# Clinical 3.0T Magnetic Resonance Scanner Can Be Used for Imaging of Mouse Atherosclerotic LesionsΦ

X. Li[1,2], H. Gu[1], H. Feng[1], X. Du[2], B. Qiu[1], and X. Yang[1]

[1]Image-Guided Bio-Molecular Intervention Researchers, Department of Radiology; Institute for Stem Cel, University of Washington School of Medicine, Seattle, Washington, United States, [2]Radiology, Peking University People's Hospital, Beijing, Beijing, China, People's Republic of

**Purpose:** To date, the reported studies on in vivo vascular MR imaging of atherosclerosis in small animal models (such as mice and rats) are mainly performed on high-field micro-MR scanners[1], which are not always available in many basic research units. The aim of this study was to explore the possibility of generating high-resolution MR images of atherosclerotic aortic walls/plaques of mice using a clinical 3.0 Tesla MR scanner.

**Methods:** MRI of eight female ApoE$^{-/-}$ mice (B6.129P2; Jackson Laboratory, Bar Harbor, Maine), which were fed with an high cholesterol diet for approximately 3 months, was performed on a clinical 3.0T Philips MR System (Achieva, Philips Medical Systems, Best, The Netherlands) equipped with a solenoid mouse coil (Philips Research, Hamburg, Germany) and a MR-compatible electrocardiogram (ECG)-gating system (Model 1025 Monitoring and Gating System, SA Instruments, Inc., Stony Brook, NY). For each animal, proton density (PD)-weighted black-blood (BB) MR images of ascending aorta were achieved using a turbo spin-echo (TSE) sequence (TR=4 heart beating intervals, TE=10ms, FOV=40mm×40mm, TSE factor=3, slice thickness=1mm, slice gap=0mm, matrix=168×162, NSA=8, and voxel size=0.24×0.24×1). After MRI, the ascending aortas from the cardiac base to the aortic arch of all mice were harvested, sectioned at 8-μm thickness, and stained with hematoxylin and eosin (HE) to grade the formation of atherosclerotic lesions. Subsequently, we calculated the ratio of the aortic wall area=(total aortic area–aortic luminal area)/total aortic area by delineating the inner and outer boundaries of the aortic walls on both cross-sectional MR images and digitized histological images using the ImageJ software. Correlation of MR-derived ratios with histological ratios was analyzed using linear regression analysis. A $P$ value <0.05 was considered statistically significant.

**Results:** All animals survived through the experiments. Of in vivo MRI, all cases demonstrated clear visualizations of the ascending aortas and thoracic structures. MR-images showed atherosclerotic lesions or thickened aortic walls with irregular inner boundaries in the aortic root and near the aortic arch, which correlated well with their corresponding histological findings (Fig.1.). The linear correlation analysis showed a significant positive relationship on the measurements of the artery wall area ratio between MRI and histology ($r$=0.73, slope=0.32, $P$=0.04) (Fig.2.).

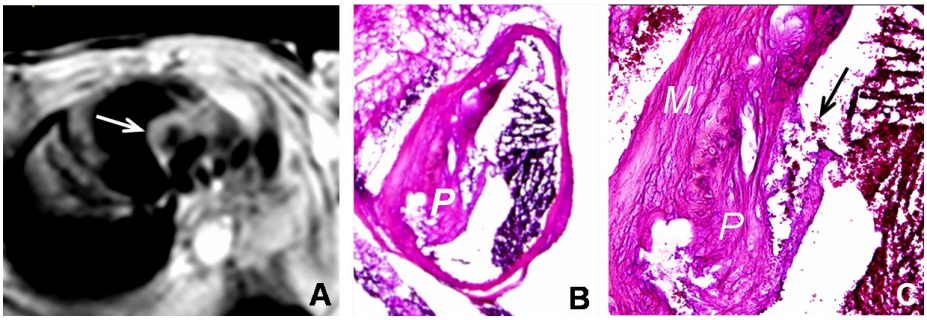


**Fig.1.** Representative MR-histological correlation. (A) Axial high-resolution PD-weighted MR images shows an atherosclerotic plaque (arrow) of a mouse ascending aorta, which is confirmed by histology (B, HE staining, 1.25×). *P*=plaque. (C) Magnification of the same microscopic image of B, demonstrating the formation of a typical atherosclerotic plaque (*P*) with a ruptured fibrous cap (arrow), intraplaque fibrin deposition and hemorrhage, as well as foam cells accumulation. *M*=media.

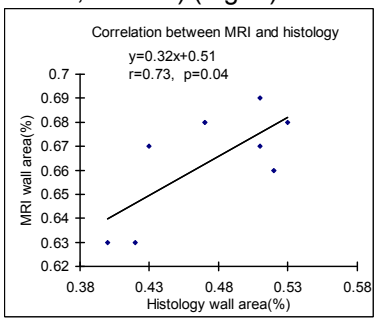


**Fig.2.** Linear regression analysis of MRI-derived ratios with histological ratios of aortic wall areas. There is a statistically significant correlation between the trend of values measured from MRI and histology.

**Conclusion:** This study demonstrates that clinical 3.0T MR scanners can be used for high-resolution imaging of atherosclerotic vascular walls and lesions in mice, which is guaranteed with a specific mouse RF coil, an effective ECG-gating system, and a BB-MRI sequence. In combination with plaque-specific target imaging tracers, clinical 3.0T MRI should enable to differentiate the components of the atherosclerotic plaques in such small animal models.

**Acknowledgements:** This study was supported in part by NIH R01 HL078672 grant and Dr. Xubin Li was supported by State Scholarship Fund of China Scholarship Council.

**References:**

1. Tsui BM, Kraitchman DJ. Recent advances in small-animal cardiovascular imaging. J Nucl Med, 2009; 50(5):667-70.