

Autonomic Dysfunction in Current Cigarette Smokers Assessed by Time Series Analysis of Heart Rate Variability

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Abstract

Background: Cigarette smoking is one of the strong contributors to the risk of development of cardiovascular diseases including coronary artery disease, stroke, sudden death, peripheral artery disease & aortic aneurysm. **Objective:** To assess HRV by time domain methods in healthy cigarette smokers. **Methods:** This cross sectional study was conducted in the Department of Physiology, Bangabandhu Sheikh Mujib Medical University (BSMMU), Shahbag, Dhaka from July 2011 to June 2012. 120 apparently healthy male current regular cigarette smokers (Group B) aged 20-55 years were enrolled in the study group. 70 apparently healthy male non smoker subjects (Group A) were taken as control. Time domain measures of HRV were recorded by a RMS digital Polyrite. Statistical analysis was done by independent sample t test. **Results:** Resting Pulse, SBP, DBP, Mean heart rate was significantly higher ($p < 0.001$) and Mean R-R interval, SDNN, RMSSD were significantly lower ($p < 0.001$) in all smokers compared to control. **Conclusion:** Generalized reduced HRV & attenuated cardiac vagal modulation occur in apparently healthy cigarette smokers.

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Introduction

Cigarette smoking is one of the strong contributors to the risk of development of cardiovascular disease including coronary artery disease, stroke, sudden death, peripheral artery disease & aortic aneurysm.¹

Cigarette smoking increases the risk of sudden death more than ten fold in men and five fold in women.² Several mechanisms for the harmful effects of smoking on cardiovascular events are suggested in the literature. Among which, smoking induced increased sympathetic activity is the most important one.³ The strong relationship between cigarette smoking and decreased vagal cardiac activity and increased cardiac death has been highlighted.⁴ Moreover Hayano et al reported that short term effect of smoking includes decreased control of vagal

cardiac activity and increased sympathetic activity.⁵

Heart rate variability (HRV) is the most sensitive and quantitative marker for individual assessment of sympathetic and parasympathetic activity. In clinical practice, HRV has been shown to be a valuable non-invasive tool for the assessment of autonomic regulation of cardiovascular function. Time domain parameters have been recommended for HRV analysis with 5-minute recordings. Several time domain measures including mean heart rate, mean R-R interval, Max/Min RR interval ratio, SDNN, RMSSD are commonly used for HRV measurement.⁶

SDNN represents general measurement of autonomic nervous system balance⁷ and it also estimates total variability⁸

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Some authors compared the influence of cigarette smoking on cardiac autonomic nervous activity in young healthy smokers with control and found higher baseline heart rate in smokers than control.⁴

Among the different form of tobacco consumption, cigarette smoking is the most common and frequently used imposing tobacco related health risk of a population. Bangladesh was the first country to sign the WHO Framework Convention on Tobacco Control (FCTC). In 2005, Bangladesh enacted the Tobacco Control Act (TCA). Despite the enactment of the TCA, Bangladesh has experienced an alarming increase in cigarette use over last five year.¹²

Relatively high prevalence of cigarette smoking in Bangladesh has been reported in urban areas compared to rural areas. This picture shows the burden of risk factors imposed on our population for development of cardiovascular complications related to cigarette smoking.¹³ No study has investigated in Bangladesh the potential of cardiac autonomic nerve dysfunction due to cigarette smoking. This study aimed to investigate cardiac autonomic nerve function by analyzing the time series data of heart rate variability to find out the role of cigarette smoking for cardiac autonomic dysfunction.

Methods

This comparative analytical study was conducted in the department of Physiology, Bangabandhu Sheikh Mujib Medical University (BSMMU), Shahbag, Dhaka from July 2011 to June 2012. Total number of 190 healthy male subjects aged 20-55 years was enrolled for this study. Of them, age, sex and BMI matched 70 non smokers were taken as control (Group A) and 120 healthy current regular male smokers were selected as study group (Group B). Smokers were selected from hospital staff, patient's attendants, motor vehicles drivers, medical colleagues from BSMMU campus and by personal contact. Study subjects were selected by following simple random sampling procedure and the protocol of this study was approved by central ethical review committee of BSMMU. Non

smoker subjects were selected by personal contact. Smokers with history of coronary artery disease, active respiratory infection, diabetes mellitus, consumption of other tobacco products, thyroid disorders, renal or hepatic dysfunction, taking drugs affecting autonomic nervous system or any psychiatric illness were excluded from the study.

Selected subjects were informed about the risk and benefit and detail procedure of the study before enrollment and written consent was obtained from the willing volunteers. For recording HRV parameters subjects were prepared from the preceeding day of examination. They were advised to complete their meal by 9:00pm on the previous night, to remain free from any physical or mental stress, refrain from smoking atleast 12 hours before the study, not to take any sedatives or drugs affecting nervous system and to have a sound sleep at night. The subjects were also asked to have light breakfast without tea or coffee. All examination were done in the autonomic nerve function test laboratory in the department of physiology, BSMMU between 9:00am to 2:00pm. Autonomic nerve function test of all subjects were done by time domain measures of HRV. For autonomic nerve function test the subject lied on a bed in supine position and allowed to take rest for 15-20 minutes. 5 minutes baseline ECG recording for HRV was taken by polygraph. Time domain measures of HRV like mean heart rate, mean R-R interval, max/min R-R interval ratio, SDNN, RMSSD were analyzed. Data were expressed as mean and \pm SEM. Comparison of data between groups were done by unpaired 't' tests. P value < 0.05 was taken as level of significance.

Results

The anthropometric parameters of the subjects are presented in Table I.

The mean values of mean heart rate, pulse, SBP and DBP were significantly higher in group B than that of group A (Table II). Mean R-R interval, SDNN and RMSSD were significantly lower in group B than that of group A. Max/Min ratio of RR interval though lower but not statistically significant (Table III).

Table I: Age and BMI in different groups (n=190)

Parameters	Group A (n=70)	Group B (n=120)	P values
Age (years)	32.3±0.97 (22-52)	32.56±0.66 (22-49)	0.849 ^{ns}
BMI (Kg/m ²)	26.67±0.43 (19.88-34.24)	24.99±0.31 (17.51-33.78)	0.427 ^{ns}

Table II: Resting Pulse rate and BP in different groups (n=190)

Parameters	Group A (n=70)	Group B (n=120)	P values
Pulse (beat/min)	72±0.58 (60-80)	78±0.5 (62-99)	0.000 ^{***}
SBP (mm of Hg)	112±0.98 (100-126)	121.63±1.01 (100-140)	0.000 ^{***}
DBP (mm of Hg)	70±0.91 (60-85)	75.37±0.72 (60-90)	0.000 ^{***}

Table III : Time domain measures of HRV in different groups (n=190)

Parameters	Group A (n=70)	Group B (n=120)	P values
Mean heart rate (beat/min)	72.83±0.66 (65-85)	79.37 ± 1.06 (67-113)	0.000 ^{***}
Mean R-R interval (sec)	0.76±0.01 (0.6-0.91)	0.71±0.007 (0.52-0.88)	0.000 ^{***}
Max/Min R-R ratio	1.77±0.06 (0.89-3.54)	1.72±0.047 (0.87-3.31)	0.57 ^{ns}
SDNN (ms)	131.32±3.32 (89.01-189.07)	77.10±1.97 (20.71-122.63)	0.000 ^{***}
RMSSD (ms)	64.73±1.23 (20.08-104.7)	49.22±2.47 (10.31-99.5)	0.000 ^{***}

Data were expressed as Mean ± SE. Figures in parentheses indicate ranges.

Statistical analysis were done by Independent sample t-test

Group A: Apparently healthy non smoker (control)

Group B: Apparently healthy male smoker

*** = p<0.001 ns = non significant (p>0.05)

Discussion

The present study assessed cardiac autonomic nerve function activity in apparently healthy current regular male cigarette smokers by analysis of time domain measures of heart rate

variability and compared in age and BMI matched apparently healthy non smoker adults. Simple time domain measures including mean R-R interval and mean heart rate reflects cardiac vagal activity.⁶ Statistical time domain measures like

SDNN and RMSSD are indices of general autonomic balance.⁷

In this study, mean HR, SBP and DBP were found significantly higher in all smokers than non smokers. Similar results were also found by Andrikopoulos et al. and Cagirci et al. in heavy smokers.^{4,11}

In the present study, lower cardiac vagal modulation supported by lower values of time domain measures agrees various other investigators.^{11,12,13,14} Also, the significantly lower mean R-R interval in all smokers compared to non smokers were comparable to the findings of Barutcu et al.¹⁵

The reduced cardiac vagal modulation and the simultaneous sympathetic hyperactivity in the smokers of this study may be the effect of consumption of nicotine and other substances contained in cigarette smoke and this view is shared by several groups of researchers.^{4,11,12, 15-17}

In smokers, the higher value of mean heart rate indicates higher sympathetic and lower values of mean R-R interval, SDNN and RMSSD indicates lower parasympathetic activity.

The exact mechanisms entailed in the genesis of impaired CANA in apparently healthy smokers cannot be explained from the nature and extent of this study. As a major component of cigarette smoke, nicotine stimulates the nicotinic receptors of autonomic ganglia as well as adrenal medulla resulting in increased cardiac sympathetic activity and increased release of catecholamine.^{12,18-19}

This effect is obviously attributed to the higher heart rate and the restriction of heart rate variability in the smokers of this study. This effect of nicotine may be further intensified by its action on peripheral chemoreceptors causing impaired baroreflex sensitivity.¹⁸⁻²⁰

In addition to nicotinic effect, the increased release of neuropeptide Y as a part of physiological

adjustment for autonomic balance causing suppression of cardiac vagal tone also contribute to the reduced vagal modulation in smokers.²¹

Conclusion

Generalized reduction in HRV & attenuated cardiac vagal modulation occurred in healthy smokers.

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