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Original article

Postprandial hypotension in older adults: Can it be prevented by drinking water before the meal?

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SUMMARY

Background & aims: An important consequence of ageing is a tendency for postprandial blood pressure to decline, which can lead to fainting. As a possible countermeasure, we investigated in healthy older adults the impact of drinking water before a breakfast meal on postprandial cardiovascular and autonomic functions.

Methods: After a stable cardiovascular baseline recording for at least 20 min, twelve older adult (67 ± 1 y) test subjects ingested, in a crossover study design, either 100 mL or 500 mL of tap water over 4 min, which was followed by the consumption of the test breakfast meal (1708 kJ) over a period of 15 min. Then, cardiovascular recordings were resumed for 90 min after the meal. Eleven young (25 ± 1 y) and healthy subjects served as a control group. Measurements included beat-to-beat blood pressure, heart rate, impedance cardiography and autonomic variables.

Results: In older adults, systolic and diastolic blood pressure started to decline around 30 min after the meal, with the lowest values around 60 min; these effects were not observed in the young control group. Postprandial systolic blood pressure decreased between 30 and 90 min to a greater extent in response to 100 mL than to 500 mL (−6.4 vs. −3.3 mmHg, $P < 0.05$). Drinking 500 mL of water tended to increase stroke volume, cardiac output and vagal markers to a greater extent than 100 mL.

Conclusions: Our data suggest that drinking a large volume (500 mL) of water before a meal may attenuate postprandial hypotension in older adults.

1. Introduction

An important consequence of ageing is the tendency for blood pressure to fall after eating a meal. Clinically, postprandial hypotension is defined as a reduction in blood pressure of 20 mmHg within 2 h after having a meal [1] and about two-thirds of older adults admitted to geriatric departments were found to have postprandial hypotension [1]. The most common symptoms of postprandial hypotension are dizziness, nausea, weakness and light-headedness [1] but more severe consequences such as syncope have also been reported. Meal composition appears to play a role in postprandial hypotension because carbohydrates, particularly glucose, have the greatest blood pressure lowering effect [2]. Even older adult individuals with no history or symptoms of postprandial hypotension tend to show some degree of blood pressure reduction after ingesting a carbohydrate meal [3].

Ingesting a meal causes pooling of blood in the abdominal vasculature that is accompanied by a drop in systemic peripheral resistance, activation of the sympathetic nervous system and increases in heart rate and cardiac output (CO) [4,5], but the rise in CO is not sufficient to counteract the dropping blood pressure, which could lead to presyncopal symptoms or even syncope. Drinking approximately 500 mL of water acutely increased blood pressure in autonomic failure patients as well as in older subjects [6] and improved orthostatic tolerance in healthy humans [7]. Moreover, in patients suffering from primary autonomic failure, ingestion of 480 mL of tap water in combination with a meal markedly improved the postprandial drop in blood pressure [8]. However, to

Abbreviations: SBP, systolic blood pressure; DBP, diastolic blood pressure; HR, heart rate; SV, stroke volume; CO, cardiac output; TPR, total peripheral resistance; BRS, baroreflex sensitivity; HF_RRI, high-frequency component of heart rate variability.

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date, the precise mechanisms of postprandial hypotension are not well characterized, though inadequate autonomic nervous system responses to meal ingestion have been implicated [1].

In the study reported here, we investigated the effects of tap water in combination with a breakfast meal on cardiovascular parameters and cardiac vagal tone in older adults. We chose a light meal because older adults often consume small meals of about 400 kcal [9]. Furthermore, a breakfast meal is the least likely meal to be skipped by older adults [9]. Therefore, we evaluated beat-to-beat hemodynamic parameters and autonomic responses in a group of older individuals drinking either 100 ml or 500 ml before a light breakfast meal. The responses were compared to a control group comprised of young and healthy adults. It was hypothesized that ingestion of a higher amount of water would prevent the postprandial drop in blood pressure in older and generally healthy individuals.

2. Methods

2.1. Participants

Eleven young (four females; Age: 25 ± 1 years; Height: 171 ± 3 cm; Weight: 75 ± 3 kg; Body Mass Index: 25.8 ± 0.8 kg m^{-2}) and twelve older (five females; Age: 67 ± 1 years; Height: 167 ± 2 cm; Weight: 75 ± 2 kg; Body Mass Index: 27.0 ± 0.8 kg m^{-2}) non-smoking individuals were recruited. The participants in the young control group were recruited from local students and their friends, whilst older adults were recruited from relatives and friends of our local staff. Seven of the older subjects were normotensive, whilst five were taking medication for hypertension (β1 selective beta blockers ($n = 2$), angiotensin II receptor antagonists ($n = 2$) and a calcium-antagonist ($n = 1$). The participants were requested to avoid alcohol and caffeine for 24h and were studied in the morning starting at 8am after an overnight (12h) fast. The treated hypertensive subjects refrained from taking their medication on the morning of the study. Written informed consent was obtained from each participant and the study protocol received local ethics committee approval in accordance with the Declaration of Helsinki.

2.2. Study design

All measurements were performed between 08.00 and 09.00 h in a temperature-controlled (22 ± 1 °C) quiet laboratory with the study participants seated in a comfortable armchair. Every older adult attended two separate experimental sessions, with each session (100 mL or 500 mL tap water before a meal) separated by at least two days according to a crossover study design; the young group served as a control for the condition with 100 mL before the meal. On arrival at the laboratory, subjects were asked to empty their bladders if necessary and to sit in a comfortable armchair. Subjects clothing consisted of a t-shirt, trousers and shoes. The equipment for cardiovascular monitoring was then attached.

Following a period for cardiovascular stability (20–30 min), a baseline recording was then made for 20 min. Then, the older adults ingested over four minutes either 100 mL or 500 mL of tap water at room temperature (the control group drank 100 mL water) which was followed by the consumption of the test meal over a period of 15 min and cardiovascular recordings were resumed for 90 min after the meal. The meal comprised a light breakfast of 100 g of toast-bread, over which was spread 12 g of butter and 30 g of jam. The total energy content was 1708 kJ, with carbohydrate, fat and protein respectively contributing to 60%, 31% and 9% of the energy intake. Such small meals are often consumed by older adults [9].

2.3. Cardiovascular recordings

Cardiovascular recordings were performed using a *Task Force Monitor* (TFM) (*CNSystems*, Medizintechnik, Graz, Austria) with data sampled at a rate of 1.000 Hz [10]. Continuous blood pressure was monitored using the *Penaz* principle from either the index or middle finger of the right hand and was calibrated to oscillometric brachial blood pressure measurements on the contralateral arm. Impedance cardiography measurements were performed using an improved estimate of thoracic volume [11], which allows calculation of stroke volume (SV). Electrode strips were placed at the neck and thoracic regions, the latter specifically at the midclavicular at the xiphoid process level (*CNSystems* standard electrode kits).

2.4. Autonomic measurements

High frequency (HF: 0.17–0.40 Hz) power components of RR-intervals (HF_RRI) were evaluated and given in absolute values (ms^2). We used changes in the HF range of heart rate variability to assess parasympathetic activity because HF_RRI is primarily mediated by parasympathetic nerve modulation [12,13]. Powers of HF_RRI were analyzed after natural logarithmic transformation. Baroreflex sensitivity (BRS) was determined from spontaneous fluctuations in blood pressure and cardiac interval using the sequence technique [14].

2.5. Data and statistical analysis

Values of cardiac interval, systolic blood pressure ((SBP), mean blood pressure and diastolic blood pressure (DBP)), SV and autonomic variables were averaged every 10 min during the baseline period and every 15 min during the 90 min post-drink period. CO was calculated as the product of SV and heart rate (HR), where HR was calculated from the appropriate cardiac interval. Total peripheral resistance (TPR) was calculated as mean blood pressure (MBP) divided by CO, where MBP was calculated as the result of DBP + 1/3 (SBP-DBP). Baseline values and responses to the intervention were statistically not different between the treated hypertensive and the normotensive group and were, therefore, combined for the final analysis.

Blood pressure variables started to decline significantly below baseline values around 30 min postprandial in older adults, therefore we chose the period from 30 to 90 min postprandial as appropriate for a statistical discrimination between the drink volumes used (Figs. 1–3, right panel).

Statistical analyses were performed using *GraphPad Prism* (Version 5, San Diego, CA, USA). All values are reported as means ± SE. Repeated-measures *ANOVA* with *Dunnetts* post hoc testing were used to test for changes over time from baseline values. One-way *ANOVA* with *Newman–Keuls* post hoc testing was used to compare baseline values between the three groups. A paired *t*-test was used to compare mean changes of the 30–90 min post-drink period with baseline values and between the conditions. All reported *P* values are two-sided. For all tests, significance was set at $P < 0.05$.

3. Results

Baseline resting values were similar for hemodynamic and autonomic measurement parameters in older adults between the drinks. Baseline DBP and TPR were higher and SV, BRS and HF_RRI lower in the respective older adult group compared to the younger controls (Table 1). None of the test subjects showed unpleasant effects after ingesting the test meal regardless of the corresponding drink type. We could not find statistical differences related to blood