BIRTH WEIGHT INFLUENCE WHITE MATTER DEVELOPMENT IN NEONATES: A DIFFUSION TENSOR STUDY BASED ON TRACT-BASED SPATIAL STATISTICS

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Introduction

Birth weight (BW) has a lifespan influence on brain development, such as brain volume, cortical surface area, cortical thickness, white matter, verbal and IQ[1, 2]. The high BW with 100-g increments is associated with an increased survival of newborn without neurodevelopmental impairment and a decrease in the risk of death [3]. However, no study to date has specifically investigated that if the BW as an independent index would influence on the white matter development in neonates. Therefore, this diffusion tensor imaging (DTI) study was aim to use the tract-based spatial statistics (TBSS) with covariate model for analyzing the effects of BW on newborn white matter development. Meanwhile, the postmenstrual age (PMA) served as a covariate.

Methods

This study was approved by the local institutional review board. Parents or guardians were informed with the goals of MRI scanning and requested written consent before enrollment. *Subjects:* Subjects who were confirmed or suspected to have congenital malformations of central nervous system, congenital infections, metabolic disorders, abnormal appearances in conventional MRI were all excluded. During Jan 2011 to Dec 2013, 86 neonates with gestational age (GA) of 29.6 - 41.4 weeks, PMA of 32.3 - 45.3 weeks, BW of 1250 - 4415 g were enrolled, including 41 preterm neonates (18 females) and 45 term neonates (16 females). *MRI acquisition:* All neonates were sedated (oral chloral hydrate, 25-50 mg/kg) before MRI scanning. Conventional MRI and DTI were performed on a 3T scanner (GE, Signa HDxt). DTI protocols were: 35 directions, b value= 1000 s/mm^2, TR/TE=5500/95ms, slice thickness= 4 mm without gap, field of view = 180mm×180mm, matrix = 256×256, voxel size= 0.70×0.70×4mm^3. *Image analysis:* After eddy currents registration, brain-extracted and FDT calculation, DTI data generated fractional anisotropy (FA), mean diffusivity (MD), axial diffusivity (AD), radial diffusivity (RD) maps. Voxelwise statistical analysis of the FA data was carried out using an optimised TBSS protocol for neonates implemented in FSL[4]. We chose the single-group average with additional covariate statistical model to analyze the effects of BW on white matter in newborn and set the PMA as a covariate. All tests were taken to be significant at $p<0.05$.

Results

The effects of BW on white matter development of neonates in various DTI parameters were showed in figure 1. Significant increase of FA were found in anterior limb of internal capsule (ALIC), corona radiata and arcuate fasciculus (anterior segment and part of long segment) and anterior central gyrus (ACG) in two sides, and external capsule in the left hemisphere, as well as genu of corpus callosum (GCC), body of corpus callosum (BCC). Significant decrease of MD and RD were found in BCC, the two sides of external capsule, ALIC, corona radiate and ACG. AD decreased with birth weight mainly in corona radiate bilaterally.

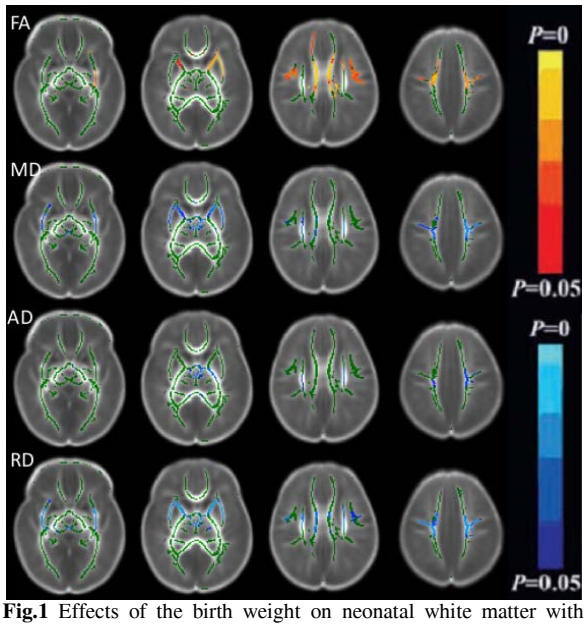

Fig.1 Effects of the birth weight on neonatal white matter with setting the postmenstrual age as a covariate. Mean FA skeleton was shown in green with no significant difference. Significant increase with birth weight was shown in warm color. Significant decrease with birth weight was shown in cool color. (P<0.05)

Discussion

In ALIC, external capsule, BCC, corona radiate and ACG, significant increase of FA and decrease of MD, RD indicted an increased myelination and a reduction in total water. The changes distributed in projection fibers (internal capsule and corona radiata), commissural fibers (corpus callosum) and association tracts (arcuate fasciculus). Moreover, the arcuate fasciculus connect the Broca's territory and Wernick's territory, which respectively dedicated to speech production and auditory comprehension[5]. Therefore, BW maybe exert the positive effects on these above tracks. It is suggested that BW serving as the stimulative factor, may be related to the development of motor, sensation speech production and auditory comprehension in newborn.

Conclusion

In this study, we demonstrated that birth weight as an independent factor exerted the positive effects on neonatal white matter development.

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References

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