Comparison of time domain heart rate variability parameters between smokers and non-smokers

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ABSTRACT

Background: Cigarette smoking induced sympathetic overdrive is one of the major independent modifiable risk factors for cardiovascular mortality and morbidity. There is altered autonomic activity with increased adrenergic activity in chronic smoking which also predisposes to cardiovascular morbidity and mortality. There are several tests that can determine the Autonomic Activity. Among them, heart rate variability (HRV), especially the time domain parameters of it, is simple, easy to perform, and non-invasive test for diagnosing autonomic dysfunction in the smokers. Aims and Objectives: The aims of this study were to compare the time domain parameters of HRV in smokers and non-smokers. Materials and Methods: The present study was carried out at autonomic function laboratory and cardiovascular function laboratory, Department of Physiology, Government Medical College, Bhavnagar, among 200 subjects, out of which 100 were smokers and 100 were non-smokers, in age group of 20–50 years. Results: There was a significant increase in mean heart rate, blood pressure, and R-R interval in smokers as compared to the non-smokers. There was also a significant decrease in all time domain parameters of HRV which suggests profound sympathetic overdrive and a decrease in vagal tone due to the actions of nicotine present in tobacco smoke. Conclusions: Cigarette smoking plays a major role in degradation and decreased function of autonomic nervous system.

KEY WORDS: Smoking, Heart Rate Variability, Time Domain Parameters, Autonomic Dysfunction, Cardiovascular Mortality, Autonomic Nervous system

INTRODUCTION

A pictorial representation and a caption of “Smoking is injurious to Health” is mandatory in all the Cigarette packs which are sold in India.¹ Despite all of this, cigarette smoking is widely prevalent in the India. Approximately, 50% of the men use some form of tobacco.² Smoking also causes ischemic heart disease, COPD, diabetes mellitus, rheumatoid arthritis, osteoporosis, and increases asthma symptoms in adults.³ There is a change in autonomic nervous system activity with increased sympathetic system activation in chronic smoking which also increases the risk of cardiovascular morbidity and mortality.⁴ The effects of smoking can be due to Nicotine.⁵ The hypertensive effects of smoking are attributed to nicotine-induced activation of the sympathetic nervous system.⁶ Nicotine is an agonist of nicotine receptors in the CNS exerting a suppressive effect on vagus and increasing sympathetic control.⁷ Autonomic nervous system imbalance is a predominant causative agent for sudden cardiac death.⁸ There are a lot of tests which detect functions of autonomic nervous system but among them, heart rate variability (HRV) represents one of the better ones.⁹ Nowadays,
commercial devices available provide measurement of HRV automatically, which becomes easier for the cardiologist as a diagnostic and research tool. Sympathetic nervous system activation increases heart rate, while decreasing HRV, whereas parasympathetic nervous system activation decreases heart rate, increases HRV. Elevations in HRV show that heart function is proper, while reductions in HRV show that the heart is vulnerable to sudden cardiac failure.

Very few studies in Gujarat have been undertaken to assess the autonomic function tests of the smokers through the heart rate variability. The main aim of the study is to assess the autonomic function system status in smokers by heart rate variability. This study also wants to compare the time domain parameters of HRV changes among young healthy male smokers and age- and BMI-matched non-smokers. The prevalence of cigarette smoking is very less in females as compared to the males and many of them will also not report it in history due to a social stigma. Consequently, females were not included in this study.

MATERIALS AND METHODS

This study was carried out at Autonomic Function Laboratory and Cardiovascular Function Laboratory in the Department of Physiology, Government Medical College, Bhavnagar, Gujarat, India. The prior approval for the study was obtained from the Institutional Ethics Committee, Government Medical College, Bhavnagar. The study population included 200 male subjects comprising of 100 smokers and 100 non-smoker controls aged between 20 and 50 years.

Inclusion Criteria

• Apparently healthy male smokers between 20 and 50 year age group willing to give informed consent were included in the study.

Exclusion Criteria

The following criteria were excluded from the study:

• Obese smokers with BMI of more than 30, any comorbidity such as hypertension, diabetes, renal failure, tuberculosis, carcinoma, having a drug history of, anti-platelet drugs, thrombolytic, and statins
• Disease that can cause autonomic neuropathy such as leprosy and alcoholic neuropathy
• Patient using pacemaker or having Cardiac Arrythmia and those who are unwilling to give informed consent.

Non-Smokers

Inclusion criteria

The following criteria were included in the study:

• Age-matched healthy male persons between 20 and 50 years who are willing to give informed consent
• Who have not smoked at any time in his life.

Exclusion criteria

Those are having any major comorbidities. Past smokers and ex-smokers have been excluded from the study.

Heart Rate Variability

HRV was measured by 5 min method. It was recorded as a continuous 2 lead ECG recording (Short Term HRV) of Heart Rate using windows-based Heart rate variability analysis system “Variowin-HR.” Analysis of HRV was done by time domain, frequency domain, geometric, and non-linear methods by the above-mentioned system which calculated all parameters automatically.

Time Domain Indices

Time domain measures analyze R-R interval statistically. In these methods, two successive QRS complex is detected and named as normal to normal (N-N) intervals. They are classified into: (1) Direct measurements of N-N intervals or instantaneous heart rate and (2) differences between N-N intervals

Table 1: Time domain HRV parameters

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Name</th>
</tr>
</thead>
<tbody>
<tr>
<td>SDNN (ms)</td>
<td>Standard deviation of NN interval</td>
</tr>
<tr>
<td>SDSD (ms)</td>
<td>SD of differences between adjacent NN intervals</td>
</tr>
<tr>
<td>RMSSD (ms)</td>
<td>The root mean square of sum of squares of differences between adjacent NN intervals</td>
</tr>
<tr>
<td>NN50 count</td>
<td>Number of pairs of adjacent NN intervals differing by more than 50 ms in the entire recording;</td>
</tr>
<tr>
<td>pNN50%</td>
<td>NN50 count divided by the total number of all NN Intervals</td>
</tr>
</tbody>
</table>

Table 2 shows the distribution of anthropometric data in subjects. Table 3 shows that the mean heart rate in non-smokers is as compared to that of smokers is significantly lower ($P < 0.05$), while the R-R interval was significantly higher in non-smokers when compared to that of smokers ($P < 0.05$). Table 4 shows the time domain parameters of the HRV which is significantly lower in the smokers than those in the non-smokers ($P < 0.0001$).

DISCUSSION

The present study was conducted to compare and analyze the heart rate, R-R interval, and time domain parameters of HRV in smokers and non-smokers.
Table 2: Distribution of anthropometric data in subjects (Mean±SD)

<table>
<thead>
<tr>
<th>Variables</th>
<th>Non-smokers</th>
<th>Total smokers</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mean age (in years)</td>
<td>33.21±7.61</td>
<td>33±7.65(NS)</td>
</tr>
<tr>
<td>Mean BMI</td>
<td>24.25±2.81</td>
<td>24.34±3.46(NS)</td>
</tr>
</tbody>
</table>

*P>0.05(NS)

Table 3: The comparison of heart rate, and r-r interval between non-smokers and smokers (Mean±SD)

<table>
<thead>
<tr>
<th>Variables</th>
<th>Heart rate (beats/min)</th>
<th>RR interval (ms)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Non-smokers</td>
<td>73.85±9.31</td>
<td>822.9±124.7*</td>
</tr>
<tr>
<td>Smokers</td>
<td>82.92±11.04</td>
<td>737.7±114.3*</td>
</tr>
</tbody>
</table>

*P<0.05

Table 4: The comparison of time domain parameters of heart rate variability in non-smokers and smokers (In Mean±SD)

<table>
<thead>
<tr>
<th>Variables</th>
<th>SDNN (ms)</th>
<th>RMSSD (ms²)</th>
<th>SDSD (ms²)</th>
<th>NN50 COUNT</th>
<th>Pnn50</th>
</tr>
</thead>
<tbody>
<tr>
<td>Non-smokers</td>
<td>58.64±</td>
<td>52.38±</td>
<td>51.78±</td>
<td>78.68±</td>
<td>27.09±</td>
</tr>
<tr>
<td>Smokers</td>
<td>35.97±</td>
<td>28.86±</td>
<td>27.94±</td>
<td>30.38±</td>
<td>9.53±</td>
</tr>
</tbody>
</table>

*P<0.0001

between smokers and non-smokers. The present study had shown a statistically significant increase in heart rate in the smokers as compared to the non-smokers. The present study also had shown a statistically significant decrease in R-R intervals, SDNN, RMSSD, SDSD, NN50 count, and Pnn50 in the smokers as compared to those in the non-smokers.

SDNN is “gold standard” for prediction of cardiac risk when recorded over a 24 h period.[14] It predicts both cardiovascular morbidity and mortality. The RMSSD is used to measure the vagal changes in HRV.[15] The pNN50 is associated with peripheral nervous system activity.[16] Study done by Tayade and Kulkarni[17] suggested that resting heart rate was higher in smokers as compared to non-smokers. Similar studies were also done by Ferdousi et al.[18] which also confirmed that there is an increase in heart rate in smokers. Behera et al.[19] concluded in his study that smoking severely affects the cardiac autonomic functions as seen from the decreased HRV parameters with a recommendation to include HRV testing in routine investigations in cardiovascular parameters of chronic smokers. Hirsch et al.[20] also observed a significant increase in mean heart rate and a significant decrease in RR interval in smokers compared to non-smokers which may be due to decreased vagal tone. Manzano et al.[21] found significant decrease in SDNN and RMSSD values when comparing between smokers and non-smokers. Other studies like Kobayashi et al.[22] also observed a decrease in all time domain parameters within 5 min after smoking. Saleem et al.[23] studied the time domain parameters of HRV on Smokers who had MI and found a statistically significant decrease in the smoker group, while Mohesh et al.[24] found a decrease in NN50 count and pNN50% in dipping tobacco users (smokeless tobacco). This was due to nicotine component in smokeless tobacco, a component which is a major culprit for autonomic dysfunction and also found in all forms of tobacco smoking. Kavitha et al.[25] concluded that there was a decrease in parasympathetic activity in smokers as compared to non-smokers. Gerhardt et al.[26] observed an increase in the sympathetic activity when a person was smoking. In addition to this, not only smoking but also chewing tobacco users experience a decrease in the HRV.[27] Smokeless tobacco also has an increasing adverse effect on cardiovascular system and has a propensity to become an important public health hazard.[28] Passive smoking also increases cardiac risk through cardiac autonomic dysfunction. Hence, passive smokers should be protected.[29]

Through this study, the authors were able to ascertain that cigarette smoking leads to altered autonomic functions by increasing the sympathetic activity and blunting the vagal response. However, this study was just a pilot study with a small sample size. Hence, a larger community wide study should be done to demonstrate to which extent, smoking can become a public health burden. Furthermore, this study was done on 5-min HRV measurements, and in the HRV, a 24-h reading is considered as “Gold Standard” as it takes into account all the autonomic fluctuations that would happen in the whole day.

CONCLUSIONS

Increased heart rate and decreased HRV parameters suggest a sympathetic overdrive and a decrease in the vagal tone in the smokers. The prevalence of smoking, especially in the young adults, is increasing. Hence, there is a need to educate the smokers about the complications of smoking related to the ones related to cardiovascular system.

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REFERENCES


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