Redistribution of Abdominal Blood Flow Following Meal Ingestion

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Background: The effect of a meal challenge on increasing gastrointestinal blood flow and on cardiac output has previously been characterised with a variety of techniques such as ultrasound and nuclear medicine [1-3]. However, gas in the stomach and colon often interfere with ultrasound assessment while isotope techniques involve a radiation dose, which precludes their repeated use in physiological studies of normal subjects [4]. MRI studies allow non-invasive, robust monitoring of the physiological blood flow and have been used to assess postprandial changes in portal [5] and superior mesenteric artery (SMA) blood flow [6]. However we have not found MRI studies which assessed serially blood flow changes in the SMA nor correlated changes in the SMA to changes in the abdominal aorta.

Aim: To use phase contrast (PC) MRI to monitor serially the separate haemodynamic responses of the SMA and abdominal aorta (AA) to a high calorie meal and to observe any possible correlation between blood flow in the splanchnic and systemic circulation in healthy volunteers.

Materials and Methods: 5 healthy volunteers (4 male 1 female, age range = 23-37 years, mean = 30 years) attended a morning session after an overnight fast. They were positioned supine within a Philips Achieva 1.5T MRI scanner with a 4 element SENSE body coil positioned around the upper abdomen. Following localization scout scans, detailed localization images were acquired to visualize the position and orientation of the vessels of interest, thus allowing breath-held, cardiac triggered, phase contrast measurements to be acquired perpendicular to both vessels' orientation. Baseline acquisitions were made using a PC sequence with FOV 320 x 256 cm ,TE=2.4 ms, TR=4 ms, 15^0 Flip angle, SENSE factor 2, with 40 measurements per R to R interval and a velocity measurement limit of 150 cm/s (due to the high flow velocity in the aorta). Measurements were acquired simultaneously using a single slice placed perpendicularly to both vessels. After a baseline measurement the subjects ingested, within 10 min, a standard meal (814 kCal, (513 kCal from glucose)), which was followed by serial flow imaging at t=30, 60 and 90 min. Flow quantification was performed retrospectively on the scanner console using the manufacturer's software to quantify blood flow in ml/s through the SMA and AA. The significance of changes in blood flow was assessed using non-parametric paired 2-tailed Wilcoxon's test at a level of $p<0.05$ versus the pre-feeding measurement.

Results: At time t=30 min after feeding we observed a four-fold increase in blood flow in the SMA ($p<0.05$, **Fig. 1**) and a concomitant 44% decrease in the AA ($p<0.05$, **Fig. 2**). We also compared the pre-feeding blood flow to peak blood flow following the meal at all time points for SMA and AA (**Fig. 3**). This correlation was stronger (Pearson's r=0.79) than the correlation between the pre and t=30 minutes blood flow values (r=0.65).

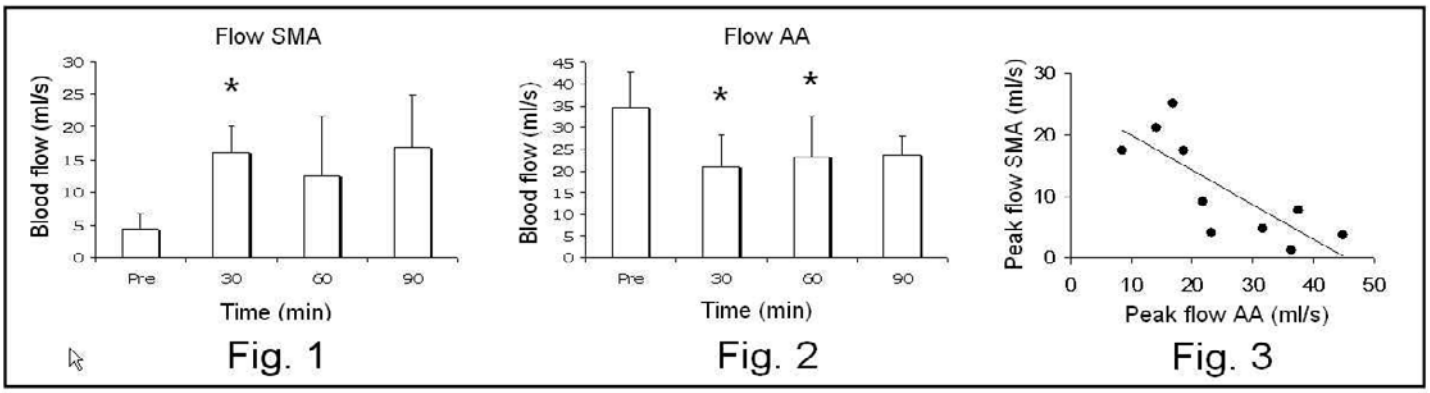

Figure 1 shows the average blood flow measurement in the SMA and **Figure 2** shows the average blood flow measurement in the AA. Data are mean ± SD. * Non-parametric paired 2-tailed Wilcoxon's $p<0.05$ versus the pre-feeding measurement. **Figure 3** shows the correlation between the individual blood flow values pre-feeding and peak blood flow following the meal at all time points for SMA and AA (Pearson's r=0.79).

Discussion: Meal ingestion is a strong modulator of intestinal blood flow. We were able to detect this change and also demonstrate that the postprandial increase was associated with a decrease in systemic blood flow as cardiac output was diverted into the splanchnic circulation. Our values are in good agreement with previously reported MRI measurements [7,8,9], although the latter were usually preformed at a single time point rather than serially. We observed some individual variations in the time of maximum blood flow change, which suggests that serial sampling at a higher temporal resolution might be an advantage. The PC-MRI sequence used was optimised with regards to the high blood velocity of the AA, which would have lowered the precision in the SMA measurement in this data. We could interleave three subjects on the same morning session, increasing throughput and cutting costs in serial studies. The time course of blood flow changes provided by serial sampling will be of great importance in understanding the normal physiological intestinal response to food. This technique could also be used to study gut blood flow in a range of important clinical conditions including mesenteric ischemia and postprandial hypotension in the aged and diabetic population. It might also be used to try to understand the rare and poorly understood ischemic colitis associated with the use of 5HT3 antagonists in the Irritable Bowel Syndrome. Future work will include studying how different meals change splanchnic and systemic circulation over time in larger groups of normal subjects and patients from the groups mentioned above.

References: If space is a problem remove titles

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