



Review Article

The dental applications of ozone: A review

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ABSTRACT

Concept of dental ozone therapy is significantly becoming a trend nowadays, O₃ is pure ozone gas has a soft sky-blue colour with a pungent smell extremely reactive, powerful oxidizing agent. It has a many biomedical properties like antibacterial, immune-stimulating, synthesis of Igs, etc. There are various uses of ozone in the field of dentistry, and the objective of this review is to shed light on clinical dental applications of ozone and summarize the research findings regarding the use of ozone in dentistry.

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1. Introduction

Ozone (O₃) is an allotrope of Oxygen (O₂) is a natural but unstable molecule. The concept of dental ozone therapy is significantly becoming a trend nowadays in some countries and is considered one of the most effective treatment methods in terms of disinfecting the harmful microorganisms in the oral cavity, and due to all of this, therapy is getting trendy these days. Before going into detailed application of zone in dentistry let us first describe about the chemical and physical properties of ozone.

2. Physical & chemical properties of ozone

The pure ozone gas has a soft sky-blue colour with a pungent smell. The molecular weight of O₃ is 48 in comparison to the oxygen diatomic molecule that is 32.¹ It occurs naturally in small amounts in the Earth's stratosphere, where it absorbs UV rays and thus protects the living beings on earth because UV radiation can cause severe damage to living organisms. Ozone is 1.5 times

denser than to the diatomic oxygen and is much more reactive than to the O₂ gas and act as an extremely powerful oxidizing agent, thus can be used as bleaching agent for organic compounds, used as a strong germicide to sterilize drinking water.² In large metropolis, ozone, mixed with the other compounds like NO₂, acidic compounds, CO, etc has become the main toxicant for the lungs, eyes, nose and, to a lesser extent, the skin.¹

3. Toxic effects of gaseous ozone in humans

It is the 3rd most reactive substance fluorine and persulphate and it is formed from pure O₂ with endothermic process at high voltage gradient in Siemens's tube.¹



4. Biomedical properties of ozone

Ozone leads to oxidative stress to cells because of its ability to produce free radicals deriving from the lipoperoxidation of cell membranes, protein oxidation, enzymatic inactivation, the destruction of DNA, and cell apoptosis³ and so its safety and toxicity depends upon its

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O ₃ concentrations in air (ppmv)	Toxic effects
0.1	Lachrymation and irritation of upper respiratory airways
1.0-2.0	Rhinitis, cough, headache, occasionally nausea and retching Predisposed subjects may develop asthma
2.0-5.0 (10-20 min)	Progressively increasing dyspnoea, bronchial spasm, retrosternal pain
5.0 (60 min)	Acute pulmonary oedema and occasionally respiratory paralysis
10.0	Death within 4 h
50.0	Death within minutes

concentration level. Also, healthy cells have antioxidant enzymes in their cell membranes, such as superoxide dismutase, catalase, glutathione peroxidase, etc. There are also antioxidants such as vitamin C, vitamin E, etc. present in the extracellular matrix fluids, plasma and these antioxidants protect the healthy cells from being oxidized by ozone⁴ but on other hand pathogens such as bacteria, Viruses, Fungi, and Parasites have little or no antioxidant enzymes in their cell membranes. This makes them vulnerable to oxidants. An oxidant (ozone) will destroy the cell membrane of the pathogen resulting in a disinfecting or sterilizing effect. Ozone leaves no toxic byproducts like chlorine compounds in vivo or ex vivo. Ozone therapy has been widely used in everyday clinical practice over the last few years, clinical evidence has suggested that ozone therapy may play a major role for the treatment of other conditions such as vascular and immune diseases.⁵ Ozone disrupts the integrity of the bacterial cell envelope through oxidation of the phospholipids and lipoproteins and in fungi it inhibits cell growth at certain stages and in case of viruses, the O₃ damages the viral capsid and upsets the reproductive cycle by disrupting the virus-to-cell contact with peroxidation, thus it acts as anti-microbial due to its oxidative properties. Also, the benefits of ozone on the body include strengthening the immune system, stimulating white blood cells, preventing infections and immune system deficiencies by destroying fungi, bacteria and viruses. It also helps to counteract cell mutations, thereby preventing some types of cancer. Oxygen/ O₃ mixture was also found to prolong the appearance of arrhythmia induced by potassium chloride, aconitine, etc., in laboratory animals like rats.⁶ Some of the most common applications include subcutaneous injections to treat pain and inflammation in localised areas such as joints and muscles. It can be used to treat skin disorders like eczema, acne and pimples where skin treatment with ozone is given using a localised blowing method with oxygen and ozone.⁶ Besides this there are many more uses of ozone therapy like in toxins elimination from body, skin treatments, weight loss management, arthritis and inflammation, disinfecting

wounds, activating the immune system, herniated discs management, treating cancer and now in dentistry also. Thus, potential effects of ozone are -

Antimicrobial activity, damage to cytoplasmic membrane, oxidation of intracellular contents, specific to microbial cell, effective in antibiotic resistive strain, immuno-stimulating, activates cellular and humoral immune system, synthesis of immunoglobulin's, enhance phagocytosis activity, activation of biological antioxidants, analgesic, anti-hypoxic and detoxicating, activation of aerobic process (Krebs cycle, glycolysis, oxidation of fatty acids) ,synthesis of interleukins, leukotrienes and prostaglandins, synthesis of immunoglobulins.¹

5. Ozone applications in dentistry

Dentists can apply ozone in the form of gas, water or oil. It has proven useful in treating a number of different dental problems:

According to Krammer, a German dentist, aqueous ozone can be used:⁴

1. As a powerful disinfectant
2. To control bleeding
3. To cleanse wounds in bones and soft tissues
4. To improve healing by increasing the local supply of oxygen to the wound area
5. To increase the metabolic processes related to wound healing as ozonated water can increase the temperature in the wound area.

Due to these activities ozonated water can be used in candidiasis, gingivitis and as a disinfectant to rinse oral cavity. The use of ozone in dentistry described briefly below-

- Wound healing - University of Basel, Switzerland conducted a study of immunohistochemical, and micromorphological examinations of the wounds of the oral mucosa in which it was found that the patients who applied ozonized water on their wounds showed an acceleration of wound healing and earlier wound closing than patients who applied regular water and did not receive treatment.⁷

- Dental caries management - Colonization by *Streptococcus mutans* can cause dental decay if they grow within deep fissures of the tooth, while *Streptococcus sobrinus* play a primary role in smooth-surface decay but when these bacteria were subject to ozone from an ozone-generating device, there was a significant reduction in ozone-treated samples.⁸

So, ozone's antibacterial properties may help prevent small cavities from growing larger in the pits and fissures on the biting surfaces of the back teeth. Additionally, ozone may be helpful in disinfecting areas of decay underneath tooth restorations. Study trials have shown that non-cavitory root caries can be reversed and arrested of

progression which eliminates the need for removal and it just requires the routine application of ozone for 40 seconds, following with the use of remineralizing products.⁹ The remineralizing effect of ozone on cavitated caries lesion is well established. Baysan et al. conducted a clinical trial evaluating the clinical reversal of root caries with 10s exposure to ozone gas at 2100 ppm, followed by 5s application of xylitol and fluoride. After 6 months follow-up, ozone-treated lesion significantly rehardened compared to controls.¹⁰

- Oral lichen planus - Lichen planus is an inflammatory condition that affects the oral mucous membranes with clinical features of white, lacy patches or red swollen lesions and open sores in the gum. Application of gaseous ozone has been proven to be effective in increasing wound healing after a high-dose radiotherapy and this therapy has shown very good results in the resolution of symptoms at the end of the treatment and thus shows its potential to replace steroid treatment.¹¹

- Herpetic Infections – As we all know that HSV-1 is mostly responsible for causing oral-facial herpes, the combination of the orthodox antiviral agents with ozone therapy plus minor autohemotherapy and topical application of ozonated oil is useful in the management.¹

- Ozone in prosthodontics - One of the most common problems associated with denture use is stomatitis that is mainly caused by *C. albicans*. A denture cleanser releasing ozone bubbles with a concentration of 10 ppm has been developed and is effective in reducing the number of *C. albicans* following a 30–60 min exposure.¹²

- Periodontal problems – Gingivitis and periodontitis are the common problems in the periodontics and are the major cause to loss of tooth among population and also leads to other discomforts to patients like swelling or tenderness, loose teeth, bleeding, pus, sensitivity, halitosis, malocclusion, etc. Ramzy et al found that irrigation with ozonated water in patients with aggressive periodontitis with scaling & root planning was effective in improving the clinical parameters; periodontal pockets in patients with aggressive periodontitis were irrigated once a week for 4 weeks with 150 ml of ozonated water for 5–10 min post scaling and root planning and following this therapy; pocket depth, plaque, gingival indices, and bacterial count were reduced significantly in the treated quadrant Also, Karapetian et al (in vitro study) conducted a study for effect of ozone on peri-implantitis and found that there was maximum reduction in bacterial counts.¹³

- Halitosis – halitosis also known as bad breath and one of the causes of halitosis is bacteria present in oral cavity that forms volatile sulfur compounds such as H₂S that causes the oral malodor and some of these bacterias are main culprit in perio diseases and in caries. And since, ozone is antimicrobial in nature also and acts as disinfectant, it can be useful in minimizing the foul smell from mouth by

killing the microbes.

- Dentin hypersensitivity - Dentin hypersensitivity causes sharp, short pains that are caused by exposed dentin when it is in contact with thermal, tactile, chemical, or osmotic stimuli. There may be a lingering aching discomfort after the stimuli is removed. The hydrodynamic theory states that dentin is permeable throughout the tubules and when the dentinal fluid movement increases, sensitivity occurs. A supporting study proved that there was an average of 55% decrease of pain level after ozone treatment.¹⁴

- Temporomandibular joint disorders - The temporomandibular joint is a hinge that connects your jaw to the temporal bone on skull. As we have already studied that ozone therapy is useful in the management of inflammatory arthritic pain conditions and also in case of TMJ dysfunction, studies showed that intra-articular ozone gas injection can treat internal derangement of the temporomandibular joint and the ozone gas was injected into the superior joint space.¹⁵

- Teeth whitening – as we know that O₃ is highly oxidative and also used to bleach various chemicals, same this property of O₃ applies to teeth whitening. Also, one study conducted by the Al-Omiri et.al shows that the teeth bleached with O₃ was much whiter than 38% of H₂O₂.¹⁶

- Dry Socket - Ozone therapy following extraction significantly reduces the incidence of dry socket because of its healing and disinfectant properties.

Other uses of ozone in dentistry includes like Biofilm purging i.e elimination of bacterial pathogens, periodontal pocket disinfection and osseous disinfection, endodontic treatment as ozone was considered an effective root canal disinfecting agent in treating apical periodontitis,¹⁷ tooth extraction, gum recession (exposed root surfaces), pain control, infection control, tissue regeneration, etc.

Routes of administration can be gaseous form, ozonated water i.e aqueous form or ozonized oil.

6. Contraindications of ozone therapy¹⁸

All cases with Blood Coagulation Failure

Bleeding Organs

Thrombocytopenia

Uncontrolled hyperthyroidism

Acute alcohol intoxication

Pregnancy

Ozone Sensitivity / Allergy (very rare)

Hemorrhagic or Apoplectic Stroke

G6PD (extremely rare)

Side-effects of O₃ therapy are¹⁸

Allergic skin reactions (very uncommon) weakness, slight dizziness (shortly during and after the the administration of ozone therapy)

7. Conclusion

Dentistry is varying with induction of modern science to practice dentistry. The ozone therapy has been more beneficial than present conventional therapeutics due to its multiple properties and uses in the field of dentistry either it is disinfection of the management of TMJ dysfunction. Also, it can be concluded that this therapy has very little contraindications and side effects so it would be well tolerated in most of the patients. However, further research is still needed to justify the routine uses of ozone in dentistry.

8. Conflicts of Interest

All contributing authors declare no conflicts of interest.

9. Source of Funding

None.

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