Original Article

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Effect of Abstinence on Audio-Visual Reaction Time in Chronic Smokers Pursuing a Professional Course

Physiology Section

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ABSTRACT

Introduction: It has now been proven that tobacco abuse is the leading cause for various carcinomas such as oral, lung and oesophageal. It also leads to atherosclerosis of major vessels, development of hypertension, autoimmune disorders, COPD, bronchitis, asthma, bronchiectasis, etc.

Most smokers are dependent on nicotine and abstinence from smoking results in tobacco withdrawal and craving. It also affects cognitive skills and reaction time. Many students in professional college have the habit of smoking. In spite of awareness programmes carried out in schools, colleges and having ban on smoking, prevalence of smoking is rising in India.

Aim: To observe the effect of abstinence on audiovisual reaction time and to note the cause for reverting to smoking by the students pursing professional course.

Materials and Methods: Sixty male volunteers in the age group of 18-25 years participated in the study. The volunteers were divided in to two groups (control group and study group). Cigarette smokers consuming at least 10-19 cigarettes per day for more than 2-3 years were included as subjects in study group.

The study was conducted using a audiovisual reaction time apparatus in a quiet and bright lit room. All volunteers were subjected to baseline readings after demonstrating working of the apparatus. Auditory (high pitched and low pitched sound) and visual (red light and green light) reaction time was recorded. Thirty students in study group were subjected to these tests immediately after smoking and after 12 hours of abstinence.

After all the individuals were tested, the recorded values were compared by Student's t-test.

Results: Statistically significant difference was recorded in auditory and visual reaction time in study group subjects immediately after smoking and after 12 hours of abstinence as compared to base line readings.

Conclusion: It was observed that auditory and visual reaction time was prolonged in chronic smokers after 12 hours of abstinence.

Keywords: Cognitive function, Nicotine, Smoking

INTRODUCTION

Approximately 2 billion people worldwide use tobacco products, mostly in the form of cigarettes. Tobacco smoking-related diseases cause approximately 4 million deaths per year [1]. The abuse of tobacco and its related products contribute to be one of the major causes of morbidity and mortality. It also leads to crippling pathological conditions such as cancer of lungs and stroke. It is a risk factor for hypertension, bronchitis and has also been associated with negative effects on cognitive functions [2]. Most of these effects can be prevented by awareness and knowledge.

According to World Health Organization the death penalty due to smoking may exceed 1.5 million annually. In India prevalence of smoking in school and college going students is increasing day by day [3].

Nicotine is one of the ingredients of cigarette smoke. Cigarette smoking has stimulant effect on nervous system and nicotine causes decrease in reaction time due to its stimulant property on the nicotinic receptors [4,5]. Smokers claim that they are able to concentrate to perform and complete the given tasks immediately after cigarette smoking [6].

It's a well known fact that nicotine has various effects on central nervous system. In chronic cigarette smokers abstinence impairs attention and cognitive abilities. The effects can be reversed by cigarette smoking to pre deprivation baseline levels [7-9].

Nicotine reinforces self-administration. Initial application of nicotine can increase the activity of the dopamine neurons, which could mediate the rewarding aspects of tobacco use [2,10]. Prolonged exposure to low concentrations of nicotine, however, can cause desensitization of the nicotinic receptors, which helps to explain acute tolerance to nicotine's effects.

It has been observed that nicotine activates and desensitizes nicotinic acetyl choline receptors. Major effect of these receptors is modulation rather than processing of fast synaptic transmission. These events contribute to the cellular events that underlie nicotine addiction. The reports suggest that the first cigarette of the day gives more pleasure, whereas the effect of subsequent cigarettes decreases. It may depend on the interplay between activation and desensitization of multiple nicotinic receptors [11,12].

Recent research indicates chronic cigarette smoking is associated with increased risk for numerous biomedical conditions that may directly or indirectly compromise brain neuro-biology and neuro-cognition [12]. Compared to the substantial volume of research on the general health consequences associated with chronic smoking, little research has been specifically devoted to understanding effects after abstinence for twelve hours on audio-visual reaction time.

Reaction, time is defined as the, time interval between applications of a stimulus and elicitation of a response [13]. Dorsal column pathways are included in carrying the sensation from an external stimulus to cerebral cortex and corticospinal pathways are included in achieving desired motor response. Processing of signal at the cortical level is of great importance. Audio-visual reaction time apparatus assesses all the mechanisms involved in this process. Most of the studies are carried out in the age group of 25 to 60 years.

Thus, the purpose of this study was to find out the influence of 12-hours of abstinence on audio-visual reaction time in chronic

smokers. This study will also highlight whether abstinence of smoking affects the processing capability of central nervous system in the age group of 19 to 25 years.

MATERIALS AND METHODS

The present study was conducted from May to July 2014 on the medical students studying MBBS course in a local medical college. Ethical approval was taken from institutional ethical committee. It was a cross-sectional study.

Study included 60 medical student volunteers aged between 19-25 years. The volunteers were divided into 2 groups, the control group (30 male non smokers) and study group (30 male smokers). All the volunteers were subjected to detailed medical examination. They were evaluated as per standard proforma which included a stress questionnaire [14]. The volunteers were physically healthy without any symptoms such as asthma, bronchitis, etc.

Detailed history of smoking was collected from the study group such as- number of cigarettes, duration of smoking, etc. Experimental protocol was explained to all volunteers and written consent was taken from them.

STUDY GROUP

Inclusion Criteria

1. Male students between the age group of 19-25 years.
2. Cigarette smokers consuming at least 10-19 cigarettes per day for more than 2-3 years.

Exclusion Criteria

1. Smokers suffering from any acute or chronic illness.
2. Smokers with any physical deformity.
3. Smokers consuming alcohol.

Control group – Consisted of age matched non smoker males, not suffering from any illness and without any physical deformity.

Audio-visual reaction time – Measurement of reaction time is a simple test which is measured by 'audiovisual reaction time apparatus' (Anand agency, Pune). Reaction time is a commonly used parameter for measuring implicit learning. In measurement of reaction time subject was asked to respond by pressing the button as soon as he had received the stimulus in the form of sound or light.

The apparatus provides both auditory (low and high pitched sounds) and visual (red and green) stimuli. The arrangement consists of a source of stimulus, response key and the time recording device. The response is given by the subject by pressing a key with his index finger. Time taken by the subject to give a response is displayed with an accuracy of one millisecond and is recorded as his auditory or visual reaction time [13,15].

The reaction time was recorded in a well illuminated and noise free room in the Department of Physiology. The location and direction of the instrument and position of subject was kept constant throughout the study period. The test subject was allowed to relax before commencing with recording of reaction time. Reaction time was measured for two varieties of auditory stimuli (low and high pitch) and two varieties of visual stimuli (red and green) provided in the instrument. The sequence of application of stimuli was kept constant. Procedure was demonstrated to all the subjects individually. All subjects were thoroughly acquainted with apparatus. When the reaction time was recorded for each stimulus, a 'ready' signal was given which was followed by a stimulus. The test subject was asked to press the button as soon as he received the stimulus [16]. Emphasis was given on how quickly the response was obtained and the subject was instructed accordingly. Three readings of the reaction time were taken for each stimulus by randomly varying the fore period (range 0 –10 seconds). The best response of three readings was taken for statistical analysis.

All of the above parameters were measured in the study group (smokers) and control group (non smokers) under the same conditions. The parameters were repeated immediately after smoking and after 12 hours of abstinence. The subjects were supervised by study observer whole night so as to ensure 12 hours of abstinence. Every day only one student's audiovisual reaction time readings were taken after keen supervision.

STATISTICAL ANALYSIS

The observations in the two groups were compared. The data was analysed by using Student's t-test and p-value less than 0.05 was accepted as an indicator of significant difference between compared values.

RESULTS

In this study mean age of control group subjects (n=30) was 20.24±2.22 years and mean age of study group subjects (n=30) was 20.20 ± 2.41 years. [Table/Fig-1-5] depicts the comparison of audio-visual reaction time using different parameters.

Parameter	Control group (n=30)	Study group (n=30)	p-value
High pitched sound (mean ± SD) ms	0.224 ±0.030	0.202±0.041	<0.05*
Low pitched (mean ± SD) ms	0.254±0.022	0.231±0.068	<0.05*
Red light (mean ± SD) ms	0.259±0.032	0.235±0.043	<0.05*
Green light (mean ± SD) ms	0.287±0.034	0.271±0.056	<0.05*

[Table/Fig-1]: Comparison of audio visual reaction time in control group and study group
*P <0.05 - significant

Parameter	Study group (n=30)		p-value
	Before smoking	After smoking	
High pitched sound (mean ± SD) ms	0.202±0.041	0.160±0.032	< 0.001*
Low pitched (mean ± SD) ms	0.231±0.068	0.177±0.028	< 0.001*

[Table/Fig-2]: Comparison of auditory reaction time in study group subjects before and after cigarette smoking
*p<0.001 - highly significant

Parameter	Study group (n=30)		P value
	Before abstinence	After abstinence	
High pitched sound (mean ± SD) ms	0.202±0.041	0.297±0.089	< 0.001*
Low pitched sound (mean ± SD) ms	0.231±0.068	0.322±0.086	< 0.001*

[Table/Fig-3]: Comparison of auditory reaction time in study group subjects before and after abstinence (*p<0.001 - highly significant)

Parameter	Study group (n=30)		p-value
	Before smoking	After smoking	
Red light (mean ± SD) ms	0.235±0.043	0.196 ±0.03	< 0.001*
Green light (mean ± SD) ms	0.271±0.056	0.214±0.03	< 0.001*

[Table/Fig-4]: Comparison of visual reaction time in study group subjects before and after cigarette smoking (*p<0.001 - highly significant)

Parameter	Study group (n=30)		Study group (n=30)
	Before abstinence	After abstinence	
Red light (mean ± SD) ms	0.235±0.043	0.351±0.061	< 0.001*
Green light (mean ± SD) ms	0.271±0.056	0.363±0.072	< 0.001*

[Table/Fig-5]: Comparison of visual reaction time in study group subjects before and after abstinence (*p<0.001 - highly significant)

DISCUSSION

The present study was aimed to observe effect of abstinence from chronic smoking on audio visual reaction time in healthy students pursuing professional course. As observed in [Table/Fig-1] statistically significant difference was observed in control group and study group subjects at baseline.

[Table/Fig-2,4] showed statistically significant difference in auditory and visual reaction time before and after smoking in study group subjects.

Similar results have been observed by Ichaporia et al., Gibbons et al., and Myrsten et al., [6,16,17]. They also noticed decrease in audiovisual reaction time after smoking one cigarette. It could be due to the stimulant action of nicotine on the nervous system [18]. Bell et al., observed that nicotine has stimulatory effect on processing capacity of central nervous system [19].

Glad and Sundaramurthy also observed similar results when smokeless tobacco was used [20]. Reaction time was significantly reduced as compared to cigarette smokers.

Decreased reaction time might be due to excessive release of catecholamines and decrease in dopamine levels in central nervous system [21].

[Table/Fig-3,5] showed statistically significant difference in auditory and visual reaction time before and after abstinence in study group subjects. Reaction time was prolonged after abstinence. This indicated delay in the transmission and processing of impulse at cortical level. Similar results have been observed by Revell et al., [22].

Armitage et al., stated that nicotine inhaled in smoke reaches to brain in only 10 seconds. It has stimulatory action and improves reaction time [23].

The delayed response to auditory as well as visual stimuli by chronic smokers might be due to several patho-physiological changes in their body systems [24,25]. With chronic stimulation of the nicotine acetylcholine receptors, there is tachyphylaxis of the nicotinic receptor.

Various studies indicated that alteration of the processing capability of central nervous system as reflected by the changes in auditory and visual reaction times might be due to impaired perceptual-motor coordination in chronic smokers [25-27].

For a further understanding of nicotine's effects on human cognitive skills, a more refined approach must be undertaken. The nicotine administered to a study group must be constant along with a proper testing using neuro physiological parameters and tools. Also, clinical radio imaging must be undertaken during testing to show effects of nicotine and the areas it affects in the brain.

This study showed that audio-visual reaction time is decreased immediately after smoking and increased after 12 hours of abstinence in chronic smokers. Increased reaction time may be due to desensitization or down-regulation of nicotinic receptors of acetylcholine, or chronic stimulation of the nicotinic receptors of acetylcholine leading to tachyphylaxis [26].

Smokers do experience delayed reaction time and are forced to smoke for better performance. This can be one of the reasons that they revert back to smoking after abstinence in spite of knowing the adverse effects. Smokers should be encouraged for smoking reduction and it should be emphasised that complete cessation should be the ultimate goal.

LIMITATIONS

For recording of the audio visual reaction time, readings were taken after 12 hour abstinence. We could not take the readings after 24 hour abstinence period. In this study female students were not included.

Future scope: Considering the effect of chronic smoking and nicotine on audio visual reaction time, future studies must be performed using more aggressive thorough tests for cognitive function along with imaging tests to visualise brain function during nicotine administration.

CONCLUSION

Significant difference was also observed after smoking and after 12 hours of abstinence in study group subjects. This indicated increased reaction time required for integration process in CNS and delayed conduction in reflex arc after abstinence. Thus, the evidence presented in this article supports that temporary abstinence from nicotine has adverse effect on reaction time which may force them to smoke again.

Health education and nicotine replacement therapy may help them to achieve the ultimate goal of complete cessation from smoking.

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