

SCOPING REVIEW

Effect of Electronic Cigarette Smoking after Tooth Extraction on the Incidence of Alveolar Osteitis

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ABSTRACT

Background: Tooth extraction is one of the minor dental surgical procedures involving the hard and soft tissues of the oral cavity and has several possible complications. One potential risk is alveolar osteitis, also known as dry socket, which is an inflammation marked by intense pain and the dislodging of the blood clot. Smoking behavior is a significant risk factor for alveolar osteitis. **Objective:** This article aimed to analyze the effect of smoking and electronic cigarette ingredients on the incidence of alveolar osteitis after tooth extraction. **Material and Methods:** This research was conducted as a scoping review by performing a thorough search of the PubMed, Scopus, ScienceDirect, and Google Scholar databases. Research published between 2013 and August 2023 in the English language was assessed in this review. **Result:** A total of ten papers have been included in the analysis. Comparative studies consistently demonstrated that individuals who engage in smoking are at a significantly elevated risk of developing alveolar osteitis following tooth extraction. **Discussion:** Both conventional and electronic cigarettes can dislodge the blood clot that forms at the tooth socket after tooth extraction as a result of the sucking movement involved in smoking. Electronic cigarette components reduce oxygen delivery to healing tissues, hence accelerating fibrinolysis. **Conclusion:** Electronic cigarettes affect the occurrence of alveolar osteitis by the act of smoke inhaling and the presence of substances like carbon monoxide and nicotine.

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Highlights

1. Smoking is a notable and extensively debated risk factor for problems following tooth extraction, but research on electronic cigarettes remains scarce.
2. Electronic cigarettes contain various components comparable with those in conventional cigarettes, potentially resulting in similar chemical composition and effects on alveolar osteitis.

BACKGROUND

Tooth extraction is the process of removing tooth from its socket. This is a minor dental surgical procedure involving the hard and soft tissues of the oral cavity (Lande et al., 2015). Extracted teeth may consist of complete teeth that require care in other areas, or teeth with crowns or roots that cannot be maintained. Ideal tooth extraction involves performing the procedure painlessly and with minimal damage to the surrounding dental tissues, allowing for complete healing of the extraction site (Ananda, et al., 2016).

All dental treatment procedures have the same possible complications or risks as extraction. Complications can be classified as intraoperative, immediately after, and long after extraction (Gowda et al., 2013). Common risk factors for difficulties during tooth extraction often include systemic disease, patient age, the condition of the tooth roots, and the existence of temporomandibular joint diseases (Badan Penelitian dan Pengembangan Kesehatan, 2013).

Complications in the extraction procedure include bleeding, swelling, pain, dry socket, fracture, and mandibular dislocation (Chandha, 2014). Dry socket or alveolar osteitis as a complication is a disorder in wound healing in the form of inflammation, which includes one or all parts of the solid bone layer in the tooth socket (lamina dura) in the form of intra-alveolar blood clot disintegration starting from the second to fourth day after tooth extraction (Khitab, et al., 2012). In Indonesia, the reported incidence rate of dry sockets following tooth extraction ranges from 0.5% to 5%. Tooth extraction is a frequently performed procedure, with a higher prevalence observed in mandibular molars, ranging from 3% to 38% (Ananda, et al., 2016).

Patients with dry sockets exhibit both subjective and objective symptoms, including intense pain, absence of blood clot in the socket due to clot rupture, accumulation of food debris in the socket, swelling and slight redness of the gingiva, halitosis, and exposed bone (Akinbami & Godspower, 2014). The exact cause of alveolar osteitis is uncertain. Various factors are thought to impact the occurrence of alveolar osteitis, including extraction-related trauma, unskilled operators, third molars, systemic disease, medication, gender, infection, curettage, age, and smoking (Suri, et al., 2021).

Smoking is recognized as a prevalent form of addiction on a global level. There are over 1.1 billion smokers worldwide, resulting in more than 8 million deaths per year (Ahmed, et al., 2021). According to the World Health Organization's 2020 report, Indonesia has over 225,700 deaths each year as a result of smoking or diseases linked to tobacco use. Indonesia has consistently high rates of tobacco use among both adults and youth, as indicated by national surveys conducted in 2013 and 2018, despite the global trend of decreasing tobacco usage. There has been no decline in the proportion of adults affected over the course of these five years. However, the proportion of teenagers aged 10 to 19 who smoke has risen from 7.2% in 2013 to 9.1% in 2018 (World Health Organization, 2020).

Smoking serves as a significant factor contributing to various oral and systemic diseases. The impact of smoking on oral health encompasses a range of negative consequences, ranging from aesthetic issues like stained teeth to more serious and potentially fatal conditions such as oral cancer (Kuśnierek, et al., 2022). Research in the past has consistently shown that smokers exhibit a greater occurrence, severity, and advancement of periodontitis in comparison to former smokers or non-smokers (Ahmed, et al., 2021).

A study conducted by Kuśnierek, et al., (2022) found an association between the incidence of dry sockets and smoking. However, they encounter challenges when attempting to relate the summarized results to individual studies due to variations in the extraction methods (surgical and non-surgical), types of tooth extraction, and the number of cigarettes consumed. The ingredients in cigarettes that can cause dry sockets are nicotine, carbon monoxide, and hydrogen cyanide.

Currently, there is an increasing inclination among young people to use alternative tobacco products, such as electronic cigarettes (EC) and water pipes (shisha, narghile, and hookah) (Münzel, et al., 2020). The purpose of the EC is to assist persons who are having difficulty quitting smoking and to bypass regulations in areas where smoking is prohibited. These marketing strategies have demonstrated significant efficacy, especially among the younger demographic. In 2018, the Food and Drug Administration (FDA) reported that more than 3.5 million middle and high school pupils participated in electronic cigarette (EC) or vaping activities (Irusa et al., 2020).

OBJECTIVE

This article aimed to analyze the effect of smoking electronic cigarettes after tooth extraction on the incidence of alveolar osteitis.

MATERIAL AND METHOD

This scoping review was conducted by extensively searching the [PubMed](#), [Scopus](#), [ScienceDirect](#), and [Google Scholar](#) databases. The keywords used for the search were electronic cigarette, electronic cigarette contents, sucking action, tooth extraction, alveolar osteitis, electronic cigarette, and incidence of alveolar osteitis. The papers were then filtered through a qualitative and quantitative selection.

The inclusion criteria were research published between 2013 and August 2023 in English language. The investigations were limited to papers that specifically examined the effects of electronic cigarettes on the occurrence of alveolar osteitis following tooth extraction. The inclusion criteria encompassed human studies, in vitro and in vivo research, literature reviews, and reports. The analysis removed publications that were not relevant to the issue.

The studies' data and analysis were screened independently by qualified and expert reviewers. After a primary check on the research title, every abstract of the identified papers was assessed at the first screening level. The full text of the included papers was obtained. Furthermore, they were classified for qualitative synthesis. The electronic database research identified a total of 49 manuscripts. Thirty-one duplicates had been deleted from the screening, and 31 papers had been considered for the full-text evaluation. 11 full texts were not found, and ten full texts were out of topic to be excluded. Finally, ten papers in all had been incorporated into the analytical synthesis.

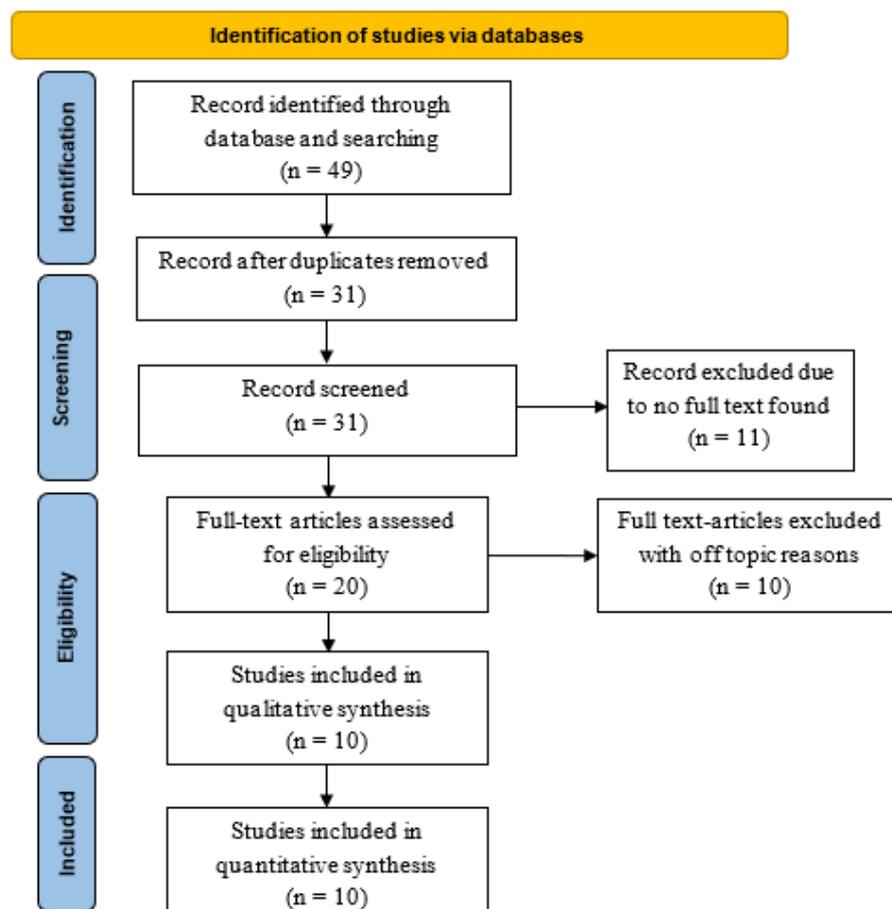


Figure 1. PRISMA flowchart of the study design and manuscript-selection process.

RESULT

The main effects of smoking on the risk of getting alveolar osteitis after having a tooth extraction, either by themselves or in combination with other factors, are shown in Table 1.

Table 1. Impact of conventional and electronic cigarettes after tooth extraction on the incidence of alveolar osteitis.

References	Sample size/studies	Result
Vettori, et al., (2019)	1701 patients	In the Unit of Oral Surgery in Trieste, 1701 exodontic procedures were performed, resulting in the extraction of 2322 teeth. It was observed that individuals with coagulopathy and those who smoked were at a higher risk of developing alveolar osteitis (with odds ratios of 5.51 and 2.5 and p-values of 0.035 and 0.029, respectively).
Mudali & Mahomed (2016)	2214 patients	Two thousand two hundred fourteen patients visited the dental clinic for tooth extraction, removing 2281 permanent teeth. Of the extractions, 42 cases were complicated by dry sockets, with a female predominance of 2:1. Smoking was the most common predisposing factor in males, with 72% (10 out of 14) of those with dry sockets having a smoking history.
Sharma (2021)	460 patients	The study involved 460 patients, consisting of 280 males and 180 females, who required the extraction of mandibular third molars. Regarding dry sockets, 14 males and 20 females experienced this complication. Among the patients with dry sockets, 30 were smokers, and 26 had systemic diseases. These differences were also statistically significant ($p < 0.05$).
Poluan, et al., (2022)	Ten studies	After performing an odontectomy, it was observed that smokers had a higher occurrence of dry sockets than non-smokers. This correlation is linked to certain cigarette components, namely nicotine, carbon monoxide, and hydrogen, which seem to influence the development of dry sockets.
Nandhini & Ramani (2020)	1300 patients	A total of 1300 tooth extractions were carried out at private dental colleges and hospitals. The overall occurrence of dry sockets was recorded at 0.5%. The primary contributors to the development of dry sockets were found to be surgical trauma and smoking.
Kuśnierek, et al., (2022)	11 studies	This systematic review incorporated eleven studies, covering data from ten distinct countries and 10,195 participants. The studies' findings reporting dry sockets' occurrence in smokers suggested a prevalence of approximately 13.2%. In contrast, non-smokers had an estimated prevalence of dry sockets of around 3.8%.
Singh, et al.,	86 patients	The research was carried out on 86 adult patients who

(2019)		needed surgical removal of impacted mandibular third molars. Among these patients, 46 were males and 40 were females. Five individuals in male group and four individuals experienced the development of dry sockets. The incidence of dry sockets was notably higher among patients with a smoking habit.
Beit (2017)	1185 patients	One thousand nine hundred twenty-one dental extractions were performed on 1185 patients, comprising 647 (54%) males and 538 (46%) females, aged 16 to 81. The occurrence of dry sockets was 10.76% among smokers, whereas it was 3.25% among non-smokers. This difference was deemed statistically significant with a p-value of 0.001.
Kumar & Sukumaran (2015)	420 patients	This study involved 420 patients, and 444 extractions were included. Among them, 48 patients experienced dry sockets, with only one female patient showing signs of this condition. The findings also revealed a clear association between smoking and an increase in dry socket development compared to non-smokers.
Eshghpour & Nejat (2013)	189 patients	During the study, researchers recorded 49 cases of dry sockets, resulting in an incidence rate of 19.14%. The data analysis indicated that both smokers and users of oral contraceptives had higher occurrences of dry sockets when compared to non-smokers, former smokers, and women who were not using oral contraceptives, respectively. The statistical analysis demonstrated significant differences between these groups ($p < 0.05$).

DISCUSSION

A dry socket is a disorder of healing that occurs after forming a mature blood clot but before the blood clot is replaced by granulation tissue (Ananda et al., 2016). Alveolar osteitis is characterized by intense pain, rupture of the blood clot so that the socket is empty without clot, the socket is often filled with food debris, there is mild swelling and redness of the gingiva, halitosis, exposed bone, etc (Akinbami & Godspower, 2014). The prevalence of alveolar osteitis ranges from 0.5% to 5%, with the greatest occurrence observed in mandibular third molars.

The correlation between cigarette smoking and oral health has been firmly established over a considerable period of time. Electronic cigarettes (EC), containing several components comparable to those found in cigarettes, have the potential to cause similar effects on the oral mucosa (Münzel, et al., 2020). EC formulations comprise three key components: a base, nicotine, and various flavours. All three elements can negatively affect oral health (National Academies of Sciences, Engineering et al., 2018).

All of the ten studies proved that individuals who smoke had a higher risk of experiencing alveolar osteitis compared to non-smokers. Several studies stated that cigarette ingredients and the smoking process caused delayed wound healing, which manifested as dry sockets. Mudali & Mahomed (2016) discussed the incidence and predisposing factors for dry sockets following extraction of permanent teeth in 2214 patients. The total occurrence rate of dry sockets was 1.8%, with a higher prevalence among females in their twenties and thirties, particularly affecting mandibular molars. The most common contributing factors were smoking, oral contraception, and a combination of both, alongside a traumatic extraction. Vettori, et al., (2019) conducted a study involving 1701 patients who underwent tooth extraction, encompassing all types of teeth. Their objective was to assess the type and frequency of complications arising from exodontic procedures, their connection to antibiotic administration, and

systemic factors in patients. The study found that smoking habits and coagulopathy presentation were associated with a higher risk of postoperative alveolitis. Another study by [Sharma, \(2021\)](#) aimed to identify the risk factors for dry sockets. The study sample comprised 460 patients who underwent the removal of third molars, with 280 male and 180 female patients. The results revealed that 90 patients experienced dry sockets, and among them, 30 were smokers.

The explanation for the higher likelihood of dry socket occurrence in smokers is the act of sucking on a cigarette. Inhaling from an EC involves a similar sucking action as smoking cigarettes, as it draws the vapor into the lungs. Consequently, the possibility of developing a dry socket from vaping is comparable to that of traditional cigarette smoking. The sucking action can dislodge the blood clot that forms at the tooth socket. The components in the EC also participate in the occurrence of dry sockets ([Chow et al., 2020](#)).

Carbon monoxide (CO), an inorganic compound, can also be found in EC. Carbon monoxide (CO) is a gas produced when organic molecules are not completely burned. Its toxicity to humans stems from its ability to bind to haemoglobin irreversibly. The production of CO in EC can occur through the thermal decomposition of base materials like propylene glycol and glycerin, along with certain flavouring compounds. Smoking leads to the presence of carbon monoxide (CO) in the bloodstream, which hampers the delivery of oxygen to the healing tissues, resulting in a reduction in the levels of oxygenated hemoglobin ([Nandhini & Ramani, 2020](#); [Poluan, et al., 2022](#)).

Nicotine can interfere with oxygen supply, which results in a lack of blood flow to the tissues through a vasoconstrictive effect. Nicotine stimulates sympathetic nerve activity and releases epinephrine, decreasing blood perfusion to tissues and peripheral vasoconstriction ([Poluan, et al., 2022](#)). Limited blood perfusion in the socket area causes a lack of oxygen which results in an increase in the process of fibrinolysis. Locally increased fibrinolysis leads to the disintegration of the clot by conversion of plasminogen to plasmin. After removal, the activator will be released through the plasminogen pathway, causing fibrin to form. The activator can be a direct activator that is released after trauma and an indirect activator that is released due to bacteria ([Gowda, et al., 2013](#)).

Strength and limitations

This paper described a thought-provoking subject to inspire authors and researchers to delve deeper into the matter. There is a wealth of research comparing the ingredients in traditional and vaping cigarettes, as well as the relationship between traditional cigarettes and alveolar osteitis. This facilitates the identification of possible connections to cases of alveolar osteitis. However, there appears to be a deficiency of studies specifically examining the impact of electronic cigarette smoking on the incidence of dry socket.

CONCLUSION

Electronic cigarettes, which are currently a trend among young people, have an influence on the healing process after tooth extraction in the form of alveolar osteitis. The effect of electronic cigarettes on alveolar osteitis is partly due to the process of inhaling smoke, which causes dryness of the wound. The content of CO and nicotine causes a decrease in oxygen supply to the socket area.

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Conflict of Interest

All authors have no conflict of interest.

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Author Contribution

DDAP contributes to conception and design, analysis and interpretation of the data, drafting of the article, critical revision of the article for important intellectual content, final approval of the article and provision of study materials. IM and AS contributes to administrative, technical, or logistic support and provision of study materials.

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