The Subdivided Corpus Callosum in Schizophrenia: A DTI Study

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Introduction

Growing numbers of studies have suggested that schizophrenia is a condition of abnormal connectivity in the cortico-cortical connections and the connections between the hemispheres [1]. The fibers from different cortical areas are distributed on corpus callosum (CC) that is the main tract dominating interhemispheric information transfer in the brain. Recently, diffusion tensor imaging (DTI) has become a popular noninvasive method for studying white matter structures and pathology of human brain in vivo [2]. To observe the abnormal brain connectivity in schizophrenia, the investigation of subdivided CC using DTI with the index, fraction anisotropy (FA), can directly and easily indicate the integrity of the fiber tracts in connection with each cortical regions.

Materials and Methods

25 patients with schizophrenia (12 M, 13 F, mean age 38.1 ± 10.1 y/o) diagnosed with the Structure Clinical Interview for DSM-IV-Patient Version (SCID-P) and 25 healthy subjects (12 M, 13 F, mean age 39.1 ± 10.1 y/o) were recruited. Exclusion criteria included the history of neurological symptoms and head injury. All subjects were scanned on a 1.5T Signa GE Excite-II MR scanner in TPE-VGH with an 8-channel head coil using a single shot diffusion spin-echo EPI sequence with TR/TE = 17000/68.9 msec, the voxel size = $2 \times 2 \times 2.2$ mm. The diffusion-weighting gradients were applied in 13 non-collinear directions with b-value = 1000 s/mm^2 and NEX = 6. All FA images were calculated from each DTI dataset and normalized to a group template created by the SPM2 package (Wellcome Department of Cognitive Neurology, Institute of Neurology, London, UK). The contours of CC were defined on the midsagittal slices of each normalized FA datasets and subdivided by the in-house program developed in Borland C++ to 8 subregions (Figure A),using a method described by Witelson in 1989.[3] The 8th subregion was a circle area divided manually from the spleium to analyze the fibers connected with the inferior temporal lobe.[4] Regional differences of FA between the patient-control groups were explored through two-tailed unpaired t-tests with a statistic threshold of $p < 0.05$.
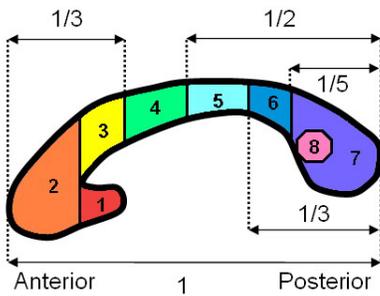
Figure A. *The corpus callosum was subdivided into 7 segments using a method described by Witelson in 1989.[3], and a circle areawas added in the 7th subregion.*

Results

The patients had lower FA in Region 1, 2, 3, 4, 5 and 8 than healthy subjects, as showed in Figure B. Region 1 and 2 might correlate with the connections of the bilateral prefrontal lobes. (Table A) Region 3 and 4 were the motor-related communication areas. Region 5 and 8 connected respectively with the somaesthetic area and inferior temporal lobe. Lower FA reflected the degraded microstructural tissue integrity. The results indicated that the communication between the hemispheres in prefrontal lobe, motor area, somaesthetic area and inferior temporal lobe were poor in schizophrenia patients.

Discussions

The connection of the major tracts with the prefrontal lobe and with the temporal lobe showed abnormal connectivity reported in the previous study for schizophrenia [5], where CC were only subdivided roughly in 3 partitions. Based on the knowledge in human brain anatomy that the altered cognitive and perceptional experiences in schizophrenia would affect the connections of specific cortical sites [3], CC should be subdivided in more regions to get more detailed information. Therefore, analyzing subdivided CC can provide more pathological, physiological and neuropsychological information.

Region	Anatomical Label	Cortical Region
1	Rostrum	Caudal/orbital prefrontal, inferior premotor
2	Genu	Prefrontal
3	Rostral body	Premotor, supplementary motor
4	Anterior midbody	Motor
5	Posterior midbody	Somaesthetic, posterior parietal
6	Isthmus	Superior temporal, posterior parietal
7	Splenium	Occipital, inferior temporal
8	Splenium	Inferior temporal

Table A. *The 8 subregions with the anatomical labels and a rough topography of callosal fibers in relation to cortical regions were listed in the table.[3]*
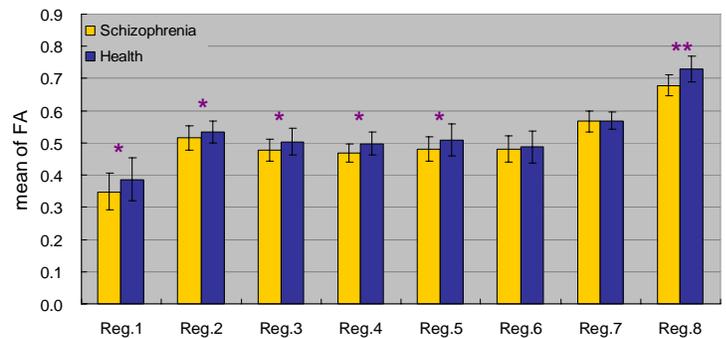
Figure B. *The mean FA of the CC in Region 1,2,3,4,5 and 8 were significantly lower in the schizophrenia patients than the healthy people with the statistic threshold of $*P<0.05$ or $**P<0.001$.*

Acknowledgements

References

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