Introduction: Symptoms of irritable bowel syndrome (IBS) namely abdominal pain and discomfort with erratic bowel habits are extremely common. There are currently few effective treatments and patients are often dissatisfied with their treatment. This is partly due to a poor understanding of the underlying physiology of the condition which can be related to dysfunction of either or both the small or large bowel making targeted treatment difficult. MRI allows non-invasive probing of the underlying physiology of the bowel and recent studies have made some progress in understanding the mechanisms of this disease in the small bowel [1-3]. However additional studies which evaluate the function and properties of the large bowel are also needed to gain a better insight into this complex disease. The aim of this study was to determine whether measurements of the NMR relaxation time $T_1$ in the chyme of the ascending colon (AC) could provide useful information on colonic function in patients with diarrhoea predominant IBS (IBS-D) compared to age-matched, healthy controls.

Methods: In-vivo study: The study was approved by the local NHS Ethics Committee and all patients and volunteers gave written informed consent. Patients (n=29, 9 male, mean age 38 range 20-60) with clinical symptoms of IBS-D as defined by the Rome III Criteria and healthy volunteers (HV) (n=18, 5 male, mean age 39 range 21-67) were scanned after an overnight fast. Scanning was carried out using a 1.5 T Philips Achieva whole body scanner using a 4-element SENSE body coil. $T_1$ was measured in the AC chyme using an Inversion recovery (IR) 2DTE (TrueFISP) sequence with the following parameters: 1 sagittal slice, TR/TE= 3.0/1.5 ms, FOV = 400 x 400 mm, matrix size 256x256, slice thickness=10mm and 8 different TIs ranging from 100-5000 ms. Each image was acquired during a breath-hold with 15 s of free breathing between each different TI to allow for full relaxation of the MRI signal. Regions of interest (ROIs) were then drawn in the top, middle and bottom of the AC, with the position adjusted if the AC had moved between images. The mean signal from each region was then fitted to a model of the signal evolution from all R.F. pulses applied during the sequence using the Powell minimisation algorithm [4] and assuming that the sample had a single $T_1$ (1-compartment model). Preliminary in-vivo data suggested that the model with a single $T_1$ was not always adequate at describing the data. The data was then fitted to a simple 2-compartment model which allowed for both a ‘long’ and ‘short’ $T_1$ components (whilst keeping $T_2$ and $M_0$ the same for both $T_1$ components to reduce the number of parameters to fit).

Results: Figure 1 shows some typical in-vivo recovery curves. There was no consistent difference in the measured $T_1$s across the sub-regions (top, middle, bottom) of the AC and Figure 2 shows the $T_1$s measured for each subject averaged over the 3 sub-regions within the AC for the 2 groups (IBS-D and HV). The 2-compartment model failed to find a second component on 2 sub-regions in the HV subjects, and 11 sub-regions in the IBS-D patients; when this occurred the remaining component was attributed to the ‘long’ $T_1$ component. Statistical differences between the means of groups are shown in figure 2 (Student t-Test). For the inversion times used here, the single $T_1$ measured from the 1-component model underestimated the mean $T_1$ of the region when compared to the mean of the long and short components multiplied by their corresponding fractions.

Discussion: The IBS-D patients showed a longer fasting $T_1$ in the AC chyme compared to the healthy volunteers for both the 1-compartment model and the short component of the 2-compartment model, however there was some overlap between the groups (although the overlap was less for the short $T_1$ component than the single $T_1$). The 2-compartment model better described the data, showing the heterogeneity of the chyme in the AC, in which there is a mixture of different $T_1$s which can be approximated to ‘long’ and ‘short’ components which have approximately the same fraction. It is difficult to determine whether the heterogeneity is inter- or intra-voxel as voxel-by-voxel analysis was not possible due to movement of the AC and is most likely due to multiple compartments of differing $T_1$ rather than a multipexponential $T_1$ relaxation. The difference in $T_1$ between patients and controls could be due to faster transit of chyme through the small bowel increasing the amount of fluid delivered to the AC [1] or increased bile or different bacteria which produce less short chain fatty acids which will reduce the rate of water absorption. Future studies will determine the reproducibility of the acquisition and analysis.


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