

PREVALENCE OF CEREBROVASCULAR RESERVE IMPAIRMENT IN PATIENTS WITH SEVERE INTRACRANIAL ARTERIAL STENOSIS

Alexandre Krainik¹, Olivier Heck², Arnaud Attyé², Naila Boudiaf³, Florence Tahon², Kamel Boubagra², Johan Pietras², and Olivier Detante²
¹Neuroradiology and MRI, University hospital of Grenoble, Grenoble, France, ²University hospital of Grenoble, France, ³LPNC, France

Purpose

Patients with Severe Intracranial Arterial Stenosis (SIAS) are at risk of stroke¹. Moreover, both diffusion imaging² and oxygenation mapping³ suggest that parenchyma downstream SIAS is exposed to chronic low-grade ischemia. Care management of these patients remains under debate. Percutaneous transluminal arterial stenting (PTAS) has been advocated to cure SIAS⁴, but it has a higher morbidity/mortality than medical treatment¹. Thus, additional data are required at the individual level to justify the risk related to PTAS. Imaging of cerebrovascular reserve (CVR) using BOLD fMRI to hypercapnic challenge has been proposed to estimate hemodynamic impairment downstream the SIAS²⁻⁶. We previously estimated the laterality index of middle cerebral artery (MCA) CVR ($LI_{MCA} = \text{Left_CVR}_{MCA} - \text{right_CVR}_{MCA} / (\text{Left_CVR}_{MCA} + \text{Right_CVR}_{MCA})$) in 100 controls; 95% of LI_{MCA} ranged from -0.07 to +0.07 (unpublished data). The objectives of the work were to estimate the prevalence of significant CVR decrease among patients referred for SIAS when compared to controls.

Subjects and Methods

35 patients (8 females; 63.2 ± 15.3 years) with unilateral SIAS of internal carotid ($n=19$) or middle cerebral artery (MCA) ($n=16$) were examined using CVR fMRI BOLD contrast with a block-design hypercapnic challenge (CO_2 8%) at 3T (Philips ACHIEVA 3T TX). Averaged end-tidal CO_2 pressure ($EtCO_2$) was used as a physiological regressor for statistical analyses (SPM8). Perfusion imaging using dynamic susceptibility contrast was acquired. We conducted regions of interest (ROI) measures of %BOLD signal change/mmHg $EtCO_2$ on segmented gray matter of the MCA territories. CBV, CBF, MTT were calculated using DSC. We calculated laterality indices (LI_{MCA}) for each parameter.

Results

In patients, 18 out 35 had an abnormal $|CVR\ LI_{MCA}| \geq 0.08$, leaving 17 patients with a normal vascular reserve. $CVR\ LI_{MCA}$ was negatively correlated with CBV LI_{MCA} ($R=-0.64$; $p<0.01$), negatively correlated with MTT LI_{MCA} ($R=-0.79$; $p<0.001$), but not correlated with CBF.

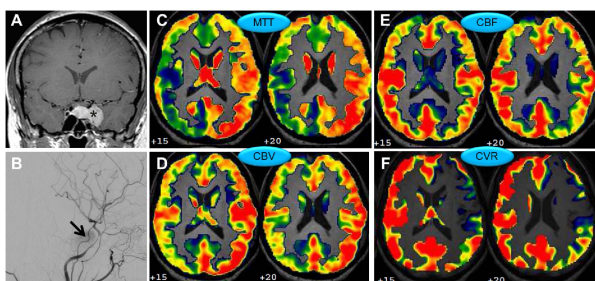


Figure 1. Illustrative case of a 42yo woman referred for a stroke that revealed a meningioma of the left cavernous sinus and a SIAS of the left internal carotid artery. In the left MCA territory downstream SIAS, MTT was increased. Autoregulation allowed to increase CBV to maintain CBF normal. However, CVR was severely decreased ($|CVR\ LI_{MCA}|=0.40$).

Conclusion

In patients with SIAS, the autoregulation raises CBV to face MTT increase and to maintain CBF constant. This compensation is associated with a significant CVR decrease in about 50% of the patients. Among these patients, clinical follow-up may help to better identify those at risk of stroke. Thus, CVR fMRI may be helpful to better manage patients with severe intracranial arterial stenosis and justify PTAS related risks.

References: [1] Chimowitz et al. NEJM 2011; [2] Conklin et al. Neurology 2011; [3] Bouvier et al. Hum Brain Mapp. 2014; [4] Attye et al. Hum Brain Mapp 2013; [5] Mandell et al. Stroke 2008 [6] Krainik et al. Diagn Interv Imaging 2013