EVALUATION OF A SELECTIVE HOMONUCLEAR MULTIPLE QUANTUM COHERENCE TRANSFER CSI (SELMQC-CSI) SEQUENCE FOR LACTATE MEASUREMENT IN ABDOMINAL TUMOURS

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PURPOSE

Lactate is considered to be an important metabolite in the assessment of malignant tissue detectable by magnetic resonance spectroscopy (MRS). It is often difficult to clinically detect the lactate methyl resonance, as the peak at 1.3 ppm is frequently obscured by intense lipid resonances. The purpose of this study was to evaluate a selective homonuclear multiple quantum coherence transfer CSI (SelMQC-CSI) sequence (1) applied in a small test group of patients with abdominal lesions, scanned at 1.5 T. SelMQC-CSI is a method that offers both good lactate detection and suppression of the lipid peak at 1.3 ppm (2). Previously it has been shown that SelMQC-CSI can be used to detect lactate in brain tumours (2) at 1.5 T. However, measuring lactate outside of the brain offers additional challenges due to internal motion and surrounding fatty tissue.

METHODS

To assess the performance of the SelMQC-CSI (TR of 1500 ms, TE=144 ms, 16x16 grid of cubic voxels (20-25 mm side), 2 kHz bandwidth, 1024 sampling points, 1 average, Qsel gradient strength 26 mT/m) sequence while the target was in motion, a small phantom containing 20mM lactate solution was placed on the abdomen of a volunteer. Respiratory gating was employed, using bellows provided by the manufacturer, placed where maximum respiratory motion could be measured. Assessment was performed of lactate detection, acquisition time and achievable linewidth.

Seven patients were scanned on a 1.5 T Siemens Avanto system, with carcinoma of the ovary (N=2), spleen (N=3), kidney (N=1) or cholangiocarcinoma (N=1) at various points in their treatment regimes. In 4/7 patients the respiratory bellows were required to trigger the acquisition.

The SelMQC-CSI sequence (acquisition time 6m24s without gating, <30min with gating) was performed in addition to a standard clinical routine imaging session. Additionally, where possible (N=5), PRESS-localised single voxel spectra (TE=135 ms, 20-25 mm cubic voxel, TR=1500 ms, 128 averages) were collected for comparison with the SelMQC-CSI spectrum. Single voxel spectroscopy was also used to collect data to provide a water reference (TE=135 ms, 20-25 mm cubic voxel, TR=1500 ms, 4 averages). Measurement in a phantom previously demonstrated that this yielded the same signal as a CSI measurement. All data were processed using jMRUI with an experimentally derived lactate basis set.

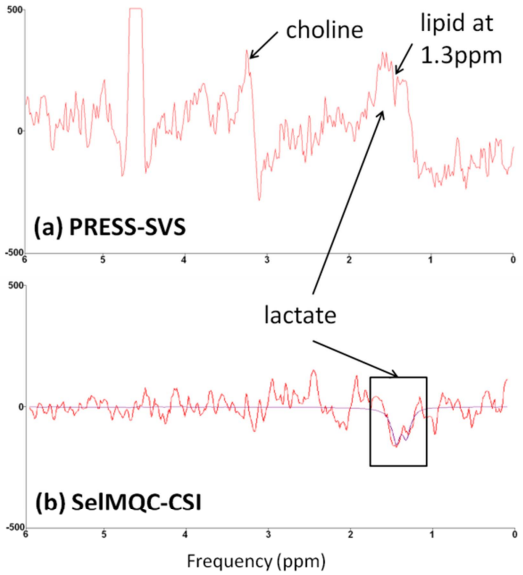

Figure 2: Splenic Carcinoma
(a) Single Voxel spectrum
(b) SelMQC spectrum

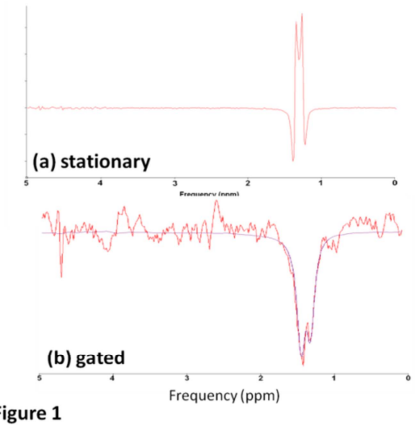

Figure 1
(a) SelMQC-CSI lactate lineshape for stationary lactate phantom;
(b) Fitting using truncated SelMQC lineshape for lactate phantom in motion with respiratory gating

RESULTS

The lineshape for SelMQC-CSI lactate has components in and out of phase, due to data collection starting prior to the peak of the echo (figure 1a). By truncating this to start at the peak of the echo, phantom data was fitted (figure 1b). Data from the phantom offered good lactate detection (concentration = 16.6 mM, not corrected for T1 or T2) while in motion, using a SelMQC-CSI sequence triggered by the respiratory bellows. The acquisition time was acceptable at less than 25 min, achievable linewidth was 6.3Hz.

Lactate was visible in three of the seven patient spectra (2 ovarian carcinoma and 1 splenic carcinoma). Example PRESS-SVS and SelMQC-CSI spectra from an ovarian carcinoma are shown in figure 2. In standard PRESS spectra (a) there is significant overlap between in-phase lipid and antiphase lactate, meaning that it is difficult to measure the component from lactate. This problem is not present in the SelMQC-CSI spectrum (b), where the lipid is no longer present at 1.3 ppm. Lipid signal at 2 ppm is unaffected. The SelMQC-CSI sequence showed signal for lactate centrally in the tumours of 3 patients (mean ± sd = 16.5 ± 1.7 mM, not corrected for T1 or T2, CRLB < 1.4).

DISCUSSION AND CONCLUSIONS

Lactate has been measured successfully in three patients with abdominal tumours. Previous work published using this sequence extracranially has been at 3 T, in a superficial thigh lesion in a patient with Non-Hodgkins Lymphoma (1). The current study has shown that the sequence can be applied at 1.5 T in lesions that require motion correction. SelMQC-CSI offers a better method of measuring lactate in abdominal tumours compared with standard single quantum PRESS-SVS, with lactate being successfully detected and lipid suppressed.

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