

Postprandial Walking but not Consumption of Alcoholic Digestifs or Espresso Accelerates Gastric Emptying in Healthy Volunteers

Andreas Franke, Hermann Harder, Anna K. Orth, Sabine Zitzmann, Manfred V. Singer

Department of Medicine II (Gastroenterology, Hepatology and Infectious Diseases), University Hospital of Heidelberg at Mannheim, Mannheim, Germany

Abstract

Background: Postprandial consumption of alcoholic beverages with high ethanol concentration (so-called digestifs) is a widespread custom to alleviate dyspeptic symptoms after comprehensive meals. Alcoholic beverages preprandially ingested inhibit gastric emptying rate of solid meals. However, the effect of a postprandial intake has never been studied in a controlled manner. **Methods:** In 10 healthy male subjects gastric emptying was repeatedly studied by ultrasonography after the intake of a 576 kcal meal. Immediately after the meal subjects received in a randomized order 40 ml of the following liquids: brandy, herb flavored liqueur, Williams pear brandy, aquavit (each 40 % (v/v) ethanol concentration), espresso, water, 40% (v/v) ethanol and 70% (w/v) glucose. Postprandial satiety, fullness and bloating were determined on a visual analogue scale every 10 minutes. On another occasion subjects received 40 ml of water and walked afterwards slowly (4 km/h) on a treadmill. **Results:** Gastric half emptying time ($t(1/2)$) of the meal with water was 123 ± 5 min, while with brandy (119 ± 9 min), herb flavored liqueur (123 ± 10 min), aquavit (125 ± 9 min), Williams pear brandy (126 ± 6 min) or espresso (125 ± 9 min) $t(1/2)$ it was not significantly different. Postprandial walking accelerated $t(1/2)$ significantly (107 ± 5 min, $p=0.02$). Dyspeptic symptoms were unchanged. Blood ethanol concentrations were under the level of detection (< 5 mg/dl). **Conclusions:** Postprandial consumption of alcoholic digestifs did not affect gastric emptying rate of a solid meal nor postprandial dyspeptic complaints. However, postprandial walking accelerated gastric emptying of the meal but this had no effect on dyspeptic symptoms.

Key words

Gastric emptying – ultrasound – alcohol – coffee – walking

Introduction

Consumption of hard liqueur after comprehensive or fatty meals is a popular custom and thought to relieve postprandial complaints such as fullness, bloating or epigastric discomfort by stimulation of the digestive functions. Therefore, the originally French term “digestif” is commonly used for such postprandially consumed alcoholic beverages.

However, scientific information regarding the effect of postprandial alcoholic beverages on gastric motility is lacking. Gastric emptying of pure ethanol solutions (4-40% v/v) is significantly slower than that of water [1, 2]. Alcoholic beverages (e.g. beer and wine) are emptied 2 to 4-fold slower than water [1]. Emptying of alcoholic beverages produced by fermentation (beer and red wine), but not those produced by distillation (whiskey) requires over 50% more time than their corresponding ethanol solutions (4, 10 and 40% v/v) [1]. Alcohol and alcoholic beverages also affect gastric emptying of solid meals. Pure ethanol solutions in different concentrations (4 and 10 % v/v) inhibit gastric emptying when consumed before or with a meal [3, 4]. Beer, red wine and whiskey prolong gastric emptying of a subsequently consumed meal by 15 to 30 % [3, 5]. To our knowledge no study dealing with the effect of postprandially ingested alcohol beverages on gastric emptying has been performed yet. But it would be of great interest since the effects of preprandially consumed alcohol beverages may not be transferrable to that of postprandial consumption. It would be ambiguous if local or systemic effects on gastrointestinal motility may even be caused by alcohol when the stomach is already filled with a meal.

Therefore, the aim of the present study was to determine the effect of some commonly postprandially consumed “digestifs” such as brandy, herb flavoured liqueur, fruit brandy and aquavit, their corresponding ethanol concentrations and

appropriate controls on the gastric emptying of solid meals in healthy volunteers. Since postprandial walking and espresso consumption are also common to relieve postprandial dyspeptic symptoms their effect on gastric emptying was additionally examined. The following questions were addressed: 1) Do digestifs affect gastric emptying of a solid meal? 2) Does the effect of alcoholic beverages differ from that of postprandial espresso or walking? 3) Do these interventions influence appearance and intensity of postprandial symptoms in healthy volunteers?

Materials and methods

Subjects

Ten healthy male volunteers (age 26.2 ± 0.8 yr, BMI 23.8 ± 0.3 kg/m²) were enrolled in this study. All were non-smokers and took no medication. Average alcohol consumption was evaluated by an alcohol consumption protocol which was daily completed by the volunteers during two weeks before inclusion. Only subjects consuming alcoholic beverages less than twice a week and less than 60 g ethanol per week were included. A written informed consent was obtained from each subject. The research protocol was approved by the Ethics Committee of the University Hospital and was conformed to the revised declaration of Helsinki 1989.

Study design

Each subject was studied 9 times, having at most one test per week. The sequence of the tests was randomized. All examinations were performed in the afternoon. The subjects had fasted at least 8 hours after a small breakfast in the morning. Volunteers consumed the breakfast at home, but were asked to take breakfast with same amount and composition of calories at the study days. Subjects were examined in a sitting position with slight leaning backwards. The solid meal was consumed during 10 minutes. One minute after the end of the meal subjects swallowed 40 ml of the test solution (Table 1). Gastric emptying was thereafter measured for the following three hours by ultrasonography (US) (see below).

Test meal

The meal consisted of 800g commercially prepared ravioli with tomato sauce and ground meat totaling 576 kcal. This meal contained 16.0g fat (24% of the total caloric content), 84.8g carbohydrate (60%) and 22.1 g protein (16%).

Test-solutions

The test and control solutions are listed in Table 1 with their respective osmolalities and ethanol concentrations. In summary, 40 ml of the following digestifs were used: aquavit, brandy, herb flavored liqueur and Williams pear brandy. In addition, postprandial consumption of 40 ml of a caffeine-containing espresso was examined. As controls 40 ml of the following solutions were given: 40% v/v pure ethanol (isoalcoholic control for the digestifs), water (volume control) and 70% (w/v) D-glucose solution (equicaloric control for 40% (v/v) ethanol and some digestifs).

To study additionally the effect of walking on gastric emptying, subjects received postprandially 40 ml of water another time and walked afterwards slowly on a treadmill (4 km/h) during the following 3 hours only interrupted by the US measurements, which were performed in sitting position. On the basis of the present literature it was not possible to identify a minimum period of postprandial exercise to have any effect on gastric motility. Therefore, we decided on walking during the whole examination. We renounced a registration of e.g. the heart rate during the walking, since a rate of 4 km/h was considered to realize only a light exertion for the young volunteers included in this study.

In the following part of this paper the ethanol concentrations represent the volume of ethanol per 100 ml of water (v/v) and the glucose concentrations represent the weight of glucose per 100 ml of water (w/v) unless otherwise stated.

Ultrasonography

Real time US can be used to assess gastric emptying directly and, as the gold standard, has major advantages over scintigraphy. Ultrasonography is simple, non-invasive and does not entail radiation which enabled us to repeat measurements with several different test solutions in the same

Table I. Test solutions with their osmolality, pH, ethanol and caloric content (based on a volume of 40 ml).

Test solution, manufacturer	Ethanol concentration	Amount of ethanol	pH	Osmolarity mosm/l	Caloric content, (approximately)
Fernet Branca (Herb flavoured liqueur), Fratelli Branca Distillerie, Italy	40% (v/v)	12,6 g	3.3	6720	100 kcal
Aalborg Jubilaeums Akvavit (Aquavit), Danish distillers, Denmark	42% (v/v)	13 g	3.8	7040	95 kcal
Gonde de Osborne (Brandy), Osborne, Spain	40.5% (v/v)	12.7 g	3.4	7360	110 kcal
Williams-Birne (pear brandy), Schladerer, Germany	40% (v/v)	12.6 g	4.3	6320	90 kcal
Lavazza-Espresso, Lavazza, Italy (12 g with 100 ml water)	–	–	5.0	160	–
Water	–	–	7.1	15	–
Ethanol 40% (v/v)	40% (v/v)	12.6 g	7.8	6880	90 kcal
Glucose 70% (w/v)	–	–	7.3	3840	110 kcal

subjects. Ultrasonography has been shown to be a reliable method to determine gastric emptying of solid meals [6-8]. Using a curved array scanner with a 3.25 MHz ultrasound transducer (Sonoline Sienna®; Siemens, Germany) a cross-sectional area of the antrum at the level of the superior mesenteric artery and the aorta was measured. The vessels served as landmarks to standardize the position of the scans. This antral area was scanned before, immediately after the meal was finished and then in 10 min intervals for 3 hours.

The inner echogenic layer corresponding to the interface between the gastric content and the mucosa of the gastric wall was outlined. The measurements were repeated twice and mean value was considered representative. The areas of the antrum were traced by the internal caliper equipped with the ultrasound instrument. Lag time ($t(\text{lag})$) represents the period of time between the end of consumption of the meal and the time when the maximal antral area was measured ultrasonographically. Gastric half emptying time ($t(1/2)$) corresponds to the interval between the end of the meal and the moment when antral area was reduced to 50% of the maximal antral area.

Serum ethanol concentrations

Blood samples (10 ml) for determination of serum ethanol concentrations were drawn at baseline and then every 15 min for 3 hours. The samples were centrifuged immediately at 4°C. Serum concentration of ethanol was determined using the alcohol-dehydrogenase method (Ethylalkohol, Roche Diagnostics GmbH, Mannheim, Germany). The limit of detection for ethanol was a concentration of 5 mg/dl.

Statistics

Data are expressed as the mean \pm standard error of the mean (SEM) unless otherwise stated. To compare the effect on postprandial symptoms the area under the curve between 0 and 60 minutes as well as between 0 and 180 minutes were additionally calculated.

Gastric half emptying time ($t(1/2)$), gastric lag-phase ($t(\text{lag})$) and postprandial symptoms fullness, bloating and satiety were compared by analysis of variance (ANOVA) for repeated measures: $p < 0.05$ was chosen as the level of statistical significance

Results

Gastric half emptying time ($t(1/2)$) after 40 ml of water was 123 ± 5 min. The lag phase ($t(\text{lag})$) was 32 ± 4 min. The alcoholic beverages induced no significant changes of gastric half emptying time ($t(1/2)$) compared to water (Fig. 1). In detail, $t(1/2)$ after brandy was 119 ± 9 min, after herb flavoured liqueur 123 ± 10 min, after aquavit 125 ± 9 min and that after Williams pear brandy was 126 ± 6 min.

The control solutions with corresponding ethanol concentration and caloric amount did not result in significant changes. $T(1/2)$ after 40% ethanol concentration was 118 ± 4 min and after 70% glucose was 123 ± 6 min (Fig. 1).

Postprandial walking accelerated gastric half emptying time significantly by 14% (107 ± 5 min, $p = 0.02$), whereas

$t(1/2)$ after espresso (125 ± 9 min) was not different compared to that after water.

Lag-phases ($t(\text{lag})$) of gastric emptying after the different test solutions were not different compared to water (Fig. 2). $T(\text{lag})$ with brandy was 31 ± 7 min, herb flavoured liqueur 34 ± 7 min, aquavit 33 ± 3 min, Williams pear brandy 34 ± 3 min, 40% ethanol 31 ± 5 min, 70% glucose 35 ± 6 min and with espresso it was 33 ± 5 min. The lag-phase after walking (32 ± 3 min) was not significantly different from the test solutions.

Serum ethanol concentrations 15, 30, 45 and 60 minutes after postprandial consumption of the digestifs of the 40% ethanol solutions were under the level of detection (< 5 mg/dl).

Satiety as measured by VAS (0-100) increased significantly from 7.6 before to 74 directly after consumption of the meal ($p < 0.0001$). Fullness increased significantly from 0.4 to 33 postprandially ($p < 0.005$) and bloating from 1.1 to 30 ($p < 0.005$). However, no significant differences between the different test-conditions were detectable concerning satiety, fullness and bloating neither for each postprandial point of time nor for the postprandial area under the curve between 0 and 60 minutes or between 0 and 180 minutes (Table 2).

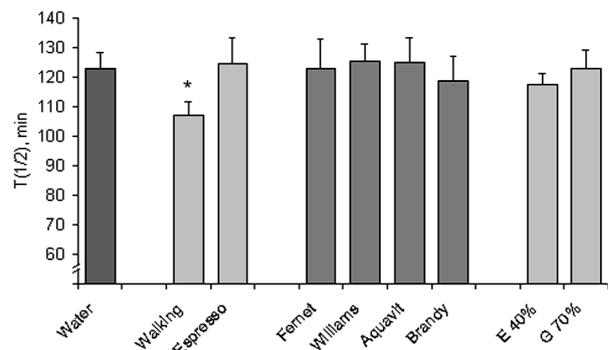


Fig. 1. Gastric half emptying time ($t(1/2)$) of meal after the different test conditions. Results are means \pm SEM of 10 subjects with each meal. G=Glucose (wt/v), E=Ethanol (v/v). * $p = 0.02$ compared with water.

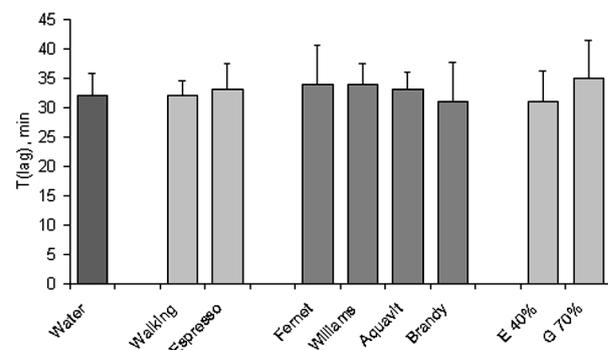


Fig. 2. Gastric lag time ($t(\text{lag})$) of the meal after the different test conditions. Results are means \pm SEM of 10 subjects with each meal. G=Glucose (wt/v), E=Ethanol (v/v).

Table II. Area under the curve at 180 min of dyspeptic symptoms on visual analogue scale (0-100) after the different test conditions. Results are means \pm SEM of 10 subjects.

Test conditions	Satiety (mm min)	Bloating (mm min)	Fullness (mm min)
Water	9269 \pm 1200	2795 \pm 800	2798 \pm 870
Herb flavoured liqueur	9090 \pm 1421	2677 \pm 843	2700 \pm 841
Aquavit	9067 \pm 1174	1867 \pm 630	2066 \pm 578
Brandy	8878 \pm 1540	2288 \pm 964	1935 \pm 743
Williams pear brandy	9607 \pm 1305	1851 \pm 729	2230 \pm 807
Ethanol 40% (v/v)	8439 \pm 1294	2303 \pm 837	2227 \pm 869
Glucose 70% (w/v)	9535 \pm 1256	1980 \pm 799	2764 \pm 838
Espresso	8374 \pm 967	2627 \pm 932	2585 \pm 809
Walking	8509 \pm 1400	1936 \pm 650	2009 \pm 567

Discussion

The major results of the present study are the following: 1) postprandially consumed digestifs such as aquavit, brandy, herb flavored liqueur and Williams pear brandy (40 % ethanol concentration, 40 ml) do not alter gastric emptying of a principal meal; 2) the administered amounts of those digestifs induce no significant increase in blood ethanol concentration; 3) postprandial espresso (40 ml) has no effect on the gastric emptying of a meal; 4) postprandial walking (4 km/h) accelerates gastric half emptying time; 5) postprandially consumed digestifs, espresso or walking have no effect on dyspeptic symptoms in healthy volunteers.

Ethanol in various concentrations and different alcoholic beverages are emptied from the stomach slower than water in humans [1, 2]. Moreover, the alcoholic beverages beer, red wine and whiskey, as well as corresponding ethanol concentrations (4 and 10% v/v) also inhibit gastric emptying of a solid meal when consumed together [3-5].

Postprandial consumption of alcoholic beverages with high ethanol concentrations, so-called digestifs, is a widely spread custom and thought to relieve postprandial discomfort after comprehensive meals. Those alcoholic beverages have no stimulatory effect on gastric acid secretion [9-11]. However, gastric emptying time after postprandial consumption of a digestif has not been studied yet.

We used a 576 kcal containing solid meal with a balanced composition of carbohydrates (60%), proteins (16%) and fat (24%) as a representative principal meal in industrialized countries. The alcoholic beverages were selected in order to have an ethanol concentration of approximate 40% (v/v), to be habitually consumed in intention to relieve postprandial dyspeptic symptoms, and to have different non-alcoholic ingredients or a different manufacturing process.

Compared to water, the digestifs had no effect on gastric half emptying time. The corresponding ethanol concentration induced also no differences. These results were at first sight inconsistent with existing studies: similar ethanol amounts had an inhibitory effect on gastric emptying of solid meals with similar caloric content [3-5]. However, the experimental design in those studies was different from that of the present study. Whereas in the present study alcohol was consumed

after the meal, in previous studies alcohol beverages or ethanol were ingested before or partially with the meal. We therefore conclude that the total amount of alcohol is less responsible for the effect of ethanol and alcoholic beverages on gastric emptying than the point of time when the alcohol is ingested.

This is further supported by the facts that blood alcohol concentrations after postprandial consumption of the digestifs were under the limit of detection. The total amount of 40 ml of the alcoholic test solution was approximately 12-13g. Corresponding ethanol amounts caused blood alcohol concentrations of 20-30 mg/dl when consumed on an empty stomach [1] and when consumed immediately before or with a meal, blood alcohol concentrations of 10-20 mg/dl [3]. Alcohol absorption is delayed when gastric emptying is inhibited [12-14] since gastrointestinal ethanol absorption occurs predominantly in the small bowel and not in the stomach due to the thinner wall and larger surface of the small bowel [15]. Additionally, gastric and hepatic ethanol metabolism is more efficient when gastric emptying is prolonged.

It may be speculated that postprandial application of larger amounts of alcohol than in our study inducing significant blood ethanol concentrations might affect gastric emptying. However, we decided to give 40 ml of the different digestifs since this is the volume usually consumed in Europe in order to alleviate postprandial symptoms.

Postprandial consumption of espresso is also popular. However, the effect of espresso on gastric emptying has not been studied yet. Only a few studies had focused on the effect of preprandially coffee on gastric emptying. Instant or brewed, filtered coffee had no effect on gastric emptying of a solid [16] or liquid meal [17]. Coffee prolonged adaptive relaxation of the proximal stomach, but had no effect on gastric wall compliance or perception [18]. Consistent with these studies, we found no effect of the postprandially consumed espresso on gastric emptying.

The effect of exercise on gastric emptying has been examined in a couple of studies. The results are partially inconsistent. This may be due to the different methods used to study gastric emptying, different degrees of exercise, different meals (consistency and caloric content), and

different gender of the volunteers. Most studies examined gastric emptying of liquid meals or water and found moderate exercise mainly accelerated it [19-21]. By contrast, high intensive exercise decreased gastric emptying rate [21, 22]. Moore et al. studied the effect of moderate walking on the gastric emptying of a solid meal. Compared to standing, light (3.2 km/h) and moderate (6.4 km/h) walking enhanced gastric emptying by 39% and 55%, respectively. However, the caloric content of the tested meal was very low (208 kcal) compared to our study [23]. This may explain why the acceleration in the study of Moore et al. was more pronounced than in our study (14%).

Neither walking nor consumption of digestifs alleviated postprandial dyspeptic symptoms in our study. It remains unclear why the consumption of digestifs are assumed to improve the well-being after large meals. We speculate that the taste of the digestifs and the oral and esophageal perception after deglutition might be responsible for this popular assumption.

Our study has some limitations resulting from the limited sample size and the cross-over-design. We examined young, healthy, male volunteers. Therefore, our results may not be valid for other groups of persons (e.g. patients). Moreover, in further studies the effect of higher amounts of alcohol should also be examined. However, to our knowledge this is the first study dealing with the popular assumption that digestifs may relieve postprandial complaints after meals. We demonstrated that postprandial walking, but not the consumption of regular amounts of various digestifs or espresso, affected gastric emptying. Neither walking nor the consumption of the digestifs or espresso improved postprandial dyspeptic symptoms.

Conflicts of interest

None to declare

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