Correlation of Thalamic Volume and Microstructural Abnormalites in Central Visual Pathways in High Risk Preterm Infants

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Purpose: To test the hypotheses that: (1) high risk preterm infants with periventricular leukomalacia (PVL) demonstrate significant correlation between thalamic volume and microstructural abnormalities (MAs) in central visual pathways (optic radiation, splenium) and (2) high risk preterm infants without PVL demonstrate more subtle MAs to central visual pathways compared to preterm infants with PVL and term controls at term equivalent age.

Methods: Preterm neonates were divided into two groups based on occurrence of PVL (focal periventricular necrosis, ventriculomegaly). Echo planar imaging (EPI) diffusion tensor Imaging (DTI) sequence using a neonatal head coil with 25 directions and b=700s/mm^2 on a 1.5T GE was performed. Tract based spatial statistics (TBSS) in FSL and Region of Interest (ROI) analyses in DTIStudio were used. Brain metric and thalamic volumes were measured using volumetric MR. ANOVA, Tukey's Pairwise and Pearson statistical analyses were performed.

Results: Neuroimaging data were compared among 34 preterms with PVL, 27 preterms without PVL, and 28 term (non-PVL) controls. Post Conceptional Ages (PCA) comparison is shown in **Table.1**. In preterms with PVL, thalamic volume was significantly reduced compared to the two other groups (p<0.005). In the same group, MAs were significant in the thalamus (p≤0.003), optic radiation (p≤0.002), splenium (p≤0.001), genu (p≤0.001), and posterior limb of internal capsule (PLIC) (p≤0.005). Preterms without PVL showed subtle MAs in the thalamus and splenium which did not reach statistical significant after correction for multiple comparisons for fractional anisotropy (FA) **(Fig.1)**. Thalamic volume correlated positively with FA in the optic radiation in all preterms (r=0.637) **(Fig.2)**.

Discussion: Preterms with PVL demonstrate extensive white matter tract damage, including MAs in central visual pathways (optic radiation, splenium) as well as non-visual pathways (genu, PLIC). Preterm neonates without PVL demonstrate only subtle MAs in the splenium and thalamus, the latter structure with subdivisions critical to visual processing (e.g., pulvinar). Importantly, the significant correlation between thalamic volume and optic radiation microstructural injury in both preterm groups suggests: 1) damage to central visual pathways is not always associated with PVL detected by neuroimaging; and 2) thalamic injury may play a pivotal role in the pathogenesis of cognitive visual impairment in survivors of prematurity with or without PVL.

Conclusion: There is a strong correlation between thalamic volume and MAs in structures involved in central visual pathways in high risk preterm infants with PVL at term equivalent age. There are subtle MAs noted in central visual pathways in preterm infants without PVL.

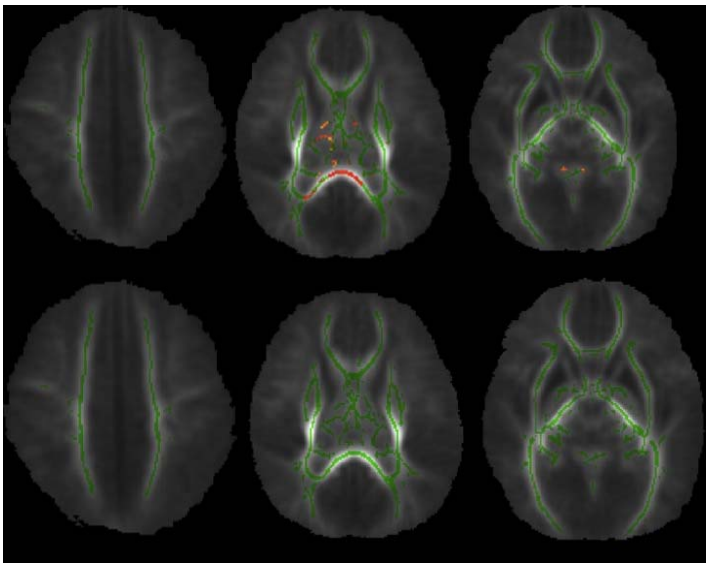

Fig.1: *Top row, TBSS uncorrected analysis of preterms without PVL vs. term controls, showing reduced fractional anisotropy (FA) in thalamus and splenium (red/yellow voxels, p<0.05). Bottom row, after correction for multiple voxel comparisons, no statistically significant difference is noted for FA values. For the ROI analysis (data not shown), there was increased radial diffusivity in the splenium and the thalamus suggesting subtle MAs in these regions.*

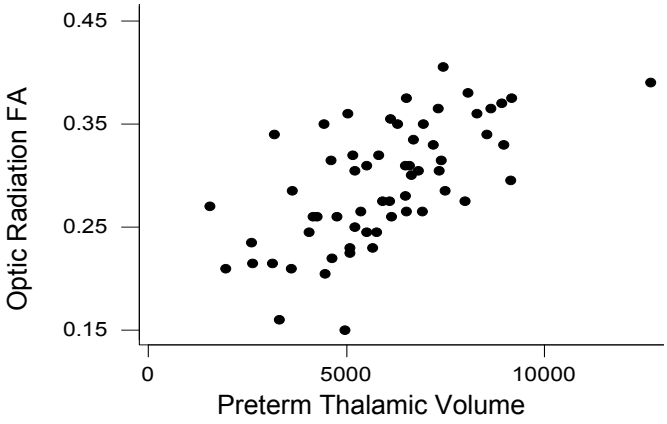

Fig.2: *Correlation between thalamic volume (mm3) and FA of Optic Radiation (p≤0.001; r=.637) of all preterms (with and without PVL).*

Table.1: *Age Comparison*

PCA (weeks): Mean (SD)			ANOVA
With PVL	Without PVL	Control Term	p
41.8 (6.1)	42.6 (6.5)	44.4 (4.2)	0.198

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References: 1. Ligam et al, Ped Res, 2009, 2. Nagasunder et al. AJNR, 2010, 3. Cheong et al. AJNR, 2009. 3. Amanda et al. Pediatr Res, 2009