Abstract

OBJECTIVE: To develop an objective method for quantifying venous vasculature in brain parenchyma on susceptibility-weighted imaging (SWI). To apply this technique in multiple sclerosis (MS) patients and in healthy controls (HC). BACKGROUND: SWI is a MRI application that can directly image cerebral veins by exploiting venous blood oxygenation. DESIGN/METHODS: Sixty-two (62) MS patients (44 relapsing-remitting and 18 secondary-progressive) and 33 age- and sex-matched HC were imaged on a 3T GE scanner using pre-contrast SWI. A subset of MS patients (50) and HC (7) obtained SWI-post gadolinium contrast sequence (0.1 mMol/Kg Gd-DTPA with 10 min delay). In-house developed segmentation algorithm, based on a 3D multi-scale line filter, was applied for vein segmentation. Absolute volumetric measurement for total vein vasculature was performed in millimeters (m) and the relative venous intracranial fraction (VIF) was obtained to correct for head size and amount of brain atrophy. The size of individual veins was measured in mm and 4 groups were created according to their mean diameter: <0.3mm, 0.3-0.6mm, 0.6-0.9mm and >0.9 mm. Voxel brain average distance-from-vein maps was also calculated with higher distance indicating fewer veins. RESULTS: A significantly lower absolute venous volume was detected in MS patients compared to HC, both in pre-contrast (67.5 vs. 82.7ml, -18.3%, p<0.001) and post-contrast (70.4 vs. 87.1ml, -19.1%, p<0.011) images. The VIF was significantly lower in MS patients (p<0.001). The highest mean diameter difference was found for the smallest veins (p<0.3 mm), both on pre- (p<0.001) and post-contrast (p<0.018) images. The distance-from-veins was also significantly higher in MS patients (p<0.001). CONCLUSIONS/RELEVANCE: We developed and validated a quantitative vein-segmentation method that showed altered visibility of venous vasculature on SWI pre- and post-contrast images in MS patients. These findings suggest severely compromised brain venous system in MS patients.

Category - MS and Related Diseases - Clinical Science

Platform Session: Integrated Neuroscience - Multiple Sclerosis Imaging (2:00 PM-3:30 PM)
DESIGN/METHODS: extracranial venous outflow pathways and by a high rate of cerebral venous reflux that may lead to increased iron deposition in the brain.

RESULTS: 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), by using specific proposed Doppler criteria (Zamboni et al, JNNP, 2009).

BACKGROUND: CCSVI is a complex vascular condition characterized by anomalies of the main extracranial cerebrospinal (CS) venous routes that interfere with the normal CS venous outflow. This condition was previously associated with clinically definite MS. DESIGN/METHODS: Cross-sectional study that will enroll consecutive 1700 subjects at one MS center including: 1000 adult patients with possible and definite MS (50 clinically isolated syndrome, 50 radiologically isolated syndrome, 500 relapsing-remitting, 300 secondary-progressive, 50 primary-progressive MS and 50 neuromyelitis optica). A comparative group will include 300 OND patients and 300 adult age- and sex-matched NC. Fifty pediatric patients (<18 yrs) with acquired demyelinating diseases (MS and acute disseminated encephalomyelitis) and 50 pediatric NC will be assessed. All participants will undergo clinical examination and a Doppler scan of the head and neck. All MS patients and a subcohort of NC and OND will undergo an MRI of the brain. A consecutive subgroup (MS, NC and OND) will have also an MRI of the veins of the neck to corroborate the Doppler diagnosis of CCSVI. The Doppler, and MRI evaluators are blinded to the subject status. The prevalence and severity of venous hemodynamic abnormalities identified in the different groups will be analyzed. Data will be unblinded at three predetermined time-points based on the number of subjects enrolled: at 500, 1000 and 1700 subjects respectively. RESULTS: As of 1 Nov 2009, 473 subjects signed informed consent. The initial interim analysis following the first 500 subjects is scheduled for December 2009. CONCLUSIONS/RELEVANCE: The interim results of the first 500 enrolled subjects will be presented.

RESULTS: All 16 MS patients fulfilled the diagnosis of CCSVI (median VH=4, median VHSS=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, NAGM and NAWM (r= -0.70 to -0.72, p<0.002), and in the thalamus, caudate, putamen, hippocampus, nucleus accumbens, red nucleus and substantia nigra. The correlation coefficients for CBV and MTT were in a range between r= -0.5 to -0.65. No relationship was observed for NC.

CONCLUSIONS/RELEVANCE: This study demonstrates that severity of CCSVI is directly associated with hypoperfusion of the brain parenchyma in MS. Supported by: Hillarescere Foundation and Buffalo Neuroimaging Analysis Center.

RESULTS: All 16 MS patients fulfilled the diagnosis of CCSVI (median VH=4, median VHSS=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, NAGM 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.

CONCLUSIONS/RELEVANCE: This study demonstrates that severity of CCSVI is directly associated with hypoperfusion of the brain parenchyma in MS. Supported by: Hillarescere Foundation and Buffalo Neuroimaging Analysis Center.

RESULTS: All 16 MS patients fulfilled the diagnosis of CCSVI (median VH=4, median VHSS=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, NAGM and NAWM (r= -0.70 to -0.72, p<0.002), and in the thalamus, caudate, putamen, hippocampus, nucleus accumbens, red nucleus and substantia nigra. The correlation coefficients for CBV and MTT were in a range between r= -0.5 to -0.65. No relationship was observed for NC.

CONCLUSIONS/RELEVANCE: This study demonstrates that severity of CCSVI is directly associated with hypoperfusion of the brain parenchyma in MS. Supported by: Hillarescere Foundation and Buffalo Neuroimaging Analysis Center.

RESULTS: All 16 MS patients fulfilled the diagnosis of CCSVI (median VH=4, median VHSS=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, NAGM and NAWM (r= -0.70 to -0.72, p<0.002), and in the thalamus, caudate, putamen, hippocampus, nucleus accumbens, red nucleus and substantia nigra. The correlation coefficients for CBV and MTT were in a range between r= -0.5 to -0.65. No relationship was observed for NC.

CONCLUSIONS/RELEVANCE: This study demonstrates that severity of CCSVI is directly associated with hypoperfusion of the brain parenchyma in MS. Supported by: Hillarescere Foundation and Buffalo Neuroimaging Analysis Center.

RESULTS: All 16 MS patients fulfilled the diagnosis of CCSVI (median VH=4, median VHSS=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, NAGM and NAWM (r= -0.70 to -0.72, p<0.002), and in the thalamus, caudate, putamen, hippocampus, nucleus accumbens, red nucleus and substantia nigra. The correlation coefficients for CBV and MTT were in a range between r= -0.5 to -0.65. No relationship was observed for NC.

CONCLUSIONS/RELEVANCE: This study demonstrates that severity of CCSVI is directly associated with hypoperfusion of the brain parenchyma in MS. Supported by: Hillarescere Foundation and Buffalo Neuroimaging Analysis Center.

RESULTS: All 16 MS patients fulfilled the diagnosis of CCSVI (median VH=4, median VHSS=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, NAGM and NAWM (r= -0.70 to -0.72, p<0.002), and in the thalamus, caudate, putamen, hippocampus, nucleus accumbens, red nucleus and substantia nigra. The correlation coefficients for CBV and MTT were in a range between r= -0.5 to -0.65. No relationship was observed for NC.

CONCLUSIONS/RELEVANCE: This study demonstrates that severity of CCSVI is directly associated with hypoperfusion of the brain parenchyma in MS. Supported by: Hillarescere Foundation and Buffalo Neuroimaging Analysis Center.

RESULTS: All 16 MS patients fulfilled the diagnosis of CCSVI (median VH=4, median VHSS=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, NAGM and NAWM (r= -0.70 to -0.72, p<0.002), and in the thalamus, caudate, putamen, hippocampus, nucleus accumbens, red nucleus and substantia nigra. The correlation coefficients for CBV and MTT were in a range between r= -0.5 to -0.65. No relationship was observed for NC.

CONCLUSIONS/RELEVANCE: This study demonstrates that severity of CCSVI is directly associated with hypoperfusion of the brain parenchyma in MS. Supported by: Hillarescere Foundation and Buffalo Neuroimaging Analysis Center.

RESULTS: All 16 MS patients fulfilled the diagnosis of CCSVI (median VH=4, median VHSS=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, NAGM and NAWM (r= -0.70 to -0.72, p<0.002), and in the thalamus, caudate, putamen, hippocampus, nucleus accumbens, red nucleus and substantia nigra. The correlation coefficients for CBV and MTT were in a range between r= -0.5 to -0.65. No relationship was observed for NC.

CONCLUSIONS/RELEVANCE: This study demonstrates that severity of CCSVI is directly associated with hypoperfusion of the brain parenchyma in MS. Supported by: Hillarescere Foundation and Buffalo Neuroimaging Analysis Center.
CONCLUSIONS/RELEVANCE: The findings from this pilot study suggest that CCSVI may be an important mechanism leading to iron deposition in brain parenchyma of MS patients. In turn, iron deposition, as measured by SWI, is a strong predictor of disability progression in patients with MS. Supported by: Hillariescere Foundation and Buffalo Neuroimaging Analysis Center.

RESULTS: Net CSF flow scan-rescan reproducibility was 10.9%. Net CSF flow rate (stroke volume) was significantly lower in MS patients than in NC patients and 8 age- and sex-matched NC were scanned on a GE 3T scanner using a two-dimensional phase-contrast gradient-echo MR technique with high spatial-temporal resolution (in-plane resolution 0.39x.039mm² and 32 phases, corresponding to a full cardiac cycle) on one 4mm thick slice positioned perpendicular to the Sylvius aqueduct. In addition to CSF flow measures, lesion volume (LV) and atrophy MRI outcomes were calculated.

DESIGN/METHODS: To develop an objective MRI technique for quantifying the cerebrospinal fluid (CSF) flow in Sylvius aqueduct. To apply this technique in a pilot study in multiple sclerosis (MS) patients versus normal control (NC) and provide further correlates with other MRI specific disease metrics. BACKGROUND: Non-invasive MRI investigation of the CSF dynamics in MS has not been previously reported. DESIGN/METHODS: For consistency and objective quantification of the antegrade (towards 4th ventricle), retrograde (towards 3rd ventricle) and net CSF flow rates, a semi-automated program was developed. The CSF flow quantification technique was validated on a tube phantom, using a power injector which provided a controlled flow rate. 2 NC and 2 MS patients were scanned and rescanned within a week, to test reproducibility. Sixteen (16) consecutive relapsing-remitting MS patients and 8 age- and sex-matched NC were scanned on a GE 3T scanner using a two-dimensional phase-contrast gradient-echo MR technique with high spatial-temporal resolution (in-plane resolution 0.39x.039mm² and 32 phases, corresponding to a full cardiac cycle) on one 4mm thick slice positioned perpendicular to the Sylvius aqueduct. In addition to CSF flow measures, lesion volume (LV) and atrophy MRI outcomes were calculated.

RESULTS: Net CSF flow scan-rescan reproducibility was 10.9%. Net CSF flow rate (stroke volume) was significantly lower in MS patients than in NC patients and 8 age- and sex-matched NC were scanned on a GE 3T scanner using a two-dimensional phase-contrast gradient-echo MR technique with high spatial-temporal resolution (in-plane resolution 0.39x.039mm² and 32 phases, corresponding to a full cardiac cycle) on one 4mm thick slice positioned perpendicular to the Sylvius aqueduct. In addition to CSF flow measures, lesion volume (LV) and atrophy MRI outcomes were calculated.

CATEGORY - MS and Related Diseases - Clinical Science
Wednesday, April 14, 2010 3:30 PM
Poster Session: Integrated Neuroscience: Multiple Sclerosis Imaging (3:30 PM-4:30 PM)