Morphometry of the pediatric Brain development in Kingdom of Saudi Arabia using Voxel-Based Magnetic Resonance Imaging

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Abstract:

In recent year, too much attention has been drawn to study the smallest details of the brain that can lead to more knowledge about the human brain. This information can help to unlock the mystery about different diseases. For this purpose, in this project we will study the pediatric brain volume in kingdom of Saudi Arabia by Voxel-Based Morphometry (VBM), the VBM is a neuroimaging analysis technique that allows investigation of focal differences in brain anatomy, using structural magnetic resonance images and the statistical approach of statistical parametric mapping1. The present project will provide a brief description of VBM and then focuses on exemplar applications in healthy and diseased subjects. The procedure involves high image resolution structural normalizing from Magnetic resonance imaging (MRI) three tesla (3T) machine to a standard template in stereotactic space, and using an isotropic Gaussian kernel to segmented normalized images to gray and white matter and smoothed. Finally, a series of voxel-wise comparisons of gray and white matter in different groups of subjects will be performed using random field theory to correct for multiple comparisons.

Objective:

In our study we provide a better understanding in how the human brain developed at late stages of the childhood to adolescence.

Methodology:

Participant: groups included: healthy controls (CON; N = 15); and development delay kids (DD; N = 15). Participants' ages ranged between 2 ± 8 yrs. Demographic data

Instruments:

A Siemens Magneto Verio ® 3T MRI clinical scanner (Siemens AG, Healthcare Sector, Erlangen, Germany) was used to collect medical imaging data

- **Brainsuite15b version 2.1** to proses medical imaging data.
- **IBM SPSS Statistics version 22** to analysis numerical data.

Results:

Cortical thickness analyses development delay DD showed significant deformity in the following cortical region :

1. **R. caudate nucleus (p<0.043)**
2. **L. Globus pallidus (p<0.046)**
3. **R. middle frontal gyrus (gray matter) (p<0.012)**
4. **L. middle frontal gyrus (gray matter) (p<0.018)**
5. **L. pars opercularis (gray matter) (p<0.037)**
6. **L. pars orbitalis (gray matter) (p<0.042)**
7. **L. cingulate gyrus (gray matter) (p<0.041)**
8. **L. subcallosal gyrus (gray matter) (p<0.002)**
9. **R. middle frontal gyrus (white matter) (p<0.031)**
10. **L. pars orbitalis (white matter) (p<0.001)**
11. **L. pre-central gyrus (white matter) (p<0.019)**

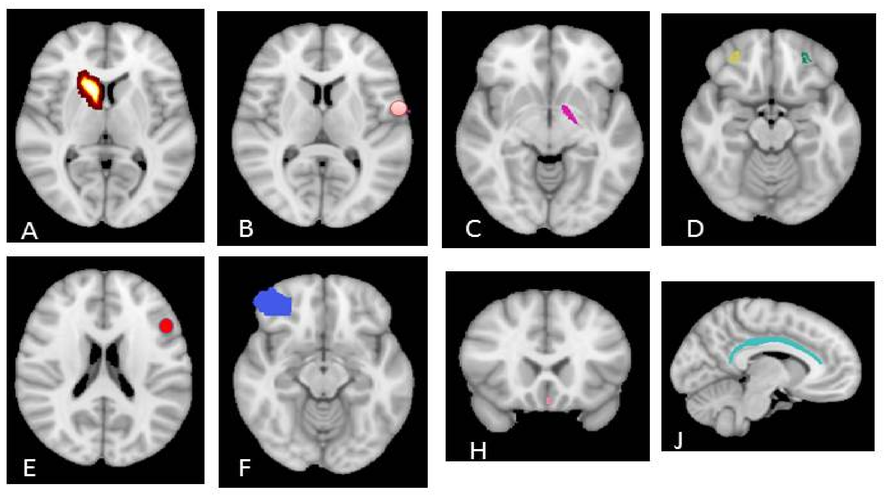

Figure 1: DD showed significant deformity in the following cortical region: A) R. caudate nucleus (p<0.043), B) L. L. pre-central gyrus (wm) (p<0.019), C) Globus pallidus (p<0.046), D) L and R. middle frontal gyrus (gray matter (gm) (p<0.018), & (p<0.012) respectively, E) L. pars orbitalis (gm) (p<0.042), L. pars operculals (gm) (p<0.037), F) R. middle frontal gyrus (white matter (wm), H) L. subcallosal gyrus (gm) (p<0.002), and J) L. cingulate gyrus (gm) (p<0.041).

Conclusions :

Voxel-Based Morphometry (VBM) based on structural MRI can be used to detect the regions in the brain that most likely cause development delay in children. However, the present study has several limitations that should be considered when interpreting the results. First, we compared the DD with healthy subject making it difficult to draw inference cortical thickness effect directly. Therefore, a longitudinal study would have undoubtedly benefited our predictions of clinical outcomes. Second, the subject group was not homogeneous with respect to DD type. This type of subject heterogeneity may have obscured the interpretation of the results. Fourth, there is limited power in the current study because of its small sample size. Future local studies in healthy subjects should take caution speculating on likely effects for patients, because patients may have heightened susceptibility for improvement as this study shows.

References:

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3. Local Brain Connectivity and Associations with Gender and Age, Dev Cogn Neurosci. 2011 Apr 1; 1(2): 187–197

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