Comprehensive assessment of cerebral hemodynamic parameters (Y, CVR, CBF, OEF and CMRO2) and perfusion territories for patients with cerebrovascular disease.

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Introduction
In patients with cerebrovascular disease hemodynamic parameters, such as cerebral blood flow (CBF), cerebrovascular reactivity (CVR), oxygen extraction fraction (OEF) and cerebral metabolic rate of oxygen (CMRO2), can be affected. In the last years, non-invasive MR techniques have been developed to evaluate these parameters. Here we present the first results of a comprehensive study protocol designed to evaluate a wide range of cerebral hemodynamic parameters in patients with cerebrovascular disease.

Materials and methods
MR imaging, in line with institutional guidelines, was performed in 5 healthy volunteers; mean age 27 years [range: 24-33] (Table1). MR imaging (~45 min) consisted of MP-RAGE, T2-FLAIR, DWI, respiratory-calibrated pseudo-continuous ASL (pCASL), T2 Prepared Blood Relaxation Imaging with Inversion Recovery (T2-TRIR), territorial selective ASL and an oxygen saturation sequence (T2-BIOS). Scan parameters of the pCASL sequence were; TR/TE1/TE2: 4000/13.79/36.25, label time 1650 and postlabel delay 1550 ms. Concurrently, a respiratory paradigm (Figure 1A) was run using the Respiract device (Thornhill Research Inc, Toronto, Canada). Scan parameters of the T2-TRIR sequence were; TR/TE1/TE2 = 1500/20/150/130 ms and eTE=0,40,80 and 160ms. Scan parameters of the T2-BIOS sequence were; TR/TE: 4385/6.6, postlabel delay 60ms and eTE=0,40,80 and 160ms. The respiratory-calibrated pCASL sequence allowed for evaluation of CBF, CVR, CBV, OEF and CMRO2. The T2-TRIR sequence was used to measure venular saturation in the sagittal sinus and from this global OEF and CMRO2 were estimated. The T2-BIOS sequence targeted the intravascular compartment by labelling moving blood and applying a short postlabel delay. An oxygen saturation map (Y) was derived from the data.

Results
Figure 1B shows example images of one subject. For all subjects gray matter (GM) CBF, GM-CVR, GM-OEF and GM-CMRO2 were calculated based on the pCASL data. The results are shown in Table 1. Mean GM-CBF was 51.4 ml/100g/min [range: 47-56 ml/100g/min]. Mean GM-CVR was 22% [range: 14-33%]. Mean GM-OEF was 37.8% [range: 30-51%]. Mean GM-CMRO2 was 161.6 μmol/100g/min [range: 123-237 μmol/100g/min].

Discussion and conclusion
We presented a comprehensive protocol for non-invasive assessment of cerebral hemodynamics which will allow us to examine oxygen consumption and vascular reserve capacity in vascular diseased patients. Preliminary results are shown for Y, CVR, CBF, OEF, and CMRO2 measured using the above mentioned sequences. This protocol will be applied to patients with (a)symptomatic steno-occlusive disease of the internal carotid arteries and symptomatic occlusion of the middle cerebral artery. In this way we will be able to study the influence of cerebrovascular disease on hemodynamic parameters.

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References