High-b-value DWI and Perfusion Findings in Idiopathic Intracranial Hypertension

P. Pianka[1], A. Kesler[2], T. Hendler[1], A. Loewenstein[2], Y. Cohen[3], Y. Assaf[1,3]

[1]Department of Radiology, Tel Aviv Sourasky Medical Center, Tel Aviv, Israel, [2]Department of Ophthalmology, Tel Aviv Sourasky Medical Center, Tel Aviv, Israel, [3]School of Chemistry, Tel Aviv University, Tel Aviv, Israel

Introduction: Idiopathic intracranial hypertension (IIH) is a disorder associated with intracranial pressure greater than 250mm water, normal neuroimaging and cerebral spinal fluid content. Symptoms include severe headache, transient visual obscuration, diplopia, and visual field defects. Ophthalmological findings include papilledema in the majority of patients, sixth nerve palsy, in severe cases, which is not accompanied by other local neurological signs. The pathophysiology of the disorder is unclear; involvement of the venous flow may be one of the causative mechanisms. Earlier studies of IIH have shown reduced cerebral perfusion using SPECT (1,2). Furthermore, studies of visual evoked potentials in IIH have shown increase in P100 latencies that correlated with severity and progression of the disease, thus inferring white matter involvement in this disorder (3). Although this patient group performs MR imaging as a diagnostic baseline, to the best of our knowledge perfusion and diffusion characteristics as seen on MRI have not been investigated in this disorder. Our objective was to investigate the effect of increased intracranial pressure in IIH on brain perfusion and white matter integrity by diffusion tensor imaging (DTI), q-Space analysis of high-b-value diffusion weighted imaging (high-b-DWI) and perfusion weighted imaging (PWI).

Methods: Eight patients with IIH (ages 22-37, 2 males) and four normal controls (ages 25-38, 1 male) were enrolled in this study. Scanning was conducted on a 3T General Electric VH/I scanner. The MRI protocol included T1, T2 and FLAIR images and MR Venography. Diffusion images included low b value DTI (bmax=1000 s/mm2, Δ/δ=31/25ms) and high b value DWI (bmax=14,000 s/mm2, Δ/δ=72/65ms). Twenty-four slices of 5mm with 1mm gap were acquired for the DTI from which 8 slices covering the occipital and temporal lobes were used in the high b value diffusion and perfusion scans. Q-Space analysis of high b value diffusion data was done as described before (4) to produce displacement and probability maps. Perfusion weighted images were acquired using a bolus injection of GdDTPA (0.5mmole/kg) from which Relative cerebral blood volume (rCBV), relative cerebral blood flow (rCBF) and mean transient time (MTT) were calculated. Regions of interest were chosen so as to include the occipital and temporal subcortical white matter and were analyzed separately for right and left hemispheres. Analysis was done on homemade software based on MatLab.

Results: All conventional neuroimaging was concluded as normal with no signs of sinus vein thrombosis. In seven patients (88%) perfusion analysis demonstrated marked reduction (Mann-Whitney U test, $p<0.05$) of both rCBF and rCBV compared with normal controls, in all ROIs. MTT values, however, were similar to that of the control group indicating a reduction in both blood volume and blood flow, rather than non-perfusion in these regions. Q-Space analysis demonstrated increase in displacement values and decrease in probability values in right and left occipital subcortical white matter (Table 1). This reduction in displacement/probability corresponded to the areas of hypoperfusion in the occipital lobe. Analysis of displacement, probability, FA and rCVB in the left and right temporal ROIs was similar to the controls. Furthermore, analysis of FA was similar to that of the controls in all ROIs. Figure 1 shows MRI data set of typical IIH patient showing areas of reduced q-space probability and rCBV (green circles).

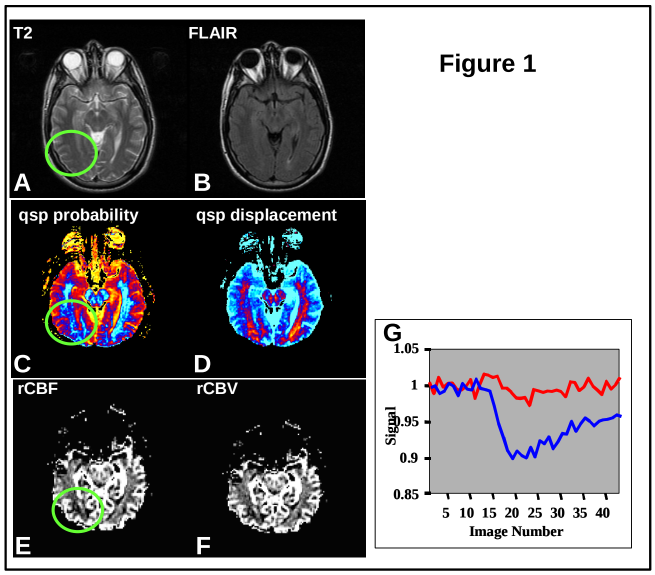

Figure 1

Discussion and Conclusion: To date, the diagnosis of IIH is one of exclusion. It is currently believed that there is no resultant damage to the brain in these patients. Our results indicate significant reduction in restricted diffusion in the occipital subcortical white matter by q-Space analysis of high-b-value DWI. This method has been shown to be sensitive to white matter changes in demyelinating disorders such as MS (4). Therefore, this reduction in displacement values may represent a process of axonal loss or demyelination. Moreover, perfusion deficits were seen in the majority of these patients corresponding to the areas of white matter abnormalities. As the perfusion deficits appeared to be more widespread than the white matter changes, it is possible that the perfusion deficits preceded the changes in white matter. Are these changes a result of ICP or rather related to the etiology of the disease? Further research may shed more light on this important issue.

Table 1	Displacement (μm)		Probability		FA		% rCBV	
	Control	IIH	Control	IIH	Control	IIH	Control	IIH
Left Occipital	2.6±1.0	3.5±0.9 (p<0.02)	7.8±0.8	7.2±0.9 (p<0.05)	0.42±0.13	0.39±0.14 (n.s.)	1.04±0.25	0.64±0.25 (p<0.03)
Right Occipital	3.2±0.4	4.1±1.1 (p<0.02)	7.9±1.0	6.8±1.0 (p<0.02)	0.35±0.11	0.33±0.13 (n.s.)	1.05±0.18	0.57±0.26 (p<0.03)
Left Temporal	2.9±0.7	3.0±0.5 (n.s)	8.2±0.9	7.9±1.0 (n.s.)	0.53±0.12	0.45±0.15 (n.s.)	1.02±0.06	0.75±0.15 (p<0.01)
Right Temporal	2.9±0.6	3.1±0.7 (n.s.)	8.4±0.8	8.2±1.0 (n.s.)	0.55±0.13	0.44±0.16 (p<0.01)	1.06±0.04	0.75±0.19 (p<0.01)

[1] Statistical analyses is done using the Mann-Whitney U test. [2] N=8 for the IIH group and N=4 for the control group. [3] %rCBV is normalized to rCBV measurements at the internal capsule.

References: (1) Baker M et-al. Nucl Med Commun 17:696, 1996 (2) Lorberboym M et-al. Clin Neurol Neursurg 103:33, 2001 (3) Sureda B et-al. Neurologia 6:242, 1991 (4) Assaf Y et-al. Magn Reson Med 47:115, 2002.