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Original Research Article

Effect of smoking on cardiovascular autonomic functions

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ABSTRACT

Introduction: Cigarette smoking is a prime risk factor for cardiovascular morbidity and mortality. Chronic smoking results in autonomic dysfunction leading to increased cardiovascular risk in smokers. The present study was planned to study the effect of smoking on the Cardiovascular Autonomic Functions among smokers.

Materials and Methods: Fifty male subjects who were in the age group of 25 to 45 years. They were grouped into 25 smokers and 25 non-smokers. The participant subjects were selected among the staff members, residents and the patients from the routine OPD in SVIMS. Prior to study, they were informed about the procedure and the purpose of the study tests and written consents were obtained from them. The Cardiovascular Autonomic Function Tests were assessed by using a POLYGRAPH which was available in the department.

Results and Conclusion: After applying the 't'-test for the difference between the two sample means, it was observed that there was a highly significant difference between the mean values of the BMI(i.e.p<0.01) and the para-sympathetic function tests among the smokers and the non – smokers(i.e.p<0.00). The Resting Heart Rate had significantly increased and the Deep breathing difference, the postural tachycardial index (Response to standing) and the Valsalva Ratio had significantly decreased in the smokers as compared to those in the non – smokers. After applying the 't'-test for the difference between the two sample means, it was observed that there was no significant difference between the mean values of the Postural hypotension test (i.e. p>0.05) and that there was a highly significant difference between the mean values of the Sustained handgrip test in the smokers and the non – smokers (i.e. p<0.00).

KEY WORDS: Cardiovascular autonomic function tests, Smoking, Resting heart rate.

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INTRODUCTION

In India, smoking is a common prevalent in both urban and rural areas irrespective of mode of smoking i.e. cigarettes, bidis, cigar etc [1]. Smoking kills about 5 million people annually worldwide [2]. The health and lifestyle factors, together with the genetic makeup of an individual determine the response to these changes [3]. There are two major causes of preventable deaths with smoking one is TB and the other is cancer. In deaths due to smoking, around 38% are attributed to TB, 31% from other respiratory causes, 33% from cancer and 20% from heart attacks or stroke [4].

Cigarette & Bidi smoking has extensive complex effects implicated in cardiac complications that include hyper coagulability , increased cardiac work, reduced oxygen transport and coronary vasoconstriction which are mainly due to actions of nicotine and carbon monoxide [5].

Nicotine is the main ingredient of cigarette &bidis. Fine particles of nicotine are absorbed from respiratory membrane into blood and exert its effects on various systems of the body. The most important effects of it is on cardiovascular system and the nervous system (anxiety, depression, congnition). Nicotine increases the cardiac output by increasing both the heart rate and myocardial contractility [6]. The autonomic alterations may contribute to the increased cardiovascular risk which is present in smokers. The nicotine also increases plasma catecholamines. Thus, suggesting that these effects are dependent on the adrenergic stimulation [7]. Cardiovascular system functions are regulated by autonomic nervous system through short-term regulating reflexes. Baroreceptor reflex maintain changes in B.P & heart rate within few seconds and the response lasts for 5 to 10 minutes. Smoking impairs the baroreflex sensitivity in humans, which may contribute to the smoking induced increase in the blood pressure and the heart rate, as well as to the concomitant alterations in their variability [8]. The autonomic responses w hich is evoked by smoking, results in the down regulation of the β - adrenergic receptors in long term smokers [9].

MATERIALS AND METHODS

The present study was carried out in the Department of Physiology, Sri Padmavathi Medical College (Women), SVIMS, Tirupati, Andhra Pradesh, India, and it was approved by Institutional ethical committee.

Fifty male subjects who were in the age group 25 to 45 years, who included 25 smokers and 25 non-smokers formed the control group were selected for the present study. The participant subjects were selected from among the staff members and the patients from the routine OPD.

Inclusion and Exclusion Criteria

The Case Group: Smokers with a history of smoking of more than 5 years were considered as the case group for the present study. Those with a history of smoking of less than 5 years were excluded from the present study. Also, the subjects with a history of any major illness like Hypertension, Diabetes Mellitus, and Peripheral Neuropathy in the past or present were also excluded from the present study.

The Control Group: The subjects who had never smoked in life and who did not have any other addiction related to tobacco chewing were considered as the control group for the present study. The subjects with a history of any major illness like Hypertension, Diabetes Mellitus in the past or present were excluded from the present study.

BMI: Body mass index was calculated based on a person weight & height by using Quetelets index.

$$BMI = Weight(Kg) / Height(m^2).$$

The following cardiovascular autonomic function tests were included:

Parasympathetic function tests:

1. Resting Heart Rate: The subjects were asked to relax in supine position for 15 min in the laboratory. It was determined by recording lead II ECG at a paper speed of 25 mm/sec. The resting heart rate was calculated from ECG.

2. Deep Breathing Difference: In the sitting position subject was asked to breathe quietly and deeply at the rate to 6 breaths/min. A continuous ECG was recorded by six cycles with marker to indicate the onset of each inspiration and expiration. The maximum and minimum R-R intervals were measured during each breathing cycle and converted to beats per min. The result was then expressed as mean of the difference between maximum and minimum heart rate for six measured cycles in beats/min.

Deep breathing difference (DBD) = mean of heart rate difference in 6 breath cycles.

3. Postural Tachycardial index (30:15 Ratio) : The subjects were asked to lie down comfortably over the couch and then they were asked to stand up. Their heart rate were recorded at the 15^{th} and 30^{th} beats immediately after standing.

4. Valsalva Ratio: The subject was seated comfortably and asked to blow into a mouth piece connected to a mercury sphygmomanometer and holding it at a pressure of 40 mm Hg for

15sec , while a continuous ECG was being recorded. The ECG continued to be recorded after release of pressure at the end of 15 seconds for 30 seconds.

The heart rate changes induced by the valsalva maneuver was expressed as as the ratio of the maximal tachycardia during the maneuver to the maximum bradycardia after the maneuver. This ratio was defined as the valsalva ratio.

Valsalva ratio (VR) = maximum tachycardia/ maximum bradycardia.

Sympathetic Function Tests

1. Resting Blood Pressure: The subjects were asked to sit comfortably for 5-10 min. measure the blood pressure by recording with mercury sphygmomanometer and it is expressed as SBP/DBP mm Hg.

2. Postural Hypotension Test: The subjects were asked to lie comfortably in the supine position for 15 minutes and their blood pressures were recorded. They were then asked to stand up and their blood pressures were recorded immediately and after 1 minute.

3. Sustained Handgrip Test: The subject was asked to sit in chair and relax. To determine the grip strength, subject was made to hold a handgrip dynamometer by the dominant hand and apply maximum force for a few seconds. Highest value of 3 similar contraction was accepted as his maximum voluntary contraction(MVC). Subject was asked to exert 30% of MVC for 5min on the handgrip dynamometer using dominant arm. BP was measured in the non-exercising arm at rest and at 1min intervals during the maneuver.

RESULTS

Table 1: Comparison of mean values of BMI in smokers and non-smokers.

	Smokers (25)	Non-smokers (25)	'p' value	Significance
	Mean ± SD	Mean ± SD		
BMI	24.224±2.35	26.396±3.36	P<0.01	HS

Table 2: Comparison of mean values of Parasympathetic Function Tests.

	Smokers (25)	Non-smokers (25)	'p' value	Significance
	Mean ± SD	Mean ± SD		
Resting Heart rate(/min)	86.96±7.721	76.56±5.331	P<0.00	HS
Deep Breathing Difference	8.36±2.984	18.92±8.121	P<0.00	HS
Postural Tachycardial Index	0.943±0.071	1.115±0.066	P<0.00	HS
Valsalva Ratio	0.995±0.089	1.484+±0.388	P<0.00	HS

HS – Highly Significant

Table 3: Comparison of mean values of Sympathetic Function Tests.

	Smokers (25)	Non-smokers (25)	'p' value	Significance
	Mean ± SD	Mean ± SD		
Resting Blood Pressure (mm Hg)				
SBP	124±6.058	122.3±6.018	P<0.35	NS
DBP	84.2±5.141	83.6±5.821	P<0.72	NS
Postural Hypotension Test (mm Hg)	2.4±1.632	1.68±1.700	P<0.13	NS
Sustained Handgrip Test (mm Hg)	8.48±2.6	21.2±4.041	P<0.00	HS

NS – Not Significant, HS – Highly Significant

DISCUSSION

Coronary Artery Disease (CAD) is a major cause of premature death and disability throughout the world. Tobacco use is an important and an avertable cause of CAD [10]. The haemodynamic changes are associated with a marked and a prolonged increase in the plasma norepinephrine and the epinephrine levels, which has prompted the hypothesis that the mechanisms which are responsible for the pressor and the tachycardic responses have an adrenergic nature [11]. So, the present study was conducted in 25 smokers and 25

non-smokers between age group 25-45yrs. Table-1 indicates the BMI in smokers and non-smokers. The obtained values are statistically significant. Similar findings are reported by Arnaud Chiolero et al. Smoking leads to weight loss by increasing the metabolic rate, decreasing the metabolic efficiency or decreasing caloric absorption. Nicotine could induce anorexic effect and increases energy expenditure. Smoking a single cigarette has been shown to induce a 3% rise in EE with in 30min. Finally smokers tend to be less physically active than non-smokers [12].

Table-2 indicates the Resting heart rate, Deep Breathing difference, Postural tachycardial index and valsalva ratio values in smokers and non-smokers, which are the indicators of parasympathetic activity. The obtained values are statistically significant. Similar findings are reported by Motilal C Tayade et al. The resting heart rate is considered to be a good barometer of the overall cardiac health and it is mainly governed by the parasympathetic activity. The deep breathing difference or Expiration:Inspiration ratio is based on the sinus arrhythmia during each respiratory cycle, which depends on the variation in the vagal tone and is significantly decreased in smokers compared to the non-smokers [13].

Table-3 indicates the Resting blood pressure, Postural hypotension test and Sustained handgrip test in smokers and non-smokers. These are reliable indicators of sympathetic activity. The obtained values are though there are minimal changes in blood pressure and postural hypotension test and values are statistically not significant. The sustained handgrip test shows marked changes and values are statistically significant. Similar finding are reported by Motilal C Tayade et al. The changes in postural hypotension test by recording the fall in SBP. It is not significant due to more number of light and moderate smokers than heavy smokers. The changes in sustained handgrip test indicate rise in diastolic blood pressure was less in smokers as compared to the non-smokers, thus suggesting that a decrease in the sympathetic activity provoked by smoking low or medium nicotine content in cigarette [14].

CONCLUSION

In the present study Autonomic Function Tests are done in smokers and non-smokers. It was observed that there is imbalance in parasympathetic & sympathetic activity on CVS in smokers. The results of parasympathetic Function Tests of heart rate had significantly increased and DBD, PTI, VR had significantly decreased in smokers as compared to those in the non smokers. These changes are probably due to the nicotine action. Tests for sympathetic function includes recording of BP in standing and after sustained handgrip exercise. The changes in BP in standing is not significant but isometric handgrip test indicates significant values with decreases in DBP and is suggestive of decreased central sympathetic activity and baroreflex sensitivity.

Conflicts of interest: **None**

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