Ozone in Dentistry

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ABSTRACT:

With the emergence of a new era in dentistry, ozone therapy has been established as a safe and effective method for preventing and treating dental caries. This novel treatment approach promotes caries reversal and the remineralization of teeth without damaging their structure. Ozone currently is a cornerstone in dental care. The strong oxidizing ability of ozone has lead to its widespread application in dentistry.

Key words: Dentistry, Ozone therapy, Ozone dentistry

INTRODUCTION

Ozone (also known as triatomic oxygen and trioxygen) is a naturally occurring compound consisting of three oxygen atoms. It is found in nature, in the form of a gas in the stratosphere in a concentration of 1–10 ppm, being continually created from and destroyed into molecular O_2.[1] Both these chemical reactions are catalyzed by very high frequency ultraviolet light from sunlight. Consequently harmful B and C ultraviolet radiations in the stratosphere reaching the outer atmosphere from the sun are absorbed by ozone. Therefore, ozone in stratosphere has a critical role in both the thermal structure of the stratosphere as well as the ecological framework for life on the Earth's surface. On the other hand, ozone in the troposphere is considered to be toxic for the pulmonary tract. In the troposphere, ozone is produced in a complicated series of chemical reactions involving the components of automobile exhaust (NO_2), sunlight (especially in hot summer months), and oxygen. The reliable microbiologic and metabolic properties of ozone, in either the gaseous or aqueous phases, make it a useful disinfectant with a wide range of activity. Ozone, in the gaseous or aqueous phase, has been shown to be a powerful and reliable antimicrobial agent against bacteria, fungi, protozoa, and viruses. It is generally accepted that the oxidant potential of ozone induces the destruction of cell walls and cytoplasmic membranes of bacteria and fungi. During this process, ozone attacks glycoproteins, glycolipids, and other amino acids and inhibits and blocks the enzymatic control system of the cell. This results in increases in membrane permeability, the key element of cell viability, leading to immediate functional cessation. Then ozone molecules can

readily enter the cell and cause the microorganism to die. Also, ozone can attack many biomolecules, such as the cysteine, methionine, and the histidine residues of proteins. By oxidizing the biomolecules featured in dental diseases, ozone has a severely disruptive effect on cariogenic bacteria, resulting in elimination of acidogenic bacteria. The strongest naturally occurring acid, produced by acidogenic bacteria during cariogenesis is pyruvic acid. Ozone can decarboxylate this acid to acetic acid. It has been shown that remineralization of incipient carious lesions can be encouraged when the production of acetic acid, or other high pKa acids found in resting plaque, buffers plaque fluid.

During World War I, ozone gas was used for treating gaseous post-traumatic gangrene, infected wounds, mustard gas burns and fistulas in German soldiers. Ozone therapy was accepted as an alternative medicine in the USA from 1880 until 1932. To date, ozone therapy has been a recognized treatment modality in countries.1 Its use has been investigated in treatment of ocular diseases, acute and chronic bacterial, viral and fungal infections, ischemic diseases, age-related macular degeneration, orthopedic diseases, and dermatological, pulmonary, renal, hematological and neurodegenerative diseases. It can react with blood components (erythrocytes,leukocytes, platelets, endothelial cells and the vascular system) and positively affect oxygen metabolism, cell energy,the immunomodular property, antioxidant defence system,and microcirculation.[1]

MECHANISM OF ACTION OF OZONE

Ozone is a thermodynamically highly unstable compound that decomposes to pure oxygen depending on system conditions like temperature and pressure. Ozone is the third most potent oxidant after fluorine and per sulfate and has a half-life of 40 min at 20°C. Potential applications of ozone in the clinical practice of dentistry and medicine is based on the actions such as antimicrobial, anti-inflammatory, immuno-modulating, biosynthetic, bioenergetic, antihypoxic, analgesic and hemostatic effects. The main antiviral actions of ozone are the change of the capsid and the irreversible destruction of viral DNA. However, ozone does not have the same strength of action on every germ. For example, enteroviruses, rotaviruses, hepatitis A and human immunodeficiency viruses are more ozone-sensitive than poliomyelitis and coxsackie viruses. The antibacterial effect of ozone is based on the inhibition of their metabolic activity and the lysis of bacterial cell wall]. In bacterial cultures, Escherichia coli and Candida albicans are more ozone-sensitive than Staphylococci.[2]

OZONE THERAPY IN DENTAL PRACTICE

Ozone was first applied in dentistry in 1932 by a Swiss dental surgeon Dr. Edwin Fisch. However, ozone seems to have disappeared from usage in dental care until 2001 when the first scientific studies were published examining the biomolecules found in dental caries, before and after treatment with ozone. As dental demographics changed and prevention based dentistry became the standard of care, the new challenges of managing and treating an aging population who have retained rather than lost their teeth needed to be addressed. This was of particular concern in regard to root surface caries and the increased susceptibility of exposed root surfaces in elderly patients.[3]

THE .LICATIONS OF OZONE IN DENTISTRY ARE:

1. Reversal of incipient caries
2. Prevention of pulpal infection in deep caries affected dentin
3. Disinfection during RCT
4. Disinfection of cavity preparations prior to restoration
5. Treatment of cervical sensitivity
6. Prior to all fissure sealant placement
7. Bleaching teeth
8. Combined with other approaches to manage caries such as ART.
9. Aphthous ulcer and Herpes simplex lesions

TREATMENT OF DENTAL CARIES

The application of Ozone therapy in the treatment of dental caries is extensively studied and many studies have proved its effectiveness in the treatment of pit and fissure caries, root caries and

interproximal caries. Ozone is delivered through a hand piece, which is equipped with a silicon cup. The cup is applied directly to the tooth so that it forms a tight seal at the application site. The mechanism of action is due to its microbiological properties and its ability to oxidize the bacterial cell wall. Pyruvic acid, that is produced by bacteria and implicated in the progression of caries, is oxidized by Ozone to acetate and carbondioxide. This treatment is an alternative therapy to conventional drilling and filling for non cavitated deciduous carious lesion. The infusion of Ozone into non-carious dentin prevented biofilm formation in vitro from S. mutans and Lactobacillus acidophilus over a 4 week period. Some studies have demonstrated that 40 s application of Ozone is sufficient to kill different concentrations of S. mutans and application of 60 s has almost completely eliminated S. mutans, L. casei and A. naeslundii. Ozone is also found to be effective against the microflora associated with primary root caries lesions.In a study the aqueous form of Ozone was found to be less cytotoxic than gaseous Ozone. But it is reported to have a minimal effect on the viability of different bacterial species organized in a cariogenic biofilm. According to some studies the application of Ozone gas to non-cavitated carious lesions does not significantly reduce the number of viable bacteria in the underlying infected dentin. But it provided strong evidence that the mechanism by which Ozone application might be effective is not mediated by direct killing of bacteria in infected dentin. Ozone treatment either alone or combined with a re-mineralizing solution was found to be effective for remineralization of initial fissure caries lesions. But randomized double blind standardized clinical studies are still required to establish Ozone therapy in the treatment of dental caries. But it can be used in conjunction to the conventional treatment modalities.

ENDODONTICS

In endodontic treatment instead of using irrigation chemicals (Naocl), Ozonated water can be used for irrigation. A Japanese study published in 2004 demonstrated the antimicrobial activity of Ozone in root canal treatment without any tissue toxicity. The study also shown that there was high metabolic activity of the associated fibroblasts indicated an increase in the healing process. Procedure includes, the canals are prepared with files lubricated with ozonated oils and irrigated with ozonated water and dried. Before filling, a slow insufflation 45-60 sec into each canal should be done with concentration of Ozone using bout 30 ml.

In a study the aqueous form of Ozone was found to be less cytotoxic than gaseous Ozone. Ozonated oils like Ozonated sunflower oil, olive oil and ground nut oil was efficient in canal sterilization than the conventional irrigation by the Sodium hypochlorite and Sodium peroxide combination. In a study on permeability of oral microorganisms and dental plaque, both gram +ve and gram –ve such as Porphyromonas endodontalis and Porphyromonas gingivalis were more sensitive to Ozonated water than gram +ve oral Streptococci and Candida albicans in pure culture and Ozonated water was proved to have bactericidal activity against bacteria in plaque biofilm. But it was found that even after 20 minute of contact time of Ozonated water, gaseous Ozone and antiseptic agents did not have antibacterial effect on Enterococcus Faecalis. Single visit treatment of infected root canals with and without ozonotherapy has resulted in complete remission of periapical lesions.

PERIODONTICS

The effect of Ozone water on oral microorganisms and dental plaque were studied. Dental plaque samples are treated with 4 ml of Ozone water for 10 sec and was observed that gram +ve and gram –ve oral microorganisms and Candida albicans in pure culture as well as bacteria in plaque biofilm are killed, hence it was used to control oral microorganisms in dental plaque . Ozone was found to considerably inactivate microorganisms causing periodontitis and antifungal effect was observed when compared to chlorhexidine, but did not show any antiviral effect.

The study of effect of ozonated water on proliferation of cells in periodontal ligament has resulted in the decontamination of root surface, without negative effect on the remaining periodontal cells on root surface. And also there is reduction in the plaque index, gingival index and bleeding index

by using ozone irrigation when compared to chlorhexidine.

Periodontal disease is a multifactorial disease. The sulci and pockets are irrigated with ozonated water to reduce the initial microbial load and insufflated with Ozone gas .The patients are also given ozonated oil to apply topically to the soft tissue. Silicon tray isolation technique can also be used where Ozone is introduced into the tray which fits the arch through the port of the tray. Excess gas is evacuated by a small evacuator which is attached to the outlet valve.

PROSTHODONTICS

Ozone can be applied for cleaning the surface of removable partial denture alloys with little impact on the quality of alloy in terms of reflectance, surface roughness, and weight. Gaseous ozone is used to disintegrate smear layer and to disinfect the prepared tooth. Denture stomatitis can be controlled by topical application of ozonated oil over tissue surface and over denture surface. A study conducted by Arita et al showed that application of ozonated water may be useful in reducing the number of Candida albicans on denture plates. The heat-cured acrylic resins were cultured with C.albicans. After treatment of flowing ozonated water, the number of attached C.albicans was counted. In some experiments, the test samples were treated with ozonated water in combination with ultrasonication. After exposure to flowing ozonated water (2 or 4 mg/l) for 1 min, viable C. albicans cells were nearly non-existent. The combination of ozonated water and ultrasonication had a strong effect on the viability of C. albicans adhering to the acrylic resin plates.

ORAL SURGERY

Ozone was found to accelerate the healing of the wounds. After a tooth is extracted or any surgical procedure the area is irrigated and insufflated which promotes faster healing without complications. Ozone therapy is found to be beneficial for the treatment of the refractory osteomyelitis in the head and neck in addition to treatment with antibiotic, surgery and hyperbaric oxygen. It also increases the benefits of surgical and pharmacological treatments causing complete healing of the lesions. A noninvasive surgery with pre and postsurgical cycles of Ozone therapy consisting of eight sessions lasting 3 minutes each besides antibiotics and antifungal therapies has been applied for the treatment of bisphosphonate induced osteonecrosis of jaw.

ORAL MEDICINE

Soft tissue lesions like herpes, aphthae, removable denture ulcers, cuts, cheilitis, candidiasis, cysts and traumatic wounds can be treated with either Ozonated water or oils. The disinfectant and healing properties help in the healing of these lesions.

IMPLANTS

In a study gaseous Ozone showed selective efficacy to reduce adherent bacteria on Titanium and Zirconia without affecting adhesion and proliferation of osteoblastic cells. Porphyromonas gingivalis was eliminated by Ozone from all surfaces with in 24 sec to below the detection limit (99.94%), while Streptococcus sanguis was more resistant and showed the highest reduction on zirconia substrates.[4]

OZONE TOXICITY

Ozone inhalation can be toxic to the pulmonary system and other organs. The known side effects are epiphora, upper respiratory tract irritation, rhinitis, cough, headache, occasional nausea and vomiting. However, complications caused by ozone therapy are infrequent. In the event of ozone intoxication, the patient must be placed in the supine position, inhale humid oxygen, and take ascorbic acid, Vitamin E and n-acetylcysteine. Further, because of its high oxidative power, all materials that come in contact with the gas must be ozone resistant such as glass, silicon andTeflon.[5]

CURE FOR OZONE INTOXICATION

The patient must be placed in the supine position. The patient should inhale the humid oxygen and treated with Vitamin E, ascorbic acid and nacetylcysteines.[6]

CONTRAINDICATIONS OF OZONE[7]

The following are contraindications of ozone therapy

1. Pregnancy

2. Glucose- 6- phoshate dehydrogenase deficiency (favism)
3. Hyper thyroidism
4. Severe anemia
5. Severe myasthenia
6. Active hemorrhage

Prolonged inhalation of ozone can be deleterious to the lungs and other organs but well calibrated doses can be therapeutically used in various conditions without any toxicity or side effects. The European Cooperation of Medical Ozone Societies, warns that direct intravenous injections of ozone/ oxygen gas should not be practiced due to the possible risk of air embolism.[8]

OZONE AND DENTAL UNIT WATER LINES

Dental unit water line (DUWL) contamination has become a concern. Water becomes stagnant when the units are not in use. Detachment of microorganisms, splatter, and aerosols from dental procedures may possibly infect health care personnel. Szymanska 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. Another study suggested that DUWL biocides may adversely affect adhesion of resin to enamel. Ozone has been used for purification of water due to its efficiency and lack of side effects. Kohno et al published their results that indicated acidic electrolyzed water could be applied as an appropriate measure against bacterial contamination of the DUWL. Montebugnoli et al concluded that dental manufacturers should be invited to design dental units that incorporate automated devices to disinfect DUWLs. In model dental unit water lines, ozone achieved a 57% reduction in biofilm and a 65% reduction in viable bacteria in spite of being used in a very low dose and with a short time of application.[9]

CONCLUSION

Ozone is the perfect substance for use in dental procedures. It disinfects the tissues treated and leaves no toxic residues like chlorinated products. It performs this task by oxidizing the cell membranes of pathogenic organisms and killing them. The oxidizing effect of ozone is as follows: one molecule of ozone will kill the same number of bacteria that requires 3,000-10,000 molecules of chlorine for the same effect and ozone kills them 3500 times faster than chlorine.[10]

REFERENCES

1. Amir Azarpazhooh, Hardy Limeback. The application of ozone in dentistry: A systematic review of literature. J Dent 2008; **36**:104–116.
2. Junaid Ahmed, Almas Binnal, Bijina Rajan, Ceena Denny, Nandita Shenoy. Ozone applications in dentistry: an overview. J Exp Integr Med 2013; **3**(3):171-176.
3. Chandrasekhar T, A Ratnaditya, Chaitanya Ram Kandregula, Guntipalli M Naidu. Ozone Therapy: Applications in Preventive Dentistry. J Res Adv Dent 2015; **4**(1):103-106.
4. Komali G. Ozone Therapy - A Revolutionary Noninvasive Therapy in Dentistry. Open Access Scientific Reports 2012; **1**(10):473.
5. Dixit KK, Anurag Gurtu, Rahul Pandey. Role of Ozone in Conservative Dentistry and Endodontics – A Review. J Dent Sci Oral Rehab 2013; **2**:1-3.
6. Dr. Sreenivas Nagarakanti. Ozone: A New Revolution in Dentistry. www.webmed central.
7. Anil Kumar, Sharnamma Bhagawati, Prashant Tyagi, Prince Kumar. Current interpretations and scientific rationale of the ozone usagecin dentistry: A systematic review of literature. Eur J Gen Dent 2014; **3**(3):175-180.
8. Gopalakrishnan S, Parthiban S. Ozone - a new revolution in dentistry. J Bio Innov 2012: **1**(3):58-69.
9. Bikash Pattanaik, Dinesh Jetwa, Seema Pattanaik1, Sachin Manglekar1, Dinesh N.Naitam, Anurag Dani. Ozone therapy in dentistry: A literature review. Journal of Interdisciplinary Dentistry 2011; **1**(2):80-86.
10. John A Rothchild, Bob Harris, Phil Mollica. Current Concepts of Oxygen Ozone Therapy for Dentistry in the United States. http://www.scribd.com/doc/78086239/Ozone-Therapy-for-Dentistry#scribd.