

E – Cigarettes - Failure to replace conventional means

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Abstract

Electronic cigarettes had been introduced as an alternative smoking option for people addicted to smoking. It was an aid for smokers to reduce the habit and eventually quit smoking. But it represents as a significant and an increasing option for tobacco consumption. It was observed that majority of population switched to vaping and a lot more started vaping as e cigarettes became a trend in the society. This has also increased the concerns of growing side effects and negative impression of electronic cigarettes. The effect of nicotine on systemic, oral and periodontal health is well known. Electronic cigarettes have nicotine levels at much lower levels as compared to conventional smoking devices, but it still is proven to be equally toxic.

Along with nicotine, the glycerin and flavoring agents have their own adverse effects affecting youth health and the lithium batteries have proved to be harmful too. Thus, the aim of electronic cigarettes of replacing the conventional means of smoking hasn't been satisfying and proven. The following review throws light on the details of electronic cigarettes related to their history, contents and their effects on the systemic, oral and periodontal health.

Keywords: e – cigarettes, electronic cigarettes, vaping, nicotine, periodontitis, wound healing, respiratory, public health

Introduction

Periodontal disease symbolizes long – standing inflammation of the tooth supporting apparatus. It

creates a complex coaction between the subgingival biofilm and the host immune–inflammatory events. The changes are seen in the gingival and periodontal tissues due to invasion of bacteria.

The burned leaves of tobacco give out smoke, aspiration of this smoke is considered as tobacco inhalation which is most commonly done in the form of cigarettes. People who smoke are at a risk of presenting with periodontitis two to seven times more than people who don't. ^{[1][2]}

They also are at high risk of developing tooth loss during periodontal maintenance than the non-smokers. ^[3]

Smoking has always been considered as a notable risk factor for many systemic diseases like lung carcinoma, respiratory diseases, and cardiovascular diseases. ^[4] Use of tobacco also affects dental health by speeding the onset, severity and progression of periodontal disease. ^{[5][6]}

E-cigarettes are electronic devices that deliver a heated aerosol of nicotine fabricated in a manner that impersonates traditional cigarettes, but it provides lower levels of toxins than there is in traditional combusted cigarette. ^[7]

Electronic Nicotine Delivery Systems (ENDS), also known as e-cigarettes, are capable of delivering nicotine without tobacco combustion. ^{[8][9]} The basic mechanism of these battery-powered devices is heating of a liquid mixture containing propylene glycol or glycerin, along with nicotine, flavorants, and other additives (e liquid) and devise an inhalable aerosol (vapor). ^[8] The other names for E-cigarettes are electronic nicotine delivery systems (ENDS), vapor pens, e-hookah, and vape pipes, and vary considerably in design. The contents of E-cigarette aerosol have been found to be made up of ultrafine particles and known toxins. These mainly include acetaldehyde, acrolein, toluene, and

formaldehyde, albeit. But these toxins are at much lower levels than found in cigarette smoke. ^[10]

Terminologies

- Vapor: gaseous particles of drugs
- Vaping: process of inhaling vapor from personal vaporizer
- Vaper: people who use e – cigs

History

A brief history has been mentioned in Table 1

Types of E – Cigarettes

Defined in Table 2

Components

1. Battery: largest part of E – cigarette usually a lithium – ion and rechargeable
 2. Cartridge: it is a reservoir for holding a solution that typically contains nicotine
 3. Atomizer: heating element that allows vaporization
 4. Mouthpiece through which the user puffs.
 5. LED light that glows when you inhale
- The device heats a liquid solution (often called e-liquid or e-juice) into an aerosol that is inhaled by the user. E-liquid typically uses propylene glycol and/or glycerin as a solvent for the nicotine and flavouring chemicals
 - The e-liquids in e-cigarettes are most often flavored; a study estimated that 7,700 unique flavors exist (Zhu et al. 2014) and that most of them are fruit or candy flavors.

How does an E – Cigarette work? ^[11]

E – Cigarette is a battery-operated device. Its battery is to be activated by the user. The user inhales through the mouthpiece or pushes a button which activates the e – cigarette. Activation of the battery vaporises the e – liquid. The liquid which is inhaled and gives nicotine in the atmosphere when exhaled is stored in the reservoir or refillable cartridges.

The inhaled vapour delivers nicotine to lungs. And it is exhaled in the atmosphere when the user exhales.

Figure 1 illustrates the process of electronic cigarette smoking

Brands and costs

- According to Global Adult Tobacco Survey (GATS 2) 2016-17, an estimated 0.02% Indian adults use e-cigarettes.
- The InVIA members undertook studies and came to the conclusion that the electronic cigarettes are mainly sold in the urban cities of India and is owned by people in the age group over 30 years.
- Vapes in India available at a range of price. It costs as low as Rs. 150 and it may go up to Rs. 1200 – 2000 for the popular ones.
- There is availability of single-use or disposable e-cigarette as well and it costs from \$2 to \$20 each or more.
- Similarly, rechargeable kits with a number of pods can cost in the range of \$20 to \$200 or more. The liquid refills for kits at around \$50 to \$75 monthly are also available for sale.

Effects of each component

Table 3 lists the effect of each component of electronic cigarettes

Effects on systemic health

- may increase cardiovascular stress^[20], increased heart rate, endothelial cell toxicity, and impaired flow-mediated dilatation^[29]
- may trigger oxidative stress and neuronal apoptosis, DNA damage, reactive oxygen species and increase in lipid peroxide^[21]
- may have negative effects on human airways by affecting the secretion of immune system proteins^[22]
- may cause respiratory alteration, pro-fibro genic and dysregulated repair due to inspired nicotine

- may affect the capability of wound healing and repair process of the mesenchymal stem cells^[22]
- it increases mitochondrial ROS, DNA nuclear fragmentation and impaired stability of electron transport chain complex IV subunit on human lung fibroblasts^[27]
- Inhaled nicotine can have detrimental results on the pulmonary system and cellular homeostasis.
- Impairs lung endothelial barrier function by causing dose related deleterious effects.^[30]
- Causes inflammation associated with increased intracellular ceramides and myosin light chain phosphorylation.^[30]

Nicotine binds nicotinic acetylcholine receptors (nAChRs), which are expressed in fibroblasts and epithelial cells of the lung^[23]. These receptors trigger protease expression^[24], mucin production^[25] and smooth muscle contraction^[26], which contribute to airway obstruction in chronic obstructive pulmonary disease (COPD).

Studies have concluded a positive relation of effects of nicotine on asthmatic adolescents^[28] but the cause of this relationship is uncertain.

Effects on oral health

- stress-induced cellular senescence^[31]
- impaired myofibroblast differentiation and epithelial mesenchymal transition^[31]
- upregulation of RAGE (receptor for advanced glycation end products) which are present in the human oral fibroblasts and gingival epithelial cells^[31]
- may affect the signaling capacity of the cellular components in periodontal ligament fibroblasts and mesenchymal stem cells.^[31]

- hyper keratinization and inflammation of the minor salivary glands (Nicotine stomatitis) due to high temperature smoke. [29]

Effects on periodontal health

- morphologic changes of gingival fibroblasts when exposed to nicotine containing e – liquid [32]
- decreased response to inflammation and reduced bleeding on probing [33]
- cause protein carbonylation and DNA damage leading to destruction of matrix and bone loss during periodontitis due to autoantibody production, [31] this occurs due to the reactive aldehydes/carbonyls present in the aerosol
- affects oral myofibroblast differentiation thus affecting wound healing and wound contraction, [31] this is an effect due to the release of prostaglandins (PGE2) and matrix metalloproteases (MMP-9, MMP-12) as well as their effects on MSCs
- cells exposed to the liquid of the electronic cigarette containing nicotine present with reduced viability and clonogenic survival, with this there is also an increased rate of apoptosis and necrosis [34]
- due to nicotine, the leukocyte activity is impaired and healing is inhibited due to effects on neovascularization and osteoblastic differentiation

Ban on E – cigs in various countries

Table 4

Ban on E – cigs in India

- Punjab was the first Indian state to ban vaping in 2014. Since then, vaping products have been banned in 12 other states.
- On the occasion of World, No Tobacco Day on May 31, 2019 Maharashtra and Rajasthan became the latest states to enact this ban.

- Considering the health risks to the young adults and its increasing addiction; on 18th September 2019, the Indian government announced a ban on electronic cigarettes.

- There was an approval by the Union Cabinet on banning the production, import, distribution and sale of electronic cigarettes.

Conclusion

In conclusion, after having known about all the known facts about e – cigs, its effects on human health and oral health, e – cigs prove to cause deleterious effects. It may not be as harmful as the conventional cigarette but it thus affects the periodontal health and the nicotine effects are also seen. These reasons have led to the banning of e – cigs which were a hope to replace the conventional smoking.

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Table 1: History of electronic cigarettes

	History
1963	Herbert A Gilbert, from Beaver Falls PA, patented smokeless non – tobacco cigarette. It basically contained a content replacing burning tobacco and paper with a heated, flavored, moist air.
2003	Hon Ilk, from Beijing China, gave the first commercially successful electronic cigarette. He was a pharmacist, inventor and smoker.
2006	Electronic cigarettes introduced to Europe.
2007	Electronic cigarettes introduced to the U.S.
2010	A federal district court of US ruling determined that e-cigs were according to FDA’s regulation a tobacco product rather than as a drug delivery device.

Table 2

First generation	Second generation	Third generation	Fourth generation
Similar to conventional cigarettes Called cigalikes Disposable designed for 1-time use	shaped like pens have larger – capacity and rechargeable batteries Some allow manual control of both puff length and frequency.	usually larger and more customizable than second generation Low-resistance cartomizers produce higher heating element temperatures	pod-style comes with fix voltage and various shaped batteries has many new entries

Table 3: Effects of each component

Propylene glycol:	It is one of the major products of e cigarettes liquid It is a viscous and colourless liquid and is lightly sweet It is used in food processing and mainly in the production of polymers It can be used as a vehicle for numerous variety of inhalant pharmaceutical products, including nicotine PG disintegrates into acetic acid, lactic acid, and propionaldehyde in oral cavity which are all virulent to enamel and soft tissue. ^[12] PG causes xerostomia by bonding of the PG molecules to the water molecules in saliva and oral tissues, leading to tissue desiccation. ^[13]
Vegetable glycerin and flavorings	It is a colourless, odourless, viscous, and sweet liquid It various roles to play in various fields including medical, pharmaceutical, and personal care. It performs the function of a humidifying agent, solvent, and sweetening agent in the field with food industry. It is almost sweet as sucrose, if quantified then up to 60%. It’s not broken down by the cariogenic bacteria, so therefore its thought that it doesn’t cause cavities. ^[15] However, there have been studies

	<p>where it has been observed that glycerine when combined with flavorings has produced four times the chance of microbial adhesion to enamel and two times increase in the chance in biofilm production. ^[14]</p> <p>The liquid of the e – cigarette is viscous in consistency and this lets Streptococcus mutans to attach to the pits and fissures. To put it in another way, e – liquid gives preference to the cavity – causing bacteria to adhere to the softer tooth and thus cause rampant decay. ^[15]</p>
Nicotine	<p>The content of nicotine in percentage is much lower (0.3%–1.8%) in electronic cigarettes than the conventional tobacco products but one electronic cartridge (200–400 puffs) can be comparable to smoking of two to three packs of regular conventional cigarettes. ^[16]</p> <p>There has been facts and literature suggesting that nicotine affects gingival blood flow as it is a vasoconstrictor. It affects cytokine production by altering it, disturbs neutrophil function, and other immune cell function. ^[17] Moreover, nicotine down regulates the turnover of connective tissue.</p> <p>Due to nicotine, the leukocyte activity is impaired and healing is inhibited due to effects on neovascularization and osteoblastic differentiation. ^[17] Likewise, nicotine present in tobacco smoking is related with an elevated risk of implant failure, impaired healing, poor papilla regeneration, and increased bone loss ^[18]. Considering these facts it is possible that the nicotine present in the e-cig, derived from the liquid may affect and alter healing potential at the bone/implant interface. The other reason affecting healing potential because of nicotine may also be due to impair functions of MSCs or resident stem cells. ^[19]</p> <p>Inhalation of nicotine causes oxidative stress and vascular remodelling and it may activate inflammatory response in periodontal tissues. Carbonylation of extracellular matrix and deposition of modified matrix is caused due to oxidative stress. All these results are in relation with the initiation of oral submucosal fibrosis.</p>
Lithium Batteries	<p>Problems have occurred with the vape pens and the lithium batteries overheating and exploding. Lithium battery explosions are usually triggered due to improper charging of the electronic device. It also depends on the type of device called a mechanical mod that has no internal safety and can overheat and explode. ^[15]</p>

Table 4: List of countries which banned electronic cigarettes

March 2008	Sale banned by Turkey's Health Ministry
September 2008	The World Health Organization (WHO) reveals that e cigarettes are not considers legal aid for cessation of smoking
January 2009	<p>Australia banned e cigarettes and stated that nicotine consumed in all form except for replacement therapies and cigarettes are considered as a form of poison.</p> <p>After World Health Organization raised its concerns on effect of e cigarettes on youth health, the Ministry of Health of Jordan banned the import of these electronic devices.</p>
March 2009	Import, sale and advertising of electronic cigarettes banned in Canada

	Electronic cigarettes banned by Hong Kong Department of Health
June 2009	The importation, sale and distribution of electronic cigarettes debarred in Panama
July 2009	Importation and sales prohibited by Israeli Health Ministry
August 2009	Brazil stopped the sale, importation and advertisement of electronic cigarettes Saudi Arabia bans sales of electronic cigarettes
September 2009	California debarred the sales of electronic cigarettes in the state by passing a bill
November 2009	New Jersey State legislators pass a bill banning electronic cigarettes usage in public
March 2010	The Ministry of Public Health of banned the import and sale of electronic cigarettes.
July 2010	Singapore bans e-cigarette importation, distribution and sales.
May 2011	Resolution passed by Argentina on banning the importation, distribution, commercialization and advertising of e-cigarettes and equipment related to them.
December 2011	Sale and import of electronic cigarettes is banned by the Minister of Health of Holland
April 2012	Venezuela's government imposed a ban and fine up to \$8,400 for those who distribute or promote electronic cigarettes