ABSTRACT

Recent studies suggest loss of efficient inter-hemispheric communication and cortex asymmetry as possible sources of schizophrenia etiology. We investigate the inter-hemispheric connection between bilateral superior temporal gyrus (STG) using diffusion tensor imaging (DTI) and correlate DTI measures to asymmetry measures of STG gray matter in this study. Decreased fractional anisotropy (FA), increased trace, axial diffusivity (AD) and radial diffusivity (RD) were found in inter-hemispheric fiber tracts connecting bilateral STG gray matter belonging to chronic schizophrenics. In chronic schizophrenics, correlation was found between FA, mode and cortical thickness asymmetry, as well as AD and volume asymmetry.

BACKGROUND

The STG is part of the temporal lobe in the human brain. Abnormalities in STG gray matter are commonly reported in magnetic resonance imaging (MRI) studies involving schizophrenics [1]. Loss of efficient inter-hemispheric communication [2] and cortex asymmetry [3] are possible sources of schizophrenia pathology. These led us to hypothesize differences in inter-hemispheric connection between bilateral STG gray matter and its asymmetry measures.

MATERIALS

Subjects:

- 27 patients with chronic schizophrenia (SZ) and 26 normal controls (NC) are involved in this study, with their demographics as shown below:

<table>
<thead>
<tr>
<th></th>
<th>Age</th>
<th>Male</th>
<th>Female</th>
<th>Age range (years)</th>
<th>Gender ratio</th>
<th>% Male</th>
<th>% Female</th>
</tr>
</thead>
<tbody>
<tr>
<td>27</td>
<td>17-74</td>
<td>13</td>
<td>14</td>
<td>18-74</td>
<td>1.2:1</td>
<td>48.1%</td>
<td>51.9%</td>
</tr>
<tr>
<td>26</td>
<td>17-73</td>
<td>13</td>
<td>13</td>
<td>17-73</td>
<td>1:1</td>
<td>50%</td>
<td>50%</td>
</tr>
</tbody>
</table>

Data Acquisition:

- A 3T GE scanner was used.
- Parameters for structural MRI: TR=7.48ms, TE=3ms, FOV=256mm, 176 axial slices with 1mm thickness each.
- Parameters for DTI: 51 directions, TR=1700ms, TE=78ms, FOV=24cm, 144x144 encoding steps, 85 axial slices with 1.7mm thickness each.

REFERENCES


FIGURES

- **Figure 1:** Coronal view of deased STG gray matter
- **Figure 2:** 3D rendering of STG gray matter
- **Figure 3:** Coronal view of white fiber tracts connecting bilateral STG, overlaid on an FA map
- **Figure 4:** Sagittal view of white fiber tracts connecting left and right STG, overlaid on a FA map
- **Figure 5:** Group difference in mean FA
- **Figure 6:** Group differences in mean trace
- **Figure 7:** Correlation between mean FA and cortical thickness asymmetry
- **Figure 8:** Correlation between mean Mode and cortical thickness asymmetry
- **Figure 9:** Correlation between mean AD and volume asymmetry

METHODS

- Non-linear registration between structural and DTI data of each individual subject was performed, with the latter as reference.
- Freesurfer (http://surfer.nmr.mgh.harvard.edu) was used for segmenting and computing volume, surface area, cortical thickness of STGs gray matter (Figures 1 and 2) from structural MRI data.
- Asymmetry was assessed using the lateralization index [4]:
  \[(\text{Left} – \text{Right}) / \{0.5(\text{Left} + \text{Right})\}\]
- Whole brain tractography from DTI data was derived using a novel filtered two-tensor method [5] developed in the Psychiatry Neuroimaging Lab.
- White matter fiber tracts of interest were extracted using STG gray matter as the regions of interest (ROIs).
- Extraneous tracts were removed through clustering [6].
- The mean FA, mode, trace, AD and RD of resulting fiber tracts (Figures 3 and 4) were then computed for each subject.

RESULTS

- The filtered two-tensor tractography method was able to reliably reproduce the fiber tracts between left and right STG gray matter for all subjects.
- Independent T-test revealed group differences for following DTI measures:
  i) FA at p = 0.045 (Figure 5)  ii) Trace at p = 0.004 (Figure 6)
  iii) AD at p = 0.026  iv) RD at p = 0.003
- No group differences were found for STG gray matter asymmetry indexes.
- Pearson correlation test revealed following correlations in SZ group:
  i) FA and cortical thickness asymmetry at p = 0.023 (Figure 7)
  ii) Mode and cortical thickness asymmetry at p < 0.001 (Figure 8)
  iii) AD and volume asymmetry at p = 0.037 (Figure 9)
- No correlations were revealed in NC group.

CONCLUSIONS

- Lower FA and higher trace in SZ suggest reduced white matter integrity, due likely to weaker myelination and/or lack of coherence in the inter-hemispheric white matter fiber tracts connecting bilateral STG.
- Higher AD and RD in SZ are likely due to the higher trace.
- Correlations between DTI and asymmetry measures in the SZ group suggest that the latter is implicated in schizophrenia.