Coronary sinus flow quantification at 3T and cold pressor test for non invasive evaluation of coronary endothelial function

P-J. Moro1,2, A. Jacquier1, F. Kober1, J-L. Bonnet1, P. Cozzone1, and M. Bernard1
1Centre de Résonance Magnétique Biologique et Médicale, CNRS UMR 6612, Université de la Méditerranée, Faculté de Médecine, Marseille, France, 2Cardiology, CHU Timone, Marseille, France

Purpose
Endothelial dysfunction (ED) plays a key role in the development of cardiovascular disease. The purpose of this study was to assess the feasibility of a non-invasive method for quantification of coronary endothelial function by measuring myocardial blood flow (MBF) using coronary sinus flow quantification at rest and during cold pressor test (CPT).

Material and Methods
Fourteen healthy volunteers (eleven men, three women) without any coronary risk factors underwent magnetic resonance imaging in a 3.0 Tesla scanner (Verio, Siemens, Erlangen, Germany). CPT was performed by immersing the right ankle in ice-water during four minutes. Heart rate and blood pressure were monitored throughout the protocol using a Maglife system (Schiller). Coronary sinus flow was measured at rest and during CPT using non breath-hold velocity encoded (VENC) phase contrast cine MRI (repetition time / echo time: 45ms / 2 ms, slice thickness: 5.5 mm, field of view: 250 x 250 mm², averages: 11, matrix: 256 x 256, flow encoding: 70 cm/sec, flip angle: 25°, acquisition time: 4 minutes, GRAPPA k-space reduction factor: 4). A representative MR image is shown in figure 1. Myocardial function and morphology were evaluated using a multislice breath-hold SSFP sequence with whole-heart coverage. MBF was calculated combining coronary sinus flow quantification and morphologic data using Argus software (flow and 2D). Coronary endothelial function was assessed by comparing MBF at rest and during CPT. Coronary vascular resistance (CVR) and endothelium-dependent vasodilation index (EDVI) were calculated.

Results
All volunteers well tolerated CPT. Typical coronary sinus flow profiles are shown in figure 2. CPT significantly increased heart rate by 32 ± 11 % (p<0.0001), systolic blood pressure by 20 ± 11 % (p<0.0001), and significantly decreased CVR by 14 ± 21 % (p=0.034). At baseline, coronary blood flow per gram of myocardial mass was 0.66 ± 0.22 ml/min/g (mean ± SD). After CPT, coronary blood flow was 1.03 ± 0.41 ml/min/g (fig 3). MBF significantly increased by 55 ± 38 % during CPT compared to the rest examination (p<0.0001). These results are in agreement with MBF values measured using first pass perfusion MRI [1]. EDVI was 1.55 ± 0.38.

Conclusion
We show here that MRI coronary sinus flow quantification as a measure of the myocardial blood flow without contrast agent allows to detect significant changes in response to CPT in healthy volunteers. This non invasive measure may help to detect changes in endothelial function which occur early in a variety of cardiovascular diseases such as in diabetes.