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The effect of electric cigarette uses on oral health and the risk of dental caries: Implications for dental conservation practices

Putu Mariati Kaman Dewi [1,*] and Made Agustya Darma Putra Wesnawa [2]

[1] *Department of Conservative Dentistry, Faculty of Medicine, Universitas Udayana, Denpasar, Indonesia.*
[2] *Department of Pulmonology and Respiratory Medicine, Faculty of Medicine, Universitas Udayana, Denpasar, Indonesia.*

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Abstract

The use of electric cigarettes (e-cigarettes) has risen sharply, especially among teenagers and young adults, as an alternative to conventional cigarettes. Although perceived as safer, electric cigarettes have a significant impact on oral health, which in turn affects the practice of dental conservation. This literature review examines the effects of electric cigarette use on the oral mucosa, soft tissues, oral microbiota, saliva production, and risk of dental caries. Electric cigarette use can cause irritation and inflammation of oral tissues, alter the composition and function of oral microorganisms, and disrupt saliva production, which reduces buffering capacity and the remineralization process of enamel. As a result, the risk of dental caries increases, although it remains lower compared to conventional cigarette smokers. The clinical implications include the need for more thorough risk assessment, modifications in conservative dental care protocols, and effective education and prevention for electric cigarette users. This article emphasizes the importance of comprehensive understanding of the impact of electric cigarette in the context of dental conservation to improve the quality of care and therapeutic outcomes.

Keywords: E-Cigarette; Oral Health; Caries; Dental Conservation

1. Introduction

Recent years have seen a sharp rise in the usage of e-cigarettes, particularly among youth and young adults. Since electric cigarettes don't burn tobacco, many consumers believe they are a safer option than traditional cigarettes. Teenagers in Indonesia have been using electric cigarettes at an increasing rate in recent years. About 3-5% of Indonesian youths have tried or used electronic cigarettes, according to data from the Basic Health Research (Riskesdas) and associated surveys. This percentage is on the rise, particularly among those between the ages of 15 and 24 (1,2).

Approximately 20–30% of electric cigarette users report experiencing health concerns like coughing, throat discomfort, and moderate respiratory problems, according to multiple international research on the topic(2). Nevertheless, several studies are starting to demonstrate that using electric cigarettes can also have detrimental effects on dental health (3). Users of electric cigarettes are more likely to experience changes in the oral microbiota, gingival tissue inflammation, and irritation of the oral mucosa, all of which can raise the risk of periodontal disease and dental caries (4). Since the oral cavity serves as the primary entrance point for a variety of substances that can impact the soft tissues surrounding the teeth, oral health is a crucial component of conservative dentistry.

Dental caries, a complex condition impacted by interactions between microbes, the host, and the environment, is one of the primary problems with oral health (5). However, there is currently little precise information on the frequency of dental health problems such cavities among Indonesian adolescent e-cigarette users, which necessitates more

* Corresponding author: Putu Mariati Kaman Dewi

investigation. Although this risk is still lower than that of traditional cigarette smokers, international research indicates that electronic cigarette users often have a higher risk of dental cavities than non-users (6).

This literature review aims to examine the effects of electric cigarette use on oral health, with a particular focus on the risk of dental caries among electric cigarette users. This review is expected to provide a comprehensive overview of the impact of electric cigarette in the context of dental conservation and to serve as a scientific basis for clinical practice and patient education.

2. Composition and action mechanism of e-cigarette

Electric cigarettes are electronic devices that heat a special liquid (e-liquid) to produce an aerosol (vapor) that can be inhaled by the user. Although electric cigarettes are considered an alternative to conventional cigarettes, the composition of the liquid and its byproducts have specific characteristics that may potentially affect oral health.

2.1. Electric cigarette liquid composition (E-liquid)

- Electric cigarette liquid consists of several main components, such as (2,7)
- Nicotine: The main addictive substance also found in conventional cigarettes. Nicotine acts as a vasoconstrictor and can interfere with tissue healing processes as well as affect the local immune response in the oral cavity.
- Propylene Glycol: A solvent in electric cigarette liquids that functions as a medium for vapor production. Propylene glycol is hygroscopic and can cause dehydration of the oral mucosal tissues, thereby increasing the risk of irritation and inflammation.
- Glycerin (Vegetable Glycerin): A substance that provides moisture and sweetness to electric cigarette vapor. Glycerin is also hygroscopic and can affect the viscosity of saliva as well as the balance of the oral microbiota.
- Flavoring Agents and Additives: Various additional chemical compounds that provide aroma and taste to electric cigarette liquids. Some flavoring agents can be irritating and toxic to oral tissues, such as cinnamaldehyde and vanillin, which may cause oxidative stress in oral epithelial cells.

2.2. E-cigarette Action mechanism

When the user activates the electric cigarette device, the heating element (coil) heats the e-liquid to a temperature of around 200–250°C, producing an aerosol composed of liquid particles dispersed in the air. This aerosol is then inhaled by the user, allowing nicotine and other chemicals to enter the respiratory tract and oral cavity. Unlike conventional cigarettes, which produce smoke through combustion, electric cigarettes produce vapor containing liquid particles that can come into direct contact with oral tissues (8).

3. Impact of e-cigarette Mechanism on the Oral Cavity

3.1. The impacts of e-cigarette on the oral cavity include (4,6,7)

Direct Exposure: The vapor produced contains nicotine and other chemicals that come into direct contact with the oral mucosa, causing local irritation and inflammation.

Modifications in Saliva: Toxins in cigarette smoke cause DNA damage in secretory gland cells. Sphingomyelin, ceramide, and sphingosine, on the other hand, are known to have pro-apoptotic and antiproliferative characteristics. These sphingolipid actions are probably "activated" by cigarette smoke, which results in programmed cell death. Instead of being retained in the cell, ceramides are carried straight to the Golgi apparatus, where they undergo a transformation into derivative chemicals. The concentration of the chemicals we examined may be lowered by long-term irritation of the oral cavity with tobacco smoke toxins due to the depletion of sphingolipid reserves, which aims to lessen the negative effects of cigarette toxins on salivary gland secretory cells.

Oxidative Stress: Some flavoring agents and aerosol components can induce oxidative stress in oral epithelial cells, potentially damaging DNA and cell membranes, and accelerating inflammation and tissue degeneration.

Microbiota Changes: Exposure to electric cigarette aerosols can disrupt the balance of oral microbiota by promoting the growth of pathogenic bacteria involved in plaque and cavity formation.

By understanding the composition and mechanism of action of electric cigarette, dental health professionals can more accurately assess the risks faced by patients who use electric cigarette and design appropriate preventive and treatment strategies in dental conservation practice.

4. The Effects of e-cigarette on Oral Health

The use of electric cigarettes has become a global phenomenon that affects various aspects of health, including oral health. Although electric cigarette is often considered a safer alternative compared to conventional cigarettes, various studies show that electric cigarette still has negative effects on oral tissues that can impact the health of teeth and supporting tissues (2,4,8).

4.1. Irritation and Inflammation of Oral Tissues

Nicotine and other compounds found in e-cigarette vapor can directly irritate the gingiva and other soft tissues as well as the oral mucosa. Periodontal disease and mucosal problems can develop as a result of chronic inflammatory reactions brought on by repeated exposure.

4.2. Changes in Oral Microbiota Composition

Among the poisonous and irritating ingredients found in electric cigarette liquids are nicotine, propylene glycol, glycerin, and flavorings. By altering factors like pH, moisture, and nutrient availability, exposure to these chemicals can change the habitat of the oral microbiota and impact the growth and dominance of specific bacterial species.

4.3. Salivary Function Disorders

Saliva's antimicrobial qualities are also impacted by e-cigarette use. Similar to cigarette smokers, a group of e-cigarette users had lower salivary IgA and lysosome levels than non-smokers. As a result, lactoferrin, an iron-binding glycoprotein with immunomodulatory and anti-inflammatory properties, had higher levels in e-cigarette users' saliva than in non-smokers', indicating the presence of inflammatory processes. Salivary IgA levels are comparatively low. Nonetheless, they are more prevalent in people with periodontitis, suggesting a defense mechanism against bacterial biofilm antigens. Reduced salivary IgA levels can impede certain immunological responses and increase the severity of periodontitis. Although it also has antiviral and antifungal action, the lysosome is an enzyme that exhibits antibacterial qualities by triggering the destruction of bacterial cell walls. According to a different study, e-cigarette users' saliva had significantly higher levels of the interleukins IL-6 and IL-1β than that of non-smokers. In the development of dental and periodontal disorders, IL-6, IL-1β, and TNF-α act as mediators, stimulating tissue deterioration through an increase in matrix metalloproteinases. Nicotine can also have an impact on the autonomic nerve system, which controls salivation, which can lead to less stimulation of secretion. Propylene glycol and glycerin are hygroscopic substances found in e-cigarette vapor that have the ability to extract water from the tissues of the oral mucosa. Due to localized dryness of the mucosa and salivary glands, this effect lowers the volume and production of saliva. Exposure to electric cigarette vapor containing flavoring agents and other chemicals can cause irritation and inflammation of the mucosal and salivary gland tissues, disrupting the normal function of these glands. Reduced or poor-quality saliva impairs the mouth’s natural protective functions, such as mechanical cleaning, buffering, and enamel remineralization, thus increasing the risk of caries.

4.4. Risk of Dental Caries

Dental caries develops in an environment that is favorable due to a combination of salivary problems, tissue irritation, and microbiota alterations. Although the risk is still lower than that of traditional smokers, epidemiological studies indicate that electric cigarette users have a higher prevalence of dental cavities than non-users.

4.5. Impact on Healing and Treatment Success

Electric cigarette nicotine slows tissue regeneration and healing by causing vasoconstriction, which prevents blood flow to oral tissues. This negatively affects the success of dental conservation procedures and restorative treatments.

4.6. Potential Risk of Mucosal Lesions and Cancer

Exposure to chemicals in electric cigarette vapor can also cause oxidative stress and DNA damage in oral epithelial cells, which may increase the risk of developing precancerous lesions and oral cancer in the long term.

Therefore, even if electric cigarettes are thought to be a safer option than traditional cigarettes, using them still has several serious dangers for dental health. Conducting risk evaluations, educating patients, and creating suitable preventive and treatment plans for e-cigarette users are all crucial components of conservative dentistry.

5. The Impact of Electric Cigarette on Dental Caries

Dental caries is a multifactorial infectious disease involving the interaction between pathogenic microorganisms, the host (teeth and saliva), and environmental factors such as diet and lifestyle habits. E-cigarette use has been shown to affect several of these factors, thereby contributing to an increased risk of dental caries (2,9,10).

5.1. Changes in Microorganism Composition and Activity

Electric cigarette can alter the balance of oral microbiota by increasing the population of pathogenic bacteria involved in plaque and caries formation, such as Streptococcus mutans and Porphyromonas gingivalis. These changes increase the risk of dental caries and periodontal disease. In addition to altering the composition of oral microbiota, electric cigarette can also affect the metabolic activity of microorganisms present in the oral cavity. This is mainly related to the ability of bacteria to produce acids as metabolic byproducts, which is a key factor in the caries process. Some oral bacteria are capable of metabolizing nicotine and other chemical compounds contained in electric cigarette liquids. This metabolic process can produce organic acids such as lactic, acetic, and propionic acid, which lower the pH of the oral environment. The drop in pH creates acidic conditions that damage the mineral structure of teeth. Bacteria such as Streptococcus mutans and Lactobacillus spp, which are the main causative agents of caries, can increase their carbohydrate fermentation activity to acids when exposed to chemicals in electric cigarette. Nicotine has been shown to enhance the adhesion of these bacteria to tooth surfaces and stimulate their metabolism, leading to increased acid production. The acids produced by bacterial metabolism lower the pH at the tooth surface below the critical threshold (around pH 5.5), causing enamel demineralization. If these acidic conditions persist without adequate remineralization, the enamel will suffer structural damage that results in the formation of carious lesions.

5.2. Disruption of Salivary Function

Electric cigarette can reduce saliva production and alter its composition, thereby lowering the buffering capacity of saliva, which is vital for neutralizing acids produced by bacteria. Furthermore, decreased saliva also reduces the remineralization ability of enamel due to diminished availability of calcium and phosphate ions supplied by saliva. These conditions lead to a prolonged acidic environment and accelerate the caries process.

5.3. Increased Acid Production by Microorganisms

Nicotine and other chemicals in electric cigarette stimulate caries-causing bacteria to increase acid production as a result of their metabolism. These acids lower the pH on the tooth surface, causing enamel demineralization and carious lesion formation. This process becomes faster and more severe if electric cigarette users also frequently consume sweet foods or drinks.

5.4. Effects of Irritation and Inflammation on Tooth-Supporting Tissues

Exposure to electric cigarette vapor can cause chronic irritation and inflammation of the gums and supporting tissues, which can worsen periodontal conditions. Poor periodontal health can accelerate damage to the hard tissues of the teeth and increase the risk of root caries.

5.4.1. Comparison with Conventional Cigarettes

Although the risk of caries in electric cigarette users tends to be lower than in conventional cigarette smokers, electric cigarette users still have a higher risk compared to non-users. This indicates that electric cigarette is not a completely safe alternative for oral health (2,6).

In conclusion, electric cigarette contributes to an increased risk of dental caries through mechanisms involving changes in microbiota, disruption of saliva function, increased acid production, and tissue inflammation. Understanding these mechanisms is crucial for dentists to provide education, prevention, and appropriate management for patients who use electric cigarette.

6. Implications of Electric cigarette Use for Conservative Dental Practice

Electric cigarette use presents new challenges in conservative dental practice due to its complex impact on oral health. Dentists need to understand the risks posed by electric cigarette use to provide appropriate and effective treatment (2,5,7,10).

6.1. Risk Assessment

Risk assessment is a crucial initial step in conservative dental practice to identify factors that can influence oral health and the success of therapy. In patients who use electric cigarette, risk assessment must be carried out more thoroughly and comprehensively because of the multifactorial impact of electric cigarette on both hard and soft oral tissues.

6.2. Importance of Anamnesis and Electric cigarette use

Dentists need to collect complete information regarding the patient's history of electric cigarette use, including duration, frequency, type of electric cigarette liquid used, and other habits that might contribute to oral health risks. A detailed anamnesis helps identify exposure to chemicals that can trigger mucosal irritation, salivary disturbances, and changes in microbiota.

6.3. Comprehensive Clinical Examination

In addition to anamnesis, clinical examination should include evaluation of the condition of the oral mucosa, periodontal status, salivary function, and early signs of caries. Examination of salivary function, for example by measuring the rate of saliva secretion and buffering capacity, provides an overview of the mouth's natural protective function which may be disturbed due to electric cigarette use.

6.4. Additional Diagnostic Tools

In some cases, the use of additional diagnostic tools such as microbiological examinations to identify changes in microbiota, or digital imaging technology to detect early carious lesions, can assist in risk determination and more precise treatment planning.

6.4.1. Benefits of Thorough Risk Assessment

A comprehensive risk assessment enables dentists to classify patients based on their risk levels for caries and periodontal disease, allowing for the design of tailored treatment protocols. This also facilitates the delivery of specific and effective patient education regarding the importance of behavior modification and the prevention of complications (2,11).

6.4.2. Modification of Treatment Protocols

Due to possible tissue inflammation and impaired healing in electric cigarette users, dentists should consider a more cautious approach in restorative and endodontic procedures. The use of restorative materials with antimicrobial properties and protection against sensitivity may be considered.

6.4.3. Routine Monitoring and Follow-Up

Electric cigarette users require more intensive and regular monitoring to enable early detection of new caries development or soft tissue complications. This is important to prevent more extensive damage and to maintain dental function.

7. Prevention Strategies and Patient Education for e-cigarette Users

Prevention is a key aspect of dental conservation, especially for patients who use electric cigarettes. Proper education can help reduce the risk of complications and increase awareness of the importance of maintaining oral health(2–4).

7.1. Education on the Risks of Electric cigarette

Dentists should provide clear, evidence-based information about the negative impacts of electric cigarette on oral health, including the risks of caries, periodontal disease, and salivary disturbances. This education is important to encourage patients to reconsider their use of electric cigarettes.

7.2. Promoting Optimal Oral Hygiene

Patients should be encouraged to maintain good oral hygiene by brushing their teeth twice a day with fluoride toothpaste, cleaning between their teeth with dental floss, and using antiseptic mouthwash if necessary.

7.3. Use of Remineralization Products

The use of products containing fluoride, such as fluoride gels, varnishes, or special toothpastes, can help enhance the remineralization of enamel and protect teeth from demineralization caused by acid exposure.

7.4. Management of Xerostomia

For patients experiencing dry mouth due to electric cigarette, dentists can recommend saliva stimulants, saliva substitutes, or other treatments to increase oral moisture and patient comfort.

7.5. Smoking Cessation Counselling

If possible, dentists can refer patients to smoking cessation programs to help reduce or stop electric cigarette use, thereby minimizing oral health risks.

With these strategies, it is hoped that electric cigarette users can maintain optimal oral health and reduce the risk of complications that could affect the success of dental conservation therapy.

8. Conclusion

The use of electric cigarettes or electric cigarettes has a significant impact on oral health, especially in the context of dental conservation. Electric cigarette can cause irritation and inflammation of the oral mucosa and soft tissues, alter the composition and function of the oral microbiota, and disrupt the production and quality of saliva. The combination of these factors creates an environment conducive to the development of dental caries by increasing acid production by pathogenic bacteria and reducing the enamel's remineralization capacity. Although the risk of caries in electric cigarette users is generally lower than in conventional cigarette smokers, electric cigarette users still face a higher risk compared to non-users. Therefore, in dental conservation practices, it is important to conduct a comprehensive risk assessment, modify treatment protocols, and provide appropriate education and preventive strategies to electric cigarette users to maintain optimal oral health.

Compliance with ethical standards

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Disclosure of conflict of interest

The author declares no conflicts of interest.

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