Restoring Cerebro-Vascular Reserve in Carotid Artery Disease

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Purpose: In carotid artery disease (CAD) information about cerebral blood flow (CBF) identified brain areas with reduced perfusion due to the occlusion of a feeding vessel. Arterial Spin Labeling (ASL) has proven to provide similar information about altered perfusion in vascular territories like PET with the advantage of its non-invasiveness [1]. Furthermore, the assessment of ASL during the administration of a vasodilatory agent allows the calculation of the cerebro-vascular reserve (CVR) [2]. CVR indicates the capacity of the vasculature to increase CBF in a specific region, which is a necessity for proper brain function. In CAD this CVR is often reduced which is suggested as the physiological basis for observed cognitive deficits.

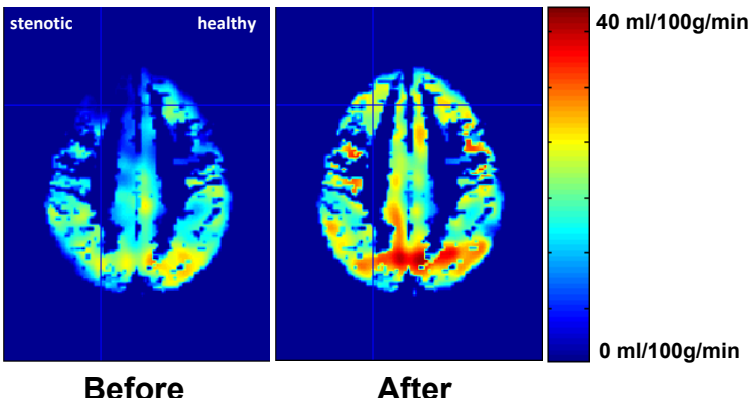
In the ongoing project we investigate whether revascularisation therapy is able to restore CVR in afore affected flow territories. In accompanying work we found that CVR is particularly reduced in the water-shed areas between the middle cerebral artery and the anterior and posterior cerebral artery, respectively. Thus, here we focussed especially on these flow territories.

Methods: Eight patients with CAD (grade of stenosis >70%) were investigated using pseudocontinuous ASL (pCASL [2]): Hanning window-shaped RF pulse with duration 0.5 ms and space between RF pulses of 0.9 ms, flip angle = 25°, slice-selective gradient = 6 mT/m, tagging duration (τ) = 1720 ms, postlabeling delay (PLD) = 1500 ms and TR/TE 4000ms/13ms, 120 volumes. Fourteen axonal slices with 6mm thickness were placed parallel to the anterior-posterior commissure line. Labelling block was 9cm below the isocenter of the readout slices. Acquisitions were performed during normal air and 7% CO2 enriched air as the vasodilatory agent. CBF was quantified for both conditions and by subtraction of the CBF values at each voxel the patient's CVR was estimated. The same was repeated one year after revascularisation therapy. In a region of interest analysis the CVRs of the vascular flow territories for anterior watershed (AW), posterior watershed (PW) and posterior carotid artery (PCA) as a control region were calculated.

Results: CVR on the stenotic hemisphere markedly increased after revascularisation therapy in the AW (+11.2 ml/100g/min) while the PW (+4.6 ml/100g/min) showed a CVR restoration in the range of the CVR observed in the healthy hemisphere (AW = +5.9 ml/100g/min; PW = +0.7 ml/100g/min). The PCA control areas showed a CVR increase of +6.3 ml/100g/min (stenotic) and +5.0 ml/100g/min (healthy).

Discussion: Our results indicate the ability of revascularisation therapy to restore CVR in patients with CAD. Specifically, the CVR of the anterior watershed areas was markedly increased after intervention. The next step of our project will be to investigate whether this restoration of CVR also improves neuropsychological functioning, and whether CVR might provide a possible marker for positive outcome.

Figure 1: CVR before and after revascularisation therapy



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