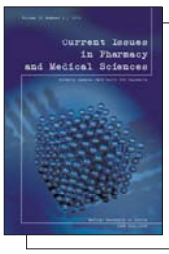

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Ozone, bacterial biofilm and dental caries – a review of literature

MAŁGORZATA H.J. SIKORSKA-JAROSZYŃSKA[1*], MARIA MIELNIK-BŁASZCZAK[1], DOROTA KRAWCZYK[1], RAFAŁ WRÓBEL[1], JERZY BŁASZCZAK[2]

[1] Chair and Department of Paedodontics, Medical University of Lublin, Poland
[2] Department of Prosthetics, Medical University of Lublin, Poland

ABSTRACT

Ozone is an allotrope of oxygen in the form of triatomic molecules (O_3). Recently, ozone and ozone therapy have become an object of ever increasing interest in the sphere of medicine and dentistry. In the paper the mechanisms of action, ozone's influence on human organism and the role in medicine are discussed.

Keywords: Ozone, ozone therapy, caries, dental prophylaxis

INTRODUCTION

Ozone is an allotrope of oxygen in the form of triatomic molecules (O_3). Atmospheric discharges, ultraviolet radiation, high temperature, cause oxygen breakup into free atoms, which, in turn, merge with subsequent oxygen molecules facilitating the creation of ozone, occurring most frequently in the distance of 15-50 km from the surface of the Earth. In the beginning of the Cambrian period 2-percent content of oxygen in the atmosphere allowed for the creation of the ozone layer protecting our planet from the ultraviolet radiation. Ozone present in the stratosphere fully absorbs ultraviolet radiation C and 90% of ultraviolet radiation B, protecting the living organisms from the mutagenic, carcinogenic and lethal influence of this type of radiation. It is worth noticing that ozone can be detected in smog. Ozone not only plays a protective role, as it is a reactive form of oxygen adversely affecting lungs, brain or liver of the living organisms. According to Bartosz, ozone is more reactive than triplet oxygen. Some of the compounds react with polyunsaturated fatty acids, methionine, tryptophane, tyrosine, cysteine, alcohol, amids, carboxylic acids, ascorbate, tocopherol and urate. Ozone reactions with unsaturated fatty acids as well as alkenes lead to the creation of ozonides, breaking up, in the initial stage, to alkoxy and peroxidic radicals, as well as aldehydes. The result of ozone reaction with thiols is the creation of sulphonic acids as well as hydroxyl free radical. In aqueous solutions, ozone breakup leads to the creation of hydrogen peroxide, as well as hydroxyl free radical and hydroperoxide free radical. Exposure to ozone, similarly as exposure to tobacco smoke, dihydroxyfumarate, alloxane, hydrogen peroxide, organic peroxides, paraquat can cause oxidative stress, which is homeostasis disturbance leading to an increase of stationary concentration of reactive forms of oxygen [1, acc. to 2, 6, 22].

Ozone and dental plaque

Recently, ozone and ozone therapy have become an object of ever increasing interest in the sphere of medicine and dentistry. Nowadays, it is thought that ozone therapy may be used in about 260 pathological states than can occur in people. Ozone has bacteriocidal capabilities, it stimulates blood flow in blood vessels and also has stimulating effect on the immunological system. The results of in vitro studies demonstrate that ozone is biocompatible with oral epithelium, exerts genotoxic effects, eliminates ecological niches for cariogenic bacteria and neutralizes pH resulting from bacterial acidogenic activity. Ozone therapy is used in case of several diseases of soft oral tissues as well as in case of pits and fissures, smooth oral surfaces and root cement caries [1, acc. to 2, 14, 18, 23, acc. to 25].

Corresponding author
* Chair and Department of Paedodontics, Medical University of Lublin
7 Karmelicka Str. 20-081 Lublin, Poland
e-mail: MHJSJ@interia.pl

Ozone and carious disease

Dental caries is considered one of five most prevalent infectious diseases. However, multifactorial etiology of caries has not been fully explained [7, 11]. Undoubtedly, some bacteria present in the bacterial plaque, *Streptococcus mutans* and *Lactobacillus acidophilus* play a role in the pathogenesis of carious disease. However, there have lately appeared reports indicating other bacteria with similar characteristics as potential causative factor for the development of caries [12, 21]. Other factors are dietary carbohydrates, constituting a substrate for bacterial organisms, time and frequency of carbohydrate intake and susceptibility of hard dental tissues. Although caries is responsible for loss of dentition in human population, it is also curable and it can be effectively prevented [12]. Thus, studies are being continuously performed concerning both preventive and therapeutic methods utilizing the least invasive techniques with minimum loss of hard, mineralized dental tissues [11, 17, 24].

Nogales et al. wrote that ozone decreases the adhesion of bacteria to the dental surfaces and stimulates the remineralization process in the sites of newly occurring carious disease foci [23]. Application of ozone therapy in case of carious cavities with uncovered dentine decreases the number of bacteria. However, in case of carious lesions located on masticatory surfaces without coexisting cavities, 40-second-exposition to ozone does not lead to decrease the number of living bacteria in dentine located below demineralized enamel [3, 15]. As it was stated earlier, supragingival and subgingival dental plaque is considered one of the main factors contributing to the occurrence and development of carious disease. Nowadays, there are two hypothesis concerning dental plaque. According to the first one, so called „nonspecific plaque hypothesis", each bacterial plaque is characterized with pathogenic features. According to the second hypotheses, so called „specific plaque hypothesis", bacterial plaque may be considered pathogenic only in case of the occurrence of clinical symptoms of oral disease [12, 19]. Hauser-Gerspach et al. found that ozone application did not have an immediate antibacterial effect when the caries infecting dentine layer was not fully removed [13]. Based on in vitro studies performed by Knight et al., they established that the application of ozone therapy on non-affected dentine surfaces prevents the creation of biofilm, and thus accumulation of *Streptococcus mutans* and *Lactobacillus acidophilus* bacteria, for the period of 4 weeks. The authors suggest that ozone may influence the change of dentine wetting due to reaction with the organic components of this tissue [15].

By now, it has been demonstrated that ozone accelerates and positively influences the enamel remineralization process. However, it is possible on the condition that the ozone therapy is applied within 6-8 weeks after detection of the occurrence of initial demineralization of hard dental tissues. In vitro study results demonstrated that ozone application had positive results in case of carious diseases of either dental crowns or dental roots [1]. Nevertheless, it should be pointed out that other studies showed that ozone therapy might lead to remineralization of carious lesions within the period of 4 to 12 weeks after ozone application [25].

In subsequent studies, Baysan et al. demonstrated that carious lesions, and thus enamel demineralization, without accompanying cavities in hard dental tissues, located on root surface underwent hardening in 38.4% cases, while in case of accompanying cavities this result was only encountered in 5.7% cases after ozone therapy [5]. Baysan et al. also observed that ozone application lasting from 10 to 20 seconds might contribute to "reversal" of chronic carious disease of dental roots. The advantage of this method is the fact that it is a non-invasive treatment modality, which can be used in any dental office, in elderly people unable to leave their homes as well as in hospital and hospice patients [4].

Dähnhardt et al. attempted to find out whether the application of ozone therapy in children with dental anxiety might be an effective treatment method influencing hard and soft oral tissues and also alleviating the symptoms characteristic for dental anxiety. The authors studied 28 children with at least two single-surface carious cavities. It was observed that not only did the hardness of the caries affecting teeth significantly increase but also, in 93% of subjects there occurred decrease or total disappearance of dental anxiety. This result demonstrated an additional advantage of ozone therapy in oral health management. The results obtained by the authors suggested, that in patients with dental anxiety, in whom ozone therapy was used, it would be possible to perform total oral cavity assanation without applying additional procedures such as neuroleptanesthesia or general anesthesia [9].

Brazelli et al. reviewed available literature concerning efficiency and cost-effectiveness of ozone therapy in case of carious lesions in fissures and in case of dental roots caries. In conclusions, the authors stated that it could not be decisively declared whether ozone therapy was an effective additional method in the treatment of these types of lesions of mineralized dental tissues [8].

Nowadays, ozone therapy has been more and more frequently mentioned as a method that could be used in carious disease prevention. Ozone therapy is considered to be an effective method preventing the accumulation of dental plaque, which is one of the etiological factors in dental caries. Change in biofilm content may contribute to reduction of the number of bacteria responsible for dental caries. [16, 20].

Dukić et al. performed studies concerning the penetration of materials used in sealants and the occurrence of

microleakages in case of application of ozone therapy before the sealing procedure. Forty extracted molar teeth not affected by caries were examined. The examined teeth were divided into 4 groups. Two groups underwent ozone therapy and were sealed with two different sealants. In the other two groups the same sealants were used but ozone therapy was not applied. The results of this study did not demonstrate improved performance of the sealants after the application of ozone. The study did not demonstrate the preventive influence of ozone therapy on the occurrence of micro-leakages either. Thus, the role of ozone therapy is still controversial [10].

Analyzing the application of ozone therapy in dentistry one should keep in mind that a series of studies have shown that it is effective in prevention and treatment of carious disease. However, it should be stressed that it is necessary to perform further large scale, longitudinal, randomized clinical studies to confirm the effectiveness of ozone therapy application [25].

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