

Hypoperfusion of Brain Parenchyma is Strongly Associated with the Severity of Chronic Cerebrospinal Venous Insufficiency in Patients with Multiple Sclerosis

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Objective: To investigate the relationship between chronic cerebrospinal venous insufficiency (CCSVI) and cerebral perfusion in patients with multiple sclerosis (MS).

Background: CCSVI is a vascular condition described in MS patients, characterized by stenoses of the main extracranial veins with hampered cerebral venous outflow. We hypothesized that the impaired venous outflow contributes to hypoperfusion of brain parenchyma.

Methods: Sixteen consecutive relapsing-remitting MS patients (mean age 36.1yrs, mean disease duration 7.5yrs and median EDSS 2.5) and 8 age- and sex-matched normal controls (NC), were scanned on a GE 3T scanner using dynamic susceptibility contrast enhanced perfusion-weighted imaging (PWI). Cerebral blood flow (CBF), blood volume (CBV) and mean transit time (MTT) were measured in the gray matter (GM), white matter (WM), normal appearing (NA) GM, NAWM, thalamus, caudate, putamen, globus pallidus, hippocampus, amygdala, nucleus accumbens, red nucleus and substantia nigra. Diagnosis of CCSVI was established based on the venous hemodynamic (VH) Doppler criteria (Zamboni, JNNP, 2009) and the severity was based on fulfilled VH criteria (score 0-5) and VH insufficiency severity score (VHISS) (score 0-16).

Results: All 16 MS patients fulfilled the diagnosis of CCSVI (median VH=4, median VHISS=9) and none of the NC. There was a significant association between VH criteria and VHISS, and CBF, CBV and MTT in all examined regions of the brain parenchyma in MS patients. The most robust correlations were observed for lower CBF and higher VHISS in the GM, WM, NAWM and NAWM ($r = -0.70$ to -0.72 , $p < 0.002$), and in the thalamus, caudate, putamen, hippocampus, nucleus accumbens ($r = -0.6$ to -0.72 , $p < 0.008$). The correlation coefficients for CBV and MTT were in a range between $r = -0.5$ to -0.65 . No relationship was observed for NC.

Conclusion: This study demonstrates that severity of CCSVI is directly associated with hypoperfusion of the brain parenchyma in MS.

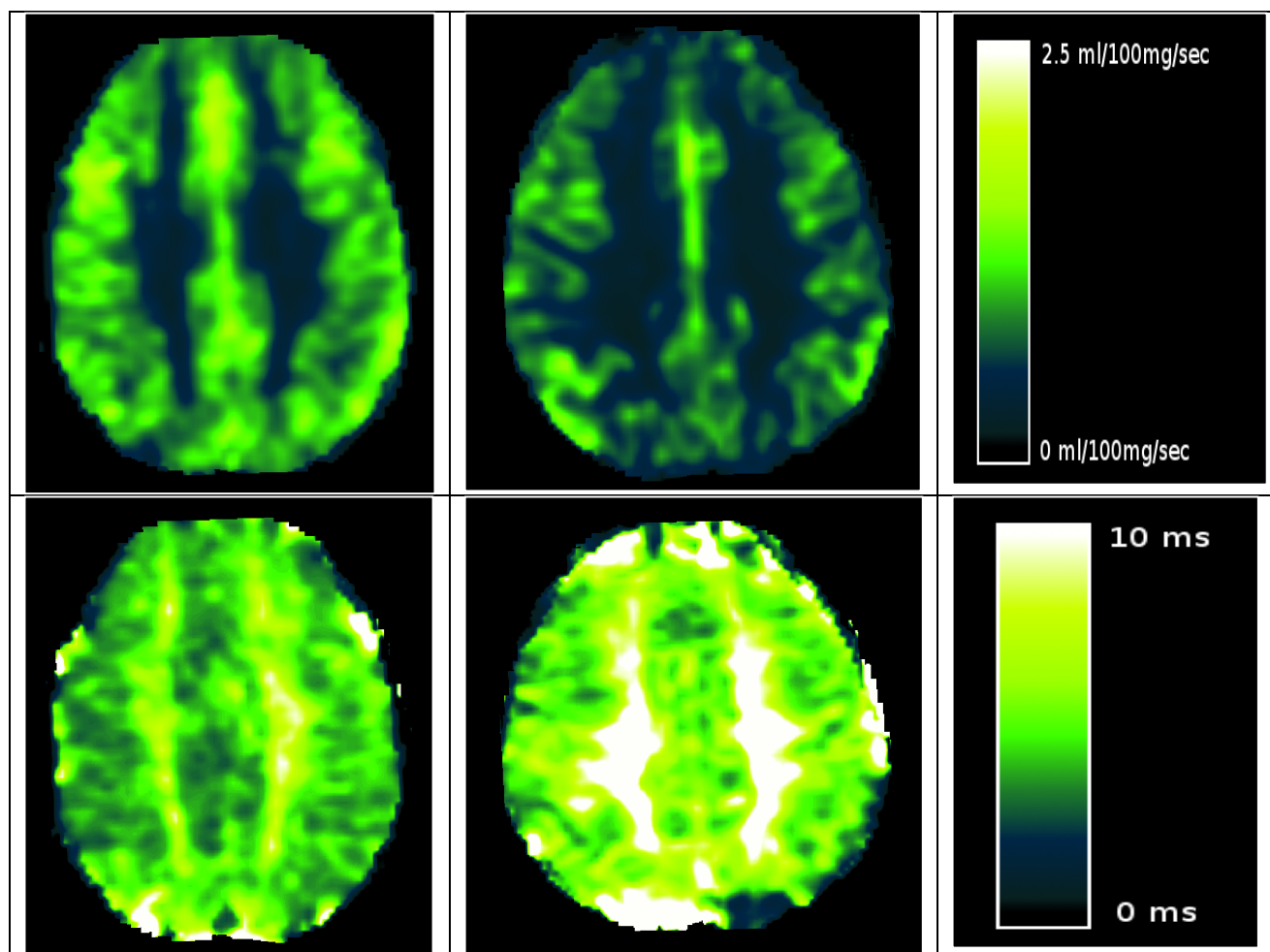


Figure. Examples of perfusion imaging maps in 2 relapsing-remitting multiple sclerosis patients with severe (right images) and less severe (left images) venous hemodynamic insufficiency severity score (VHISS). The patient on the left side is a 33 year old RRMS pts with VHISS 5, and the patient on the right is an 38 year old RRMS patient with VHISS 12. The upper row images represent cerebral blood flow (CBF) results with the dark areas indicating lower CBF flow. Please note more dark areas in the white and gray matter on the right compared to the left image. The lower row images represent mean transit time (MTT) results with bright areas indicating higher MTT. Please note more bright areas in the white and gray matter on the right compared to the left image.