

Dental Ozone: A Boon for Dentistry

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Abstract

In today's world dentistry is quite dynamic. New materials and protocols are developing at a rapid pace. Ozone a triatomic molecule, blue colored gas is not at all new but it has become a new treatment modality in dentistry over the conventional therapeutic modalities. Use of ozone is based on its antimicrobial, antihypoxic and immunostimulating properties. Ozone is used in the form of ozone gas, ozonated water and oil. Its applications includes caries prevention as a disinfectant, irrigant, antimicrobial agent and adjunct to periodontal therapy and in osteoradionecrosis of jaw. Ozone is used in all the aspects of dentistry because of its biocompatibility. The primary objective of this article is to provide a general review about the applications of ozone in dentistry.

Keywords: Antimicrobial, bleaching, caries, ozone

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INTRODUCTION

History

Christian Friedrich, the German chemist, first discovered ozone in 1840 and is considered as the father of ozone therapy. Werner Von Siemens (1857) developed the first ozone generator. In Germany, Dr. C. Lender first applied it in the medical field for purification of blood in test tubes in 1870. The first dentist to use ozone in 1950 was Edward Fisch.^[1]

Chemistry

Ozone is a blue-colored gas with three atoms of oxygen arranged in a cyclic structure. It is present in abundance in the stratosphere and absorbs the harmful ultraviolet rays present in the light spectrum from the sun.^[2]

Ozone which is used for the medical purpose is a mixture of oxygen (95%–99.95%) and pure ozone (0.05%–5%). Ozone is an unstable gas, as it gives up nascent oxygen molecule to form oxygen gas.^[3] Therefore, it is impossible to store ozone for a more extended period, as only half of the mixture remains ozone within an hour after the preparation. Ozone acts as an oxidant, which led to its use in the medical and dental fields. Ozone has unique properties because of which it has a wide range of applications. These properties include antimicrobial, immune stimulator, antihypoxic, vasodilator, detoxicating, and biosynthetic. In addition, ozone is a

potent reparative agent for pulp tissue and is completely biocompatible.^[4]

MATERIALS AND METHODS

Three databases (Medline, Google Scholar, and EBSCO) were used to search for the articles using keywords include ozone in caries prevention, ozone in dentistry, ozone in endodontics, ozone in wound healing, and ozone in prosthodontics.

The search was confined to the articles of the English Language from the period of 1997–2019.

The objective of this review was to find as follows:

- Mechanism of action of ozone on oral tissues
- Application of ozone in the dentistry
- Uses of ozone in the dentistry.

VARIOUS FORMS OF OZONE

Ozone is dispensed in different forms such as ozone gas, as an oil, or aqueous solution. These forms are used either in combination or singly for the treatment of dental disease.

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Ozone gas

There are various systems for ozone gas generation:

- Ultraviolet system generates a minimum concentration of ozone. It is used for air purification and esthetics
- Corona discharge system generates a large concentration of ozone. It is the most prevalent system in the medical/dental field. It has a controlled rate of ozone production and easy way to handle it
- Cold plasma system is used in the purification of water and air.^[2]

Ozone oil

Ozonated oils are naturally occurring plant extracts; pure oxygen and ozone are passed through them. Ozonized oil (Oleozone and Bioperoxoil) is effective against *Staphylococci*, *Streptococci*, *Enterococci*, *Pseudomonas*, *Escherichia coli*, and especially mycobacteria.^[5-7]

Ozone aqueous solution

Ozonated aqueous form can be used as a disinfectant, sterilizing agent, irrigation solution, and hemostatic agent.^[8]

The first O₃ generator was developed by Werner von Siemens in Germany as early as 1857, and the first report of it being used therapeutically was to purify the blood by C. Lender in 1870.^[1]

MECHANISM OF ACTION

- Antimicrobial action – Ozone leads to inactivation of bacteria, viruses, fungi, and protozoa. First, it damages the bacterial cell membrane as a consequence of the ozonolysis of double bonds. Second, it causes secondary oxidant effect, which leads to oxidation of phospholipid and lipoprotein. Gram-positive bacteria are more responsive to ozone than Gram-negative bacteria. Human body cells are resistant to antimicrobial action due to its antioxidative property, resulting in their work specific to bacteria only.^[9]
- Immune-stimulating action – Ozone stimulates immunoglobulin synthesis and immunocompetent cell proliferation and influence cellular and humoral immune system. It activates the purpose of macrophages and increases the respond of microorganisms to phagocytosis. It further causes the production of cytokines and activation of other immune cells. It causes the synthesis of active substances such as interleukins, prostaglandins, and leukotrienes, which helps in the reduction of inflammation and wound healing^[1,9]
- Anti-hypoxic effect – Ozone results in a change of cellular metabolism by raising the partial pressure of oxygen in tissues and thereby improves the transportation of oxygen in the blood. Ozone increases oxygenation and reduces local inflammatory processes, thus improving the metabolism of inflamed tissues^[9]
- Analgesic and detoxification action – Ozone causes the secretion of vasodilators such as NO, which is responsible for the dilation of arterioles and venules.

APPLICATIONS IN DENTISTRY

Disinfectant

- Antimicrobial properties of ozone make it an excellent disinfectant
- Studies have been reported that ozone treatment is useful in disinfecting the gypsum casts.^[10] It is also used as a disinfectant in dental treatment units
- Filippi confirmed the efficiency of ozonated water as a disinfectant on the water in dental treatment units over 8 years.^[11]

Healing of wounds

Ozonated water can accelerate the healing rate of the oral mucosa when the wound is subjected to more oxygen after the application of ozone. Moreover, ozone leads to higher expression of cytokines, which are essential for the regulation and coordination of initial wound-healing phase.^[9]

In cases of herpes labialis and mandibular osteomyelitis, when ozonated oil was applied, then the lesions healed faster than the conventional modality.^[8]

Remineralization therapy

As ozone is a strong oxidant, it can remove proteins from the carious lesion. A minimal amount of carious tissue needs to be removed before the restoration, unlike conventional drill and fill technique. Furthermore, ozone facilitates calcium and phosphate ions to penetrate the lesion and enables the remineralization potential of the carious lesion.^[12]

In prosthodontics

Ozone is an active antimicrobial agent and has excellent healing properties because of which it is used for faster healing of ulcers and used in denture cleaning as well.

Alzarea reported that exposure of 60 s of ozone gas on denture-related traumatic ulcer resulted in better ulcer healing, decreased pain level, reduction in ulcer size, and duration.^[13]

Decontamination of avulsed tooth

Ozone has a broad-spectrum antimicrobial activity in water and is biocompatible with human oral epithelial cells and fibroblast cells of gingiva because of this property it can be used to decontaminate the avulsed tooth. According to this study, 2 min of irrigation with ozonated water facilitates mechanical cleansing as well as decontamination. No negative effects were noticed on the remaining tooth and attached tissue.^[14,15]

Dental caries

Caries prevention

The American Academy of Pediatric Dentistry has established “the objectives of restorative treatment are to repair or limit damage from caries, protect and preserve tooth structure, reestablish adequate function, restore esthetics (where applicable), and facilitate good oral hygiene” (American Academy of Pediatric Dentistry Clinical Affairs Committee-Restorative Dentistry Subcommittee and American Academy of Pediatric Dentistry Council on Clinical Affairs, 2008).^[16]

Beretta and Federici Canova in 2017 conducted an *in vitro* study to assess the effectiveness of ozone for the disinfection of carious dentin, and they concluded that in deciduous teeth, ozone was an effective and efficient protocol in the treatment of deep carious lesion over the conventional restorative treatment.^[17] Dähnhardt *et al.* used ozone in apprehensive children who were referred to as nontreatable by a dentist; a study revealed that 94% of children were treatable and 93% of children lost their dental anxiety.^[18]

Root canal treatment

Ozone is found to be effective against root canal pathogens such as *Candida albicans*, *Peptostreptococcus microns*, and *Pseudomonas aeruginosa*. Hence, it is used as an intracanal irrigant. Studies have revealed that sodium hypochlorite on ozonation becomes more effective oxidant. According to Nagayoshi *et al.*, ozonated water and 2.5% sodium hypochlorite have the same antimicrobial efficiency, and ozonated water is less cytotoxic.

Hems *et al.* assessed the antimicrobial effect of ozone gas on the strain of *Enterococcus faecalis*. However, there was no reduction seen in the microflora in biofilm incubated for 240 s. Consequently, ozone has a minimum effect when bacteria are arranged in biofilm and a powerful antimicrobial effect on planktonic *Enterococcus faecalis*.^[19,20]

In peri-implantitis

Being a powerful antimicrobial agent, ozone kills all the microorganisms which cause peri-implantitis. Ozone also has excellent wound-healing property. Karapetian *et al.*, in 2007, reported that ozonated gas or ozonated water shows better wound healing as compared to nonozonated one.^[21]

PERIODONTAL TREATMENT

Bactericidal and healing properties of ozone make it an active agent in periodontal therapy as a subgingival irrigant. Dodwad *et al.* (2011) compared the efficacy of ozonated water, 0.2% chlorhexidine, and 10% povidone-iodine as an oral irrigant in patients with chronic periodontitis. The present study revealed that ozonated water shows a better reduction in all the parameters as compared to chlorhexidine and povidone-iodine. Nagayoshi *et al.* inferred that ozonated water was quite effective in killing both Gram-positive and Gram-negative organisms such as *Porphyromonas endodontalis* and *Porphyromonas gingivalis*.^[22]

Durga Kshitish and Vandana K Laxman reported that ozone is a useful therapeutic agent in periodontitis associated with fungus, virus, and bacteria both for home care and professional level. Current treatment of periodontitis is based on disinfecting the supragingival and subgingival tissues to reestablish a microorganism-free environment.^[23] This fact renders ozone application reasonable and justifiable treatment option. It has been shown *in vitro* that ozone is bactericidal against periodontopathic organisms.^[9,24]

In oral maxillofacial surgery

Ozone has a positive influence on bone metabolism and reparative process of the bone (Sanseverino ER *et al.*, 1989). In patients with chronic mandibular osteomyelitis, it had been observed that medical ozone exposure promoted more complete and rapid normalization of nonspecific resistance and T-cellular immunity, thus accelerating clinical cure and reducing the incidence of complications.

Ozonated water showed a faster healing rate.^[8] Alveolitis, when treated with ozonated oil, healed much quickly. According to various studies, ozone can also be used in avascular osteonecrosis of the jaw, and healing occurs with complete disappearance of symptoms.^[22,25-27]

Teeth whitening

Ozone can be used for teeth whitening due to its strong oxidizing properties.

Al-Omiri *et al.* reported that the application of ozone for 60 s and 38% of H₂O₂ for 20 min resulted in similar results and lighter shades of teeth.^[28]

Tessier *et al.* reported successful lightening of tetracycline-stained incisors with the use of ozone.^[29]

LIMITATIONS

Today, most of the therapists either have a misconception or do not know how ozone acts on blood and biological fluids.^[1]

Hence, to use ozone in dental practice, one must avoid toxicity that can only be controlled if operate cautiously, and the following points should be taken into consideration before using ozone:

1. Use of a precise ozone generator equipped with a well-standardized photometer
2. By use of precise gas volume with a defined ozone concentration
3. To know and use the optimal dose for achieving a therapeutic effect
4. Use of appropriate facial masks.

CONTRAINDICATIONS OF OZONE

1. Pregnancy
2. Glucose-6-phosphate dehydrogenase deficiency (favism)
3. Hyperthyroidism
4. Severe anemia
5. Severe myasthenia.

Calibration of the dose is essential as prolonged inhalation can be deleterious to the lungs.^[30]

According to the European Cooperation of Medical Ozone Societies, direct IV injection of ozone gas should be not be used to avoid the risk of air embolism.

CONCLUSION

Ozone therapy is a paradigm shift in dentistry. It can be used in treatment modalities such as infections, wound healing, bleaching of the tooth, and root canal disinfection. Ozone therapy is a painless, minimally invasive, efficient treatment modality and is more beneficial than the conventional therapeutic modalities.

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Conflicts of interest

There are no conflicts of interest.

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