International Journal of Science and Research (IJSR)
ISSN: 2319-7064
ResearchGate Impact Factor (2018): 0.28 | SJIF (2018): 7.426

Dental Public Health Reports on Periodontal Response to Electronic Cigarettes Vaping: A Literature Review

Maria Dimitrova

DMD, Resident, Department of Social Medicine and Public Health, Faculty of Public Health, Medical University – Plovdiv, Bulgaria

Abstract: ***The use of e-cigarettes has increased worldwide nowadays, and so is the need of awareness of the pathogenic changes in the periodontium it causes. Due to the anti-proliferative properties of nicotine, the fibroblasts' differentiation is impeded. This leads to periodontitis and other harmful effects on the periodontal ligament. The flavorings, heavy metals, metal particles and other chemicals in the electronic cigarette aerosol, such as reactive oxygen species, aldehydes and carbonyls, lead to inflammation, protein carbonylation of the extracellular matrix and DNA damage. Further research is required in order to prevent oral disease by administering safety regulations and promote oral health by informing the society about the possible adverse effects of electronic cigarettes vaping.***

Keywords: e-cigarettes, ENDS, vaping, periodontium, dental public health

1. Introduction

The use of e-cigarettes, or the so-called "vaping", has increased dramatically nowadays, especially among young adults. Palazzolo, D., 2014, reports that manufacturers promote their products as a cheaper and safer smokeless alternative to traditional cigarettes, and a possible cessation tool. [15] According to Woodcock, J., 2013, the Food and Drug Administration (FDA) has informed the President of the Electronic Cigarette Association about "violations of good manufacturing practices, making unsubstantiated drug claims, and using the devices of delivery mechanisms for active pharmaceutical ingredients". [27] Westenberger, BJ, 2009, claims that e-cigarette cartridges and solutions were reported to contain nitrosamines, diethylene glycol and other potentially harmful to humans ingredients. [25] FDA also states that the sale of e-cigarettes should be prohibited or regulated as dangerous nicotine delivery systems. [16] Javed, F. et al., 2017; Reibel, J., 2003; Stoykova, M., N. Musurlieva, D. Boyadjiev, 2014, report that while the effect of smoking tobacco on the progression of periodontal diseases and other adverse outcomes is well-described, the information regarding the impact of e-cigarettes vaping on oral and dental health is scarce. [7, 19, 22] The aim of the current review is to summarize the current data on the topic.

Electronic Nicotine Delivery Systems (ENDS)

According to Javed, F. et al., 2017, ENDS (electronic cigarettes, e-cigs) are battery-operated devices, consisting of a metal heating element in a stainless steel shell, a cartridge, an atomizer and a battery. [7] Numerous authors describe the ingredients in the solution - Barrington-Trimis, JL et al., 2014; Cheng, T., 2014; Gerloff, J. et al., 2017; Javed, F. et al., 2017; Jensen RP et al., 2015; Kosmider, L. et al., 2014. They reach the conclusion that the heating element vaporizes a solution, which contains diverse chemicals, such as nicotine (at high concentration – up to 24 mg) and other additives (humectants) – base/carrying agents, propylene glycol, glycerin, and different flavoring agents, including fruit and candy flavors – ortho-vanilin (vanilla), maltol (malt), cinnamaldehyde, coumarin, etc.; chemicals such as aldehydes (carbonyls), heavy metals (nickel, chromium, copper, silver), metal nano-particles, and tobacco specific itrosamines, as well as diacetyl, 2,3-pentanedione, and acetoin (buttery). [2, 4, 5, 7, 8, 9]

Cellular Senescence of the Periodontium

Javed, F. et al., 2017, state that oxidative stress leads to stress-induced cellular senescence (a state of irreversible growth arrest which re-enforces chronic inflammation) and impaired myofibroblast differentiation and epithelial mesenchymal transition. [7] According to Sundar, IK et al., 2016, ENDS affect the receptors in the periodontal ligament, therefore the cellular signaling in periodontal fibroblasts and gingival epithelial cells. [23] Javed, F. et al., 2017, explain that these processes are implicated with regulation of inflammation and cellular senescence. [7]

Periodontal Disease

The definition of periodontal disease according to Carranza, F. et al., 2014, is that it comprises of a group of inflammatory conditions of the supportive tissues of the teeth that are caused by bacteria. [3] The author describes that periodontal ligament cells, gingival fibroblasts and epithelial cells play a fundamental role in periodontal regeneration. Upon stimulation or stress, these cells are able to incite and maintain inflammatory responses [3] Smoking causes loss of periodontal attachment level, deepening of the periodontal pockets, and more extensive alveolar bone loss, as well as connective tissue and matrix lysis. According to Carranza, F. et al., 2014; Javed, F. et al., 2014; Musurlieva, N., M. Stoykova, 2015; Musurlieva, N., M. Stoykova, D. Boyadjiev, 2012; Reibel, J. et al., 2003; Stoykova, M., N. Musurlieva, D. Boyadjiev, 2014, these etiological factors lead to an increased risk of periodontitis, the progression of which impairs the quality of life of the patients. [3, 6, 13, 14, 19, 22] Lerner, CA et al, 2015, state that the concentration of reactive oxygen species in the e-cig aerosols is comparable to conventional cigarette smoke. [11] Moreover, Sancilio, S. et al., 2015, and Willershausen, I., 2014, claim that direct exposure to e-liquids has also been proven to produce harmful effects in periodontal ligament cells and gingival fibroblasts in culture. [21, 26] Reactive aldehydes and carbonyls from the aerosol can cause protein

carbonylation and DNA damage. Pradeep, AR et al, 2013, report that protein carbonylation causes auto-antibody production, which may lead to destruction of matrix and bone loss. [17] Therefore, carbonyls and aldehydes play an important role in oral health damage, caused by vaping. Rothem, DE et al., 2009, explain that nicotine presents with anti-proliferative properties and affects fibroblasts *in vitro*. [20] Lei, W. et al., 2017, state that this affects oral myofibroblast differentiation, thus reducing the wound-healing ability by decreasing wound contraction by myofibroblasts. [10]

The nicotine concentration in ENDS varies significantly. Numerous studies - Al Amri, MD et al., 2016; Levin, L. et al., 2005; Raes, S. et al., 2015; Twito, D. et al., 2014 – prove that nicotine is associated with impaired leukocyte activity and healing by inhibiting neovascularization and osteoblastic differentiation, as well as an increased risk of implant failure, impaired healing, poor papilla regeneration, and increased bone loss. [1, 12, 18, 24]

2. Conclusion

Electronic cigarettes contribute to the pathogenesis of periodontal disease and other oral complications due to the inhaled nicotine, flavorings and other chemicals. They affect the periodontal ligament, stem cells and gingival fibroblasts and reduce the wound healing ability because of the decreased release of pro-inflammatory mediators. Further research is required in order to prevent oral disease by administering safety regulations and promote oral health by informing the society about the possible adverse effects of electronic cigarettes vaping.

References

[1] Al Amri, MD, SV Kellesarian, TS Abduljabbar, MQ Al-Rifaiy, AM Al Baker, AA Al-Keraif. Comparison of Peri-Implant Soft Tissue Parameters and Crestal Bone Loss Around Immediately-Loaded and Delayed Loaded Implants Among Smokers and Nonsmokers: 5-Year Follow-Up Results. J Periodontol, 2016, 1–12.
[2] Barrington-Trimis, JL, JM Samet, R. McConnell. Flavorings in electronic cigarettes: an unrecognized respiratory health hazard? JAMA, 2014, 312:2493–2494.
[3] Carranza, F. et al. Carranza's Clinical Periodontology, 12th Edition, 2014.
[4] Cheng, T. Chemical evaluation of electronic cigarettes. Tob Control, 2014, 23(Suppl 2):ii11–ii17.
[5] Gerloff, J., IK Sundar, R. Freter, ER Sekera, AE Friedman, RJ Robinson, T. Pagano, I. Rahman. Inflammatory response and barrier dysfunction by different e-cigarette flavoring chemicals identified by GC-MS in e-liquids and e-vapors on human lung epithelial cells and fibroblasts. Applied In Vitro Toxicology, 2017, Mar, 1;3(1):28-40.
[6] Javed, F, H. Bashir Ahmed, GE Romanos. Association between environmental tobacco smoke an periodontal disease: a systematic review. Environ Res. 2014, 133:117–22.
[7] Javed, F., SV Kellesarian, IK Sundar, GE Romanos, I. Rahman. Recent Updates on Electronic Cigarette Aerosol and Inhaled Nicotine Effects on Periodontal and Pulmonary Tissues. Oral Dis., 2017, Nov; 23(8): 1052–1057.
[8] Jensen RP, W. Luo, JW Pankow, RM Strongin, DH Peyton. Hidden Formaldehyde in E-Cigarette Aerosols. The New England journal of medicine. 2015, 372:392–394.
[9] Kosmider, L., A. Sobczak, M. Fik, J. Knysak, M. Zaciera, J. Kurek, ML Goniewicz. Carbonyl compounds in electronic cigarette vapors: effects of nicotine solvent and battery output voltage. Nicotine Tob Res. 2014, 16:1319–1326.
[10] Lei, W., C. Lerner, IK Sundar, I. Rahman. Myofibroblast differentiation and its functional properties are inhibited by nicotine and e-cigarette via mitochondrial OXPHOS complex III. Scientific Reports. 2017, Mar 3, 7:43213. doi: 10.1038
[11] Lerner, CA, IK Sundar, RM Watson, A. Elder, R. Jones, D. Done, R. Kurtzman, DJ Ossip, R. Robinson, S. McIntosh, I. Rahman. Environmental health hazards of e-cigarettes and their components: Oxidants and copper in e-cigarette aerosols. Environ Pollut, 2015, 198:100–107.
[12] Levin, L., D. Schwartz-Arad. The effect of cigarette smoking on dental implants and related surgery. Implant Dent. 2005, 14:357–361.
[13] Musurlieva, N., M. Stoykova. Evaluation of the impact of chronic periodontitis on individual's quality of life by a self-developed tool. Biotechnology & Biotechnological Equipment, 2015, 29(5):1-5
[14] Musurlieva, N., M. Stoykova, D. Boyadjiev. Validation of a scale assessing the impact of periodontal diseases on patients' quality of life in Bulgaria (pilot research). Braz Dent J., 2012, 23(5):570-4.
[15] Palazzolo, D. Electronic Cigarettes and Vaping: A New Challenge in Clinical Medicine and Public Health. A Literature Review. Front Public Health, 2013, 1:56.
[16] Pandemic and All-Hazards Preparedness Reauthorization Act of 2013 Federal Food, Drug and Cosmetic Act as Amended through 2013, Pub L No 113-5, 127 Stat 161, http://www.gpo.gov/fdsys/pkg/PLAW113publ5/pdf/PLAW-113publ5.pdf
[17] Pradeep, AR, MV Ramchandraprasad, P. Bajaj, NS Rao, E. Agarwal. Protein carbonyl: An oxidative stress marker in gingival crevicular fluid in healthy, gingivitis, and chronic periodontitis subjects. Contemporary clinical dentistry. 2013, 4:27–31.
[18] Raes, S., A. Rocci, F. Raes, L. Cooper, H. De Bruyn, J. Cosyn. A prospective cohort study on the impact of smoking on soft tissue alterations around single implants. Clin Oral Implants Res. 2015, 26:1086–1090.
[19] Reibel, J. Tobacco and oral diseases. Update on the evidence, with recommendations. Medical principles and practice : international journal of the Kuwait University, Health Science Centre, 2003, 12(Suppl 1):22–32.
[20] Rothem, DE, L. Rothem, M. Soudry, A. Dahan, R. Eliakim. Nicotine modulates bone metabolismassociated gene expression in osteoblast cells. Journal of bone and mineral metabolism. 2009, 27:555–561.

[21] Sancilio, S., M. Gallorini, A. Cataldi, V. di Giacomo. Cytotoxicity and apoptosis induction by ecigarette fluids in human gingival fibroblasts. Clinical oral investigations. 2015, Apr, 20(3):477-83.
[22] Stoykova, M., N. Musurlieva, D. Boyadzhiev. Risk factors for development of chronic periodontitis in Bulgarian patients (pilot research). Biotechnology & Biotechnological Equipment, 2014, 28 (6):1150-1154.
[23] Sundar, IK, F. Javed, GE Romanos, I. Rahman. E-cigarettes and flavorings induce inflammatory and pro-senescence responses in oral epithelial cells and periodontal fibroblasts. Oncotarget, 2016, Nov 22;7(47):77196-77204.
[24] Twito, D., P. Sade. The effect of cigarette smoking habits on the outcome of dental implant treatment. PeerJ. 2014, 2:e546.
[25] Westenberger, BJ. Evaluation of e-Cigarettes. St. Louis, MO: Department of Health and Human Services, Food and Drug Administration, Center for Drug Evaluation and Research, Division of Pharmaceutical Analysis, 2009, http://www.fda.gov/downloads/drugs/Scienceresearch/UCM173250.pdf
[26] Willershausen, I., T. Wolf, V. Weyer, R. Sader, S. Ghanaati, B. Willershausen. Influence of Esmoking liquids on human periodontal ligament fibroblasts. Head & face medicine. 2014, 10:39.
[27] Woodcock, J. Letter to Mr. Matt Salmon, President, Electronic Cigarette Association., 2013, http://www.fda.gov/downloads/Drugs/GuidanceComplianceRegulatoryInformation/UCM225263