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REVIEWARTICLE

OZONE – CHANGING THE FACE OF DENTISTRY

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ABSTRACT

Ozone is acquiring its place in the field of dentistry and in day to day dental practice. Since many years, it has been used owing to its oxidizing property, which makes it an excellent antimicrobial agent. Because of its potent anti-inflammatory property, favorable cellular and hormonal immune response, ozone acts as an effective therapeutic agent. Versatility of ozone therapy, its unique properties, non-invasive nature, absence of any side effects or adverse reactions were responsible for its wide spread use. Ozone's potentiality of arresting and reversing carious lesions in a predictable way has led to a new chapter in minimal invasive dentistry. It has a wide application in conservative dentistry and in endodontics which includes treatment of carious lesions, root caries, hypersensitivity, disinfection of the root canal, bleaching, etc., without any toxic effects. It is important to look ozone as a synergistic part of the dental treatment, bacterial elimination and site of oxygenation. This poster summarizes the ability of ozone in treating various dental diseases and its possible clinical applications in future

INTRODUCTION

Ozone is a natural gaseous inorganic molecule with chemical formula O_3. It is made up of three oxygen atoms. The word ozoneoriginates from the Greek word ozein, which means odor and was first used by German chemist Christian Friedrich Schonbein, father of ozone therapy (1799-1868) in1840.The first application of ozone in medical field seems to have been for treating gaseous, post-traumatic gangrene in German soldiers during the 1st world war (**Bocci, 2004**). Ozone is an instable molecule.Its variability concerned to more common dioxygen is such that both concentrated gas and liquid ozone may explosively decompose (**Streng, 1961**). Thus it is used only in low concentrations.Ozone is a potent oxidant (far-off thandioxygen) and has several industrial and consumer usesassociated to oxidation.Ozone has a long history in the field of research and medicine.Ozone therapy can be defined as a versatile bio-oxidative therapy in which oxygen/ozone is administered via gas or dissolved in water or oil base to obtain therapeutic benefits.Ozone therapy comprises of the summary of ozone into the body via various means, usually involving mixing of the ozone with various gases and liquids and injecting this into the body, including the vagina, rectum, intramuscular (in a muscle), subcutaneously (under the skin), or intravenously (directly into veins). Ozone can also be introduced via autohemotherapy, in which blood is drawn from the patient, exposed to ozone and re-injected into the patient.

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Also, Ozone in high concentrations is toxic to living systems, causing damage to cell membranes. This toxicity has led ozone to be suggested as an agent for the disinfecting of dental unit water lines (**Pankhurst*et al.*, 1998**).

It has been suggested that the application of ozone to carious dental lesions will arrest or reverse these lesions and that the use of ozone will provide an alternative to conventional drilling and filling.

Ozone, which is used for medical purposes,is a gas mixture comprised of 95 to 99.95%oxygen and 0.05 to 5% pure ozone. Due to proven therapeutic advantages of ozone, many fields in dentistry could benefit from ozone therapy. The first dentist who used ozone was Edward Fisch in 1950 for treating Austrian surgeon Ernst Payr for a gangrenous pulpite and thereby inspired him to begin a line of investigations dedicated toozone use in health care.

Ozone generation

The first ozone generator for medical use was developed by German physicians named Joachim Hansler and Hans Wolff. Their design remains to be the foundation for recent equipment.

Medical grade ozone is an assortment of pure oxygen and pure ozone in the ratio of 0.05% to 5% of O3 and 95% to 99.95% of O2. Medical grade ozone must be freshly prepared before use due to the unpredictability of the O3 molecule. In order to

control the decomposition of Ozone into oxygen can be correlated with a vehicle with aqueous properties to encourage conversion more rapidly or with a vehicle with more viscid properties to delay the conversion.

There are 3 different systems for generating ozone gas

Ultraviolet System

It produces low concentrations of ozone, used in aesthetics, saunas, and for air purification. They customarily produce ozone with an application of about 0.5% or lower.

Corona discharge method

This is the utmost common type of ozone generator for most industrial and personal uses. These units frequently works through a corona discharge tube. They are economical and do not need an oxygen source other than the ambient air to produce ozone concentrations of 3–6%. Disparities in ambient air, due to weather or other environmental circumstances, cause capriciousness in ozone production.

Cold plasma

Pure oxygen gas is opened to a plasmaformed by dielectric barrier discharge. An ionic movement is persuaded in a glass cathode tube occupied with a noble gas, which is extremely electrified. This unit is enclosed in a second tube into which pure oxygen is passed. This is the second electrode, which acts only as a ground, and does not take any direct current. The flow of plasma induces the oxygen to reorganise as Ozone. The diatomic oxygen splits into single atoms, which then recombined in triplets to form ozone. Cold plasma machines utilizespure oxygen as the input foundation and produces maximum concentration of about 5% ozone. They produce moreamounts of ozone in a particular space of time for ultraviolet production. But, because cold plasma ozone producers are very expensive, they are found regularlyless than the former two types.

Electrolytic Ozone Generation

Electrolytic ozone generation (EOG) ruptures water molecules into H2, O2, and O3. In most EOG methods, the hydrogen gas is parted to leave oxygen and ozone as the only reaction products. Therefore, EOG can attain greater suspension in water without other contending gases found in corona discharge method, such as nitrogen gases present in ambient air. This method of generation achieves concentrations of 20–30% and is self-governing of air quality because water is used as the source material.

Methods of Ozone Administration

Most common methods are

1. Inhalation
   a. Ambient room air purifiers
   b. Filtered through Oil
2. Ingestion
   a. Ozonated water
   b. Ozonated oil
3. Sauna/Body Suit
   a. Absorbed through the skin
4. Topical
   a. Ozonated oil
   b. Localized Application
5. Insufflation
   a. Rectal
   b. Vaginal
   c. Auricular
6. Injection
   a. Minor auto hemotherapy
   b. Major auto hemotherapy
   c. Direct Injection into vein
   d. Hemorrhoidal vein
   e. Directly into tumour

Mechanism of action

There are several known actions of ozone, such as antimicrobial (bactericidal, viricidal, and fungicidal), immune stimulating, immune modulatory, anti-inflammatory, biosynthetic (initiation of the breakdown of carbohydrates, proteins, lipids), bio energetic, antihypoxic, analgesic, haemostatic, etc. Ozone oxidizes biomolecules, disrupts microbial cell structures and metabolism. Ozone disrupts microbial cell walls in seconds, leading to immediate cell lysis. An ozone application of 10 – 20second has been reported to eliminate more than 99% of the microorganisms found in the dental caries and associated biofilms –and a 40 second treatment time covers alleventualities (**Baysan and Lynch, 2001**).

Ozone gas application

The ozone is directed to a hand piece fitted with asilicone cup. Contrarily shaped silicone cups are available that relate to the form of numerous teeth and their surfaces. This confirms close contact between the silicone cup and the carious part of the tooth so that the ozone does not escape. The ozone is headed through the silicone cup over the tooth for aatleast10 seconds. Ozone in the silicone cup is collected again and reconverted to oxygen by the apparatus.

Ozone aqueous solution

The following properties of ozone are used in this case:

- Disinfectant and sterilizing effect
- Hemostatic effect, especially in cases of hemorrhages
- Accelerated wound healing, improved oxygen supplyand support of metabolic processes

Ozone oil

Ozonated oils are pure plant extracts, through which pureoxygen and ozone are passed. Extracts of the plant go through a chemical reaction to form a thick, viscous oil, or in some cases, a petroleum jelly-like product. The final products

contain ozonides. This method of external application is harmless.

Contraindications of ozone

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. after recent heart attack
7. thrombocytopenia
8. Alcoholic Intoxication
9. Allergy to Ozone
10. after recent internal bleeding episodes

Prolonged inhalation of ozone can be deleterious to the lungs and other organs butwell calibrated doses can be the rapeutically used in various conditions without any toxicity or side effects (**Bocci and Borrelli, 2009**). The European Cooperation of Medical Ozone Societies, cautions that direct intravenous injections of ozone/oxygen gas should not be practiced due to the possible danger of air embolism (**Nogales *et al.*,2008**).

Reimplantation and Ozone

Great level of biocompatibility of aqueous ozone on the human oral epithelial cells, gingival fibroblast cells, and cells of the periodontium has been found. Irrigation of the avulsed teeth for up to two minutes with non isotonicozonated water not only delivers mechanical cleansing, but also fumigates the surface of the root, with no negative effect on periodontal cells remaining on the tooth surface before replantation (**Gopalakrishnan and Parthiban, 2012**).

Ozone and Plaque biofilm

Caries and periodontal disease are initiated principally by plaque biofilm. Ozonemight be beneficial in controlling the oral infectious microorganisms in dental plaque. Ozonated water powerfully inhibited dental plaque collection. Ozonated oil is used as a safe therapeutic substitute in patients with Acute Necrotizing Ulcerative Gingivitis. Healingand bactericidal properties makes it useful as a subgingivalirrigant. The antimicrobial property of ozone is not only effective in diminishing the number of cariogenic bacteria ,but also cause marked decrease in the micro organisms present in the root canal. However it was not successful incompletely eliminating these bacteria entrenched in the biofilm (**Gopalakrishnan and Parthiban, 2012**).

Ozone therapy and dental caries

Ozone can be used to kill bacteria present in carious lesion, painlessly and even without anaesthetic. Ozone is applied to the cariouslesion in a controlled manner, safely killing Bacteria that have caused caries, thusrequiring minimal of physical intervention and just a few seconds. In cases of incipientcaries, ozone can kill bacteria in the demineralized part and this demineralized tooth structure then, can be remineralized using a special remineralization kit, containing Calcium, Fluorine, Phosphorus and Sodium, all in their ionic forms (**Celiberti and Pazera, 2006; Baysan and Whiley, 2000; Baysan and Beighton, 2007; Abu-Nab'a and Shorman, 2003**).

Ozone had no influence on the physical properties of the enamel to enhance or hinder the sealing ability. Thus, ozone can be applied over intact and prepared enamel during the restoration process (**Celibertiand Pazera, 2006; Schmidlin *et al.*, 2005**). A study concluded that the application of gas form ozone does not affect the modulus of elasticity and the Vicker's hardness of dentin. Thus, the application of ozone on dentin could be performed by the dental clinician without impairing the micromechanical properties of the substrate (12).

Uses in Endodontics

Ozone oils can be used to sterile the root canal systems and to clear the canals of necrotic debris by virtue of ozone's bactericidal and effervescent properties. Ozone oils are ozonated sunflower oil or olive oil or groundnut oil. This ozone oilirrigation is more quick and efficient in canal sterilization than that conventional irrigation by the sodium hypochlorite and sodium peroxide combination (**Estrela *et al.*, 2007; Nagayoshi and Kitamura, 2004**). It has been postulated that ozone will penetrate through the apical foramen and entrinto the surrounding and the supportive bone tissue. Effect of ozone on such tissues will be to encourage healing and regeneraton (**Huth *et al.*, 2009**).

Conclusion

Ozone is utilized in virtually all facets of dentistry. There are good indication of ozone biocompatibility, and effectiveness in eradicating the microorganisms from dental unit water lines, the oral cavity, and dentures. Advantage of ozone therapy is it is an atraumatic, biologically based treatment. The Introduction of Ozone in the filed of dentistry has proven to be successful, in effectively treating dental caries as it is painless without causing fear t the patient, often there is no need for drilling. In Endodontics, ozone has been introduced in routine disinfection of root canal, it has proven to be effective but studies are required to elucidate its use in endodontics.

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