

Treatment of Dental Caries by Ozone Therapy – A Review

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Abstract Ozone, a powerful oxidizer effectively kills bacteria, fungi, viruses and parasites at a dramatically lower concentration and also has the capacity to stimulate blood circulation, platelets, and immune response. Ozone being biocompatible is used in all aspects of dentistry in gaseous, ozonated water and as ozonated oils. Ozone therapy is a well-established alternative and complementary therapy in most of the European countries. Treatment may be achieved by increasing the resistance of the tooth against the microbial activity and reducing the extent of microbial activity. In addition to the recent materials and techniques, the therapeutic actions of ozone may provide beneficial results by reducing the demineralization of the tooth. The treatment is completely painless and increases the patient's acceptability and compliance with minimal adverse effects. In the present paper, a systematic review was performed on studies investigating the effects of ozone on oral tissues and microorganisms and unveil the uses of ozone in dentistry in all aspects.

Keywords: *Ozone, Oxygen, Dentistry.*

INTRODUCTION

The word Ozone (O₃) is derived from the Greek word ozein (odorant). Ozone is one of the most powerful antimicrobial agents available for use in medicine and dentistry. In the 1920s Dr Edwin Parr, a Swiss dentist, started to use O₃ as part of his disinfection system. Ozone (O₃) is a triatomic molecule, consisting of three oxygen atoms. Its molecular weight is 47,98 g/mol (Stopka,2003). Ozone is thermodynamically highly unstable compound that, is dependent on system conditions like temperature and pressure,decomposes

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to pure oxygen with a short half-life (Stubinger, Sader and Filippi,2006). Ground-level ozone is an air pollutant with harmful effects on the respiratory system. Ozone in the upper atmosphere filters potentially damaging ultraviolet light from reaching the Earth's surface. It has many different applications in various fields; one of them is usage of ozone in medicine (Wikipedia).

Ozone therapy is one of the modern non-medication methods of treatment. It is being used for more than 100 years. Medical reports on successful application of ozone in therapy of different diseases and studies of its effects caused a rapidgrowing interest in it. Some other factors were responsible for its wide spreading, such as simplicity of performance, good tolerance by patients, absence of side-effects or adverse reactions and high medical-social and economic efficiency.

Even though ozone therapy is still being ignored by most of medical establishment because of facts that gaseous ozone is quite toxic and has strong oxidative properties (BOCCI,1999)

Ozone is an unstable gas and it quickly gives up nascent oxygen molecule to form oxygen gas. The release of nascent oxygen has beneficial effects on every part and organ (Garg and Tandon, 2009). It has been used in medical field since long due to its extremely strong oxidant property that oxidizes nearly all surfaces to the highest oxidation stage. It is used as a circulatory enhancement and stimulation of oxygen metabolism, disruption of tumor metabolism and to kill pathogens(Garg and Tandon,2009; Nogales, Ferrari, Kantorovich and Lage-Marques,2008) . O₃ is a powerful oxidant capable of interacting as metabolic & immune modulator as well as anti-microbial agent. Multiple microbiological & the biochemical studies justified that there are no doubts about the effectiveness of ozone in bacterial reduction . Among other things, ozone is used to purify drinking water and water in dental equipment and for sterilizing instruments for medical use(Shah, Chandra , Grover and Gupta,2011).

HISTORY

In 1839, Christian Friedrich Schonbein, first noticed the emergence of a pungent gas with an electric smell. According to the Greek language, he called it ozone and presented a lecture entitled "On the smell at the positive electrode during electrolysis of water" at the Basel Natural Science Society(Stubinger, Sader and Filippi,2006). Oxygen/ozone therapy has a long history of research and clinical application with humans. The first medical application was in 1870 when Dr. C. Lender purified blood in test tubes. Medical applications became widespread throughout Europe and America. As of 1929, more than

114 diseases were listed for treatment with oxygen/ozone therapy. Interestingly enough, in 1930, a German dentist, Dr. E.A. Fisch, used ozone on a regular basis in his dental practice in Zurich, Switzerland, and published numerous papers on the subject.

APPLICATIONS

The potential application of ozone therapy in human body and its biological horizons are listed below:-

Potential applications of ozone therapy:

- Antimicrobial (Bactericidal and fungicidal)
- Damage to cytoplasmic membrane
- Specific to microbial cell
- Effective in antibiotic resistive strain
- Immuno stimulating
- Activates cellular and humoral immune system
- Synthesis of immunoglobulin's
- Enhances phagocytosis activity
- Activation of biological antioxidants
- Analgesic
- Detoxification

Antimicrobial effect of ozone is the most studied. Oxygen/ozone therapy in dentistry contains a multiplicity of protocols to deal with dental infection. Three fundamental forms of application to oral tissue are applied — (1) ozonated water, (2) ozonated olive oil, and (3) oxygen/ozone gas. Ozonated water and olive oil have the capacity to entrap and then release oxygen/ozone, an ideal delivery system. These forms of application are used singly or in combination to treat dental disease. The different clinical application of ozone therapy in combating the dental disease and their treatment modalities are listed below:-

Dental treatment modalities of ozone therapy:

- Biofilm purging (elimination of bacterial pathogens)
 - Periodontal pocket disinfection and osseous disinfection(Rajesh, Rao, Bolloor and Pratap,2013)
 - Prevention of dental caries
 - Endodontic treatment
 - Tooth extraction
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- Tooth sensitivity
- Temporomandibular joint treatment
- Gum recession (exposed root surfaces)
- Pain control
- Infection control
- Accelerated healing
- Tissue regeneration

The ozone therapy has also certain limitations and contraindications as listed below:-

Contraindications of ozone therapy (Nanduri,2012).

- Pregnancy
- Autoimmune disorders
- Hyperthyroidism
- Anaemia
- Myasthenia
- Alcohol intoxication
- Haemorrhage

USAGE OF OZONE IN DENTISTRY

The main use of ozone in dentistry relies on its antimicrobial properties itself. It is proved to be effective against both Gram positive and Gram negative bacteria, viruses and fungi (Greene, Few, Serafini, 1993). Muller et al. (Muller, Guggenheim and Schmidlin, 2007) compared the influence of ozone gas with photodynamic therapy (PDT) and known antiseptic agents (2% Chlorhexidine, 0.5 and 5% hypochlorate solutions) on a multispecies oral biofilm in vitro. The following bacteria were studied – *Actinomyces naeslundii*, *Veillonella dispar*, *Fusobacterium nucleatum*, *Streptococcus sobrinus*, *Streptococcus oralis* and *Candida albicans*.

Gasiform ozone was produced by vacuum ozone delivery system Kavo Healozone. They concluded that the matrix-embedded microbial populations in biofilm are well protected towards antimicrobial agents. Only 5% Hypochlorate solution was able to eliminate all bacteria effectively. Usage of gasiform ozone or PDT was not able to reduce significantly or completely eliminate bacteria in the biofilm (Muller, Guggenheim and Schmidlin, 2007). Baysan et al. (Baysan, Whiley and Lynch, 2000) assessed antimicrobial effect of Kavo Healozone device on primary root caries lesions (PRCL) and evaluated the efficiency of ozone specifically on *Streptococcus mutans* and *Streptococcus sobrinus*. As

a result, ozone exposure to either 10 or 20 s under experimental conditions reduced the total levels of micro-organisms in the PRCLs to < 1% of the control values. Application of ozone for a period of 10 s was also capable of reducing the numbers of *Streptococcus mutans* and *Streptococcus sobrinus* in vitro (Baysan, Whiley and Lynch, 2000). Holmes (Holmes, 2003) observed the effect of KaVo Healozone device on PRCL followed by professionally-applied remineralising solution containing xylitol, fluoride, calcium, phosphate and zinc. This treatment modality was applied to 89 patients, aged from 60 to 82 years. After 18 months 100 % of ozone-treated PRCL's had improved. In control group, where lesions were left without treatment, only one PRCL had improved. In 62 % of cases the status remained leathery, while in 37 % of PRCL's had worsened from leathery to soft (Holmes, 2003).

Polydorou et al. (Polydorou, Pelz and Hahn, 2006) studied antibacterial effect of Kavo Healozone device on *Streptococcus mutans* in comparison with the already proven activity of two dentin-bonding systems. Their findings show that an 80 s application of ozone is a very promising therapy for elimination of residual micro-organisms in deep cavities and therefore of potentially increasing the clinical success of restorations.

A 40 s application of ozone was found to reduce significantly the numbers of *Streptococcus mutans*, but not to extend of other treatments. A longer period of ozone activity could be advantageous as a result of its anticariogenic effect (Polydorou, Pelz and Hahn, 2006). Nagayoshi et al. (Nagayoshi M., Fukuizumi, Kitamura, Yano, Terashita and Nishihara, 2004) tested the efficacy of ozonated water on survival and permeability of oral micro-organisms and dental plaque. They confirm that ozonated water (0.5–4 mg/l) was highly effective in killing of both gram positive and gram negative micro-organisms. Gram negative bacteria, such as *Porphyromonas endodontalis* and *Porphyromonas gingivalis* were substantially more sensitive to ozonated water than gram positive oral streptococci and *Candida albicans* in pure culture. Furthermore, ozonated water had strong bactericidal activity against bacteria in plaque biofilm. In addition, ozonated water inhibited the accumulation of experimental dental plaque in vitro (Nagayoshi M., Fukuizumi, Kitamura, Yano, Terashita and Nishihara, 2004).

Huth et al. (Huth, Jacob, Saugel, Capello, Paschos, Hollweck, Hickel and Brand, 2006) in their study declared that the aqueous form of ozone, as a potential antiseptic agent, showed less cytotoxicity than gaseous ozone or established antimicrobials (chlorhexidine digluconate-CHX 2%, 0.2%; sodiumhypochlorite-NaOCl 5.25%, 2.25%; hydrogen peroxide-H₂O₂ 3%) under most conditions. Therefore, aqueous ozone fulfils optimal cell biological characteristics in terms of biocompatibility for oral application. (Huth, Jacob, Saugel, Capello, Paschos, Hollweck, Hickel and Brand, 2006).

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Hems et al. (Hems, Gulabivala, Ng, Ready and Spratt,2005) evaluated the potential of ozone as an antibacterial agent using *Enterococcus faecalis* as a test species. Ozone was used both as gasiform (produced by Purezone device), and aqueous form (optimal concentration 0.68 mg/l). It was concluded that ozone in solution was antibacterial against planktonic *Enterococcus faecalis* after 240 s treatment. However, it was not effective against *Enterococcus faecalis* cells in a biofilm unless they were displaced into the surrounding medium by agitation. Gaseous ozone was not effective on the *Enterococcus faecalis* biofilm (Hems, Gulabivala, Ng, Ready and Spratt, 2005).

Estrela et al.(Estrela, Estrela, Decurcio, Hollanda and Silva,2007) studied antimicrobial effects of ozonated water, gaseous ozone and antiseptic agents (2.5 % hypochlorite and 2 % chlorhexidine) in infected human dental root canals. All these substances had no antibacterial effect against *Enterococcus faecalis* over a 20 minute contact time in the infected root canals(Estrela, Estrela, Decurcio, Hollanda, and Silva,2007).

Thanomsub et al. (Thanomsub, Anupunpisit, Chanphetch, Watcharachaipong, Poonkhum and Srisukonth, 2002) tested the effects of ozone treatment on cell growth and ultrastructural changes in bacteria (*Escherichia coli*, *Salmonella* sp., *Staphylococcus aureus* and *Bacillus subtilis*). It was discovered that ozone at 0.167 mg/min/l can be used to sterilize water, which is contaminated with up to 10⁵ cfu/ml bacteria within 30 minutes. Destroying of bacterial cell membrane was observed, subsequently producing intercellular leakage and eventually causing cell lysis.

Nevertheless, these ozone concentrations have no significant effect on the cell viability in bacterial cultures at higher concentrations of 10⁶ and 10⁷ cfu/ml.

Kronusová (Kronusova M.,2007) used ozone in following cases: prevention of dental caries in fissures of the first permanent molars in children, application of ozone in prepared cavity, after tooth extraction, in case of postextractional complications, in patients with chronic gingivitis, periodontitis and periodontal abscesses, herpes labialis, purulent periodontitis, dentition difficilis etc. Almost all patients with gingivitis showed subjective and objective improvement of their status, as well as patients with periodontal abscess, where no exsudation was observed. Application of ozone after tooth extraction was found also quite useful – only 10 % of patients suffered from such complication as alveolitis sicca, but even in these cases the clinical course was shorter and more moderate (Kronusova M., 2007).

The influence of ozonized water on the epithelial wound healing process in the oral cavity was observed by Filippi(Filippi A., 2006)). It was found that ozonized water applied on the daily basis can accelerate the healing rate in

oral mucosa. This effect can be seen in the first two postoperative days. The comparison with wounds without treatment shows that daily treatment with ozonized water accelerates the physiological healing rate.

CONCLUSION

Dentistry is changing as we are now using modern science to practice dentistry. In contrast with traditional medicine modalities such as antibiotics and disinfectants, ozone therapy is quite economical. This state of the art technology allows us to take a minimally invasive and conservative approach to dental treatment; as it markedly reduces both medical cost and invalidity. The elucidation of molecular mechanisms of ozone further benefits practical application in dentistry. Treating patients with ozone therapy lessens the time of treatment with a great deal of difference and it eliminates the bacterial count more specifically. The treatment is completely painless and increases the patients' acceptability and tolerability with minimal adverse effects. Future of ozone therapy must focus on the establishment of safe and well-defined parameters, thus further research is needed to regulate indications and treatment procedures of ozone therapy.

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