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Original Article

Salivary pH and DMFT Index in Smokers and Non-smokers: A Comparative Study Based on the Quantitative Rate of Smoking

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Abstract

Background: The effect of cigarette smoking duration on salivary pH and its relation to the rate of dental caries is unknown. Our aim was to comparatively investigate the salivary pH and DMFT index in cigarette smokers and non-smokers based on the quantitative rate of smoking.

Methods: This case-control study was conducted using simple random sampling. Three ml samples of not stimulated whole saliva were collected from 92 smokers and 37 nonsmokers. DMFT indices were recorded. The rate of smoking was calculated by pack-year index. Salivary pH was measured by pH meter (744 Metrohm). The data were analyzed by analysis of variance (ANOVA) and Pearson correlation coefficient was used to compare the status of pH and DMFT between smokers and non-smokers. The correlation of pH level and DMFT index with the amount of smoking was also investigated in smokers.

Results: The mean salivary pH level in smokers and non-smokers was 6.57±0.06 and 7.04±0.06, respectively. The mean DMFT in smokers and nonsmokers was 7.60±0.5 and 4.80±0.5, respectively. Salivary pH decreased significantly with the increase of pack-year index ($P=0.01$). The relationship between DMFT and the amount of smoking was not significant. DMFT index was significantly higher in smokers with over 300 pack-years than in other smokers ($P=0.01$).

Conclusions: Cigarette smoking was associated with lower salivary pH and higher DMFT index. The increased number of smoked cigarettes was associated with increased number of decayed teeth.

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Background

Respiratory and cardiovascular problems and cancer are important complications due to cigarette smoking. Smoking, especially tobacco smoking, is an important risk factor for cancer, periodontal disease, failure of implant therapy and gingivitis (1-3).

The relationship between smoking and the risk of dental caries development is controversial. Although some authors have reported cigarette smoking to be effective in decreasing caries, some others have reported that cigarette smoking contributes to increasing caries (4-7).

The increased development of tooth decay due to cigarette smoking is related to certain factors such as poor oral hygiene (8, 9), increased consumption of sugar (10), adding sugar to tobacco as an ingredient (11) and salivary buffering capacity (12). Salivary pH level is the most potential cause of dental caries in smokers. Reduced salivary pH increases the demineralization of the calcium phosphate in the teeth. Reduction in pH from 7.6 to 2.6 causes dentin demineralization and from 4.5 to 5.5 leads to enamel demineralization. The destruction of minerals initiates tooth decay (13). Studies have shown that salivary pH is reduced after smoking. Salivary pH has been reported to be significantly lower in long-term smokers than in non-smokers (14,15).

Habitual smoking is an important health problem. Understanding the association between smoking and dental disease is important to improve the attitude and knowledge of health workers and people. Although studies have shown that cigarette smoking has an effect on salivary pH levels, the effect of smoking duration on salivary pH and its relationship to the rate of dental caries is unknown. Our aim was to comparatively investigate the salivary pH and DMFT index in cigarette smokers and non-smokers based on the quantitative rate of smoking.

Highlights

Cigarette smoking is associated with lower salivary pH level and higher DMFT index.
Increased number of smoked cigarettes is associated with increased number of decayed teeth.
Salivary pH decreases significantly with the increase in smoking (pack-year index).

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Methods

This case-control study was conducted using simple random sampling. Signed inform consent was obtained from all volunteers to participate in the study. The subjects were selected from patients who referred to Department of Oral and Maxillofacial Medicine, Shahed University, Tehran, Iran.

The inclusion criteria were being male and 20- 40 years, lack of taking any medications, lack of suffering from systemic diseases, being on an omnivorous diet regime, having good oral hygiene and being from middle-class socioeconomic status. The exclusion criteria were surgical and/or periodontal treatment, having undergone radiography in the past 6 months, smoking hookah and consuming alcohol, using completely or partially removable dental dentures. In addition, previous smokers were not included in non-smoker group. Subjects who had periodontal health of grades 1- 3 based on the community periodontal index of treatment needs (CPITN) were included in the study (16).

According to the WHO oral health criteria, DMFT index is used to assess the teeth status of individuals according to the number of decayed, missing, and filled teeth (17). Demographic information, the DMFT index and the periodontal status of the participants were recorded by a single trained dental student. The WHO standard form was used to record DMFT index and periodontal status (18).

DMFT index was recorded using disposable dental explorer and mirror under artificial light of dental unit. Non-stimulated whole salivary secretion (NSSS) was sampled. For saliva sampling, the subjects were asked not to smoke or eat food for at least 2 hours (15,19). Saliva sampling was carried out during 9:00 AM to 11:00 AM (20), because its composition has the least chemical change during this interval. All participants were asked to spit at least 3 cc of their saliva into the test tube. The pH of saliva samples was immediately determined by pH meter (744 pH Meter, Metrohm, Switzerland).

The pH meter was calibrated according to the manufacturer's instruction before first use. Then, it was calibrated manually again before each measurement. Standard method of washing and drying of electrode was performed for each sample. After washing and drying the electrode, it was left in 3M KCl 3 solution. After removing the electrode from the solution and washing it with normal saline, it was inserted into the test tube containing saliva to display the pH of the electrode. After displaying the pH, the electrode was washed again and dried for use in the next test. Only 10 samples per day were tested to maintain the accuracy of the measurements.

The subjects were divided into 2 groups: smokers as cases and non-smokers as controls. Smokers were classified according to the amount of smoking in terms of the number of cigarette packs smoked per year (pack-year) into one of the following four groups: group 1: from 1 to 100 cigarettes per year; group 2: from 101 to 200 cigarette per year; group 3: from 201 to 300 cigarette per year; and group 4: at least 301 cigarettes per year.

The mean salivary pH level and DMFT index were determined. Comparison of the mean values of the groups was done by Duncan's multiple-range test and analysis of variance (ANOVA) at the significance level (P) of <0.05. The correlation between variables was investigated by Pearson correlation coefficient. The data were presented as the mean ± (standard deviation [SD]). Statistical analysis was done using the SPSS version 22 (IBM, Chicago, IL, USA).

Results

Table 1 shows the distribution of demographic information, DMFT index and salivary pH level in smokers and non-smokers. Duncan's multiple range test revealed that there was a significant difference in the number of smoked cigarettes among the different groups of smokers ($P=0.01$). Salivary pH decreased significantly with the increase of cigarette smoking (in pack-year). The difference between groups 1, 2 and 3 and non-smokers was not significant. The difference between group 4 and other groups was significant ($P=0.01$). Table 2 shows the average salivary pH level and DMFT index of smokers based on the amount of smoking (in pack-year) in the four groups.

The comparison of the mean pH level between the smokers and non-smokers using Duncan's multiple range test showed that the difference in pH level was significant ($P=0.01$).

The relationship between pH level and DMFT index was significant. A strong and inverse correlation was also observed between pH level and DMFT index in smokers (r = -435).

Discussion

Our results showed that cigarette smoking was associated with lower salivary pH level and higher DMFT index compared to non-smokers. The number of caries, especially cervical tooth decay, was higher in smokers than in non-smokers. These findings are consistent with

Table 1. Distribution the Demographic Characteristics, DMFT Index and Salivary pH Level in Cigarette Smokers and Non-smokers

	Smokers	Non-smokers
Characteristics	Mean ± SEM	Mean ± SEM
Age	29.9± 6.23	27.7± 6.3
DMFT	7.6±0.36	4.80± 0.50
Salivary pH	6.57±0.06	7.42± 0.07
Pack-year	145.9±14.6	0
Group 1 (n=30)	50.9±4.85	0
Group 2 (n=21)	139.9±6.08	0
Group 3 (n=21)	252.8±6.72	0
Group 4 (n=20)	453.2±27.7	0

Table 2. Average salivary pH Level and DMFT Index in Smokers Based on the Amount of Smoking (in Pack-Year)

Groups	DMFT Mean value ± SEM	PH Mean value ±SEM
Controls	4.80±0.50	7.42±0.07
Smokers		
Group 1	5.13±0.57	7.08±0.06
Group 2	6.71±0.70	6.71±0.07
Group 3	6.86±0.78	6.35±0.08
Group 4	10.80±1.08	5.90±0.12

Group 1: from 1 to 100 cigarettes per year, Group 2: from 101 to 200 cigarette per year, Group 3: from 201 to 300 cigarette per year, Group 4: at least 301 cigarettes per year.

previous studies (15-21).

Comparably higher number of caries in smokers has been attributed to poor oral hygiene (21). In the present study, to control for the effect of oral hygiene on decay, people with a CPITN score of 1-3 were included in the study and the people who did not have good oral hygiene were excluded.

Voelker et al used saliva stimulation to study the effect of cigarette smoking on salivary pH (12). They observed that cigarette smoking had a significant association with dental caries, salivary buffering capacity and pH, which confirms the findings of the current study. The present study was conducted on non-stimulated saliva to obtain more reliable results.

The action mechanism of cigarette smoking on the reduction of salivary pH has not yet been fully understood; according to previous studies, this can be attributed to the decrease of the function of salivary buffering system and reduction of salivary flow (12, 21).

Some studies have shown that salivary pH levels in smokers and non-smokers are not different (22). Since pH level is lower in smokers than in non-smokers, the salivary buffering capacity may be lower in smokers. This can increase the number of dental caries in smokers.

The current study showed that the DMFT index was significantly higher in smokers with more than 300 pack-years than in other smokers. This finding suggests that the increase of number of smoked cigarettes was associated with the increase of tooth decay. It has been suggested that smoking can reduce salivary flow rate, thus reducing the production of bicarbonate and the amount of salivary pH (23). This explanation is in agreement with the present study.

It has been shown that tobacco chewing like cigarette smoking has an attenuating effect on salivary pH (24). Contradictory findings about the attenuating effect of tobacco on salivary pH have been reported for tobacco chewing and tobacco smoking (25). Inconsistency in the findings has been attributed to the amount of tobacco used or other ingredients in it (24). In the study of Kanwar et al, salivary flow rate and salivary pH were lower in smokeless tobacco users than in smokers and controls (26). The research findings, consistent with the findings of the present study, have shown that even non-smoked tobacco can also reduce the salivary pH.

The review of the literature shows that the effect of the amount of smoked tobacco and the duration of tobacco smoking on salivary pH and its relationship to DMFT index have not yet been studied. The current study showed that the DMFT index was significantly higher in smokers with more than 300 pack-years than other smokers. This finding suggests that the increase of number of smoked cigarettes was associated with the increase of tooth decay. This is in agreement with the study of Rad et al. that showed that long-term smoking caused the decrease of SFR and increase of the oral and dental problems including cervical caries and calculus deposition (21). This subject deserves further investigation.

The findings of Heintze suggest that the levels of salivation of smokers and non-smokers were not different, but the number of lactobacilli and *Streptococcus mutans* was significantly higher in smokers than in non-smokers. The number of lactobacilli had a significant association with the number of smoked cigarettes per day. The number of *S. mutans* in smokers was twice that in non-smokers (27). This finding can partly explain the effect of cigarette smoking on dental caries.

In the present study, the association between salivary pH level and DMFT index was investigated in smokers and non-smokers in 20- to 40-year-old men.

Lack of including women was one of the limitations of our study. The tendency of women to cigarette smoking has increased in recent years. Gathering up-to-date information on oral health status in female smokers, is one of the most important measures to promote community health. The study of the health of the teeth in both genders and young people with respect to the associated factors and comparison of salivary pH level and DMFT index in women and people aged under 20 are recommended.

Conclusion

Cigarette smoking was associated with lower salivary pH and higher DMFT index. The increased number of smoked cigarettes was associated with increased number of decayed teeth.

Authors' Contribution

MRGM contributed to acquisition of data and drafting of the manuscript; FA contributed to acquisition the data; MS contributed to conception of the work, interpretation of data and drafting of the manuscript; and NJN contributed to conception of the work and drafting of the manuscript.

Ethical Statement

The study protocol was approved by the Ethics Committee of Shahed University (ethics code: IR.Shahed.REC. 1395.115).

Conflict of Interest Disclosures

The authors declare that they have no conflict of interests.

Acknowledgment

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