EFFECT OF FILTER-CIGARETTE SMOKING ON CEREBRAL AND PERIPHERAL HEMODYNAMICS

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It is epidemiologically well known that tobacco smoking, especially cigarette smoking, gives rise to a harmful effect on the circulatory system. However, there seem to be several concepts as to the circulatory pathophysiology of tobacco smoking such as coronary vasospasm vs. vasodilatation in tobacco angina, cerebral vasospasm vs. vasodilatation in cerebral hemodynamics, etc. The experimental conflict as to the circulatory effect of tobacco smoking may be partly derived from the difference in experimental subject and/or methodology.

In a previous study, the circulatory effect of cigarette smoking without filter on cerebral hemodynamics was presented and it was reported that tobacco smoking gave rise to the decreased cerebral vascular resistance and increased cerebral blood flow.

In this study, the circulatory effect of filter-cigarette smoking on cerebral and peripheral hemodynamics examined by means of a newly devised ultrasonic Doppler technique, which is capable of multiple and simultaneous blood flow measurement non-operatively and continuously in man in situ is presented.

MATERIALS AND METHODS

The subjects were 10 adult males, i.e., 4 normal young males and 6 healthy looking males over 60 years old. They were all habitual tobacco

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smokers (10–20 cigarettes daily).

The subjects were instructed to smoke the same type of filter-cigarette. The blood flow in the internal carotid artery and brachial artery, blood pressure and heart rate were simultaneously and continuously measured before and after one inhalation and two inhalations at ordinary speed and several repeated inhalations at rapid speed.

The blood flow change in the internal carotid artery and brachial artery was investigated in each subject by means of a newly devised ultrasonic Doppler apparatus5–7. The change of heart rate was also simultaneously investigated by means of the Heart Rate Tachometer.

RESULTS

(1) Effect of filter-cigarette smoking on cerebral

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Fig. 4. Effect of filter-cigarette smoking on cerebral and peripheral circulation (71 yrs.).

Fig. 5. Effect of filter-cigarette smoking on cerebral and peripheral circulation (21 yrs.).

circulation.

The following two types of cerebral blood flow pattern were observed after filter-cigarette smoking: Type 1 - biphasic blood flow pattern, i.e., initial decreased blood flow followed by increased blood flow (Fig. 1-4). Type II - Monophasic blood flow pattern, i.e., increased blood flow without decreased blood flow (Fig. 5).

The former type was more frequent than the latter, i.e., biphasic type 8 and monophasic type 2. A significant difference in cerebral circulatory response was not observed between the young and elderly subjects.

(2) Effect of filter-cigarette smoking on peripheral circulation.

Although conspicuous alteration in peripheral blood flow were not observed after one or two inhalations, a slight but continuous increased blood flow was observed in one-half of the subjects (5 cases) after several repeated inhalations (Fig. 2-4). The changing rate of peripheral blood flow was slight as compared with the cerebral blood flow.
(3) Effect of filter-cigarette smoking on blood pressure and heart rate.

The alterations in blood pressure and heart rate were both slight. The changing rate of both factors was slight with one or two inhalations as compared with several repeated inhalations (Tab. I–II).

**DISCUSSION**

In the previous experiment, a decrease in cerebral vascular resistance (dilatation of cerebral blood vessel) and increase in cerebral blood flow were observed in all subjects with non-filter cigarette smoking. On the other hand, blood pressure and heart rate did not change or slightly increased. Further, a conspicuous increase in cerebral blood flow, blood pressure and heart rate were observed with rapid and repeated smoking.

In contrast to the above, decreased cerebral blood flow after one or two inhalations and increased cerebral blood flow after several repeated inhalations were chiefly observed in the present study.

The cerebral blood flow change may be derived from the cerebral vascular resistance change, i.e., cerebral vasoconstriction after one or two inhalations and cerebral vasodilatation after several repeated inhalations, since the changes in blood pressure and heart rate were conspicuously slight. As for the basis of the discrepancy between the former and latter experiments, the difference in method of smoking, especially with or without filter, i.e., amount of nicotine inhaled, should be considered besides the difference in recording system, i.e., the offline system in the former experiment and the online system in the latter experiment.

*Ingenito* examined the effect of nicotine HCl on the cerebral circulation of the cat and showed that nicotine caused only a mild and transient vasoconstriction of the cerebral circulation, mediated primarily by stimulation of the superior cervical ganglia, and a small direct cerebral vasoconstrictor component. This experimental finding coincides with the cerebral blood flow pattern after one or two inhalations in the present study.

Although the mechanism of cerebral vasodilation and increased cerebral blood flow after several repeated inhalations is not yet clear, reactive hyperemia and/or chemical ingredients of cigarette smoke except nicotine should be considered.

As for the effect of filter-cigarette smoking on the peripheral circulation, the following finding was observed, i.e., no alteration in blood flow after one or two inhalations and slight but continuous increased blood flow. The increased blood flow in the peripheral hemodynamics after several repeated inhalations may be derived from the decreased vascular resistance, i.e., peripheral vascular dilatation since the change in blood pressure and heart rate were conspicuously slight.

*Ingenito* examined the effect of nicotine HCl on the denervated hindlimb of the cat, and reports that the effect of nicotine on the denervated hindlimb vasculature was a weak but sustained vasodilatation. This experimental finding is coincident with the result in the present study.

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In the previous study, rapid and repeated cigarette smoking without filter gave rise to conspicuous increases in blood pressure and heart rate. In contrast to the above, the alterations in blood pressure and heart rate after several repeated inhalations were markedly slight in the present study. This finding suggests that the filter is advantageous for protection against unfavorable nicotine inhalation, i.e., harmful effect to the circulatory system.

To summarize, it may be said that the filter-cigarette is more suitable for the habitual smoker, especially patients with various circulatory disorders, as compared with the cigarette without a filter.

SUMMARY

The circulatory effect of filter-cigarette smoking on cerebral and peripheral circulation, blood pressure and heart rate was investigated in four normal young males and six healthy looking elderly males, all habitual tobacco smokers (10–20 cigarettes daily).

(1) The following two types of cerebral blood flow pattern were observed after filter-cigarette smoking, Type I - biphasic blood flow pattern, i.e., initial decreased blood flow followed by increased blood flow and Type II - monophasic blood flow pattern, i.e., increased blood flow without decreased blood flow.

The former type was more frequent than the latter, i.e., biphasic type 8 and monophasic type 2. A significant difference in cerebral circulatory response was not observed between the young and elderly subjects.

(2) Although a conspicuous alteration in peripheral blood flow was not observed after one or two inhalations, a slight but continuous increased blood flow was observed in one-half of the subjects (5 cases) after several repeated inhalations. The changing rate of peripheral blood flow was slight as compared with the cerebral blood flow.

(3) Alterations in blood pressure and heart rate were both slight. The changing rate of both factors was slight with one or two inhalations as compared with several repeated inhalations.

(4) The findings suggest that the filter-cigarette is more suitable for habitual smokers, especially patients with various circulatory disorders, as compared with the cigarette without a filter.

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