Review Article

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Applications of Ozone in Conservative Dentistry and Endodontics

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ABSTRACT

Background: Ozone due to its oxidizing property is highly valued for various effects, such as antimicrobial, analgesic, immune-stimulating etc. on biological systems. With standard protocols we can produce and utilize Ozone in various forms for the treatment of various dental diseases without any toxic effect. This review on ozone describes different uses in the field of conservative dentistry and endodontics.

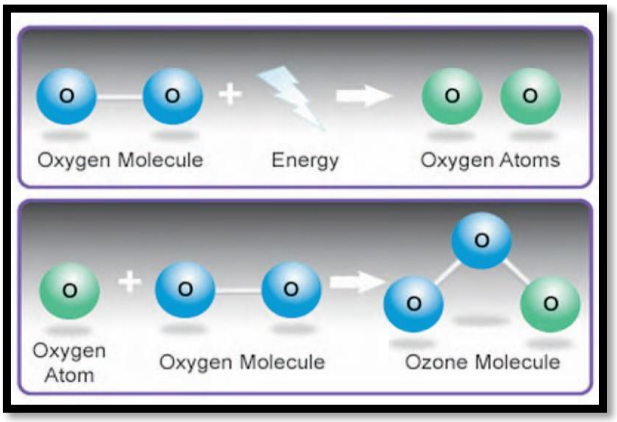
Keywords: Conservatitive dentistry, endodontics, ozone.

INTRODUCTION

Ozone (O3) is a natural gaseous molecule made up of three oxygen atoms. The father of ozone therapy Christian Friedrich Schonbein in 1840 first used the word ozone originates from the Greek word ozein, which means odor.[1] The stratosphere layer of the atmosphere contains very large amount of ozone[2] protecting the living organisms from the ultraviolet rays. Ozone being profound than air falls downward to earth from such high altitudes.[3] It combines with any pollutant that it comes in contact thus cleansing the air.[4] Since more than 100 years medical grade ozone has been used when treatment is not involving medication The main use of ozone in dentistry relays on its antimicrobial properties.[5] The objective of this article is to discuss the details of ozone applications in conservative dentistry and endodontics.

STRUCTURE OF OZONE

Three oxygen atoms establish to form a tri-atomic molecule of ozone. Equal oxygen – oxygen bonds bound them together at an obtuse angle of 116 degree C. The structure prevents the formation of triangular form due to the internal steric barrier.[6] So single bonds are formed instead of double bonds with other oxygen molecule creating a negative charge all around the ozone molecule.[2] as shown in the figure:



OZONE GENERATING SYSTEMS

There are three different systems for generating ozone gas:[7,3]

1. Ultraviolet System: produces low concentrations of ozone. It is used in esthetics, saunas, and for air purification.
2. Corona Discharge System: produces high concentrations of ozone. It is the most common system used in the medical/ dental field. It is easy to handle and it has a controlled ozone production rate.
3. Cold Plasma System: used in air and water purification.

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MECHANISM OF ACTION:

1. Anti-microbial effect:

Ozone leads to inactivation of bacteria, viruses, fungi, yeast and protozoa. It breaks the integrity of the bacterial cell envelope by oxidation of phospholipids and lipoproteins. Ozone at low concentration of 0.1 ppm, is adequate to inactivate bacterial cells including their spores.[8] In fungi, O3 hinders the cell growth at certain stages in which the budding cells are the most sensitive.[9] In viruses, the O3 destroys the viral capsid and thus reproductive cycle is disrupted leading to the virus-to-cell contact with peroxidation.[10]

2. ***Anti-inflammatory and analgesic action***: Ozone helps in the synthesis of biologically active substances such as interleukins, leukotrienes and prostaglandins which is beneficial in reducing inflammation and pain. The infection or inflammation is positively charged (acidic) and ozone is negatively charged (basic) so the chemistry of infection and inflammation attracts ozone to the area[11]

3. ***Immune-stimulating action***: The electromagnetic action of ozone triggers and regulates immune system particularly lymphocytes producing interleukins. It also initiates the function of macrophages and elevates sensitivity of microorganisms to phagocytosis[12]

4. ***Anti – hypoxic action*** : Ozone causes secretion of nitrous oxide, vasodilator. It prevents clumping of red blood corpuscle and increases partial pressure of oxygen. It also activates aerobic processes like glycolysis and Krebs cycle at cellular level thus stimulating circulation of blood and hence used in treatment of circulatory disorders.[7]

5. Bioenergic and biosynthetic action

Ozone starts up the procedure of protein synthesis, increases amount of ribosomes and mitochondria in cells, thus increasing regeneration prospective of tissues.[7]

ROUTES OF OZONE ADMINISTRATION :

1. Gaseous form:

Gaseous ozone could be conducted topically either by an open system or by a sealing suction system to avoid inhalation and adverse effects. Most frequently used in restorative dentistry and endodontics. It is a noninvasive therapy for treatment of dental caries and may be used as a disinfectant before the placement of a direct restoration and also as remedy for hypomineralized teeth.[7]

An Ozone generator produces ozone by passing air through high voltage in a polyurethane console. Some of the commercially available ozone units for medical use are: HealOzoneTEC3 (Curozone,USA). Prozone(W&H), O3 ozicure ozone device. The generated ozone is applied to the patient through hand piece which gets adapted to teeth through a silicon cup and is exposed for a minimum period of 10 seconds.[9,13]

2. Ozonated water

It has been shown to be effective against Gram-positive and Gram-negative oral microorganisms as well as bacteria in plaque biofilm. In comparison to other chemical cleaners, it appears to be cheap.[14] Gaseous ozone may be used as a dental disinfectant if applied for 3 min and is considered more productive to kill microorganisms than the aqueous form.[15] If ozone gas is inspired into the respiratory tract[16] it has virulent effects, hence to control oral infections and various pathogen-sozonated water may be useful.[17] Commercially available as ultra-pure, tripple ozone treatment system.

3. Ozonized oil

It is competitive antimicrobial agent due to wide accessibility of sunflower oil. It is found efficacious against Streptococci, Enterococci, Staphylococci, *Pseudomonas, Escherichia coli* and especially *Mycobacteria* and is used for the cure of fungal infections[18] Commercially available as Oleozone, Bioperoxoil

OZONE IN TREATMENT OF CARIES :

Primary Pit & Fissure Caries Lesions: Ozone therapy is an atraumatic treatment procedure in dentistry. Some of the in vitro studies with short-term follow-up assessed the effect of ozone on pit and fissure caries [19, 20] and primary root caries with results showing significant decreased number of

microorganisms in the carious lesions. Ozone can be used along with diagnodent to find out the caries risk in the early stages and then when checked on diagnodent ozone is thus delivered according to the severity of the lesion[21]. However in cavitated carious lesions, ozone therapy has to be done along with restorative therapy and patient has to be educated about the preservation phase of caries treatment involving oral hygiene maintenance and balanced diet. It is advisable to apply remineralizing agent immediately after the ozone treatment.

Proximal Carious Lesions and root caries:

The protocol remains the same as the proximal caries and root caries laying stress on the fact that a non invasive protocol is followed for non cavitated lesions. In case of cavitated lesion it needs to be restored. As the exposure time of ozone increases from 10sec to 20 sec it changes the antimicrobial effect from disinfection to sterilization [22,23]. Application of ozone for 40 seconds reduced S.mutans count remarkably, whereas 60sec exposure almost destroyed the cariogenic species like S.mutans, L.casei and A.naeslundii in carious lesions in roots[24,25].

ENDODONTICS

The major causes of failure on root canal treatment is the microorganisms.[26] Ozone is the most strongest antimicrobial agent with numerous advantages to reduce the number of micro organisms in the root canal due to its oxidative potential ,especially it is effective against Mycobacteria,Streptococcus, Pseudomonas aeruginosa, Escherichia coli, Staphylococcus aureus, Peptostreptococcus, Enterococcus faecalis, and Candida albicans. Ozone is successful in producing the desired results, when it is advised in sufficient concentration, used for adequate time and delivered correctly into root canal after cleaning and shaping and irrigation. Studies have proved the potential use of ozone gas, ozonated water and ozonised oil in endodontics[22,23].

Nagayoshi et al. [27]found that ozonated water (0.5–4 mg/L) was highly effective in killing both gram positive and negative micro-organisms. Porphyromonas (P.)endodontalis and P. gingivalis the Gram negative bacteria were considerably more sensitive to ozonated water than gram positive oral streptococci and C. albicans in pure culture.

Hems et al assessed the potential of ozone as an antibacterial agent using Enterococcus (E.) faecalis as a test species. Ozone was used both as gaseous (produced by Pure zone device), and aqueous (optimal concentration 0.68 mg/L). It was concluded that ozone in solution was antibacterial against planktonic E. faecalis after 240 sec treatment. In case of E. faecalis within a biofilm it was not effective unless they were displaced into the surrounding medium by agitation. [28]

Intra canal gas circulation of ozone at a flow rate of 0.5–1 l/min with net volume of 5 gm/ml for 2–3 min showed encouraging results against pathogenic microbes in the root canal. In reducing the marked anaerobic odor emanating from infected teeth ozonated water can be used as an intracanal irrigant and in infected necrotic canals, ozonized oils can be used as an intra-canal dressing. Ozone encourages tissue regeneration and bone healing when used as an irrigant. Also when a root canal was disinfected by ozone water with sonification, the antimicrobial efficacy was comparable to 2.5% NaOCl.[29] Hence in periapical infections, ozone therapy can increase the scope of nonsurgical management of these lesions.

BLEACHING

After root canal treatment, crown discolouration is a major aesthetic problem. Tessier et al evaluated, in an experimental model of growing rats, the efficacy of using ozone to lighten tetracycline-stained incisors. This study showed that ozone can be successfully used for lightening the yellowish tinge of tetracycline-stained rat incisors. [30]. The bleaching effect with ozone is seen when the bleaching agent is placed in the access cavity & crown is exposed to ozone for a minimum of 3 to 4 minutes with marginal success. Al-Omiri MK conducted a study and found that bleaching with 38% H2O2 and ozone resulted in teeth with lighter shades than bleaching with 38% H2O2 alone.[31]

DENTAL UNIT WATER LINE DISINFECTION (DUWL):

Multiple pathogenic bacteria were constantly found in randomized control trials. Ozone achieved 57% reduction in biofilm and 65% reduction in viable bacteria[32] and hence due to absence of any side

effects it became an accepted water line disinfectant. 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.[33] Montebugnoli et al concluded that dental manufacturers should be invited to design dental units that incorporate automated devices to disinfect DUWLs.[34]

CONCLUSION

Ozone doesnot cause any pain as compared to conventional treatment for tooth decay and has proven to stop primary root caries, primary pit and fissure decay and clinically reverse the lesion. The introduction of ozone in routine root canal disinfection has proven to be effective. However further research is required to investigate efficacy in treatment morality of conservative dentistry and endodontics.

CONFLICT OF INTEREST

No potential conflict of interest relevant to this article was reported.

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