

Ozonoterapia- An alternative to conventional dentistry

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Abstract

Ozone benefits in oral health care is flourishing with the evidence of its effectiveness in treating dental caries. As we know its importance in the troposphere, it is now even witnessed in the dental sphere. There is growing evidence that it can be employed as a therapeutic agent in both medicine and dentistry. Its painless, atraumatic, non-invasive nature and absence of discomfort makes it an ideal treatment option especially in the case of pediatric patients where patient’s acceptance is of utmost

importance. So, this article enlightens the therapeutic benefits of ozone in dentistry.

Keywords: Ozone, dental, ozone therapy, ozonated gas, aqueous ozone contraindications of ozone

Introduction

Ozone (O₃) is a triatomic oxygen molecule with a molecular weight of 47, 98 g/mol. It is an unstable compound and cannot be stored, hence should be prepared just before use. As soon after preparation within an hour, it gets transformed to oxygen depending on the conditions

such as temperature and pressure [half-life 40min at 20°C].¹ Ozone can be naturally generated by lightening or ultraviolet energy via photolysis of molecular oxygen (O₂) into oxygen atoms which further interact with other oxygen atoms. While in clinical setting, this is done by ozone generator which simulates lightening condition via an electrical discharge field.² Ozone therapy is one of the contemporary non-medication approach of treatment. It is being used for almost 100 years. The number of reports of its successful application in treating different diseases and studies of its effects has increased thriving interest in it. Some other factors responsible for its wide-spreading include simplicity of performance, good tolerance by patients, minimal side-effects or adverse reactions and high medical-social and economic efficiency.³

Despite its benefits it is still ignored because of facts that gaseous ozone is quite toxic and has strong oxidative properties. Ozone, which is used for medical purposes, is a gaseous mixture comprised of a major amount of oxygen i.e. 95 to 99.95 % and 0.05 to 5% of pure ozone. It exhibits multiple actions on the human body, such as anti-microbial, analgesic, anti-hypoxic, immune-stimulating, detoxicating, bioenergetics and biosynthetic.^{3,4}

History

The word ozone comes from a Greek word ozein which means odor and was first described by German chemist Christian Friedrich Schonbein in 1840, who is considered as Father of ozone therapy. The first medical application was done by Dr. C. Lender to purify blood in test tubes. Dr. Edwin Parr used it as a part of disinfection system in 1920. The first dentist to use ozone was Dr. Edward Fischin in 1950, on regular basis and reported many cases based on this.^{1,4}

Modes of ozone administration

Ozone can be delivered in various forms such as topical or locoregional in gaseous or aqueous form or as ozonated

oil or sunflower oil.⁵ The European Cooperation of Medical Ozone Societies warns from injecting gaseous ozone intravenously as it can cause air embolism.²

Ozone Gas

Oxygen is converted into ozone by ozone generating apparatus which has hand piece with a silicon cup on the top of it through which ozone gas is transmitted to the teeth. The silicon cup varies according to the form and size of the teeth to establish snug fit between the cup and the carious lesion. Ozone is led over the tooth for a minimum of 10s. Collected ozone in the silicon cup is converted back to oxygen by the equipment.⁶

Ozonated Water

In its aqueous form ozone shows lowest drug resistance, toxicity and highest biocompatibility when compared to most of the antimicrobials.⁵ This kind of ozone can be generated by bubbling ozone gas through sterile distilled water (O₃ concentration 24mg/L). The selection of ozonated water concentration is according to the higher concentration, which generators produce.⁷

Ozonized Oil

It is most commonly used as a topical treatment for fungal infections as these oils have atoxic and oxidant characteristics.⁸ Since gaseous ozone is highly unstable, ozonized vegetable oils are used clinically to enhance its stability.⁹ These oils are naturally occurring plant extract through which ozone or pure oxygen is passed. Examples of ozonized oils are Oleozone and Bioperoxoil.¹⁰

Ozone Generation

Different systems for generating ozone gas are:

1. Ultraviolet System: produces low concentrations of ozone, used in esthetics, saunas, and airpurification.
2. Cold Plasma System: used to purify air and water, produces high concentrations of ozone. The latter one is the most common system used in the medical/dental field, easy to handle and controlled ozone

production rate are its advantages.

3. Corona Discharge System: most commonly used. It has an easy production of high ozone concentration.

Commercially available ozone generator: CurOzone USA Inc. (Ontario, Canada) developed the HealOzone, which is now distributed by KaVo Dental (KaVo, Biberach, Germany), for use in dentistry.^{11,12}

Mechanism of Action

Ozone oxidizes bio-molecules, disrupts microbial cell structures and metabolism. Within seconds it can disrupt microbial cell wall, leading to immediate cell lysis. 10–20 second application of ozone has been reported to eliminate approximately 99% of the microorganisms found in the dental caries and associated biofilms and a 40 second treatment time covers all outcomes (Lynch and Baysan, 2001). A low concentration of ozone about 0.1 ppm, is sufficient to inactivate bacterial cells as well as their spores. (Broadwater WT et al., 1973).¹¹

Application of Ozone in Dentistry

Ozone presents unique properties and great advantages to clinical practice in dentistry and medicine. It acts as an adjunct to conventional treatment modalities and can be used in a wide range of dental practice.

Ozone can be used for treatment of following conditions

- Early carious lesion
- Sterilization of prepared tooth cavities
- Sterilization of root canals
- To enhance the epithelial wound healing
- Decontamination of avulsed teeth
- Desensitization of extremely sensitive teeth
- Bleaching of discoloured root canal treated teeth
- Treatment of periodontal pockets and peri-implantitis
- As a denture cleaner and decontamination of used toothbrush.

Ozone and Dental Caries

Aqueous and gaseous modes of ozone are used for the treatment of dental caries. Though aqueous ozone is less viable to various micro-organisms it is found to be less cytotoxic than gaseous form.¹¹ In the treatment of dental caries it can be applied through a handpiece that has a silicon cup. It is applied in a controlled manner on the carious lesion, it kills the bacteria that cause caries, thus require only a minimum physical intervention and a few seconds. Ozone exhibits its antibacterial effect by oxidizing bacterial cell wall. During cariogenesis, acidogenic bacteria produces pyruvic acid which is considered as strongest naturally occurring acid and ozone can decarboxylate this acid into acetic acid.¹³ Ozone can be applied to carious lesion to prevent further progression. This is due to the reduction in bacterial counts in the active carious lesion. Ozone with a concentration of 630–2100 ppm for 10 sec can be used for this purpose.¹⁴ It is known to remove the smear layer leaving behind exposed dentin on which remineralizing agent can be effectively applied. Ozone therapy is effective against lactobacillus and some streptococcus strains.¹⁵

Management of pit and fissure caries: Deep pits and fissures are prone to caries due to lack of access to clean. Ozone is an effective agent to arrest or reverse pit and fissure caries. To permit ozone directly on to the caries, prior cleansing of pits and fissures is recommended. It is advised to apply remineralizing agent and seal the fissures after ozone therapy.¹⁶ An in vivo study by Atabek and Oztas (2011) on initial pit and fissure caries lesions in permanent molars using ozone alone and ozone with a remineralizing solution showed that following application on 40 s gaseous ozone 2,100 ± 200 ppm with a flow of 615 mL/min was found to be effective for remineralization of initial fissure caries lesions.¹⁷

Management of root caries

Ozone has the ability to penetrate shallow lesions of maximum 1mm depth. For best result the ozone cap must be held directly over the lesion. For deeper root carious lesions of 4mm, the outer carious portion is removed leaving 1mm of caries and proceed with the ozone treatment and routine restoration is indicated¹⁷.

Sterilization of prepared tooth cavity

Ozone in the gaseous form is used to disinfect the cavities by removing the smear layer. Exposure of gaseous ozone is known to have a strong bactericidal effect on microorganisms, which result in increasing the clinical success of restorations, with no negative impact on shear bond strength of enamel and dentin and on the adhesive restoration.¹⁸

Sterilization of the root canals

Ozone oils are used to sterilize the canal systems and to clear off the necrotic debris by ozone's antibacterial properties. Ozone oils are in the form of ozonated sunflower oil, olive oil or groundnut oil. Application of ozone for a period of 10 s was also capable of reducing the number of *Streptococcus mutans* and *Streptococcus sobrinus* in vitro.³ Cardoso assessed ozonated water as an irrigating agent against *Candida albicans* and *Enterococcus faecalis* and effective results were obtained within 10 minutes of application. No residues were found on the collection of second sample even after a week. Despite this, ozonated water could not neutralize *E. coli* and lipopolysaccharides within the canals and the remaining amount of lipopolysaccharides might cause apical periodontitis.¹⁹ In a study, Zan et al found out that with 4 mg/L aqueous ozone for 180s, had a significant antibacterial effect but lesser efficient than traditional NaOCl against *E. faecalis*.²⁰ Hubbezoglu et al showed delivery of 16ppm aqueous ozone with ultrasonic tip for 180 seconds was effective in eradicating complete

E. faecalis in root canals. Ultrasonication technique allows deeper penetration of ozone into the dentinal tubules and lateral canals which increases its antibacterial action in root canals²¹. According to Reddy S et al, intracanal circulation of ozone gas at a flow rate of 0.5- 1 l/min with a net volume of 5 gm/ml at a flow rate for 2-3min exhibited marked effects against pathogenic microorganisms in the root canal.²²

Ozone in healing wounds

Ozone is known to accelerate the healing of soft tissue conditions, i.e. herpes labialis, aphthous ulcers, acute necrotizing ulcerative gingivitis (ANUG) and other gum infections. Antiviral action of ozone might be due to damage to the protein capsule. Virus does not have any enzymatic protection against oxidative conformation so lipid envelop viruses such as Herpes Virus, Epsilon Bar Virus are sensitive to ozone therapy. Ozone in the form of oil when applied on herpes labialis and mandibular osteomyelitis demonstrates faster healing than conventional treatment.²³

Filippi observed epithelial wound healing with the use of ozonated water, he found that regular use of ozonated water can accelerate healing of the oral mucosa and this effect was seen in the first two postoperative days. Post-extraction healing time is also reduced by forming a pseudo-membrane over the socket, and this protects from external insults. In case of alveolitis accelerated healing by irrigation with ozonated water was seen after removal of the necrotic pulp & debris with supportive antibiotic coverage.³ Clavo et al from his study came to a conclusion that ozone therapy can produce an improvement in blood flow and oxygenation in some tissues & appears to have a positive effect in the treatment of patients with advanced head & neck tumors.²³ A study done by Kim et al, showed topical application of 2 drops of ozonated oil 0.1mL was sufficient to heal oral wounds²⁴.

Decontamination of avulsed teeth

Ozonated water is found to be biocompatible with oral epithelia, gingival fibroblasts, and periodontal cells. Irrigating an avulsed tooth with ozonated water for 2 minutes at a concentration of 2.5–3.5µgml⁻¹, cleanses and decontaminates the root surface. It doesn't have any negative impact on periodontal cells remaining on the tooth surface before replantation²⁵.

Desensitization of extremely sensitive teeth

Ozone is also known to terminate root sensitivity. Sixty-second mineral wash over the exposed dentine in a repetitive manner gives quick relief from sensitivity. Ozone works by removing smear layer, opening up the dentinal tubules, broadening their diameter and then the Calcium and Fluoride ions can flow into the tubules easily, deeply and effectively to block the dentinal tubules, so that it prevents exchange of fluid through these tubules. Therefore, ozone can successfully terminate the root sensitivity problem within a few moments and also lasts longer than those by conventional methods.²⁶

Bleaching of discoloured teeth

Ozone can be used as a bleaching agent for the discolouration caused by intracanal medicaments like minocycline. Discoloration of the crown can be treated placing the bleaching agent into the inner aspect of the tooth then the crown is exposed to ozone gas for a minimum of 3-4min. This ozone treatment bleaches the tooth within few minutes.²³ Study by Zanjani et al revealed the bleaching effect of ozone when used at a concentration of 140ppm for 4 mins but it was found less effective when compared with hydrogen peroxide gel which was used for 8min²⁷. Study on mice by Tessier et al showed 3 minutes of ozone exposure on tetracyclin stained incisors, reduced the yellow color by 28%, while five minutes achieved a 56% reduction. They used ozone at a fixed concentration of 2100 ppm. ozone ± 5% at a

flow rate of 615 cc/ min. The mechanism of this process may involve the ozonation of double bond systems, which contribute to the chromophoric properties of the product²⁸.

In periodontics

Ozone in periodontics mainly utilizes its antimicrobial action over the gram- positive and gram-negative microflora, viruses and fungi. It kills the microorganisms causing periimplantitis. It also shows a positive effect on wound healing by increasing circulation to that area. Nagayoshi et al explored that, almost no microorganisms were detected after being treated with ozonized water (4 mg/l) for 10 seconds.²⁹ Study conducted by Mon J et al in mixed dentition age group children showed that Ozonated water was more effective in reducing debris when compared to herbal water and chlorhexidine when 2.4mg/l of ozonated water rinse for 1 minute was used.³⁰

Ozone as denture and tooth cleanser

Microbial plaque piling up over the dentures is mainly of *C. albicans*. The application of ozonated water (2 or 4 mg/L) for 1 min, might be useful in reducing the number of *C.albicans* on denture bases. Even though both gaseous ozone and ozonated water are used for denture cleansing, gaseous ozone was found to be more effective. Ozone application was found to remove the toothbrushes bristles microbiota following conventional brushing.³¹ Cleaning of removable partial denture alloys with ozone is beneficial but it has little impact on the quality of alloy in terms of reflectance, surface roughness, and weight.²⁶

Contraindications of ozonotherapy

The following are contraindications of ozonotherapy:-

- Pregnancy
- Autoimmune disorders
- Hyperthyroidism
- Anemia
- Myasthenia
- Alcohol intoxication

- CVD, myocardial infarction
- Hemorrhage
- Ozone allergy

Inhalation of ozone for a longer duration can have serious effects on the lungs and other organs as well but calibrated doses can be therapeutically used in various conditions without any toxic or side effects. (Bocci V et al., 2009).³¹ Ozone therapy if performed correctly then nothing to worry but the dentist should know how to overcome emergency as a delayed intervention might lead to death. He/she must know all the steps of basic life support (BLS) and must have ambu bag, medical oxygen, an automated defibrillator and ampoules of epinephrine, atropine and corticosteroids at their hospital/clinic set up (Cummins, 1994).³³

CONCLUSION

As that of conventional procedures, ozone therapy also possesses some risks, which can be avoided if the dentist has practical as well as theoretical knowledge. A judicious dose of ozone prevents its risk of hazards. It is more advantageous than present conventional therapeutic modalities that follow a minimally invasive and conservative application to dental treatment. It lessens patient's treatment time and eradicates a large scale of micro-organisms which is of utmost importance especially in the case of treating pediatric patients. The treatment is painless and increases the patient's tolerability and fulfillment with minimal adverse effects. Contraindications of this controversial method should not be forgotten. Further research is needed to regulate indications and treatment procedures of ozonotherapy.

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