Vessel Wall Imaging in Peripheral Vascular Disease

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Introduction

Vascular disease is a leading cause of death and disability in the industrialized world. Peripheral artery disease (PAD) affects over 10 million people in the US alone. Until recently MRI based evaluation of PAD patients had focused almost solely on findings using a variety of both non-contrast and contrast enhanced angiographic techniques. Studies of the development and composition of atherosclerotic plaque[1] in the carotid arteries has been associated with increased risk of stroke at transient ischemic attacks[2]. We hypothesize that plaque burden measured in the superficial femoral arteries can be an important indicator of the presence and severity of peripheral artery disease. We have measured plaque burden in the lower extremities, defined a series of imaging metrics that reflect plaque burden and correlated MRI findings with well defined indicators of peripheral vascular disease in a series of PAD patients.

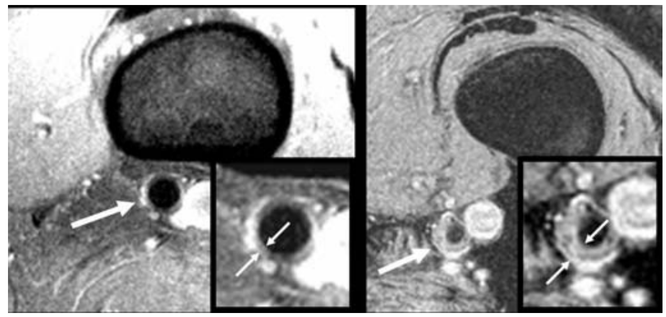

Figure 1: Representative vessel wall images acquired in the adductor canal of a normal (left) and PAD patient (right). Note the greater wall thickness and diminished lumen in the PAD patient.

Methods

A series of patients (N=11) with PAD as defined by the ankle brachial index (ABI < 0.90) [3] were selected from an ongoing study of functional impairment in PAD. Results from PAD patients were compared to a series of age-matched controls (N=14). All subjects were scanned on a clinical 1.5T MRI scanner (Siemens, Sonata) using a knee coil for signal reception. The imaging protocol consisted of a series of True FISP localizers followed by proton density weighted (TR/TE=2160/5.6 ms) Turbo Spin Echo (TSE) scan acquired with region saturation bands (RSAT) proximal and distal to the 12 imaging slices. A set of co-registered (FOV =12 x 12 cm, matrix 192), 2D TOF (TR/TE=28/7.2 ms) were acquired to aid the definition of the lumen boundary. Images were post processed using a plaque burden analysis software package (CASCADE) developed by VIL, University of Washington [4]. Vessel wall volume, wall thickness and plaque volume, normalized to the outer wall volume were compared. The Pearson correlation coefficients between ABI and total plaque volume, mean arterial wall thickness and maximal arterial wall thickness were calculated.

	PAD(N=11)	Non PAD(N=14)	P-value
Plaque Volume	0.666 +/- 0.139	0.498 +/- 0.074	0.003
Max. Wall Volume	0.771 +/- 0.151	0.568 +/- 0.081	0.001
Max. Wall Thickness	0.436 +/- 0.165	0.260 +/- 0.068	0.006
<Wall thickness>	0.245 +/- 0.072	0.165 +/- 0.029	0.004
Lumen Reduction (%)	0.713 +/- 0.141	0.539 +/- 0.067	0.002
Eccentricity	0.681 +/- 0.180	0.769 +/- 0.099	0.162

Results

Due to the slow blood flow in the peripheral blood vessels, the use of time of flight images was instrumental in defining the inner lumen boundary. We have found significant differences in wall volume and area between PAD and non-PAD patients (See Table). Notably, the vessel lumen eccentricity shows no difference between PAD and non-PAD patients. Pearson correlation coefficients for ABI and MRI outcomes showed a strong negative correlation between total plaque volume (r= -0.803, p<0.001) maximal arterial wall thickness (r=-0.764, p<0.001) and mean arterial wall thickness (r= -0.700, p<0.001) indicating that the ABI decrease as plaque burden increases.

Conclusions

We have developed an MRI examination to measure plaque burden in the lower extremities. We have shown that imaging metrics that reflect plaque burden are significant higher in PAD patients than non-PAD patients. Furthermore, plaque burden and ABI are strongly correlated in these patients.

References

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