Increased Perfusion in Hypointense Multiple Sclerosis Lesions: A Marker of Lesion Reactivity?

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INTRODUCTION: Vascular inflammation in brain is the critical event in the pathogenesis of multiple sclerosis (MS). MS plaques typically develop along venous structures and tend to disappear and reappear on MRI during the disease progression. Histopathologically, lesion activity has been linked to microvascular inflammatory injury (1), which will in turn influence cerebral hemodynamics or microcirculation. Knowledge on the hemodynamic changes in MS is limited and now can be evaluated in vivo using quantitative dynamic susceptibility contrast MRI (DSC-MRI).

PURPOSE: We investigated the hemodynamic changes, including cerebral blood volume (CBV), cerebral blood flow (CBF), and mean transit time (MTT), in different lesion types and normal appearing white matter (NAWM) in patients with relapsing-remitting MS by using absolute measurements based on artery input function (AIF) of DSC-MRI.

MATERIALS AND METHODS: Seventeen patients with clinical relapsing remitting MS disease were recruited for this study. Imaging was performed on a 1.5T Siemens Vision imager (Siemens Medical Systems, Iselin, New Jersey). After conventional MR imaging, which included T2- and T1-weighted images, a series of 60 gradient-echo echo-planar images (TR/TE/flip angle: 1000/54/30˚) with 3 mm thickness were acquired at 1s intervals during the first pass of a standard dose (0.1mmol/kg) bolus of gadopentetate dimeglumine. Absolute perfusion measurements for CBV, CBF, and MTT were determined using an automated method for calculation of artery input function (2, 3). Measurements were made in 51 non-enhancing lesions (33 hypointense and 17 isointense), 10 enhancing lesions, and 58 standardized locations in frontal lobe NAWM.

RESULTS: Enhancing lesions have significantly increased CBF (mean ± SD: 20.2 ± 5.9; p=0.04) and CBV (1.40 ± 0.32; p=0.005) compared to NAWM (CBF: 17.0 ± 5.7; CBV: 1.14 ± 0.34; respectively). As shown in Figure 1, most hypointense (Hypo2) and isointense lesions showed reduced perfusion with significantly lower CBF (p< 0.004) and prolonged MTT (p<0.01) than NAWM. However, 9 out of 33 hypointense lesions (Hypo1) demonstrated increased CBF (23.7 ± 6.4) and CBV (1.86 ± 0.52) compared to NAWM (p<0.009) (Fig. 2).

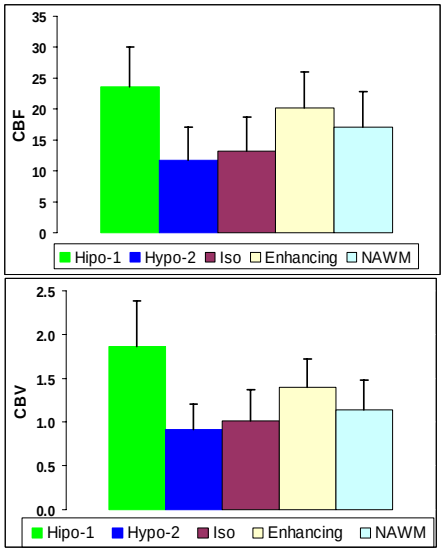

Fig 1. CBF (top) and CBV (bottom) measurements in different type of lesions and NAWM in MS patients. Hypo-1: hypointense lesions with increased perfusion; Hypo-2: hypointense lesions with lower perfusion; Iso: isointense lesions. CBF: cerebral blood flow (ml/100g/min); CBV: cerebral blood volume (ml/100g).

CONCLUSION: Our preliminary findings suggest that cerebral perfusion is increased in enhancing lesions due to the vascular inflammatory changes (ie. vesodilation) seen in the acute plaques. There is hemodynamic impairment in non-enhancing MS lesions demonstrating significantly decreased CBF and increased MTT compared to NAWM, which may reflect microvascular occlusive change and possible hypoperfusion in the less acute phase. The increased perfusion in some hypointense lesions (Fig. 2) suggests some reactivity with lesion inflammation and subsequent increase in perfusion. We are undertaking further studies to determine if DSC-MRI can provide additional information in disease pathogenesis, lesion development and disease activity in MS study.

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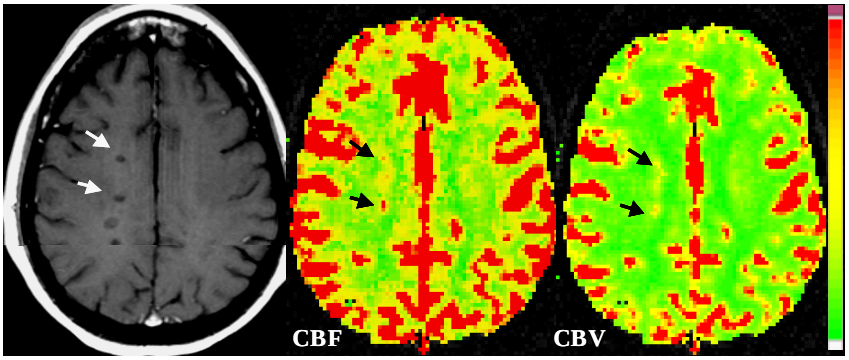

Fig 2. Example of hypointense lesions with increased perfusion (CBF and CBV) in a RR-MS patient.

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