Correlation of H-1 MRSI with long-term Neurodevelopmental Outcome in term neonates with hypoxic ischemic encephalopathy

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Introduction

It is estimated that 1.5/1000 live births suffer from neonatal hypoxic ischemic encephalopathy (HIE), which is one of the most common causes of cerebral palsy and often associated with poor neurodevelopmental outcome. Proton (H-1) MR spectroscopy is a powerful method for non-invasively investigating brain metabolism. The newborn brain is relatively immature and has much less neuronal activity compared with the adult brain. NAA is initially lower relative to other metabolites and its rate of increase has been shown to correlate with the maturation process [1]. Limited lactate can be detected in the newborn brains that develop normally; however, in HIE, a larger quality of lactate is typically present [2-3]. A correlation between the MRS results with neurologic and developmental status at age 12 months has been reported [4]. In this study, we evaluated long-term neurodevelopmental outcome at age of 4 in the term neonates with HIE using H-1 MR spectroscopic imaging (MRSI).

Methods

As a part of the study of brain injury in term neonates suffering from HIE, 33 patients who had a MR examination at the median age of 4 days and returned for follow-up examinations were studied. The MR data were acquired from 1.5 T scanner (GE Healthcare Technologies, Waukesha, WI). The 3D H-1 lactate-edited MRSI data (TE/TR = 144/1000 ms) were obtained using PRESS volume selection, VSS outer volume suppression and CHESS water suppression with a nominal spatial resolution of 1 cm^3. The MRSI data were processed as described previously [4]. Regions of interest (ROIs) were draw bilaterally on T2 images for thalamus, basal ganglia, corticospinal tract, parietal white matter, and frontal white matter [4]. Among these patients, 17 patients completed outcome assessment at the age of 2-year and 4-year old using the Bayley Scales of Infant and Toddler Development, III edition (Bayley-III) and Wechsler Preschool and Primary Scale of Intelligence (WPPSI) tests. The spearman rank correlation coefficients were calculated to determine the association between estimated brain metabolites and development outcome scores. A p-value of <0.05 was regarded as significant.

Results/Discussion

An example of 3D MRSI data and locations of ROIs is illustrated in Figure 1a. Of all the metabolite parameters, the levels of Cho/Cr were negatively associated with the language component of Bayley-III (Lang-Bayley-III) at 2 years (left basal ganglia, r = -0.581, p = 0.023; right thalamus, r = -0.536, p = 0.039) and WPPSI Performance IQ at 4 years (right basal ganglia, r= -0.496, p = 0.043) (See Figure 1b), which indicates that neonates with lower Cho/Cr within the basal ganglia and thalamus at birth had worse long-term neurodevelopment. It is also reported in a long-term study that adolescents who were born prematurely had abnormal Cr and NAA compared to healthy controls [5]. These results suggest that obtaining using MRSI at birth may be valuable in predicting brain development.

Conclusion

This study demonstrated the relationship between metabolic parameters at birth and long-term brain development.

References

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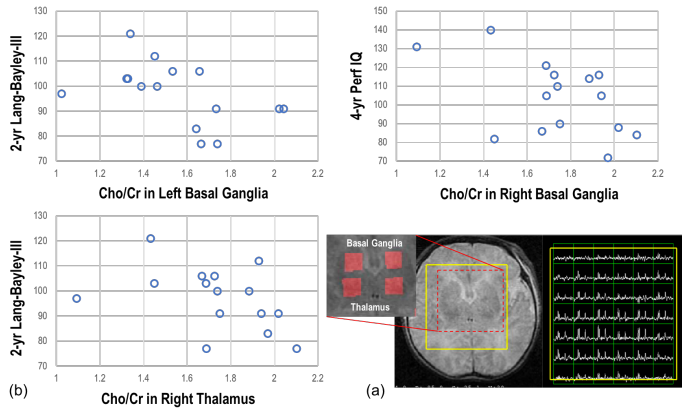

Figure 1. (a) Example of MRSI and ROI; (b) Scatter plots of clinical measurement and Cho/Cr