Abstract: A quantitative evaluation of the lipid composition within healthy and leukaemic human bone marrow is reported. The saturated : unsaturated lipid proton ratios were calculated using specific volume integrals measured from localised DQF-COSY spectra. In summary, no significant differences in bone marrow lipid composition were observed between healthy volunteers and the patient group.

Introduction: A localised variant of double quantum filtered - correlated spectroscopy (DQF-COSY) was recently employed to acquire 2D spectra from tibial bone marrow of healthy volunteers (n = 6) and patients with leukaemia (n = 4). The pilot study also included patients with leukaemia in remission (n = 3). The resulting contour plots revealed characteristic 2D diagonal peaks and well-resolved cross peaks corresponding to saturated and unsaturated triacylglyceride (TAG) protons. The primary objective of this study was to calculate the saturated : unsaturated lipid proton ratios in all individuals. This quantitative assessment will determine whether alterations in lipid composition are associated with neoplastic cell invasion of human bone marrow.

Materials and Method: All examinations were performed using a 1.5 T Siemens Vision whole-body clinical MRI scanner supplied with shielded gradient coils (25 mTm-1). A quadrature extremity coil was used for radiofrequency (RF) transmission and reception in all studies. Data processing was performed using the FELIX multi-dimensional NMR data analysis software (Biosym Inc, San Diego). Following the acquisition of three orthogonal T1-weighted FLASH images, a voxel (typically 27 ml) was positioned within the region-of-interest (ROI). BI acquisition of three orthogonal TI-weighted FLASH images, a voxel was achieved using three slice-selective RF pulses in combination with pulsed field gradients. A localised version of the DQF-COSY sequence described by Shaw et al [90°-t,-G-90°-G-90°-G-t2] was also implemented [1,2]. Water suppression was not used. The raw 2D FIDs were acquired using 1024 complex points. 48 t1 increments were used to sample the second frequency dimension (F2 = 625 Hz). In general, the data were zero-filled once in both time dimensions. Sine-bell apodisation functions were applied to both time domains prior to a 2D complex Fourier transformation (FT). The inclusion of CTF gradients within the evolution period (t2) gives rise to phase-modulated data. The resulting 2D COSY spectra are therefore displayed in the magnitude mode.

Quantification Strategy: The coronal gradient-echo MR image recorded from a male subject is displayed in Fig. 1, illustrating the typical placement of the voxel within the right tibial marrow. The localised DQF-COSY spectra recorded from the voxel is shown to the right of the MR image.

The volume integrals were initially measured for the olefinic lipid proton cross-peaks labelled A, A', B and B'. The volume integral was also calculated for the diagonal peak (C) corresponding to the saturated polymethylene (-CH2-) resonances. Finally, the unsaturated : saturated lipid proton ratio was calculated using the summed cross peak volumes and the diagonal peak (C) volume.

Table 1.0 Summary of mean ratios

<table>
<thead>
<tr>
<th>Patient Group</th>
<th>Lipid Ratio</th>
</tr>
</thead>
<tbody>
<tr>
<td>Controls (n = 6)</td>
<td>0.69 ± 4 x 10^(-7)</td>
</tr>
<tr>
<td>Diseased (n = 6)</td>
<td>0.75 ± 4 x 10^(-7)</td>
</tr>
<tr>
<td>Remission (n = 4)</td>
<td>0.76 ± 4 x 10^(-7)</td>
</tr>
</tbody>
</table>

The results illustrate that DQF-COSY does not detect any significant differences in tibial bone marrow lipid composition between healthy volunteers and patients with leukaemia. The mean ratios were comparable for each patient group although the diseased population showed a slightly increased variability of calculated ratios.

Conclusions: A localised variant of DQF-COSY has been implemented at 1.5 T to improve spectral resolution and assist reliable peak quantification. The sequence has been used to investigate and compare the lipid composition of healthy and leukaemic bone marrow. For a small patient population (n = 16), no significant quantitative differences were observed.

Acknowledgements: This work was supported by CRC grant no. SP1780/0103 and Medical Research Council.

References: