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RESEARCH ARTICLE

EFFECTS OF FATTY AND CARBOHYDRATE MEALS ON SUPERIOR MESENTERIC ARTERY BY COLOR DOPPLER ULTRASONOGRAPHY

***Elsamani, M., Garelnabi, M. E. M., Osman, H. and Elsafi Ahmed Abdalla**

[1]College of Medical Radiologic Science, Sudan University of Science and Technology P.O. Box 1908, Khartoum, Sudan

[2]National University-Sudan, Fucullty of Radiology & Medical Imaging, Khartoum, Sudan

[3]Taif University, College of Applied Medical Science, P.O. Box 2425, Post Code 21944, Taif KSA

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ABSTRACT

Introduction: Duplex ultrasound (DU) provides a simple, portable, reproducible, and non-invasive assessment of blood flow. Measurement of luminal diameter and blood velocity allows estimation of blood flow and peripheral resistance and the detection of arterial occlusive disease. Owing to its size and anatomic position, the superior mesenteric artery (SMA) is also accessible to DU. Applied to the superior mesenteric artery; the method confirms that blood flow in this vessel increases in response to a meal.

Objective: To investigate the contribution of the different types of meals to blood flow of the Superior Mesenteric Artery (SMA) by Doppler ultrasonography as a means of determining the relative potencies of the major nutrient stimuli in healthy human subjects.

Materials and Methods: One hundred healthy volunteers , with age variation (20 -50) years, were examined before and after different two meals type that include varying Kcals and contents (250 gram, 545 Kcal and 270 gram, 477 Kcal) in order to assess (SMA) , diameter DM and blood flow volume BFV.

Results: The peak values of DM and BFV for the fatty, and carbohydrate meal appear at 60 min, and 30 min respectively, after meal taken up to 90 min. There was significant value for the correlation between the varying time with the mean values of DM, and BFV of SMA for fatty and carbohydrate meal.

Conclusion: The fatty compared to carbohydrate meal take long time for SMA response songraphically.

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INTRODUCTION

Blood Flow (BF) in the splanchnic organs reflects motor, secretory, and absorptive activities. All of these activities increase after a meal and, consequently, induce a great increase in splanchnic BF. The splanchnic circulation provides nutrients and oxygen to its supplying organs, carries away the absorbed substances, and removes waste products from the organs. It is important to understand the nature and mechanism of BF regulation in the splanchnic organs (Nami Someya *et al.,* 2008). Sonography can be enhanced with Doppler measurements, which employ the Doppler effect to assess whether structures (usually blood) are moving towards or away from the probe, and its relative velocity.

By calculating the frequency shift of a particular sample volume, for example flow in an artery or a jet of blood flow over a heart valve, its speed and direction can be determined and visualized. This is particularly useful in cardiovascular studies (sonography of the vascular system and heart) and essential in many areas such as determining reverse blood flow in the liver vasculature in portal hypertension. The Doppler information is displayed graphically using spectral Doppler, or as an image using color Doppler (directional Doppler) or power Doppler (none directional Doppler). This Doppler shift falls in the audible range and is often presented audibly using stereo speakers: this produces a very distinctive, although synthetic, pulsating sound (Abd Elrahim *et al.,* 2016). Doppler ultrasound has become increasingly important in investigating abdominal vascular disease. Both the coeliac and superior mesenteric vessels have been studied in detail in response to physiological stimuli such as feeding and exercise. Also its

****Corresponding author: Elsamani, M.***
College of Medical Radiologic Science, Sudan University of Science and Technology P.O. Box 1908, Khartoum, Sudan.

use in diagnosing renal artery stenosis, and a few anecdotal reports have discussed the potential role of ultrasound in investigating both superior mesenteric artery and coeliac artery stenosis (Muller, 1992). At ultrasound scanning combined with the pulsed Doppler technique we can non-invasively monitor alterations in blood flow velocity. Applied to the superior mesenteric artery (SMA), the method confirms that blood flow in this vessel increases in response to a meal. The vasoactive components seem to be influenced by the digestive products of the diet, so that the effect of a meal on splanchnic blood flow may depend on the intraluminal digestion (Hornum *et al.,* 2006). Duplex ultrasound (DU) provides a simple, portable, reproducible, and non-invasive assessment of blood flow. Measurement of luminal diameter and blood velocity allows estimation of blood flow and peripheral resistance, and the detection of arterial occlusive disease. This method has gained widespread acceptance as a reliable tool in many vascular beds such as the carotid, aorto-iliac, periopheral limb, and renal (Michael *et al.,* 1988). Duplex ultrasound scanning has added valuable information to the diagnosis and postoperative follow-up of patients with cerebrovascular disease or occlusive disease of the extremity. Recently this technique has been used to evaluate the mesenteric circulation, and several investigators have demonstrated the ability to measure resting mesenteric blood flow and to detect mesenteric vascular responses to a meal (Ala *et al.,* 2014).

Rationale of the study

There are no data or recent studies was done in the effects of meals on SMA in the human in any Arab countries as far as authors Knew, in spite of spread of bad dietary habits in these countries. So the conducted study may clarify the effect of meals on SMA in healthy human subjects.

MATERIALS AND METHODS

100 healthy volunteers with body weights averaging 35 kg (range 20-50 kg) were scanned by Duplex ultrasound in order to assess changes in SMA for BFV and DM after fatty meal(250 gram, 545 Kcal), and carbohydrates meal (270 gram, 477 Kcal). Data sheet was prepared before scanning to include the different measurements during scan. Volunteers were scanned in the morning after overnight fasting 8 hours on different days and in random order. The investigations were carried out under resting conditions with the volunteer lying in the supine position. Each volunteer was scanned in fasting state, then postprandial, first immediately after 5 mins, and then 6 times with interval time of 15 mins continuously up to 90 mins. The SMA was identified and the DM, and BFV measured 1 to 2 cm distally to the origin and proximally to the first side branches. The measurements performed while the volunteers held their breath. The angle between the incident Doppler beam and the long axis of the vessel was kept at less than 65° (Sieber *et al.,* 1991). All scanning were carried by two expert sinologists who were blind from the goals and objective of the study. All volunteers were scanning in Taif city from December 2013 up to April 2016. All volunteers were selected carefully after approved from the clinician that they were healthy and they have no history of cardiovascular disorder or diabetic and hypertensive.

Ultrasound Equipment

This study was performed using ultrasound scanner available at the areas of study such as Siemens Sonoline G60S (Siemens, Germany). This machine allows a real-time cross-sectional images (i.e., B-mode echo) to be displayed simultaneously with real-time Doppler spectral display and sound. The scanner drive convex Doppler scan probes produce a frequency of 3.5 MHz-pulsed Doppler frequency was used; also they were connected with printing facility through digital graphic printer

Ultrasound Techniques (Protocol)

The examination technique was carried out with the volunteer in supine position. A coupling agent gel was used to ensure good acoustic contact between the transducer and the skin. After informing the volunteers about the procedure, the area of interest in the abdomen was completely evaluated in at least two scanning planes. The focal zone was at the depth of the SMA, as well as at the proximal segment of artery. The Doppler beam isonation angle was maintained 60° or less to the blood vessel. High-quality Doppler tracings were obtained by determining the optimal positions of the Doppler probe for each subject (via an anterior abdominal approach) before the trial (Perko, 2001; Qamar *et al.,* 1985). The experimenter adjusted the probe angle and position throughout the protocol. After adjusting the sample volume width to cover the target artery, the Doppler transducer was maintained in a constant position on the subject's anterior abdominal wall. When the target artery moved out of observation range for five consecutive beats, the probe was readjusted. Duplex scan examinations were videotaped to measure vessel diameters in SMA by cross-sectional resolution for 1 min every 5 min.

Statistical Analysis

Microsoft office Excel 2007 was used to analyze data after entering all measurements readings Mean max and standard deviations were calculated. Soon after that figures were used to display the results.

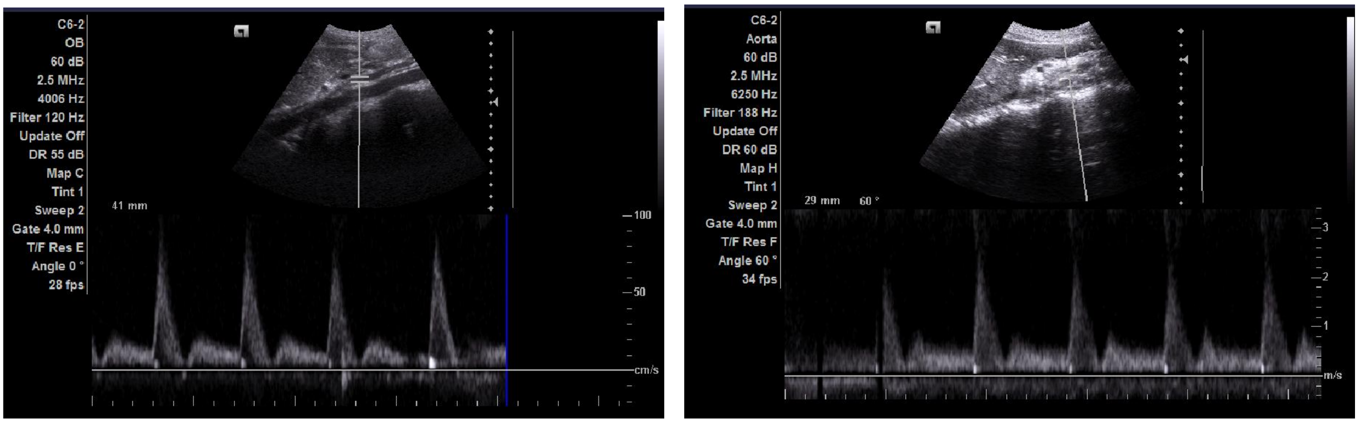
Ethical Consideration

Special consideration was given to the right to confidentiality and anonymity of all survey participants. Anonymity was achieved by using numbers for each survey participant that will provide link between the information collected and the participants. In addition confidentiality was censured by making the collected data accessible only to the researchers.

RESULTS AND DISCUSSION

The baseline values for DM, and BFV for SMA did not differ between fatty and carbohydrate meal. The DM, and BFV in SMA showed changes throughout the measurements during the time from baseline up to 90 min, and these changes were greater in the fatty than the carbohydrate meal. Compared with the baseline, the DM, and BFV increased gradually during the fatty meal (from 5.809 to 7.324 mm, and 282.77 to 787.3 ml/min respectively), and this increase persisted 0–60 min, and then decrease slowly to values greater than baseline at the end of the meal.

Time (min)		0	5	15	30	45	60	75	90
SMA DM (mm)	Fatty Meal	5.809	6.358	6.741	6.934	7.02	7.324	7.163	7.074
	Carbohydrate Meal	6.102	6.472	6.764	7.29	7.074	6.97	6.857	6.578
SMA BFV (ml/min)	Fatty Meal	282.77	330.43	472.18	621.36	715.6	787.3	688.88	723.3
	Carbohydrate Meal	302.24	418.03	595.51	680.28	634.3	555.23	470.23	434.91



(A) (B)

Figure 1. SMA Doppler spectrum in the fasting state (A) and after meal (B)

The DM, and BFV increased gradually during the carbohydrate meal (from 6.102 to 7.29 mm, and 302.24 to 680.28 ml/min respectively), and this increase persisted 0–30 min, and then decrease gradually to values near to the baseline at the end of the meal (Table 1).

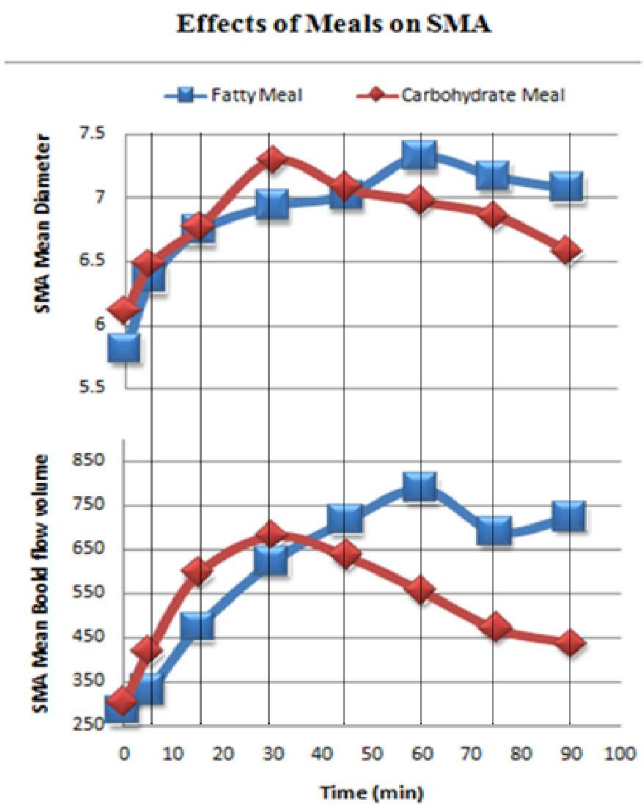


Figure 2. The effects of fatty and carbohydrate meals on SMA in Blood Flow Volume BFV, and Mean diameter DM

The shape of the Doppler wave was different in the fasting state and after two meals: after two meals, the negative diastolic component seen in ultrasound spectrum in fasting state absent (Figure: 1). The BFV and DM were increase gradually in response to the oral intake of fatty and carbohydrate, an immediate and marked increase in mesenteric blood flow was observed, and the peak mean values was reached within 30 minutes after carbohydrate meal and 60 min after fatty meal (Figure 2). This study established the normal value of SMA DM, and BFV before and after fatty and carbohydrate meals in healthy volunteers. The mean values of SMA DM, and BFV for two meals was significant correlate with varying time (Figure 3,4). The SMA DM, and BFV were taken more time to reach the maximum values for fatty meal than carbohydrate meal, in contrast there was significant fall in SMA DM, and BFV in carbohydrate meal more than fatty meal. This study showed minute-by-minute SMA blood flow Indies data in human splanchnic arteries during and after fatty and carbohydrate meal.

The main findings is that the DM, BFV in SMA started increasing in the first minute of the two meals and reached a peak at 60 min, and 30 min after the end of the fatty and carbohydrate meal respectively. The increase was slowly shown in fatty meal compare with carbohydrate meal .The mean blood velocity MBV in the SMA increased from the baseline 10 min after the end of the meal and reached its peak increase (from 0.28 - 0.02 to 0.64 - 0.03 m/s) at 36- 4 min after the end of the meal. Postprandial splanchnic vessels' diameters and BF. SMA BF increased from baseline to 15 min after the end of the meal (Diana Gentilcore *et al.,* 2008) . The MBV in SMA also increased within a minute of the meal. The SMA supplies BF only to the small intestine, except that it supplies a small portion of BF to pancreas via its inferior pancreatic duodenal branch (Jager *et al.,* 1986). The MBV in SMA observed in the present study, therefore, could start increasing before chyme reached the small intestine.

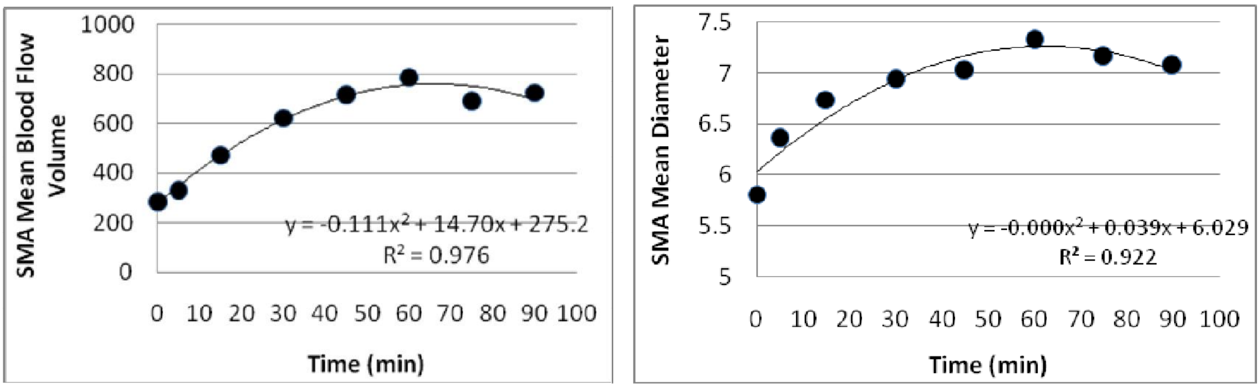


Figure 3. Time for fatty meal versus Mean of SMA Blood Flow Volume BFV(A), and Mean diameter (B)

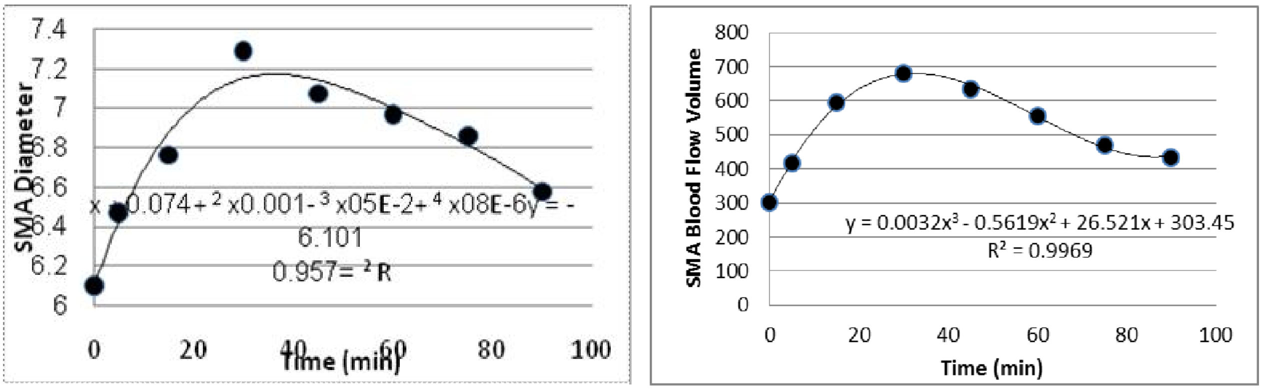


Figure 4. Time for carbohydrate meal versus Mean of SMA Blood Flow Volume BFV(A), and Mean diameter DM (B)

The first gastric emptying episode was 6.9 (range: 3.9 –16.2) min after the start of a 294-kcal solid meal (Jager *et al.,* 1984). Thirty minutes after 2nd and 4th meal intake, SMABFV fall towards basal values and was not significantly different from baseline at 105 minutes post prandially. (359ml/min for meal 2, and 433ml/min for meal 4). In contrast sixty minutes after 1st and 3rd meal intake, SMABFV decreased gradually, but was still significantly (p<005) above basal values (656ml/min for meal 1, 779ml/min for meal 4) at the 105 minutes (Abd *et al.,* 2016). So the studies above (Nami Someya *et al.,* 2008; Jager *et al.,* 1984, 1986Abd *et al.,* 2016) were showed similar response for SMA to different meals .as explained above.

Conclusion

This study showed that the fatty compared to carbohydrate meal take long time for SMA response songraphically. So that Doppler Ultrasound Study despite its difficulties and limitations - is a reliable reasonable method for measuring SMA blood flow Indies both in health and disease.

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