

EFFECT OF SMOKING ON HEART RATE VARIABILITY

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The aim of the study is to determine the effect of smoking on heart rate variability (HRV), accepted as an index for autonomic function.

We studied 21 healthy nonsmoker males who have never smoked and 22 healthy smoker males who have smoked 10 cigarettes/ day or more daily for at least one year. Total and hourly time domain parameters of HRV (SDNN, SDANN, RMSSD, Triangular index) were obtained from the holter recordings by computer. We didn't find any statistical significance between the total HRV parameters of both groups. However, the means of each parameter were lower in the smoker group than that in the nonsmoker group. Also, for both groups, the means of each parameter were statistically lower in daytimes than those in nighttimes.

In conclusion, smoking causes the reduction of HRV especially in daytime. But it doesn't have any effect on its circadian variation.

Key Words: Smoking, heart rate variability, circadian variation

It is well-known that smoking is a major risk factor for cardiovascular diseases such as coronary heart disease, sudden death, peripheral artery disease, stroke, aortic aneurysm etc. (1). The mechanisms include endothelial dysfunction, accelerated atherosclerosis, coronary vasoconstriction, increased platelet aggregation and increased carbon monoxide levels (2-4). Also, there may be a link between acute sympathetic and hemodynamic responses to smoking and acute cardiovascular events. It has been reported in studies assessing the effect of smoking on autonomic function that it activates sympathetic autonomic system (5). Increased sympathetic activity may result in the lethal arrhythmias (6,7). Determining the autonomic function has still a specific importance in clinical practice. Heart rate variability (HRV) is commonly used for this aim. Decreased variability may result in the sudden cardiac death (7). It can be measured easily with recent technology (8). The aim of the study is to determine the effect of smoking on heart rate variability accepted as an index for autonomic function.

MATERIALS AND METHODS

We studied 21 nonsmoker males who have never smoked and 22 smoker males who have smoked 10 cigarettes/ day or more daily for

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Table I. The means of total HRV parameters and the comparison of them in according to subject groups.

	SDNN (Mean ± SD)	SDANN (Mean ± SD)	RMSSD (Mean ± SD)	TRIA (Mean ± SD)
Nonsmokers (n=21)	126 ± 14	173 ± 34	66 ± 16	391 ± 58
Smokers (n=22)	112 ± 16	155 ± 40	58 ± 16	358 ± 49
<i>p</i>	> 0.05	> 0.05	> 0.05	> 0.05

SD: Standard Deviation

at least one year. All were apparently healthy. Criteria for healthy status were: 1. They had no any cardiac symptoms 2. Had a normal clinical examination 3. Had a normal 12-lead electrocardiography 4. Had a normal chest X ray 5. Had a normal echocardiography. Holter monitoring was performed in all. Diagnostic monitoring Win Plus 1 was used. Holter recordings with at least 18-hour recording duration were evaluated. ECG recordings in the flash card were scanned with the holter processing unit. Recordings were reviewed by a cardiologist to detect and eliminate the artifacts and the mislabeled beats. The total and hourly time domain parameters of HRV were obtained out of the recordings with a computer software program. The measurements were accepted as nighttime measurements between 11:00 PM and 07:00 AM. The mean of hourly measurements were counted for daytime and nighttime separately. Time domain parameters of HRV used in the study were as follows:

Statistical methods:

SDNN (ms): Standard deviation of all normal to normal (NN) intervals.

SDANN(ms): Standard deviation of the averages of NN intervals in all 5 minutes segments of the entire recording.

RMSSD (ms): The square root of the mean of the sum of the squares of differences between adjacent NN intervals.

Geometric methods:

HRV Triangular index (TRIA): Total number of all NN intervals divided by the height of the histogram of all NN intervals measured on a discrete scale with bins of 1/128 s.

The total, daytime and nighttime HRV parameters were separately compared. Mann-Whitney U test and Wilcoxon test were used. Results were expressed as mean ± standard deviation. *P* < 0.05 was considered significant.

RESULTS

All subjects in both groups were males. The means of ages were 21.3 ± 2.4 years for the nonsmoker group and 21.7 ± 2.7 years for the smoker group. There was no statistical significance between the means of ages (*p* > 0.05). The means of maximal heart beats were 139.4 ± 15.6 for the nonsmoker group and 142.4 ± 15.0 for the smoker group. The means of minimal heart beats were 44.4 ± 3.7 for the nonsmoker group and 44.5 ± 7.6 for the smoker group. There were also no statistical significances between the means of both maximal and minimal heart beats (*p* > 0.05).

The means of the recording duration were 21.3 ± 2.6 (18.5-24.0 hours) for the nonsmoker group and 20.4 ± 1.8 (18.0-24.0 hours) for the smoker group. There was no statistical significance as to the recording duration between groups.

Table 1 shows the means of total HRV parameters and the comparison of them in according to the subject groups. According to Table 1, any statistical significance wasn't found between total HRV parameters (SDNN, SDANN, RMSSD, TRIA) between groups. In

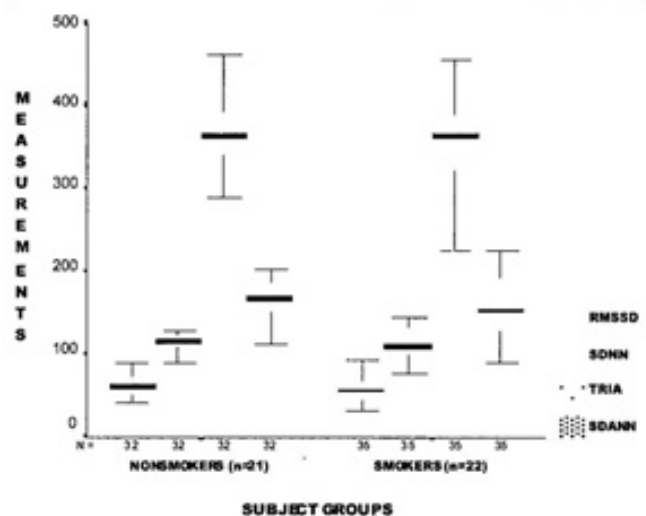


Figure 1. The means of total HRV parameters in according to subject groups as a boxplot graphic.

Table 2. The means of daytime and nighttime SDNN, RMSSD, TRIA measurements and the comparisons of them between groups and in each group.

	SDNN (Mean ± SD)			RMSSD (Mean ± SD)			TRIA (Mean ± SD)		
	DT	NT	p	DT	NT	p	DT	NT	p
NONSMOKERS (n=21)	117 ± 6.0	134 ± 25	*	53 ± 12	78 ± 24	*	387 ± 77	395 ± 52	>0.05
SMOKERS (n=22)	105 ± 14	119 ± 22	*	49 ± 14	67 ± 21	*	358 ± 58	357 ± 51	>0.05
p	*	>0.05		>0.05	>0.05		>0.05	*	

SD : Standard deviation

DT : Daytime, NT: Nighttime

* : Statistical significance (p<0.05)

spite of the fact that there was no statistical significance, when the means of them were taken into consideration, the means of them were lower in the smoker group than those in the nonsmoker group. Figure 1 shows the results in Table 1 as a boxplot graphic.

Table 2 shows the means of daytime and nighttime SDNN, RMSSD, TRIA measurements and the comparison of them between groups and in each group. According to table 2, the statistical significance was found between the means of the daytime SDNN measurements of groups (117 ± 6.0 for nonsmokers, 105 ± 14 for smokers, p < 0.05). Although there was no statistical significance between the nighttime SDNN measurements of groups (134 ± 25 for nonsmokers, 119 ± 22 for smoker, p > 0.05), the statistical significance was found between the means of the daytime and nighttime SDNN measurements of each group (117 ± 6.0 in daytimes, 134 ± 25 in nighttimes for nonsmokers; 105 ± 14 in daytimes, 119 ± 22 in nighttimes for smoker, p < 0.05 for both). For RMSSD, there was no statistical significance between the means of both daytime and nighttime RMSSD measurements of groups (Table 2). Like SDNN, the statistical significance was found between the means of the daytime and nighttime RMSSD measurements of each group (53 ± 12 in daytimes, 78 ± 24 in nighttimes for nonsmokers; 49 ± 14 in daytimes, 67 ± 21 in nighttimes for smokers, p < 0.05 for both). With regard to TRIA measurements, statistical significance was found only between the means of the nighttime TRIA measurements of groups (Table 2). But, as we expressed

above, the means were lower in smokers than those in nonsmokers. Also, the means in the nighttimes were higher than those in daytimes for both groups. Figure 2 shows the means of the daytime HRV parameters as a boxplot graphic. The means of the nighttime HRV parameters as a boxplot graphic can be seen in Figure 2.

DISCUSSION

HRV is accepted as an index of autonomic function. It may be expected that any factor changing the autonomic system may alter the HRV. Time domain and frequency domain parameters are used to measure the HRV. The basis of time domain methods is to determine RR intervals and the differences between them. To measure them, either statistical

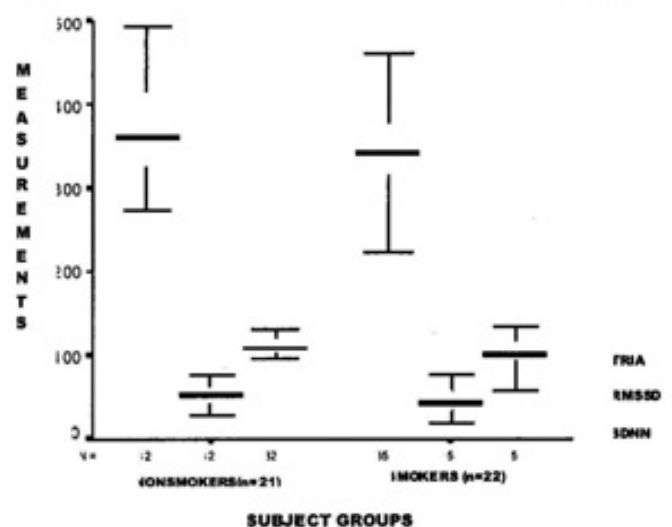


Figure 2. The means of the daytime HRV parameters as a boxplot graphic for each group.

methods or geometric methods which use the geometric shapes converted from statistical measurements are used. The parameters of time domain method which are commonly used and recommended are SDNN, SDANN, RMSSD and triangular index (TRIA)(8). For that reason, these parameters were used and compared in our study.

There are many factors which have some effects on HRV. One of them is age. It is shown that the HRV is lower in older persons than those in younger (9). In our study, there was no difference between the means of ages of groups. The other factor is gender. It is reported that the HRV in women is lower than those in men especially under 30 years old (10). All subjects were males in presented study. The another factor is the duration of recording. This may influence especially SDNN. As the period of monitoring decreases, SDNN estimates shorter and shorter cycle lengths (8). The durations of recording in our study weren't statistically different between groups. So, in our study, we overcame the possibility of effects of these factors mentioned above on the HRV.

It is well-known that smoking changes the autonomic system. Nicotine, the main chemical in tobacco, activates the sympathetic autonomic system (5). Activated sympathetic autonomic system may be associated with the reduction of HRV. Its effect like that on HRV was shown in studies both assessing the effects of the smoking on HRV and showing the increase of HRV after the cessation of smoking (6,11-12). There is in agreement that the smoking causes the reduction on HRV. Hayano et al.(13) reported that there was a reduction in HF power, one of the parameters of frequency domain, after smoking in subjects under 30 years of age. Levin et al.(14) found the results consistent with those of Hayano et al. Kupari et al.(15) divided the subjects into groups in according to the amount of smoking and observed that HRV was lower in people who smoke 10 cigarettes / day or more daily than in the nonsmoker group or the people who smoke fewer than 10 cigarettes / day. Eryonucu et al.(16) shown that the total and daytime time domain parameters were significantly lower in

the smoking group that in the nonsmoker group. In our study, although we didn't find any differences statistically between the nonsmoker group and the smoker group for the total time domain parameters, the measurements in the smoker group were lower than those in the nonsmoker group (Table 1, Figure 1). So, we considered our results were consistent with those mentioned above.

The other feature of HRV is to have a circadian variation. It is shown in many studies that time domain parameters increase in daytime and decrease in nighttime (17). In presented study, we found that the parameters of the time domain increased in nighttime and decreased in the daytime. We also showed that there were statistical significance between them (Table 2, Figure 2, Figure 3). Our findings were consistent with those of the previous studies. Although there was no statistical difference with regard to total SDNN between groups, we found the statistical difference between groups in regard to only the daytime SDNN measurements (Table 2). This result supported that smoking reduces the HRV.

In conclusion, smoking causes the reduction of HRV especially in daytime. But it doesn't have any effect on its circadian variation.

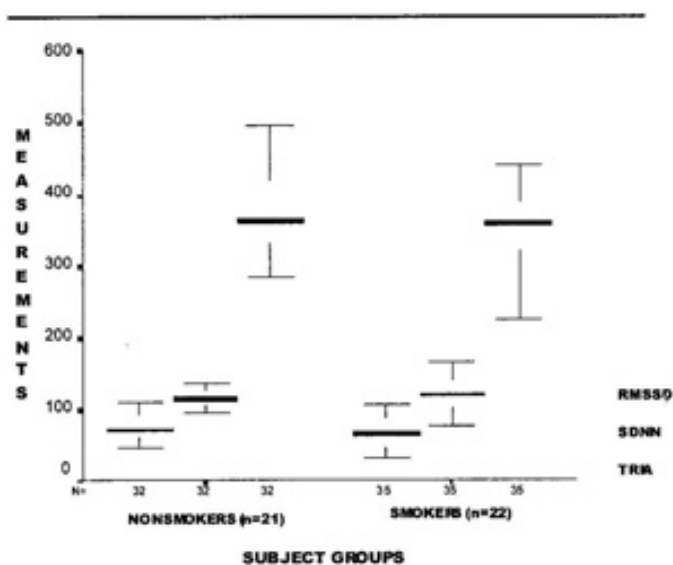


Figure 3. The means of the nighttime HRV parameters as a boxplot graphic for each.

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