Circulatory Effect of Cigarette Smoking, with Special Reference to the Effect on Cerebral Hemodynamics

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It is well known that tobacco smoking, especially cigarette smoking, is an important socio-medical problem, since tobacco smoking exerts a harmful effect on many organs in man, i.e., respiratory, circulatory, digestive, endocrine and neurogenic organ, etc. Pulmonary cancer and myocardial infarction especially are more frequently found in heavy smokers. Hence, it would not be too much to say that the control of tobacco smoking is a key point in the management of the adult diseases.

On the other hand, the cerebral hemodynamics of tobacco smoking is not yet clear, since measurements in tobacco smoking are difficult methodologically. In this study, the circulatory effect of cigarette smoking, with special reference to the cerebral hemodynamics, was investigated.

Materials and Methods

The subjects were 12 men, i.e., 4 normal young men, 8 patients over 60 years old with mild diseases (bronchial asthma 4, coronary insufficiency 4). They were all habitual tobacco smokers (10-20 cigarettes daily).

The subjects were instructed to smoke the same type of cigarettes with ordinary inhaling speed. Cerebral hemodynamics, blood pressure and pulse rate were measured before, during and after smoking. On the other hand, the effect of rapid smoking on the circulatory system was examined in four elderly subjects.

The cerebral hemodynamics was measured using the ultrasonic Doppler technique via the internal carotid artery. The changing rate of cerebral blood flow (ΔCBF) and the changing rate of cerebral vascular resistance (ΔCVR) were used as the measure of cerebral hemodynamics.

Results

1. Effect of cigarette smoking on cerebral hemodynamics (Fig. 1-4).

In ordinary smoking, increase in cerebral blood flow and decrease in cerebral vascular resistance were observed in all subjects following one to three inhalations. The state continued for about 10-20 minutes after stopping of smoking. In addition, a significant difference in circulatory response was not observed between the young and elderly subjects.

The effect on cerebral hemodynamics of rapid smoking, moreover, was more conspicuous than ordinary smoking.

2. Effect of cigarette smoking on blood pressure and pulse rate (Fig. 5-8).

In ordinary smoking, blood pressure and pulse rate were not changed or slightly increased. The effect of rapid smoking on the circulatory system was more conspicuous than with ordinary smoking.

3. Effect of cigarette smoking on subjective symptoms.

In ordinary smoking, slight facial flushing or dizziness were observed in 8 of the 12 subjects. Subjective symptoms were observed more conspicuously in all subjects with rapid smoking.

Discussion

Tobacco smoking affects various circulatory factors, i.e., cardiac output, cardiac work, coronary blood flow, blood pressure and pulse rate,
Fig.1. Change of cerebral circulation in ordinary cigarette smoking (internal carotid artery).

normal young man 27 Yrs. B.P. 120/70
\[ \Delta \text{CBF}: +120.0\% \]
\[ \Delta \text{CVR}: -54.5\% \]

Fig.3. Change of cerebral circulation in ordinary cigarette smoking (internal carotid artery).

Coronary insufficiency 67 Yrs. B.P. 140/60
\[ \Delta \text{CBF}: +38.0\% \]
\[ \Delta \text{CVR}: -37.2\% \]

Fig.2. Change of cerebral circulation in ordinary cigarette smoking (internal carotid artery).

Bronchial asthma 69 Yrs. B.P. 140/85
\[ \Delta \text{CBF}: +100.0\% \]
\[ \Delta \text{CVR}: -50.0\% \]

Fig.4. Change of cerebral circulation in rapid cigarette smoking (internal carotid artery).

*Japanese Circulation Journal Vol. 33, September 1969*
Fig. 5. Change of blood pressure (systolic pressure) in ordinary cigarette smoking.

Fig. 6. Change of pulse rate in ordinary cigarette smoking.

Japanese Circulation Journal  Vol. 33, September 1969
Fig. 7. Comparison of blood pressure (systolic pressure) between ordinary and rapid cigarette smoking in old men.

Fig. 8. Comparison of pulse rate between ordinary and rapid cigarette smoking in old men.
The circulatory effects of tobacco smoking seem to be dependent upon the type of inhalation or duration of tobacco smoking, since the circulatory effect is mainly due to the effect of nicotine.

On the other hand, the circulatory effects of tobacco smoking will vary with the subject or measuring method. However, the following seem to be acceptable in general, i.e., an increase in cardiac output, cardiac work, blood pressure and pulse rate. This is supported by the results of the present experiment.

With respect to the mechanism of circulatory response to tobacco smoking, the following concept is remarkable in general, i.e., increase in blood catecholamine resulting from the stimulation by nicotine of the adrenal medulla or peripheral sympathetic ganglia; increase in blood pitressin resulting from the stimulation by nicotine of the supra-optic nuclei, etc.9

Undhavary10 suggested that the increase in blood catecholamine (namely, increase in circulatory response) resulting from tobacco smoking varies with age, type of tobacco or duration of smoking. In addition, he stated that the increase in blood catecholamine due to tobacco smoking is more conspicuous in nonsmokers than in habitual smokers, and more conspicuous in younger subjects than in older subjects.

In this study, a significant difference in circulatory response was not observed between the young and elderly with ordinary smoking. However, a conspicuous difference was observed between ordinary and rapid smoking, i.e., the more conspicuous increase was observed with rapid smoking than with ordinary smoking.

The effect of tobacco smoking on cerebral hemodynamics is not yet clear compared with the effect on the respiratory or cardiovascular system, since the measurement of cerebral hemodynamics in tobacco smoking is very difficult methodologically. Boyle11 has reported on the dizziness frequently occurring with administration of nicotine bitartrate. In fact, facial flushing and dizziness were frequently observed in the present study.

The effect of nicotine on cerebral hemodynamics in animals can be summarized as follows: Nicotine affects the cerebral vessel directly, and follows a biphasic pattern, i.e., contraction of the vessel (namely, decrease in cerebral blood flow) or dilation of the vessel (namely, increase in cerebral blood flow). The latter is more conspicuous than the former. Moreover, it is suggested that the effects of tobacco smoking on cerebral hemodynamics is specific in general, since the cerebral hemodynamic effect of tobacco smoking is independent of the blood pressure.

In this study, a decrease in cerebral vascular resistance (namely, dilatation of cerebral blood vessel) and an increase in cerebral blood flow were observed in all subjects. The changes in blood pressure and pulse rate were not observed with ordinary smoking. In other words, it may be said that the effect of tobacco smoking on cerebral hemodynamics is specific generally.

In addition, it is suggested that the change of cerebral hemodynamics in ordinary smoking may not be resulted from the secondary effect of blood chemical agents (PCO2, PO2, pH) but from the primary effect of chemical ingredients of cigarette (especially nicotine), since the change of cerebral hemodynamics in ordinary smoking appears immediately after the beginning of smoking.

However, the secondary effect of cardio respiratory hemodynamics on cerebral hemodynamics must be considered in rapid smoking, since a more conspicuous increase in blood pressure and pulse rate are found.

To summarize the findings, ordinary tobacco smoking appears at a glance to have a favorable effect on cerebral hemodynamics but habitual long term tobacco smoking causes an abnormal increase in blood catecholamine and lipid12-15 acceleration of cerebral arteriosclerosis and blood coagulation, and cerebral vascular disorders? The above concept is supported by the fact that in Framingham's study, both myocardial and cerebral infarction frequently occurred in heavy smoker.

Summary

The circulatory effect of cigarette smoking on cerebral hemodynamics, blood pressure and pulse rate were investigated in four normal young men and eight elderly patients with mild diseases, all habitual tobacco smokers (10-20 cigarettes daily).

(1) Decrease in cerebral vascular resistance (dilatation of cerebral blood vessel) and increase in cerebral blood flow were observed in all subjects with the ordinary smoking. On the other hand, blood pressure and pulse rate did not change or slightly increased.

(2) A conspicuous increase in cerebral hemodynamics, blood pressure and pulse rate were ob-
served in the elderly subjects with rapid smoking. (3) It is suggested that the cerebral circulatory effect of tobacco smoking is mainly due to the direct effect of nicotine, since a significant correlation is not observed between cerebral hemodynamics and blood pressure with ordinary smoking.

REFERENCES