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Comparative assessment of periodontal parameters among e-cigarette users, smokers, and non-smokers: A cross-sectional study

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Abstract

Background: Tobacco smoking is a well-established risk factor for periodontal disease. In recent years, electronic cigarettes (e-cigarettes) have gained popularity as an alternative to conventional smoking; however, their effects on periodontal health remain inadequately understood. This study aimed to compare periodontal parameters among e-cigarette users, conventional smokers, and non-smokers.

Methods: A comparative cross-sectional study was conducted among 45 participants attending the Department of Periodontology, M.A. Rangoonwala College of Dental Sciences and Research Centre, Pune. Participants were equally divided into three groups: e-cigarette users (n=15), conventional smokers (n=15), and non-smokers (n=15). Clinical periodontal parameters assessed included Plaque Index (PI), Gingival Index (GI), Probing Pocket Depth (PPD), Bleeding on Probing (BOP), and Gingival Recession (GR). Data were analyzed using SPSS version 26.0. Intergroup comparisons were performed using one-way ANOVA with Tukey's post hoc test and Chi-square test. Statistical significance was set at $p<0.05$.

Results: Conventional smokers demonstrated significantly higher plaque index (1.86 ± 0.28), gingival index (1.67 ± 0.31), and probing pocket depth (3.67 ± 0.41 mm) compared with e-cigarette users (1.18 ± 0.23, 0.98 ± 0.20, and 3.14 ± 0.32 mm, respectively) and non-smokers (1.10 ± 0.19, 0.87 ± 0.18, and 2.13 ± 0.28 mm, respectively) ($p<0.001$). Gingival recession was observed in 66.7% of e-cigarette users and 60.0% of smokers, whereas no cases were identified among non-smokers ($p<0.001$). Bleeding on probing was most prevalent among smokers (86.7%), followed by e-cigarette users (53.3%) and non-smokers (26.7%) ($p<0.001$). Oral hygiene practices were comparable among all groups and showed no statistically significant differences.

Conclusion: Both conventional smoking and e-cigarette use were associated with poorer periodontal health compared with non-smokers. Conventional smokers exhibited the greatest periodontal destruction and inflammation, while e-cigarette users demonstrated intermediate periodontal findings. These findings indicate that e-cigarette use is associated with adverse effects on periodontal tissues and should not be considered a safe alternative to conventional cigarette smoking. Further longitudinal studies with larger sample sizes are required to evaluate the long-term periodontal effects of e-cigarette use.

Keywords: E-cigarettes, smoking, periodontal disease, plaque index, gingival index, probing pocket depth, gingival recession, bleeding on probing.

Introduction

Periodontal disease is one of the most common chronic inflammatory conditions affecting the supporting structures of the teeth and continues to be a major oral health concern globally(1). It is initiated primarily by the accumulation of microbial dental plaque, which leads to inflammation of the gingival tissues. If left untreated, this inflammatory process may progress from gingivitis to periodontitis, resulting in periodontal pocket formation, clinical attachment loss, alveolar bone destruction, gingival recession, tooth mobility, and eventual tooth loss [1]. Although dental plaque is the primary etiological factor, the progression and severity of periodontal disease are influenced by several modifying risk factors, of which smoking is one of the most significant and well-established [2].

Smoking has long been identified as a major environmental risk factor for periodontal disease. Tobacco smoke contains numerous toxic substances, including nicotine, carbon monoxide, formaldehyde, and oxidizing chemicals, which adversely affect both oral tissues and systemic host responses [3]. Studies have consistently shown that smokers experience greater periodontal destruction than non-smokers, with increased probing pocket depth, attachment loss, alveolar bone loss, and poorer periodontal treatment outcomes [4]. The risk of developing periodontitis is significantly higher in smokers, and this risk tends to increase with the duration and intensity of tobacco exposure [5].

In recent years, electronic cigarettes (e-cigarettes) have emerged as an increasingly popular alternative to conventional cigarette smoking, particularly among younger individuals. These devices deliver nicotine through aerosolized vapour without the combustion of tobacco [6]. Because they do not produce tobacco smoke in the traditional sense, many users believe e-cigarettes to be a safer substitute. However, this perception remains uncertain, particularly with respect to oral and periodontal health.

Clinical studies evaluating periodontal health among e-cigarette users have reported mixed findings. Glantz and Bareham highlighted the increasing popularity of e-

cigarettes and emphasized the need for further research regarding their health effects and long-term safety [6]. Furthermore, Sundar et al. demonstrated that e-cigarette aerosols and flavoring agents can induce inflammatory and oxidative stress responses in oral tissues, suggesting a potential mechanism for periodontal damage [7]. Since the composition of e-cigarette aerosols varies depending on nicotine concentration, device type, frequency of use, and flavouring agents, their long-term periodontal effects remain incompletely understood.

With the increasing use of e-cigarettes and the continued prevalence of conventional smoking, comparative evaluation of their effects on periodontal health is clinically important. Understanding whether e-cigarette use presents a periodontal risk similar to or different from conventional smoking may help improve preventive strategies, patient education, and periodontal management. Therefore, the present study aims to comparatively assess periodontal parameters among smokers, e-cigarette users, and non-smokers.

Methodology

Study Design and Setting: The present comparative cross-sectional study was conducted at Dental O.P.D M.A. Rangoonwala College of Dental Sciences and Research Centre, Pune. The study was undertaken to compare periodontal health parameters among e-cigarette users, conventional smokers, and non-smokers.

Sample Size Calculation: The sample size was calculated using the formula for comparison of means between three independent groups:

$N = 2(Z\alpha/2 + Z\beta)^2\sigma^2 / d^2$

Where:

- n = required sample size per group
- $Z\alpha/2$ = standard normal deviate corresponding to 95% confidence level (1.96)
- $Z\beta$ = standard normal deviate corresponding to 80% power (0.84)
- σ = pooled standard deviation obtained from previous literature
- d = minimum expected difference between groups

Based on data reported in previous studies evaluating periodontal parameters among smokers, e-cigarette users, and non-smokers, the minimum required sample size was estimated to be 13 participants per group. To compensate for possible dropouts and incomplete data, the sample size was increased to 15 participants in each group. Therefore, a total of 45 participants were included in the study, with 15 participants allocated to each study group.

Study Population: Adult patients attending the Dental O.P.D. were screened for eligibility and recruited after obtaining written informed consent. The sample size was calculated using a comparison of means formula at a 95% confidence level and 80% statistical power. The minimum required sample size was estimated to be 13 participants per group; however, to account for potential dropouts, 15 participants were recruited in each group. Thus, a total of 45 participants were included and equally distributed among three groups: e-cigarette users (n=15), conventional smokers (n=15), and non-smokers (n=15). Participants were selected from patients attending the Dental O.P.D. who met the inclusion criteria and agreed to participate in the study. Written informed consent was obtained from all participants before enrollment. Based on their habit history, participants were divided into three groups: e-cigarette users, conventional smokers, and non-smokers. Individuals aged 18 years and above with a history of exclusive e-cigarette use, conventional cigarette smoking, or no history of tobacco or nicotine use and having a minimum of 20 natural teeth were included in the study. Individuals with systemic diseases known to affect periodontal health, those undergoing or having received periodontal treatment within the previous six months, subjects using antibiotics, anti-inflammatory drugs, or other medications affecting periodontal status within the preceding three months, pregnant or lactating women, and individuals with a history of smokeless tobacco use or mixed tobacco habits were excluded from the study.

Study Procedure: A detailed case history was obtained from each participant using a structured proforma. Information regarding demographic characteristics, medical and dental history, oral hygiene practices, smoking or vaping habits, duration of habit, frequency of use, and nicotine consumption was recorded. Participants were subsequently assigned to their respective study groups based on their habit history.

Clinical Examination: Clinical Examination: Clinical periodontal examination was performed by a single trained and calibrated examiner under adequate illumination using a mouth mirror, explorer, and a UNC-15 periodontal probe. Standard infection control measures were followed throughout the examination. Periodontal parameters assessed included Plaque Index (Silness and Löe), Gingival Index (Löe and Silness), Probing Pocket Depth (PPD), Bleeding on Probing (BOP), and Gingival Recession (GR)(9). Plaque Index and Gingival Index scores were recorded according to their respective standard criteria. Probing pocket depth was measured in millimeters from the gingival margin to the base of the periodontal pocket at six sites per tooth (mesiobuccal, mid-buccal, distobuccal, mesiolingual, mid-lingual, and distolingual) using a UNC-15 periodontal probe. Bleeding on probing was assessed within 15 seconds after gentle probing and recorded as present or absent. Gingival recession was measured as the distance from the cementoenamel junction (CEJ) to the free gingival margin and was recorded in millimeters. All clinical findings were documented in a predesigned clinical proforma, and periodontal status was determined based on the recorded clinical parameters.

Statistical Analysis

The collected data were entered into Microsoft Excel and analyzed using Statistical Package for Social Sciences (IBM SPSS Statistics for Windows, Version 26.0; IBM Corp., Armonk, NY, USA). Descriptive statistics were expressed as mean ± standard deviation (SD) for continuous variables and frequency with percentage for categorical variables.

Intergroup comparisons of continuous periodontal parameters, including Plaque Index (PI), Gingival Index (GI), and Probing Pocket Depth (PPD), were performed using one-way Analysis of Variance (ANOVA). When significant differences were identified, Tukey's post hoc test was applied for pairwise comparisons between groups.

Categorical variables, including oral hygiene practices, Bleeding on Probing (BOP), and Gingival Recession (GR), were compared using the Chi-square test. A p-value of less than 0.05 was considered statistically significant. The results were presented in the form of tables and graphs.

Result

A total of 45 participants were included and equally distributed among three study groups comprising e-cigarette users, conventional smokers, and non-smokers. The mean age of participants ranged from 30.00 ± 4.55, with a predominance of male participants across all groups.

E-cigarette users reported a mean duration of use of 4.33 ± 2.23 years, whereas conventional smokers demonstrated a significantly longer duration of use of 6.80 ± 2.86 years. Similarly, smoking frequency and quantity were higher among conventional smokers compared with e-cigarette users.

Table 1: Demographic Characteristics of Study Participants

Variable	Group 1 (E-cigarette Users)	Group 2 (Smokers)	Group 3 (Non-smokers)
Age (years), Mean ± SD	34.00 ± 5.00	30.00 ± 4.55	31.73 ± 4.92
Male, n (%)	11 (73.3)	10 (66.7)	12 (80.0)
Female, n (%)	4 (26.7)	5 (33.3)	3 (20.0)

Values expressed as mean ± standard deviation (SD) or frequency (%).

Table 2: Habit Exposure Characteristics

Variable	Group 1 (E-cigarette Users)	Group 2 (Smokers)
Duration of Use (years), Mean ± SD	4.33 ± 2.23	6.80 ± 2.86
Frequency of Use/day, Mean ± SD	9.27 ± 4.64	11.40 ± 5.59
Quantity of Use/day, Mean ± SD	13.40 ± 4.84	17.80 ± 5.02

Values expressed as mean ± standard deviation (SD). Group 3 was excluded as participants had no history of smoking or e-cigarette use.

Table 3: Oral Hygiene Practices among Study Groups

Variable	Category	Group 1 n (%)	Group 2 n (%)	Group 3 n (%)	p-value
Brushing Frequency	Once daily	5 (33.3)	5 (33.3)	8 (53.3)	0.215
	Twice daily	4 (26.7)	8 (53.3)	3 (20.0)	
	More than twice daily	6 (40.0)	2 (13.3)	4 (26.7)	
Type of Toothbrush	Soft	6 (40.0)	7 (46.7)	5 (33.3)	0.758
	Medium	9 (60.0)	8 (53.3)	10 (66.7)	
	Hard	0 (0.0)	0 (0.0)	0 (0.0)	
Brushing Technique	Horizontal	5 (33.3)	7 (46.7)	4 (26.7)	0.738
	Vertical	2 (13.3)	3 (20.0)	1 (6.7)	
	Circular	5 (33.3)	3 (20.0)	6 (40.0)	
	Modified Bass	3 (20.0)	2 (13.3)	4 (26.7)	
Interdental Aids Used	Floss	6 (40.0)	2 (13.3)	1 (6.7)	0.454
	Interdental Brush	1 (6.7)	2 (13.3)	3 (20.0)	
	Mouthwash	3 (20.0)	2 (13.3)	3 (20.0)	
	Water Flosser	4 (26.7)	7 (46.7)	5 (33.3)	
	None	1 (6.7)	2 (13.3)	3 (20.0)	
Tongue Cleaning	Yes	6 (40.0)	7 (46.7)	9 (60.0)	0.537
	No	9 (60.0)	8 (53.3)	6 (40.0)	

Values are presented as percentages. Intergroup comparisons were performed using the Chi-square test. Statistical significance was set at $p < 0.05$.

Table 4: Clinical Periodontal Parameters among Study Groups

Parameter	Group 1 (Mean ± SD)	Group 2 (Mean ± SD)	Group 3 (Mean ± SD)	p-value	Post Hoc Comparison
Plaque Index	1.18 ± 0.23	1.86 ± 0.28	1.10 ± 0.19	<0.001*	G2 > G1 > G3
Gingival Index	0.98 ± 0.20	1.67 ± 0.31	0.87 ± 0.18	<0.001*	G2 > G1 > G3
Probing Pocket Depth (mm)	3.14 ± 0.32	3.67 ± 0.41	2.13 ± 0.28	<0.001*	G2 > G1 > G3

Values are expressed as mean ± standard deviation (SD). Intergroup comparisons were performed using one-way analysis of variance (ANOVA) followed by Tukey's post hoc test for pairwise comparisons. G1 = E-cigarette users; G2 = Conventional smokers; G3 = Non-smokers. Statistical significance was set at $p < 0.05$. Different group comparisons in the post hoc column indicate statistically significant pairwise differences.

Table 5: Comparison of Periodontal Soft Tissue Parameters across Study Groups (n = 15 per group)

Variable	Group 1 n (%)	Group 2 n (%)	Group 3 n (%)	p-value
Gingival Recession – Present	10 (66.7)	9 (60.0)	0 (0.0)	<0.001*
Gingival Recession – Absent	5 (33.3)	6 (40.0)	15 (100.0)	
Bleeding on Probing – Present	8 (53.3)	13 (86.7)	4 (26.7)	<0.001*
Bleeding on Probing – Absent	7 (46.7)	2 (13.3)	11 (73.3)	

Footnote: Values are presented as frequency (n) and percentage (%). Intergroup comparisons were performed using the Chi-square test. *Statistically significant at $p < 0.05$.

Table 3 presents the distribution of oral hygiene practices among e-cigarette users, conventional smokers, and non-smokers. No statistically significant differences were observed among the study groups with respect to brushing frequency, type of toothbrush used, brushing technique, interdental aid usage, or tongue-cleaning practices ($p > 0.05$). Although minor variations were noted in the percentages of participants reporting different oral hygiene behaviors, these differences were not statistically significant. The findings indicate that oral hygiene practices were generally comparable across all three groups and are therefore unlikely to have influenced the observed differences in periodontal status.

Table 4 compares the clinical periodontal parameters among the three study groups. Statistically significant intergroup differences were observed for plaque index, gingival index, and probing pocket depth ($p < 0.001$). Conventional smokers exhibited the highest mean plaque index (1.86 ± 0.28), gingival index (1.67 ± 0.31), and probing pocket depth (3.67 ± 0.41 mm), followed by e-cigarette users and non-smokers. Tukey's post hoc analysis demonstrated significant pairwise differences among all three groups, with smokers showing significantly poorer periodontal health than e-cigarette users, while non-smokers exhibited the most favorable periodontal status.

Table 5 illustrates the distribution of gingival recession and bleeding on probing among the study groups. Gingival recession was present in 66.7% of e-cigarette users and 60.0% of conventional smokers, whereas no cases were observed among non-smokers. Similarly, bleeding on probing was most prevalent among smokers (86.7%), followed by e-cigarette users (53.3%) and non-smokers (26.7%). The differences observed for both gingival recession and bleeding on probing were statistically significant ($p < 0.001$). These findings indicate that exposure to tobacco products, whether through conventional cigarette smoking or e-cigarette use, is associated with a higher prevalence of periodontal tissue inflammation and destruction compared with non-smokers. The greatest burden of periodontal disease was observed among conventional smokers, while e-cigarette users demonstrated intermediate findings between smokers and non-smokers.

Discussion

The present study compared periodontal health among e-cigarette users, conventional smokers, and non-smokers and demonstrated clear differences among the three groups. Conventional smokers exhibited the poorest periodontal status, followed by e-cigarette users, whereas non-smokers showed the most favorable periodontal health. Smokers demonstrated higher plaque accumulation, gingival inflammation, probing pocket depth, gingival recession, and bleeding on probing compared with the other groups. Although the periodontal parameters observed among e-cigarette users were generally less severe than those among smokers, they remained poorer than those observed among non-smokers. These findings suggest that both smoking and vaping may adversely influence periodontal tissues, with conventional smoking exerting the greater effect.

The destructive effects of smoking on periodontal tissues occur through several biological mechanisms. Smoking impairs neutrophil function, alters immune and inflammatory responses, reduces antibody production, suppresses fibroblast activity, and delays wound healing. Nicotine-induced vasoconstriction reduces blood supply to the gingival tissues, often masking visible signs of inflammation such as gingival bleeding, despite active underlying periodontal destruction. Smoking also promotes colonization by pathogenic periodontal microorganisms, further increasing susceptibility to periodontal breakdown [4, 10].

Although e-cigarettes eliminate some combustion-related toxins, their aerosol still contains nicotine, flavouring chemicals, aldehydes, heavy metals, and ultrafine particles that may adversely affect oral tissues. Experimental evidence suggests that exposure to e-cigarette aerosols can induce oxidative stress, inflammatory responses, epithelial cell injury, and microbial imbalance in the oral cavity. These effects may potentially contribute to periodontal tissue damage similar to that seen with conventional smoking [7, 12].

In the present study, the mean plaque index was significantly higher among conventional smokers (1.86 ± 0.28) compared with e-cigarette users (1.18 ± 0.23) and non-smokers (1.10 ± 0.19). Similar findings were reported by Aljoghaiman et al., who observed significantly greater plaque accumulation among cigarette smokers than among non-smokers and reported an intermediate plaque burden among e-cigarette users, suggesting that nicotine-containing products promote biofilm retention irrespective of delivery method [14]. Likewise, Panariello et al. concluded in their umbrella review that e-cigarette use contributes to increased plaque accumulation and microbial dysbiosis, although the effects remain less severe than those associated with conventional smoking [15]. The findings of the present study closely mirror these observations and support the hypothesis that tobacco exposure promotes plaque accumulation in a dose-dependent manner.

The gingival index was significantly higher among smokers (1.67 ± 0.31) than e-cigarette users (0.98 ± 0.20) and non-smokers (0.87 ± 0.18). These findings are consistent with those reported by Charde et al., who demonstrated elevated gingival inflammation among e-cigarette users compared with healthy controls and attributed these changes to oxidative stress and increased inflammatory cytokine production induced by vaping aerosols [16]. Similarly, Mohajeri et al. reported increased gingival inflammation among users of electronic nicotine delivery systems, suggesting that e-cigarette aerosols exert pro-inflammatory effects on periodontal tissues despite the absence of tobacco combustion products [17]. The intermediate gingival index values observed among e-cigarette users in the present study further support these conclusions.

Probing pocket depth represents a critical marker of periodontal destruction. In the present investigation, conventional smokers demonstrated the greatest probing depth (3.67 ± 0.41 mm), followed by e-cigarette users (3.14 ± 0.32 mm) and non-smokers (2.13 ± 0.28 mm). These results are in agreement with the systematic review and meta-analysis conducted by Thiem et al., who reported significantly deeper periodontal pockets among smokers and e-cigarette users than among non-smokers, with cigarette smokers exhibiting the most severe periodontal breakdown [18]. Similarly, Alkattan et al. found that e-cigarette users demonstrated significantly greater probing depths and attachment loss than non-smokers, although the severity remained lower than that observed among conventional smokers [19]. Furthermore, Alnufaiy et al. reported

significantly increased probing pocket depth and clinical attachment loss among e-cigarette users compared with healthy controls, reinforcing the notion that vaping contributes to periodontal tissue destruction [20]. The present findings corroborate these studies and suggest that periodontal destruction increases progressively with greater exposure to tobacco-related products.

With regard to gingival recession, 66.7% of e-cigarette users and 60.0% of smokers exhibited recession, whereas no recession was identified among non-smokers. These findings are comparable to those reported by Aljoghaiman et al., who demonstrated a significantly higher prevalence of gingival recession among both cigarette smokers and e-cigarette users compared with non-smokers. The authors proposed that nicotine-mediated vasoconstriction, impaired fibroblast proliferation, and reduced collagen synthesis may contribute to gingival soft-tissue breakdown and recession [14]. The current findings therefore provide additional clinical evidence supporting the detrimental effects of nicotine-containing products on gingival tissues.

Bleeding on probing was observed in 86.7% of smokers, 53.3% of e-cigarette users, and only 26.7% of non-smokers. These results align with the findings of Shabil et al., whose systematic review demonstrated significantly increased bleeding on probing and gingival inflammation among e-cigarette users compared with non-smokers [21]. Likewise, Charde et al. reported elevated inflammatory biomarkers and greater clinical signs of gingival inflammation among individuals exposed to e-cigarette aerosols, supporting the biological plausibility of the present findings [16]. The substantially higher prevalence of bleeding among conventional smokers observed in the current study may be attributed to cumulative tobacco exposure and longer duration of use.

An important finding of the present study was the absence of significant differences in oral hygiene practices among the three groups. Brushing frequency, brushing technique, type of toothbrush, use of interdental aids, and tongue-cleaning habits were comparable across all groups. This observation is consistent with the findings of Alnufaiy et al., who reported that differences in periodontal outcomes persisted even after controlling for oral hygiene behaviors, suggesting that tobacco exposure itself acts as an independent risk factor for periodontal disease [20]. Consequently, the poorer periodontal status observed among smokers and e-cigarette users in the present study is unlikely to be explained solely by differences in oral hygiene practices.

The present findings are consistent with recent systematic reviews conducted by Thiem et al., and Tattar et al., all of whom reported that e-cigarette users exhibit poorer periodontal health than non-smokers but generally better periodontal outcomes than conventional cigarette smokers [18, 22]. While vaping may represent a less harmful alternative to conventional smoking, accumulating evidence indicates that e-cigarette aerosols adversely affect periodontal tissues through mechanisms involving oxidative stress, inflammatory mediator release, microbial dysbiosis, and impaired wound healing [7, 12]. Therefore, e-cigarettes should not be considered a safe alternative to conventional tobacco products from a periodontal perspective.

The results of the present study support a dose-dependent relationship between tobacco exposure and periodontal destruction. Conventional smokers demonstrated the greatest burden of periodontal disease, e-cigarette users showed intermediate impairment, and non-smokers exhibited the healthiest periodontal status. These findings emphasize the need for comprehensive tobacco cessation programs and reinforce the importance of including e-cigarette use in routine periodontal risk assessment and patient counselling [22].

Limitations

The present study has certain limitations that should be considered while interpreting the findings. First, the cross-sectional nature of the study does not allow determination of a cause-and-effect relationship between tobacco use and periodontal disease. The study was conducted at a single center with a relatively small sample size, which may limit the generalizability of the findings to the wider population.

Information regarding smoking and e-cigarette use was obtained through self-reported responses and may therefore be subject to recall bias. In addition, only selected clinical periodontal parameters were assessed. Other important measures such as clinical attachment level, radiographic bone loss, microbiological analysis, and inflammatory biomarkers were not evaluated. These factors could have provided a more comprehensive understanding of periodontal status.

Furthermore, variations in e-cigarette characteristics, including device type, nicotine concentration, flavoring agents, frequency of use, and duration of vaping, were not analyzed separately and may have influenced the observed outcomes. Future studies involving larger sample sizes, multiple study centers, and longer follow-up periods are recommended to better understand the long-term effects of e-cigarette use on periodontal health.

Recommendations

Based on the findings of the present study, dental professionals should routinely assess both conventional cigarette smoking and e-cigarette use during periodontal examination and risk assessment. Tobacco cessation counseling should be incorporated into routine dental care, emphasizing that e-cigarettes are not risk-free alternatives to conventional smoking and may adversely affect periodontal health. Public health initiatives should focus on increasing awareness regarding the potential oral health consequences of vaping, particularly among young adults. Regular periodontal screening and preventive care should be encouraged among smokers and e-cigarette users for early detection and management of periodontal disease. Furthermore, future longitudinal studies with larger and more diverse populations are recommended to establish causal relationships and to investigate the effects of nicotine concentration, device type, flavoring agents, clinical attachment loss, radiographic bone loss, and inflammatory biomarkers on periodontal health.

Conclusion

The present study demonstrated significant differences in periodontal health among e-cigarette users, conventional smokers, and non-smokers. Conventional smokers exhibited the poorest periodontal status, with significantly higher plaque accumulation, gingival inflammation, probing pocket depth, and bleeding on probing, whereas non-smokers demonstrated the most favorable periodontal health. E-cigarette users showed intermediate periodontal findings,

indicating that although vaping may be less harmful than conventional smoking, it is not without adverse effects on periodontal tissues. The higher prevalence of gingival recession among both smokers and e-cigarette users further highlights the detrimental impact of nicotine-containing products on periodontal health. As oral hygiene practices were comparable across the study groups, the observed differences are likely attributable to tobacco and nicotine exposure rather than variations in oral hygiene behavior. Within the limitations of this study, it can be concluded that both conventional cigarette smoking and e-cigarette use are associated with compromised periodontal health, with conventional smoking exerting the greatest detrimental effect. These findings underscore the importance of tobacco cessation interventions, patient education, and increased awareness regarding the potential periodontal risks associated with e-cigarette use.

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