Inter-Hemispheric Fiber Tracts Between Bilateral Superior Temporal Gyrus Gray Matter and Its Asymmetry in Chronic Schizophrenia

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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:

	SZ	NC	Two Sample *t*-test (2-tailed)		
	(n=27)	(n=26)	*df*	*t*	*p*
Age (yr)	44.22 ± 9.59 (47)	38.88 ± 11.62 (40.5)	51	-1.827	0.074
Socioeconomic Status (SES) [a]	3.37 ± 1.08 (3)	2.04 ± 0.81 (2)	49	-4.928	0.001**
Parental SES [a]	2.52 ± 1.12 (3)	2.22 ± 1.17 (2)	46	-0.916	0.364
Education (yr)	13.20 ± 1.82 (13)	14.67 ± 1.95 (14.5)	49	2.772	0.008**
Handedness	0.72 ± 0.24 (0.73)	0.76 ± 0.19 (0.8)	43	0.619	0.539
WAIS-III IQ	98.63 ± 14.28 (97)	109.44 ± 17.71 (110)	41	2.193	0.034*
Duration of Illness (yr)	16.78 ± 10.05 (19)	-		-	
Age at onset	23.61 ± 5.80 (23)	-		-	

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=17000ms TE=78ms FOV=24cm, 144×144 encoding steps, 85 axial slices with 1.7mm thickness each.

FIGURES

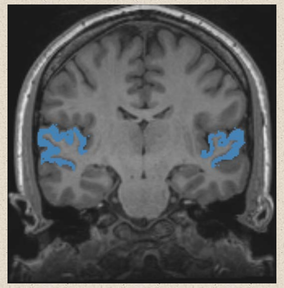

Figure 1: Coronal view of delineated STG gray matter

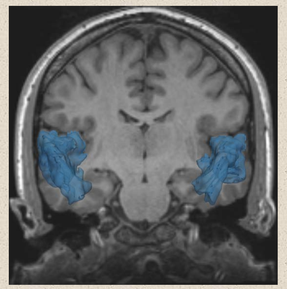

Figure 2: 3D rendering of STG gray matter

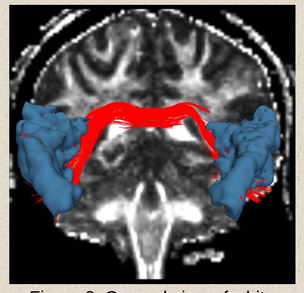

Figure 3: Coronal view of white matter fiber tracts connecting bilateral STG, overlaid on an FA map

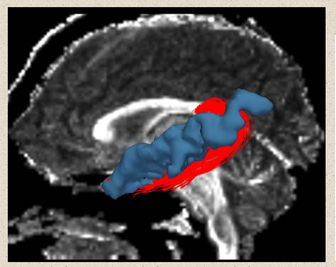

Figure 4: Sagittal view of white matter fiber tracts connecting left and right STG, overlaid on a FA map

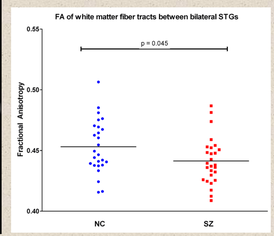

Figure 5: Group difference in mean FA

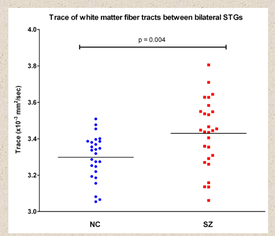

Figure 6: Group differences in mean trace

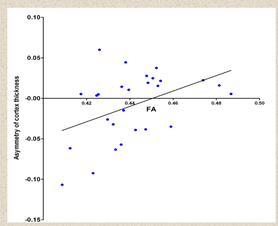

Figure 7: Correlation between mean FA and cortical thickness asymmetry

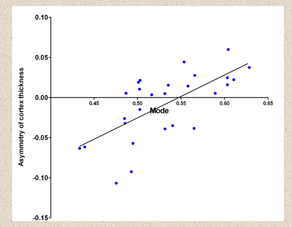

Figure 8: Correlation between mean Mode and cortical thickness asymmetry

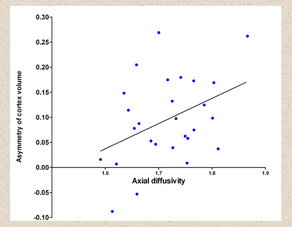

Figure 9: Correlation between mean AD and volume asymmetry

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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]:

(Left – Right) / [0.5*(Left + 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.