



Ozone: A Future in Periodontal Therapy!

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Ozone therapy, periodontal diseases, anti-microbial

Dr. Chandni Adalja

Post graduate student, Dept. of Periodontics, K.M.Shah Dental College & Hospital, Vadodara.

Dr. Neeraj Deshpande

Professor, Dept. of Periodontics, K.M.Shah Dental College & Hospital, Vadodara.

Dr. Deepak Dave

H.O.D & Professor, Dept. of Periodontics, K.M.Shah Dental College & Hospital, Vadodara.

ABSTRACT

Ozone, an allotropic form of oxygen is an unstable gas which has been successfully used in the treatment of various diseases for more than hundred years. It is highly valued for various effects, such as antimicrobial, anti-hypoxic, analgesic, immuno-stimulating and biosynthetic effect on biological systems. In comparison with classical medicine modalities such as antibiotics and disinfectants, ozone therapy is quite inexpensive, predictable and conservative. Accumulation of bacterial plaque in increased amounts leads to gingivitis and periodontitis. The application of ozone therapy has shown promising results in periodontics. Although more clinical research has to be done to standardize indications and treatment procedures of ozone therapy, still many different approaches are so promising, or already established, that hopefully the use of ozone therapy becomes a standard treatment for disinfection of an operation sites in dentistry.

INTRODUCTION

Ozone (O_3), an allotropic form of oxygen, consists of three molecules of oxygen. Its molecular weight is 47.98 g/mol.^[1] It has a characteristic, penetrating odor and is of pale blue color that condenses to a deep blue liquid at very low temperatures. It is present naturally in the upper part of atmosphere in abundance as long as sun is shining and potentially filters the damaging ultraviolet rays from reaching the Earth's surface.

Ozone being unstable gas quickly gives up nascent oxygen molecule to produce oxygen gas. Its half life is very short around 40mins at 20degree C which varies based on temperature and pressure. This property of releasing nascent oxygen molecule is beneficial on every part and organ of the body.^[1] It has been used in human medicine since long as its powerful oxidizing property is capable of killing bacteria, fungi, inactivating viruses in controlling hemorrhages, in circulatory enhancement, stimulation of oxygen metabolism as well as immune response and disruption of tumor metabolism. Moreover, Ozone can also be used to purify drinking water and water in dental equipment and for sterilizing instruments for medical & dental use.^[2] Medical grade ozone is a mixture of pure oxygen and pure ozone in the ratio of 0.05% to 5% of O_3 and 95% to 99.95% of O_2 . Due to its instability property, medical grade ozone must be prepared immediately before use.^[3]

HISTORY

The word OZONE is derived from a Greek word "ozein" (which means odor) and it was first produced as well as termed by a German scientist named Christian Friedrich Schonbein, the father of Ozone therapy. In 1840, he passed an electrical discharge to the water and a strange smell was produced which he noted it as "odor of electrical matter"-ozein. In 1950, a German dentist, Dr. Edward.A.Fisch was the first dentist to use ozone in the form of ozonated water to treat a gangrenous pulpitis. In 1958, Joachim Hansler, a German physicist and physician along with Hans Wolff, a German physician, developed the first ozone generator for medical use during which ozone resistant materials started manufacturing such as Nylon, Dacron and Teflon.

OZONE GENERATORS

There are three different systems for generating ozone gas:^[3]

- Ultraviolet System
- Cold Plasma System
- Corona Discharge System

In the field of dentistry for which DENTAL OZONE GENERATORS are used which are as follows:

- ❖ **HEALOZONE-** An air based system by which gas application takes place in a closed circuit with the help of air tight cap. Concentration of gas produced =2100ppm adjacent to the tissue.
Disadvantage- Its application is limited as it can be applied to only those areas where such, air tightness is possible.
- ❖ **OZONYTRON-** This system consisting of a glass probe uses the power of high frequency and voltage and emits electromagnetic energy around the treated area splitting the environmental diatomic oxygen into single oxygen atom and ozone. Concentration of gas produced =10-100µg/ml.
Advantage-No air tight cap present in this system so gas can be applied to gingival/periodontal pockets or root canals.
- ❖ **PROZONE-** A system producing preset tissue-compatible dosages of ozone gas in the indicated areas of periodontitis with the help of exchangeable plastic attachments (Perio tips).
Advantage- It is easy to use and safe in application.

ROUTES OF ADMINISTRATION

In order to control the rapid decomposition of ozone into oxygen, it is administered with the help of a vehicle with aqueous properties to promote the conversion more quickly or with a vehicle with more viscous properties to retard the conversion.^[4] Hence it is available in gaseous form, aqueous form and oil form.

MECHANISM OF ACTION

The following are the actions are explained in brief as follows:

1. Anti-microbial action:-

Ozone is responsible for cell death which is non-specific but selective for microbial cells and does not cause damage to human body cells because of its major antioxidative property. It causes local damage of cytoplasmic membrane by ozonolysis of dual bonds and ozone-induced modification of intracellular contents which includes oxidation of proteins and loss of organelle functions due to secondary oxidant-effects. Ozone is very effective against antibiotic restraint strains. Moreover, in viral infections, its action lies in intolerance of the infected cells to peroxides by reacting with the unsaturated fatty acids of lipid layer in cell membranes and change of activity of reverse transcriptase that takes part in synthesis of viral proteins.

2. Immuno-stimulatory action:-

Ozone is responsible for influencing cellular and humoral immune system thereby stimulating the proliferation of immuno-competent cells and synthesis of immunoglobulins. It also activates function of macrophages and increases sensitivity of micro-organisms to phagocytosis. These immune cells of the body respond to the action of ozone and produce special messengers called cytokines which are actually weak cytokines. The cytokine molecules then stimulate other immune cells and ultimately resist the diseases. Ozone causes the synthesis of biologically active substances such as interleukins, leukotrienes and prostaglandins^[5] which helps in reduction of inflammation and finally leads to acceleration of wound healing.

3. Anti-hypoxic action:-

Ozone brings about the rise of pO₂ in tissues and improves transportation of oxygen in blood, which results in change of cellular metabolism – activation of aerobic processes (glycolysis, Krebs cycle, B-oxidation of fatty acids) and use of energetic resources. It also prevents formation of erythrocytes aggregates and increases their contact surface for oxygen transportation.^[5] Moreover, the flexibility of the erythrocytes is restored as well as the surface structures of the erythrocytes are changed. This leads to reduction of blood cell rolling and enables blood flow in capillary vessels.

4. Bioenergetic and biosynthetic effect:-

Ozone activates the of protein synthesis, increase amount of ribosomes and mitochondria in cells.^[5] As a result of which the functional activity of the cells as well as the regeneration potential of tissues and organs is elevated.

5. Detoxicating action:-

Ozone causes secretion of vasodilators such as NO, which are responsible for dilatation of arterioles and venules.

GOALS OF OZONE THERAPY

Therapeutic goals are inclusive and not exclusive of standard of care. The goals of oxygen/ozone therapy are^[6]:

- ✓ Elimination of pathogens.
- ✓ Restoration of proper oxygen metabolism.
- ✓ Induction of a friendly ecologic environment.
- ✓ Increased circulation.
- ✓ Immune activation.
- ✓ Simulation of the humoral anti-oxidant system.

OZONE THERAPY IN PERIODONTICS

The use of ozone in periodontics as well as in other branches of dentistry usually utilizes anti-microbial action against the gram positive and gram negative microflora, viruses and fungi.

A study by Ebensberg et.al^[7] investigated the effect of irrigation with ozonized water on the proliferation of cells in the periodontal ligament adhering to the roots of 23 human extracted teeth. The teeth were randomly treated by intensive irrigation with ozonized water for 2min or with sterile isotonic saline solution serving as a control. After fixing, decalcification and routine histological processing, a total of 690 specimens were obtained. The periodontal cells of these specimens were examined immunohistologically, with the help of Proliferating Cell Nuclear Antigen (PCNA). The labelling index (LI) (the number of positive cells compared to the total number of cells) performed for quantification purpose which was about 6.6% after irrigation with saline and 7.8% after irrigation with ozone but the difference cannot be statistically substantiated (p=0.24). Thus it is concluded that, ozonized water leads not only to a mechanical cleansing, but also decontaminates the root surface with no negative effect on periodontal cells remaining on the tooth surface.

A study by Nagayoshi et.al^[8] examined the effect of ozonated water on oral microorganisms and dental plaque. He found that *S. mutans* was killed instantaneously in ozonated

water (2 and 4 mg/l). The cell viability *S. mutans*, *S. sanguis*, *S. Sobrinus* and *S. salivarius* were decreased when exposed with ozonated water for 10 secs. The number of viable cells was significantly decreased when *P. gingivalis*, *P. endodontalis*, and *A. actinomycetemcomitans* were treated with ozonated water (0.5, 2, and 4 mg/l). Ozonated water strongly inhibited the accumulation of experimental dental plaque in vitro. After dental plaque samples from human subjects were exposed to ozonated water in vitro, almost no viable bacterial cells were detected. These results suggest that ozonated water should be useful in reducing the infections caused by oral microorganisms in dental plaque.

A study by Ramzy et.al^[9] assessed the clinical and antimicrobial effect of ozonized water in management of 20 aggressive periodontitis patients whose age ranged from 13-25 yrs. Periodontal pockets were irrigated with 150 ml of ozonized water over 5 to 10 minutes once weekly, for a clinical four weeks study. There is a significant statistical difference concerning the changes in both, plaque index score and gingival index score as well as significant improvement between the pocket depths before and after the different treatment plans. After 4 weeks period there is an overall significant difference in the bacterial counts also in the sites treated with ozonized water.

A study by Muller et.al^[10] assessed the anti-microbial potential of gasiform ozone and photodynamic therapy (PDT) in comparison to 2% of chlorhexidine solution or 5% hypochlorite solution on multicrobial species in plaque samples in vitro. *Actinomyces naeslundii*, *Veillonella dispar*, *Fusobacterium nucleatum*, *Streptococcus sobrinus*, *S. oralis* and *Candida albicans* were studied in this study. The gasiform ozone was produced by vacuum ozone system i.e. HealOzone. It was shown that 5% hypochlorite solution was able to eliminate all micro-organisms while 2% chlorhexidine solution as well as gasiform ozone with PDT was unable to reduce microbial counts significantly. Thus, it is concluded that gasiform ozone and PDT had a minimal effect on the viability of micro-organisms organized in the biofilm.

A study by Huth et.al [11] investigated the effect of aqueous ozone on the NF- κ B system, a paradigm for inflammation associated signaling/transcription. It was analyzed that activation of NF- κ B was dose-dependently inhibited in oral cells cultured in O₃ medium. Incubation with O₃ medium also inhibited NF- κ B activity in periodontal ligament tissue of periodontally damaged teeth, suggesting that gaseous ozone displays anti-inflammatory effects in certain conditions. Furthermore, TNF-stimulated inhibitor 1 (I κ B) was prevented in the presence of O₃ medium indicating that incubation with O₃ medium affects signaling at the level and/or upstream of I κ B. In addition, it is showed that B-dependent transcription and the expression of the NF- κ B target genes interleukin-8 and -1 were prevented by O₃ medium, suggesting its immune-modulatory property.

A study by Kshitish and Laxman^[12] did a randomized controlled, split mouth design on 16 chronic generalized patients in which subgingival irrigation of ozonated water or 2% chlorhexidine solution at different time intervals. Clinical parameters and microbial counts were assessed at baseline, 7th day and 18th day. Plaque index, Gingival index and Bleeding index were significantly reduced from baseline in areas irrigated with ozonated water compared with that of 2% chlorhexidine rinse. The micro-organisms assessed were *A. actinomycetemcomitans* (Aa), *P. gingivalis*, *T. forsythus*, Herpes simplex 1&2, Human Cytomegalovirus, Epstein Barr virus and *Candida albicans*. There was 25% reduction of Aa and 37% reduction of *Candida albicans* in areas used with ozonated water in comparison to no change in areas rinsed with Chlorhexidine. They concluded that ozone can be considered as an alternate management therapy due to its powerful ability to inactivate micro-organisms.

OZONE THERAPY CONTRA-INDICATIONS^[3]

- ✓ Pregnancy
- ✓ Glucose-6-phosphate-dehydrogenase deficiency

- ✓ Hyperthyroidism
- ✓ Severe anaemia
- ✓ Active hemorrhage
- ✓ Recent Myocardial infarction

OZONE TOXICITY

Various side-effects that have been known till now are epiphora, upper respiratory irritation, rhinitis, cough, headache, occasional nausea, vomiting, shortness of breath, blood vessel swelling, poor circulation leading to heart problems and

sometimes even stroke.

CONCLUSION

Thus various periodontal diseases contain over more than 500 distinct species of microflora, and for which higher concentrations of antibiotics are required which when killed may produce other side-effects on the host beneficial microflora. As an alternative, Ozone can be used in periodontics as it has shown potential results in eliminating bacterial counts more precisely. Moreover, it is painless which ultimately increases patients' acceptability and compliance. Hence, further research is needed to standardize indications and treatment procedures of ozone therapy.

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