Anomalous lipid signal investigation when measuring water/lipid signal with unsuppressed <1>H MR spectroscopy

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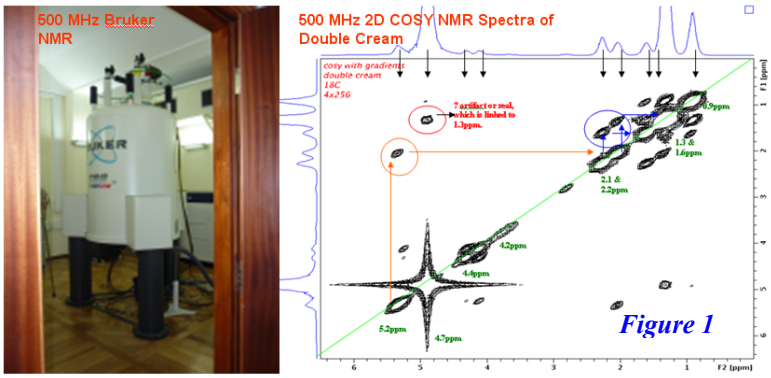
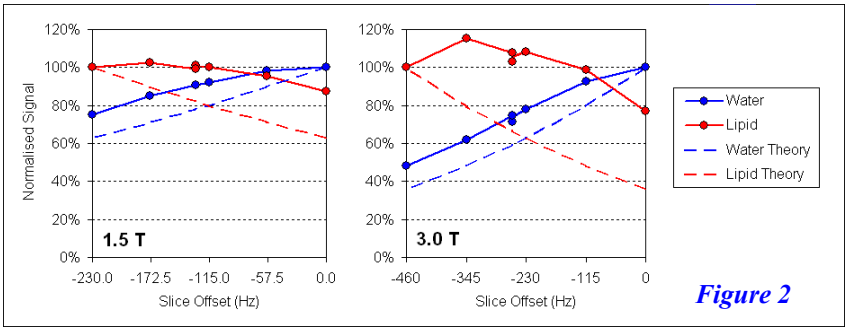
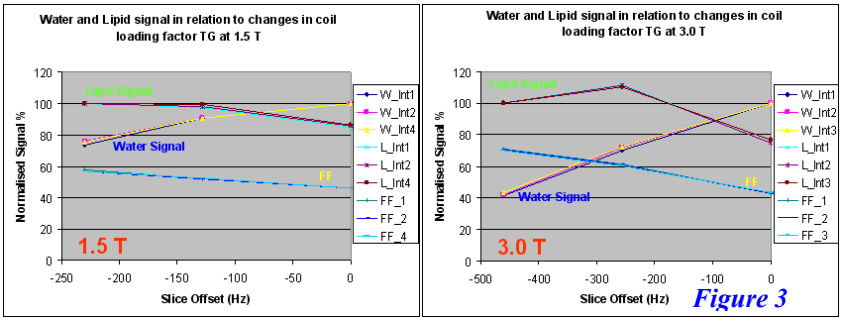
Purpose/Introduction: Water:lipid signal ratio (WLSR) can be measured with unsuppressed ^{1}H MR spectroscopy and such data can be used to characterise breast cancer and bone disease. It is important, however, to be aware of potential bias (systematic errors) in these measurements as caused by chemical shift-induced voxel offsets which will be relatively large for the 3.4 p.p.m. water-lipid separation.



Subjects and Methods: Single-voxel experiments were carried out at 3.0 and 1.5 Tesla (both GE Signas) using PRESS (PROBE-P) on cartons of cow's double cream. Chemical shift slice-selection offsets were varied between having the water voxel aligned with the prescribed voxel (0 Hz), and having the 1.3 p.p.m. lipid voxel aligned (–460/–230 Hz for 3.0/1.5 T). Pulse bandwidths were 2366.67 and 1384.62 Hz for the 90° and refocusing (167°/137° for 3.0/1.5 T) pulses. Six outer-volume (VSS) saturation bands were also used to sharpen voxel profiles. At present, STEAM (PROBE-S) does not enable variable offsets. The cream experiments were repeated over a range of coil loadings by adding aqueous phantoms into the coil (transmitter gains: 11.3, 16.2 and 17.4 dB; relative transmitter powers: 1.0, 3.0 and 4.0). High resolution 500 MHz 2D (correlation spectroscopy) COSY spectra of the cream were also acquired in order to determine spin-spin (J) coupling (*Figure 1 right/left*).

Results: The graphic (*Figure 2*) shows how measured signal varied with offset along with theoretical values, as calculated using the pulse bandwidths and assuming perfect ("top hat") slice profiles. It can be seen that whilst the water curves behave as expected (the slightly elevated signal can be explained by non-ideal slice profiles), the lipid curves are anomalous with higher than expected signal at intermediate offsets. *Figure 3* illustrates the graphs plotted for the different coil loadings for both 1.5 T and 3.0 T, the data shows a difference of less than ±1.13 percentage points showing that any bias is highly reproducible. COSY *Figure 1* (right) spectra shows a potentially unexpected coupled spin between 1.3 (parts per million) p.p.m and 4.7 p.p.m. Work is ongoing to study these effects in detail.





Discussion/Conclusion: Data show that whilst a strong systematic bias can be expected in WLSR measurements, this will be highly reproducible between examinations allowing patient-patient differences and longitudinal changes to be measured with confidence. The anomalous lipid signal behaviour might be explained by anomalous refocusing of coupled spins [1] as the 1.3 p.p.m peak displayed multiple couplings. Variability in VSS pulse effectiveness between water and lipid may also be a factor. Action is also underway to enable slice offsets in STEAM so that this pulse sequence can be evaluated too.

References: 1. D.A.C. Kelley, *et al.*, *JMRI* 9(5):732-737 (1999)