Characterisation of the time course of the superior mesenteric, aorta and internal carotid arteries' blood flow response to the Oral Glucose Challenge Test

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Background: The Oral Glucose Challenge Test (OGCT) is widely used to assess glucose tolerance. Gastrointestinal blood flow increases following an OGCT and this has been shown using techniques such as ultrasound, nuclear medicine and MRI. However such changes in blood flow are often measured only at two points (baseline and a single time point after a test meal). We carried out a pilot phase contrast (PC) MRI study [1] in which we measured the blood flow in the superior mesenteric artery (SMA) at 30, 60 and 90 min after a meal challenge. We found individual variations in the size and timing of the SMA blood flow response to a meal, which has prompted us to characterise this response to feeding with higher temporal resolution. We are also interested in studying conditions such as postprandial hypotension, which has been reported as a cause of falls and syncope in the elderly and diabetic population. Using a moving table, MRI offers the possibility of monitoring serially both the gastrointestinal and the internal carotid arteries blood flow response to the OGCT.

Aim: To characterise, with high temporal resolution, the haemodynamic responses of the SMA, abdominal aorta (AA) and internal carotid arteries (IC) to the OGCT in healthy volunteers with a view to developing methods that could be used in patients studies.

Materials and Methods: 8 healthy volunteers (5 male, 3 female, 34±4years old, Body Mass Index 26±2 kg/m^2) attended a morning session after an overnight fast. They were positioned supine within a Philips Achieva 1.5T MRI scanner with a 2 element, SENSE Flex coil positioned around the neck. Following localization scans, detailed localization images were acquired to visualize the position and orientation of the vessels of interest, thus allowing cardiac triggered, phase contrast measurements to be acquired perpendicular to the orientation of the vessels in both the abdomen and neck. Automated table movement was used to scan the neck and the abdomen alternately with a total acquisition time of 88 sec per cycle. Acquisitions in the abdomen were made using a PC sequence with FOV 320 x 256 cm ,TE=2.7 ms, TR=4.7 ms, 15° flip angle, 20 measurements per R-R interval and a velocity measurement limit of 150 cm/s. Measurements on the SMA and aorta were acquired simultaneously using a single slice placed perpendicularly to both vessels. Acquisitions in the neck were made using a PC sequence with FOV 200 x 170 cm, TE=3.1 ms, TR=15 ms, 15° flip angle, SENSE factor 2, 40 measurements per R-R interval and a velocity measurement limit of 70 cm/s. Measurements in the left and right carotids were acquired simultaneously using a single slice placed perpendicularly to both vessels. After 13 min of baseline the subjects ingested, within 4 min, a standard OGCT drink (75 g of glucose dissolved in 296 ml water, 273 kcal) which was followed by further 44 minutes of serial flow imaging. Flow quantification was performed retrospectively on the scanner console using the manufacturer's software to quantify blood flow in every vessel.

Results: The data are shown as mean±SEM. Fig.1 shows the average SMA mean flow response to the glucose challenge meal ingestion over time. The postprandial SMA mean flow increased from baseline by 303% with a range of individual variations from 208% to 603%. The time for the SMA mean flow to reach its peak varied between individuals from 22 to 51 min. A correlation between the individual SMA blood flow time to peak and the individuals' Body Mass Index (BMI) was found (Fig. 2, r=0.93, p<0.001). Fig.3 shows the peak flow through both carotids. The postprandial values of the peak and mean blood flow through both carotids did not change significantly from baseline (overall mean flow 3.89±0.03 ml/s, n=320 measurements).

Figure 1

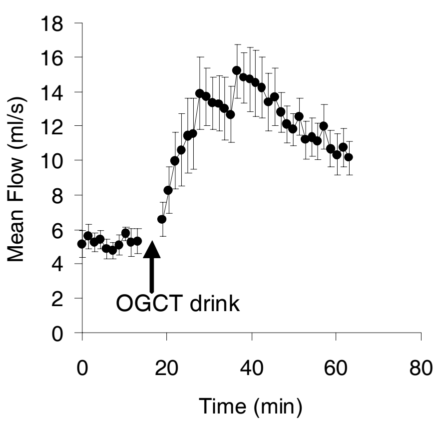


Figure 2

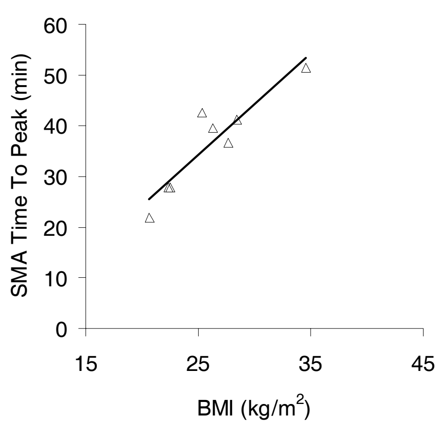
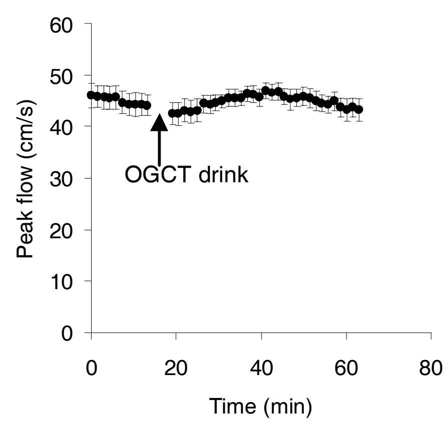


Figure 3



Discussion: We were able to describe the time course of the flow of the gastrointestinal and cereberal blood supply following the OGCT within the same study and with high temporal resolution. We found substantial variations in the size of the SMA postprandial blood flow increase between individuals and a relationship with the BMI of the subjects. This novel approach could be valuable for future studies of postprandial hypotension.

References:

[1] JJ Totman, L Marciani, S Foley, E Campbell, RC Spiller, PA Gowland. Redistribution of Abdominal Blood Flow Following Meal Ingestion. Proceedings 14th ISMRM, Seattle 2006, p. 837