Post prandial cardiovascular response in non-instituzionalized normotensive elderly

Postprandial cardiovascular response in non-institutionalized normotensive elderly

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Objective: To investigate the daily blood pressure pattern and the response to a meal and to common daily activities in healthy, non-institutionalized, normotensive elderly.

Design and methods: Thirty-five non-institutionalized healthy individuals aged 72.5±4 years, and 32 young normotensive controls aged 45±7 years were investigated. All participants underwent a standing-up test and 24 h ambulatory blood pressure monitoring.

Results: A large postprandial systolic blood pressure fall without any significant heart rate increase was observed in the elderly group. The blood pressure fall was significantly more marked in those with asymptomatic orthostatic hypotension.

Conclusion: Elderly individuals experience a more marked blood pressure decrease after a meal than younger controls. This pattern is even more pronounced in the elderly with a positive standing-up test for orthostatic hypotension.

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Keywords: orthostatic hypotension, ambulatory monitoring, tilt table test, postprandial hypotension

Introduction

In both healthy elderly and dysautonomic people [1,2], impaired postprandial autonomic modulation of the heart rate has been reported. Falls are a major source of suffering in the elderly [3–6] and are a common consequence of postprandial and orthostatic hypotension. Falls occur in about 23% of people older than 65 years, with the social cost of more than 200 000 hip fractures each year in the United States [7] and a majority of deaths resulting from injury. Jansen *et al*. observed a blood-pressure lowering effect after oral glucose [8] but not after oral fructose [9] or intravenous glucose loading [10] and showed that the hypotensive effect of a meal increased with age [9].

The aim of the present study was to investigate the pattern of blood pressure response to common daily activities, especially the consumption of a meal, in a population of healthy, independent, elderly people living at home in comparison with younger and age-matched controls; in particular, we aimed to establish whether postprandial hypotension could be predicted by the presence of postural hypotension.

Methods

Participants investigated

Sixty-seven healthy normotensive individuals divided into two age groups were investigated: group I, aged 45±7 years (22 men and 13 women) and group II, aged 72±4 years (21 men and 11 women). All the participants were recruited from the hospital staff and their relatives and were free from cardiovascular disease, diabetes mellitus, hypertension, Parkinson's disease and chronic varicose vein syndrome. None of the participants had experienced any anamnestic fall episodes. All the individuals were living at home and were completely independent in their daily living activities.

Standing-up test

All the individuals underwent a standing-up test. Tests were performed in the morning, at least 1 h after a light breakfast (bread, butter, jam and milk) without coffee or tea, in a quiet room with an ambient temperature of 22–24°C. Blood pressure was measured by a mercury sphygmomanometer and heart rate was derived from an electrocardiogram. After explanation of the experimental procedure and a test run, the protocol started. The

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standing-up manoeuvre was performed in about 3 s after at least 20 min supine rest. Some participants were helped to stand up quickly. They were asked to stand up for at least 10 min. Measurements were performed at 1 min intervals during the 5 min before standing up and repeated after 30 s and then at 1 min intervals for the next 10 min after standing up.

Control values were obtained by averaging systolic and diastolic blood pressure and heart rate values over the 5 min period before standing up. The test was considered positive when a 20 mmHg or more fall in systolic blood pressure or a 10 mmHg or more fall in diastolic blood pressure occurred within 5 min of standing [1,11]. It has been reported previously that these limits can be used in both young and elderly people [12,13].

Ambulatory non-invasive blood pressure monitoring

Blood pressure monitoring was performed using a portable automatic non-invasive device (ICR-90207; SpaceLabs Inc., USA). The ambulatory monitoring procedure has been previously described in detail [14] and the reliability of the device was assessed in previous studies [15,16]. At least four calibration readings were taken in the sitting position to ensure that the monitoring gave readings within 5 mmHg of a mercury sphygmomanometer measurement [17]; otherwise, the participant was excluded from the study.

The blood pressure recorder was worn by the patients at 8.00 a.m. on a normal working day and the recording was continued without interruption until the 24 h period was over, at 8.00 a.m. the following morning. During this period blood pressure measurements were pre-programmed to occur at 15 min intervals. Each time the recorder took a reading, participants were requested to keep their arm as motionless as possible to prevent artefactual readings. The following morning four additional calibration readings were obtained before removing the recorder.

Time and type of activities performed during the day (such as eating, shopping, listening to music, reading and watching television) were specified by the participants on a form. All participants awoke at 7.00 a.m., had a 900 kcal standard lunch with no caffeine or hot beverages (20% proteins, 50% carbohydrates and 30% fats) at 1.00 p.m., had a light supper at 8.00 p.m. and retired to bed at 10.00 p.m. Each individual was asked to avoid postprandial bed rest during the day.

Analysis of experimental data

At the end of the monitoring period, data were read and transferred to an IBM PC personal computer. Mean pressure was calculated as diastolic pressure plus one-third of pulse pressure. Average values from the 24 h monitoring period were obtained for systolic, diastolic and mean pressure and heart rate [10]. Daytime was considered to be from 10.00 a.m. to 10.00 p.m. and night-time from 1.00 to 6.00 a.m. [15].

To calculate the blood pressure and heart rate changes after the meal, baseline values were obtained by averaging systolic and diastolic blood pressure and heart rate values measured during the hour before lunch.

Statistical analysis

Values are reported as mean ± SD with ranges in parentheses. Changes in ambulatory monitoring daily curves were assessed by multivariate analysis of variance (MANOVA). All tests were performed by SPSS (Microsoft Inc., USA).

Results

Group I

Ambulatory mean systolic blood pressure values were 121 ± 7 mmHg over 24 h, 125 ± 7 mmHg during the daytime and 113 ± 9 mmHg at night (Table 1). Lunch induced a non-significant reduction in systolic blood pressure values during the next 4 h (on average 4.9 ± 3.8%) with a concomitant heart rate increase (10.2 ± 4.9%; Fig. 1). None of the participants developed hypotension after the standing-up test (Table 2).

Table 1. Ambulatory blood pressure values.

	Group I	Group II	Group IIa	Group IIb
Systolic (mmHg)				
24 h	121±7	124±6	125±6	127±10
Day	125±7	128±6	129±6	132±9
Night	113±9	117±8	117±8	120±13
Diastolic (mmHg)				
24 h	77±5	74±6	72±3	77±8
Day	81±4	78±6	76±3	80±8
Night	70±5	67±6	65±3	70±9
Heart rate (bpm)				
24 h	71±8	71±8	71±9	70±4
Day	76±8	75±9	75±10	73±5
Night	61±8	64±8	64±9	64±5

Table 2. Systolic blood pressure and heart rate after tilting.

	Basal	30 s	2 min	5 min	10 min
Group I					
SBP (mmHg)	135±4	133±6	132±4	134±5	136±9
HR (bpm)	73±5	75±7	73±9	72±3	77±8
Group IIa					
SBP (mmHg)	148±2	146±4	153±3	150±8	150±4
HR (bpm)	67±9	76±7	75±8	74±6	68±7
Group IIb					
SBP (mmHg)	140±5	118±4	121±8	118±3	124±6
HR (bpm)	74±4	76±7	76±6	74±8	72±4

SBP, systolic blood pressure; HR, heart rate.

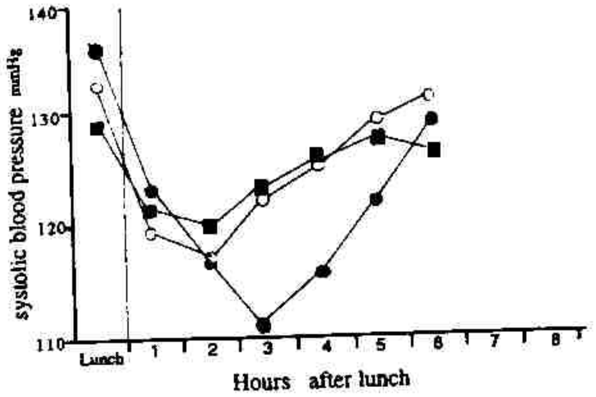

Fig. 1. Effect of lunch on systolic blood pressure in young healthy controls, ■ (group I, n = 35), elderly controls, ○ (group IIa, n = 23; $P<0.03$ vs Group I) and elderly participants with orthostatic hypotension ● (group IIb, n = 9; $P<0.0001$ vs group I vs Group IIa).

Group II

Ambulatory mean systolic blood pressure values were 124±6 mmHg over 24 h, 128±6 mmHg during the daytime and 117±8 mmHg at night (Table 1). The postprandial blood pressure decrease was significantly more pronounced in this group than in group I, with a larger peak systolic reduction (22±7 mmHg versus 12±5 mmHg in group I, $P<0.01$), a larger average reduction during the 4 h after the meal (11.3±3.9%, $P<0.01$) and a significantly smaller increase in heart rate (3.6±9.2% versus 10.2±4.9%, $P<0.001$; Fig. 1).

Nine participants in group II had a positive standing-up test for asymptomatic orthostatic hypotension. Group II was therefore subdivided into group IIa (test negative) and group IIb (test positive; Table 2).

Mean 24 h blood pressure did not differ between groups IIa and IIb (Table 1). According to MANOVA for repeated measures, group IIa showed a pattern of systolic blood pressure significantly different from that of group I ($P<0.03$), characterized by a larger blood pressure reduction (Fig. 1). In particular, the peak reduction was 19±5 mmHg (average 9.5±3.1%; $P<0.05$); however, the duration of the reduction did not last significantly longer than in younger controls.

In contrast, individuals in group IIb showed a significantly greater and longer-lasting decrease in postprandial systolic blood pressure than those in groups I and IIa ($P<0.0001$ versus both, MANOVA test). A marked peak reduction (27±8 mmHg) occurred during the third hour after lunch, with an average reduction of 14.7±3% during the 4 h after lunch ($P<0.01$ versus group IIa and $P<0.0001$ versus group I; Fig. 1).

Postprandial heart rate changes did not differ between the two subgroups IIa and IIb (3.5±9.2% versus 3.9±9.1%, NS).

Discussion

The present findings show a large postprandial blood pressure fall in the elderly, with no physiological increase in heart rate, compared with healthy young controls. The effect of the meal on blood pressure appeared within 1 h and lasted for at least 3 h after the meal. Moreover, the postprandial hypotension was more marked and lasted longer in the elderly with a positive response in the standing-up test than in age-matched controls.

We obtained a blood pressure pattern in healthy old people who were physically and mentally independent in daily activities. A reduction in postprandial systolic blood pressure has been previously reported both in old people with a history of syncope and in institutionalized healthy elderly attending a daily lunch programme [20–24]. However, in these two conditions a large number of risk factors for transient hypotension were identified. In particular, prolonged bed rest and physical deconditioning might lead to impaired autonomic blood pressure control and to a greater prevalence of orthostatic hypotension. Moreover, old institutionalized people often have several risk factors for transient hypotension, such as prolonged inactivity, reduced mobility, cardiovascular and autonomic diseases, diabetes and the taking of blood-pressure lowering drugs.

The lack of blood pressure control and of heart rate response to a meal in the elderly may be a result of a progressive age-related reduction in the cardiopulmonary and baroreflex-mediated blood pressure and heart rate response, which is relatively common in healthy elderly people without other clinical signs of autonomic failure

[25–28]. Previous studies have documented a progressive impairment of the arterial baroreflex with ageing, which affects the ability of the heart rate to be stimulated and deactivated by a blood pressure rise and fall [29–31]. This impairment also involves the baroreceptor ability to alter vasoconstriction rapidly, thereby minimizing blood pressure changes induced by environmental disturbances [32,33].

More recently, an alteration in the cardiopulmonary receptors has been reported in the elderly. The cardiopulmonary baroreflex increases peripheral vasomotor tone and noradrenaline secretion in response to a reduction in the distension of the heart. Impairment of the cardiopulmonary reflex, which seems to be due mainly to reduced cardiac distensibility and the inability of mechanoceptors located in the heart to sense central volume changes, could be the main factor responsible for the large blood pressure fall in the elderly. Blood pressure reduction is also detectable in elderly people without clinical signs of autonomic failure.

All the study participants remained asymptomatic during the systolic blood pressure fall. However, even if autoregulation of cerebral blood flow in response to a decrease in perfusion blood pressure is usually preserved in the healthy elderly [24], sequential blood-pressure lowering events, such as postural and drug-induced hypotension, may have an additive effect after the consumption of a meal rather than at any other time of day.

Thus, a meal induces a large, transient fall in blood pressure in the elderly, even in those without signs of autonomic failure (i.e. positive standing-up test), and may predispose normotensive healthy elderly individuals to recurrent falls and syncope [21].

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