

Association between Adventitial Vasa Vasorum and Atherosclerosis: A Dynamic Contrast-Enhanced Magnetic Resonance Imaging Study

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Introduction

Vasa vasorum may play an important role in the pathogenesis of atherosclerosis. However, the role of the vasa vasorum during atherogenesis remains unclear. Although human autopsy studies have suggested that the vasa vasorum is associated with plaque progression (Fleiner et al., 2004), an inability to serially assess the vasa vasorum *in vivo* has prevented the identification of its relationship to the pathophysiology of human atherosclerotic disease. Recently, dynamic contrast-enhanced (DCE) MRI has demonstrated a strong correlation between the rate of carotid plaque contrast enhancement and histological evidence of neovascularity and macrophage infiltration of the human atherosclerotic lesion (Kerwin et al., 2006). This technique has been recently modified to only capture the transfer constant, K^{trans} , of adventitial tissue to visualize and quantify the vasa vasorum of the carotid atherosclerotic lesion. In the present study, we tested the hypothesis that the extent of adventitial vasa vasorum as measured by K^{trans} is related to the severity of atherosclerosis.

Methods

73 carotid arteries with 16-99% stenosis by duplex ultrasound were imaged at 1.5T with a high-resolution, multi-contrast MRI protocol that included a DCE-MRI sequence. Imaging parameters were TR=100 ms, TE=3.4ms, flip=60, matrix=192x144, FOV=16x12, and 0.1 mmol/kg of contrast agent (Omniscan, GE Healthcare) was injected coincident with the second of 12 images in the sequence. Using a semi-automated image analysis tool, the area of lumen, area of wall, and normalized wall index (NWI), were obtained, where $NWI = \text{wall} / (\text{wall} + \text{lumen})$. We also performed kinetic modeling of the results to extract the partial plasma volume (v_p) and transfer constant (K^{trans}) for each pixel, using an automated procedure. Results were displayed as a two-color parametric image with v_p in red and K^{trans} in green. An active contour technique was used to identify the adventitia in the parametric DCE-MRI image and average K^{trans} along this boundary was measured. Spearman's correlation was applied for correlation between average K^{trans} and NWI.

Results

Of the 73 arteries evaluated, 5 arteries were excluded because of poor image quality. The average K^{trans} was significantly correlated with mean NWI ($r=0.63$, $p<0.01$) and maximum NWI ($r=0.52$, $p<0.01$) (Figure).

Conclusions

Extent of the adventitial vasa vasorum in the human carotid atherosclerotic lesion appears to be associated with the degree of carotid stenosis. DCE-MRI may be an effective technique for the *in vivo* evaluation and monitoring of the adventitial vasa vasorum in human atherosclerotic disease. Prospective studies are underway to assess whether the degree of adventitial enhancement is predicts more rapid atherosclerosis progression.

References

Fleiner M, et al. (2004) *Circulation*. 110:2843-2850.
Kerwin W, et al. (2006) *Radiology*. 241(2):459-68.

