Abstract

Background: During puberty, gray matter volume decreases and white matter volume increases in the brain. It has been suggested that pubertal hormones may induce some neuroanatomical changes during puberty. Central precocious puberty (CPP) is caused by premature activation of the hypothalamus-pituitary-gonadal axis inappropriately at early age. However, little is known about the differences of brain structure (especially brain volume) in idiopathic CPP. Also the relation between lutinizing hormone (LH) and brain morphology in CPP remains unclear.

Hypothesis: This study aimed to evaluate the difference of brain structure in idiopathic CPP, age-matched healthy control, and the normal puberty girls, and the association between LH and brain structure.

Method: The study enrolled fifteen girls with idiopathic CPP, 15 age-matched healthy girls, and 15 normal puberty girls as controls. The subjects underwent on a 1.5 Tesla Avanto MR Scanner (Siemens Medical Solutions, Erlangen, Germany). Anatomical T1-weighted images were acquired with a T1 spin echo sequence.

MR image data were processed by using SPM8 software. (Statistical Parametric Mapping 8, The Welcome Department of Cognitive Neurology, University College London, U.K.) with Diffeomorphic Anatomic Registration Through Exponentiated Lie Algebra (DARTEL) algorithm. Regional measures of gray matter and white matter concentration (density) were evaluated using voxel-based morphometry.

Results: The mean age of CPP, age-matched group and puberty group were 8.0 ± 0.9 year, 7.8 ± 0.9 year and 11.9 ± 0.9 year, Compared with controls, CPP showed a significant increase in gray matter (GM) volume of the left cerebellar cortex, and in white matter (WM) volume: the left superior temporal lobe (STL), right middle temporal pole (MTP) and left lingual gyrus (LG) (p<0.05). Especially, the WM volume of the STL (r=0.56), MTP (r=0.56) and LG (r=0.57) were positively correlated with LH concentrations (p≤0.05).

Conclusion: Regional GM and WM volumes were increased in girls with idiopathic CPP compared with age-matched and pubertal controls. The growth of white matter might be directly or indirectly mediated by LH production in idiopathic CPP. These data suggest that the presence of early sexual maturation-related variations in structure of developing brain of girls with idiopathic CPP.

Subjects and Methods

The study enrolled fifteen girls with idiopathic CPP, 15 age-matched healthy girls, and 15 normal puberty girls as controls. The subjects underwent on a 1.5 Tesla Avanto MR Scanner. Anatomical T1-weighted images were acquired with a T1 spin echo sequence. MR image data were processed by using SPM8 with DARTEL algorithm.

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The mean age of CPP, age-matched group and puberty group were 8.0 ± 0.9 year, 7.8 ± 0.9 year and 11.9 ± 0.9 year. Compared with controls, CPP showed a significant increase in gray matter (GM) volume of the left cerebellar cortex, and in white matter (WM) volume: the left superior temporal lobe (STL), right middle temporal pole (MTP) and left lingual gyrus (LG) (p<0.05). Especially, the WM volume of the STL (r=0.56), MTP (r=0.56) and LG (r=0.57) were positively correlated with LH concentrations (p≤0.05).

Conclusion: Regional GM and WM volumes were increased in girls with idiopathic CPP compared with age-matched and pubertal controls. The growth of white matter might be directly or indirectly mediated by LH production in idiopathic CPP. These data suggest that the presence of early sexual maturation-related variations in structure of developing brain of girls with idiopathic CPP.

Purpose

Puberty is the important period during development in which major physical, psychological and complex social skills occur. It has been suggested that pubertal hormones may induce some neuroanatomical changes during adolescence.

Central precocious puberty (CPP) is caused by premature activation of the hypothalamus-pituitary-gonadal axis inappropriately at early age (before 8 ages in girls and 9 ages in boys). In adolescents with early pubertal timing, there is a tendency of severe emotional problems and antisocial behavior. Psychosocial changes may be related to cerebral development, including widespread changes in brain morphology.

However, little is known about brain structure (especially brain volume) in idiopathic CPP. Therefore, this study aimed to evaluate the difference of brain structure in idiopathic CPP, age-matched healthy control, and the normal puberty girls, and the association between LH and brain structure.

Fig. 1. Brain areas with an significant increase in gray matter (a) and white matter (b) volumes in female patients with precocious puberty as contrast to normal puberty controls (uncorrected; p<0.001, excluded 100 voxels). Hi, hippocampus; PHG, parahipocampal gyrus; PCG, posterior cingulate gyrus; ACG, anterior cingulate gyrus; PsG, Posccentral gyrus; PCC, posterior corpus callosum; OFG, orbitofrontal gyrus; ITG, inferior temporal gyrus; Fug, fusiform gyrus; Ipo, inferior parietal gyrus; MTG, middle temporal gyrus; SFG, superior frontal gyrus.

Table 1. Brain regions with an significant increase in gray matter volumes in female patients with precocious puberty over normal puberty controls (uncorrected; p<0.001, excluded 100 voxels)

Table 2. Brain regions with an significant increase in white matter volumes in female patients with precocious puberty over normal puberty controls (uncorrected; p<0.001, excluded 100 voxels)

Table 3. Brain regions with an significant increase in gray matter in gray matter (a) and white matter (b) volumes in female patients with precocious puberty as contrast to age matched and normal puberty controls (ANOVA analysis; covaraited for age, uncorrected; p<0.001, excluded 100 voxels)

Summary

Compared with controls, CPP showed a significant increase in gray matter (GM) volume of the left cerebellar cortex, and in white matter (WM) volume; the left superior temporal lobe (STL), right middle temporal pole (MTP) and left lingual gyrus (LG) (p<0.001).

Especially, the WM volume of the STL (r=0.56), MTP (r=0.56) and LG (r=0.57) were positively correlated with LH concentrations (p<0.05).

Conclusion

Regional GM and WM volumes were increased in girls with idiopathic CPP compared with age-matched and pubertal controls.

The growth of white matter might be directly or indirectly mediated by LH production in idiopathic CPP.

These data suggest that the presence of early sexual maturation-related variations in structure of developing brain of girls with idiopathic CPP.