-out (-/-) mice has been recently shown to correlate closely with histology. However these results are limited to the aortic-root. We intended to further enhance the ability of high-field magnetic resonance (MR) to characterize plaque formation in murine models of atherosclerosis at microscopic levels.

Methods: All measurements were performed on a 17.6 Tesla Bruker AVANCE 750 scanner. Imaging was performed in 5 apoE -/- mice. In vivo imaging contained a multi-slice multi-SE (MSME) sequence (TR:~1000ms, TE: 8-42ms, in plane resolution: 78x78 µm) and a gradient-echo (GE)-FLASH sequence (FA: 30deg, TR: ~120ms, TE: 1ms). Afterwards mice were sacrificed. The heart and the aorta were removed *en bloc*, fixed in formaldehyde (24 hours) and perfused with Fomblin. *Ex vivo* imaging was performed with similar MSME sequences as described above (in plane resolution: 38x38 µm). Thereafter histology was obtained (haematoxylin-eosin stain, Oil-Red stain, von Kossa stain) and results were matched to MR images by planimetry.

Results: Plaques in apoE -/- mice showed cellular, lipid-rich and calcified regions all over the aortic arch in a comprehensive histology protocol (HE, Red-oil, von Kossa) (Fig. 1.). In 4 mice *in vivo* plaque characterisation with a PDW-to-T2 weighted MSME sequence showed a moderate to excellent correlation to corresponding *ex vivo* and histology findings (HE) (Fig. 2.). Therewith the plaque core area could be distinguished in all mice from the fibrous-cap or normal vessel wall. Due to the dark appearance of some core areas in single slice (T1-weighted) GE sequences and other areas with long T2 on MSME sequences we are going to test the hypothesis if multi-parametric MR imaging not only allows to detect core areas of plaques in apoE -/- mice but even to further distinguish between lipid-rich and calcified regions (Fig. 3.). Promising results have been achieved so far, but further validation is necessary.

Conclusion: High resolution multi-parametric plaque imaging at 17.6 Tesla is feasible with good correlation to HE histology. Nevertheless larger studies are necessary to further distinguish plaque components compared to a more comprehensive histology protocol.

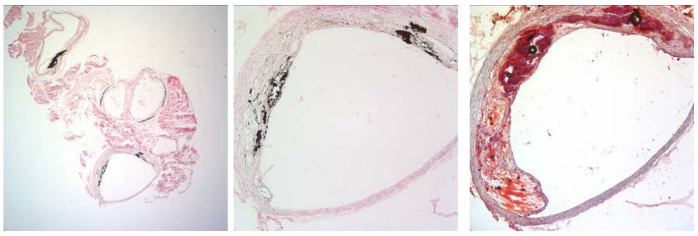

Fig. 1.: von Kossa staining shows calcified regions in apoE -/-. Oil-Red staining confirmed lipid rich areas.

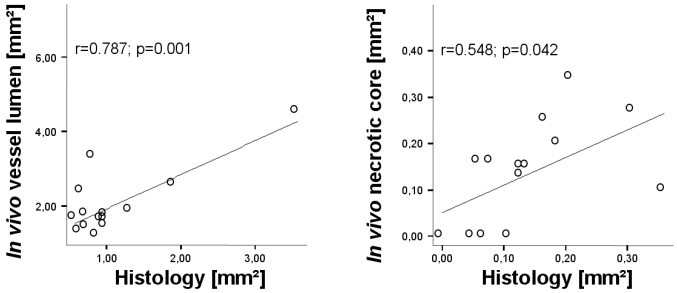

Fig. 2.: Examples of correlations of *in vivo* MRI with histology findings. Note that necrotic cores beyond MR resolution limits could not be detected.

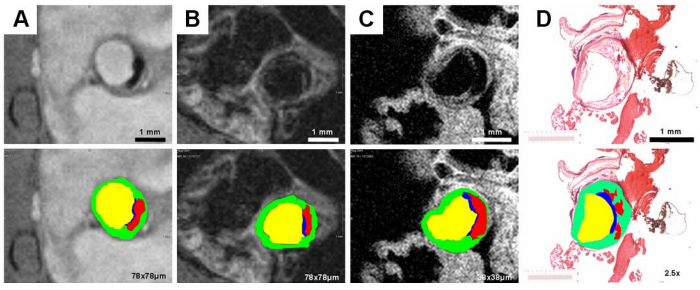

Fig. 3.: In vivo GE-FLASH (A) and MSME (B) allow detection of plaque core areas and fibrous-cap in good agreement with corresponding ex vivo MRI (C) and histology (D).

Support: DFG SFB 688