E-Cigarette Vaping and Periodontium: A Systematic Review

Ameer A. Altabatabaie[1], Ahmed A. Alquzweeni[2], Hussein A. Alnajar[3], Raya Ali Dalol[4]

[1]Research Scholar, Department of Conservative Dentistry, Faculty of Dentistry, University of Kufa, [2]Research Scholar, Department of conservative dentistry, Faculty of Dentistry, university of Kufa, [3]Research Scholar ,Department of orthodontics, Faculty of Dentistry, university of Kufa, [4]Research Scholar ,periodontics department, Nassir Almoussawy Specialized Dental Center

Abstract

Conventional cigarettes have shown severe toxicity on immune cells and wound healing in the periodontium, but little is known about the comparative effects of vaping or electronic cigarettes. If current conventional cigarette users are to transition to a less detrimental alternative, the evidence must demonstrate if electronic nicotine delivery systems can be deemed safer than conventional options. The intent of this literature is to summarize the evidences on the effect of E-cigarette on the periodontal health.

The main sources of evidence for this report included: a comprehensive report from National Academies of Sciences, Engineering, and Medicine, reviews published in the past 10 years.

As a conclusion, further investigation and studies are needed to evidence the effect of new smoking methods on the oral health of newly users and on the shifted persons who was previously tobacco smokers.

Keywords : *E-cigarettes , Vaping , Periodontium , Nicotine , Aerosols*

Introduction

In recent years, electronic e-cigarettes have been gaining popularity. The main purpose of invention of e-cigarettes was to replace the conventional cigarette for helping in smoking cessation [(1)]. E-cigarettes are the electronic devices that produce aerosol. Aerosol is a mixture of fine particles/ liquid droplets suspended in a gaseous medium [(2)].

Several authors have shown that tobacco smoking, was a risk factor in periodontal disease progression, and can also impair the effectiveness of periodontal treatment. Over the past years, a new mode of nicotine delivery has been introduced, claiming less harm to the consumer when compared to conventional smoking [(3)]. Electronic-cigarettes (e-cigs) represent a significant and increasing proportion of tobacco product consumption, which may pose an oral health concern. Different level evidence including systematic reviews of randomized control trials (RCTs) on the effect of E-cigs on the periodontium is currently lacking and the available data worldwide is necessary to allow further knowledge on this subject [(3)].

Corresponding author :
Ameer A. Altabatabaie
Research Scholar, Department of Conservative Dentistry, Faculty of Dentistry, university of Kufa,

E-Cigarettes

E-cigarettes or Electronic nicotine delivery systems (ENDS) are battery-operated devices that electronically heat a solution to create an inhalable aerosol. This solution, also known as 'e-liquid' or 'e-juice', is commonly made up of propylene glycol or glycerin, water, flavorings and nicotine (although many liquids do not contain nicotine) [(4)]. E-cigs are battery operated devices, which consist of a metal heating element in a stainless steel shell, a cartridge, an atomizer and a battery. The heating element vaporizes a solution containing a mixture of chemicals including nicotine and other additives/humectants, such as base/carrying agent's propylene glycol, glycerin/ glycerol, and flavoring agents including fruit and

candy flavors. Apart from inhaled nicotine, variable levels of aldehydes and carbonyls are detected in e-cig aerosols during vaporizations [5,6]. E-cigarettes are also commonly referred to as 'vape pens', 'hookah pens' or 'e-hookah' among youth [7,8].

History of evolution

Electronic smoking devices are not a new phenomenon, with a patent being recorded in 1965 in the USA [9]. The modern rise of e-cigarettes is attributed to Hon Lik, a Chinese inventor, who filed a US patent in 2005 for an 'electronic atomization cigarette that contains nicotine without tar [10]. E-cigarette devices firstly introduced in the early 2000s [11]. Over the years, e-cigarettes have evolved to more complex devices that come in different shapes and sizes, also involved changes in device configuration and components [12].

Newer versions of e-cigarettes, such as JUUL pods, incorporate nicotine salts in a novel product design . These more recently available products have a higher nicotine content, have become immensely popular with users, particularly among youth, and account for a major portion of the e-cigarette market share in the US at this time [13].

Types of E-Cigarettes

First generation: Also known as ciga-likes/minis. It is low cost and disposable. 200-300 puffs per cartridge which is equivalent to 1 pack of 20 cigarettes. It has limited battery life. The nicotine delivery is poor.

Second generation: Also known as 'tanks'. It resembles a pen. It contains a tank which is refillable. It has larger batteries and is rechargeable.

Third generation: Also known as 'mods'. It has advanced features like adjustable voltage systems and is digitalized [14].

Content of fluid and vapor

Most studies have used conventional cigarettes as reference and investigated presence or concentrations of substances that are known to be harmful in conventional cigarettes. Some of the studies performed in vitro experiments with cells exposed to fluid or vapour, for example to test for cytotoxicity or viral defense [15]. These studies are also mentioned in this section. Many studies found that the product labels did not show the ingredients (e.g. flavours, solvent, nicotine) or that the declaration did not correspond with the concentrations found (e.g. of nicotine) [15] . The following ingredients may be found :

1-Glycols.

2-Nicotine.

3-Particles. One study found that e-cigarette liquids generate many nanoparticles, up to 3000 times more than found in ambient air [16] .

4-Metals. Such as lead and chromium, nickel, tin, silver and aluminum [17] .

5-Tobacco-specific nitrosamines.

7-Carbonyls.

8-Volatile organic compounds.

9-Hydrocarbons and polycyclic aromatic hydrocarbons.

10-Phenols [15] .

Effects of smoking on periodontal diseases

Epidemiological studies have demonstrated that tobacco use is a significant risk factor for the development of periodontal diseases [14]. Disease severity increases with the frequency of smoking [18]. Smokers accumulate markedly more dental calculus than do non-smokers, and the quantity of calculus is correlated with the frequency of smoking [14]. Smoking is also associated with an increased risk of periodontal attachment loss and formation of periodontal pockets, as well as alveolar bone loss .

The adverse effects of smoking on the periodontium correlates well with both the quantity of daily consumption and the duration [19]. Approximately half of the cases of periodontitis in the United States have been attributed to smoking [20]. Smokers were recorded to have a 2.5 to 3.5 times greater risk of severe periodontal attachment loss [14].

Mechanism of the effect of tobacco on the periodontal tissue:

The main property of nicotine is the vasoconstrictive effect at the end-arterial vasculature of the gingivae and other tobacco components can also induce tissue necrosis and ulceration seen in the disease. Smokeless tobacco users known to possess a painless loss of gingival tissues and alveolar bone destruction in the area of chronic tobacco contact, as a result of collagen breakdown due to increased release of collagenase [22] . Nicotine inhibits the growth of gingival fibroblasts and their production of fibronectin and collagen [23]. Furthermore, oral leukocytes, especially neutrophils, may exhibit diminished ability to migrate and phagocytose, and they contribute to the inactivation of tissue proteinase inhibitors [23] . Tobacco smoking may exert a masking effect on gingival symptoms of inflammation, which might give smoking patients a false sense of assurance of gingival health [22]. Interleukin-1 genotype positive smokers are more susceptible to severe adult periodontitis [24] .

Effect of e-cigarette on periodontal tissue

Since e-cigarettes became available in the markets, their safety and use as a substitute for tobacco smoking have been surrounded by medical and public controversy. However, a recent report by the Royal College of Physicians concluded that e-cigarettes are likely to be much safer than smoking [25] .

The effect of e-cigarette use on the gingival condition and inflammatory biomarkers has not yet been investigated [26] . E-cigarette users also have been known to develop lacy white patches on the gums, tongue or insides of the cheeks, a condition called an oral lichenoid reaction. Oral thrush also can develop in vapers, caused by an overgrowth of Candida yeast in the mouth [27].

It could cause a pretty significant burn, where you lose at least the top layer of skin, if not more. Device explosions also have caused people to lose teeth, the findings showed. For example, an estimated 2,035 people with electronic cigarette burn injuries were treated in U.S. emergency rooms between 2015 and 2017, more than 40 times the number of vaping burns reported between 2009 and 2015, researchers found [28] .

Nicotine and periodontal health

Nicotine is vasoconstrictor. It constricts the arteries and reduces the amount of oxygenated blood flow and nutrients to the gums thereby reducing the wbc's that provide anti-inflammatory action against harmful foreign substances. Three types of bacteria thrive in a deoxygenated environment which are porphyromonas gingivalis, aggregatibacter actinomycetem comitans, prevotella intermedia [29] . These bacteria are found in plaque, tartar and pocket depth of up to 3mm. This leads to the destruction of PDL and alveolar bone. Without sufficient blood gingival and periodontal tissues cannot be healthy. Also nicotine is a muscle stimulant which causes bruxism due to hyperactivity of the muscles [30] .

Cigarette smoke induces epidermal growth factor receptor-dependent redistribution of apical Mucin 1 and junctional beta-catenin in polarized human airway epithelial cells [31]. Desmoglein 3 and keratin 10 expressions are reduced by chronic exposure to cigarette smoke in human keratinized oral mucosa explants [32] .

Aerosols and periodontal health:

E-cigarettes produce aerosol. Aerosol can cause carbonyl inflammatory action. Also heat produced from the vapor leads to xerostomia . Saliva contains lysozymes that kill the bacteria. Therefore, xerostomia leads to formation of harbor for the bacteria to pool in. Especially in the advanced featured cigarettes the voltage is regulated at high temperature for more effect which causes xerostomia. When e-cigarettes are heated to high temperature it produces carbonyls like formaldehyde, acetaldehyde. Researchers have noted that Propylene based e-liquids produced more carbonyls. There were multiple user questionnaires/surveys that repeatedly detailed 'mouth and throat dryness and irritation' as one of the most common reported side effects of e-cigarette use [31,33] .

An in vitro study on periodontal ligament fibroblasts demonstrated decreased fibroblast proliferation rates with menthol additives [31]. The topical effects of nicotine are worthy of specific consideration. The nicotine in the aerosol is primarily absorbed in the buccal and pharyngeal mucosa, rather than the alveoli, demonstrating the potential to have effects on the oral tissues [34] .

Conclusion

Numerous studies over the past several years have made stronger correlations to the effects of conventional cigarette smoking on the periodontium. A systematic review has linked smoking to increased risk of tooth loss, periodontal attachment loss, deeper periodontal pockets, and more expansive alveolar bone loss. E-cigaratte vapor and conventional cigarettes, especially with flavoring chemicals, have been shown to contribute to the pathogenesis of periodontal disease as well as dysregulated repair responses. The damage done to myofibroblasts can affect the patient's ability to heal properly due to the decrease in wound contraction [34] .

The research explored in this review shows an association between E-cigaratte and detrimental effects on the periodontal tissues as well as the inflammatory immune response. However, further studies should be performed to establish a stronger association between vaporized metals and chemicals found in E-cigaratte and the effects on the periodontium.

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Source of Funding : Self

Conflict of Interest : Nil

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