ABSTRACT

The basal ganglia (BG) are integrally involved in motor function, and have recently been shown to form part of limbic and cognitive components in frontal-striatal-thalamic (FST) circuits. Abnormalities in FST circuits have also been theorized to account for some of the symptoms and cognitive disturbances observed in schizophrenia. Much of this circuitry converges on the globus pallidus (GP), before projecting to the thalamus. More specifically, the GP pars interna (GPi) represents a major “output” nucleus of the BG.

Pathology in this structure, therefore, could severely affect FST circuit function and, in turn, account for motor, limbic, and cognitive deficits in schizophrenia. Using structural MRI, we explored differences in the GP between schizophrenics and normal controls.

Structural MR images were acquired on a 3T GE Echospeed system for 17 male, chronic schizophrenics and 19 normal controls group matched for age and parental socioeconomic status. A Sobel filter, an edge detection operator, was applied to highlight the borders of the GP. The GP was manually delineated by following the high-intensity borders marked by the Sobel filter. Volume measurements, relative to intra-cranial contents, were calculated.

Volumetric measurements revealed a significant increase in schizophrenics in the left (p=0.013) and right (p=0.007) GP relative volumes (i.e., corrected for head size).

Our findings of increased GP relative volume in schizophrenia is consistent with our lab’s previous findings, and with the notion that GP is important in the pathophysiology of schizophrenia. These findings also suggest the importance of further partitioning of the GP into its internal and external segments to determine if there is a further localization to the enlargement and to further clarify the role of the effect of medication.

RESULTS

Volumetric measurements revealed (Table 1):

- A non-significant difference between diagnostic groups for left non-normalized GP volume (p=0.117)
- A significant increase in right non-normalized GP volume in schizophrenia (p=0.005)
- A significant increase in left and right normalized GP volume in schizophrenics (p=0.013 and p=0.007, respectively)

DISCUSSION

Using the Sobel filter to highlight unclear borders of the GP allows for a more accurate and easier way to segment the structure.

The bilateral increase in schizophrenic GP volume is consistent with previous findings from our group (Hokama et al.) using a 1.5T scanner - this further validates our findings.

This significant change in volume supports the theory that the basal ganglia are intimately involved in schizophrenic symptomatology. Further studies are necessary to investigate the degree to which neuroleptics affect the size of the GP in schizophrenics, since these medications are believed to increase basal ganglia volumes.

Correlation analyses may also help explain how the notable increase in volume affects neuropsychiatric and clinical measures.

Additionally, shape studies and further segmentation of the structure into internal and external portions may further localize the change in schizophrenics.

METHODS

Subjects

- 17 male chronic schizophrenics and 19 male normal controls, group matched for age and parental socioeconomic status.

Data Acquisition

- Images were acquired on a 3.0-T GE scanner: 176 axial slices, 1mm x 1mm x 1mm voxel size.

ROI Analyses

- A Sobel filter, an edge detection operator, was applied to structural scans to help identify borders of the GP (Figure 1).
- The Sobel filters were overlaid on the corresponding structural scans to clarify borders for GP segmentation (Figure 2).
- Volumes for segmented GP ROIs were measured, normalized for intra-cranial contents (Figures 3 & 4).

Volumetric Analyses (normalized for head size)

- Correlation analyses may also help explain how the notable increase in volume affects neuropsychiatric and clinical measures.
- Additionally, shape studies and further segmentation of the structure into internal and external portions may further localize the change in schizophrenics.

REFERENCES


(1) Psychiatry Neuroimaging Laboratory, Brigham and Women’s Hospital, Harvard Medical School
(2) Clinical Neuroscience Division, Laboratory of Neuroscience, Boston VA Health Care System-Brockton Division, Department of Psychiatry, Harvard Medical School
(3) Department of Computer Science, Department of Psychiatry, University of North Carolina, Chapel Hill, NC

Table 1. Non-normalized and normalized average volumes and standard deviations for the GP in SZs and NCs

<table>
<thead>
<tr>
<th></th>
<th>Schizophrenics (N=17)</th>
<th>Normal Controls (N=19)</th>
<th>p-value</th>
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<tbody>
<tr>
<td>Non-Normalized Volume</td>
<td></td>
<td></td>
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<tr>
<td>Left GP</td>
<td>1.335 (0.268)</td>
<td>1.797 (0.246)</td>
<td>0.117</td>
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<tr>
<td>Right GP</td>
<td>1.952 (0.265)</td>
<td>1.806 (0.159)</td>
<td>0.05</td>
</tr>
<tr>
<td>Normalized Volume</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Left GP</td>
<td>1.272 (0.164)</td>
<td>1.141 (0.133)</td>
<td>0.013</td>
</tr>
<tr>
<td>Right GP</td>
<td>1.282 (0.142)</td>
<td>1.151 (0.130)</td>
<td>0.007</td>
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Figure 1. A Sobel filter operator generates an image that highlights edges by applying a 2-D gradient

Figure 2. Overlapping the T1-weighted structural image and the Sobel-filtered T1 creates an easy to see border between the GP and surrounding tissues

Figure 3. Border tracing of the GP using the Sobel filter

Figure 4. a. (above) 3-D axial model of the final GP volume. b. (below) 3-D coronal model of the final GP volume