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Practical use of ozone in dentistry – comments

Ozone is an allotropic form of oxygen taking the form of a triatomic molecule. It is blue coloured with a characteristic smell. Ozone in natural conditions appears in the upper atmosphere (as high as 10–50 km, in the amount of 6 to 30 ml). It surrounds the earth, and protects it from ultraviolet radiation. Ozone comes from oxygen and is produced both by atmospheric discharges and chemical reactions occurring in coniferous forests (turpentine oxidation). In the upper atmosphere, in some oxygen molecules chemical bonds break as a result of the absorption of ionization energy and then unbounded oxygen atoms and oxygen molecules combine to form ozone. This phenomenon was described by Ch. F. Sconbein in 1840. Landler was the first person to use ozone in medicine in 1870. In today's scientific literature it is possible to find a number of reports on the use of ozone in therapy of infections, vascular diseases, or those characteristic of reduced immunity as well as degenerative diseases. Edward Lynch, professor of the Department of Conservative Dentistry and Gerostomatology, Queens University of Belfast is regarded as a pioneer of ozone therapy in dentistry (1).

The application of ozone in dentistry comes as a results of physico-chemical properties:

- Ozone improves the metabolism of inflamed tissues by increasing their oxygenation and reducing local inflammatory processes. By changing the cell membrane structure of erythrocytes and causing the increase of its negative charge it influences the structure change as well as blood cell elasticity. This in consequence reduces blood cell rolling and enables blood flow in capillary vessels. By increasing the concentration of 2,3 Diphosphoglycerate (2,3-DPG), ozone changes the configuration of erythrocytes, which enables them to return oxygen in the inflamed tissue.

- Ozone activates an immune response, in high concentration causes immunodepressive effect whereas in its low concentration – immunostimulating effect.

- Ozone affects the oxidation balance of an organism. Repeating low doses of ozone activate enzymes: super-oxide dismutasis, catalasis, dehydrogenase, glutathione peroxidasis. They are part of complex enzymatic systems which protect oxygen organisms against the action of oxygen-free radicals.

- Ozone works destructively against bacteria, fungi, and viruses. Being a very strong oxidant it joins with biomolecules containing cysteine, cysteine, methionine, histidine (all being part of bacterial cell membranes. The main targets of their attack are the thiol groups of the amino acid cysteine. As a result of the reaction of ozone with unsaturated fatty acids of a lipid sheath of a virus the lipid sheath of a virus melts. The research shows that a few-second-application of ozone stops all vital functions of bacteria which are incapable of developing any self-immunity to its action. Gram+ (Gram-positive) bacteria are more sensitive to the action of ozone than Gram– (Gram-negative) bacteria. Oxygen-free bacteria react to ozone as well. Among cariogenic bacteria *Streptococcus*

mutans and *Streptococcus sobrinus* are the most sensitive. Ozone easily acts on multiunsaturated fatty acids which occur in virus sheaths. Ozone reacts also with ascorbinians and tocopherols.

- Ozone increases the concentration of cytokines and chemotactic factors (monocytes).
- Ozone activates angiogenesis.

• Ozone, when acting on the organic substance of mineralized tooth tissues intensifies their remineralization potential. At the same time, it is capable of “opening” dentinal tubules, which enables the diffusion of calcium and phosphorus ions to the deeper layers of carious cavities (1–4).

According to most authors, a 10-sec-application of ozone causes the destruction of 99% of bacteria, and a 20-sec-application even of 99.9%. In this way, so-called ecological niche appears. However, it is not conducive to their repeated colonization within 4 to 6 weeks (5–8). Ozone is not toxic when it is given in the amount of 0.05 ppm for 8 hours. During ozone therapy a maximum concentration of ozone in oral cavity amounts to 0.01 ppm.

Indications in the application of ozone in dentistry: 1) caries prophylaxis, 2) early carious lesions, 3) *caries media* and *caries profunda*, 4) root caries, 5) enamel cracks, 6) dentine hypersensitivity, 7) tooth whitening, 8) root canal disinfection, 9) infectious diseases occurring in oral cavity mucosa, 10) marginal parodontium diseases, 11) in prosthodontics, dental surgery and implantology.

The medical procedures in the case of caries prophylaxis, early carious lesions, dentine hypersensitivity and root caries are as follows:

- clinical examination of the oral cavity and tooth cleaning by using prophylactic air-flow
- making a bite wing radiogram to detect possible caries foci. It is advisable to use a diagnostic laser (KaVo DIAGNOdent) which measures the degree and the depth of tissue demineralization
- the application of ozone according to the chosen indicator CSI or by using the laser's own indication
 - covering the ozoned surface with a liquid initiating remineralization
 - recommending a patient to use a remineralization kit which consists of aerosol, a toothpaste, and a mouth rinse 5 times a day for 4 weeks. The use of these kits makes ozonotherapy for the treatment of dental caries more effective. The liquid for remineralization contains among others: zinc, fluorine, calcium, magnesium, phosphorus.

The indicator CSI (Clinical Severity Index) according to Lynch and Holmes was based on the classification by K. Ekstrand which defines the type of carious lesions. According to CSI: Index 1 – carious lesions which require a mechanical cavity preparation as well as its filling (the occurrence of demineralized and infected dentine is detected) – the recommended time of lesion treatment with ozone is 40 sec. Index 2 – carious lesions that can require a mechanical cavity preparation (a carious process got to enamel-dentine junction and caused dentine demineralization) – the recommended time of lesion treatment with ozone is 30 sec. Index 3 – the lesions that require the treatment with fluorine (a carious process does not get as far as enamel-dentine junction) – the recommended time of lesion treatment with ozone is 20 sec. Index 4 – arrested carious lesions (caries is arrested within the limits of enamel tissue or on the border of enamel and dentine) – the recommended time of lesion treatment with ozone is 20 sec. In the course of using laser appliances (e.g. DIAGNOdent) to define hard-tissue demineralization rate the time of ozone treatment depends on the results obtained. When DIAGNOdent indicates from 0 to 19, the time of gas application is from 10 to 30 sec, when it indicates from 20 to 24, we use a 40-sec-application, when from 25 to 29 – we use a 60-sec-application, and when the result obtained is more than 40, we should apply ozone for 60 sec as well. However, it should be stressed that when the indicator shows from 0 to 9 it proves that there are changes in enamel mineralization, from 20 to 24 – it means that the changes get as far as enamel-dentine border, above 25 – changes can be noticed in dentine, 28 – mineralization changes are in 2- or 3- mm-dentine strip. However, when it indicates 58 it proves that the process of dentine

tissue mineralization is disturbed in the region of tooth chamber. In the case of medium and deep caries ozone has a supportive function. It does not replace a mechanical cavity processing and it is not recommended to be used in the case of *caries subruens*. In deep cavities, after a very precise mechanical processing of lateral walls we can leave a layer of solid dentine only at the bottom of the cavity. After having applied ozone and having used the remineralization initiator we should fill the cavity according to what is suggested for each class.

In endodontology ozone is used to disinfect a root canal. However, it requires using a special piece which is inserted as far as the two-thirds of the canal which was previously rinsed with sodium hypochlorite. The time of ozone treatment is 30 sec.

In the process of bleaching teeth, high oxidating properties of ozone set with the chemical compounds like perborate sodium and hydrogen peroxide are used. However, it should be pointed out that this procedure can only be carried out on non-vital teeth. Additionally, before beginning ozone therapy a filled canal should be protected with glassionomer material. We then put a chemical agent e.g. Peroxidon mixed with glycerin to pulp chamber. The time of ozone treatment is 40 sec. If after the procedure a cosmetic effect is not satisfactory, we should leave the oxidating agent in the pulp chamber, fill the cavity tightly with glassionomer material, and repeat the procedure after 6 to 8 days. We cannot forget to check a tooth colour according to a colour chart, e.g. Vita before and after each procedure.

To minimize the development of recurrent caries, it is possible to carry out ozone therapy on prosthetic pillars before any restoration.

In periodontology, bactericidal ozone effect is used to treat gingival pockets, while a viruscidal effect is used to treat aphtha and the lesions on oral mucosa and skin caused by e.g. *Herpes simplex*. Treating herpes with ozonotherapy brings the most spectacular effect. In the case of patients with early stage of disease one 60-sec-application of ozone is usually sufficient. However, patients with big eruptions in the advanced stage of disease should have ozonotherapy procedures repeated every day. But still all the patients observe a considerable relief from painful ailments and long remission periods of eruption.

The effect of ozone on wounds obtained in the process of surgical and implantological procedures is used to prevent complications like after-surgical infection and to conduce to proper tissue healing.

Contraindications. Patients with cardiac pacemakers, suffering from asthma, epilepsy, and other neurological diseases as well as pregnant women should not be treated with ozone therapy. Moreover, ozone should not be applied to children below the age of 6, although some authors claim that it is not recommended even until the age of 12.

Nowadays two types of appliances producing ozone for dental use are available:

1. HealOzone by KaVo is air-based and the application of the gas takes place in a closed circuit. Its surplus is sucked out and neutralized by manganese ions. The concentration of ozone in the cap adjacent to the tissue amounts to 2100 ppm. Perfect air tightness of the cap is necessary for the application of ozone. Therefore, the application is only possible on the surfaces where such air tightness can be provided (e.g. the application of ozone to treat a class II carious cavity according to Black's classification requires sealing the cap with a sealing wax or with impression material).

2. OzonyTron by MYMED Gmb H. In this apparatus, ozone is produced in glass tips through which it is transported to the operation surface. The concentration of ozone in the operation field is 10 to 100 µg/ml (becomes a fungi-, viru-, and bactericide at the intensity of 1–5 µg/ml). There is no closed circuit here, therefore, ozone can be applied to the places that are difficult to reach, e.g. gingival pockets or root canals.

CONCLUSIONS

1. Ozonotherapy is a supportive method in the conservative treatment of carious cavities.
2. The application of ozone is one of the methods of anti-caries prevention.
3. Ozone's antibacterial and antiviral properties can be used in the treatment of the diseases of peripheral parodontium and oral mucosa.

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SUMMARY

On the basis of the literature, the detailed information about using ozone in dentistry was presented in this paper. Special attention was paid to its practical aspects, especially in conservative dentistry. Indications in the application of ozone were: caries prophylaxis, early carious lesions, dentin caries, root caries, enamel cracks, dentine hypersensitivity, tooth whitening, tooth canal disinfections, infectious diseases occurring in oral cavity mucosa, marginal parodontium diseases, dental surgery and implantology. The time of application of ozone was dependent on the indications of DIAGNOdent and Clinical Severity Index according to Lynch and Holmes. Additionally, special available ozone apparatuses were described in this paper.

Zastosowanie ozonu w stomatologii – uwagi praktyczne

W pracy na podstawie piśmiennictwa przedstawiono informacje na temat ozonu i jego praktycznego zastosowania w stomatologii. Zwrócono uwagę na szczegółowe wskazania do zastosowania ozonu głównie w stomatologii zachowawczej: profilaktyce próchnicy, wczesnych stadiach rozwoju choroby próchnicowej, próchnicy zębiny i korzeni, pęknięciach szkliwa, nadwrażliwości zębiny, wybielaniu zębów, leczeniu endodontycznym, stanach zapalnych błony śluzowej jamy ustnej i przyzębia brzęznego oraz po leczeniu chirurgicznym i implantologicznym. Czas aplikacji gazu wyznaczano posługując się głównie wskaźnikiem Clinical Severity Index wg Lyncha i Holmsa lub zgodnie ze wskazaniami lasera diagnostycznego. W pracy przedstawiono również urządzenia wytwarzające ozon do celów terapeutycznych.