Diffusion Tensor MRI and Fiber Tractography of Cerebellar Atrophy in Phenytoin Users

S. Lee¹, S. Mori², D. Kim³, D. Kim³

¹Yonsei University College of Medicine, Seoul, Korea, Republic of, ²Johns Hopkins University School of Medicine, Baltimore, MD, United States, ³Yonsei University College of Medicine, Seoul, Seoul, Korea, Republic of

Synopsis
The authors used diffusion-tensor MR imaging (DT-MRI) to examine cerebellar atrophy induced by long-standing phenytoin use and olivoponto-cerebellar atrophy. DT-MRI showed normal fractional anisotropy (FA) of cerebellar peduncles and transverse pontine fibers of phenytoin users while primary cerebellar degeneration group showed decreased FA values. Fiber tractography demonstrated decreased volume and altered fiber integrity of peduncles and transverse pontine fibers in primary cerebellar atrophy group, while phenytoin users showed nearly the same fiber intactness as normal controls, suggesting phenytoin affects cerebellum directly with preserved interconnecting fibers. DT-MRI findings of cerebellar atrophy by phenytoin therapy suggest direct injury to Purkinje cells rather than alteration of afferent fiber tracts to cerebellum as OPCA.

Purpose
To assess the pattern of cerebellar atrophy in phenytoin (PHT) users on diffusion tensor MR imaging (DT-MRI) and evaluate differences from OPCA.

Methods
Thirteen patients (M:F = 7:6, Mean age = 42.5 years) and age matched normal controls participated in this study. Patient group consisted of epileptic patients who had received phenytoin therapy (n=9) and clinically diagnosed as olivopontocerebellar atrophy (OPCA) (n=4). All studies were performed using a 1.5T Philips Gyroscan Intera system. DT-MRI was performed using SSEPI with navigator echo phase correction (motion correction) and 2 channel SENSE. A data matrix of 128 over a FOV 230mm was obtained and zero-filled to 256. Slice thickness was 3mm without a gap (36 slices); TE = 88ms; TR = 6000ms; SENSE factor = 2; EPI factor = 67; Number of acquisition = 4. Diffusion weighting was performed along six independent axes, using diffusion weighting of b = 600 s/mm². Fractional anisotropy and color-coded vector maps were calculated. FA of middle cerebellar peduncle (MCP), cerebellum and transverse pontine fiber (TPF) were measured and compared between PHT users and non-PHT cerebellar atrophy group. Three dimensional fiber tractography was processed by PRIDE software (Philips Medical Systems, Best, Netherlands) and visual comparison was performed between normal controls and patient group.

Results
Phenytoin user showed FA value as 0.84±0.09 in MCP, 0.72±0.08 in TPF and 0.21±0.04 in cerebellum. OPCA patients showed FA value as 0.39±0.11 in MCP, 0.46±0.12 in TPF and 0.22±0.07 in cerebellum. Phenytoin user showed statistically significant reduction of FA only in cerebellum, while OPCA demonstrated significant decrease of FA in MCP, TPF and cerebellum (one-way ANOVA, p<.01) (Table and centered figure). Three dimensional fiber tractography demonstrated decreased volume and altered fiber integrity of peduncles and transverse pontine fibers in OPCA group, while phenytoin users showed nearly the same fiber intactness as normal controls (Right figure).

Conclusions
PHT users showed normal orientation and anisotropy of MCP and TPF while OPCA demonstrated impaired values, suggesting PHT affects cerebellum directly. DT-MRI can demonstrates detailed fiber configuration of brain stem and cerebellum.

References