Contrast Agent Uptake by Carotid Atherosclerotic Plaque is Associated with Mediators of Plaque Inflammation

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Introduction

Inflammation plays a key role in the pathogenesis of atherosclerosis, making it a primary target for detection by medical imaging. Several studies have suggested a link between inflammation in atherosclerotic plaque and contrast enhancement characteristics of the vessel wall on MRI [1,2]. Further evidence for this link could be obtained by showing that subjects with a propensity for plaque inflammation, such as those with low serum HDL [3], exhibit greater plaque enhancement. The purpose of this study was to investigate the link between pro-inflammatory mediators and enhancement parameters measured by kinetic modeling of dynamic contrast-enhanced MRI.

Methods

Twenty-five male subjects with >50% carotid stenosis by duplex ultrasound underwent a carotid MRI examination including a dynamic contrast-enhanced sequence (SPGR, TR=100 msec, TE=3.4 msec, FOV=16x12 cm, matrix=256x144, thickness=3 mm). For each subject, 7 axial locations were imaged (interleaved) at 10 time frames separated by 15 seconds. Coincident with the second image in the sequence, 0.1 mmol/kg of Omniscan (Amersham Health) was injected. For each subject, two adjacent images exhibiting the thickest plaque were selected and the average signal intensity change from baseline was measured in the lumen and wall in all time frames. These measurements were then analyzed with the standard kinetic model of contrast uptake including a vascular component [4]. From this model, measurements of the transfer constant K^{trans} of contrast agent uptake within the plaque were recorded for each subject. These values were compared to the continuous population parameters listed in Table 1 using Pearson's correlation coefficient with an F-test for statistical significance. The mean values for K^{trans} were also compared for subjects with and without the features listed in Table 2, using a two-sided t-test to assess significance of the difference.

Results

The correlation coefficients between K^{trans} and the continuous population parameters are listed in Table 1. The only significant association was a negative correlation with serum HDL. The mean values of K^{trans} for subjects with and without diabetes, hypertension, and a history of smoking are listed in Table 2. The only significant association was a higher value of K^{trans} in smokers compared to non-smokers.

Table 1. Correlation (r) and significance (p) between K^{trans} measured by DCE-MRI and continuous population characteristics

	r	p
Age	-0.03	0.9
Body Mass Index	-0.23	0.3
Total Cholesterol	-0.15	0.5
LDL	0.10	0.7
HDL	**-0.66**	**0.001**

Table 2. Differences in mean K^{trans} (min^{-1}) and statistical significance (p) between subjects with and without the characteristics listed.

	Mean K^{trans} with	Mean K^{trans} without	p
Hypertension	0.119	0.105	0.7
Diabetes	0.094	0.119	0.5
Smoking	**0.139**	**0.074**	**0.02**

Conclusion

A negative association of plaque K^{trans} with serum HDL and a positive association with smoking were demonstrated. Because HDL is thought to inhibit plaque inflammation [3], whereas smoking is thought to facilitate inflammation [5], both results are consistent with a positive association between K^{trans} and inflammation. This study therefore lends further support to a link between contrast-enhancement and inflammation in atherosclerotic plaque.

References

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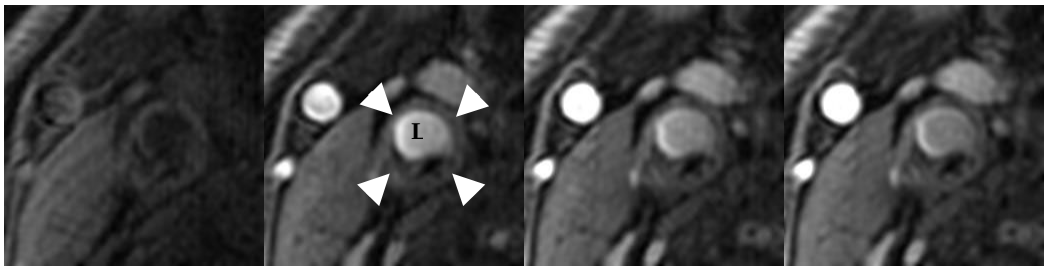

Figure 1. Pre-contrast and three post-contrast DCE-MR images of carotid atherosclerotic plaque. Lumen (L) and outer wall boundary (arrows) are indicated.