ENHANCED ELEVATION OF BLOOD PRESSURE DURING CIGARETTE SMOKING IN THE ELDERLY

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Acute changes in blood pressure and heart rate during cigarette smoking were investigated in 10 elderly subjects aged 75.6 ± 4.8 (mean ± SD) years and in 10 non-elderly subjects aged 35.6 ± 10.5 years. All subjects were healthy normotensive men with no cardiovascular disease. While each subject smoked two cigarettes containing 5.4 mg of nicotine, systolic and diastolic blood pressures increased significantly more in the elderly subjects (18.2 ± 6.0/9.0 ± 5.0 mmHg) than in the non-elderly subjects (4.8 ± 4.7/3.9 ± 4.2 mmHg, p < 0.05). However, the increases of heart rate in the two groups were similar (elderly: 10.5 ± 4.1 beats/min versus non-elderly: 12.1 ± 6.4 beats/min, ns). These results indicate that there is an age-related difference in blood pressure elevation during cigarette smoking in healthy subjects. (Jpn Circ J 1993; 57: 955-959)

Cigarette smoking is a strong risk factor for myocardial infarction and sudden death! However, the relationship between smoking and blood pressure is paradoxical. Most epidemiological studies have shown that smokers, as a group, have blood pressures that are similar to, or slightly lower than, those of non-smokers²⁻⁴ probably because smokers are leaner than non-smokers. In contrast, cigarette smoking or administration of nicotine apparently increases blood pressure⁵⁻⁷

Although the cardiovascular response to acute cigarette smoking has been investigated in young and middle-aged subjects⁵⁻⁷ there is a lack of information regarding elderly subjects. Therefore, the present study was designed to compare the effects of acute cigarette smoking on blood pressure and heart rate in elderly and non-elderly subjects who were habitual cigarette smokers with no clinically overt cardiovascular disease.

Key words:
Cigarette smoking
Blood pressure
Heart rate
Elderly

METHODS AND SUBJECTS

Twenty healthy subjects took part in the present study. All of the subjects were habitual cigarette smokers with no cardiovascular disease. The elderly subjects consisted of 10 men with a mean age ± SD of 75.6 ± 4.8 (range, 70–84). The non-elderly subjects also consisted of 10 men with a mean age ± SD of 35.6 ± 10.5 (range, 21–57). Before the study, the aim of the study was explained to each subject and informed consent was obtained.

All experiments were begun at 8:00 a.m. with the subjects comfortably seated in armchairs after an overnight fast. In addition to fasting, cigarette smoking, coffee and alcohol intake had also been prohibited for the previous night. After a control period of 20 min, each subject smoked two cigarettes (Peace, filter type, Japanese Tobacco Industry) containing 5.4 mg of nicotine for 10 min. Blood pressure and heart rate were monitored at two-minute intervals during the control period, at one-minute intervals during cigarette smoking, and again at two-minute

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intervals during a 20 min recovery period, using an automatic sphygmomanometer (Nihon Colin, BP 102 N II).

All data are given as mean ± SD. To determine whether blood pressure and heart rate changed significantly before, during and after smoking, the data were analyzed by repeated-measures one-way analysis of variance (ANOVA). When a significant difference was found, Fisher's least-significant difference test was used to determine where these differences were significant. Significance between groups was determined either by one-way ANOVA followed by Scheffe's test, or by two-tailed Student's t test, as applicable. A probability value of less than 0.05 was considered significant.

RESULTS

When 10 elderly subjects and 10 non-elderly subjects smoked two cigarettes each, both systolic and diastolic blood pressures significantly elevated from the baseline values (123.5 ± 11.7/72.2 ± 8.1 mmHg for elderly subjects and 110.7 ± 10.3/68.0 ± 10.0

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mmHg for non-elderly subjects, Figs. 1 and 2). The elevation in systolic blood pressure was 1.6—3.7 times higher in elderly subjects than in non-elderly subjects, based on a comparison of the mean values at corresponding times during the smoking period. When the 10 blood pressure readings during smoking in each group were averaged and compared with the baseline values, systolic blood pressure/diastolic blood pressure increased by 18.2 ± 6.0/9.0 ± 5.0 mmHg in the elderly subjects, and by 4.8 ± 4.7/3.9 ± 4.2 mmHg in the non-elderly subjects. These differences were statistically significant (p < 0.05).

Heart rates also significantly increased from the baseline values (68.0 ± 7.5 beats /min for elderly subjects and 65.7 ± 5.8 beats/min for non-elderly subjects, Fig. 3) in both elderly subjects and non-elderly subjects. Smoking increased heart rates by 10.5 ± 4.1 beats/min in the elderly subjects and by 12.1 ± 6.4 beats/min in the non-elderly subjects, as compared with the respective baseline values. There was no significant difference between the increases in heart rates of the two groups.

DISCUSSION

The present study demonstrates that smoking two cigarettes after a night of not smoking, produces significant elevation of blood pressure and heart rate in both elderly and non-elderly subjects. This finding agrees with those of established studies. The present study supports the idea that the elevation of blood pressure during smoking is much greater in elderly than in non-elderly subjects.

The absolute increases in systolic blood pressure (4.8 mmHg), diastolic blood pressure (3.9 mmHg), and heart rate (12.1 beats/min), in non-elderly subjects while smoking two cigarettes containing 5.4 mg of nicotine, were similar to or slightly lower than those observed in previous studies which involved juvenile habitual smokers.
Cryer et al.\textsuperscript{5} reported an average increase of 12 mmHg, in both systolic and diastolic blood pressures, and an average increase of 18 beats/min in heart rate, in association with an increase in plasma catecholamines. However, their experimental protocol did not clarify the amount of nicotine their subjects inhaled. Trap-Jensen et al.\textsuperscript{6} reported an average increase of 7.3 mmHg in mean blood pressure and an average increase of 20 beats/min in heart rate in subjects who smoked two cigarettes which contained 5.6 mg of nicotine. Furthermore, Freestone and Ramsay\textsuperscript{7} reported, that when mild hypertensive patients smoked cigarettes which contained 3.4 mg of nicotine, systolic blood pressure increased by 10 mmHg, diastolic blood pressure increased by 8 mmHg, and heart rate increased by 12 beats/min. Thus, the degree of the cardiovascular response to cigarette smoking is closely related to the nicotine content\textsuperscript{8} and the study population, and is also affected by inhalation behavior\textsuperscript{9}.

There have been few studies on the cardiovascular response of elderly subjects to acute cigarette smoking. Myers et al.\textsuperscript{10} showed that cigarette smoking did not significantly alter blood pressure, heart rate, or plasma catecholamine levels in relatively older patients with ischemic heart disease, suggesting that the response of the sympathetic nervous system to smoking may be blunted with increasing age. However, the present results indicate that there was a greater increase in blood pressure in healthy elderly subjects than in non-elderly subjects. The reason for this discrepancy between Myers’ study and mine, is not clear. However, since left ventricular performance has been found to be impaired in smokers with ischemic heart disease\textsuperscript{11} the cardiovascular response to acute smoking is likely to differ in healthy elderly persons. Actually, in patients with coronary disease, coronary blood flow either does not change or decreases during smoking\textsuperscript{12} while in healthy subjects coronary blood flow significantly increases, accompanied by an increase in heart rate and cardiac output\textsuperscript{13}.

Because the present study was not intended to investigate the mechanisms involved in the elevation of blood pressure during smoking, the mechanisms which underlie the enhanced elevation of blood pressure in elderly subjects are unclear. Proposed explanations include impaired baroreceptor function in the elderly\textsuperscript{14} structural remodeling of the vascular wall at the resistance vessels\textsuperscript{15} and reduced vasodilator responsiveness with aging\textsuperscript{16} These hypotheses, along with the pharmacokinetics of nicotine in elderly subjects, should be studied in more detail in the future.

In summary, the present study shows that there is an age-related difference in blood pressure elevation during cigarette smoking in healthy subjects. This fact may substantially influence the analysis of blood pressure variability during daytime in habitual cigarette smokers, especially in the elderly. However, the discrepancy between the short-term and long-term effects of cigarette smoking on blood pressure remains unsolved.

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