LACTATE-EDITED MRS IN NEONATAL HYPOXIC ISCHEMIC ENCEPHALOPATHY

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Target audience: Researchers interested in pediatric MRS

Purpose: Neonatal hypoxic ischemic encephalopathy (HIE) is a serious neurological condition characterised by acute or subacute brain injury arising from perinatal hypoxia. HIE is thought to affect approximately 0.2% of live births, and is associated with a high risk of mortality or long-term neurological disability.[1-2] According to a recent meta-analysis, the ratio of the cerebral concentrations of lactate and N-acetly aspartate (NAA) represents the most accurate prognostic indicator of outcome following HIE,[3] but the measurement of lactate using standard point resolved (PRESS) MRS is suboptimal due to the overlap of lactate with lipid peaks, and at high field is further confounded by chemical shift displacement errors. The purpose of this study was to evaluate the relative sensitivity of a lactate editing MRS sequence in comparison to PRESS MRS for detecting lactate in neonates with suspected HIE.

Methods: The patient group included 5 infants (2 male), referred for cerebral MRI for suspected perinatal asphyxia. MRI and MRS studies were performed with a 3T GE HD.xt TwinSpeed MRI scanner (GE Healthcare, Milwaukee, WI, USA), using an 8-channel receive-only head coil. PRESS MR spectra (TE=35 ms, TR=3000 ms) and lactate-edited MR spectra (TE=144 ms, TR=3000 ms) were acquired from a voxel in the left basal ganglia (voxel size=15x15x15 mm^3 (n=2);16x16x16 mm^3 (n=3)). Lactate-edited MR spectra were collected using a BASING sequence with editing pulses applied at +/- 77 Hz in alternate spectral lines, and slice selective broadband (BURBOP) refocusing pulses with high bandwidth included in order to reduce chemical shift errors and improve lactate yield.[4] Spectra were coil-combined and FID .raw files were written out for the averaged TE=144 edit OFF lines and the subtracted (edit OFF – edit ON) lines, as well as the averaged water reference lines and the TE=35 spectral lines. Water-scaled lactate and NAA concentrations were calculated with LCModel version 6.3-0 using experimental basis sets including propylene glycol (pgc) in addition to the standard metabolites. Both lactate-edited and the edit OFF spectra were analysed using a basis set with TE=144 ms. The average lactate concentration and lac/NAA ratio was calculated for each spectrum, and the reliability of lactate detection was assessed from the Cramer-Rao lower bounds (CRLB) of the LCModel fit.

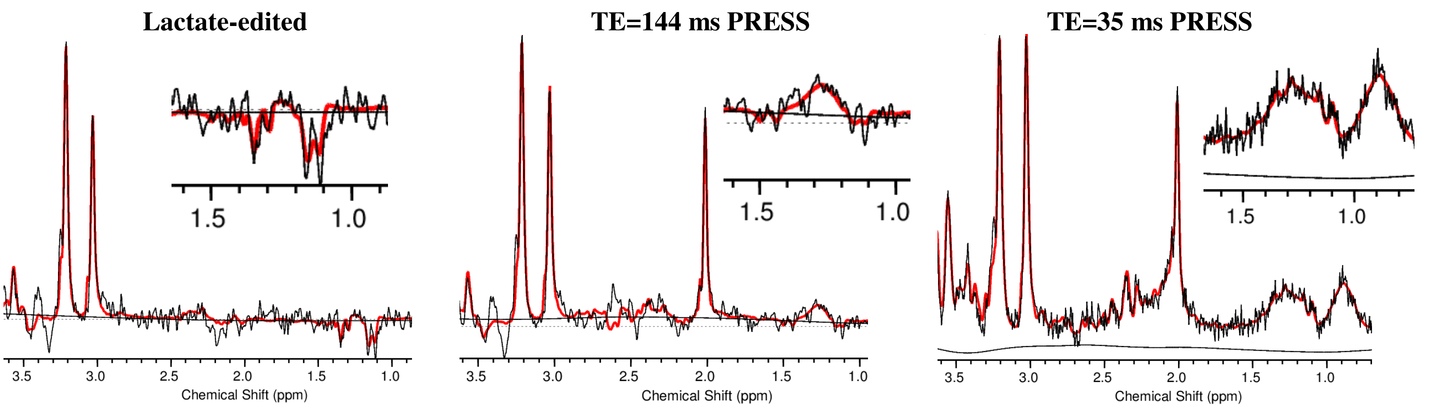

Figure 1. Lactate-edited spectrum (left) showing the lactate and propylene glycol doublets at 1.3 and 1.15 ppm, in an infant with suspected perinatal asphyxia. TE=144 ms and TE=35 ms PRESS (middle, right) are shown for comparison.

Results: An example lactate-edited spectrum is shown in figure 1, with the corresponding PRESS TE144 and TE35 spectra shown for comparison. The lactate doublet at 1.3 ppm and the co-edited propylene glycol doublet at 1.15 ppm are both well visualized in the edited spectrum, but both signals are masked by strong lipid resonances in the TE35 spectrum, and absent from the TE144 spectrum. Water-scaled lactate concentrations and Lac/NAA ratios were higher for the lactate-edited spectra relative to corresponding values from short TE (35 ms) and TE=144 ms PRESS (see table 1). The short TE (35 ms) and lactate-edited spectra show comparable sensitivity to lactate using a lenient CRLB cutoff (25%), but the fit reliability was higher (eg CRLB were lower) for the lactate edited spectra.

Discussion/Conclusions: While short TE PRESS MRS shows adequate sensitivity to high concentrations of lactate, overlap with lipid resonances can reduce the reliability and specificity of lactate detection. Lactate-edited MRS can improve the specificity and reliability of lactate detection in neonates with suspected HIE, particularly in the presence of strong lipid signals.

Table 1. Average lactate concentrations and lac/NAA ratios measured from the J-difference edited, TE=144 ms and TE=35 ms PRESS spectra

	Lactate-edited	TE=144	TE=35
[Lac]	3.96	1.02	1.38
Lac/NAA	2.99	0.99	0.91
Sensitivity (CRLB<25%)	40%	0%	40%
Reliability (avg. CRLB)	17%		21%

References

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