A Resting-State Functional MRI Study in Violent Offenders with Schizophrenia

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Target Audience: Those who interest in novel functional MR research especially in the neuroscience, psychiatry and forensic field.

Purpose: Schizophrenia is a mental disorder characterized by problems with thought processes and by poor emotional responses. There is much evidence that schizophrenia patients have an increased risk for aggression and violent behavior, including homicide. Low-frequency (0.01–0.08 Hz) fluctuations of the blood-oxygenation-level-dependent (BOLD) signal in resting state fMRI data are thought to reflect spontaneous neural activity. Though a lot of studies had been carried out in the past years using functional MR to explore the neural activity abnormalities in schizophrenia, few articles had focus on the subgroup of patients with severely violence behavior without drug abuse. In the current study, we aim to perform a tentative study on neural activity abnormalities in schizophrenia patients with severely violent behavior with functional MRI.

Methods: Thirty-one male violent offenders appraised as schizophrenia (VS) according to DSM-IV were recruited from the forensic psychiatry department (mean age = 37.9±12.2 years) and 33 age and handedness matched male healthy controls (HC) (mean age=37.2±13.1 years) were also recruited through advertisement. Modified Overt Aggression Scale (MOAS), Wisconsin Card Sorting Test (WCST) and Positive and Negative Syndrome Scale (PANSS) for schizophrenia were used for clinical evaluation in the violent schizophrenia group. The MRI examinations were performed via a 3-Telsa GE MRI system with an 8 channel phase array head coil. The resting-state fMRI sensitized to changes in BOLD signal levels were obtained via a GE-EPI sequence (TR/TE=2000/30msec, flip angle=90°, slice thickness=5mm with no gap, 30 axial slices, 200 volumes in each run). Subjects were instructed to relax with their eyes closed without falling asleep during MR examination. DPARSF software (http://www.restfmri.net) was used to calculate the parametric maps of Amplitude of Low Frequency Fluctuations (ALFF) (0.01–0.08 Hz). Head translation movement of all participants was <1.5 mm and rotation was < 1.5°. Voxel-based analysis of the ALFF maps between the violent schizophrenia patients and the healthy controls was performed using two sample *t*-test in SPM. The FWE-corrected p value of less than 0.05 at cluster-level was deemed to be significant for the analysis. The ALFF values at significant different regions were extracted to perform the correlation with the clinical and behavioral assessment scales.

Table 1. The reduced ALFF regions in violent schizophrenia patients comparing to healthy controls.

Cluster No.	Location	Cluster Size	Coordinate (x, y, z)	p FWE-corr
1	Right superior frontal gyrus	46	0, -6, 72	0.017
2	Right paracentral lobule	104	3, -33, 51	0.001
3	Right lingual gyrus	80	9, -63, -3	0.003
4	Right thalamus	31	9, -21, 6	0.044
5	Left lingual gyrus	31	-15, -54, -19	0.044

Results: Compared with the healthy controls, the violent schizophrenia group demonstrated significant ALFF reductions in various brain regions including the right superior frontal gyrus, right paracentral lobule, right thalamus and bilateral lingual gyrus (Fig.1). The locations and the coordinates were exhibited in Table 1. The MOAS, PANSS, WCST Scales scores were exhibited in Table 2. Participants in VS group showed significant negative correlations of ALFF value in the left lingual gyrus with PANSS-Positive score(r = -0.401, p = 0.025) (Fig.1).

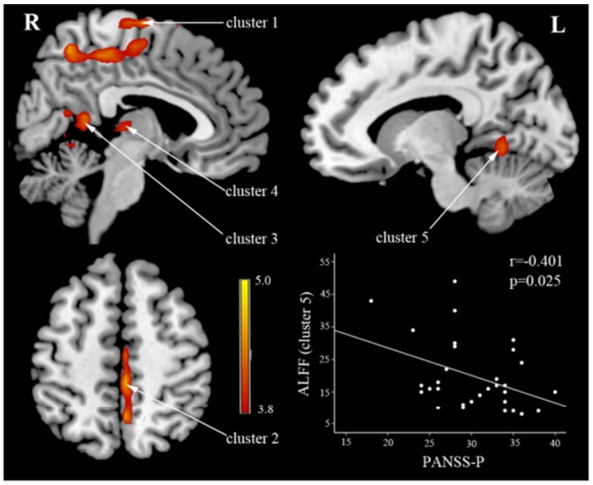

Fig.1 The reduced ALFF regions in the violent schizophrenia patients comparing to the healthy controls and the correlation between the PANSS-P scores and ALFF values in the left lingual gyrus.

Discussion and Conclusion: The decreased ALFF in the above regions indicated the reduced regional neural activity in the violent offenders with schizophrenia comparing to the healthy controls. The supplementary motor area of the superior frontal gyrus is a part of the primate cerebral cortex that contributes to the control of movement. Neurons in the supplementary motor area project directly to the spinal cord and may play a role in the direct control of movement. The out-of-control status may result in the severe violent behavior. In addition, the lingual gyrus is linked to processing vision, analyzing of logical conditions and encoding visual memories. The result was consistent with the previous studies that indicated reduced fronto-temporal functional connectivity in schizophrenia would associate with auditory hallucinations. The thalamus plays a key role in information precessing. The reduced thalamic activity observed in this study lends further support to the concept of deficits in sensory filtering in schizophrenia. In summary, the above defects in cortical-thalamus-cortical circuitry could explain a wide range of schizophrenia symptoms and violent behavior.[1] Further studies combining the structural connectivity and functional connectivity may give comprehensive insight to these special subgroup schizophrenia patients.

Table 2. The WCST, PANSS, MOAS Scales scores in the violent schizophrenia patients.

Scales	Score (Mean±SD)
WCST	
Total Correct	25.19±8.91
Categories Completed	2.03±1.02
Total Errors	22.74±8.66
Perseverative Errors	14.81±9.90
Nonperseverative Errors	7.92±4.57
PANSS	
General	30.29±5.03
Positive	27.35±5.24
Negative	37.83±4.22
Supplementary	11.32±3.61
MOAS	28.84±7.69

Reference:1.Richard J. Davidson, Katherine M. Putnam, Christine L. Larson. Dysfunction in the neural circuitry of emotion regulation- a possible prelude to violence.Science.2000;289:591-594.