Proton MRSI identifies white matter injury in neonates with perinatal asphyxia

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Introduction

Hypoxic-ischemic cerebral encephalopathy (HIE) is one of the major complications in neonates with perinatal asphyxia (1). MR research on HIE has focused on the gray matter predominantly in the basal ganglia (2,3). Neonatal white matter appears to be as susceptible to ischemic damage as gray matter partly due to the limited vasodilatory capacity of the neonatal cerebral white matter in the presence of anaerobic glycolysis and increased substrate demand, prominent developments in asphyxia. The purpose of this study was to assess whether quantitative cerebral lactate and ADC obtained from the white matter regions of infants with perinatal asphyxia are correlated with clinical outcome.

Materials and Methods

Seventeen full-term infants were examined with diffusion-weighted MR imaging. Proton MR spectroscopic imaging exams were performed on 13/16 infants with on a 1.5-T MR system. Proton MR spectroscopic imaging was performed using multi-voxel chemical shift imaging (CSI) with point resolved spectroscopy (PRESS) and volume pre-selection. Briefly, after selecting a 50-100 cc volume, shimming and water suppression were adjusted. Water suppression was performed using CHESS and volume selection using RF pules with bandwidths of 1100Hz for the 180 degree pulses and 2000 Hz for the 90 degree pulses. Then, a large data set was acquired using phase-encoding gradients in two directions. The following acquisition parameters were used: TR=1s, TE=65msec, 16x16 phase encoding matrix, 160 mm FOV, slice thickness of 10 mm, 1250 Hz spectral width, 2 averages and 512 points. Data sets of 1-1.2 cc nominal resolution were obtained. Data processing was performed on a Sun workstation (Sun Microsystems, Mountain View, Calif.) using software by General Electric (SAGE) and in-house developed software utilizing IDL 5.3. DWI was performed using a line-scan diffusion-weighted imaging method (4).

Results

No significant differences were found between patients with a normal clinical outcome and those with abnormal or fatal outcomes regarding ADC values (p = .96) or Cho/NAA ratio (p = .23). A significantly higher ratio of Lac/Cho was found in patients with an abnormal or fatal outcome compared to patients who had a normal outcome (p = .02).

Variable	Normal Outcome	Abnormal or Fatal Outcome	P-value
ADC	3.56 (2.77 – 6.16)	4.09 (2.81 – 5.86)	0.96
Cho/NAA	1.31 (1.25 – 2.26)	1.63 (0.97 – 2.45)	0.23
Lac/Cho	0.05 (0.00 – 0.13)	0.30 (0.00 – 0.50)	0.02*

* Statistically significant. Data are medians with ranges shown in parentheses with groups compared with the nonparametric Mann-Whitney U-test. Normal outcomes correspond to 3 exams for ADC and 6 for Cho/NAA and Lac/Cho. Abnormal or fatal outcomes are based on 18 exams for ADC and 8 exams for Cho/NAA and Lac/Cho

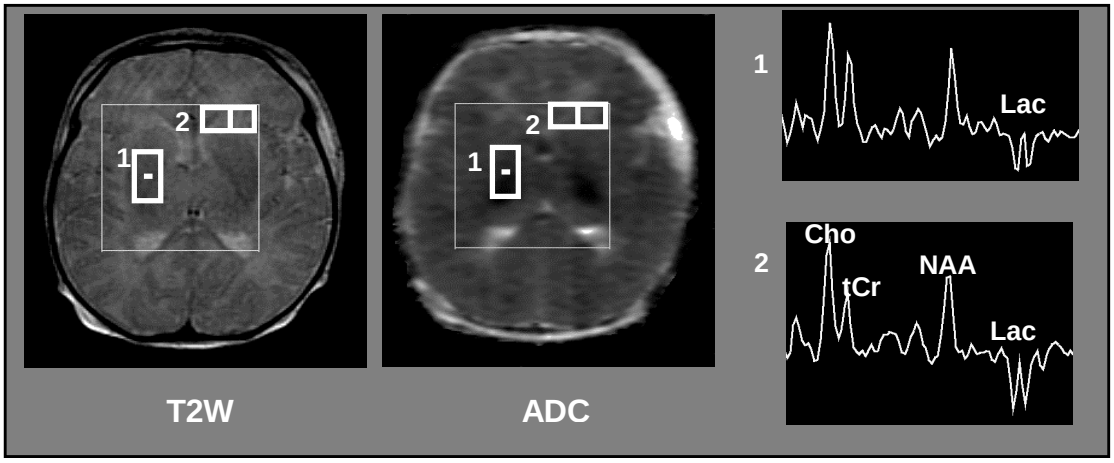

Figure 1: T2-weighted image (T2W) and apparent diffusion coefficient (ADC) image and proton (MRSI) of one-day-old neonate with perinatal asphyxia. T2W image is not abnormal. Abnormally low ADC is shown only within the (deep gray matter) basal ganglia (1). Selected spectra exhibit abnormally high lactate (Lac) within both basal ganglia (1) and white matter (2). Choline (Cho), total creatine (tCr), n-acetylaspartate (NAA).

Discussion

Metabolic changes in HIE, as evaluated by proton MRSI, do occur within the white matter as well as the basal ganglia (deep gray matter). In this study, proton MRSI, on the basis of high lactate levels, distinguished neonates with normal from those with abnormal or fatal outcome. Although demonstrating abnormalities within the deep gray matter, ADC values were not correlated with clinical outcome. It remains to be seen whether neonates with high levels of lactate both within the basal ganglia and white matter have worse late neurodevelopmental outcome. Our study demonstrates the potential of MR imaging, assisted by proton MR spectroscopy, in permitting an earlier identification of the risk for HIE in neonates with perinatal asphyxia.

References

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