Cold Pressor Test in MRI for Quantitative Myocardial Perfusion Imaging

A. Weng, C. O. Ritter, M. Kowalski, M. J. Beer, D. Hahn, and H. Köstler

Institut für Röntgendiagnostik, Uniklinik Würzburg, Würzburg, Bayern, Germany

Purpose
Alterations in myocardial perfusion are crucial for coronary artery disease (CAD). In nuclear medicine a risk assessment is established that can reveal endothelial dysfunction which is the first step towards CAD: the cold pressor test (CPT) [1, 2]. Nuclear medicine provides the opportunity to quantify myocardial blood flow but suffers from two main drawbacks: limited spatial resolution and the use of radioactive tracers. In contrast first-pass perfusion MRI is able to evaluate myocardial perfusion with a high spatial resolution and with waiving of radiation. Thus, it was the aim of this study to establish a CPT in the MRI environment.

Materials and Methods
For this study 10 healthy non-smoking volunteers were examined in a 1.5 T scanner (Magnetom Quantum Symphony, Siemens Medical Solutions, Erlangen/Germany) using a multislice-SSFP-perfusion sequence (TR 2.8 ms, TE 1.1 ms, TI 110 ms, FA 50°, resolution 2.7 x 3.3 x 8.0 mm³, 3 short-axis slices). For quantification of myocardial blood flow the prebolus-technique [3] was used with 1ml/4ml Gd-BOPTA.
CPT was performed by putting the left hand in an over-head ice-water bath for one minute before the measurement was started to create an adequate stimulus. During the measurement the hand remained in the ice-water. 15 minutes after the CPT a rest-examination was performed to obtain baseline values of the subjects’ MBF.
The acquired perfusion series were automatically motion-corrected using an algorithm similar to the one proposed by Adluru et. al. [4]. Subsequently an image-segmentation was performed using the software Developer Life (Definiens, Munich/Germany) to obtain signal intensity time courses of eight sectors in the left ventricular myocardium and of the blood pools [5]. The myocardial courses were evaluated using both baseline and contamination correction [6] to obtain absolute MBF values.

Results
All healthy volunteers were able to keep the hand in the ice-water bath during the whole measurement and it was possible to evaluate all datasets with the mentioned postprocessing tools. The averaged rest values for all volunteers were 0.61 ± 0.34 ml/g/min (mean ± standard deviation) while during CPT values of 1.16 ± 0.66 ml/g/min were obtained. For every single subject the mean perfusion was significantly higher during CTP compared to the rest examination (significant: p < 0.05).

Conclusion
Absolute quantification of myocardial blood flow during CPT is feasible. MBF values showed a significant increase during CPT in comparison to the rest examination. Further studies with patients with known cardiac risk factors like hypercholesterolemia, diabetes or hypertension have to prove the capabilities of this new MRI application.

References

Figure 1
Comparison of the MBF values obtained in CPT and in rest.