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Linear Short-Term Heart Rate Variability Parameters of Subjects Tobacco Cigarette Smokers and Subjects Nonsmokers in Preoperative Period

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ABSTRACT

Background: Variations of heart cycles reflect complex dynamic cardiocirculatory regulatory systems in humans. Exposure to tobacco from cigarettes has been shown to elicit specific alterations of heart rate variability parameters leading to predominance of sympathetic and decreasing parameters of parasympathetic measures of cardiac autonomic nervous system tone. **Aim:** The aim of the trial was assessing differences of linear parameters of heart rate variability in subjects with habit of consuming of cigarettes tobacco in regard to subjects who are not consumers of tobacco. **Methods:** Patients of ASA II class with border-line arterial hypertension planned for elective abdominal surgery were included in the clinical trial. Twenty-two subjects were allocated to group I, with history of smoking twenty or more cigarettes per day for five or more years, and twenty-three subjects nonsmokers were allocated to group II. Recordings of electrocardiogram were done by Holter device and later on short-term heart rate variability (five minutes periods) were analyzed. Parameters of time domain analysis (SDNN-standard deviation of NN intervals, mean RR interval, mean heart rate) and frequency domain measures (low frequency (LF), high frequency (HF), and LF/HF ratio) were analyzed. **Results:** Baseline measures of mean NN intervals and standard deviation of normal to normal interval (SDNN) were slightly lower in subjects consumers of nicotine by cigarette tobacco smoking in regard to nonsmokers but without significant difference (640 ± 15 ms vs 675 ± 8 ms, $p < 0.1$; 45.1 ± 3.4 ms vs 51.4 ± 3.7 ms, $p < 0.08$, respectively). Values of frequency domain measures (LF, HF and LF/HF ratio) have shown variations between two groups, but no significant difference was found.

Keywords: heart rate variability, smoking tobacco, nicotine, preoperative period.

1. INTRODUCTION

Despite numerous detrimental effects on the overall health and strong association with higher morbidity and mortality it has been estimated that worldwide high incidence of tobacco smoking will increase in future decades (1, 2). There is a lot of evidence that the most deleterious effects on cardiovascular system are in close association with effects on autonomic nervous system tone besides the other effects on the whole system. Epidemiological data have shown strong association of tobacco

cigarette smoking with increased incidence of coronary events in the adult subjects of both gender (3, 4, 5). Inhalation of tobacco cigarette smoke lead to higher predisposition to different clinical syndromes like coronary artery disease, sudden cardiac death and stroke, atherosclerosis of main and peripheral arterial vessels with clinical condition of intermittent claudication and aneurysms of aorta (6, 7).

On the other hand numerous publications have suggested alterations of autonomic nervous system mod-

ulation of cardiac rhythm by decreased overall heart rate variability, increased sympathetic and decreased parasympathetic modulation of heart cycles (8, 9, 10). It has been postulated that exposure to nicotine that account for sympathetic activation leads to predisposition to various heart rhythm disorders including sinus tachycardia, atrial fibrillation, ventricular rapid rhythms and different kinds of blocks (6).

2. PATIENTS AND METHODS

After obtaining institutional approval and informed consent patients of ASA II class with border-line arterial hypertension without regular medication, planned for elective abdominal surgery were included in the clinical trial. Twenty-two subjects were allocated to group I, with history of smoking of twenty or more cigarettes per day for five or more years, and twenty-three subjects nonsmokers were allocated to group II. Not including criteria were: glucose metabolism disorders, use of medications that could affect heart rhythm, heavy caffeine and alcohol consumption. Subjects were advised of cessation of caffeine and tobacco cigarettes consumption 24h before recordings. Recordings of electrocardiogram were performed on the day of the scheduled procedure, in the frame of one hour before the induction of general anesthesia by Holter ECG recorder-analyzer (Trillium 3000 Holter System, Forest Medical, USA). After manual verifying for the artifacts and eliminating technically incorrect parts of the recordings, analysis was continued by Trillium HrvFreq 4.01, 2006 software (ForestMedical, LLC, East Syracuse, USA). Parameters of hemodynamics were also recorded and analyzed (heart rate and systolic arterial pressure and diastolic arterial pressure). All data were displayed as mean values of time domain parameters: mean normal-to-normal (NN) intervals, SDNN (standard deviation of normal-to-normal (NN)intervals), mean logarithmic values of the power of the total spectrum of heart rate variability (TP), mean values of the logarithmic values of low frequency band (LF), mean values of the logarithmic values of high frequency range (HF). Parameters of hemodynamics were presented as mean values of heart rate and mean values of systolic and diastolic arterial pressure (14). Linear measures of heart rate variability in time domain and frequency domain that were analyzed are listed in the Table 1.

Statistical analysis

Statistical analysis of the data obtained was performed by software package IBM SPSS version 20.0 (SPSS, Chi-

FREQUENCY- DOMAIN METHOD (Short-term recordings)		
VLF	Power of VLF range (ms ²)	=< 0,04Hz
LF	Power in LF range (ms ²)	0,04-0,15Hz
HF	Power in HF range (ms ²)	0,15-0,4 Hz
MEASURES OF TIME DOMAIN METHOD		
Mean NN interval	Normal-to-normal interval (ms)	
SDNN	Standard deviation of all NN intervals (ms)	

Table 1. Linear measures of HRV in Time-domain and Frequency-domain analysis (modified from „Heart rate variability: standards of measurement, physiological interpretation and clinical use“, Circulation, 1996.

	N	Gender	BMI (mean, SD)	Age(mean, SD)
Group I	22	14 M+8F	24.818(1.182)	54.45 (5.152)
Group II	23	12 M+11F	24.635(1.298)	54.00 (5.248)
Total	45	26M+19F	24.724(1.232)	54.22 (5.145)

Table 2. Demographic data

cago, IL, USA). Nonparametric Mann Whitney U test was used for comparison of the parameters of heart rate variability of the groups. Values of parameters of frequency domain were logarithmic-transformed before further analysis. P value of <0.05 was considered statistically significant.

3. RESULTS

Results of analysis are presented in the Table 2 and Table 3. Demographic data are shown in Figure 1 and HRV parameters in the groups are shown in Figure 2. Baseline measures of mean normal-to normal (NN) intervals and standard deviation of normal to normal interval (SDNN) were slightly lower in subjects consumers of nicotine by cigarette tobacco smoking in regard to nonsmokers but without significant difference (640+-15ms vs675+-8ms, p<0.1;45,1+-3,4 ms vs 51,4+-3,7ms, p<0.08, respectively).

Parameters of frequency domain measures (LF,HF and LF/HF ratio) have shown variations between two groups. Parameters of hemodynamics have shown variations in the two groups but without significant difference (14).

4. DISCUSSION

Exposure to tobacco smoking affects parameters of heart rate variability that has been suggested to reflect autonomic nervous system modulation of cardiac function by decreasing the overall variability and by alteration of the balance between the sympathetic and parasympa-

Group		Mean NN interval	Mean heart rate	Mean systolic AP (mmHg)	Mean diastolic AP (mmHg)	SDNN (ms)	LnTP	LnLF	LnHF	LF/HF
I	Mean	640.01	93.7	139	85	45.1	5.111	3.835	2.77	1.4336
	N	22	22	22	22	22	22	22	22	22
	SD	15.001	7.2	3	5	3.42	0.806	0.709	0.7085	0.235
II	Mean	675.02	88.8	143	83	51.4	5.686	3.778	3.0108	1.4599
	N	23	23	23	23	23	23	23	23	23
	SD	8.263	6.1	1.8	2.5	3.712	0.633	0.638	0.7146	0.318
Total	Mean	657.510	91.4	141	84	42.37	5.0405	3.804	2.896	1.447
	N	45	45	45	45	45	45	45	45	45
	SD	18,73	5.8	1.9	3.2	6.886	0.7715	0.686	0.713	0.2779
p		p<0.1	p<0.2	p<0.45	p<0.8	p<0.08	p<0.33	p<0.71	p<0.11	p<0.65

Table 3. Selected parameters of time domain and frequency domain analysis and hemodynamic parameters

thetic components of modulation with predominance of sympathetic influence.

Although precise mechanism that is fundamental for eliciting adverse effects of tobacco cigarette smoke on cardiovascular system epidemiological data have clearly confirmed that exposure to mainstream or side stream tobacco cigarette smoke predispose to increased cardiovascular morbidity and mortality (1, 2, 6).

About two decades ago Narkiewicz K et al. examined effects of acute cigarette smoking in small group of subjects with findings that tobacco cigarette smoking produced blood pressure increase, decrease of muscle sympathetic nerve activity and increase of skin sympathetic nerve activity (8).

Karakaya et al. have shown in their trial with small number of subjects that after acute consumption of cigarette smoke significant alterations of heart rate variability happened in terms of significant decrease of the mean normal-to-normal interval, decrease of standard deviation of normal-to-normal interval and the root mean square of subsequent NN interval differences (9).

Cagirci et al. compared parameters of heart rate variability of 69 subjects smokers and 74 subjects nonsmokers with findings of significantly higher values of LF and LF/HF ratio and decreased values of SDNN, RMSSD and HF in the subjects exposed to tobacco smoke in regard to subjects non-smokers (11).

In the observational study by Dietrich and coworkers that included 1218 randomly selected subjects non-smokers of middle age whose 24-h recordings were analyzed, there were evident differences between those of them who were exposed to tobacco smoke at work or at home in regard to those who were not exposed. Their conclusion was that exposure to tobacco smoke at home and work was associated with decreased parameters of heart rate variability and with higher heart rate (12).

There is strong similarity in changes of heart rate variability in subjects with verified arterial hypertension in regard to subjects exposed to tobacco cigarette smoking, with decrease of overall measures of heart rate variability and exceeding of sympathetic input over the effects of parasympathetic branch of autonomic nervous system modulation (13).

Kobayashi et al studied effects of cigarette smoking in relatively healthy volunteers who were exposed to cigarette smoking in different periods of the day during their working hours. Their findings have shown that cigarette smoking had influence on increase of LF/HF and de-

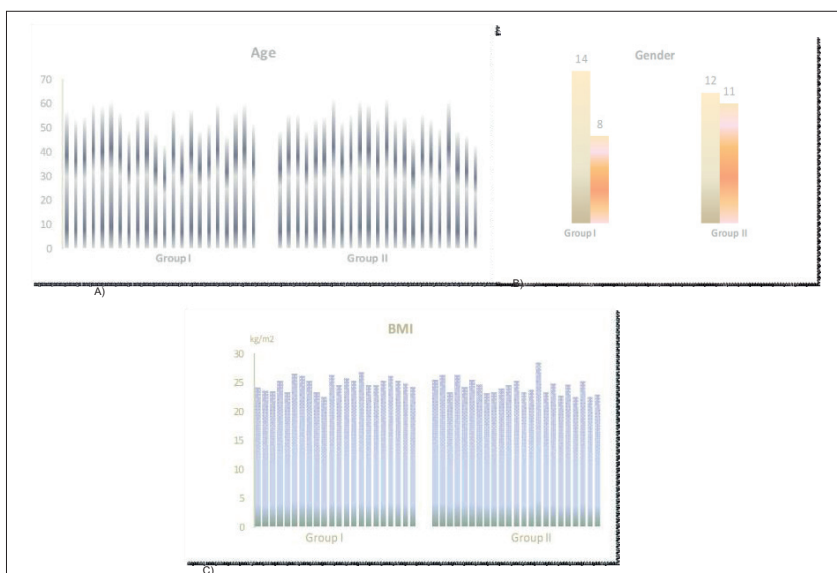


Figure 1. Demographic data

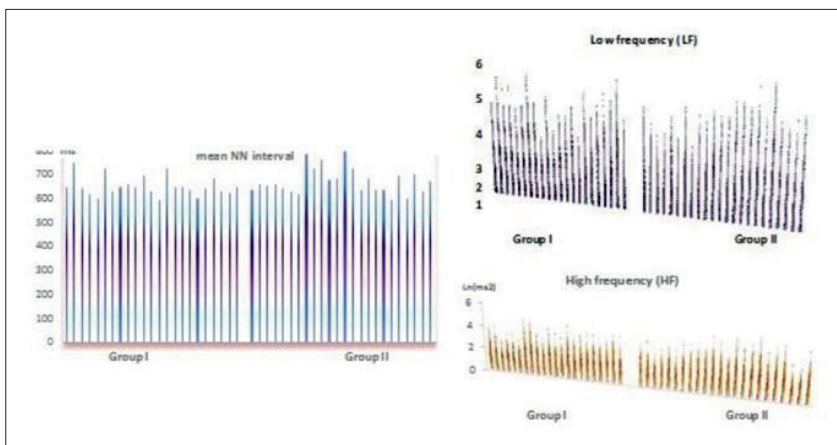


Figure 2. Graphic presentation of NN intervals, Ln values of low frequency (LF) and high frequency (HF) components

crease of HF component in first five minutes after starting smoking, but significant difference was found only during night hours (14).

Minami et al investigated effects of smoking cessation in small group of habitual male smokers on their hemodynamic parameters and heart rate variability from 24-h recordings and the data that were obtained showed that smoking cessation of one week could be associated to decrease of ambulatory measures blood pressure, heart rate and sympathetic nerve activity and increase of parasympathetic modulation in male habitual smokers with normal arterial blood pressure (15).

Gondim et al studied possible relationship between smoking of cigarettes in adolescents and changes of heart rate variability, and they did not find significant difference between the participants exposed to cigarettes and participants who were not smokers nor exposed to side stream smoke, but there was a note of limitation of the trial because of lack of measuring time of exposure to smoke (16).

According to the results obtained in this trial there were no statistically significant differences of the values of heart rate variability parameters between the subjects with who were smoking tobacco cigarettes and subjects

nonsmokers. The results of this study have been presented at ESC Congress 2016 in the form of poster (17).

5. CONCLUSION

In this clinical trial on the effects of exposure to tobacco cigarette smoking with small groups of patients who participated there was no significant difference between the parameters of measured heart rate variability in the observed groups.

Limitations of this trial include small number of participants, the lack of possibility to quantify tobacco cigarette smoking in individuals who also could have difficulties in cessation of smoking prior the procedure, and uncertainty regarding the possible effects of high values of arterial blood pressure as the possible result of increased sympathetic modulation per se.

- Conflict of interest: none declared.

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