Preliminary evaluation of the short term reproducibility of dynamic contrast enhanced (DCE) MRI in patients with carotid atherosclerosis

C. Calcagno1, V. Mani1, S. Ramachandran1, S. Aguiar1, J. Postley2, and Z. A. Fayad4
1Radiology, Mount Sinai School of Medicine, New York, NY, United States, 2Columbia University - College of Physicians and Surgeons

Introduction
Several studies highlighted the pivotal role of inflammation in the pathogenesis of atherosclerosis1. Dynamic contrast enhanced (DCE) MRI has been shown to correlate to plaque inflammation in atherosclerotic rabbits and patients2-3. This technique has been shown to have excellent reproducibility and to be a good read-out for anti-inflammatory therapies in atherosclerotic rabbits. These results are encouraging and suggest a potential role for DCE-MRI in future clinical practice for the assessment of progression and/or regression of human plaques and as a surrogate imaging marker in clinical drug trials. However, DCE-MRI studies in patients are much more challenging than in animals, due to patient motion and signal dependence on surface coils sensitivity profile. Therefore, the reproducibility of this technique has to be evaluated in patients.

We present a preliminary study of the inter-scan reproducibility of DCE-MRI in patients with carotid atherosclerosis.

Methods
MRI Imaging: Three patients underwent carotid MR imaging at baseline and one week after baseline scan using a 1.5T clinical scanner and a 4-channel carotid array. Twelve non-overlapping black blood T1W, T2W and PDW cross sectional slices were obtained in the common carotids for plaque characterization4. DCE-MRI was performed on one selected axial slice (chosen as the slice with the greatest degree of wall thickening) using a double inversion recovery (DIR) black blood turbo spin echo (TSE) sequence (100 images, time resolution = 4.8 s). After a 24s delay from the beginning of the DCE-MRI acquisition (5 pre-contrast images), 0.1 mmol/Kg of Gd-DTPA was injected with a power injector followed by a 20 ml saline flush. Following DCE-MRI acquisition, a post-contrast T1 weighted image of the same slice chosen for DCE imaging was acquired for tracing of the vessel wall. All patients were imaged using the exact same protocol one week after baseline scan. Slice matching of DCE-MRI slices between sessions was achieved by evaluating anatomical fiducial markers (carotid bifurcation and cervical spine) in T1, T2 and PDW multi-slice scans.

Statistical analysis showed good reproducibility for all measures (ICCs > 0.7, p<0.1). Plaque absolute AUC, showed very poor reproducibility (see Table 1). Relative AUC calculated at 1 minute after contrast agent injection showed poorer reproducibility. Sternocleidomastoid muscle AUC showed excellent reproducibility of relative AUC measures was evaluated.

Results
Statistical analysis show excellent reproducibility of relative AUC calculated 2 and 7 minutes after contrast agent injection (ICCs respectively 0.972 and 0.755, p<0.05). Relative AUC calculated at 1 minute after contrast agent injection showed poorer reproducibility. Sternocleidomastoid muscle AUC showed good reproducibility for all measures (ICCs > 0.7, p<0.1). Plaque absolute AUC showed very poor reproducibility (see Table 1).

Conclusions
DCE-MRI of atherosclerosis has the potential to become a useful surrogate marker of plaque progression/regression in future clinical practice. In this preliminary study we investigate the reproducibility of DCE-MRI in patients with carotid atherosclerosis. We show excellent reproducibility of the AUC by DCE-MRI in the carotid arteries when normalized by ipsi-lateral muscle uptake. Despite being preliminary, this study shows promising results. We anticipate that more extensive evaluation of DCE-MRI reproducibility in carotid atherosclerosis could determine if this technique could be a useful tool for the evaluation of human atherosclerosis.

References

Table 1: ICCs, R and p-values are reported. Significant correlations are flagged in bold.