MR Spectroscopy of Premature Newborns

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Introduction

MRI techniques have recently demonstrated the ability to provide valuable anatomic imaging in the newborn brain, but additional metabolic markers would be important to provide improved assessments of neonatal brain injury. 3D point-resolved spectroscopic imaging (PRESS-MRSI) can provide accurate measurements of metabolite levels throughout the brain, but it is more complex than commercially available single voxel and 2D MRSI techniques. In this study, lactate-edited 3D-PRESS was used to acquire MRSI in neonatal subjects, in order to better define the extent of normal and abnormal metabolite distributions. This study of 55 premature neonates (many studied serially for a total of 104 exams) demonstrated significant correlation between age and metabolite ratios.

Methods

A series of standard MR scans were performed for clinical assessment of the neonatal patient on 1.5 T GE Signa Echospeed scanner (GE Healthcare, Milwaukee, USA) that include 1) T1 weighted sagittal and axial spin-echo images with TR/TE of 500/11, 4mm thickness, 1 excitation, 192x256 encoding matrix; 2) T2 weighted axial dual echo, spin-echo with TR of 3sec, TE of 60 and 120ms, 192x256 encoding matrix, 4mm thickness. A multivoxel 3D MR spectroscopy scan was performed to obtain metabolite levels covering most of the brain using PRESS acquisition with band selective inversion with gradient dephasing (BASING) lactate editing method [1-3]. The uniformity of the selected region was obtained by slightly overexcite the prescribed region and shaped with very selective saturation (VSS) pulses [4]. The acquisition parameters are 144ms/1s TE/TR, 1cc, 8x8x8 array, and an acquisition time of 17 minutes. Regions of interests (ROI's) were drawn on T2 images for thalamus, basal ganglia, optic radiation, central grey matter, corticospinal tract, parietal white matter, and frontal white matter.

A total of 55 newborn subjects (34.2 ± 3.0 weeks gestational age), a total of 104 scans were studied. The studies were performed in an MR compatible incubator with a specialized neonatal head coil to provide a temperature-controlled, well-monitored, safe environment and to improve image quality with informed consent [5]. The study was approved by our institutional review board. Motor outcome was assessed at 1 year of age using a neuromotor score (NMS) of 0-5 as previously defined [6]; cognitive outcome was measured using the mental development index (MDI) of the Bayley's Scales of Infant Development II. For the compilation of a normative developmental MRSI database, we only included newborns with normal neurological outcome (NMS=0; MDI>85). The included 55 subjects were among a population of 217 potential subjects.

Results

The NAA to Cho ratio increased significantly with age for all regions in the premature infants with normal outcome. Lac to NAA ratio decreased significantly with age in the regions of THAL, BG, CST, and PWM, and showed a decreasing trend in the other regions. Lac to Cho ratio decreased statistically with age for CST, and varied differently for other regions.

Discussion

This study demonstrated the feasibility of the new 3D lactate-edited MRSI methods to analyze the spatial and temporal variations of brain cellular metabolite levels in preterm infants. In this project, we established a dataset of normative metabolite levels, which may be used to assess patients with injuries at similar age. We observed the significant increase in NAA/choline with age due to brain maturation.

Reference

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