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Correlation between exhaled carbon monoxide level and oral hygiene status among nonsmokers and smokers

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Abstract

Background and aim: Tobacco use among the adolescent population is concerning because of the increase in the prevalence of chronic illness and premature death. It has been observed that with the increased use of tobacco, the chances of developing some oral pathology such as oral cancer have increased. The measurement of exhaled carbon monoxide level can provide an immediate assessment of smoking status. The measurement of Exhaled Carbon monoxide level is done for those who want to stop smoking.

Method: In this study, a total of 30 subjects were enrolled and the level of exhaled carbon monoxide was checked for which a device named Picosmokerlyzer was used. The subjects were categorized into three groups of 10 patients each based on their smoking status. Group 1: Non/former smoker, Group 2: Light smoker, and Group 3: Heavy smoker. The parameters that were checked were the oral hygiene index and gingival index, the patients were also asked to exhale into a device called a picosmokerlyzer to check the level of exhaled carbon monoxide.

Result and conclusion: On comparing the OHI it was found to be highest in heavy smokers followed by light smokers and then non-smokers, similarly the exhaled carbon monoxide level was found to be highest in heavy smokers followed by light smokers and then non-smokers. The gingival index score was least in non-smokers followed by light smokers and heavy smokers.

Keywords: Smokers, oral hygiene, picosmokerlyzser, tobacco consumption.

Introduction

The epidemic of tobacco use is one of the greatest but reversible global health issues today. [1] The most susceptible age groups are those transitioning from middle to high school. Many studies have reported that cigarette smoking from an early age contributes to severe health damage often leading to death, but the cessation of this habit by the age of 50 leads to less damage to the body, and cessation at the age of 30 avoids almost all of it. [2] Not only does tobacco usage has side effects on overall health but it also greatly affects the socioeconomic status, quality of life, and general well-being of the person. It is known that there are more than 4000 chemicals present in tobacco, out of which almost 50 are considered carcinogens. These chemicals exist in two phases: the gaseous phase and the solid phase. In the gaseous phase, the chemicals that have been found are carbon monoxide, ammonia, formaldehyde, hydrogen cyanide, etc, they also contain carcinogenic compounds such as benzo (a) pyrene and dimethylnitrosamine. In the solid phase the compounds present are "Tar" and "Nicotine"[3] Carbon monoxide (CO) is a colorless and odorless gas that is produced when the compounds containing carbon are partially oxidized. Carbon monoxide binds with hemoglobin more than that oxygen, when carbon monoxide mixes with hemoglobin it results in the production of carboxyhemoglobin. Hence, is no longer available for the transport of oxygen in the body. The increase in the concentration of carbon monoxide in the hemoglobin disturbs the natural cycle of the body leading to seizures, comas, and even leading to fatal consequences.[4] Biochemical confirmation of the smoking status of an individual is considered reliable so that the smoking cessation process can be monitored. The present study was designed to assess the correlation between exhaled carbon monoxide levels as measured by Smokerlyzer (Bed font instruments, Kent UK) and the oral hygiene status in both smokers and nonsmokers. This present study aimed to assess the correlation between the Exhaled Carbon Monoxide level and the Oral Hygiene Status of Smokers and Nonsmokers.

Materials and method

A total of 30 subjects were enrolled in the present study, and the level of exhaled carbon monoxide was checked for which a device named Picosmokerlyzer was used. The inclusive criteria to participate in the study were a smoker patient, a patient more than 19 years of age, and a systemically healthy patient. The patients with some acute or chronic systemic disease, pregnant and lactating women, and patients on antibiotic therapy or any other drug which can affect the periodontal status were excluded from the study. The subjects were categorized into three groups of 20 patients each based on their smoking status.

GROUP 1: Non/former smoker.

GROUP 2: Light smoker.

GROUP 3: Heavy smoker.

A case sheet was used to record the information from the patient that included age, gender, diet, and smoking history. The oral cavity was examined and all the patients with a history of smoking were selected to be a

part of this study. The indices to be used in this study for the evaluation included:

1. Gingival index
2. Oral hygiene index (debris and calculus index)
3. Exhaled Carbon Monoxide level.

Statistical analysis

The statistical analysis was done using SPSS (Statistical Package for the Social Sciences, SPSS Inc., v.16). The results obtained were statistically analyzed using ANOVA followed by Tukey's Post hoc test for multiple comparisons. The level of significance for the present study was fixed at a P-value less than 0.005.

Results

The comparison of OHI scores among the study groups is shown in **Table 1**. Statistical analysis showed that there was a statistically significant difference in OHI scores among the study groups (P<0.001) Multiple comparisons **(Table 2)** showed that there was a statistically significant difference in OHI scores between non-smokers and light smokers (P<0.001). The mean OHI score of light smokers was significantly higher than that of non-smokers. There was a statistically significant difference in OHI scores between non-smokers and heavy smokers (P<0.001). The mean OHI score of heavy smokers was significantly higher than that of non-smokers. There was no statistically significant difference in OHI scores between light smokers and heavy smokers (P=0.155). The comparison of GI scores among the study groups is shown in **Table 3**. Statistical analysis showed that there was a statistically significant difference in GI scores among the study groups (P=0.014) Multiple comparisons **(Table 4)** showed that: There was no statistically significant difference in GI scores between non-smokers and light smokers (P=0.716). There was a statistically significant difference in GI scores between non-smokers and heavy smokers (P=0.013). The mean GI score of non-smokers was significantly higher than that of heavy smokers. There was no statistically significant difference in GI scores between light smokers and heavy smokers (P=0.090). The comparison of CO levels among the study groups is shown in **Table 5**. Statistical analysis showed that there was a statistically significant difference in CO levels among the study groups (P<0.001) Multiple comparisons **(Table 6)** showed that: There was a statistically significant difference in CO levels between non-smokers and light smokers (P<0.001). The mean CO levels of light smokers was significantly higher than that of non-smokers. There was a statistically significant difference in CO levels between non-smokers and heavy smokers (P<0.001). The mean CO levels of heavy smokers was significantly higher than that of non-smokers. There was a statistically significant difference in CO levels between light smokers and heavy smokers (P<0.001).The mean CO levels of heavy smokers was significantly higher than that of light smokers.

Discussion

More than 8 million deaths per year is caused due to smoking worldwide and for a very long-time smoking has also been found to be associated both etiologically and pathologically with various diseases related to the respiratory system. It has also shown to have a clear impact on oral health along with systemic health. Carbon monoxide is an important component of tobacco smoke. When you inhale smoke from a cigarette, the CO gets absorbed into your blood through the lungs because CO binds with hemoglobin 200 times more readily than oxygen. The present study which was conducted in healthy smokers and nonsmoker participants found a correlation between plaque, calculus, and gingival indices as a part of oral health evaluation and smoking.

While conducting this study, the participants were divided into 3 groups after a questionnaire was filled which included their smoking status whether the participant is a smoker or not, if a smoker,

- Smoking history
- Duration of smoking,
- Number of cigarettes per day and
- The details about the last cigarette smoked are taken

Exhaled carbon monoxide levels were measured using a special monitoring device called Picosmokerlyzer (Bed font Scientific Ltd. Kent, United Kingdom).

This result was supported by a previous study conducted by Mindora Moga et al,[6] where a positive correlation was seen between the plaque, calculus, and gingival indices and smoking.

Another study that favored the result obtained in this particular study was conducted by Modupe O. Arowojolu et al[7], in which the mean Oral hygiene index was higher in smokers, which shows that smokers generally had poor oral hygiene when compared to non-smokers. This finding can be explained by the fact that cigarette smoking is known to cause staining of teeth, which roughens the surface of the teeth and encourages more rapid plaque accumulation. However, some contrary studies have reported that smokers do not necessarily have poor oral hygiene when compared to nonsmokers. In a study conducted by Alexander et al,[8] he reported that accumulation of bacterial plaque was not associated with tobacco smoking among a group of students, a report that was supported by another report by Bastiaan and Waite [9] among young adults. The contrary findings of this study could be since the majority of the participants were in the lowest socio-economic classes and had little education in comparison with the students studied by Alexander et al.

The comparison of GI scores among the study groups is shown in Table 3. Statistical analysis showed that there was a statistically significant difference in GI scores among the study groups (P=0.014) GI scores were highest in Group 1(nonsmokers), followed by Group 2(light smokers), and least in Group 3 (heavy smokers).

On intergroup comparisons (Table 4, Graph 2), it was found that there was a statistically significant difference in GI scores between Group 1 (non-smokers) and Group 3(heavy smokers) (P=0.013). There was no statistically significant difference in GI scores between the rest of the groups. (P>0.005)

These results were similar to the results observed in a study conducted by Cassiano Kuchenbecker Rosing et al,[10] in which heavy smokers presented with a lower level of gingival inflammation and bleeding when compared with light and moderate smoker's despite of them having increased amounts of plaque and calculus. This could be because the initial signs of inflammation are suppressed in smokers because of the presence of a compound "Nicotine" which stimulates the sympathetic ganglion, which further releases neurotransmitters including catecholamines (Trauth JA et al).[12] Catecholamines are potent vasoconstrictors which can cause a reduction in the blood flow in the gingiva. Another study conducted by (Kumar and Faizuddin 2011)12 supported the result of the present study and they said that this could be since the density of the blood vessel lumen area is higher in nonsmokers compared to smokers. In another study conducted by Bajagic V et al (2006)[13], it was observed that heavy smokers had thickened, fibrotic gingival tissue along with grayish discoloration and hyperkeratosis which could mask the clinical signs of inflammation.

However, contrary to the report given by Skaleric and Kovac-Kavcic[14] who concluded that smokers have the

same or less gingival inflammation than non-smokers and the higher degree of inflammation seen in the smokers can be because of their poorer oral hygiene when compared with the non-smokers.

The comparison of CO levels among the study groups is shown in Table 5. Statistical analysis showed that there was a statistically significant difference in CO levels among the study groups (P<0.001). The CO levels were found to be highest in Group 3 (heavy smokers), followed by Group 2 (light smokers), and least in Group 1(nonsmokers). On intergroup comparison (Table 6, Graph 3), it was noted that there was a statistically significant difference among the mean CO levels of Group 1 and Group 2 (P<0.001), Group 1 and Group 3 (P<0.001) and Group 2 and Group 3 (P<0.001). The result procured in this study was similar to the result obtained in a study done by Qiuli Zhang et al,[15] where current smokers were much more likely to have increased levels of exhaled carbon monoxide level when compared to nonsmokers. When the comparison was made among the current smokers, the level of exhaled carbon monoxide was found to be more in those who smoked more (heavy smokers) and people who inhaled more deeply. Carbon monoxide is one of the many hazardous chemicals present in cigarette smoke. When a person smokes CO gas enters his/her body via inhalation. Once it enters the body it displaces oxygen from the red blood cells and forms Co Hb. In this form, CO has a half-life of 5-6 hours and remains in the blood for 24 hrs (Middleton et al)[16]. In a report given by WHO it was mentioned that the concentration of CO in tobacco smoke was about 4-5% and smokers inhale it with a concentration of 400-500 ppm during smoking. This could be the reason why smokers usually have a higher concentration of CoHb when compared to Nonsmokers.[17]

In a study carried out by Ann Sofi Sandberg et al[18], the use of exhaled carbon monoxide (CO breath) which is considered a well-established method for separating smokers from nonsmokers was checked to evaluate the smoking status. It was found that CO breath levels were significantly higher in smokers than in nonsmokers. In this study, the patient suffering from chronic obstructive pulmonary disease were also included which was not taken in this present study. In yet another study which was conducted by Mindora Moga et al[6], the exhaled carbon monoxide level was found to be greater in smokers than in nonsmokers. In the above-mentioned study, the smokers were examined 15 minutes after they had smoked their first cigarette which was not considered in this present study.

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Legends Figures and Tables

Table 1: Comparison of OHI scores between non-smokers, light smokers and heavy smokers.

	N	Mean	Std. Deviation	Std. Error	95% Confidence Interval for Mean		P value
					Lower Bound	Upper Bound	
Non-smokers	20	2.8465	1.04951	.23468	2.3553	3.3377	
Light Smokers	20	6.2810	1.51879	.33961	5.5702	6.9918	<0.001*
Heavy Smokers	20	7.0845	1.44793	.32377	6.4068	7.7622	
Total	60	5.4040	2.28210	.29462	4.8145	5.9935	

*Statistically significant (P<0.05, Analysis of Variance)

Table 2: Multiple comparisons of OHI scores between non-smokers, light smokers and heavy smokers.

Group	Group	Mean Difference	P value	95% Confidence Interval	
				Lower Bound	Upper Bound
Non-smokers	Light Smokers	-3.43450*	<.001*	-4.4653	-2.4037
Non-smokers	Heavy Smokers	-4.23800*	<.001*	-5.2688	-3.2072
Light Smokers	Heavy Smokers	-.80350	.155	-1.8343	.2273

*Statistically significant (P<0.05, Post-hoc Tukey's test)

Table 3: Comparison of GI scores between nonsmokers, light smokers and heavy smokers.

	N	Mean	Std. Deviation	Std. Error	95% Confidence Interval for Mean		P value
					Lower Bound	Upper Bound	
Non-smokers	20	1.1525	.80957	.18102	.7736	1.5314	
Light Smokers	20	.9865	.64232	.14363	.6859	1.2871	0.014*
Heavy Smokers	20	.5315	.53309	.11920	.2820	.7810	
Total	60	.8902	.71100	.09179	.7065	1.0738	

*Statistically significant (P<0.05, Analysis of Variance)

Table 4: Multiple comparisons of gingival index scores between nonsmokers, light smokers and heavy smokers.

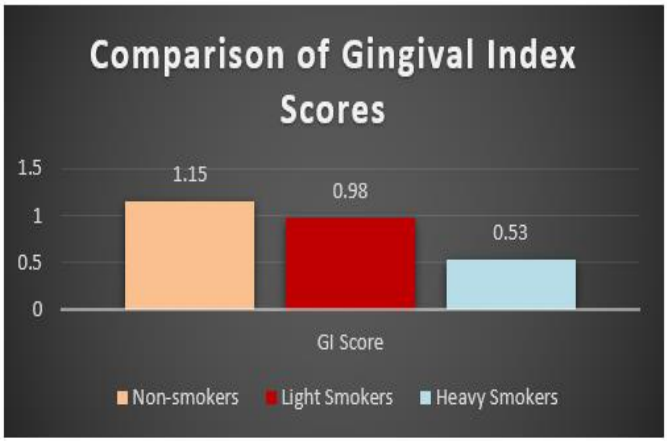
Group	Group	Mean Difference	P value	95% Confidence Interval	
				Lower Bound	Upper Bound
Non-smokers	Light Smokers	.16600	.716	-.3449	.6769
Non-smokers	Heavy Smokers	.62100*	.013*	.1101	1.1319
Light Smokers	Heavy Smokers	.45500	.090	-.0559	.9659

*Statistically significant (P<0.05, Post-hoc Tukey's test)

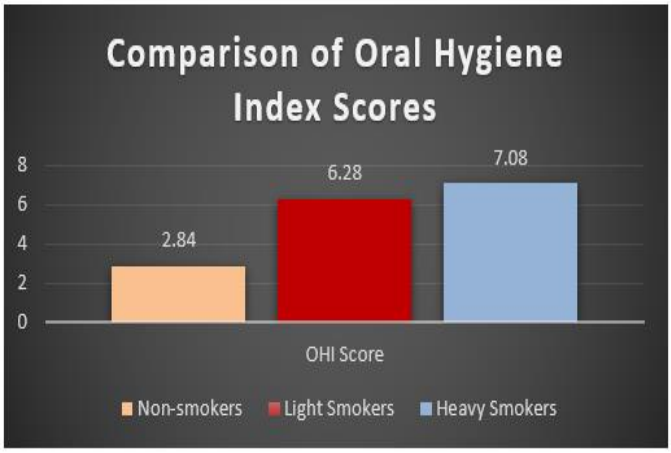
Table 5: Comparison of CO levels between nonsmokers, light smokers and heavy smokers.

	N	Mean	Std. Deviation	Std. Error	95% Confidence Interval for Mean		P value
					Lower Bound	Upper Bound	
Non-smokers	20	1.8000	.83351	.18638	1.4099	2.1901	
Light Smokers	20	12.1000	6.62452	1.48129	8.9996	15.2004	<0.001*
Heavy Smokers	20	25.2000	11.25120	2.51584	19.9343	30.4657	
Total	60	13.0333	12.18079	1.57253	9.8867	16.1800	

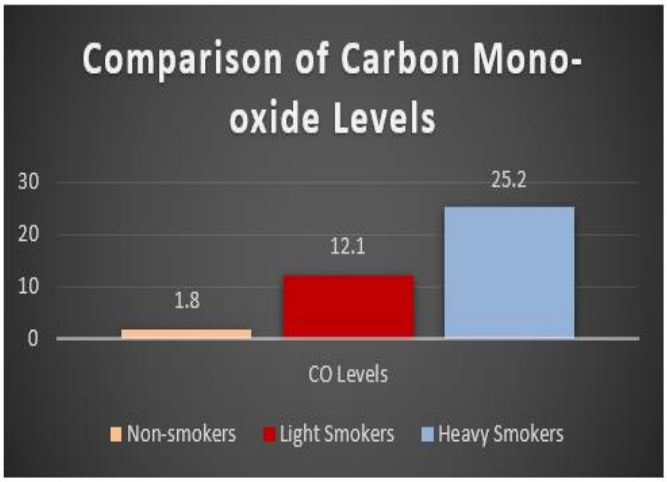
*Statistically significant (P<0.05, Analysis of Variance)



Graph 1: Comparison of gingival index score between non-smokers, light smokers and heavy smokers



Graph 2: Comparison of Oral Hygiene index scores between nonsmokers, light smokers, heavy smokers.



Graph 3: Comparison of carbon monoxide levels among nonsmokers, light smokers and heavy smokers

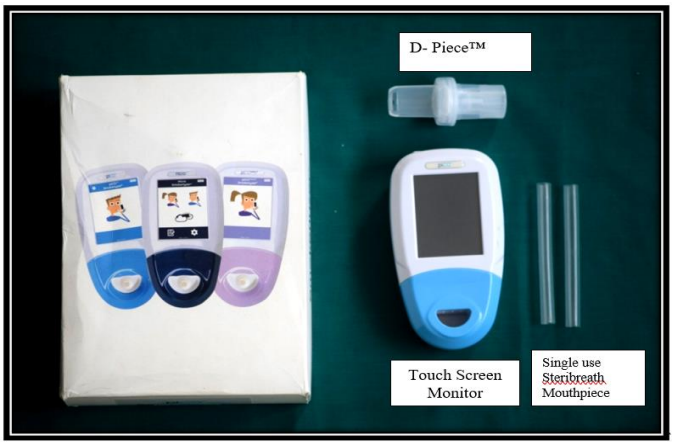


Fig 1: Carbon Monoxide level detector (PICOSMOKERLYZER)

Fig 2: Patient using Picosmokerlyzer