MRI and MRS measurements of intragastric fat spatial distribution
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Background: Gastrointestinal (GI) function and satiety are strongly influenced by intragastric distribution of fat. Early nuclear medicine studies showed the rate of emptying of water and fat from the stomach depended on whether the fat was incorporated within the food matrix [1]. However such studies were limited by radiation dose and did not investigate the intragastric behaviour of oil-in-water emulsions, which are commonly used in food products. MRI allows fat and water components to be imaged separately. We have recently shown that acid stable emulsions stimulate greater cholecystokinin release, delay gastric emptying and increase satiety compared to acid unstable emulsions in which the fat layer empties after the aqueous phase [2-3]. Proton spectroscopy (MRS) is widely used to determine the fat/water ratio of a sample; multi-echo DIXON (mDIXON) [4] can measure fat fraction at a much higher spatial resolution but the results may not be so quantitative. This initial study aims to compare MRS and mDIXON for fat fraction estimates in vivo to determine the effect of fat microstructure on GI handling of emulsion meals.

Methods: Meal: Two fat emulsions were prepared: coarse and fine (mean droplet diameters ~0.4 μm and ~8 μm). Both contained 79% water, 20% sunflower oil, 1% emulsifier, sweetener and flavouring. Subjects: The study was approved by the local Ethics Committee. 6 healthy male volunteers (18-35 y.o) with no history of GI disease attended on 2 mornings having fasted overnight. Initial baseline scans were acquired and then the volunteer consumed 300g of one of the meals (60g fat in total) in random order. MRI and MRS: Data were acquired hourly for 3 hours using a Philips 1.5T Achieva scanner. Data were acquired in a 13s breath-hold, FA=80

Results: The images and quantitative data showed that the coarse emulsion immediately separated in the GI tract, into a high fat content floating phase and a low fat content sunk phase. The fine emulsion remained stable. At t=0 the MRS measures of total fat content of the stomach and the average fat fraction of the emulsion (fig 3) agreed better with fat in the ingested meal (assuming only small meal dilution at t=0) than mDIXON measures. Gastric emptying of the fine emulsion was significantly delayed compared to the coarse emulsion with p=0.03 (fig 1b) although the differential volume measurements showed that both the upper and lower layers of the gastric contents emptied steadily and MRS showed the fat content of the upper layer gradually reduced over 3 hours (fig 3). Interestingly the net rate of emptying of fat (calculated from volumes and MRS fat fractions) was similar for both meals (fig 4).