

## Review Article

### Ozone in Dentistry: A Review of Literature

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#### **ABSTRACT:**

Ozone, which is effectively used in the treatment of different diseases, is an allotropic form of oxygen. Because of increasing antibiotic resistance, ozone therapy is used as alternative that rationales to increase the amount of oxygen to the body through institution of ozone into the body. Because of its beneficial biological properties including antimicrobial and immune stimulating effects, ozone therapy has opened new vistas in treatment modalities of dental pathologies for patients of all ages. The objective of this article is to review the literature available on applications of ozone in dentistry.

**Keywords** - antimicrobial, healOzone, ozone, ozone dentistry, ozone intoxication

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#### **INTRODUCTION**

Ozone is derived from the greek word "Ozein" which implies odorant. It occurs naturally in the climate, encompassing the earth at a height somewhere in the range of 50,000 and 100,000 feet, and plays a major defensive role in the earth's ecological equilibrium.<sup>1</sup> Ozone (O<sub>3</sub>) comprises three atoms of oxygen hence called trioxygen or triatomic oxygen, it is a higher dynamic form of atmospheric oxygen (O<sub>2</sub>). Ozone is an unstable gas releasing nascent oxygen which renders it useful in the field of medicine as an antimicrobial agent, immune, and metabolic modulator and is widely used for disinfection of medical and dental equipment as well as purification of water.<sup>2</sup>The viability of Ozone against Gram-positive and Gram-negative bacteria, fungi and viruses make "Ozone therapy" an adaptable bio oxidative treatment in which ozone is dispensed through gas or dissolved in water or oil base to acquire therapeutic effects.<sup>3,4</sup>

#### **MODES OF OZONE ADMINISTRATION<sup>5,6</sup>**

##### **OZONE GAS**

Generation of ozone involves the passage of air via high voltage in a polyurethane console. Various merchantile units available are: HealOzone TEC3 (Curozone, USA), Prozone(W&H), O<sup>3</sup> ozicure ozone device. Silicon cup is adjusted to teeth through which produced ozone is administered to the patient through a handpiece and is uncovered for a base time of 10 seconds. The pre-owned ozone is processed back to the generator through a reducing agent to change back over to oxygen.

##### **OZONE AQUEOUS SOLUTION**

It shows hemostatic effect, hence used in the management of haemorrhage as well as in cases of acceleration of wound healing since it boosts up the local oxygen supply thus supporting the metabolic processes. Also used for disinfection and sterilization purposes.

### **OZONE OIL**

When plant extracts are treated with Ozone, it forms a thick gel consisting of ozonide and this is used for external applications.

### **OZONATED WATER**

Some studies reveal that ozonated water improved lipopolysaccharide induced inflammatory response and increased fibroblast cell metabolism of L29 mouse. It is effective against plaque biofilm because it has strong bactericidal activity.

### **VARIOUS OZONE GENERATING SYSTEMS**

#### **UV SYSTEM**

Upon exposure to UV light, low concentrations of ozone are produced. In ground state oxygen particle absorbs this light energy and separates, then oxygen atom reacts with other oxygen atoms, thus forming ozone.

#### **COLD PLASMA SYSTEM**

When the voltage jumps between the anode and the cathode rods, an electrostatic field is generated in this system. Applications of this system are air and water purification.

#### **CORONA DISCHARGE SYSTEM**

This system is mostly used in the medical and dental fields; it works on the principle of power dissipation giving rise to high concentration of ozone. By using a dielectric, an electric release is diffused over an area creating a corona discharge, now oxygen is passed through this discharge to be transformed into ozone. The ozone production rate can be controlled and handling is easy for this design.

### **EFFECTS OF OZONE ON MICRO-ORGANISMS AND BLOOD CELLS**

#### **EFFECT ON BACTERIA**

Ozone causes disintegration of bacterial cell membranes, due to its oxidative actions against the cell components such as lipid and lipoproteins. This mechanism is also responsible for controlling spore germination as it damages its inner membrane.

#### **EFFECT ON VIRUSES**

For viruses, ozone targets the polypeptide chains and proteins thus impairing the attachment capability, it also breaks down the viral RNA. All viruses show a variable degree of susceptibility towards ozone, the most sensitive being lipid enveloped virus.<sup>7</sup>

#### **EFFECT ON PROTOZOA AND FUNGUS**

Ozone inhibits protozoa and fungus by action on cells at different stages of cell development.<sup>8</sup>

### **EFFECT ON BLOOD**

Ozone produces free radical scavengers in blood namely glutathione peroxidase, catalase, and superoxide dismutase.<sup>9</sup>

### **EFFECT ON WHITE BLOOD CELLS**

Ozone acts as a frail cytokine, for example, tumor necrosis factor- $\alpha$  (TNF- $\alpha$ ), interleukin-2, interleukin-6, interleukin-8, transforming growth factor- $\beta$  [TGF- $\beta$ ] inducer. Ozone reacts with the unsaturated fats of the lipid layer, forming hydrogen peroxides (H<sub>2</sub>O<sub>2</sub>), perhaps the main cytokine inducers.<sup>10</sup>

### **EFFECT ON PLATELETS**

Hydrogen peroxide created by blood ozonation activates phospholipase C, phospholipase A<sub>2</sub>, cyclo-oxygenases and lipoxygenases, and thromboxane synthetase, which brings about increment of intracellular calcium and arrival of prostaglandin E<sub>2</sub>, prostaglandin F<sub>2a</sub>, and thromboxane A<sub>2</sub> with irreversible platelet accumulation.

### **MECHANISM OF ACTION**

#### **ANTIMICROBIAL ACTION**

Ozone possesses antimicrobial action even after few seconds of application and leads to the destruction of bacteria, fungi, and viruses. The non-specific and selective antimicrobial action is due to ozonolysis of dual bonds which leads to damage to the cytoplasmic membrane of cells.<sup>11</sup>

#### **IMMUNOSTIMULATING EFFECT**

Sensitivity of ozone to the two types of immune systems (cellular and humoral) leads to the proliferation of immune competent cells and immunoglobulins. As a result of this proliferation there is increased production of immune cell mediator, cytokines, which activates other immune cells as well. Ozone helps in increases in the phagocytosis of bacterial cells. Ozone therapy effectively reduced inflammation with effects, at least in part, mediated through reduction of pro-inflammatory cytokines and activation of IL-10 anti-inflammatory cytokine.<sup>12</sup>

#### **ANTI-HYPOXIC EFFECT**

Ozone helps ameliorate the cellular metabolism by improving the oxygen exchange and transportation in the blood and elevating the partial pressure in tissues.<sup>12</sup>

#### **BIOSYNTHETIC EFFECT**

Ozone accentuates functional and regenerative potential of tissues and organs by increasing the cellular components namely mitochondria and ribosomes. Elevation of these cellular components causes activation of the protein synthesis mechanism.

## **AS VASODILATORS**

Nitric oxide is play an imperative role in the maintenance of blood vessel health. It acts as a vasodilator, and helps maintain low blood pressure and increased blood flow, ozone therapy thus helps in increasing the synthesis of nitric oxide in blood.<sup>13</sup>

## **IMPLICATIONS OF OZONE IN CONSERVATIVE DENTISTRY AND ENDODONTICS**

### **OZONE IN TREATMENT OF CARIES**

Ozone therapy has shown to be effective in reducing the number of microorganisms responsible for carious lesions, briefly follow ups of some in-vitro cases saw successful use of ozone for pit and fissure caries as well as in primary root caries cases.<sup>14</sup> Hence in dental practice it can be used as an atraumatic treatment modality. Some studies suggest that ozone related reversal of carious lesion was specific to size and location since smaller non cavitated lesions showed greater reduction when compared to larger non cavitated lesions; gingivally located lesions showed less reunion in the number of microorganisms.<sup>15</sup> Altogether ozone therapy can be used as adjunctive restorative therapy, especially in cases of established carious lesions.

### **OZONE IN RESTORATIVE DENTISTRY**

Studies have shown that ozone implicates no negative impact on physical properties of sound enamel, dentin as well as on the shear bond strength of adhesive restorations, hence it can be used effectively before etching and sealer placement for imparting its bactericidal activity in dentinal tubules by longer exposure of ozone gas even in deep cavities.<sup>15,16</sup>

### **OZONE IN TREATING DENTIN HYPERSENSITIVITY**

Ozone can be used in cases of dentin hypersensitivity and reduce the problem of root sensitivity among patients in much less time and prolonged effects as compared to conventional methods. The mechanism of action involves opening of dentinal tubules by removal of smear layer which widens up the tubules thus enabling an easy flow of calcium and fluoride ions in the tubule, these ions plug the tubules, blocking any exchange of fluids through them. The protocol for ozone application involves ozone spray for 60 seconds which is repetitively followed by mineral wash.<sup>17</sup>

### **OZONE THERAPY IN ENDODONTICS**

Upon treatment of sodium hypochlorite (NaOCl) with ozone it is converted to ozonated sodium hypochlorite, which produces chloramines that interfere with cell metabolism and leads to the destruction of cell walls. The mechanism of action involved is that ozonated sodium hypochlorite releases hypochlorous acid which upon reaction with insoluble protein forms soluble polypeptides, amino

acids and helps in the destruction of fatty acids into fatty acid salts and glycerol; acts as an organic and fat solvent by reducing the surface tension of the residual solution.<sup>18,19</sup>

### **OZONE IN BLEACHING**

Conventional walking bleaching protocols are often time-consuming procedures with results that are unsatisfactory most of the time when used as a treatment protocol for crown discolorations. When ozone is used in such cases where a crown is exposed for 3-4 minutes after bleaching agent is placed in access cavity, results of such treatment is satisfactory for the patient as a tooth is bleached within minutes giving them healthy looking smile.

### **PERI-IMPLANTITIS**

In cases of peri-implantitis, both forms of ozone can be used, gaseous or aqueous. Ozone gas is infiltrated via PVC or silicone caps that cover the abutment fully and is sealed around the gingival borders. Ozonated water is used to irrigate during debridement and curettage. Ozonized oil can also be used as a topical application over the treated areas 3-4 times a day.

### **OZONE TOXICITY**

Ozone can be considered safe when exposure levels are below 0.0007 per application. Some of the known complications are upper respiratory tract irritation, shortness of breath, cough, rhinitis; since ozone is toxic to the pulmonary system. Other complications include nausea, vomiting, and poor blood circulation leading to heart problems and sometimes may lead to stroke. Materials used (glass, silicon, Teflon) should be ozone resistant since ozone has high oxidative power.<sup>20,21</sup>

### **CONTRAINDICATIONS**

Acute alcohol intoxication, myocardial infarction (less than 6 months), hyperthyroidism, pregnancy, severe anemia, active hemorrhage, and thrombocytopenia are certain contraindicated conditions.

### **ADVANTAGES**

Easy, manageable and non-invasive technique, less time consumption eliminates dental anxiety.

### **DISADVANTAGES**

Ozone toxicity (>0.0007% per application), elusive availability, instability.

### **CONCLUSION**

Ozone therapy is a minimally invasive and conservative approach in contrast to the present conventional therapeutic modalities. It is inexpensive, painless therapy which increases the acceptability and compliance of the patient with minimal adverse effects. However, further research is still needed to justify the routine uses of ozone in dentistry.

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## CONFLICT OF INTEREST

No Conflict of Interest

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