White matter tractography by diffusion tensor imaging in Insular Epilepsy

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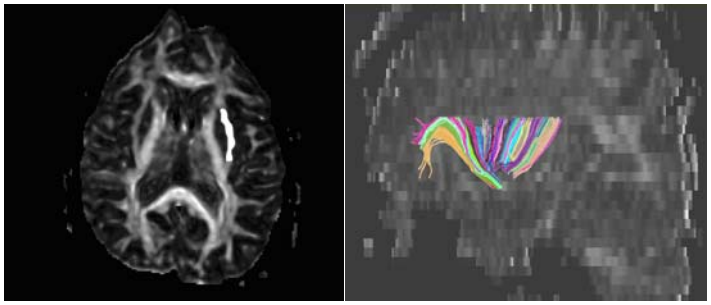
Introduction: The identification of an insular origin of partial epilepsy remains a significant challenge. We hypothesized that in cases of an insular epileptogenicity, a difference in fiber density in the subinsular white matter could be measured. Therefore, a comparative hemispheric study of the subinsular white matter was performed using DTI and tractography in four patients with a unilateral partial epilepsy of insular origin. The same analysis was performed in five patients with unilateral medial temporal lobe epilepsy (mTLE) and ten nonepileptic subjects to establish whether the findings may be unique to the former condition.

Materials: Magnetic resonance (MR) DTI was performed in patients with insular epilepsy (n=4), medial temporal lobe epilepsy (n=5) and in nonepileptic subjects (n=10). MR imaging data were acquired on a GE Signa 3 Tesla scanner (General Electric, Milwaukee, WI). Each volume covered a 240 mm x 240 mm field of view with 0.9375 mm x 0.9375 mm in-plane resolution. Patients datasets were acquired using 25 noncolinear weighting directions and a single shot echo planar imaging (EPI) sequence with a 'b' value of 1000 sec/mm^2 and 2.6 mm slice thickness. All patients underwent extraoperative electrocorticography, which identified a focal epileptogenicity in the insular region. MEG provided further confirmation in three patients.

Methods: Single ROI tractography was performed using the Fiber Assignment by Continuous Tracking (FACT) algorithm [1] with an angular threshold greater than 50° retaining only those voxels with an FA > 0.25. ROIs outlined manually in the subinsular white matter in each hemisphere. To ensure reproducibility of the subinsular ROIs among subjects, the axial slice approximating the dorsoventral midinsular point was chosen as the slice upon which to establish the ROI (Fig. 1). Fiber densities (i.e., number of fibers per voxel) were calculated for a ROI confined to the subinsular white matter within each cerebral hemisphere.

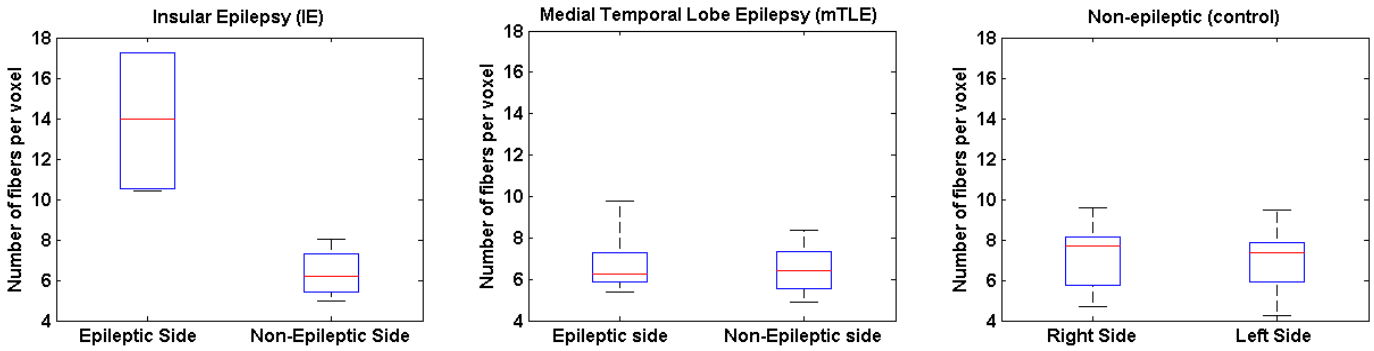
Results: In the insular epilepsy group, differences in fiber density between the epileptic and nonepileptic sides were apparent with as much as a 100% increase in density on the epileptic side and a significant difference established for the means (p = 0.01) (Fig. 2-a). In contrast, similar fiber density measurements for each of the mTLE and nonepileptic groups identified no significant differences between the two sides with p values of 0.86 and 0.45, respectively (Fig. 2-b,c).



(a) **(b)**

Fig 1. (a) Fractional Anisotropy (FA) axial image with a region of interest (ROI) demarcated within the left subinsular white matter. (b) A tractographic reconstruction of the subinsular white matter as defined in (a).

Discussion: Fiber density measurement of the subinsular white matter using MR tractography in cases of insular epilepsy shows a distinct increase on the side of epileptogenicity in this preliminary study. Apart from identifying a hidden site of epileptogenicity which, at times, accounts for the failure of temporal lobe surgery [2], this simple approach provides a consistent and robust measure of laterality. The absence of comparable asymmetry of subinsular fiber density in cases of mTLE or in those without epilepsy and free of any other neurologic or psychiatric disorder supports the contention that a unique diagnostic situation exists in the case of insular epilepsy.



(a) **(b)** **(c)**

Fig 2. Box plots show the range of fiber density values with standard deviation again showing a significant difference in the insular epilepsy group (a) (P=0.01) but not in the medial temporal lobe epilepsy group (b) or any difference between right and left sides in the nonepileptic group (c).

References: [1] Jianga *et al*, Comput. Methods Programs Biomed.,81:106-16, 2006. [2] Ryvlin *et al* Curr. Opin. Neurol.,18:125-7, 2005.
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