HIGH RESOLUTION MAGNETIC RESONANCE IMAGING DEMONSTRATES IMPAIRED BRACHIAL ARTERY REACTIVITY AS WELL AS REDUCED AORTIC AND CAROTID COMPLIANCE IN YOUNG SMOKERS

F. Wiesmann[1], S. Petersen[1], J. M. Francis[1], M. D. Robson[1], P. M. Leeson[1], R. Choudhury[1], K. M. Channon[1], S. Neubauer[1]

[1]Dept of Cardiovascular Medicine, University of Oxford, Oxford, United Kingdom

INTRODUCTION:

Cigarette smoking is a known cause for endothelial dysfunction, reflected by impaired brachial artery reactivity to hyperemia. However, previous methods of non-invasively investigating endothelial function such as venous occlusion plethysmography and brachial artery ultrasound have been hampered by limited accuracy and reproducibility. High-resolution magnetic resonance imaging bears the potential to quantify vascular function highly accurately and reproducibly. Furthermore, MRI allows to assess vascular function at different sites within the vascular tree and to simultaneously acquire information on vessel structure, distensibility and flow within one examination. Aim of this study was to test the hypothesis that smoking not only induces peripheral endothelial dysfunction but also alters function and flow dynamics of the great arteries.

METHODS:

20 healthy young volunteers (mean age 30±2 y; 12 non-smokers (NS), 8 smokers (S): average daily cigarette consumption 9.4±2.6 /day, cumulative nicotine consumption 8.4±3.1 pack-years) were studied. Both groups were matched for age, height and body weight. Non-invasive high-resolution cine MRI at 1.5T (Siemens Sonata, Erlangen, Germany) was performed for assessment of vascular compliance of the aorta and common carotid arteries using a TrueFISP sequence. Imaging parameters for aortic and carotid imaging were TR/TE 42 ms / 1.4 ms, FOV_{read} 380 mm, in-plane resolution 1.97 mm, SLT 7 mm, and TR/TE 45.3 ms/ 2.4 ms, FOV_{read} 200 mm, in-plane resolution 520 µm, SLT 3 mm, respectively. Flow-mediated dilatation (FMD) was evaluated by MRI-measured BRA relative cross-sectional area increase after forearm cuff occlusion (FOV_{read} 117 mm, in-plane resolution 300 µm, SLT 3mm).

RESULTS:

Smokers and non-smokers showed no difference in heart rate and systolic or diastolic blood pressure. As expected, smokers showed a significant reduction in FMD (cross-sectional area change 7.5±2.7% vs. non-smokers 14.9±1.8%, p=0.03), indicating impairment of endothelium-dependant relaxation. Brachial arterial response to sublingual GTN (400 µg) was identical in both groups. The reduced FMD in smokers was accompanied by a marked decrease in vascular compliance in the common carotid arteries (3.69±0.60 $10^{-3}mmHg^{-1}$ vs. NS 6.80±1.00 $10^{-3}mmHg^{-1}$, p=0.02) and at various sites of the descending aorta (DA) (thoracic DA 5.79±0.55 $10^{-3}mmHg^{-1}$ vs. non-smokers 7.56±0.38 $10^{-3}mmHg^{-1}$, p=0.01; abdominal DA 7.81±0.91 $10^{-3}mmHg^{-1}$ vs. non-smokers 10.52±0.54 $10^{-3}mmHg^{-1}$, p=0.02), suggesting a significant role of the endothelium for central vascular distensibility. Aortic mean and peak flow velocities as well as blood volume flow in the ascending aorta were similar between smokers and non-smokers. However, central aortic pulse wave velocity in smokers was significantly increased (p=0.03 vs. non-smokers).

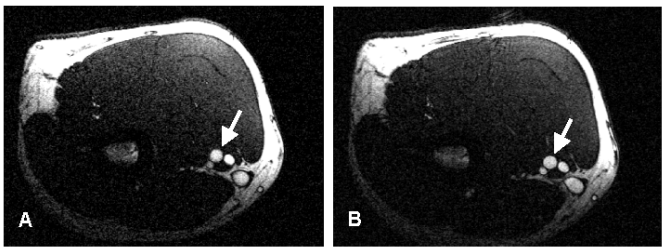

Figure 1: Cross-sectional MR image through right ellbow perpendicular to brachial artery (arrows) acquired at A) baseline and B) at maximal reactive hyperemia post cuff release

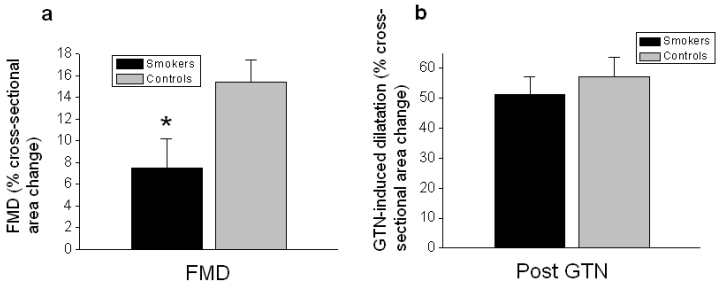

Figure 2: Relative cross-sectional area changes induced by (a) hyperemia (flow-mediated dilatation (FMD) representing endothelium-dependent relaxation) and by (b) GTN (endothelium-independent relaxation). * indicates p<0.05.

CONCLUSION:

Cigarette smoking in young and otherwise healthy volunteers not only results in reduction of hyperemia-induced brachial artery reactivity but also in significant impairment of carotid and aortic compliance. Non-invasive MRI allows for detailed characterization of vascular function and can give new insights into the role of the endothelium in regulating peripheral and central vascular function.