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THE EFFECT OF SMOKING ON THE CARDIOVASCULAR AUTONOMIC FUNCTIONS: A CROSS SECTIONAL STUDY.

Physiology

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ABSTRACT

Background: Smoking is mediated by impaired autonomic nervous system (ANS) activity. Cigarette smoking is major risk factor for the development of atherosclerosis. Cigarette smoking alters baseline sympathetic and vagal modulation of the sinoatrial node (S-A Node) and peripheral sympathetic vascular control. **Aims & Objective:** To assess the effect of active smoking on ANS function as manifested by Heart rate variability or deep breathing test abnormalities. **Methods And Materials:** The present cross sectional study was carried out in the Department of Physiology, Madhubani Medical College, Madhubani, Bihar during April 2021 to March 2022 and it was approved by the Institutional Ethical and Research Committee. **Result:** The difference was observed between the mean values of the Para sympathetic function tests in the smokers and the non – smokers (i.e. $p<0.01$). It was seen that the Resting Heart Rate had significantly increased and that the Expiration: Inspiration Ratio, the 30:15 Ratio (Response to standing) and the Valsalva Ratio had significantly decreased in the smokers as compared to those in the non – smokers. **Conclusion:** The cardiovascular autonomic function tests are reliable, non-invasive and easy to carry out. By doing some simple tests we can detect the early involvement of the autonomic nervous system before the clinical symptoms appears. The results of this study are suggestive of decreased sympathetic reactivity in smokers.

KEYWORDS

Cardiovascular autonomic function tests, Smoking and Resting heart rate

INTRODUCTION:

Smoking is a worldwide major cause of preventable morbidity and mortality [1]. About 17% smokers in the world live in India [2]. Presently, nearly 2200 people per day and 9 lacs every year die in India due to tobacco related diseases. The Health Ministry has estimated that 40% of India's health problems stem from tobacco use [3]. The health and lifestyle factors, together with the genetic makeup of an individual, determine the response to these changes [4]. Heavy smoking is the commonest cause of ischemic heart disease and death in the 30–40 years of age group, who are likely to be free from other myocardial risk factors [5]. Heart rate variability (HRV) and the deep breathing test (DBT) represent common quantitative markers of ANS activity due to their simplicity and reliability. Autonomic nervous system plays a vital role in the regulation of cardiovascular activities [6] and balance between its two components i.e. sympathetic and parasympathetic system is responsible for the efficient control of cardiovascular system. [7,8,9]. Heart rate variability measures the variation in the S-Anode due to sympathovagal change [10]. Smoking is said to increase arterial pressure and heart rate acutely [11-16]. The acute effect of smoking is mainly due to nicotine while reduction in cardiac vagal tone is responsible for chronic effects [17]. Although smoking increases arterial pressure and heart rate acutely, the effect of smoking on sympathetic activity is not well understood. Smoking or nicotine infusions have been shown to decrease not change, to increase plasma norepinephrine levels and to decrease or not change directly recorded muscle sympathetic nerve activity [18-21]. Classical autonomic function tests are simple non-invasive methods for determination of both sympathetic & parasympathetic divisions of cardiovascular autonomic control in clinical setting. [22, 23] The present cross –sectional study was therefore planned to assess the effects of cigarette smoking on sympathetic & parasympathetic activity on cardiovascular system.

AIMS AND OBJECTIVE:

To assess the effect of active smoking on ANS function as manifested by Heart rate variability or deep breathing test abnormalities.

MATERIAL AND METHODS:

Study Design:

A cross-sectional study was done after the institutional ethical committee approved the research protocol, and all participants provided written informed consent study in Madhubani Medical College and Hospital, Madhubani, Bihar for a period of 12 months from April 2021 to March 2022.

Participants:

80 healthy adult male cigarette smokers aged between 20-55 years.

METHODS:

80 healthy adult male cigarette smokers aged between 20-55 years, smoking for one year from local area were selected for study. They constitute the study group (cases). According to calculation of smoking index, our study group falls in Light smoker's category (smoking index 1-100). Autonomic function tests of these smokers were compared with 80 healthy adult non-smokers males with age and BMI (Body mass index) matched. Who served as control group. Anthropometrical measurements were taken along with preliminary clinical examination to exclude any systemic disorders affecting cardiovascular system for all the subjects. Autonomic function tests were performed as follows on each subject in an environment with the room temperature ranging from 23 °C to 25 °C using computerized Polyrite -D (ModalDSMP0410, RMS, Chandigarh, India).

Inclusion criteria and Exclusion criteria:

Smokers with a history of smoking of more than 6 years were considered as the case group for the present study. Those with a history of smoking of less than 6 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 Smoking Index:

This is a parameter which is used to express the smoking exposure quantitatively. This is especially useful in defining the risk ratio of a smoking related disease. Here, the smoking index was calculated by multiplying the average number of cigarettes which was smoked per day and the duration of the smoking in years. The number of cigarettes meant the average numbers of cigarettes which was smoked per day. According to the Smoking Index, the smokers were classified into:

1. Light smokers (Smoking index 1-100)
2. Moderate smokers (Smoking index 101-200)
3. Heavy smokers (Smoking index >201)

Parasympathetic Function Tests:

The Resting Heart Rate:

The subjects were asked to lie comfortably for 15 minutes. The ECG was recorded continuously for 1 minute. The resting heart rate was calculated.

The Expiration–Inspiration Ratio (E: I Ratio):

The subjects were asked to take deep inspirations for 5 seconds, followed by deep expirations for 5 seconds. The ECG was recorded for 3 such cycles. This test is based on the sinus arrhythmia during each respiratory cycle, which depends on the variation in the vagal tone.

The 30:15 Ratio: (Response to standing):
The subjects were asked to lie down comfortably over the couch and then they were asked to stand up. Their heart rates were recorded at the 15th and 30th beats immediately after standing.

The Valsalva Ratio:
The subjects were asked to sit comfortably. Their heart rates were recorded at rest, with the ECG. Their noses were clipped with nose clips and mouth pieces were inserted between their teeth and lips. The other ends of the mouthpieces were connected to mercury manometers. The subjects were asked to blow air into the mouthpieces and the pressure was maintained at 40 mmHg for 15 seconds. The ECG was continuously recorded. The Valsalva ratio was calculated as the ratio of the longest RR interval after the strain to the shortest RR interval during the strain.

Sympathetic Function Tests
The Postural Hypotension Test (Postural challenge 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.

The Sustained Handgrip Test:
The subjects were asked to hold spring dynamometers in their left hands and to compress them maximally and the values were noted. Then they were asked to hold the spring dynamometers in their left hands and to compress them to up to 30% of the maximum and to hold them for 4 minutes. The rise in the diastolic blood pressure at the point, just before the release of the handgrip, was noted. This test is an indicator of the sympathetic insufficiency.

Statistical Analysis:
The collected data was analyzed by using the SPSS software.

RESULTS:
The difference was observed between the mean values of the Para sympathetic function tests in the smokers and the non – smokers (i.e. $p<0.01$) It was seen that the Resting Heart Rate had significantly increased and that the Expiration:
Inspiration Ratio, the 30:15 Ratio (Response to standing) and the Valsalva Ratio had significantly decreased in the smokers as compared to those in the non – smokers. In the present study 80 smokers of age range 20-55 years were compared with 80 healthy non-smokers of same age and BMI matched. The parameters studied were shown in Table -1

Table 1 Baseline characteristics of the study population by severity of COPD according to the GOLD stage

Characteristics		GOLD stage				p-value
		I	II	III	IV	
Age (years, SD)		68.34 (6.13)	64.72 (12.64)	66.67 (10.66)	63.33 (11.98)	0.802
Gender	Male	12	51	54	27	0.134
	Female	4	16	39	31	
Smoking (pack/ years)		26.68 (5.76)	26.82 (18.64)	23.87 (22.16)	16.48 (18.53)	0.482
FEV1 (SD)		83.66 (6.33)	57.79 (7.56)	44.26 (5.05)	23.08 (3.83)	0.000
Duration of Illness (Years)		8.00 (3.65)	8.27 (3.46)	11.31 (11.78)	7.86 (3.48)	0.684
BMI		22.86 (1.73)	18.62 (5.03)	18.28 (3.53)	18.50 (3.88)	0.739

Table 2: Basal cardiovascular parameters of smokers and non-smokers

Parameters	(Non-smokers) Control	(Smokers)Cases	P Value
	Mean (S.D.)	Mean (S.D.)	
Resting pulse rate (in beats/min)	74.95(1.24)	73.25(1.33)	0.02*
Systolic blood pressure (in mmHg)	112.4(3.82)	116.35(4.46)	0.26
Diastolic blood pressure (in mmHg)	79.85(0.70)	79.9(0.63)	0.74

DISCUSSION:
Cigarette smoking is an established risk factor for coronary artery disease. A group of researchers observed that nicotine dependent inactivation of vagal cardiovascular control is one of the factor responsible for hemodynamic changes in smokers. In our study, there was no significant difference in the mean physical parameters like age and body mass index on calculating the mean and the standard deviation in the smokers and non-smokers. A significant difference was observed in resting pulse rate, but no significant difference was found in systolic and diastolic blood pressure between smokers and non-smokers resting heart rate reflects the balance of parasympathetic and sympathetic influences at the sinoatrial node. It can be used for assessing both parasympathetic and sympathetic activity because of dual innervation of the heart [24]. Systolic blood pressure was also found to be low in smokers, although it was not statistically significant. These above results are suggestive of decreased sympathetic reactivity in smokers. 30:15 ratios were not statistically significant. This may be due to less sample size. Valsalva ratio was similar in smokers and non-smokers though not significant. As the procedure of Valsalva ratio depends largely on subjective control, So one of the causes of this insignificance may be subjective variation to perfectly complete the maneuver. Another cause may be lesser sample size. DBD was lower in smokers though not significant statistically. Our finding were similar to the findings of Singh K. et al [25], whose study showed that there was no significant difference in DBD between smokers and non-smokers. Out of all these parasympathetic function test, the deep breathing test is very easy to use and is considered as the most reproducible of the cardiac autonomic function tests .A decreased heart rate variation in response to deep breathing has been suggested as a primary indicator of decreased parasympathetic response [26].

CONCLUSION:
The cardiovascular autonomic function tests are reliable, non-invasive and easy to carry out. These simple tests we can detect the early involvement of the autonomic nervous system before the clinical symptoms appear. The results of this study are suggestive of decreased sympathetic reactivity in smokers.

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