# Fiber Tractography Visualizing Altered White Matter Connection in Periventricular Leukomalacia: PET Correlation Study

S. Y. Kim[1], S-K. Lee[1], D. J. Kim[1], D-I. Kim[1]

[1]Diagnostic Radiology, Yonsei University College of Medicine, Seoul, Korea, Republic of

**Introduction**

Periventricular leukomalacia (PVL) is a form of deep white matter injury, due to hypoxic-ischemic insult in the watershed region peculiar to the premature infant, which occurs in the brain developement between 24 to 34 weeks (1). Lesions are characteristically distributed along the white matter tracts dorsal and lateral to the external angle of the lateral ventricles, and are most frequently observed near the occipital horn. The typical MRI finding of PVL is a diminished volume of the periventricular white matter with close approximation of the posterior temporal and occipital cortices to the ventricular wall and thinning of the posterior body and splenium of the corpus callosum. A recent diffusion tensor-MRI (DT-MRI) study in children with PVL, demonstrated prominent abnormalities in the white matter fiber tracts projecting to and from the occipital and parietal lobes (2). The impaired or altered cerebral cortical development in premature patients with PVL, has also been indicated in previous specialized histopathological study, quantitative volumetric three-dimensional MRI study and radionuclide studies using PET or SPECT (3,4). Integration of white and gray matter pathology in patients with PVL might facilitate the understanding of pathyphysiology of ischemic insult in preterm babies.Here, our recent experience of the correlative imaging findings from conventional MRI, DT-MRI and FDG-PET in a patient with PVL, is reported.

**Materials and Methods**

The patient was an 8-year-old boy, born at 32 weeks weighing 1,950 grams with no known history of perinatal asphyxia, jaundice or seizure. Incubator care was performed in the neonatal intensive care unit for 2 months. He had an operation history for correction of strabismus at 5 years old. On examination, he had limitation in independent walking or standing, while the motor function of the upper extremities was unimpaired. His intelligence was proportionate to his age. An MR study was performed using a 1.5-T Philips Gyroscan Intera system (Philips Medical System, Best, the Netherlands), with a 6-channel Sensitivity Encoding (SENSE) head coil. Conventional MR images were obtained using spin-echo T1-weighted axial, fast spin-echo T2-weighted axial and sagittal sequences. The section thickness and intersection gap were 5 and 1mm, respectively, with two excitations, and the matrix was 256 × 192. Diffusion weighted imaging was performed using single-shot spin echo – echo planar imaging, with navigator echo phase correction (motion correction) and SENSE factor 2. A data matrix of 96 acquisitions, reconstructed to 128 over a field of view of 220mm, was obtained. The imaging slices were positioned to make the slice perpendicular to the anterior commissure-posterior commissure (AC-PC) line. The slice thickness was 2.3mm, without a gap (45 to 55 slices); TE = 70ms; TR = 6599-8280ms; number of acquisition = 2, b = 600 $mm^2/s$. The data were processed on a Windows-2000 PC, equipped with the PRIDE research software (Philips Medical Systems, Best, Netherlands), based on the FACT method (5). The anisotropy was calculated using orientation-independent fractional anisotropy (FA), and DT-MRI-based color maps were created from the FA values and three vector elements. Vector maps were assigned as red (x element, left-right), green (y, anterior-posterior), and blue (z, superior-inferior), with proportional intensity scales according to the FA. The three-dimensional fiber tractography was then obtained by connecting voxel to voxel with a FACT algorithm. Regions of interest (ROI) were drawn in the entire bilateral peritrigonal white matter on the coronal scan, and every fiber connected to and from the peritrigonal region was produced. The PET scans were obtained, using a GE Advance tomograph (GE Medical Systems, Milwaukee, WI), 30 minutes after the intravenous administration of 150 MBq of FDG. The images were acquired in 3 dimensions using 4-mm transverse and 8.5-mm axial filters. The acquisition time was approximately 20 minutes, and the images were reconstructed using filtered back projection with a calculated attenuation coefficient.

**Results**

Conventional MR images revealed a decreased volume and an increased T2 signal intensity of the deep periventricular white matter of the bilateral parietooccipital lobe (Fig. 1). Thinning of the corpus callosum was also noted. Fiber tractography revealed a relatively more decreased volume of the white matter bundle of the right parietooccipital area (Fig. 2A, B and C). Thinning of association fiber connecting the deep white matter of the right parietooccipital and right temporal lobe was also noted. On FDG-PET (Fig. 2D), decreased glucose uptake in the right anterior temporal lobe, with a mildly decreased uptake in the bilateral caudate nuclei and thalami were also seen, all of which revealed no structural abnormalities on a conventional MRI.

Fig.1 Fig.2

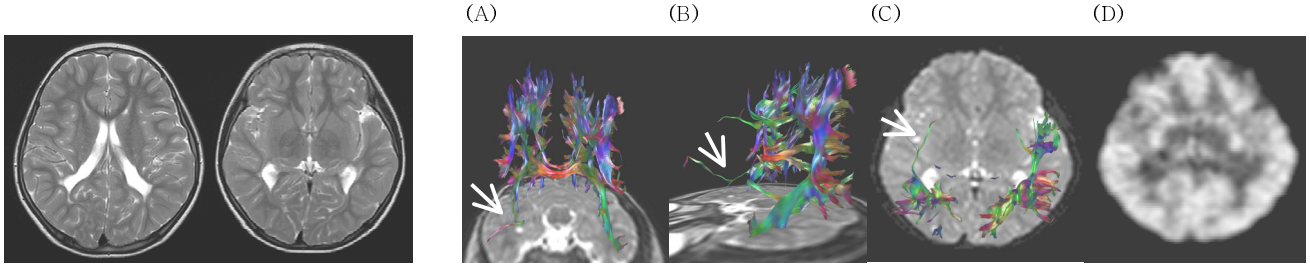


Fig. 1. T2-weighted MRI showing decreased volume and increased signal intensity of the deep periventricular white matter of the bilateral parietooccipital lobe. There are no structural abnormalities of the anterior temporal gray and white matters.

Fig. 2. Fiber tractography using DT-MRI and FDG-PET. Coronal (A), left anterior oblique coronal (B) and axial (C) views of the fiber tractography demonstrate a more prominent volume reduction of the right parietooccipital white matter bundle, with thinning of the right association fiber. FDG-PET reveals a decreased glucose uptake in the right anterior temporal area (D).

**Conclusions**

The present result provides an additional insight to the idea of the impact of early ischemic injury to the white matter in the developing brain of a patient with PVL. Integration of the imaging findings of gray and white matter pathologies, depicted separately on FDG-PET and DT-MRI, might provide insight into the anatomical and functional correlation for neurological deficits in patients with PVL.Owing to its ability for direct mapping of the organizational patterns of the white matter, DT-MRI might play a role in supporting the preexisting hypotheses on normal and altered development of the white matter tract of the brain.

**Reference**

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