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Acute Effects of Tobacco and Non-tobacco Cigarette Smoking on the Blood Pressure and Heart Rate

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Abstract: Smoking of tobacco cigarettes is associated with a rise in blood pressure together with increase in heart rate. This study was aimed to examine the acute effect of tobacco and non-tobacco cigarette smoking on the blood pressure and heart rate by randomized crossover study. In the results, systolic/diastolic blood pressure and heart rate changes after smoking were significantly different between male and female group. Blood pressure and heart rate were elevated after smoking, but statistical significance for the difference was identified only in the female group. Because Non-tobacco smoke made from leaves of *E. ulmoides* has no nicotine, its effect on blood pressure and heart rate was negligible. Remarkable difference of heart rate changes in women was observed between tobacco cigarette smoking group and non-tobacco cigarette smoking group.

Keywords: tobacco, non-tobacco cigarette, blood pressure, heart rate, *E. ulmoides*

Introduction

The established risk factors for cardiovascular disease include smoking, plasma LDL (low density lipoprotein) concentration, high blood pressure, obesity, factors associated with fetal and infant growth, diabetes, risk of thrombogenesis, lack of physical activity and some dietary factors.[1] Tobacco cigarette smoking is notorious for giving rise to various disease as well as cardiovascular disease.[2,3]

Of the thousands of chemicals in tobacco smoke, nicotine may be the most important in that nicotine makes tobacco addictive and largely explains why people use tobacco products.[4,5] This compound is known to stimulate catecholamine release from both sympathetic neurons and the adrenal medulla. Nicotine also stimulates reflex increases in blood pressure and heart rate through its actions on carotid and aortic chemoreceptors.

Davis *et al.*[6] demonstrated enhanced platelet aggregation after experimental tobacco cigarette smoking. The study was carried out for addressing the question of whether the acute effects of tobacco on endothelium and on platelet aggregation can be avoided by the substitution of non-tobacco cigarettes.

In a cross-sectional study of the Tucson population study, it was shown that non-tobacco cigarette smoking, marijuana smoking had an important effect on respiratory symptoms and pulmonary function.[7] Furthermore, they confirmed and extended most of the results from the cross-sectional analysis through longitudinal observations in the same community population sample.[8]

In addition, various studies have analyzed the relationship between cigarette smoking and blood pressure and physical activity and have shown that the smoking of tobacco cigarettes is associated with a rise in blood pressure together with an increase in heart rate.[9-12]

We studied non-tobacco cigarettes manufactured from leaves of *E. ulmoides* about the effects on blood pressure and heart rate in comparison with tobacco cigarettes sold most commonly. Because non-tobacco cigarettes have no nicotine in them, it might be expected that they would not share the hypertensive and tachycardiac effects of tobacco cigarettes. This study was designed to examine these hypotheses.

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Materials and Method

Tobacco and Non-tobacco Cigarette

We used non-tobacco cigarette made from leaves of *E. ulmoides* by UDS Corporation and 'THIS' for tobacco cigarette because it was smoked by most Korean people at that time. According to chemical contents examination by KT&G central research institute, there is negligibly low nicotine in the non-tobacco cigarette used in the test.

Study Population

Thirty nine volunteers (15 females and 24 males) participated in this randomized crossover study. All of them have joined in privately organized smoking control program. Each of volunteer was given written informed consent and passed medical examination before participating in the clinical test. All of them were smokers aged from 20 years to 60 years and had no specific cardiovascular disease.

Self-reported Questionnaire

The following variables were evaluated by direct interview and recorded by self-administered questionnaire: age, sex, level of education, employment status, economic status, alcohol consumption, smoking habit and history, habitual physical activity, history of disease related to smoking habit, and symptoms of cardiovascular and respiratory disease.

Clinical Trial

This study was performed as randomized crossover study[13] in February 2000. On each study day, the subjects fasted (except for water and fruit juice) and refrained from smoking for 6 h before attending the research center in the early evening. Upon arrival they were seated comfortably for rest. After 20 minute seated rest, blood pressure and heart rate were recorded using US Baumanometer, stethoscope and stopwatch.

On the first day, half of the subjects (belonged to A group) smoked 3 non-tobacco cigarettes and other subjects (belonged to B group) smoked equal tobacco cigarettes up to clearing off for 20 minutes and recorded blood pressure and heart rate every 15 minute for 1 hour. The second test began one week after the first day. On the second day, the subjects in A group smoked 3 tobacco cigarettes and vice versa.

Statistical Analysis

The differences in the variation patterns of blood pressure and heart rate were compared with paired t-test between tobacco and non-tobacco smoking of cross-over test. The trends of blood pressure and heart rate change after smoking were observed by repeated measured analysis. A significance level of α, 0.05, was used to test all hypotheses. Statistical analysis was performed by SAS V8.1.

Results and Discussions

General characteristics of subjects participated in this study listed on Table 1. Mean age of male was significantly higher than that of female. As age is one of the risk factor for hypertension, systolic (SBP) and diastolic blood pressure (DBP) were higher in man than that in women.[14] Factors probed to be statistically significantly related to basal blood pressure in this study were age, gender, years of smoking, amount of meat intake, amount of fish intake and amount of coffee intake.

Table 1. General characteristics from subjects of clinical test (mean ± SD)

Parameter	Male	Female	Total
Age (year)	37.8 ± 10.9	27.9 ± 5.5	34.0 ± 10.3
Height (cm)	168.3 ± 6.4	160.3 ± 3.3	165.2 ± 6.7
Weight (kg)	67.6 ± 7.7	54 ± 4.8	62.3 ± 9.5
Year of Smoking	17.2 ± 10.0	6.5 ± 2.6	13.1 ± 9.5
Systolic Blood Pressure	122.9 ± 13.2	110.5 ± 8.8	118.3 ± 13.2
Diastolic Blood Pressure	82.6 ± 10.1	74.5 ± 7.3	79.6 ± 9.9
Heart Rate (pulse)	72 ± 7.8	75.8 ± 7.6	73.4 ± 7.9

Table 2. Blood pressure and heart rate changes of non-tobacco and tobacco smoking group

Parameter	Time (min)	Non-tobacco smoking (NS) group			Tobacco smoking (TS) group		
		Male	Female	Total	Male	Female	Total
SBP	Base	125.2(12.9)	110.4(8.8)	120(13.5)	122.6(11.9)	111.7(11.5)	118.6(12.8)
	20	127.7(13.5)	107.7(9.7)	120(15.6)	131.2(13.3)	115.4(7.5)	125.5(13.7)
	35	122.5(14)	108.8(7.7)	117(13.6)	123.1(12.4)	114.3(11.1)	119.9(12.5)
	50	117.5(11.2)	108.1(6)	114(10.6)	120.9(13.6)	112.5(9.2)	117.8(12.7)
	65	117(12.5)	107.8(5.9)	114(11.4)	121.1(12.6)	109.6(8.4)	116.9(12.4)
DBP	Base	83.2(9.7)	71.5(5.5)	78.9(10.1)	81.9(8.5)	75.8(9.5)	79.7(9.2)
	20	86.8(12.1)	72.3(7.8)	81.4(12.8)	87.5(10.1)	79.2(4.7)	84.5(9.4)
	35	80.2(11.7)	71.9(6.3)	77.1(10.7)	83.8(10.2)	77.9(9.2)	81.7(10.1)
	50	79.5(7.9)	72.3(7.0)	76.9(8.2)	80.9(11.3)	77.9(7.5)	79.8(10.0)
	65	79.3(6.4)	71.9(5.2)	76.6(6.9)	82.6(9.7)	75.4(5.0)	80(8.9)
Heart rate	Base	75.1(10.5)	76.6(9.2)	75.7(10.0)	73.1(8.1)	74.7(8.1))	73.7(8.5)
	20	71.6(7.7)	73.8(6.0)	72.5(7.1)	74(8.2)	81.7(7.3)	76.8(8.6)
	35	70(7.7)	73.2(7.4)	71.2(7.6)	71.5(6.9)	78(7.9)	73.9(7.8)
	50	69.5(7.4)	73.5(6.0)	71(7.1)	70.3(6.1)	78.3(6.0)	73.2(7.2)
	65	71.6(7.1)	71.7(7.7)	71.7(7.2)	73.1(6.5)	77.7(3.6)	74.8(6.0)

*mean (standard deviation).

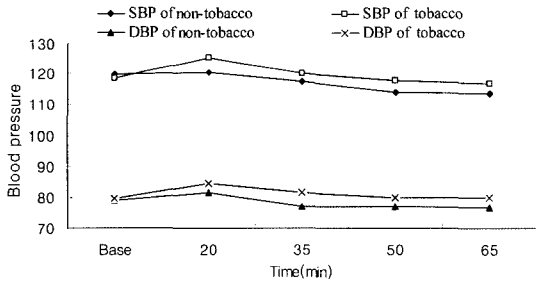
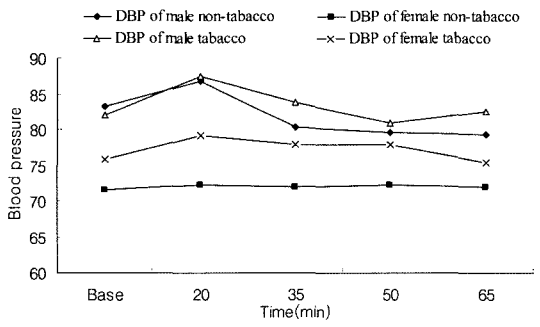
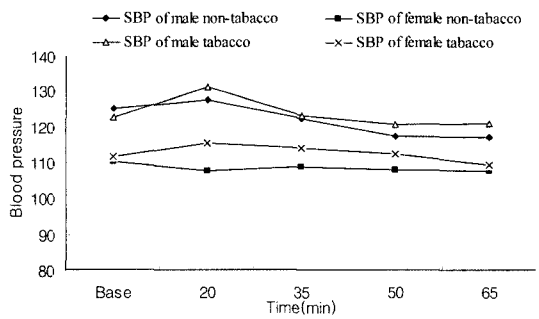


Fig. 1. Systolic and diastolic blood pressure changes of non-tobacco and tobacco smoking.



* p<0.001 : male vs. female group, tobacco vs. non-tobacco group of female

Fig. 2. Diastolic blood pressure changes of non-tobacco and tobacco smoking group.



* p<0.001 : male vs. female group, trends by repeated measured analysis

Fig. 3. Systolic blood pressure changes of non-tobacco and tobacco smoking group.

SBP and DBP changes after smoking were significantly different between non-tobacco cigarette smoking (NS) group and tobacco cigarette smoking (TS) group (Table 2 and Fig. 1). Especially increase of SBP and DBP for women was remarkable in TS group comparing to NS group (Fig. 2 and Fig. 3).

Because the mean age of male group was higher than that of female group, the differences of blood pressures between male and female group were statistically significant in both of tobacco and non-tobacco group ($p<0.001$). In the female group,

SBP and DBP changes were significantly different between TS and NS group at the time of 35 min after smoking by repeated model (p values were 0.0374 and 0.0148, respectively).

Tobacco smoking seemed to raise subjects' blood pressure in the short time after smoking. SBP and DBP were elevated at the time of 20 min after smoking in the both group of male and female, but statistical significance for the difference were identified only in the female group by the result of paired t-test for TS and NS of each subject.

A dramatic increase in the number of deaths related to coronary heart disease (CHD) has been observed worldwide and CHD of Koreans is nearly comparable to that of western developed countries.[15] Daviglus *et al.*[16] reported that low blood pressure, serum cholesterol levels and body mass index, absence of diabetes and being a non-smoker when young predict a lower long-term risk of coronary heart disease, cardiovascular and all-cause mortality. In the prospective cohort study from Netherlands,[17] they found that SBP and mean arterial pressure were most strongly related to cardiovascular disease related mortality. Therefore, using smoking replacement therapy for smoking cessation would be helpful for smoker's cardio-vascular state and life expectancy, even though the long-term success rates of giving up smoking are typically very low[18] and the health effects from non-tobacco smoking such as lung cancer or respiratory disease is not considered.[7,8]

In general, smoking habits was positively related to heart rate[19] and heart rate of female is slightly higher than that of male, but female have lower cardiovascular risk.[20] In this study, decrease in heart rate after non-tobacco smoking and increase in heart rate after tobacco smoking were observed (Fig. 4). The heart rate changes after smoking in the female groups were significantly different ($p<0.01$) between TS and NS group by both paired t-test and repeated model (Fig. 5). In our study, the remarkable difference of heart rate changes in women (Fig. 5) suggests that the cardiovascular risk from smoking would be different by gender and smoking is more dangerous in women.

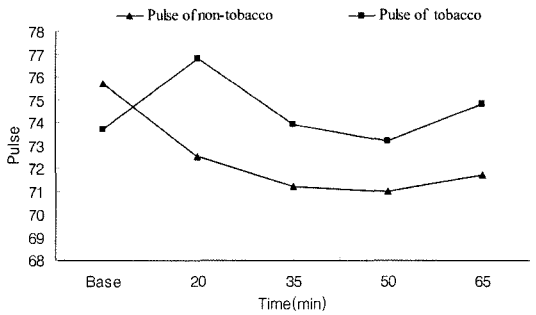
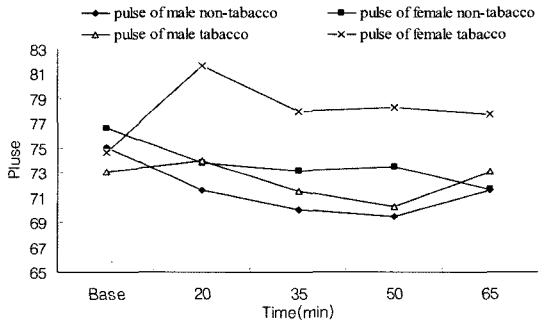


Fig. 4. Heart rate (pulse) changes of non-tobacco and tobacco smoking group.



* $p<0.001$: tobacco vs. non-tobacco of female group

* $p<0.05$: trends of tobacco group by repeated measured analysis

Fig. 5. Heart rate changes of non-tobacco and tobacco smoking group by sex.

Conclusions

Tobacco smoking raised subjects' blood pressure in the short time after smoking. SBP and DBP were elevated at the time of 20 minutes after smoking in the both group of male and female, but statistical significance for the difference were identified only in the female group by the result of paired t-test for TS and NS of each subject. Because Non-tobacco smoke made from leaves of *E. ulmoides* has no nicotine, its effect on blood pressure and heart rate was negligible. It was suggested that the cardiovascular risk from smoking would be different by gender and smoking is more dangerous in women.

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