Research article

Gingival health condition and salivary alkaline phosphatase concentration in relation to electronic cigarette smoking

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Abstract: Background: Electronic cigarettes are rising in popularity not only amongst those who smoke cigarettes but also amongst the youth. Although thought to be less harmful than regular cigarettes, electronic cigarettes are now the subject of considerable debate. This study aimed to assess oral hygiene status, gingival health condition and salivary alkaline phosphatase concentration in relation to electronic cigarette smoking. Materials and Methods: A cross-sectional study was conducted amongst 80 college students aged 18–25 years old, who were divided into 40 users of electronic cigarettes and 40 non-users who were enrolled as the control group. They had been diagnosed for plaque index and calculus index according to the calculus component of the Periodontal Disease Index and gingival index. Enzyme-linked immuno-sorbent assay was used to chemically evaluate unstimulated salivary samples for the detection of alkaline phosphatase. Statistical analysis was carried out by SPSS version 22. Results: Results showed that electronic cigarette smokers had significantly higher mean values of plaque index, gingival index and salivary alkaline phosphatase concentration than the control group. No significant difference was found between the two groups regarding the calculus index. Conclusion: This study revealed that daily use of electronic cigarettes is linked to an increased chance of poor oral health in adults, and using them increases the odds of developing periodontal disease and teeth loss.

Keyword: electronic cigarette, plaque index, gingival index, alkaline phosphatase.

Introduction

Although electronic cigarettes (ECs) have been marketed as a healthier alternative to tobacco use, their aerosol still contains a variety of harmful substances [1]. For smokers and those who are passively exposed to the vapor from an EC, prolonged exposure to these chemicals at a considerably higher level than in the air continues to pose a serious health concern [2]. The US Food and Drug Administration classifies ECs as electronic nicotine delivery systems, which are battery-powered devices that are generally used to heat nicotine and chemically contained flavouring to create an aerosol that the user inhales [3,4]. The liquid used in EC cartridges typically contains nicotine, vegetable glycine and flavourings in propylene glycol [5]. Heavy metals such as nickel, tin, lead or chrome may also be present in the cartridge [6]. Although fewer components are included in ECs as compared with regular cigarettes, they still have toxic and cancer-causing residues, such as formaldehyde, acetaldehyde and acrolein [1].

The usage of ECs has negative effects on oral and overall health. Mouth and throat irritation and periodontal breakdown are the most common oral side effects. EC use leads to increased accumulation of plaque and deep probing depth [7]. The implication of ECs on various aspects of oral health status including oral hygiene status and gingival health condition was investigated by many studies, which found higher mean value of plaque index (PlI), calculus index (CalI) and gingival index (GI) amongst EC smokers than amongst non-smokers [8–11]. Saliva has gained attention as an important fluid in diagnosis, similar to urine and blood. Saliva contains the same biomolecules that are measured commonly in other body fluids [12]. The measurement of saliva activity may be valuable in the diagnosis of human periodontal disease; salivary alkaline phosphatase is often measured as a periodontal disease indicator [13–16]. Salivary alkaline phosphatase can be considered a biomarker for evaluating adverse effects of smoking [17]. Karem and Ibrahim [18] found that smokers have higher levels of salivary alkaline phosphatase than non-smokers.

This study aimed to evaluate the oral hygiene status, gingival health condition and salivary alkaline phosphatase concentration in relation to EC smoking. To date, no Iraqi study has investigated the effects of EC smoking on oral health amongst college students.

Materials and Methods

Approval was obtained from the Scientific and the Ethical Committee at the Pedodontics and Preventive Dentistry Department/ College of Dentistry/ University of Baghdad, Iraq. The study consisted of a study group, which included 40 college male students who were active EC smokers who had been smoking ECs with total daily vaping duration of at least 60 min [19] for a minimum of 1 year [20] in Al-Najaf City/Iraq; their age range was 18–25 years old [21]. In addition, the control group included 40 college students who were matched to the study group in number, age and gender, but they were non-smokers.

Using a dental probe and a plane mouth mirror, a clinical evaluation of oral hygiene state was carried out. Dental plaque was coded according to the criteria described by Silness and Loe in 1964 [22]. Meanwhile, dental calculus was assessed in accordance with the calculus component of the Periodontal Disease Index (PDI) of Ramfjord in 1959 [23]. The GI of Loe and Sillness [24] was used to assess gingival inflammation by using a plane mouth mirror and WHO community periodontal index probe. Unstimulated salivary samples were obtained in the morning between 9 AM and 12 PM to compare salivary alkaline phosphatase concentrations. Prior to having their saliva collected, participants were instructed to avoid eating, drinking and smoking for 60 min [25]. Each salivary sample was then centrifuged and stored at (−20 °C) until it was sent to the laboratory to analyse the level of salivary alkaline phosphatase [26]. The concentration of salivary alkaline phosphatase in K.A.U/dL was measured via a colorimetric method using a ready kit [27]. According to the manufacturer's instructions, the reagent preparation principle, assay technique and result calculation were all carried out.

Statistical analysis was performed by SPSS version 22 (Statistical Package for Social Sciences) using frequency and percentage as qualitative variables, mean and standard deviation as quantitative variables and independent two-sample T test and Pearson correlation as inferential statistics. $P<0.05$ was used to determine if the data were statistically significant.

Results

The mean values of PlI and CalI amongst EC smokers and non-smokers are shown in Table 1. The mean value of PlI and CalI was higher amongst EC smokers than those in the control group with a statistically significant difference ($p<0.05$) for PlI. The results of the present study illustrated that the mean value of GI was significantly higher amongst EC smokers than amongst non-smokers ($p<0.05$; Table 2). The concentration of alkaline phosphatase in saliva amongst EC smokers was higher than that in non-smokers, and the difference was statistically significant ($p<0.05$; Table 3). The results showed the correlation between GI and salivary alkaline phosphatase. The correlation between GI and salivary alkaline phosphatase was positive and not significant ($p>0.05$; Table 4).

Table 1: Dental plaque and calculus indices (mean ± SD) and statistical difference in the study and control groups.

Variables	Groups					
	Study		Control			
	Mean	±SD	Mean	±SD	T test	P valu
PlI	1.262	0.870	0.829	0.462	2.782	0.007*
CalI	0.063	0.088	0.051	0.074	0.685	0.495

* significant $p<0.05$

Table 2: Gingival index (mean ± SD) and statistical difference in the study and control groups.

Groups	Mean	±SD	T test	P value
Study	1.139	0.798	4.089	0.000*
Control	0.495	0.596		

* significant $p<0.05$

Table 3: Concentration of salivary alkaline phosphatase concentration (K.A.U/dL; mean ± SD) and statistical difference in the study and control groups.

Variables	Groups	Mean	±SD	T test	P value
Alkaline	**Study**	3.019	0.519	2.057	0.043*
phosphata	**Control**	2.811	0.375		

* significant $p<0.05$

Table 4: Correlation coefficient between gingival index and salivary alkaline phosphatase in the study and control groups.

Groups		Alkaline phosphatase	
		r	p
Study	**GI**	0.062	0.706
Control	**GI**	0.074	0.648

Discussion

EC use is a recent phenomenon that is spreading rapidly around the world. ECs encourage users, irrespective of their age and social background, to select and manage the nicotine level because of the large range of flavours and widespread availability [28]. Given that EC users were thought to be comparatively younger than cigarette users, whose average age is 19 compared with 34 for cigarette users, the present study was conducted on college students between the ages of 18 and 25 [29,30].

Data from this study showed a significantly higher PlI amongst the study group compared with the control group (Table 1), and this result was inconsistent with findings from other studies [31,32]. Studies on EC smoking have explained the differences in plaque accumulation due to variations in periodontal pathogen presence; the usage of ECs may change the oral microbiome's profile towards a state that is different from that found in people who do not smoke or who consume tobacco [33]. Meanwhile, previous studies did not find a significant difference in plaque level between EC smokers and non-smokers [8,10]. CalI in this study was higher amongst EC smokers than amongst the control group, but the difference was not significant (Table 1). This result agreed with the findings of Ghazali et al. [10]. This increase in dental calculus amongst EC smokers could be due to the increase in the mean value of dental plaque, and calculus acted as a retentive factor of dental plaque [34].

In the present study, GI was significantly higher amongst EC smokers than the control group (Table 2). The high level of GI in the study group could be due to an increase in plaque accumulation amongst EC smokers as dental plaque was documented to be the main etiological factor of gingivitis, and the disease severity increased with increasing mean PlI [35]. Additionally, as a vasoconstrictor, nicotine, which is present in EC liquid, constricts the arteries and decreases the quantity of blood flow and nutrients to the gums, which decreases the white blood cells that act as an anti-inflammatory against harmful foreign substances. As a result, the alveolar bone and periodontal ligament were destroyed. Gingival and periodontal tissues cannot be healthy without sufficient blood [36]. The findings of the current study disagreed with those of Ghazali et al. [10], who discovered no statistically significant difference in the GI between the study and control groups, with a lower value amongst the EC group relative to the control group.

The mean salivary alkaline phosphatase concentration in the present study was higher amongst the study group than amongst the control group, with the difference being statistically significant (Table 4). This result was attributed to the fact that nicotine increases alkaline phosphatase activity [37]. The relationship between using ECs and salivary alkaline phosphatase levels has not been investigated previously. Salivary alkaline phosphatase has been measured as a probable indicator of gingival inflammation and bone metabolism, and the level of salivary alkaline phosphatase changes in relation to gingival inflammation and bone loss [38]. In the present study, the significant increase in the salivary alkaline phosphatase concentration was evident in the EC smoker group who had a significantly higher mean GI compared with the control group. This result was in agreement with various studies, which reported that the salivary alkaline phosphatase concentration is significantly higher in the gingivitis group than in the healthy group [13,14]. The present study also found a positive but insignificant correlation between the salivary alkaline phosphatase concentration and GI (Table 5).

Conclusion

According to this study, smoking ECs on a regular basis increases the likelihood of having poor oral health. Smoking ECs may also raise the chance of developing periodontal disease and teeth loss. The popular perception that EC smoking is less harmful than traditional cigarettes has undoubtedly led to an increase in the number of consumers of these products throughout the world. Therefore, efforts should be done to stop this occurrence.

Conflict of interest:

The authors have no conflicts of interest to declare.

Author contributions

ZMA; study conception and design. ZMA; data collection. ZMA ; Methodology. ZMA and NMH; statistical analysis and interpretation of results. ZMA; original draft manuscript preparation. ZMA and NMH; Writing - article & editing. Supervision; NMH. All authors reviewed the results and approved the final version of the manuscript to be published.

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References

1. Grana R, Benowitz N, Glantz S.A. E-cigarettes: a scientific review. Circulation, 2014: 1972-1986. https://doi.org/10.1161/CIRCULATIONAHA.114.007667

2. Hess I.M, Lachireddy K, Capon A. A systematic review of the health risks from passive exposure to electronic cigarette vapour. Public Health Res Pract, 2016; 26(2):1-9. https://doi.org/10.17061/phrp2621617

3. Breland A, Soule E, Lopez A, Ramoa C, ElHellani A, Eissenberg T. Electronic cigarettes: what are they and what do they do? Ann N Y Acad Sci, 2017:5-30. https://doi.org/10.1111/nyas.12977

4. Food and Drug Administration. Vaporizers, E-cigarettes, and other Electronic Nicotine Delivery Systems (ENDS). 2020.

5. Varlet V, Concha-Lozano N, Berthet A, Plateel G, Favrat B, Cesare M.D, et al. Drug vaping applied to cannabis: is "Cannavaping" a therapeutic alternative to marijuana? Sci Rep, 2016: 25599. https://doi.org/10.1038/srep25599

6. Hwang OJ. E-cigarette use among adolescents' Nurse Pract, 2020: 453-456. https://doi.org/10.1016/j.nurpra.2020.02.021

7. Yang I, Sandeep S, Rodriguez J. The oral health impact of electronic cigarette use: a systematic review. Critical reviews in toxicology, 2020; 50(2):97-127. https://doi.org/10.1080/10408444.2020.1713726

8. Alharthi, S. S. Impact of cigarette smoking and vaping on the outcome of full-mouth ultrasonic scaling among patients with gingival inflammation: a prospective study. Clinical Oral Investigations. 2018; 23(6):10. https://doi.org/10.1007/s00784-018-2725-2

9. Mokeem SA, Alasqah MN, Michelogiannakis D, Al-Kheraif AA, Romanos GE. Javed F. Clinical and radiographic periodontal status and whole salivary cotinine, IL-1β and IL-6 levels in cigarette-and waterpipe-smokers and E-cig users. Environmental Toxicology and Pharmacology, 2018; 61: 38-43. https://doi.org/10.1016/j.etap.2018.05.016

10. Ghazali AF, Ismail AF, Faisal GG, Halil MHM, Daud A. Oral health of smokers and e-cigarette users: A case-control study. J Int Dent Med Res, 2018;11(2),428-432.

11. Al-Aali KA, Alrabiah M, Arrejaie AS, Abduljabbar T, Vohra F, Akram Z. Peri-implant parameters, tumor necrosis factor-alpha, and interleukin-1 beta levels in vaping individuals. Clinical implant dentistry and related research, 2018; 20(3): 410-415. https://doi.org/10.1111/cid.12597

12. Pfaffe T, Cooper-White J, Beyerlein P, Kostner K, Punyadeera C. Diagnostic potential of saliva: current state and future applications. Clinical Chemistry, 2011; 57(5):675- 687. https://doi.org/10.1373/clinchem.2010.153767

13. Patel RM, Varma S, Suragimath G, Zope S. Estimation and Comparison of Salivary Calcium, Phosphorous, Alkaline Phosphatase and pH Levels in Periodontal Health and Disease: A Cross-sectional Biochemical Study. J Clinic Diag Res 2016; 10(7): 58-61. https://doi.org/10.7860/JCDR/2016/20973.8182

14. Koppolu P, Sirisha S, Mishra A, Deshpande K, Lingam AS, Alotaibi DH, et al. Alkaline phosphatase and acid phosphatase levels in saliva and serum of patients with healthy periodontium, gingivitis, and periodontitis before and after scaling with root planing: A clinico-biochemical study. Saudi J Bio Sci 2021; 28: 380-385. https://doi.org/10.1016/j.sjbs.2020.10.016

15. Randhir K. Salivary Alkaline Phosphatase level as diagnostic marker for periodontal disease. J Int Oral Health, 2011; 3: 82-85.

16. Ramenzoni LL, Lehner MP, Kaufmann ME, Wiedemeier D, Attin T and Schmidlin PR. Oral Diagnostic Methods for the Detection of Periodontal Disease. Diagnostics: 2021; 11: 571. https://doi.org/10.3390/diagnostics11030571

17. Prakash AR, Indupuru K, Sreenath G, Kanth MR, Reddy AVS, Indira Y. Salivary alkaline phosphatase levels speak about association of smoking, diabetes and potentially malignant diseases? Journal of oral and maxillofacial pathology: JOMFP, 2016; 20(1):66. https://doi.org/10.4103/0973-029X.180934

18. Karem B, Ibrahim LAM. Periodontal Health Status and Salivary Enzymes Level in Smokers and Non-Smokers: Comparative Cross Sectional Study. J Bagh Coll Dent 2013; 325(2207):1-6.

19. Visser W, Geraets L, Klerx W, Hernandez L, Stephens E, Croes E, et al. The health risks of using e-cigarettes. National Institute for Public Health and the Environment 2015,

20. Lestari DA, Regina TC, Tandelilin, Rahman FA. Degree of Acidity, Salivary Flow Rate and Caries Index in Electronic Cigarette Users in Sleman Regency, Indonesia. 2020. https://doi.org/10.32793/jida.v3i1.449

21. Villarroel MA, Cha AE, Vahratian A. Electronic cigarette uses among U.S. adults. NCHS data brief, no 365. Hyattsville, MD: National Center for Health Statistics, no 365. 2018.

22. Silness J, Loe H. periodontal disease in pregnancy. Correlation between oral hygiene and periodontal condition. Acta Odont Scand 1964; 22: 121-35. https://doi.org/10.3109/00016356408993968

23. Ramfjord S. Indices for prevalence and incidence of periodontal disease. J. periodontal 1959; 30: 51-9. https://doi.org/10.1902/jop.1959.30.1.51

24. Loe H, Silness J. Periodontal disease in pregnancy I. Acta Odonto Scand 1963; 21:533-551. https://doi.org/10.3109/00016356309011240

25. Navazesh M, Kumar SK. Measuring salivary flow: challenges and opportunities. University of Southern California School of Dentistry. 2008. https://doi.org/10.14219/jada.archive.2008.0353

26. Agha-Hosseini F, Mirzaii-Dizgah I, Moghaddam PP, Akrad ZT. Stimulated whole salivary flow rate and composition in menopausal women with oral dryness feeling. Oral Disease, 2007; 13(3): 320-3. https://doi.org/10.1111/j.1601-0825.2006.01288.x

27. Millan JL. Alkaline phosphatase. Biochemical Society Transactions, 1990; 18(2): 170-180. https://doi.org/10.1042/bst0180178

28. Bertholon JF, Becquemin MH, Annesi-Maesano I, Dautzenberg B. Electronic Cigarettes: A Short Review. Respiration 2013; 86, 433-438. https://doi.org/10.1159/000353253

29. Institute for Public Health. National Health and Morbidity Survey 2015—Report on Smoking Status Among Malaysian Adults.

30. Public Health Institute. Tobacco and E-cigarette Survey among Malaysian Adolescent. 2016: 27-67

31. BinShabaib M, AlHarthi SS, Akram Z, Khan J, Rahman I, Romanos G E, et al. Clinical periodontal status and gingival crevicular fluid cytokine profile in cigarette-smokers, electronic-cigarette users and never-smokers. Arch Oral Bio 2019; 102, 212-217. https://doi.org/10.1016/j.archoralbio.2019.05.001

32. Vohra F, Bukhari IA, Sheikh S A, Albaijan R, Naseem M. Comparison of self-rated oral symptoms and periodontal status among cigarette smokers and individuals using electronic nicotine delivery systems. J American Coll Health 2020; 68(7), 788-793. https://doi.org/10.1080/07448481.2019.1709476

33. Wu J, Peters BA, Dominianni C, Zhang Y, Pei Z, Yang L, et al. Cigarette smoking and the oral microbiome in a large study of American adults. ISME J. 2016; 10(10):2435-2446. https://doi.org/10.1038/ismej.2016.37

34. Carranza. Clinical periodontology by Newman M, Taki H, Carranza F. Part 3, Saunder Elsevier 9th ed.: 2002; 164-150.

35. Robinson PJ, Schmerman M. Influence of pregnancy on the oral cavity. Glob. libr. women's med. 2015. https://doi.org/10.3843/GLOWM.10105

36. Karasneh J A, Al Habashneh RA, Marzouka NA, Thornhill MH. Effect of cigarette smoking on subgingival bacteria in healthy subjects and patients with chronic periodontitis. BMC oral health. 2017; 17(1): 64. https://doi.org/10.1186/s12903-017-0359-4

37. El_Batran MM, Soliman NL Mikael FF. Passive smoking and alveolar bone density. Aust J BasiApplSci, 2009; 3(2), pp.713-9.

38. Kumar R. Sharma G. Salivary Alkaline Phosphatase level as Diagnostic marker for periodontal disease. Journal of International Oral Health, 2011; 3(5).

الحاله الصحيه للثه وتركيز الفوسفاتاز القلوي اللعابي فيما يتعلق بتدخين السجائر الالكترونيه

زينب مهدي عبد الجبار , نبال محمد هوبي

المستخلص:

الخلفية: تزداد شعبية السجائر الإلكترونية ليس فقط بين مدخني السجائر. أولاً ، على الرغم من أن السجائر الإلكترونية يُعتقد أنها أقل ضررًا من السجائر العادية ، إلا أنها الآن موضع نقاش كبير. كان الهدف من هذه الدراسة هو تقييم حالة نظافة الفم والحالة الصحية للثه وتركيز الفوسفاتاز القلوي اللعابي فيما يتعلق بتدخين السجائر الإلكترونية. المواد والطرق: أجريت دراسة مقطعية على 80 طالبًا جامعيًا تتراوح أعمارهم بين 18-25 عامًا ، 40 مستخدمًا للسجائر الإلكترونية و 40 من غير المستخدمين الذين تم تسجيلهم كمجموعة ضابطة. تم قياس مؤشر الصفيحة الجرثومية للاسنان ومؤشر الترسبات الكلسية الفموية بالاضافه الى قياس مؤشر صحة اللثة. باستخدام فحص مناعي مرتبط بالإنزيم تم تحليل عينات اللعاب غير المحفزة كيميائيًا للكشف عن الفوسفاتيز القلوي. النتائج: وجد أن مدخني السجائر الإلكترونية لديهم متوسط قيمة أعلى بكثير لمؤشر الصفيحة الجرثومية للاسنان ، مؤشر صحة اللثة وتركيز الفوسفاتيز القلوي اللعابي مقارنة بالمجموعة الضابطة بينما لم يكن هناك فرق معنوي بين المجموعتين فيما يتعلق بمؤشر الترسبات الكلسية الفموية. الاستنتاج: خلصت هذه الدراسة الى أن الاستخدام اليومي للسجائر الإلكترونية ارتبط بزيادة فرصة الإصابة بسوء صحة الفم لدى البالغين ، ومن الممكن أن يؤدي استخدامها إلى زيادة احتمالات الإصابة بأمراض اللثة وفقدان الأسنان.