

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

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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: 70cm/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.

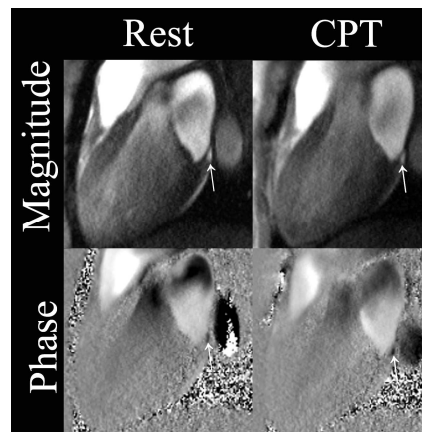


Figure 1: Coronary sinus (arrows) on magnitude images and corresponding phase images at rest and during CPT

Results

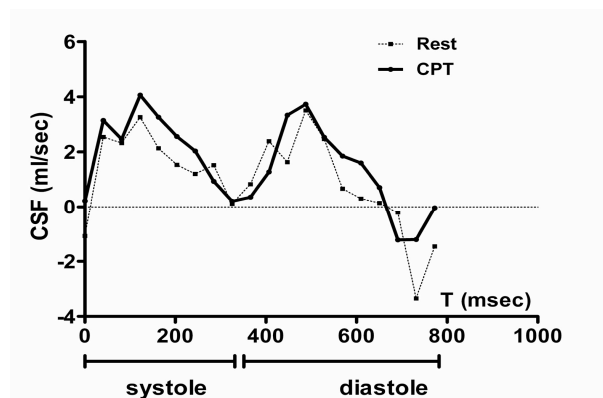


Figure 2 : Coronary sinus flow in a volunteer at rest and during CPT during a cardiac cycle

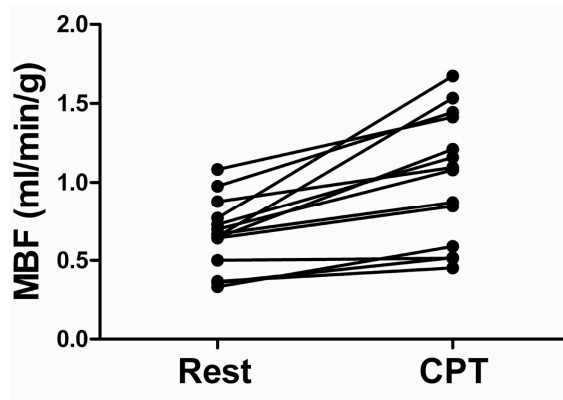


Figure 3 : Myocardial blood flow values obtained at rest and after CPT for each volunteer

All volunteers well tolerated CPT. Typical coronary sinus flow profiles are shown in figure 2. CPT significantly increased heart rate by $32 \pm 11\%$ ($p < 0.0001$), systolic blood pressure by $20 \pm 11\%$ ($p < 0.0001$), and significantly decreased CVR by $14 \pm 21\%$ ($p = 0.034$). At baseline, coronary blood flow per gram of myocardial mass was 0.66 ± 0.22 ml/min/g (mean \pm SD). After CPT, coronary blood flow was 1.03 ± 0.41 ml/min/g (fig 3). MBF significantly increased by $55 \pm 38\%$ 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.

[1] Weng et al, Proc Intl Soc Magn Reson Med 17 (2009).