Cortical thinning in children with frontal lobe epilepsy

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Background

Seizure localization in frontal lobe epilepsy (FLE) is challenging due to the rapid spread of seizure activity as a result of the extensive network of subcortical and cortico-cortical connections of the frontal lobe. This extensive network may lead to widespread cortical thinning or cortical atrophy beyond the seizure onset zone. Previous studies on mesial TLE have demonstrated widespread cortical changes beyond the hippocampus, occurring in frontal, temporal and occipital lobes (1-3). The pattern of cortical thinning or cortical atrophy may differ depending on the epileptogenic network. Our hypothesis was that spread of seizure activity outside the frontal lobe due to cortico-cortical connections resulted in alteration in the cortex beyond the frontal lobe in children with intractable FLE. The aim of this study was to identify regions of reduced cortical thickness beyond the frontal lobe in children with intractable FLE.

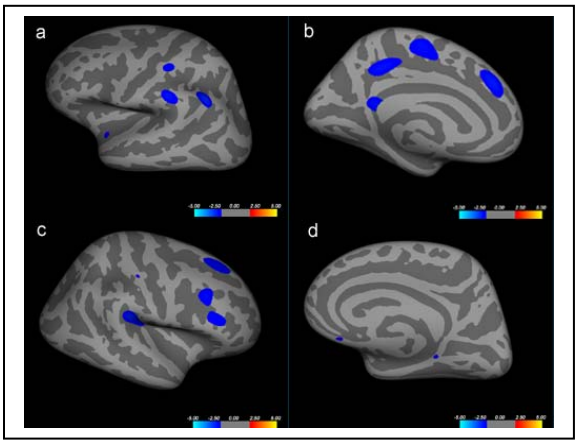
Methods

17 children with FLE who were being evaluated for epilepsy surgery due to intractable epilepsy were recruited. All patients had normal MRI. The mean age of the patients was 11.7 years (range: 5.9 to 18.6 years). The mean age at seizure onset was 4.9 years (range: 4months to 7.5 years) and mean duration of epilepsy was 6.5 years (range: 21months to 14 years). Twelve children had left FLE and five children had right FLE. Twenty-six age-matched healthy subjects with mean age of 11.5 years (range: 5.1 to 18 years), without neurological or psychiatric disorders and normal MRI formed the control group. FreeSurfer was used for cortical surface reconstruction and cortical thickness estimation of the volumetric T1-weighted imaging of patients and controls. The cortical thickness at each vertex across the cortical mantle was calculated and then mapped to the inflated surface of each brain reconstruction. Group differences in cortical thickness of patients with right and left FLE were compared to controls using general linear model provided by FreeSurfer. The group analysis was performed using uncorrected trends with $p<0.01$. A False Discovery Rate (FDR) of $p<0.05$ was also applied to correct for multiple comparisons. We also assessed the thickness of gyral-based regions of interest, as defined by Desikan et al. (4) and computed the z-scores of gyral thickness.

Results

Left FLE: Using an uncorrected trends of $p<0.01$, the regions with cortical thinning in the left hemisphere included the superior frontal, paracentral, precuneus, cingulate, inferior parietal, supramarginal, post central and superior temporal gyri (figure 1 below). The regions with cortical thinning in the right hemisphere included the superior and middle frontal, medial orbitofrontal, supramarginal, post central, banks of superior temporal sulcus, and parahippocampal gyrus. Group wise analysis using a FDR of $p<0.05$ showed cortical thinning in the left superior frontal and inferior parietal and right supramarginal gyri. Amongst the 12 patients with left FLE, eight patients had z-scores of <-2.0 within the Desikan gyral-based regions of interest. Seven of the eight patients had z-scores of <-2.0 within both frontal lobes and one had z-scores of <-2.0 in the left frontal lobe only. All eight patients had z-scores of <-2.0 in the extra-frontal lobes.

Right FLE: Using an uncorrected trends of $p<0.01$, the regions with cortical thinning in the right hemisphere included the precentral and postcentral, transverse temporal, parahippocampal, lingual and lateral occipital. The regions with cortical thinning in the left hemisphere included the superior frontal, inferior parietal, post central, superior temporal, posterior cingulate and lingual. Group wise analysis using a FDR of $p<0.05$ showed cortical thinning in the right transverse temporal and left superior frontal gyri. Amongst the five patients with right FLE, four patients had z-scores of <-2.0 within the Desikan gyral-based regions of interest. Two of the four patients had z-scores of <-2.0 within both frontal lobes and one had z-scores of <-2.0 in the left frontal lobe only. All four patients had z-scores of <-2.0 in the extra-frontal lobes.



Conclusion

We have found frontal and extra-frontal cortical thinning in both right and left FLE, which may reflect the epileptogenic network in FLE. The clinical significance of the cortical changes remains to be elucidated. Further studies with larger patient cohort and correlation with neuropsychological outcomes are needed.

Reference

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