Effects of Electronic Cigarettes on Oral Health

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Key points

- E-cigarettes and dental caries.
- Vaping harms the structure of teeth.
- Long-term exposure to E-cigarettes
- E-cigarette vapor causes mouth and tongue irritations.

Electronic cigarettes

An electronic cigarette is made up of a cylinder with a mouthpiece and a cartridge on one end that acts as a reservoir for "vaping" substances. The cartridge can be prefilled or refillable. As the e-cigarette's first, second, and third generations evolved, a variety of capacities were developed. Additionally, e-cigarettes have an atomizer, which is a heating element powered by batteries and is often and incorrectly referred to as a "vapor" by suppliers. This atomizer turns the liquid into an aerosol. A non-rechargeable or rechargeable battery, which may be made of nickel-cadmium, nickel-metal-hydride, lithium-ion, alkaline, lithium polymer, or lithium manganese, powers e-cigarettes. Since lithium batteries can store plenty of energy in a small amount of space, they are frequently used in e-cigarette technology.1

Liquids used in E-cigarettes

The liquids used in e-cigarettes contain nicotine which is transferred from the device to the user's airway in the form of aerosol.1

E-cigarettes promote dental caries

E-cigarette liquids have a high viscosity because of Propylene Glycol and Vegetable Glycerin. Aerosols

from these liquids are therefore likely to stick to exposed surfaces, such as the soft and hard tissues in the oral cavity and dental implants. This association may then encourage bacterial adherence, which could be paramount to dental illnesses like caries. According to a recent study, Streptococcus mutans were more likely to stick to enamel and develop a biofilm when inhaled through e-cigarette aerosols. When compared to controls, enamel exposed to flavored e-cigarette aerosols exhibited less hardness. High concentrations of esters (ethyl butyrate, hexyl acetate, and triacetin) detected in e-cigarette liquids were linked to this bacterially induced enamel demineralization.1

Adverse effects of E-cigarettes on teeth and tooth-supporting tissue

When using an e-cigarette, the aerosol comes into direct contact with the teeth and could distress the structure of the teeth. When the relationship between e-cigarette usage and several symptoms in teenagers was investigated, it became clear that vaping carried a greatly elevated risk of tooth destruction.1

E-cigarettes Liquid Vapor and the toxicity on oral cells

According to toxicology studies, e-cigarettes contain several hazardous substances, including nicotine, carbonyl, diacetyl, volatile organic compounds, ultrafine particles, and heavy metals like nickel, tin, and lead. According to Lerner et al. (2015), the reactive oxygen species activity in e-cigarette vapors is comparable to that of tobacco cigarette smoke. Report of substantial cytotoxicity and apoptosis induction to human gingival fibroblast cells following exposure to e-cigarette vapors for 48 hours supports the data. Human periodontal ligament fibroblasts treated with menthol-flavored e-liquid showed significantly lower proliferation rates compared to controls. Both fruit- and tobacco-flavored e-liquids were found to be injurious in another investigation that used nasopharyngeal tissues. As clinical trials are conducted as pilot studies with small sample sizes, there aren't many studies looking into the potential harm that e-cigarette vapors may cause to oral mucosa cells. It is well recognized that both environmental and civilizational factors can have an impact on a person's health and the way their tissues and organs function. One factor is smoking, which has a number of well-established negative consequences on human health. Although it has been said that e-aerosol contains fewer different chemical compounds and trace elements than cigarette smoke, prolonged exposure to aerosol can still be detrimental to the health of the oral cavity. In contrast to the advantages of using e-cigarettes, there is growing evidence of their hazards. Inhaling the heated e-cigarette fluid aerosols

produced by vaping, a tobacco-simulating alternative, is frequently thought to be less damaging. A report on the harmful effects of e-cigarettes on the progression of respiratory and dental disorders was released in 2018 by the National Academy of Sciences, Engineering, and Medicine. The mouth cavity's tissues are the first to encounter the inhaled e-aerosol and have direct chemical and toxicological interactions with it. Daily vaping is linked to poor oral health, there is little research on potential oral health changes after exposure to e-cigarettes, and there is some debate over the safety of e-cigarette use. Regular electronic cigarette users may take more puffs per day than in experimental laboratory trials, hence experimental studies often fail to accurately reflect real-world situations. The development and severity of periodontal disease, such as bleeding from gingival tissue after probing, the measurement of the amount of plaque (plaque index), the quantification of the gingival crevice as a marker of periodontitis, and the potential effects on the lining of epithelial cells and the oral microbiome should all be taken into account when evaluating the effects of e-aerosol exposure on the human oral cavity.3,5

E-cigarettes vapor and the impacts on oral mucosa

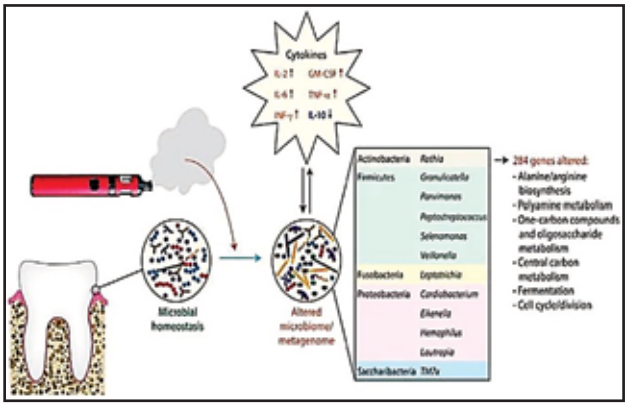
The heating of the vapor produced by an e-cigarette device has the potential to inflame soft tissue, including the minor salivary glands. According to recent reviews of case reports e-cigarette users have been reported to experience mouth and tongue soreness and irritations. According to the study, participants who used e-cigarettes for 30 days experienced mouth ulcers (8.3%) and bleeding on brushing (17.1%) more frequently than those who did not use e-cigarettes. In addition, e-cigarette users exhibited greater rates of hyperplastic candidiasis, nicotine stomatitis, and hairy tongue in the retro-commissural region than non-users. Akinkugbe (2019) found that a study on dual and e-cigarette users found that they were more likely to have debilitated oral health outcomes than they had previously reported. It can be claimed that e-cigarette smoking is not safe for all age groups even though most oral symptoms are self-reported with minimal longitudinal evidence and limited clinical evaluation.3

Throat Issues

There were numerous reports of throat problems. The majority of the throat effects were self-reported, descriptive, and unaffected by any other variables. Common minor and transient e-cigarette fluid ingestion or inhalation side effects included throat dryness.4

Microbiological evidence

Recent research suggests that using e-cigarettes may alter the oral microbiome's profile towards a condition that differs from that of nonsmokers or tobacco smokers. For instance, shotgun sequencing of pooled subgingival plaque samples from periodontally healthy e-cigarette users (without a history of smoking), smokers, and controls revealed nearly 300 genes that were enriched in e-cigarette users, encoding parts of pathways like arginine and alanine biosynthesis, metabolism of 1-carbon compounds and (oligo) saccharides, central carbon metabolism, fermentation, and cell cycle/cell division. Taxonomically, e-cigarette users' microbiomes were more diverse and had larger concentrations of numerous phyla and species, such as Actinobacteria, certain Firmicutes (such as Selenomonas and Veillonella), Fusobacteria, Proteobacteria, and Saccharibacteria.2



The metagenome and oral microbiome have been impacted by e-cigarette use. In comparison to nonsmokers who had never used e-cigarettes, those who self-reported not smoking tobacco had higher -diversity and enrichment of species within several genera of bacteria in subgingival dental plaque, according to data from Ganesan et al. (2020). The inset table lists the genera that comprise the species that, according to a second study were also more prevalent in the saliva of e-cigarette smokers. Changes in 284 genes, which code for a variety of metabolic pathways and other activities, were linked to e-cigarette use. Interleukin (IL)-2 and IL-6, granulocyte-macrophage colony-stimulating factor (GM-CSF), tumour necrosis factor (TNF), and interferon (IFN) were a few proinflammatory cytokines that were raised in e-cigarette users, while the anti-inflammatory cytokine IL-20 was decreased.2

DNA Damage in Oral Cells

The primary objectives of current research typically center on the pulmonary effects of e-cigarettes in both in vitro and in vivo models, as well as the study of the mechanisms of the inflammatory response and oxidative stress. There are few studies comparing DNA damage in oral cells between e-cigarette users and non-users. According to the International Agency for Research on Cancer's (IARC) Group 2A classification, acrolein is probably carcinogenic to

humans. In a recent study, researchers measured the amount of -OH-Acr-dGuo in oral buccal cells of e-cigarette users and non-users of any nicotine-containing product using a validated liquid chromatography-nano electrospray ionization-high-resolution tandem mass spectrometry approach. Analysis of urine biomarkers (total nicotine equivalents and cyanoethyl mercapturic acid) confirmed the use of e-cigarettes. The level of -OH-Acr-dGuo in e-cigarette users was 179 fmol/mol dGuo (range: 5.0–793 fmol/mol dGuo), but it was 21.0 fmol/mol dGuo (range: 5.0–539 fmol/mol dGuo) in non-users ($p = 0.001$).In oral cells from smokers, levels of -OH-Acr-dGuo were 446 fmol/mol dGuo (range: 158–5830 fmol/mol dGuo), which is comparable to a previous research of this adduct in smokers' oral cells and much higher than those of e-cigarette users. These findings serve as a cautionary tale although that possible effects of -OH-Acr-dGuo concerning oral diseases in e-cigarette users are still unknown. Increased DNA adduct production from acrolein in the oral cavity may indicate a potential increased risk of cancer.6

Conclusion

Given the constantly changing nature of the products and the difficulty in identifying potential e-cigarette effects in patients with a history of combustible tobacco use, researching the impact of e-cigarette usage on oral health is a difficult task. Despite the scant evidence, it does appear that using e-cigarettes may have negative effects on oral health. The evidence of oral health effects for persons using e-cigarettes as a tobacco quit help is dubious and confounded by the significant oral health changes that occur when users stop smoking tobacco. Finding out the effects of e-cigarette use as a tobacco cessation aid (especially in the dental setting) and determining any effects on smokers' periodontal health when they switch to e-cigarettes are the areas with the greatest potential to help patients.2

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