A comparison of inversion recovery and selective excitation for observation of choline in normal breast tissue

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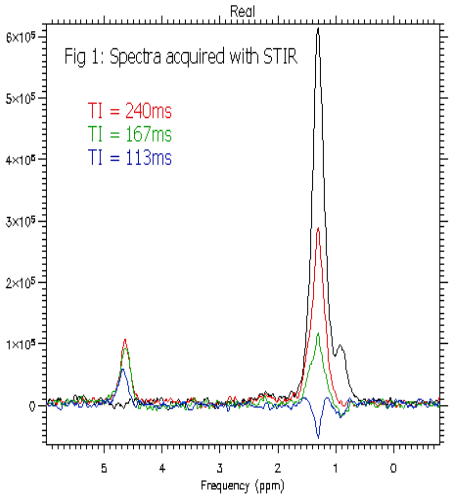
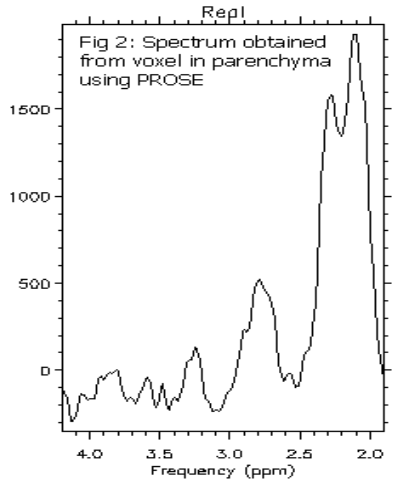
Introduction

It is now recognised that ^{1}H MRS can be used to distinguish benign and malignant breast lesions, and to follow chemotherapy, using the presence of choline as an indicator of malignancy[1]. However, the abundance of lipids in the breast, coupled with the large number of protons per molecule in lipids compared to choline, result in lipids dominating the acquired spectra, making choline difficult to detect. Many studies on choline detection have been performed using long echo times, in an attempt to reduce the lipid signal and make the choline peak more visible. Unfortunately SNR is considerably reduced by this approach. Consequently, some investigators[2] have employed an IR-prepared sequence, taking advantage of the relatively short T_1 of lipids compared to choline to reduce their signals. For this method to be feasible, however, a reliable and consistent value for the T_1 of lipid is required. Alternatively a sequence in which neither water nor lipid are excited could be employed thus removing the requirement for either long echo times or inversion. We report here investigations of the latter two approaches aimed at optimisation of choline visibility in breast lesions.

Methods

Examinations were performed on volunteers and patients using a 1.5T scanner (GE Signa LX) and a bilateral breast coil (Machnet). T_1 values of lipid and water were obtained using both spectroscopic and imaging methods. Single voxel ^{1}H MRS was performed using PROBE-P with voxel sizes of 1-3.4cm^3, TR 1500ms, TE 144ms and 128 averages. Four spectra were acquired, in 3 of which an inversion pulse was applied prior to water suppression with subsequent inversion times (TI) of 113, 167 and 240ms. In a separate group of subjects selective excitation for removal of water and lipid was achieved with a 2D-PROSE acquisition using an 8×8 matrix over an 8x8cm FOV with 8 NEX. A 2D-PROBE acquisition with IR (TI of 118ms) using the same parameters was also performed on this group. Spectral processing included 2.5Hz Gaussian line-broadening, zero-filling to 4K points, Fourier transformation and phasing. Peak areas (A) were then obtained by line-fitting of the major lipid peak, and of the water peak in unsuppressed spectra and T_1 values calculated. T_1-weighted images were acquired with a spin echo sequence using a minimum TE and TRs of 100 - 1000ms. Image sampling was performed using hand-traced ROIs for regions of predominantly fat and parenchyma and T_1's calculated using non-linear least squares curve fitting.





Results & Discussion

The spectra from a typical inversion series performed in a volunteer (Figure 1) demonstrate effective removal of lipid with very short TI times. Mean values in ms (± S.D.) of T_1 determined by the imaging and spectroscopic methods are given in Table 1. As expected these approaches give very different relaxation times, even for fat where the dominant contributor to image signal intensity is expected to be lipid. This is not surprising given that the imaging signals arise from the full selection of protons, whereas specific protons generate the spectroscopic signals. Hence the TI used to null lipid in IR spectra should logically be calculated from the spectroscopically obtained T_1. Calculation shows that lipid signals are best nulled at 118ms, a value much shorter than those used previously to optimise choline visibility in breast lesions[2]. Unfortunately this TI may be at the limit of the scanner's capabilities, and only achievable by compromising some other parameter, perhaps water suppression. More importantly, the range of calculated TI_{null} values, 83 – 153ms (95% CI) would necessitate the optimisation of the spectroscopic determination of choline for each subject and exam. The PROSE spectrum from a voxel localised completely within normal parenchyma (Figure 2) shows clearly the benefit of not exciting the 1.3ppm lipid protons. The metabolite and minor lipid peaks are much more evident. In particular, the choline peak at 3.2ppm, though small, is now clearly visible. This was seen in 2 out of 4 cases, as opposed to none with IR, which indicates that, even without special optimisation, PROSE is much better than STIR at improving the dynamic range of the choline signal.

Table 1

Method	Fat	Parenchyma
Imaging	414 ± 140 (13)	1071 ± 527 (6)
	Lipid	Water
Spectro	171 ± 26 (12)	425 ± 67 (10)

Conclusions

Although IR-preparation of the spectroscopic acquisition will lead to significant improvement in potential choline visibility, the variability of lipid T_1 values suggests that on a routine basis this would be impractical. On the other hand, using a spectral-spatial pulse in which neither water nor lipid are excited resulted in choline being detected in normal breast tissue at 1.5T, a result, we believe, not previously reported. The use of PROSE not only improves the visibility of choline in breast tumours, but also implies the necessity for quantification[3] as a means of providing normal limits for lesion diagnosis in clinical practice.

References

1. Katz-Brull *et al* (2002) J. Natl. Cancer Inst. **94** 1197-1203. **2.** Jacobs *et al* (2003) Proc. ISMRM **11** 599. **3.** Bolan *et al* (2003) Proc. ISMRM **11** 265.

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