Indian J Physiol Pharmacol 2017; 61(2) : 128–133

Original Article

Effect of Tobacco Smoking; Pre and Post Cessation on Autonomic Functions Among Health Science Professionals; An Interventional Study

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Abstract

Background: Long term cigarette smoking is an independent risk factor for cardiovascular morbidity and mortality. Smoking influences the tone of the autonomic nervous system as reflected by Heart Rate Variability. The present study aimed at studying the effect of cigarette smoking and its cessation for 1 week on HRV.

Materials & Methods: 35 smokers and 35 age matched controls (non smokers) working as health science professionals were selected considering the inclusion and exclusion criteria. Information was collected regarding their smoking history and was subjected to HRV analysis.

Results: HRV was significantly reduced in study group than controls. Further, HRV among study group after they quit smoking for one week was significantly higher ($p<0.009$). The increase in HRV was comparable to that of non smokers ($p<0.61$).

Conclusion: There was reduction in HRV among cigarette smokers. Furthermore, there is an immediate and substantial increase in HRV after one week cessation of smoking.

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(Received on January 12, 2017)

Introduction

In the last two decades, an interesting relationship has been noticed between autonomic nervous system derangement and cardiac morbidity and mortality. In addition to the major roles played by factors such as age, sedentary lifestyle, food habits

and deranged lipid profile, cigarette smoking is an important risk factor. Long term cigarette smoking is found to be an etiological factor for cardiovascular morbidity and mortality such as myocardial infarction, ventricular arrhythmias and sudden death in which dysfunction of the autonomic nervous system may be an important causal component (1). Smoking affects the health of smokers as well as that of people who are exposed to it. It has been shown to cause the imbalance of the autonomic nervous system as mirrored by heart rate variability (HRV).

HRV represents one of the most promising markers for detecting sympathovagal imbalance. HRV has become the conventionally accepted term to describe variations of both instantaneous heart rate and RR intervals where RR interval is the time between the QRS complexes. Reduced HRV has been used as an indicator of reduced vagal activity and is a valuable non-invasive tool in assessment of cardiovascular autonomic function (2).

SDNN (Standard Deviation of Normal to Normal RR intervals) is a time domain measure of HRV and has been used as the parameter to quantify HRV signals. Reduced SDNN depicts reduced HRV thus indicating the altered sympathovagal balance with a shift towards sympathetic dominance (3). SDNN is an indicator of total power. It is the score used to predict mortality as shown by several risk predictive values of HRV measures in selected outcome studies. Previous studies on predicting death with various medical indices found that a reduction of SDNN was the most powerful predictor of risk of death due to cardiovascular mortality than other conventional clinical measurements (4). Few studies have been done till date among health science professionals by using only time domain measure of HRV to assess the association of one week cessation of smoking on autonomic functioning. Hence the present study has been carried out to study the association of smoking on SDNN and the consequences of its cessation for duration of one week on SDNN.

Materials and Methods

The study group comprised of 35 smokers (30 to 50 years) and 35 age and gender matched non smokers. Seventy cases and controls were recruited for this study to detect a minimum difference of 20% of autonomic changes with alpha of 0.05 and power of 80%. The subjects were recruited based on various inclusion and exclusion criteria from professionals working in a private medical college in Karnataka, India. Written informed consent was obtained from all the volunteers and ethical clearance for the study was also obtained from the Institutional Ethics Committee. 35 middle aged smokers without any diseases and who volunteered to abstain from smoking for one week were included in the study. Also 35 middle aged healthy non smokers were recruited as controls. All volunteers who had history of diabetes mellitus, heart disease, anxiety disorders, Guillian barre syndrome and other demyelinating disorders and those on medication with antiarrhythmics and atropine were excluded from the study.

General physical examination, vital signs, complete systemic examinations was done on all the subjects. A detailed history including smoking history like duration, number of cigarettes smoked per day, pack years of smoking [pack years of smoking is defined as the number of packs (one pack=20 cigarettes) smoked per day multiplied by the duration of smoking in years] personal history, drug history and family history were documented. Their age, anthropometric measurements, Blood Pressure (BP) by JNC 7 criteria (5), Body Mass Index (BMI) using Quetlet's formula (6) were also recorded.

A high quality ECG recording was taken using portable ECG system (BPL CARDIART 8408 VIEW, Bangalore) (7) under standardized conditions to minimize artifacts. The RR peak detector was adjusted appropriately. The digital ECG signal was obtained using lead II. Analysis of this was done and time domain measure, SDNN in seconds was obtained. Recording was done in the morning hours between 9:00 a.m. and 11:00 a.m. The subjects were asked to avoid food two hours prior to testing, coffee or alcohol 24 hours prior to testing and to wear loose and comfortable clothing during the test. The ECG was recorded in the supine position for 5 minutes after 10 minutes of supine rest in a quiet dark room.

Subjects were instructed to close the eyes and to avoid talking, moving of hands, legs and body, coughing and sleeping during the test.

The study group were counseled to quit smoking for one week and asked to come for repeat HRV after one week. Compliance was ensured by daily phone calls and text message reminders. HRV was again recorded and analyzed at the end of one week. The control group was also instructed to come after one week for repeat HRV recordings.

The data obtained was suitably arranged. Descriptive statistical analysis was carried out on this data. Results on continuous measurements are presented as Mean±Standard Deviation and results on categorical measurements are presented in number %. Significance was assessed at 5% level of significance. HRV recording was compared between smokers and age matched controls using independent student 't' test. SDNN of smokers before cessation and after cessation was compared using paired student 't' test. The Pearson correlation between pack years of smoking and SDNN was also done.

Results

Table I shows mean age of cases and controls were respectively 39.57±5.97 and 36.57±8.85 years respectively**.**

Table II shows distribution of cases according to their pack years of smoking. Mean±SD of pack years of smoking was 13.33±8.81 pack years.

Table III shows a significant reduction of SDNN among cases was observed as compared to control at baseline with a p value of less than 0.009. After 1 week of smoking cessation, SDNN of cases was comparable to that of controls.

Graph 1 shows correlation between pack years of smoking and SDNN of smokers which was not significant with r value of –0.09 and p value of 0.61.

TABLE I: Comparison of mean age of smokers and non smokers.

	Cases (N=35)	*Control (N=35)*	*Independent 't' test p value*
Mean age±SD (years)	39.57±5.97	36.57±8.85	0.10

TABLE II: Distribution of cases according to pack years of smoking

Number of pack years	*Number of Smokers*	*%*
1-10	18	51.43
11-20	10	28.57
21 years & above	7	20
Total	35	100

Table III: Comparison of SDNN of cases before and after cessation of smoking (n=35).

	Before cessation	*After cessation of smoking*	*Paired 't' test p value*
SDNN (s)	0.0531±0.053	0.0766±0.023	<0.005***

***<0.05 highly significant.

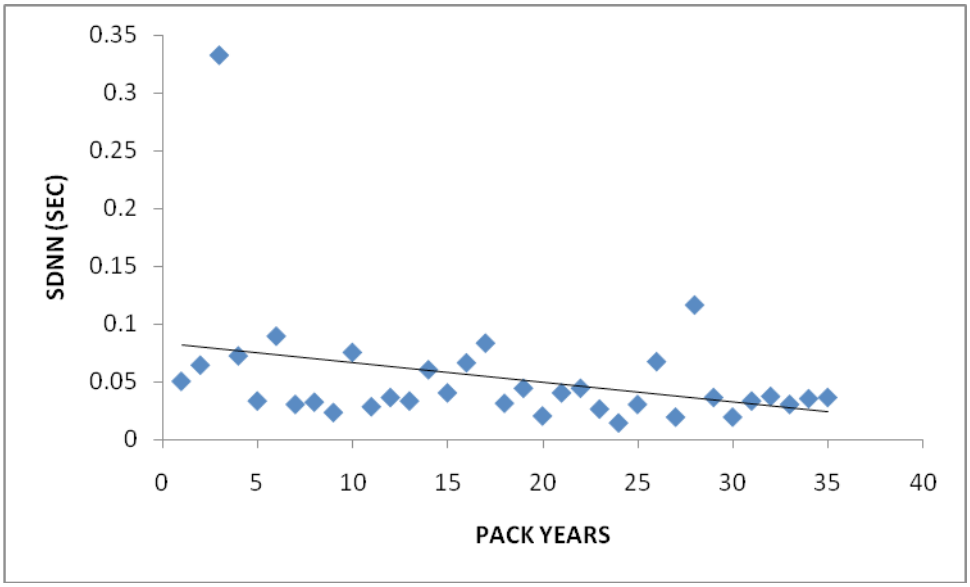
TABLE IV: Comparison of SDNN between cases and control at baseline and after 1 week.

	Cases (N=35)	*Control (N=35)*	*Independent 't' test p value*
Baseline SDNN (s)	0.05±0.05	0.08+0.03	0.009***
SDNN (s) after 1 week	0.08±0.02	0.08+0.02	0.61

***Highly significant

Discussion

Cigarette smoking is injurious to health. Among its several ill effects, hazards to the cardiovascular system are an important cause of morbidity and mortality. Our study showed that there was significant reduction in SDNN of smokers as compared to that of non smokers (Table III). This showed that there was significant reduction in HRV and hence cardiovascular sympathetic dominance. A few investigators have shown that HRV is lower in smokers than in nonsmokers on the basis of a cross-sectional comparison of habitual smokers and nonsmoking controls (8, 9). In humans, the



Graph 1: Correlation between pack years of smoking of cases with their SDNN (s).

sympathetic activation induced by cigarette smoking probably depends on an increased release and/or a reduced clearance of catecholamines at the neuroeffector junctions (8, 9). It has also been theorized that a smoking related impairment of the baroreflex ability to counteract peripheral adrenergic stimulation results in the sympathoexcitatory effects of smoking in humans which is in accordance with our observed results (10). A significant increase in pulse rate and blood pressure due to sympathetic hyperactivity and blunting of vagal modulation during parasympathetic maneuver in the smokers has been documented (11). Exposure to environmental tobacco smoke exposure is said to be associated with lowered HRV and cardiac autonomic dysregulation, which is likely to be an intermediate step in the pathway to cardiac instability (12, 13).

We found a significant increase in SDNN following cessation of smoking and this has been documented in literature at various time frames of quitting smoking. In our study, we found a significant increase in SDNN of smokers after they quit smoking for duration of 1 week (Table III, IV) indicating increase in HRV thus implying reduction in sympathetic activity or an augmentation of parasympathetic activity or both. A study found an increase in HRV within 3 days of reduced exposure to cigarette smoke (14). Minami J et al found a significant decrease in blood pressure, heart rate and plasma catecholamine following quitting of smoking for one week which demonstrated the substantial and immediate benefits of smoking cessation on these cardiovascular indices (15).

There are some concerns about the time-related effects on the measures of HRV following smoking cessation. Studies have shown that when all time and frequency domain indices of HRV were assessed after a 4 week cessation of smoking, they were significantly elevated, although the LF/HF ratio was not affected. In contrast, it was also shown earlier that in a smaller number of subjects in whom HRV was analysed during the first month of smoking cessation, there was a significant increase in HRV within 24 hours and the magnitude of increase in HRV peaked 2 to 7 days after smoking cessation and gradually declined thereafter (16). Also, studies have reported that the smoking cessation significantly decreased both pNN50 and the HF component throughout a 24-hour period, showing that in chronic smokers, parasympathetic function is impaired even when they are sleeping and not smoking cigarettes. As for the effect of smoking cessation on sympathetic activity in these subjects, plasma catecholamine was found to be much lesser in the nonsmoking period than in the smoking period (15). Harte C B et al, conducted an 8 week study in which they concluded

that the improvement of HRV was maximum when the smokers were off both smoking as well as nicotine patch (17). However, Stein et al have found that despite the cessation of both smoking and nicotine patch use for a duration of 8 weeks, the resting heart rate remained high and the HRV remained lower than that of the healthy middle aged adults (18). Haustein K O et al studied on people who abstained from smoking for a period of 6 months and showed that there was an improvement in cardiovascular disease risk parameters like plasma fibrinogen levels, reactive capillary flow, hematocrit and lowering of WBC count (19). The risk associated with cigarette smoking on total mortality among former smokers has been shown to reduce to that of non smokers 10 to 14 years after cessation (20).

Our study further showed that, not only was there a significant increase in HRV in study group following quitting of smoking but also, the improvement was comparable to that of non smokers (Table III). It was similarly shown in a study done in India that the resting HRV following cessation of smoking for 12 hours in young and old smokers is comparable with that of nonsmokers (21).

On correlating the pack years of smoking with SDNN, we found that there was no significant correlation between the two (Graph 1). This finding verified the substantial and immediate beneficial effects of smoking cessation on the cardiovascular indices irrespective of the duration of this addiction. The clinical implications seem to be quite favourable even for individuals who have been long-term cigarette smokers. On the other hand, a study has concluded that HRV was reduced in people who smoked ten or more cigarettes in a day as compared to non smokers or those smoking less than ten cigarettes in a day (11). Studying the effect of chronicity of smoking on cardiovascular indices on larger sample size in wider time frames forms the future scope of this study. Further studies need to be done to determine the persistence of effect of quitting smoking on HRV along with measurement of blood parameters like plasma catecholamine, fibrinogen levels, reactive capillary flow, hematocrit and total leucocyte count.

In conclusion, our study demonstrated a profound sympathetic dominance among smokers and a significant increase in parasympathetic tone following cessation of smoking for one week. This increase was comparable with that of non smokers. Thus, our findings verify the substantial and immediate beneficial effects of smoking cessation on the cardiovascular indices, the clinical implications of which seems to be favorable even for individuals who have been long term cigarette smokers which can be very useful for persuading the smokers to quit smoking.

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