Alteration of developmental trajectory of temporal lobe grey matter in ADHD boys

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TARGET AUDIENCE: Neuroradiologists and psychiatrists who are interested in VBM and /or ADHD.

PURPOSE: Attention Deficit/Hyperactivity Disorder (ADHD) is a common childhood-onset neurodevelopmental disorder with higher prevalence in boys. Although gray matter volume (GMV) deficits have been frequently reported in ADHD children via structural magnetic resonance imaging, few of them had specifically focused on male patients. Even fewer studies had explored the development trajectory of age effect or the relationship between structural abnormalities and cognitive functions. So present study aimed to apply the relatively new VBM technique with Diffeomorphic Anatomic Registration Through Exponentiated Lie (DARTEL) algebra algorithm to investigate the neuroanatomical differences of GMV between ADHD boys and controls, and further analyzed the affected areas for changes with age and their correlation between neuropsychological measurements.

METHODS: The study was approved by local ethnical committee and written consent was obtained from parents of all the subjects. 56 medication-naïve ADHD boys and 55 healthy boys matched with age and IQ were recruited. The diagnosis of ADHD was made according to the DSM-IV criteria. The MRI scan was performed via a 3T MRI system with 3D SPGR sequence. All participants went through Conners' ADHD Scale and a set of neuropsychological battery including Wechsler Intelligence Scale for Children-Chinese Revision, Stroop test, visual memory test, verbal fluency test, and Wisconsin Card sorting test. The T1-weighted images were processed via DARTEL, and voxel-based analysis of whole-brain GMV between two groups were done via two sample t-test in SPM8 with age as covariate, threshold at $p<0.005$ (voxel level) and $P_{FWE}<0.05$ (cluster level). Then the resultant cluster was extracted as ROIs to correlate with age and clinical scores using spearman's correlation with SPSS 20.0.

RESULTS: comparing to controls, ADHD boys exhibited significant decrease GMV in bilateral temporal lobe extending to amygdala (Left: peak coordinates [-17, 9, -30], T=3.75; Right: peak coordinates [12, -2, -24]) (*Figure.1A*). in the control group, there is a statistically significant correlation of both GM ROIs with age, but such correlation was not observed in the ADHD boys(*Figure.1B/C*). In ADHD boys, there were significant positive correlations between GMV of both temporal lobe with total numbers and right numbers in verbal fluency test. While the GMV of left temporal lobe also demonstrated positive correlation with score and right numbers in Stroop test. (Figure.*1D-I*)

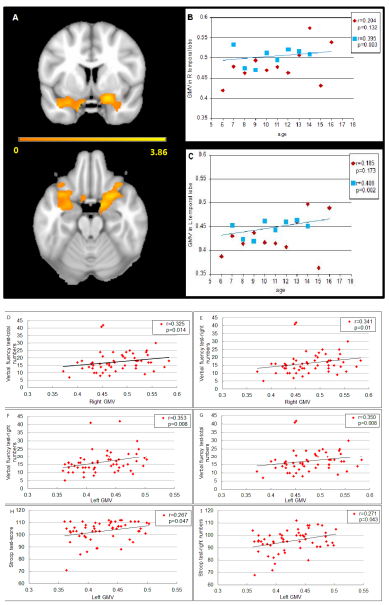

Figure.1 **A** is two sample t-test of GMV between ADHD children and healthy controls ($P<0.005$). The yellow-red clusters show smaller GMV in the patients compared to the controls. **B** and **C** show correlation of age with GMV (red presents ADHD, blue presents controls). **D-I** are the spearman's correlation of GMV with neuropsychological tests

DISCUSSION As part of the paralimbic system, temporal lobe is proposed as a key node in the integration of emotion and perception in ADHD, since it owns abundant interconnections with amygdala and orbitofrontal cortex[1]. Present study found GMV decreases in bilateral temporal lobes extending to the amygdala in a relatively large population of medication-naïve ADHD boys. Interestingly, the developmental trajectory of those areas demonstrated in the normal boys was not seen in the ADHD boys. This might represent cerebral deficit in the ADHD boys from a developmental perspective. Due to differences in illness duration and severity, the normal GM increase with age trajectory was disrupted in the ADHD boys. Moreover, the decreased bilateral temporal GMV correlated with some particular cognitive domains including verbal fluency and executive function while no correlation was seen in normal control boys. Thus we postulated that temporal lobe maybe played an important role in ADHD psychopathology concerning cognitive functions.

CONCLUSION: As far as we know, current study explored the trajectory change of particular GM regions in ADHD boys for the first time. Future longitudinal studies focused on the dynamic change of whole brain GMV in ADHD would be needed to help elucidate the pathology.

REFERENCE:

1. Proal E, et al. Arch Gen Psychiatry. 2011 Nov; 68(11):1122-34