THE INFLUENCE OF BIRTH WEIGHT ON BRAIN NETWORK CONSTRUCTION IN NEONATES

Yajie Hu[1,2], Xianjun Li[1,2], Mengye Lyu[1,2], Yanyan Li[1], Huan Li[1], Miaomiao Wang[1], and Jian Yang[1,2]

[1]Department of Diagnostic Radiology, The First Hospital of Medical School, Xi'an Jiaotong University, Xi'an, Shaanxi, China, [2]Department of Biomedical Engineering, School of Life Science and Technology, Xi'an Jiaotong University, Xi'an, Shaanxi, China

INTRODUCTION

The structural network of neonatal brain is important to understand early brain development. The structural covariance networks (SCNs) based on graph theory provide an objective insight to understand cerebral structure. Birth weight as a crucial independent factor has been reported that can influence on brain development, such as brain volume, cortical surface area, cortical thickness, white matter, verbal and IQ1. However, no study has investigated the effect of birth weight on brain networks using MRI data. So the aim of this study was to set the birth weight as a independent factor for detecting the variation of brain structural connectivity based on 3D T1WIs in neonates by the structural covariance networks analysis. The structural covariance networks in neonatal brain with the low and normal birth weight (<2500g and 2500-4000g) were compared based on 64 regional volumes correlation in preterm and full term groups respectively to reveal its effect on brain development.

MATERIALS AND METIODS

This study was approved by the local institutional review board. The neonates were all sedated (oral chloral hydrate, 25-50 mg/kg) with parental consent before MRI scanning. The postmenstrual age (PMA) of preterm and full term groups were matched in order to set the birth weight as a single influence factor.12 low birth weight term neonates (5 males and 7 females, mean PMA = 39.64 ±1.36 weeks, mean weight = 2115.0 ±266.68g) and 12 normal term neonates (8 males and 4 females, mean PMA = 39.77±1.22 weeks, mean weight = 3071.67±229.78 g) were examined.Similarly,11 low weight preterm neonates (8 males and 3 females, mean PMA = 36.65 ±1.10 weeks, mean weight = 2050.91 ±343.17g) and 11 normal weight preterm neonates (5 males and 6 females, mean PMA = 36.77±1.22 weeks, mean weight = 2761.82±216.79g) were examined. Data were acquired by 3D-T1 FSPGR sequence on a 3T scanner (GE, Signa HDxt) with 8-channel head coil. Acquisition parameters were as follows: repetition time =10.28ms, echo time =4.616ms, inversion time =400ms, slice number =110-140; voxel size=0.94×0.94×1mm3, resampling resolution =0.6×0.6×0.6mm3. Preprocessing of T1 data was performed using fslroi and flirt in FMRIB's Software Library (FSL) and it striping skull by using iBEAT(which developed by the IDEA group at the University of North Carolina at Chapel Hill). The neonatal template for registration has 64 anatomically cortical and subcortical regions from neonatal atlas of Johns Hopkins University [1]. The residuals of the regression was taken as corrected cortical volume estimates to model effects of total brain volume, gender, postmenstrual age and birth weight. Pearson correlation coefficient [2] was estimated as the connection between cortical volume measures of every subjects in each group. The parameters of network, including degree, global efficiency, local efficiency and small-world topology [3], were calculated by Brain Connectivity Toolbox (http://www.nitrc.org/projects/bct/). Then according to the brain edge files and node file, the result can be drawn in the network of brain. The structural brain network were derived from each connection matrix and visualized via BrainNet Viewer(http://www.nitrc.org/projects/bnv/).All the math analyzes were performed using the MATLAB (Mathworks, Natick, MA, USA).

RESULTS

The results of adjacency matrix and the parameters of network in two groups were shown in Fig.1 and Table 1. The communication of information and the connection of nodes of normal birth weight is more fluently and tightly than low birth weight whether in full-term or in preterm groups. In addition, the normal birth weight neonates have higher degree, global efficiency and local efficiency than the low birth weight neonates.

DISCUSSIONS AND CONCLUSION

Our research investigated the influence of birth weight on neonatal brain network construction between low and normal birth weight in preterm and full-term neonates based on structural covariance networks. The degree, global efficiency and local efficiency in brains of normal birth weight were higher than those of low birth weight whether in full-term or in preterm groups. It revealed that the brain development in neonates with the normal birth weight are superior to that in neonates with the low birth weight. Moreover, the previous studies revealed that small-world characteristics were exhibited in neonates [4]. Our finding shown that the small-world topology is more obviously in low birth weight than it in normal birth weight. The birth weight maybe has an influence on small-world characteristics in low birth weight neonates. Our study firstly provide objective evidence for the birth weight is related to the neonatal brain network construction. The neonatal brains with normal birth weight are more mature to some extent. In conclusion, the birth weight maybe provide a significant influence on the network construction.

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Table 1: network measures of the cerebral of two groups

Group	Degree	Global efficiency	Local efficiency	Smallworld topology
L_term	7.9063	0.4048	0.6775	2.1301
N_term	11.1563	0.4600	0.7234	1.2969
L_preterm	8,2813	0.4273	0.7220	2.6353
N_preterm	9.1875	0.4420	0.7432	2.3277

L for low birth weight neonates; N for normal birth weight neonates.

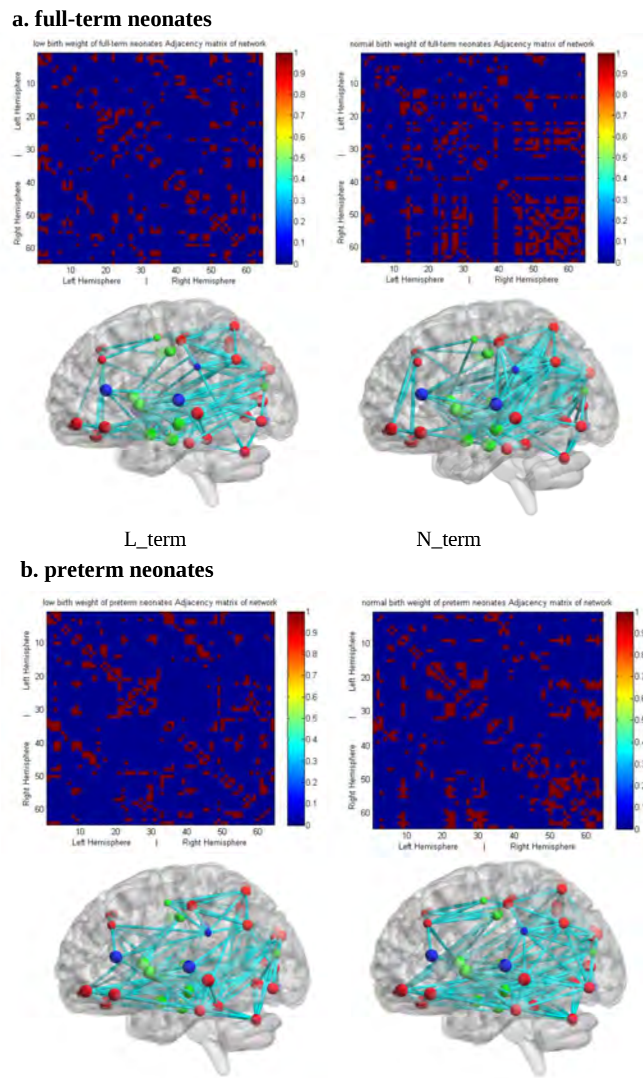

Fig1. The results of adjacency matrix and the notes connection of the brain on full-term neonates group (a) and term neonates group (b).L for low weight neonates; N for normal weight neonates.