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Review Article

Diagnostic pitfalls of tobacco smoking: The effect of nicotine addiction on the oral cavity – Literature review



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ABSTRACT

Introduction: Tobacco smoking is acknowledged to be the most dangerous risk factor for many diseases. Tobacco enters the organism through the oral cavity. Here, both local and systemic effects of smoking are visible. One of many clinical symptoms caused by smoking is “diagnostic masking.” The World Health Organization has recognized nicotine addiction as a chronic and recurring disease which requires a comprehensive therapy. A dentist can be the first person who begins such a therapy.

Aim: To present the effect of smoking on the condition of the oral cavity with reference to its masking influence and to promote an anti-nicotine attitude.

Material and methods: This article is based on a review of the medical literature.

Results and discussion: Making patients aware of the negative effects of nicotine on one's organism is more difficult if they do not notice or experience negative symptoms of smoking. **Conclusions:** The hazards associated with tobacco smoking have been known for a long time and confirmed with research results. The so-called “masking symptoms” should not escape a physician's attention. A lack of reddening, swelling and bleeding of the gums during probing in smoking patients does not prove that they do not suffer from a periodontal disease. The presence of lesions typical of smoking in the oral cavity does not mean they should not be differentiated from diseases which pose threat to life and health. Thus it is indispensable to perform additional diagnostic procedures to avoid hypodiagnosis. Numerous unfavorable consequences of cigarette smoking which occur in the oral cavity and elsewhere should be presented as warnings and posted on tobacco products' packaging.

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1. Introduction

Nicotine addiction affects many people in Poland. According to the World Health Organization (WHO) report of 2010, tobacco smokers constitute 28% of the Polish population (on the basis of the research conducted in 2008).¹² A comparative analysis of the WHO data collected over more than 10 years indicates that the percentage of men smoking cigarettes has slowly decreased, yet the percentage of smoking women has remained stable since 1999.^{12,13,14} Data found in literature concerning the subject show that one in five deaths results from tobacco-induced diseases.⁴

Smoking tobacco products has been considered a risk factor for the development of numerous diseases and a modifying factor in their course. This is due to the fact that tobacco smoke contains harmful substances which have antigenic, cytotoxic, carcinogenic and mutagenic effects on the human organism. As research has shown, cigarette smoke contains 4000 potentially toxic substances, whilst nicotine is the most recognizable component of tobacco.^{6,15}

Numerous oral cavity diseases are connected to nicotine addiction. Lesions caused by tobacco can be divided into systemic and local, with the latter resulting from a direct impact on the oral cavity. Some symptoms are very typical of smokers and are not life-threatening. However, the similarity of some lesions caused by tobacco smoking to other dangerous diseases has to be taken into consideration in the diagnostic process.

2. Aim

The main aim of this article is to present the effect of tobacco smoking on the condition of the oral cavity and to point attention to differences between symptoms in smoking and non-smoking patients, and as a consequence to encourage physicians to introduce a minimal anti-nicotine intervention in their practice.

3. Material and methods

This article is a review of the medical literature, health reports and media reports.

4. Results

Data from the WHO report indicate that the prevalence of smoking among people over 15 years of age in Poland has slightly changed over the last decade or so. A greater decrease in the number of smokers has been observed in men – between 1994 and 2001 it amounted to 2.0%, and between 2005 and 2010 the percentage of smoking men dropped from 37.6% to 33.2%. Among women, no such decrease has been observed. Data for the 1994–1998 period show that 24.0% of women smoked, and in 2001, 2007 and 2010 this number did not change and amounted to 23.0%.^{12,13,14} Generalizing, it can be assumed that in 2010 one-third of Poles smoked cigarettes. This indicates that every third person who visits a medical office is a smoker and can exhibit

problems associated with this addiction. Table 1 presents the percentage of women and men smoking cigarettes in Poland over the last dozen years or so.

The effects of tobacco smoking on the oral cavity can be considered with regard to local as well as systemic aspects. The local impact of tobacco smoke is evident in the form of the following pathologies:

- hygienic negligence,
- discolored teeth and dentures,
- halitosis, unpleasant body odor,
- increased caries, as an indirect effect of smoking cigarettes,
- changes in microbiota,
- pigmentation changes involving the oral mucosa,
- disorders of oral keratosis,
- xerostomia,
- fungal infection,
- black hairy tongue,
- neoplasms of the oral mucosa.

Neglecting the hygiene of the oral cavity is more often found in smokers than in non-smokers. Numerous studies confirm these findings.^{2,6} According to some authors, such neglect results from devoting an insufficient amount of time to hygienic activities.² Still other authors emphasize that a less hygienic condition of the oral cavity in smokers is fostered by an increased mineralization of the plaque, which in turn facilitates the development of both supragingival and subgingival calculus deposits.⁶ The nicotine deposit penetrates into the enamel and dentine as well as fillings and dentures, causing unsightly black and dark brown stains on these structures. Additionally, an unpleasant odor emanating from the mouth can be detected, which also results from smoking. Halitosis occurs because tobacco smoke includes many odorous gases which permeate the smoker's body and clothes. The smoker is very often not conscious of these drawbacks concerning their addiction. Masking the unpleasant smell is not a good solution to this problem, since breath refreshing products contain sugars and citric acid, which foster the development of caries. In consequence, caries becomes another indirect effect of smoking cigarettes.⁶ Changes in the oral microbiota which are caused by smoking have been the subject of many studies. Most recent reports indicate that the effect of smoke coupled with the influence of bacteria has harmful outcomes.²

Table 1 – Percentage of male and female smokers in Poland.

Years	Sex	
	Female (%)	Male (%)
1994–1998	24.0	44.0
1999–2001	23.0	42.0
2007–2005	23.3	37.6
2010–2008	23.2	33.2

Changes in the content of microbiota are also influenced by the reduced amount of saliva in smokers, thus stimulating the development of a fungal infection. The reduced amount of saliva makes chewing, swallowing and speaking more difficult. Thick saliva at the bottom of the oral cavity is saturated with harmful substances from tobacco smoke which affect tissues. Such saliva becomes a carrier of toxins. During every examination of the oral cavity, it is important to assess thoroughly the tissues in the area of the so-called saliva drainpipe. In this area, preneoplastic lesions as well as neoplasms themselves frequently develop. Lesions caused by smoking also include disorders of oral keratosis. An increase of temperature in the oral cavity relating to smoking causes microburns. Then, mucosa becomes inflamed and the process of keratosis accelerates.⁶

The clinical picture presents keratosis typical of smokers. This disease is not a preneoplastic lesion. When affecting the palate, it is the so-called smoker's palate; yet it can be found in other areas of the oral cavity as well. White lesions can prove to be a diagnostic pitfall, and they cannot be ignored. It is essential to differentiate between them and leukoplakia, i.e., the actual preneoplastic lesion, which can develop into a carcinogenic metaplasia when untreated. Also other pigmentation changes of oral tissues found in smokers can divert the physician's attention from a potential threat. Such lesions should also be differentiated from a melanoma of the oral mucosa.¹⁰ An accumulation of symptoms such as chronic irritation with tobacco smoke, colonization with *Blastomyces*, and growth and strengthening of keratosis of filiform papillae leads to the black hairy tongue.³

Changes in pigmentation caused by tobacco, keratosis and candidosis can mask dangerous pathological changes since they can mimic melanoma. Keratosis caused by tobacco is clinically difficult to differentiate from leukoplakia, while candidosis requires differentiating from erythroplakia, which is also a preneoplastic lesion.

The systemic effect of smoking on the oral cavity results from immune, enzymatic, and circulatory disorders. They facilitate the development of periodontal diseases, which constitute yet another disease entity in which nicotine addiction is a known risk factor. According to the Berne University hexagonal model, smoking cigarettes is one of six identified risk factors for periodontal diseases. The degree of this risk is directly proportional to the number of cigarettes smoked per day.^{1,16} The impact of smoking on etiology and pathogenesis of periodontal diseases is detected in three main mechanisms: causing local damages, modifying the host's response and changing the recovery mechanisms of the periodontal tissues. Clinically, nicotine addiction leads to an increase in periodontal diseases, as evidenced by an accelerated epithelial attachment loss, and accelerated tooth and bone loss. It also contributes to recurrent inflammatory conditions and resistance to treatment.^{2,7} Comparing clinical indexes of periodontium condition in smokers and non-smokers, the following are found:

- higher indexes of oral cavity hygiene in smokers as compared to non-smokers – assessed with API (Proximal Plaque Index modified according to Lange) or Plaque Index (PI – bacteria plaque index according to O'Leary),
- higher values of periodontal pockets' depth assessed with Pocket Depth (PD) index in smokers when compared to non-smokers,
- a higher attachment loss in smokers – assessed with Clinical Attachment Loss (CAL),
- a higher percentage of patients with class II and III furcation defects among smokers when compared to non-smokers,
- a higher bone loss in the alveolar process detected through radiological imaging in smokers when compared to non-smokers,
- a higher percentage of teeth with pathological mobility in smokers when compared to non-smokers,
- a higher number of teeth lost in patients actively exposed to tobacco smoke when compared to non-smokers, lower levels of Bleeding on Probing (BOP) indexes or Sullcus Bleeding Index (SBI) in smokers when compared to non-smokers.^{2,8}

Quantitative bone loss of the alveolar process in tobacco addicts has been evaluated in many studies. Radiological assessment of bone loss shows that smokers are more likely to suffer from the loss of this tissue than non-smokers. Numerous research results also confirm that the percentage of bleeding spots in smoking patients with periodontal diseases is lower than in non-smoking patients with the same diseases. This results from the contraction of vessels due to nicotine activity, thus the vessels in the gums are narrowed. Such an impact not only changes the clinical picture of periodontal diseases, but also results in alterations in the immune system. With the weaker vascular response in the inflammatory process, fewer serum soluble immune factors are available for the periodontal tissues. Although there may be no basic symptoms of the inflammation, the process will nevertheless continue to develop.^{2,7} Such masking effects of nicotine as a lack of swelling, reddening or bleeding make the clinical diagnosis more difficult. Thus, it is essential to extend the diagnostic process to include a radiological test.

At the enzymatic level, tobacco smoke can both damage periodontal tissues and also contribute to the development of neoplasms in the oral cavity. This can be due to the hindering impact of thiol groups present in the saliva of smokers on peptidase inhibitors.

Peptidases are the enzymes cutting through peptidase bonds, cysteine proteases constituting one of the groups of these enzymes. The key role of these enzymes is described in the context of neoplastic transformation. Cysteine proteases are also involved in the inflammatory process in the periodontal area. It has been proven that these proteases are produced by *Porphyromonas gingivalis* bacterium, which is pathognomonic for periodontal diseases. The isolated bacterial enzymes have been called gingipains. They contribute to periodontal tissues degradation, and their function is hindered by protease inhibitors, for instance by cystatins. It is suspected that the presence of thiol groups can be conducive to disturbing the activity of the protease inhibitors and stop hindering the impact of cysteine proteases.¹⁰ Research into the correlations between bacteria of periodontal diseases and peptidases as well as their inhibitors has been conducted by

Professor Jan Potempa, Head of the Department of Microbiology at the Faculty of Biochemistry, Biophysics and Biotechnology of the Jagiellonian University. In 2011, the Polish Science Foundation awarded him for the results of this research with the so-called "Polish Nobel Prize."

Medical literature has also referred to the economic aspect of smoking cigarettes. According to academic reports, billions of PLN – which come from taxpayers, both smokers and non-smokers – are spent annually to treat tobacco-induced diseases. Additional billions are devoured by indirect expenses, i.e., costs related to absenteeism at work and lower productivity of smokers.⁴ A three-month cost related to smoking cigarettes amounts to 720–900 zloty. At the same time, a set of the oral cavity hygiene tools, which should be replaced every three months, costs only 30 zloty.

A minimal anti-nicotine intervention by a dentist should be introduced as one of the services offered by dental offices. It is also an important element of cancer prevention. The intervention method is simple: it only requires the will and involvement on the part of the dentist. Following the rules determined by the originators of this method brings the awaited for results.⁷ The minimal anti-nicotine intervention is a few-minute activity undertaken during every visit to the dentist. The methodology of such intervention includes getting acquainted with the

patients and diagnosing them as having nicotine addiction during their first visit. The next step involves the implementation of motivation and treatment programs within the individual treatment plan for the patient. This program consists of five components introduced one after the other.

The components oblige the physician to

- ask – always ask if the patient smokes,
- advise – advise the patient to quit smoking, present benefits of the anti-nicotine attitude, make the patient aware of the effect of smoking,
- reinforce – when you notice that a smoker is ready to stop smoking, proceed to the next stage, i.e., help patients to maintain their decision, continue to give advice, build up their motivation,
- help – when patients make the decision to quit smoking, help them to plan a course of activities leading to changes in their habit,
- plan – plan follow up visits.

In order to implement such a treatment, the dentist has to get acquainted with patients. Knowing their family as well as their financial, professional and social situations provides a lot of benefits. It allows the physician to increase patients' motivation while referring to various aspects of their lives

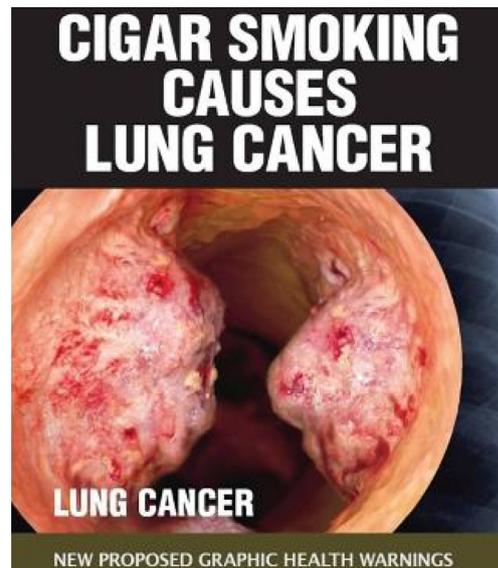
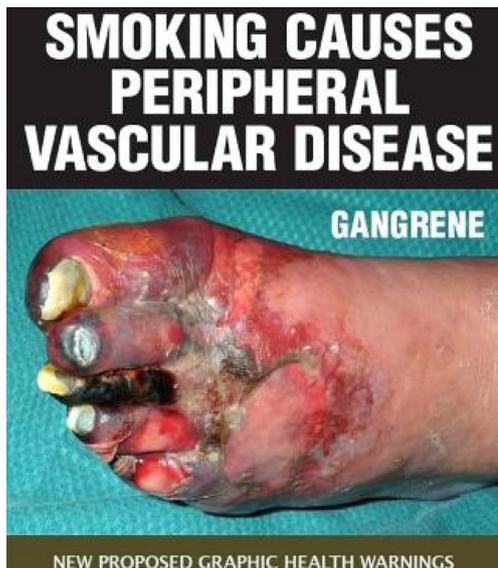


Fig. 1 – New cigarette packets to be introduced in Australia.^{5,11}

and to find the correct key arguments to persuade them to quit smoking.⁷

Considering the economic aspect of anti-nicotine prophylaxis with reference to treating this addiction with pharmacological agents and managing its complications, one can obviously see more benefits in the prophylaxis.⁴ It confirms the rule that “prevention is better than cure.” Explaining thoroughly how tobacco works can be an “ace up one’s sleeve” with respect to the minimal anti-nicotine therapy conducted in the dentist’s office.

5. Discussion

There are numerous lesions involving the oral cavity mucosa and periodontal tissues which are caused by tobacco smoking. Familiarity with these lesions will allow the diagnosing doctor to choose the right course of treatment. Many of these lesions are life-threatening, still others are not neoplastic. Clinical similarity between lesions caused by tobacco and other dangerous disease entities should be taken into consideration when deciding upon the diagnosis. However, a lack of inflammatory manifestations can also lead to hypodiagnosis. Bleeding, swollen and painful gums induce patients to seek a dentist’s help. A patient who smokes cigarettes arrives at the doctor’s considerably later than one who does not smoke, since tobacco smoke masks the typical symptoms of a periodontal disease. It is difficult to explain to patients that they suffer from such a disease if they cannot see it themselves. Such diagnostic pitfalls can lead to failures in treatment.

In August 2012, the High Court of Australia maintained the decision to ban placing logos of tobacco concerns on cigarette packets. Plain gray and olive color packets and photographs of lesions caused by smoking cigarettes are supposed to discourage people from smoking (Fig. 1). Such esthetically displeasing packets, constantly reminding one of the threats which result from smoking, can seemingly render smoking unattractive. Seeing such photographs, smokers will perhaps realize what effects may occur later, even though currently they do not experience any such symptoms of the disease. As the media report, similar legal decisions are to be taken in the European Union countries. One should hope that also in Poland, like in Australia and Canada, visual stimuli will contribute to limiting the pathological process of smoking.

Economically, such a dramatic step can decrease the prevalence of tobacco-induced diseases, and in consequence expenses associated with their treatment. Prophylaxis of tobacco-induced diseases requires involvement on the part of physicians as well as state authorities. Anti-nicotine campaigns conducted in the media and on tobacco products’ packets heighten people’s awareness of nicotine addiction and its effects.

6. Conclusions

1. The percentage of smokers in Poland over the last dozen years or so has not changed considerably, which points to the need to continuously inform that society about the effects caused by smoking.
2. Awareness of the so-called masking influence of tobacco

smoke will allow the physician to arrive at the correct diagnosis and introduce appropriate treatment.

3. A minimal anti-nicotine intervention should be introduced as one of the services provided by dental and medical offices.

Conflict of interest

None declared.

Financial disclosure

None.

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