

Ozone therapy a new vista in dentistry: integrated review

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Abstract

Application of ozone in oral care comes as new and alternative treatment modality in dentistry. The impact of biological and digital information leads to use of ozone application by various means for numerous treatment options in oral cavity. Ozone is a form of oxygen, which has an effective role in management of oral diseases. This review mainly emphasizes on utility of ozone in oral health care management. Its therapeutic potential and its clinical application in oral pathologies, periodontology, endodontics, oral surgery, prosthodontics, orthodontics, restorative dentistry, wound healing, tooth mineralization as treatment choice are reviewed.

Key words: antimicrobial; dentistry; immune stimulating; ozone; tooth remineralization; wound healing

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INTRODUCTION

An abundance of natural ozone present in the atmosphere helps to protect living organisms from the ultraviolet rays. Ozone helps to naturally self-cleansing our environment. Ozone is formed by sun and lightning in the storm in nature. Ozone is a molecule, consisting of three oxygen atoms. Application of ozone in medicine field has been indicated for preventing and treating various pathologies in dentistry. General wellbeing of the individual is directly related to their oral health. Presently as most of the patients are becoming more resistance to antibiotics, ozone is emerging as a new adjunct therapeutic in oral care. Ozone therapy is non-traumatic, painless and non-invasive that increases the patient's acceptability.

In 1839, Christian Friedrich Schonbein first noticed the emergence of a pungent gas with an electric smell and called it as ozone, which means to give off a smell in Greek.¹ In 1940 word ozone was introduced. Ozone therapy acts as an alternative medical treatment that increases the oxygen content of the body by applying ozone into the body surfaces. Positive effects of ozone in biological properties include antimicrobial, immune-stimulating and biosynthesis effects that used in treating and maintaining good oral hygiene. In the 1930's, Dr. EA Fisch first used ozone in dental treatment.¹

OZONE GENERATING SYSTEM

Three ozone generating systems are ultraviolet system, cold plasma system and corona discharge system.²

Ultraviolet system

Ultraviolet light is emitted from the system at 185 nm producing ozone by disrupting the oxygen molecule and splitting it into two oxygen atoms. An oxygen molecule absorbs light energy in ground state when exposed to ultraviolet light and then it dissociates. These two oxygen atoms then attach to another oxygen molecule. It is the attachment of this third

oxygen atom that creates ozone.^{3,4}

Cold plasma system

In this system, gas is ionized at around 20°C. The ionization of oxygen gas takes place between two electrodes that are separated with a dielectric barrier. An electrostatic field is formed as the voltage jumps between the anode and the cathode rods. These causes splitting of oxygen molecule into single oxygen atom which recombines with other oxygen molecule to form ozone.⁵

Corona discharge system

Oxygen passes through corona discharge in which plasma is created. Initially a single oxygen atom is produced from the plasma which is free to adhere with other oxygen molecules that in turn produces ozone. The handling of this design is easy and the ozone production rate can be controlled.⁴

Ozone is a 10-fold more soluble in water than oxygen. It is most potent oxidant. Ozone which is used in dentistry is of three forms namely ozonated water, ozone mixed with oil mostly olive oil and ozone gas.

Oil and water containing ozone have the ability to entrap and then release oxygen, which are the ideal delivery systems.⁶ More viscous solutions like olive oil are used for the better shelf life of the medication. The common treatment forms of ozone in patient oral care are by incorporating ozone in ozonated water, ozone gas and ozone with olive oil. Applying any of these three forms or in combination allows the practicing dental surgeon to treat most of oral infections. The ozonated water is one of the best irrigation solutions for gingival sulcus, periodontal pockets and during removal of infected debris in root canal of tooth. Ozone in gaseous form has the ability to go deep and reach the surface of carious dentin, dentinal tubules and even accessory root canals where local application of antibiotic or disinfectant cannot reach.⁷



PREVENTION AND PROTECTION OF CLINIC ENVIRONMENT AND WORKING INSTRUMENT

Ozonated water can be used as a pretreatment mouthwash for the patient undergoing dental treatment to disinfect their oral cavity. Ozonated water used in water supply to dental chair, pizo reservoir and during ultrasonic scaling procedure helps to protects practicing dental surgeon and their assistance and technician staff from aerosol contaminants. Moreover it prevents the production of biofilms in the inward and outwards water drainage in dental chair. Ozone performs sterilization and leaves only oxygen and water as byproducts.

ANTIMICROBIAL ACTION OF OZONE IN ORAL MICROORGANISMS

Dental caries, gingival, periodontal diseases and oral mucosal lesions mainly caused by bacteria, virus, fungi. Ozone leads to destruction of organism by primarily damage to the cytoplasmic membrane of cells as a consequence to ozonolysis and secondly changes in the intracellular contents due to secondary oxidant effect that leads to oxidation of protein loss of organelle function. Ozone acts as a strong antioxidant leading disinfecting effect by breaking the cell membrane of the microorganism. Ozone leaves no toxic byproducts. Due to the ability of ozone, cells are not damaged and the action remains non-specific and selective to microbial cells. All vital functions of bacteria are halted as a after few seconds of ozone application. Gram-positive bacteria shows more sensitivity to ozone compared to gram negative organism.⁸ Ozone causes disruption on bacterial cells, leading to the removal of acidogenic bacteria that commonly causes dental caries.⁷

Immune stimulating effect

The immune competent cell proliferation and immunoglobulin synthesis is stimulated as an influence of ozone to cellular and humoral immune system. The function of macrophages is activated due to which sensitivity of microorganisms to phagocytosis is increased which leads to production of cytokines as a consequence other immune cells are activated.⁷

Anti-hypoxic effect

Ozone results in alteration in metabolism of cells by raising partial pressure of oxygen in tissues that improves the transporting capacity of oxygen in blood. Ozone when given multiple times in low dose activates enzymes such as dehydrogenase, superoxide dismutases, glutathione peroxidases and catalases.⁹

Biosynthetic effect

Ozone enables activation of protein synthesis in cells. It helps to increase the ribosome and mitochondria that cause regeneration of tissues by increasing the functional activity. Ozone secretes vasodilators, such as nitric oxide, that cause dilatation of arteries and veins.⁹ Nitrous oxide is used as anesthesia.

Remineralization of tooth structure

Ozone causes tooth mineralization by acting on its organic substances. It enables the diffusion of calcium and phosphorus ions to the inner surface of decayed tooth by opening of the

dentinal tubules.⁹

Enhancing wound healing

Interleukins, prostaglandins, and leukotrienes are the proteins synthesized by ozone that help in cell growth and differentiation in reduction of inflammation and wound healing.¹⁰ Ozone application initiates early healing of wounds by improving properties of erythrocytes, and facilitating oxygen release in the tissues. Ozone causes more blood supply to the ischemic zones caused due to surgical interventions like tooth extractions and implant placement.²

Table 1 shows the ozonated water, gas and oil indicated for prevention and management of various oral and dental conditions. **Table 2** shows limitations of ozone therapy which is contraindicated for certain conditions.

IMPACT OF OZONE IN ORAL CAVITY

1. Help in reducing halitosis. Ozone water in 4 mL gargle for 10 seconds showed that oral microorganisms bacterial and fungal present in dental plaque are killed, thus halitosis which is caused due to oral microorganisms in dental plaque is reduced.⁴ Removal of bacterial pathogens as a plaque biofilm over tooth surfaces.^{11,12}

Table 1: Indications of ozone in oral and dental conditions

No.	Indication
1	Use of ozonated water by patients as a pre-treatment oral rinse for disinfectant
2	Ozonated water is used in dental chair unit to prevent biofilm formation
3	Ozonated water can be used in the ultrasonic unit for oral prophylaxis
4	Ozone gas is used before placing sealants
5	Ozone gas and water application in root-surface caries
6	Ozonated gas can be applied during and after cavity preparations
7	Ozonated gas applied during crown preparations to sterilize the prepared tooth
8	Reduce post-operative sensitivity
9	Ozone water or oil acts as desensitizing by oxidizing the organic material in dentinal tubules
10	Ozonated water acts as irrigating solution for deep gingival and periodontal pockets
11	Intraoral custom trays with ozone are used in carious lesions, precarious areas, interproximal region and restoration of tooth
12	Ozone solution helps to regain calcification initial caries lesions
13	Irrigate the primary and accessory root canals to remove debris
14	Ozonated water and gas are injected intraarticularly into the tempromandibular joint
15	Applying ozonated oil and ozonated water rinse twice daily for 7 d helps to heal oral lesions such as aphthous ulcer, cheilitis, candidiasis
16	Denture induced stomatitis - applying ozonated olive oil over denture bearing area
17	Ozone helps in teeth whitening when used in adjuvant with hydrogen peroxide. Done by ozotop unit for 4 min

**Table 2: Contraindications of ozone in therapy**

No.	Contraindication
1	Pregnancy
2	Hyperthyroidism
3	Thrombocytopenia
4	Immunocompromised patients
5	Severe anemia
6	Glucose 6 phosphate dehydrogenase deficiency
7	Alcohol intoxication
8	Myocardial infraction
9	Hemorrhage
10	Ozone allergy
11	Recent myocardial infarction
12	Acute alcohol intoxication

2. Help to disinfect the gingival and periodontal pockets which is commonly colonized by gram-positive and gram-negative micro-organisms. Areas affected during and after oral prophylaxis and root planning should be irrigated with ozone water.¹³⁻¹⁶ The gingival and periodontal pockets are irrigated with ozonated water to limit the microorganism growth and insufflated with ozone gas. In addition ozonated oil should also be applied topically to the oral soft tissue. Thus bacteria at the heart of infection are destroyed, without any side effects.
3. Ozone helps in prevention of dental caries. Exposure ozone for more than 30 seconds causes salivary proteins degradation. Actinomyces naeslundii, Streptococcus mutans and Lactobacillus casei that main causative organism of dental caries is killed when it is exposed to ozone for 30 seconds.
4. During endodontic treatment ozone helps in sterilization of primary and accessory canals. Prepared root canal first lubricated with ozonated oils and then irrigated with ozonated solution and dried. Followed by insufflations 60 seconds into each canal should be done with concentration of ozone gas before root canal filling.
5. Reduce the dentinal hypersensitivity of tooth which is mainly caused by attrition and abrasion of tooth surfaces causes removal of enamel and exposed the dentinal tubules. Ozone gas enables the diffusion of calcium and phosphorus ions to the deeper layers of dentine by opening of the dentinal tubules.^{10,17}
6. Use of ozone gas in infection control in clinical setup area as ozone is quite effective in antibiotics resistant strains of bacteria.
7. Ozone gas helps to reduce bacterial adherence on titanium and zirconia based implants without altering the adhesion and proliferation of osteoblastic cells.¹⁸
8. Pain control measures as the oxidation leads to inactivation of metabolic mediators of pain increase blood circulation locally, and lead to an increase in oxygen delivery to the tissues, which is essential for the generation of anatomic structures. It removes the toxins and resolves the physiological disturbance that initiates the pain.^{19,20}
9. Tissue regeneration and wound healing of the extraction socket and in surgical site shows positive results by ozonized oil.^{21,22}

10. Ozone reduces the formation of mediators that causes inflammation.¹⁰
11. Ozone is used as tooth whitening measures in extrinsic staining. When used in combination with hydrogen peroxide it has better effect resulting in lighter shade.^{23,24}
12. Temporomandibular joint dysfunctions, such as trismus, spasm, myoarthopathy. Patients with internal derangement of the temporomandibular joint showed positive results by injecting ozone gas in joint space.^{25,26}
13. Applying ozone oil over the denture bearing mucosal area and over the denture surface helps to reduce denture induced stomatitis. Patients are advised to place the dentures in ozonated water for minimum of 10 minutes after removal and rinse denture thoroughly with water before inserting into mouth.^{7,13,27}
14. Ozonated water or oils can be applied on soft tissue lesions such as herpes, major and minor aphthous stomatitis, removable denture ulcers, angular cheilitis, candidiasis, traumatic wounds. The disinfectant properties help in the disinfecting and healing of these lesions.^{28,29} Oral lichen planus which is mainly the autoimmune disorder can be treated with ozonated oil topically applied on the lesion.³⁰
15. Ozone therapy can be applied for the treatment of the refractory osteomyelitis in the maxillary and mandibular bone along with antibiotic and hyperbaric oxygen therapy.^{31,32}
16. Ozone helps to accelerate the healing of the surgical wounds. Ozone therapy stimulates cell proliferation and soft tissue healing in patients with bone necrosis using bisphosphonates.^{19,20,33} Osteonecrosis of the jaw showed positive results when treated with ozonated oil.³⁴

Depending on requirement of treatment ozone is applied for 6, 12, 18, 24 seconds by ozotop, an ozone delivery system in endodontic root canal treatment and in treatment of periodontal pocket. For surgical disinfection it is used for 12 seconds, while for periodontal disinfection used for 18 seconds.⁷

Ozone gas does not have any color but has a pungent smell at room temperature. Ozone gas can be detected even at concentrations as low as 0.02–0.05 ppm.³⁵ Half-life of ozone alters with change in temperature. At 20°C it has a half-life of 40 minutes and at 0°C its half-life increases to 140 minutes.³⁶ Ozone administered of 0.05 ppm for 8 hours do not produce any toxic effect. Maximum concentration of ozone amounts to 0.01 ppm, during dental treatment. Few side effects that may be encountered are cough, nausea, vomiting, headache, rhinitis, irritation in respiratory tract, shortness of breath, and cardiac problems.³⁶ Ozone inhalation causes toxic effect in lungs. The common side effects are epiphora, upper respiratory tract irritation, rhinitis, cough, headache, occasional nausea and vomiting.³⁷

As ozone is a very strong oxidant, scavenging the excess ozone gas and preventing it from escaping into clinical area are issues of concern. The membranes of the eyes and lungs are very weakly protected by antioxidant enzymes. These are the only tissues that require protection from the dosage levels that are used in dental ozone protocols. Moreover the intravenous



injections of ozone cause air embolism.

CONCLUSION

Ozone has successfully evolved in oral and dental treatment. Ozone therapy is the most minimally invasive treatment method with no discomfort or pain. It also minimizes patient's anxiety and stress level as it reduces the treatment duration. The beneficial role of ozone in treating different oral and dental conditions is still limited. There are possible side effects during intra-oral application as it might go to upper respiratory tract. Follow-up studies should be conducted to see its outcome in various dental treatment plans.

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