ORAL PRESENTATIONS

Cerebral blood flow dependency on systemic arterial circulation in progressive multiple sclerosis

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Background

Cerebrovascular reactivity (CVR) is a regulatory mechanism responsible for redistributing cerebral blood flow based on vasoactive stimuli and fluctuations in metabolic demand. Under normal conditions and proper functioning of the neurovascular unit, a direct association between cerebral arterial blood flow and systemic arterial blood flow (SABF) is not expected. Previous studies have suggested impairment of CVR in multiple sclerosis (MS).[1] Moreover, lower cerebral perfusion in MS has been linked with greater neuronal pathology and worse disability outcomes.[2, 3]

Objectives

To determine the relationship between SABF and cerebral perfusion measures in MS patients.

Materials and methods

Cerebral perfusion and SABF were assessed in 118 patients (75 clinically isolated syndrome (CIS)/relapsing-remitting MS and 43 progressive MS) through magnetic resonance imaging (MRI) examination with dynamic susceptibility contrast perfusion-weighted imaging (DSC-PWI) and Doppler ultrasound, respectively. Measures of mean transit time (MTT) and time-to-peak (TTP), measured in seconds, of the normal-appearing whole brain (NAWB) and gray matter (GM) were calculated. Blood flow through the bilateral common carotid and vertebral arteries (in mL/min) represents the SABF. Whole brain volume (WBV) and body mass index (BMI) were used as additional covariates.

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Results

Higher systolic blood pressure was associated with lower SABF (-0.256, p=0.006). In the total MS sample, higher SABF was associated with shorter MTT and TTP of the NAWB (r=-0.256, p=0.007 and r=-0.307, p=0.001) and GM (r=-0.239, p=0.012 and r=-0.3, p=0.001). The SABF and TTP associations were driven by the progressive multiple sclerosis (PMS) patients (r=-0.451, p=0.004 and r=-0.451, p=0.011). Only in PMS, SABF remained a significant predictor of NAWB (standardized β=-0.394, p=0.022) and GM TTP (standardized β=-0.351, p=0.037). MTT and TTP were significantly lower in patients within lower SABF quartiles when compared to the higher quartiles (age, sex, BMI and WBV-adjusted ANCOVA p<0.025). (Figure 1) The differences in PWI-based measured remained significant after additional correction for the prevalence of hypertension. Although statistically

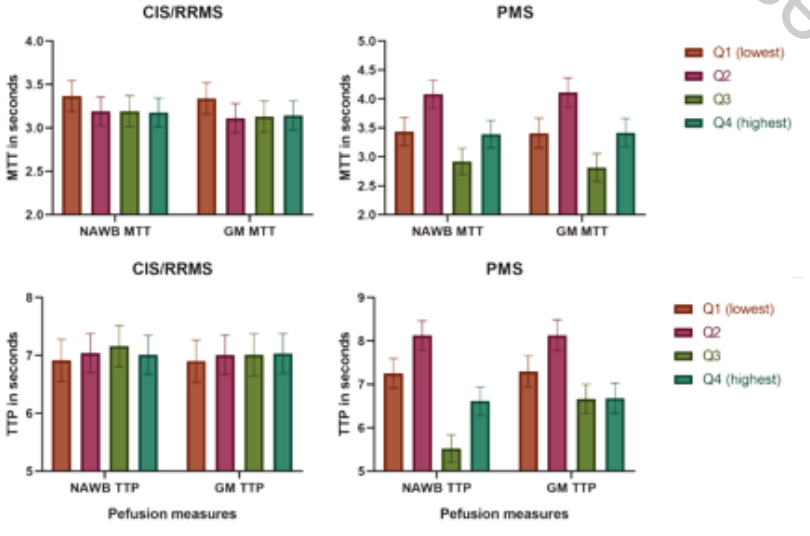

Figure 1. Differences in PWI-based measures between SABF quartiles in CIS/RRMS and PMS patients. PWI: perfusion-based imaging; CIS: clinically isolated syndrome; RRMS: relapsing-remitting multiple sclerosis; PMS: progressive multiple sclerosis; MTT: mean transit time; TTP: time-to-peak; NAWB: normal-appearing whole brain; GM: gray matter; SABF: systemic arterial blood flow.

non-significant, PMS patients within the lower SABF quartiles had a numerically greater disability (expanded disability status scale scores of 5.9 *vs* 5.0 for Q1 and Q4), (multiple sclerosis severity score of 5.8 *vs* 3.8), slower walking as measured by timed 25-foot walk test (23.9 s *vs* 15.8 s) and worse hand dexterity as measured by 9-hole peg test (50.8 s vs. 29.3 s).

Conclusions

The direct relationship between systemic and cerebral blood flow seen in PMS patients may suggest a failure in cerebrovascular reactivity mechanisms and insufficient perfusion control. Cerebral blood flow in PMS may be increasingly dependent on the SABF.

References

1. Marshall O, Lu H, Brisset JC, et al. Impaired cerebrovascular reactivity in multiple sclerosis. JAMA Neurol 2014;71:1275-1281.
2. Jakimovski D, Bergsland N, Dwyer MG, et al. Serum Neurofilament Light Chain Levels are Associated with Lower Thalamic Perfusion in Multiple Sclerosis. Diagnostics (Basel) 2020;10.
3. Jakimovski D, Bergsland N, Dwyer MG, et al. Cortical and Deep Gray Matter Perfusion Associations With Physical and Cognitive Performance in Multiple Sclerosis Patients. Front Neurol 2020;11:700.