In vivo observation of hypernatremia during sodium lactate infusion

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Introduction

Sodium lactate (Lac) infusion has been used in clinical studies of lactate-induced panic. It has been suggested that lactate responsiveness is a sensitive and specific marker of panic disorder (1). Sodium lactate can also act as a hyperosmolalitic agent. Previous *in vitro* studies have been demonstrated that hypernatremia can induce metabolic changes of osmotically active amino acids in rat brain during NaCl administration (2,3). In this study, we investigate the changes in brain metabolite concentrations during prolonged intravenous infusion of sodium lactate into α-chloralose anesthetized rats using *in vivo* ^{1}H magnetic resonance spectroscopy at 11.7 Tesla.

Materials and Methods

Male adult Sprague-Dawley rats (170-210 g, n = 10) were fasted for ~24 hrs and anaesthetized using α-chloralose during the infusion experiment. Both femoral veins were cannulated for the intravenous infusion of sodium lactate and α-chloralose, and one artery was cannulated for blood sampling to monitor blood gases and arterial blood Lac level. After acquisition of a baseline ^{1}H MRS spectrum, intravenous infusion of sodium lactate (0.6 M, Fluka, Switzerland) was started. The sodium lactate infusion protocol consisted of a bolus of 0.08 ml/100 g body weight immediately followed by constant-rate infusion at 1.5 ml/100 g body weight/hr (4). Arterial blood sampling (70 µl) was performed during the baseline acquisition and every 15 minutes after initiation of Lac infusion. All experiments were performed on a Bruker 11.7 T AVANCE spectrometer interfaced with an 89 mm i.d. vertical-bore magnet. A ^{1}H surface RF coil of 15-mm diameter was used. It was positioned ~ 0-2 mm posterior to bregma and located close to the gradient isocenter. A single-shot adiabatic short-TE sequence was used for data acquisition from a 4.5 x 2.5 x 4.5 mm^3 voxel. An infusion period of 2 hrs was studied. TR/TE = 2000/15 ms. For each spectrum, 256 acquisitions were averaged for a total of 8.5 min. MRS data were fitted using the LCModel package.

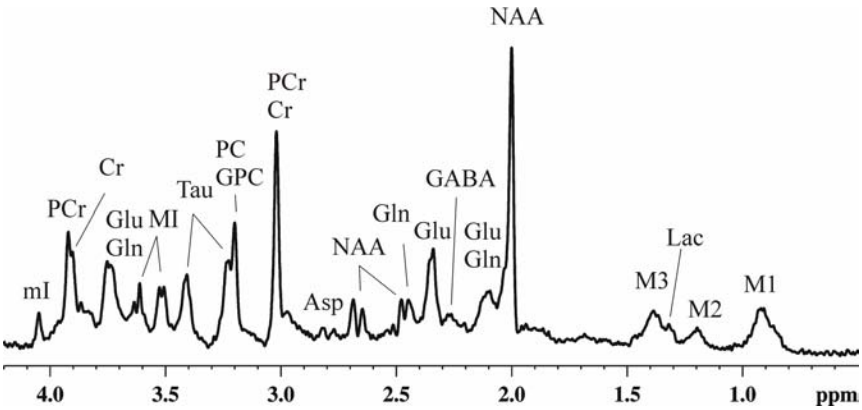

Fig.1. *In vivo* ^{1}H spectrum in a rat brain obtained during lactate infusion at 120 minutes time point.

The concentration of N-acetylaspartate (NAA) was assumed to be 10.3 mM and used as an internal concentration reference standard. Repeated measures ANOVA was used for statistical analysis.

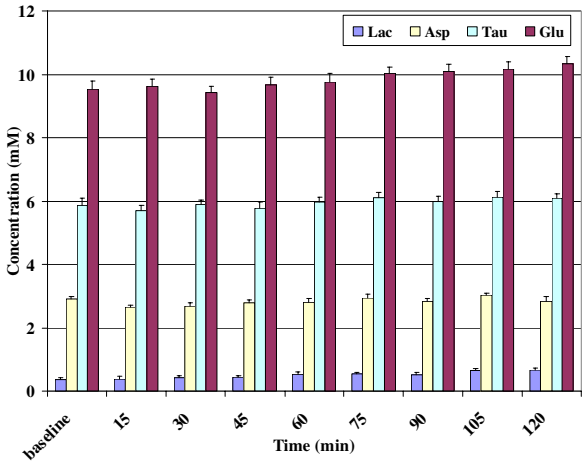

Fig.2. Changes in brain metabolites during lactate infusion.

Results and Discussion

Localized *in vivo* short-TE ^{1}H endpoint spectrum of one rat is shown in Fig.1. The short-TE *in vivo* ^{1}H spectrum demonstrates excellent spectral resolution and sensitivity. The Lac signal at 1.32 ppm was clearly resolved. Using repeated measures ANOVA, no statistically significant differences in PCr, Cr, PE, Gln, GABA, GPC and PCh concentrations between the baseline and the sodium lactate infusion spectra were found. The Lac concentrations in both brain (n=10, $F(8,72)=11.198$, $P<0.0005$, Fig. 2) and artery (n=8, $F(8,56)=6.681$, $P<0.0005$) were significantly increased during sodium lactate infusion as expected. The concentrations of Asp ($F(8,72)=2.258$, $P<0.03$, Fig. 2), Glu ($F(8,72)=10.545$, $P<0.0005$, Fig. 2), and Tau ($F(8,72)=3.689$, $P<0.001$, Fig. 2) were significantly increased as well due to sodium lactate infusion. The increase in Asp, Glu and Tau observed in this study during prolonged lactate infusion is consistent with the hypernatremia effect observed previously during sodium chloride infusion (2,3). The increase in brain Lac level during sodium lactate infusion is consistent with previous findings in the human brain using *in vivo* ^{1}H MRS (5).

References

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