FMRI OF CEREBROVASCULAR RESERVE IN PATIENTS WITH SEVERE INTRACRANIAL ARTERIAL STENOSIS

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Background and Objective

Care management of patients with Severe Intracranial Arterial Stenosis (SIAS) at risk of stroke events recurrence remains controversial. Thus, a better characterization of patients with SIAS might be helpful to better define therapeutic strategy. To estimate the risks of ischemic event, imaging of cerebrovascular reserve (CVR) has been proposed using BOLD fMRI to hypercapnic challenge[1-3].

The objectives of the work were to provide 1) normal CVR values in 100 controls without SIAS using a laterality index approach; 2) to provide CVR results in patients referred for SIAS using BOLD fMRI during a hypercapnic challenge

Subjects and Methods

21 patients (5 females; 61.3±19.0 years) with unilateral SIAS of internal carotid (n=9) or middle cerebral artery (MCA) (n=12) were examined using CVR fMRI BOLD contrast with a block-design hypercapnic challenge (CO2 8%) at 3T. Averaged end-tidal CO_2 pressure ($EtCO_2$) was used as a physiological regressor for statistical analyses (SPM8). We conducted regions of interest (ROI) measures of %BOLD signal change/mmHg $EtCO_2$ on segmented gray matter of the MCA territories. We calculated a laterality index with CVR LI_{MCA}=(Left_CVR_{MCA}-Right_CVR_{MCA})/(Left_CVR_{MCA}+Right_CVR_{MCA}). CBV, CBF, MTT were calculated using DSC.

CVR data were compared to those of 100 right-handed volunteers without SIAS (41 women; 47.5±21.6 years).

Results

In controls, mean CVR LI_{MCA} was 0.02 with a slight predominance of the left MCA territory. The standard deviation was 0.03. Thus, 95% confidence interval was [-0.05;+0.07].

In patients, 9 out 21 had an abnormal |CVR LI_{MCA}| ≥ 0.08, leaving 12 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.
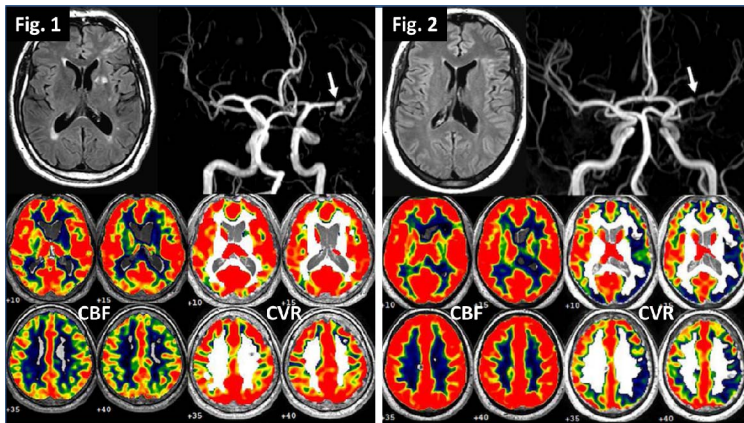

Figure 1. Illustrative case of a 30yo man referred for a stroke and a left MCA SIAS with a post-stenotic aneurysm. Out of the stroke sequel, basal perfusion and CVR were normal (|CVR LI_{MCA}|=0.04).

Figure 2. Illustrative case of a 28yo man referred for a stroke and a left MCA SIAS. Out of the stroke sequel, basal perfusion was normal whereas CVR was severely impaired (|CVR LI_{MCA}|=0.38).

Conclusion

In 100 volunteers without SIAS, the 95% confidence interval of LIMCA was [-0.05;+0.08].

In patients with SIAS, the autoregulation raises CBV and MTT to maintain CBF constant. This compensation is associated with a significant CVR decrease in about 40% of the patients.

CVR fMRI may be helpful to better manage patients with severe intracranial arterial stenosis.

References: [1] Mandell et al., Stroke. 2008; [2] Attye et al., Hum Brain Map 2013; [3] Krainik et al. Diagn Interv Imaging 2013