Optimising Choline Visibility In Breast Lesions With J-Resolved PRESS

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Introduction Proton MRS can be used to distinguish benign and malignant breast lesions, and to follow chemotherapy, using the presence of choline at 3.2ppm.[1] However, the abundance of lipids in the breast, coupled with their large number of protons, result in lipids dominating the acquired spectra. Furthermore, lipid signal sidebands caused by gradient-induced modulations in the B_o field may confound the detection of choline[2]. Since the choline signal arises from uncoupled spins, a possible solution is to employ a TE-averaging sequence[3] to acquire a series of spectra with increasing echo times, the summation of which would eliminate sidebands and reduce the intensities of coupled resonances. The purpose of this study is to investigate the optimum parameters for this sequence to achieve maximized visibility of choline in breast lesion spectra.

Methods Examinations were performed on 4 patients with invasive ductal carcinoma using a 1.5T scanner (GE Signa Infinity) and a bilateral breast coil (Machnet). Single voxel ^{1}H MR spectra were acquired from the lesion of each patient (voxel size 2.9-5.2cm^3) after a clinical examination that included contrast administration. A PROBE-P based TE-averaging sequence was developed which allowed the acquisition, into separate frames, of signals at several TE values. Two sets of sequence parameters were used, *A*: TR 1.5s, initial TE 35ms, 64 steps of 2.5ms, and 4 water-suppressed acquisitions per TE, and *B*: TR 2s, initial TE 145ms, 4 steps of 5ms, and 32 water-suppressed acquisitions per TE. Spectral processing included 2.5Hz Gaussian line broadening, zero-filling to 4K points, Fourier transformation and phasing. Peak amplitudes of residual water, choline and the lipid peak at 1.3ppm (Lip13) for each TE were obtained and used to estimate T2 values and intensities at TE = 0ms (M_o) of the respective signals. These calculated T2 and M_o values for the 4 patients were then averaged and used to obtain theoretical T2 decay curves for residual water, choline and Lip13. Subsequently the spectra were divided into 8 groups, each containing spectra acquired at 8 consecutive echo times. The spectra in each group were averaged, giving a representative spectrum for their average TE (TE_{avg}), and used to assess the conspicuity of choline.

Results Figure 1 shows representative grouped spectra acquired from one of the patients. A 2D Fourier transform of the original data confirmed that a single uncoupled resonance was present at 3.2ppm. The estimated T2 values (mean ± S.D.) for residual water, choline and Lip13 were 72 ± 23, 163 ± 18 and 79 ± 9ms respectively. The theoretical T2 decay curves for the above compounds, along with the predicted Cho/Lip13 ratio, are plotted as a function of TE in Figure 2.

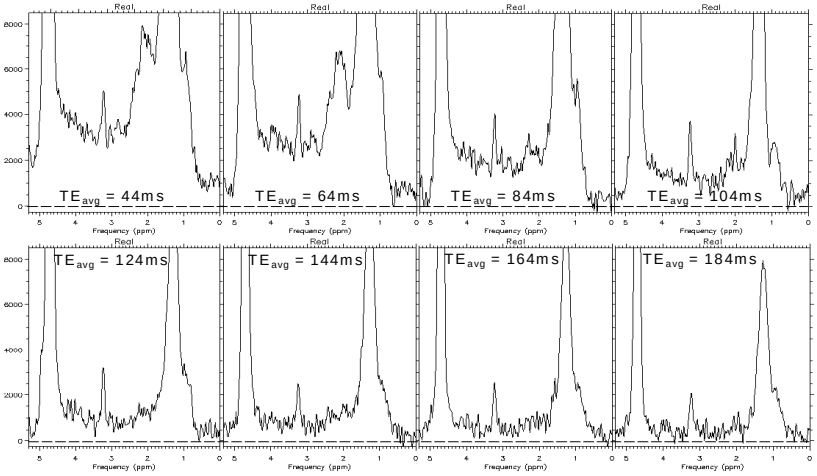

Figure 1: Representative grouped spectra of a malignant breast lesion.

Discussion As Figure 1 clearly shows, although the SNR of the choline peak decreases as TE_{avg} increases, its conspicuity is actually improved up to a TE of about 144ms. This appears to arise by a reduction of the tails of the much larger water and lipid resonances. Their overlap in the intervening frequency range results in an elevated "baseline" that masks some of the choline signal at shorter echo times. As the TE is increased, these tails become progressively less prominent, effectively disappearing by a TE of 184ms, as a result of their relatively short T2 values. In addition, the 2.1ppm lipid peak, with a similarly short T2 value (75ms, n=1), also disappears into the "baseline" at a TE of around 144ms. These empirical observations suggest that acquiring spectra starting with an initial TE of about 140ms would result in a more prominent choline peak than a spectrum acquired with a minimum TE. This is further supported by the calculated Cho/Lip13 ratios (Figure 2). As the T2 of choline is much longer than that of lipid, Cho/Lip13 increases with TE, implying an increase in choline visibility. However, if too long a TE were used, the gain in Cho/Lip13 would be overcome by poor SNR (Figure 1). Hence we believe that the optimum TE range for good choline visibility is about 125-160ms. With these results in mind, we tested the optimised sequence parameters *B* on 2 patients. As expected, the spectra showed a more prominent choline peak compared to the 64 TE sequence (Figure 3), even though the 4 TE sequence had only half the number of acquisitions.

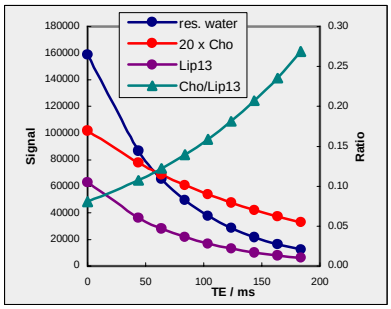

Figure 2: T2 decay curves of residual water, choline and Lip13, superimposed with plot of Cho/Lip13 v TE.

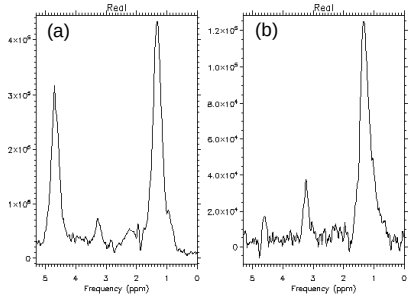

Figure 3: TE-averaged spectra of the same lesion acquired with (a) 64 steps, initial TE 35ms and (b) 4 steps, initial TE 145ms. Spectra were scaled to the largest peak.

Conclusion Using the TE-averaging sequence, acquiring spectra from malignant breast lesions with a long initial TE of about 140ms gives better conspicuity of the choline signal compared to using a short initial TE.

References [1]Katz-Brull *et al* (2002) J. Natl. Cancer Inst. **94** 1197-1203. [2]Bolan *et al* (2002) Mag. Reson. Med. **48** 215-222. [3]Hurd *et al* (1998) Mag. Reson. Med. **40** 343-347.

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