RESEARCH ARTICLE
Influence of smoking on autonomic functions in light and heavy smokers measured by heart rate variability

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ABSTRACT

Background: Various studies using heart rate variability (HRV) as a tool have found reduced HRV in smokers in comparison with non-smokers. However, not many studies have studied the influence of smoking on HRV in light and heavy smokers calculated by pack years. Aim and Objective: The main aim of this study was to measure and compare the influence of smoking on autonomic functions in male light and heavy cigarette smokers using HRV. Materials and Methods: The present was conducted in the Department of Physiology, Navodaya Medical College, Raichur. Permission to conduct the study was obtained from the Institutional research ethical committee. This study was conducted among male cigarette smokers with age between 20 and 50 years who were apparently healthy. The selection of subjects participating in the study was done by simple random sampling, the subjects were residents of the Raichur district. The study group subjects were divided into light and heavy smokers considering both the amount and duration of smoking calculated by pack years. HRV was recorded by using the instrument Polygraph (AD instruments, Australia, model noML870). Statistical analysis was done by independent sample t-test to compare between the groups using EPI Info Version 7.0 software. A P < 0.05 was considered as statistically significant whereas a P < 0.001 was considered as highly significant. Results: The HRV parameters indicating sympathetic function such as low frequency (LF) component, LF power expressed in normalized unit (LFnu) and LF-HF ratio were significantly increased in heavy smokers in comparison to light smokers, whereas the HRV parameters indicating parasympathetic function such as total power, high frequency (HF) component and HF power expressed in normalized unit (HFnu) were significantly decreased in heavy smokers in comparison to light smokers. Conclusion: Increased sympathetic stimulation associated with a decrease in the cardiac vagal modulation leading to imbalance in the autonomic functions was more in heavy smokers when compared to light smokers.

KEY WORDS: Heart Rate Variability; Cigarette Smokers; High Frequency; Low Frequency

INTRODUCTION

Cigarette smoking is a preventable causative factor of many diseases related to the cardiovascular system in humans. In various diseases related to the cardiovascular systems such as coronary artery disease leading to angina or myocardial infarction smoking is an established causative factor.[1] Previous studies have shown that smoking changes the functioning of the autonomic nervous system resulting in an increased sympathetic stimulation.[2] The occurrence of arrhythmias,[3,4] death due to cardiac arrest[5] is more in cigarette smokers. Smoking enhances the events in heart failure by altering the hemodynamic status in the body.[6] Many investigators have used heart rate variability (HRV) as a tool to measure dysfunction of the cardiovascular system resulting from imbalance of autonomic nervous system.[7] In HRV analysis,
the measure of sympathetic function is given by the parameters low frequency (LF) and LF power expressed in normalized unit (LFnu) and the measure of parasympathetic function is given by the parameters total power (TP), high frequency (HF), HF power expressed in normalized unit (HFnu). The ratio of LF to HF power (LF-HF ratio) gives the net function of both sympathetic and parasympathetic system. Various studies using HRV as a tool have found reduced HRV in smokers in comparison with non-smokers. However not many studies have studied the influence of smoking on HRV in light and heavy smokers calculated by pack years. Therefore, the main aim of this study is to measure and compare the influence of smoking on autonomic functions in male light and heavy cigarette smokers using HRV.

MATERIALS AND METHODS

The present study was conducted in the Department of Physiology, Navodaya Medical College, Raichur. Permission to conduct the study was obtained from the Institutional research ethical committee. This study was conducted among male cigarette smokers with age between 20 and 50 years who were apparently healthy. The selection of subjects participating in the study was done by simple random sampling, the subjects being residents of Raichur district. After matching the body mass index (BMI) history was sought considering the details of smoking habit. The study group subjects were divided into light and heavy smokers considering both the amount and duration of smoking calculated by pack years. Smokers having pack years in the range 0.1 and 20 were classified as light smokers and smokers having pack years >40 were classified as heavy smokers. The number of light smokers and heavy smokers selected were 50 in each group. Calculation of pack years was done using the formula.

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

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

After explaining the procedure to each subject, informed consent was sought before starting the procedure. Detailed history and clinical examination of the subjects were done to make sure they met the specifications made in inclusion and exclusion criteria. BMI of the subjects was calculated after measuring their height and weight. The subjects were instructed to have light breakfast at 8 AM and refrain from having coffee or tea. The parameters were recorded during 10–11 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 the supine position. Using the instrument Polygraph (AD instruments, Australia, model no ML870), electrocardiogram (ECG) was recorded for a duration of 5 minutes in lead II, keeping the subject in awake state. The recorded ECG was subjected for HRV analysis as per the suggestion of task force. To determine the heart rate an ECG in lead II was obtained which was analogous and had a QRS complex of good amplitude with base line which was stable. The collected data were subjected to analysis of HRV in the frequency domain. The HRV parameters obtained from the inbuilt software include LF power, HF power, TP, ratio of LF power to HF power (LF/HF).

Statistical Analysis

The data collected in a structured proforma were entered in MS excel sheet and analyzed by using EPI Info Version 7.0 software. The final data were expressed in terms of mean and standard deviation (SD) as shown in Table1. Comparison of mean and SD between groups was done using Independent sample t-test. A \( P < 0.05 \) was considered as statistically significant and a \( P < 0.001 \) was considered as highly significant.

RESULTS

Comparison of BMI between light smokers and heavy smokers was not significant. The HRV parameters indicating sympathetic function such as LF component, LF power expressed in normalized unit (LFnu), and LF-HF ratio were significantly increased in heavy smokers in comparison to light smokers, whereas the HRV parameters indicating parasympathetic function such as TP, HF component and HF power expressed in normalized unit (HFnu) were significantly decreased in heavy smokers in comparison to light smokers as shown in Tables 1 and 2.

DISCUSSION

The main intention of the present study was to measure and compare the influence of smoking on autonomic functions in light and heavy cigarette smokers using HRV. It was observed that HRV parameters indicating sympathetic function such as LF component, LF power expressed in normalized unit (LFnu), and LF-HF ratio were significantly increased in heavy smokers in comparison to light smokers. This suggests that the cardiac sympathetic activity in heavy smokers was more when compared to light smokers. It was observed that HRV parameters indicating parasympathetic function such as HF, HFnu, and TP were significantly decreased in heavy smokers in comparison to light smokers. This suggests that the parasympathetic activity in heavy smokers was less when compared to light smokers. It is suggested that nicotine and various substances in cigarette smoke are responsible for the imbalance observed in autonomic functions in cigarette smokers. The additive effect of smoking exposure...
because of the long duration and increased dose of exposure to different substances found in cigarettes including nicotine is the possible explanation for changes observed in parameters of HRV in heavy smokers in comparison to light smokers.

The impact 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. 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.

In our study same observations were made, the difference was the intensity of smoking was between heavy and light smokers. Ferdousi et al. 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 the cardiovascular system, similar observations were made in our study also. Patil and Patil studied the changes in the autonomic functions caused by cigarette smoking and concluded cigarette smoking alters the functioning of both sympathetic and parasympathetic system, the same observations were made in our study as well.

CONCLUSION

Increased sympathetic stimulation associated with decrease in the cardiac vagal modulation leading to imbalance in

<table>
<thead>
<tr>
<th>Variables</th>
<th>Group</th>
<th>n</th>
<th>Mean</th>
<th>Standard deviation</th>
<th>Standard error mean</th>
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<tr>
<td>BMI</td>
<td>Light smokers</td>
<td>50</td>
<td>28.7132</td>
<td>3.78663</td>
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<td>Heavy smokers</td>
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<td>29.2214</td>
<td>4.15548</td>
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<td>2881.5030</td>
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<td>157.24279</td>
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<td>1.17881</td>
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BMI: Body mass index, TP: Total power, LF: Low frequency, HF: High frequency, Lfnu: LF power expressed in normalized unit, Hfnu: HF power expressed in normalized unit
the autonomic functions was more in heavy smokers when compared to light smokers. Considering increased prevalence of smoking, also knowing that various diseases are associated with smoking, various preventive measures should be addressed at all levels of health care.

REFERENCES


