Surface-based morphometric abnormalities in patients with early psychosis: an MP2RAGE-based study at 7T

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BACKGROUND

Schizophrenia is a neurodevelopmental disorder affecting cerebral morphology. Most morphometrical studies of schizophrenia were performed based on MP2RAGE images at 1.5T or 3T. It has been demonstrated that the MP2RAGE sequence leads to more excellent reproducibility and higher tissue contrast relative to MP-RAGE.1-3 Due to subtle brain abnormalities in EP, it is essential to use more sensitive neuroimaging techniques to study cortical features. High sensitivity for detecting such features and their precise localization is a key advantage of using Surface-based morphometry (SBM). SBM may facilitate the observation of subtle cortical changes at the early stage of the disease. This study aims to investigate cortical features in patients with EP compared to healthy controls via the first time, Surface-based morphometry (SBM) analysis using MP2RAGE images at 7T.

RESULTS

- No significant difference in TIV and surface areas between patients and controls.
- The average cortical thickness of both left and right hemisphere are significantly reduced in the EP patients (left: p = 0.008, F = 7.26; right: p = 0.02, F = 5.72).
- At the cluster-wise level, the significant clusters were identified at the junction of the left lateral occipital, lingual and perilunate region where the cortical area and volume are shrinked in the patients. The peak P-value is located at the left fusiform (left in Figure 1) and para hippocampal (right in Figure 1), respectively.
- At the vertex-wise scale, some relatively small clusters where the cortical areas are reduced in the patient group were found at right lateral occipital, left postcentral, left caudal middle frontal, and right insula. The cortical thickness was decreased at left reticular, right inferior temporal, and left lateral occipital lobe in the EP patient. The thickness increased slightly at the right lingual in patients. The cortical volume reduction was also highlighted in right isthmus cingulate, left postcentral, and left precentral.

Table 1: Demographic information of subjects

<table>
<thead>
<tr>
<th>Characteristics</th>
<th>EP (n = 47)</th>
<th>HC (n = 35)</th>
<th>p Value***</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age (years)</td>
<td>24.66(4.90)</td>
<td>23.49(5.39)</td>
<td>0.059</td>
</tr>
<tr>
<td>Gender (M/F)</td>
<td>34/13</td>
<td>27/8</td>
<td>0.682</td>
</tr>
<tr>
<td>Hand dominance</td>
<td>Right</td>
<td>Right</td>
<td>0.708</td>
</tr>
<tr>
<td>Onset age (years)</td>
<td>23.39(4.5)</td>
<td>22.78(5.7)</td>
<td>-</td>
</tr>
<tr>
<td>Illness duration</td>
<td>1.56(1.73)</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>PANSS-positive score</td>
<td>11.62(3.42)</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>PANSS-negative score</td>
<td>16.08(5.46)</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>PANSS-general score</td>
<td>30.64(12.52)</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>PANSS-total score</td>
<td>58.71(13.92)</td>
<td>-</td>
<td>-</td>
</tr>
</tbody>
</table>

* Continuous variables are expressed in mean values (standard deviations);
** Categorical variables in frequency
*** t test for continuous variables; χ2 test for categorical variables

Figure 1: Statistical maps of cortical area (left) and cortical volume (right) change in the left hemisphere between EP patients and healthy controls. A large significant cluster (cyan cluster in the lower row) survived after permutation multiple comparison correction. The colour bar represents the significance level common logarithm of p-value. Blue and red stand for negative (patient < control) and positive (patient > control) contrasts, respectively.

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This is the first 7T MP2RAGE-based SBM study in patients with EP. The most significant clusters with reduced cortical area and volume in EP were identified at the junction of left lateral occipital, lingual and perilunate region. The clusters, where the surface area and cortex volume in patients were aberrant, largely overlap. Previous studies4-7 using MPRAGE imaging at 3T and 1.5T, and alterations in the occipital area of EP patients. However, research on the chronic cases1-3 reported abnormal geometric changes in the subregions of occipital area. Therefore, our current results suggest that ultra-high field utilization and MP2RAGE images could provide the detection of the neural disease at an early stage of neurodevelopmental process. A previous meta-analysis11 showed that the majority of the cortex thinning and surface area shrinkage in patients with schizophrenia were situated in frontal and temporal lobes regions. Considering EP cases, studies mostly identified the cortical changes appearing at temporal and anterior cingulate cortex.12-13 The different outcomes between ours and chronic research could be the cortical alteration expansion to the frontal part with the duration of illness.

In conclusion, the results of surface-based analysis using MP2RAGE images at an ultra-high magnetic field provide evidence of different cortical structural features between EP patients and controls. Equipped with such sensitive techniques, we may capture the subtle alterations at the early stage of neurological disorder. The findings are comparable with the relevant neuroimaging studies.