



OZONE THERAPY IN CONSERVATIVE DENTISTRY AND ENDODONTICS- A LITERATURE REVIEW

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ABSTRACT Ozone(O_3), a pungent smelling gas, discovered by Professor Christian Schonbein, who is called as “Father of Ozone Therapy”, has been used in medical practice since 1800s but now it was introduced in dentistry also by Dr Fisch in 1932. Antihypoxic, anti-inflammatory, antibacterial actions are the prime actions of oxone along with other actions. Ozone is available as a gas, ozonated water or oil.

Ozone therapy can be used in cervical root carious lesions, white spot lesion remineralization, early secondary caries around crown and bridges, disinfection of root canal walls, etc due to its advantages of remineralization by oxidizing caries, kills 99% of microorganisms, removes organic debris on carious lesion, is painless and noiseless, decrease in treatment time with this therapy, etc.

Further research should be conducted on whether ozone therapy can be useful as a promising aid in minimally invasive dentistry in the near future.

KEYWORDS : conservative dentistry, minimally invasive dentistry, ozone therapy, operative dentistry

INTRODUCTION

Dental treatment has always met with apprehension by most of the patients. So, researchers have always sought a quick, painless and a pleasant way for treating dental problems. One such minimally invasive option is the application of “Ozone Therapy”. It is a simple, effective and very economical alternative for the dental practitioner.¹

History

“Ozone” in Greek is derived from the word “ozein” meaning “smelling gas”. The discovery of ozone in 1840 happened by chance when Professor Christian Schonbein² (1799-1868), the “Father of Ozone Therapy”, exposed oxygen to electrical charges and a strong smell was produced, so, the ozone gas was first discovered. The first Ozone generator was developed by Werner Von Siemens in Germany in 1857. Ozone started to be used on a regular basis in dental practice in 1932 by Dr. E. A. Fisch.³ First ozone research centre in the world was in Cuba in 1959. Various authors, emphasized the use of ozone over the years.

Structure and Properties

Ozone is a triatomic molecule with symbol O_3 , continuously formed in the upper atmosphere.³ Ozone exists as a pale blue gas, with a pungent odour at room temperature.⁴ Ozone is an unstable gas that cannot be stored and should be used at once because it has a half-life of 40 min at 20 °C⁵

Indications

It may be useful for cervical root carious lesions, early carious lesions around crowns and bridges. Also, in non-carious hypersensitive teeth, where it helps in alleviating the pain. It can also be used in case of cracked tooth syndrome. After relieving the cracks, apply ozone gas for 60-120 sec and restore with a long-term filling i.e. GIC. It finds its applications in root canal therapy due to its strong disinfection property and absence of cytotoxicity as well as other negative side effects.⁶

Contraindications

Ozone therapy is not used after recent cardiopathy, pregnancy, recent internal bleeding, hyperthyroidism, thrombocytopenia, alcoholic intoxication, autoimmune disorders, myasthenia, severe anaemia, Haemorrhage. It may be harmful for patients with Ozone allergy⁵ or Glucose-6-phosphate-dehydrogenase deficiency (favism)⁷

Advantages

It kills more than 99% of microorganisms in caries, speeding up remineralization by oxidizing caries, also, removing organic debris on carious lesion. It removes volatile sulphur compounds (main cause of halitosis) from root caries. There is decreased treatment time with this therapy and it is painless and noiseless. Ozone does not cause allergic reaction. Microorganisms do not develop resistance to ozone.⁸

Ozone production

Medical grade oxygen is made to flow through high voltage tubes with outputs ranging from 4000 V to 14000 V. In dentistry, there are two widely used ozone units: the HealOzone and Ozotop.⁹

Ozone can be produced in these 4 ways:

1. Ultraviolet radiation
2. Cold plasma
3. Corona discharge system
4. Electrolytic ozone generation

Ozone systems used:

1. Open system (e.g. Ozi-Care): More research is still needed with the open systems.
2. Closed systems: HEALOZONE TEC 3 (CurOzone, USA Inc)



Figure II- Healozone Tec 3 (CurOzone, USA, Inc)

Biological actions

1. Antimicrobial effect- Ozone works destructively against bacteria, fungi, and viruses. It has action on cells by damaging its cytoplasmic membrane due to ozonolysis of dual bonds and also ozone-induced modification of intracellular contents. It is non-specific and selective to the bacterial cell; no damage to human body cells. Ozone is very efficient in antibiotics resistant strains. The research reveals that if applied for a few seconds, ozone stops all vital functions of bacteria which are incapable of developing any self-immunity to its action.¹⁰
2. Anti-hypoxic effect/ stimulation of oxygen metabolism- It helps protect organisms against the action of oxygen-free radicals, improves the metabolism of inflamed tissues.¹⁰
3. Activation of immune system/ Immune stimulating action: Ozone has an influence on cellular and humoral immune system by stimulating proliferation of immunocompetent cells and synthesis of immunoglobulins.¹¹ It causes the synthesis of biologically active substances such as interleukins, leukotrienes and prostaglandins which is beneficial in reducing inflammation and wound healing of human body cells.⁴

4. Biosynthetic effect⁴
It activates protein synthesis effect and elevation of functional activity.
5. Angiogenesis- Vasodilators (nitric oxide) responsible for dilation of arterioles and venules are secreted.
6. The remineralization potential is intensified of organic part of tooth.¹⁰
7. It enables the diffusion of calcium and phosphorous ions to the deeper layers of carious cavities by opening dentinal tubules.¹¹
8. It relieves toxic effect and ensures a bioenergetic effect.¹²
9. It is a powerful oxidizing agent.^{13,14}
10. Oxidation of lipoproteins and phospholipids in bacterial cell envelopes causes its inactivation and results in lysis of the cell.¹⁵

Applications

It is administered as a gas or oil¹⁶, or ozone aqueous solution¹⁷. Ozone therapy is described as “a versatile bio – oxidative therapy in which oxygen/ozone is administered via gas or dissolved in water¹⁹ or oil base to obtain therapeutic benefits²⁰”

• Ozone and oral pathogens

Various microbiological factors are involved in formation of oral lesions²¹; Main focus in dental treatment is the elimination of microorganisms. Some studies reported that an exposure of about 60s exhibited 99.9% killing efficiency against cariogenic bacteria such as *Actinomyces naeslundii*, *Streptococcus mutans* and *Lactobacillus casei*. However, exposure for such a long period showed degradation of salivary proteins and hence 10s –30s of exposure was proven to be effective in killing a significant number of bacteria.²²

• Ozone and oral tissues

Ozone application has various beneficial effects on the oral tissues including remission of various mucosal alterations, enhanced wound healing and increased turnover rate of oral cells. Huth et al reported that ozone is a potential antiseptic agent and the aqueous form showed less cytotoxicity than gaseous ozone and stated that it is better than most antimicrobials like sodium hypochlorite, chlorhexidine or hydrogen peroxide.²³

• Role of ozone in dental caries prevention and management

Ozone has been shown to be used in treatment of dental carious lesions management.⁴ Fagrell et al in an in-vitro study, tested the effect of ozone on three different strains of mutans streptococci and one strain of *Lactobacilli*. They found bactericidal effect of ozone on all the four different strains of bacteria.²⁴ In another in vitro study, they showed that application of ozone gas for a period of 10 seconds was capable of reducing the numbers of *Streptococcus mutans* and *Streptococcus sobrinus*.

• Role in Endodontics

Effect of ozone is manifest when it is prescribed in adequate concentration, time and delivered correctly into root canals after the traditional cleaning, shaping and irrigation is done. The potential use of ozone gas, ozonated water and ozonized oil in endodontic therapy has been repeatedly reported in the literature. Intra canal circulation of ozone gas at a flow rate of 0.5–1 l/min with net volume of 5 gm/ml for 2–3 min had encouraging results against pathogenic microbes in the root canal.¹⁶ Ozonated water can be used as an intracanal irrigant and in infected necrotic canals, ozonized oils can be used as an intra-canal dressing reducing the marked anaerobic odor emanating from infected teeth. Ozone encourages tissue regeneration and bone healing by its irrigant action. Also when a root canal was disinfected by ozone water with sonification, the antimicrobial efficacy was comparable to 2.5% NaOCl. Hence in periapical infections, ozone therapy can increase the scope of nonsurgical management of these lesions.¹⁹

• Cracked tooth syndrome

After exploration of the crack, the prognosis is assessed and the tooth is exposed to ozone for 60-120 seconds and seal the tooth with an intermediate restoration like GIC. The tooth needs to be periodically assessed and restored.¹⁹

• Role in bleaching

Crown discolouration is one of the major esthetic problem in root canal treated teeth.²⁵ Tooth whitening can be done using ozone gas due to its strong oxidizing properties. When the bleaching agent is placed in the access cavity and crown is exposed to ozone for a minimum of 3-4 minutes, bleaching effect of ozone is seen.²⁶ This Ozone treatment bleaches the tooth within minutes and provides good esthetic result.²⁷

The first experimental study was done by Tessier *et al.* to evaluate, in an experimental model of growing rats, the efficacy of using ozone to lighten tetracycline- stained incisors and it was seen that ozone can be surely used to lighten the yellowish tinge of tetracycline-stained rat incisors. But further studies are required for its potential use in the dental clinic.²⁸

• Role in hypersensitive teeth

Quick relief from root sensitivity has been documented when ozone spray is used for 60 seconds followed by mineral wash onto the exposed dentine, repetitively. This desensitization of dentine lasts for a long time. Smear layer over the exposed root surface prevents the penetration of ionic Calcium and Fluorine well into the dentinal tubules. Ozone removes this smear layer to open up the dentinal tubules so that their diameter is broadened and then Calcium and Fluoride ions flow into the tubules quite easily, deeply and effectively to plug the dentinal tubules and prevents the fluid exchange through these dentinal tubules. Thus, ozone can effectively terminate the root sensitivity problem within seconds and results last longer than those by conventional methods.²⁹

Ozgul³⁰ conducted a study in order to evaluate the hypersensitivity that was observed in Molar incisor hypomineralization affected teeth and the effect of desensitizing agents with or without ozone to incisors affected by it and it was demonstrated that desensitizing paste, reduced the hypersensitivity. More effective was a CPP-ACP paste, and ozone therapy helped prolong its effect.

• Dental unit water line disinfection

Just as biofilm forms on the surfaces in the oral cavity, it also forms in the dental unit water lines. These water lines harbour bacteria that can be harmful to patients and dental team. The biofilm build-up in water lines can be thick and is enclosed in a protective layer that makes it resistant to chemical agents. Since the majority of dental treatments require water, this is a real concern for dentists.⁷

Szymanska³¹ identified moulds, bacteria, and yeasts in biofilms which are hazardous to the health care worker and other patients during treatment. Opportunistic pathogens were cultured from the mains water. Initial research on the use of the HealOzone, applied to water lines via the dental unit water supply, has shown greatly reduced numbers of bacteria present and also a significant reduction in the biofilm present). It is interesting to note that the HealOzone unit may be adapted to allow ozone to be applied to the water lines via the “clean water system” water bottle. Significant savings may be made by the resulting reduction in blockages of hand pieces, couplings, etc.³²

In a study investigating the effectiveness of ozone in controlling the contamination of dental water lines, the initial bacterial count was just above 5000 CFU/ml. After the first three-minute application of ozone and flushing of the water line, the bacterial count was reduced to 300CFU/ml, and then to 0 CFU/ml after the second and subsequent application. For five weeks after ozone treatment, the lines continued to be sterile.³³

Ozone toxicity

Evidence shows that the bronchial– pulmonary system is extremely sensitive to ozone so this gas should never be inhaled, may cause pulmonary embolism.

Precautions

Its use may show certain side effects, like, Epiphora, Rhinitis, Cough, Headache, Occasional nausea, vomiting, Shortness of breath, Blood vessel swelling, Poor circulation. In case of Ozone intoxication the patient must be placed in the supine position, inhale humid oxygen and take ascorbic acid, vitamin E and N acetyl cysteine. Because of ozone's highly oxidative power, all materials that come in contact with the gas must be ozone resistant, such as glass, silicon, teflon.

CONCLUSION-

Ozone therapy is truly a paradigm shift in dental practice which complies the demands of the public for non- invasive, effective dental care. The ozone more therapy has been more beneficial than present conventional therapeutic modalities that follow minimally invasive and conservative application to dental treatment. Future of ozone therapy must focus on the establishment of safe and well-defined parameters in accordance with randomized controlled trials to determine the precise indications and guidelines in order to treat various dental pathologies with this promising agent.

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