Tract-specific analysis of the superior occipitofrontal fasciculus in schizophrenia

N. Kunimatsu[1], A. Kunimatsu[2], S. Aoki[1], O. Abe[1], Y. Masutani[1], H. Yamasue[3], K. Kasai[3], and K. Ohtomo[1]

[1]Department of Radiology, Graduate School of Medicine, University of Tokyo, Tokyo, Japan, [2]Institute of Clinical Medicine, University of Tsukuba, Tsukuba, Japan, [3]Department of Neuropsychiatry, Graduate School of Medicine, University of Tokyo, Tokyo, Japan

Introduction

Increasing attention has been given on cerebral white matter abnormalities of schizophrenic patients. Although not fully understood, disorganization of the thalamo-prefrontal circuitry has been given a putative role in pathogenesis of schizophrenia [1]. However, little is known about any specific white matter tracts between the prefrontal cortex and the thalamus. According to an anatomic dissection study, the superior occipitofrontal fasciculus (SOFF) may be a candidate [2]; but, the previous MR studies did not explore SOFF as a potential element of the circuitry [3, 4]. We aimed to visualize fibers of SOFF which extend to the thalamus by diffusion tensor (DT) tractography and to seek diffusion abnormality of the tract.

Methods

Subjects

Nineteen right-handed male patients with schizophrenia and twenty right-handed, age- and gender-matched normal control subjects were studied. All patients were diagnosed according to DSM-IV criteria (American Psychiatric Association 1994) by experienced psychiatrists. The mean duration of their disease was 6.9±6.0 years (mean±SD). All patients received antipsychotic drugs during the whole course of the disease. The mean age of the patients and the control subjects were 28.8±7.0 and 29.5 ±4.9 years respectively.

Methods for DT tractography

We used a 1.5-T imager (SignaHorizon, GE Healthcare, Wis, USA) for DT imaging with a single-shot echo-planar sequence (TE/TR = 78/7000 ms, 6 MPG directions, b-values = 0 -1000 s/mm^2, NEX = 4, FOV = 24 cm, 30 contiguous, 5-mm-thick slices, matrix = 128×128). After realignment, DT tractography was created using dTV [5] with a streamline method. On color-coded fractional anisotropy (FA) maps, SOFF was identified adjacent to the lateral wall of the lateral ventricle. Two regions of interest (ROIs) were placed on SOFF in slightly different locations (the seed ROI on an anterosuperior location and the target ROI on a posteroinferior location) in order to visualize axonal fibers of SOFF extending to the thalamus (DTT-SOFF) (Fig 1). Voxels that trajectories penetrated were segmented to measure FA and apparent diffusion coefficient (ADC) on a tract-specific basis.

Analysis

Five ROIs were placed on right and left DTT-SOFF respectively (Fig 1). FA and ADC values were measured on each ROI and averaged. Unpaired t-test was used for a test for difference between the patients and the controls. Statistical significance was set at $P = 0.05$.

Results

With our method, DTT-SOFF could be depicted in all of the patients and the controls. DTT-SOFF appeared to extend to the thalamus. The mean FA values of DTT-SOFF were 0.376 in the schizophrenic patients and 0.432 in the controls. The mean ADC values of DTT-SOFF were 0.771 (×10^{-3} mm^2/s) in the patients and 0.726 (×10^{-3} mm^2/s) in the controls. Significant decrease in FA ($P < 0.0001$) and significant increase in ADC ($P = 0.0002$) were found in the schizophrenic patients compared to the controls (Fig 2).

Conclusion

DT tractography allowed us to depict SOFF, a part of which might extend to the thalamus. FA decrease and ADC increase suggest loss of integrity of SOFF of schizophrenics. Results of our DT-based analysis support the hypothesis of thalamo-prefrontal circuitry abnormality deduced from the results of previous anatomical or neurohistochemical studies.

References

1. Lewis DA. Neuron, 2000. 2. Ture U. Neurosurgery, 1997. 3. Catani M..Neuroimage, 2002. 4. Mori S. MRM, 2002. 5. Available at http://www.volume-one.org.

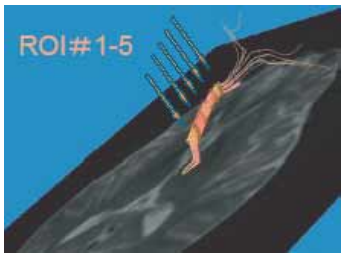

FIGURE 1. DTT-SOFF and ROI placement

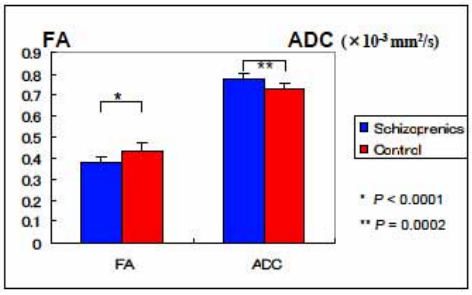

FIGURE 2. Results of FA and ADC measurement