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Original Research Article

Comparison of autonomic functions in moderate and heavy smokers using heart rate variability

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ABSTRACT

Background: Previous studies using heart rate variability (HRV) have confirmed decreased HRV in cigarette smokers compared with non smokers. However only few studies have been done considering the effect of smoking on HRV in moderate and severe smokers assessed by pack years. Objective: The main objective of this study was to compare the autonomic functions in male moderate and heavy cigarette smokers.

Materials and Methods: The present was conducted in our department of Physiology. Permission to conduct the study was obtained from Institutional research ethical committee. This study was conducted among male cigarette smokers with age between 20 to 50 years who were apparently healthy. The study group subjects were divided into moderate and heavy smokers considering both the amount and duration of smoking calculated by pack years. HRV data was recorded, statistical analysis was done by independent sample t test to compare between the groups. A p value of <0.05 was considered as statistically significant whereas a p value <0.001 was considered as highly significant.

Results: The HRV parameters namely Low frequency (LF) component, LF power expressed in normalized unit (LFnu) and LF-HF ratio were significantly higher in heavy smokers compared to moderate smokers. Total power, high frequency (HF) component and HF power expressed in normalized unit (HFnu) were found significantly less in heavy smokers compared to moderate smokers.

Conclusion: Autonomic imbalance characterized by increased sympathetic function with associated decrease in the cardiac vagal modulation was seen in heavy smokers compared to moderate smokers.

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1. Introduction

The causative factors responsible for various diseases of the cardiovascular system are many but cigarette smoking is considered a major preventable risk factor. Previous studies have shown that smoking a cigarette increases heart rate and blood pressure due to the increase in the plasma concentration of norepinephrine and epinephrine.¹ Further studies confirmed smoking caused increase in sympathetic stimulation of the heart.² It is also suggested that the

incidence of arrhythmias^{3,4} and cardiac arrest⁵ was more in cigarette smokers. Heart rate variability (HRV) has been used as a tool to measure cardiovascular dysfunction caused due to autonomic imbalance.⁶ In HRV analysis, low-frequency (LF) component, LF power expressed in normalized unit (LFnu) represent sympathetic function and total power (TP), high-frequency (HF) component, HF power expressed in normalized unit (HFnu) represent parasympathetic function, and ratio of LF to HF power (LF-HF ratio) gives the net result of autonomic functions.⁶ Many studies done earlier have established that HRV is decreased in smokers when compared to non-smokers.⁷ However not

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many studies have compared the autonomic functions in moderate smokers and heavy smokers assessed by pack years. Therefore this study is aimed to measure and compare autonomic functions in male moderate and heavy cigarette smokers.

2. Materials and Methods

The present study was conducted in our Physiology department. Permission to conduct the study was obtained from institutional research ethical committee. The study was conducted among male cigarette smokers in the age group between 20-50 years who were healthy. The subjects for the study were the residents of our District and selection was done by simple random sampling. After matching body mass index (BMI), detailed history was taken regarding smoking habit. The study group subjects were divided into moderate and heavy smokers taking into account the duration and amount of smoking calculated by pack years.⁸ Smokers having pack years between 20.1 and 40 were grouped as moderate smokers and smokers having pack years > 40 were grouped as heavy smokers, pack years was calculated using the formula.⁸

$$\text{No. of pack-years} = \frac{\text{No. of cig. smoked per day} \times \text{no. of years smoked}}{20}$$

Fig. 1:

50 smokers were selected in each group, the sample size being calculated by considering the prevalence of smoking. The prevalence of smoking being 42.4%⁹ with 14% acceptable error and 95% confidence interval, the sample size was calculated by using the formula, $n = 4pq/d^2$ where p is the prevalence, q is (1-p) and d being acceptable error. The sample size turned out to be 49.8 which was rounded to 50.

Smokers with history of hypertension, diabetes mellitus, active respiratory infection, other cardiovascular illness, thyroid disorders, renal and hepatic disorders, psychiatric illness, smokers taking drugs affecting autonomic nervous system and beedi smokers were excluded from the study

After explaining the procedure informed consent was taken from each subject. Detailed history and clinical examination of the subjects was done to make sure the subjects met the inclusion and exclusion criteria. On inquiring about the type of cigarettes smoked most of the smokers told they smoked filtered cigarettes. The height and weight of the subjects was measured and BMI was calculated. The subjects were instructed to have light breakfast at 8 AM and refrain from having coffee or tea. The parameters were recorded during 10 AM to 11 AM in the morning for all the subjects to minimize the circadian

effects.

Before starting the procedure the subject was made to rest for 15 min in supine position. A lead II electrocardiogram was recorded for HRV analysis for duration of 5 minutes as per the recommendation of task force,⁶ with subject awake using the instrument Power lab 8/30 series with dual bio amplifier (Manufactured by AD instruments, Australia, with model no ML870). To record heart rate, the ECG signal which was analogous was obtained using lead II which had a QRS complex of good amplitude and stable base line. The gathered data was subjected to analysis of HRV. HRV analysis was done by inbuilt software using parameters total power (TP), high frequency power (HF), low frequency power (LF), ratio of low frequency power to high frequency power (LF/HF).

2.1. Statistical analysis and methods

Data was collected by using a structured proforma. Data entered in MS excel sheet and analysed by using EPI Info Version 7.0 software. Data was expressed in terms of Mean and Standard deviation. Comparison of mean and SD between groups was done by using Independent sample t test. A p value of <0.05 was considered as statistically significant whereas a p value <0.001 was considered as highly significant.

3. Results

No significant difference was observed for BMI between moderate smokers and heavy smokers. The HRV parameters namely Low frequency (LF) component, LF power expressed in normalized unit (LFnu) and LF-HF ratio which represent sympathetic activity were significantly higher in heavy smokers compared to moderate smokers. Other HRV parameters namely Total power, high frequency (HF) component and HF power expressed in normalized unit (HFnu) which represent parasympathetic activity were found significantly less in heavy smokers compared to moderate smokers.

4. Discussion

The main purpose of the present study was to measure and compare autonomic functions in moderate and heavy smokers. It was observed that parameters representing sympathetic function such as LF, LFnu and LF/HF ratio were significantly increased in heavy smokers compared to moderate smokers. This suggests that the cardiac sympathetic activity was increased in heavy smokers compared to moderate smokers. It was observed that parameters representing parasympathetic function such as HF, HFnu and TP were significantly decreased in heavy smokers compared to moderate smokers. This suggests that the parasympathetic activity was less in heavy smokers compared to moderate smokers. The imbalance observed

Table 1:

		Group Statistics			
	Group	N	Mean	Std. Deviation	Std. Error Mean
BMI	Moderate Smokers	50	28.8248	4.05917	.57405
	Heavy Smokers	50	29.2214	4.15548	.58767
TP	Moderate Smokers	50	2772.5278	154.02450	21.78235
	Heavy Smokers	50	2359.4596	157.24279	22.23749
LF	Moderate Smokers	50	818.4040	23.30667	3.29606
	Heavy Smokers	50	963.6450	7.69742	1.08858
HF	Moderate Smokers	50	448.0810	16.62493	2.35112
	Heavy Smokers	50	371.5658	17.81130	2.51890
Lfnu	Moderate Smokers	50	64.6788	.99755	.14107
	Heavy Smokers	50	72.1818	.94128	.13312
Hfnu	Moderate Smokers	50	35.3734	.84767	.11988
	Heavy Smokers	50	27.8052	.93829	.13269
LF/HF	Moderate Smokers	50	1.8246	.06938	.00981
	Heavy Smokers	50	2.5946	.12218	.01728

Table 2:

	t	df	Sig. (2-tailed)	t-test for Equality of Means			
				Mean Difference	Std. Error Difference	95% Confidence Interval of the Difference	
						Lower	Upper
BMI	-.483	98	.630	-.39660	.82152	-2.02688	1.2337
TP	13.270	98	.000	413.06820	31.12839	351.29492	474.8415
LF	-41.842	98	.000	-145.24100	3.47117	-152.12942	-138.3527
HF	22.206	98	.000	76.51520	3.44567	69.67739	83.3530
Lfnu	-38.682	98	.000	-7.50300	.19396	-7.88792	-7.1181
Hfnu	42.322	98	.000	7.56820	.17883	7.21333	7.9231
LF/HF	-38.752	98	.000	-.77000	.01987	-.80943	-.7306

in autonomic functions in smokers has been attributed to the effects of nicotine and other substances present in cigarette.^{10–13} The possible explanation for changes in HRV parameters observed in heavy smokers compared to moderate smokers is because of the higher dose and long duration of exposure to nicotine and other substances found in cigarettes.

The effects of smoking of conventional cigarettes on autonomic control of cardiovascular system was studied by George K. Ndrkopoulos, Dimitrios J. Richter, Polychronis E. Dilaveris et al,¹⁴ the study concluded smoking causes an increase in sympathetic control and decrease in parasympathetic control of cardiovascular system. The effect of the intensity of smoking on cardiac autonomic functions measured by using HRV was studied by Ana Paula Soares dos Santos, Dionei Ramos, Gabriela Martins de Oliveira.¹⁵ The study concluded that the intensity of smoking had an influence over the autonomic regulation of cardiac functions, it was seen that autonomic regulation was less functional in heavy smokers than in moderate smokers.¹⁵ In our study same observations were made. Sultana Ferdousi, Mehboba Ferdous, Md. Saiful Islam¹⁶ studied influence of smoking on autonomic functions considering different intensity of exposure, they used

HRV as a measuring tool and concluded that smoking causes an increased sympathetic stimulation leading to autonomic dysfunction of cardiovascular system,¹⁶ similar observations were made in our study also.

The strength of our study was we compared autonomic functions in smokers by classifying them taking into account both the dose and duration of smoking exposure. The limitations of the study were we relied on the history given by smokers for classifying smokers, and there is a possibility that the information given may not be accurate. Studies in future can be done by considering the plasma nicotine level of each smoker.

5. Conclusion

Autonomic imbalance characterized by increased sympathetic function with associated decrease in the cardiac vagal modulation was seen in heavy smokers compared to moderate smokers. Taking into account the high prevalence of smoking, also knowing that various diseases are associated with smoking, health education of general population should be done to decrease the cardiovascular morbidity.

6. Source of Funding

None.

7. Conflict of Interest

The authors declare no conflict of interest.

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