European Review for Medical and Pharmacological Sciences 2022; 26: 2676-2682

Comparative assessment of periodontal treatment needs among the electronic cigarette users and traditional smokers

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Abstract. – OBJECTIVE: It is currently presumptuous that electric cigarettes are less harmful than the conventional ones; this is increasing the consumption of electric cigarettes. Therefore, this study intended to evaluate the periodontal treatment needs among conventional smokers, electronic cigarette smokers and non-smokers. This cross-sectional designed study involved 150 patients with a mean age of 29.88±7.81 years.

PATIENTS AND METHODS: Among all patients, 50 patients were recruited in each group. The periodontal condition and the treatment need for the patients were assessed using the community periodontal index treatment need (CPITN). Fisher exact test was used to find the significant association of all three groups with the periodontal status and the treatment need. Female patients (12.5%) showed better periodontal status than the male patients (87.5%) and required less complicated periodontal treatment independently from smoking type.

RESULTS: Furthermore, deeper pocket depth ≥6 mm (75%) has been found among the conventional cigarette smokers whereas the majority of the electric cigarette smokers (50%) have calculus deposition. Thus, 50% of the electric smokers require professional scaling whereas 57.1% of conventional smokers prerequisite complex periodontal treatment.

CONCLUSIONS: Besides, there was a significant difference ($p \leq 0.05$) observed among all groups in periodontal health index and treatment need. Conventional cigarette consumers need more complicated periodontal treatment compared to the patients who consume electric cigarettes.

Key Words:
Electric cigarette smoking, Conventional cigarette smoking, CPITN, Periodontal treatment need.

Introduction

Periodontal diseases are the oral inflammatory conditions most found among other dental diseases[1]. Though there are various risk factors for developing periodontal diseases, smoking is considered the most significant one[2]. Smoking interferes with the blood flow, microbiological changes and affects the inflammatory and host responses which ultimately distress the periodontal tissues[3]. It has been observed that those who quit smoking showed 30% more significant clinical improvements in periodontitis management than those who are continuing smoking[4].

A new form of smoking device, electronic cigarettes have become popular nowadays among smokers of all ages. There are more than 40 million users around the world consuming tobacco *via* electronic cigarettes[5]. Nicotine, a carrier solution (a mixture of propylene glycol) and a flavoring agent are the main three components of electronic cigarettes. Based on the international survey, the percentage of electronic cigarettes consumers in the USA are 15%, 10% in the UK, 4% in Canada, and 2% in Australia. A dramatic increase in the number of consuming electronic cigarettes was observed among young individuals[6]. Extensive debates are going on in various social and healthcare disciplines about the potential risks and benefits of electronic cigarettes. Based on the outcome of previous clinical trials, different systematic reviews[7,8] concluded that electronic cigarettes are effective aids in terms of tobacco cessation. However, studies[9,10] with larger sample sizes contradict

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the aforementioned statement. Additionally, it has been reported that exposure to electronic cigarettes, aerosol and flavorings may increase oxidative stress. Moreover, the production of inflammatory cytokine in gingival epithelium progenitors also increases in human periodontal ligament[11-13]. During the consumption of electronic cigarettes, the oral mucosa is the first structure in contact while they are at the highest temperature and in the most concentrated form. Hence, there is a concern that electronic cigarettes may have adverse effects on periodontal/gingival oral health. Electronic cigarettes might induce periodontal diseases by causing inflammations, injuries and impaired host responses. Nicotine involved in electronic cigarettes harms proliferation as it affects fibroblasts, as well as the differentiation of myofibroblasts. Therefore, this will impair the capability of oral wound healing. It has been reported[14] that electronic cigarettes damage cultured periodontal ligament, gingival tissue and fibroblasts.

Periodontal health is integral to maintain the proper function, esthetic, and reducing the prevalence of tooth loss. The adverse effects of traditional cigarette smoking on periodontal health have been widely studied. Smoking is the second most important risk factor for periodontal disease after poor oral hygiene and it affects the prevalence, extent, progression and severity of periodontal disease[15,16]. Smoker patients have a deeper periodontal pocket, greater attachment loss and experience more tooth loss than non-smoker patients. Also, there is less bleeding on probing (BOP) due to reduced vascularity in smoker patients than non-smokers[17]. Apart from periodontitis, conventional tobacco cigarette use is also one of the most common causative factors of peri-implantitis. The overall frequency of participants presenting with periodontitis has been significantly higher among smokers[18]. Although the effect of smoking on periodontium is well documented, however, the comparison of different smoking types, specifically smoking with electronic cigarettes received limited attention. Therefore, this study aimed at comparing the periodontal treatment needs in patients using conventional cigarettes with those using electronic cigarettes using the Community Periodontal Index for Treatment Needs (CPITN) index.

Patients and Methods

Study Design

This cross-sectional study was conducted at the College of Dentistry, Prince Sattam Bin Abdulaziz University Alkharj, Saudi Arabia following the "Helsinki Declaration of Human Studies" and approved by the Institutional Review Board (Reference No: REC-HSD-75-2021).

Study Sample

A total of 150 patients visiting the College of Dentistry, Prince Sattam Bin Abdulaziz University Alkharj were recruited for this study. The participants were divided into three different groups as:

Group 1: 50 subjects who are Conventional Smokers (C-smokers);

Group 2: 50 subjects who use Electronic Cigarettes (E-smokers);

Group 3: 50 subjects who do not smoke (Non-smokers).

Clinical Examination and Recruitment

At the screening visit, participants were advised to read the informed consent document. All their questions were addressed, including the pros and cons which were discussed thoroughly. They were allowed to discuss with their family and friends regarding their participation in this study. Once the subjects decided to participate, they were asked to sign informed consent documents before their screening visit. A medical health history and dental history form were filled out. The inclusion criteria of this study were: at least 18 to 60 years of age, present with general good health, non-smoker, conventional smoker (C-smoker) or E-cigarette smoker (E-smoker) and received no scaling and root planning in the last 6 months. On the other hand, patients with heavily restored teeth or undergoing orthodontic treatment, participants currently using other forms of smoking, patients on antibiotic therapy or with medical conditions, such as diabetes, history of radiation therapy to head and neck region, any acute infections, or patients having oral mucosal lesions, such as candidiasis and leukoplakia were excluded from this study. The oral examination was carried out by the three calibrated intern dentists.

Participation and Index Recording

Participants were distributed in equal numbers to each group (group 1: C-smokers, group 2: E-smokers and group 3: Non-smokers). All clinical examinations were done in the intern dental clinic and supervised by the periodontist invigilators. A CPITN was recorded for all the subjects using a mouth mirror and CPITN World Health Organization (WHO) probe (0.5

Table I. CPITN index coding system.

	CPI (Community Periodontal Index)		TN (Treatment need)
Code 0	Healthy tissue – No signs of disease	**TN 0**	No need for treatment
Code 1	Bleeding observed during or after probing.	**TN 1**	Need for improving the personal oral hygiene
Code 2	Calculus or plaque retentive factors such as ill-fitting crowns or poorly adapted edges of restoration are either seen or felt during probing.	**TN 2**	Need for professional cleaning of teeth and removal of plaque retentive factor
Code 3	The pathological pocket of 4mm or 5mm present	**TN 3**	"Complex treatment" can involve deep scaling, root planning and more complex surgical procedures
Code 4	The pathological pocket of 6mm or deeper		
Code X	When only one tooth or no teeth are present in a sextant.		

mm ball end with color markings at 3.5 mm and 5.5 mm) model CP-11.5B6. The dentition was divided into six sextants for the assessment of treatment need. Each sextant of the mouth was evaluated according to the following indexed teeth: 17, 16, 11, 26 and 27 in the maxillary arch and 47, 46, 31, 36, and 37 in the mandibular arch. The sextant was operatively defined as edentulous when less than two functional teeth were present. Molars were examined in pairs and the highest scores were recorded for each sextant. The clinical examination and index recording session took approximately 25 minutes in which the Periodontal Invigilator was always present to ensure safety and correct recording of the CPITN Index (Table I). All the participants and research coordinators were aware of the distribution of the patients' group. However, the examiners were blinded by the grouping protocol. A total of 30 patients from all three groups (20% of total samples) were measured twice in a week interval with CPITN index by two different operators for the inter-observer agreement.

Statistical Analysis

Statistical analyses were performed using the IBM SPSS, version 27.0 (IBM Co., Armonk, NY, USA). Cohen's kappa analysis was performed to assess the inter-observer agreement. The kappa scores are graded with <0.20, 0.21-0.40, 0.41-0.60, 0.61-0.80 and 0.81-1 which indicate poor, fair, moderate, substantial and near-perfect agreement, respectively[19]. The frequency of the periodontal status measured by the CPITN index for different groups and gender were calculated. Pearson chi-square (x^2) test was used to assess the gender distribution in all groups and Fisher's exact test was used to investigate the CPITN index distribution for all groups. p-value<0.05 was considered statistically significant.

Results

A total of 150 patients from 18 to 53 years (mean age 29.88± 7.81 years) were uniformly divided into three groups (C-smoker, E-smoker and Non-smoker) where the non-smoker group consists of equally males and females. Cohen's kappa score for the recording of the CPITN index for 30 patients showed the absolute level of inter-rater agreement (Kappa score=1). Pearson chi-square test showed that among all the participants, 74.7% were male and 25.3% were female and most of the male patients were conventional smokers (92%) while their counterpart mostly consumes electronic cigarettes (18%). The percentage of smoking is significantly different between male and female consumers (Table II).

Regardless of smoking habits, 90% of the female participants have healthy periodontal tissue; therefore, they do not need any active treatment. On the other hand, 87.50% of the male participants have deeper pockets (≥6 mm); hence, they

Table II. Number and percentage of C-smoker, E-smoker and non-smoker groups based on gender.

Gender	C-smoker (%)	E-smoker (%)	Non-smoker (%)	X^2	p-value
Male	46 (92.0)	41 (82.0)	25 (50)	25.45	0.0001*
Female	4 (8.0)	9 (18.0)	25 (50)		

C-smoker; Conventional smoker, E-smoker; Electronic smoker, %; percentage, X^2; Pearson Chi-Square, P; p-value, *; Significant difference.

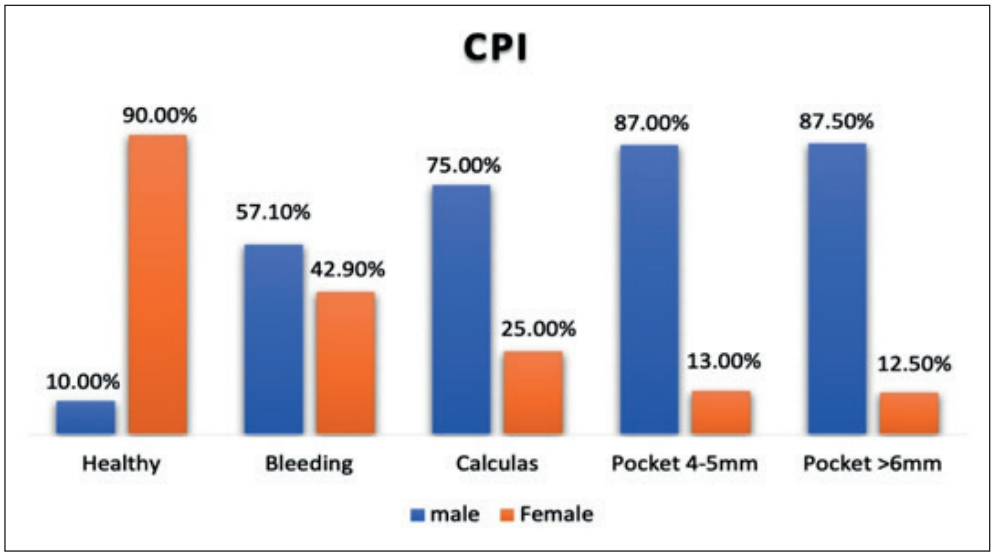

Figure 1. Community periodontal index (CPI) for males and females.

need complex periodontal treatment (Figure 1 and Figure 2).

Measurements of periodontal condition showed that most of the C-smokers have deep pockets ≥6 mm (75%) whereas the majority of the E-smokers have calculus deposition (50%) among all the CPI index scores. On the other hand, 90% of the non-smokers have healthy periodontal tissue. Fisher's exact test showed a significant difference in periodontal condition measured by CPITN index among all the groups (Table III).

Based on the periodontal condition, 57.1% of C-smokers need complex periodontal treatment, whilst 50% of the E-smokers only need professional cleaning of teeth and removal of plaque followed by improving personal oral hygiene (35.7%). Unlike smokers, 90% of non-smokers do not require any active treatment and 57.1% only require the improvement of personal oral hygiene. Moreover, Fisher's exact test showed a significant difference in treatment need measured by CPITN index among all the groups (Table IV).

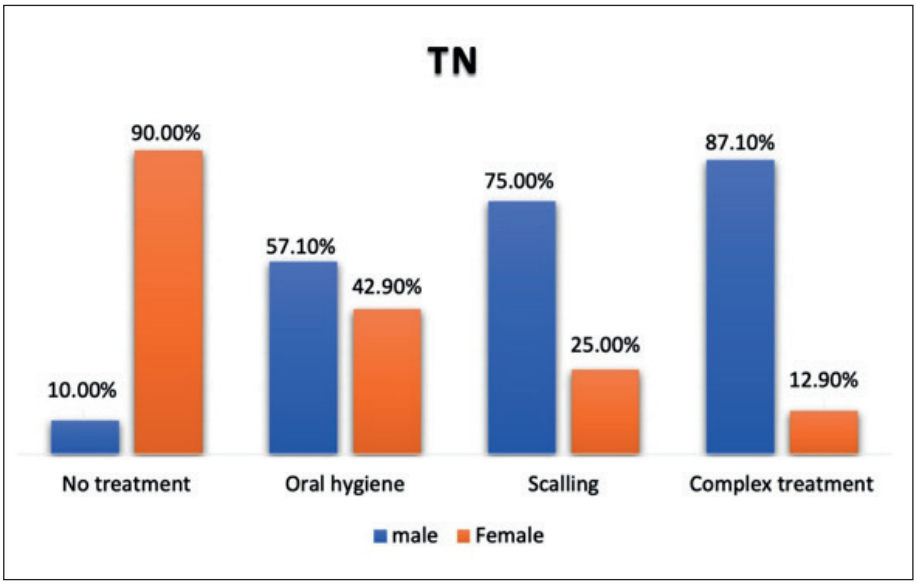

Figure 2. Periodontal treatment need (TN) for males and females.

Table III. Community Periodontal Index measurement among different groups.

Groups	Code 0 (%)	Code 1 (%)	Code 2 (%)	Code 3 (%)	Code 4 (%)	*p*-value
C-smoker	0 (0.0)	1 (7.1)	9 (16.1)	28 (51.9)	12 (75.0)	
E-smoker	1 (10.0)	5 (35.7)	28 (50)	15 (27.8)	1 (6.3)	0.0001*
Non-smoker	9 (90.0)	8 (57.1)	19 (33.9)	11 (20.4)	3 (18.8)	

Smoker; Conventional smoker, E-smoker; Electronic smoker, %; percentage, P; *p*-value, *; Significant difference, Code 0; Healthy tissue-No signs of disease, Code 1; Bleeding observed during or after probing, Code 2; Calculus or plaque retentive factors such as ill-fitting crowns or poorly adapted edges of restoration are either seen or felt during probing, Code 3; Pathological pocket of 4mm or 5mm present, Code 4; Pathological pocket of 6 mm or deeper.

Discussion

Smoking is becoming a social threat among young generations, even though teenagers are in the social protection system[20]. There is a misconception developing about electronic cigarettes that it is less detrimental and helps to reduce the consumption of conventional cigarettes[21]. Though it is not completely evidenced that electronic smokers have fewer side effects than the conventional method of smoking, the electronic form of smoking became a fashion trend among the young generation, and it increases the ultimate nicotine inhalation. Thus, it has a deleterious effect on periodontal health[14]. Therefore, this study aimed to assess and compare the periodontal treatment needs among C-smokers, E-smokers and non-smokers.

In this current study, a total of 112 patients were male and 38 patients were female. It showed that male participants were more into the conventional cigarette whereas females were more using electronic cigarettes. Many of the previous studies[22-24] did not include female subjects in the studies related to smoking or included the female subjects in the non-smoker group only. Therefore, the outcomes of the single-gender studies on smoking could generate bias when comparing the periodontal condition and treatment needs for smokers and non-smokers. Though due to cultural and social barriers, many female smokers refuse to participate in this type of study as smoking is considered a disgraceful act. The current study could include only 13 female smokers against 87 male smokers in both C-smoker and E-smoker groups. However, non-smoker groups were equally divided by both genders.

Irrespective of smoking status, this study showed that male patients were more exaggerated by the periodontal diseases than their counterparts which are similar to the outcome of many previous studies[25-27]. Therefore, generally male patients need more complex periodontal treatment while most female patients do not require any treatment. The outcome of the current study exhibited that conventional smoker have significantly deeper pockets which are consistent with the results of previous studies[22-24,27].

However, one previous study[28] did not identify any significant difference in periodontal condition between the smoker and non-smoker group. Moreover, it showed that percentages of the deep pocket are more prevalent in the non-smoker group. Though this finding is contrasting with the majority of the previous studies along with the current study, the inclusion of more non-smoker subjects than the smoker subjects might reflect the results.

The effects of electronic smoking on periodontal disease are not elucidated; however, evidence from previous studies[9,10,29] indicates that it is not less harmful than regular cigarettes. Aerosols produced from electronic cigarettes cause oxidative stress which ultimately affects the periodontal tissues[29]. Moreover, an electronic cigarette could also damage the connective tissues and initiate bone loss with the damage of DNA

Table IV. Treatment needs among different groups.

Groups	TN 0 (%)	TN 1 (%)	TN 2 (%)	TN 3 (%)	p-value
C-smoker	0 (0.0)	1 (7.1)	9 (16.1)	40 (57.1)	
E-smoker	1 (10.0)	5 (35.7)	28 (50)	16 (22.9)	0.0001*
Non-smoker	9 (90.0)	8 (57.1)	19 (33.9)	14 (22.9)	

C-smoker; Conventional smoker, E-smoker; Electronic smoker, %; percentage, P; *p*-value, *; Significant difference, TN 0; No need for treatment, TN 1; Need for improving the personal oral hygiene, TN 2; Need for professional cleaning of teeth and removal of plaque retentive factor, TN 3; "Complex treatment" which can involve deep scaling, root planning and more complex surgical procedures.

strands[30]. It also believes that electronic smoking increases the prostaglandin level and matrix metalloproteases which are related to periodontal tissue damage[14]. One recent survey[31] showed that electric smokers have more oral health-related problems than those who do not smoke and maintain oral hygiene. In this study, the E-smoker group exhibited that calculus or plaque retentive factor is the most prevalent among other community periodontal index (CPI) where the index is more damaging in the conventional smoker group. Though many studies have been conducted comparing the periodontal index between smokers and non-smoker groups, only a few studies focused on electronic cigarettes. One previous study[27] compared the periodontal index among conventional cigarette, electronic cigarettes, shisha and non-smoker groups which showed a significant difference in periodontal status between electronic smokers and conventional smokers. Nevertheless, no significant difference was observed between the electronic smoker and the Shisha group. This result complies with the findings of this current study in the electric smoker and conventional smoker groups, though this study did not include any patients who take Shisha as nicotine inhalation.

Analysis of the treatment need revealed that smokers need more sophisticated periodontal treatment than non-smokers which is a consistent outcome with various previous studies[27,32-34]. Generalized periodontal treatment need scores used in this current study are similar to the previous studies[24,35]. However, many studies[22-24,28] only focused on the periodontal index and did not assess the treatment need based on the CPITN index. This study focused on both periodontal index and their appropriate treatment need. Conventional smokers need more complex periodontal treatment than electric smokers and non-smokers. Electric smokers mostly need professional calculus removal whereas the majority of the non-smokers do not need any active periodontal treatment. Though electric smokers might need less complicated treatment than the conventional smoker group, they still need treatment by professionals. Therefore, periodontal conditions might not affect to an extent like conventional smokers, it could not be claimed that electronic smoking is less harmful. Since the treatment need for electric smokers is significantly different than the non-smokers, any form of smoking could not be vindicated for healthy periodontal conditions. Age and oral hygiene habits may also be considered as important variables for developing periodontal conditions between smokers and non-smokers[28,35], the current study mainly focused on the treatment need of different groups.

Conclusions

Based on the outcome of this study it could be concluded that female patients' periodontal condition is better than the male subjects; thus, male patients require higher treatment needs than females. As smoking is playing the most imperative role in periodontal health regardless of the types of smoking method, electronic cigarette smokers need a less complicated treatment protocol than conventional cigarette smokers. However, further studies should be conducted on larger groups.

Acknowledgments

The authors want to thank the Deanship of Scientific Research, Prince Sattam Bin Abdulaziz University Alkharj for supporting this study.

Author Contributions

Conceptualization, A.S.A., N.R.A, K.G, methodology, A.M.A., A.A., formal analysis, T.M.B., H.M.W.H., data curation, F.F.A., A.S., N.M.A., writing-reviewing and editing, A.S.A., K.G., supervision, N.R.A., A.M.A. project administration, A.S.A. All the authors have read and agreed to the published version of the manuscript.

Funding

The authors have no relevant financial or non-financial interests to disclose.

Conflict of Interest

The authors declare they have no financial interests.

Ethical Approval

This cross-sectional study was conducted at the College of Dentistry, Prince Sattam Bin Abdulaziz University Alkharj, Saudi Arabia following the "Helsinki Declaration of Human Studies" and approved by the Institutional Review Board (Reference No: REC-HSD-75-2021).

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