PLASTICITY OF THE OPTIC RADIATION FOLLOWING UNILATOCCIPITAL LOBE RESECTION: A DIFFUSION TENSOR IMAGING STUDY.ERAL

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Introduction: Children with unilateral damage to the primary visual cortex and optic radiation exhibit a blind region of the peripheral visual field contralateral to the side of injury [1,2]. Functional MRI studies have demonstrated that, following injury to the striate cortex, reorganizational changes may occur in the ipsilateral extrastriatal and contralateral visual cortex [3,4]. We hypothesized that diffusion tensor MRI (DTI) might demonstrate plasticity changes of optic radiation following occipital lobe resection in children with intractable epilepsy.

Materials and Methods: We studied 10 epileptic patients (mean age= 12.3 ± 4.3 years) who had undergone surgical resection of unilateral occipital cortex for control of seizures, and 13 subjects (mean age= 9.1 ± 4.01 years), who had undergone MRI scan either as normal controls or for illness such as sinusitis, headache or febrile seizures. DTI was acquired with 6 non-collinear diffusion sensitization gradients averaged 6 times with b= 1000 [s/mm^2] and a set of reference T2W (b $\sim$ 0 s/mm^2). Fiber bundles representing the posterior thalamic radiation including optic radiation (Figure 1A, 1B) were tracked using DTI-Studio software [5]. The mean fractional anisotropy (FA), apparent diffusion coefficient (ADC), diffusivity parallel to the fiber tract ($ADC_{\parallel}$) and perpendicular to the fiber tract ($ADC_{\perp}$) values of the fibers were calculated. The recorded time periods (PRD) between surgery and DTI acquisition were subdivided into Early (EG < 5 months), Intermediate (IG = [19, 26] months), and Late groups (LG = [35,70] months). We verified, in each case, the completeness of surgical resection where absence of tractographic fibers following surgery was associated with visual field loss [6].

Results: In the surgery group, FA values of the optic radiation contralateral to the side of surgical resection showed a significant positive partial correlation (r^2=0.756, p<0.05) with PRD (Figure 1C). The between-group univariate ANCOVA comparison was significant (p = 0.011). The between-group analyses for ADC and $ADC_{\parallel}$ for the optic radiation were significantly different (ADC, p=0.026; $ADC_{\parallel}$, p=0.045). Post-hoc tests showed higher mean values for the three study subgroups as compared to that of the control group. Although $ADC_{\perp}$ appeared lower in the LG and IG as compared to the EG (Figure 1D), the difference was not statistically significant.

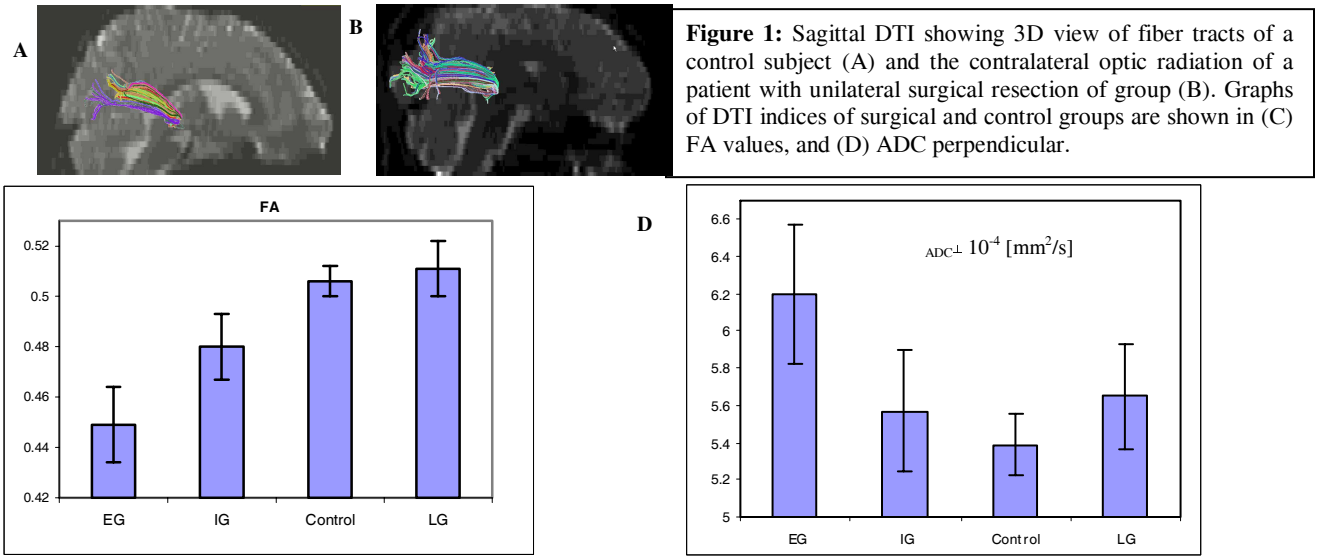

Figure 1: Sagittal DTI showing 3D view of fiber tracts of a control subject (A) and the contralateral optic radiation of a patient with unilateral surgical resection of group (B). Graphs of DTI indices of surgical and control groups are shown in (C) FA values, and (D) ADC perpendicular.

Conclusion: The present study clearly demonstrates that FA and ADC undergo significant changes in the contralateral optic radiation following unilateral occipital resection. The most robust finding is that FA values of the contralateral optic radiation in the surgical group undergo a linear increase with duration from the surgical resection to the time of DTI acquisition. This increase in FA value with time since surgery is consistent with increased functional activity seen in fMRI [3], and positron emission tomography studies on subjects with unilateral visual cortex injury [7]. In normal children, enhanced myelination on existing axons and changes associated with white matter glial cells affecting the compactness of existing axons might contribute to anisotropic changes associated with age [8,9]. However, in our surgical patients, anisotropic changes might be due to the formation of new axonal fibers in a given volume and subsequent myelination.

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