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## **ROLE OF OZONE IN MINIMAL INVASIVE DENTISTRY AND ENDODONTICS**

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### **Abstract**

Ozone has been part of the medical field for the past 100 years. Its strong oxidizing property makes it outstanding presenting great vantage when used as an adjunct to conventional treatments. In addition to its therapeutic actions, it shows no side effects making it even versatile for a variety of treatments. This review of literature is to summarize current applications of ozone in dentistry.

**Keywords:** ozone, anti-microbial, minimal invasive, dental caries, Endodontics

### **Introduction**

Ozone is part of the atmospheric air, which filters potentially harmful rays such as ultraviolet rays from reaching the Earth's surface (1). Ozone is an inorganic molecule consisting of three oxygen atoms with a chemical formula of O<sub>3</sub>. This triatomic molecule has a molecular weight of 4798 g/mol (2). Ozone is an allotrope of oxygen, which is unstable compared to diatomic allotrope of oxygen, and thus it instantly gives up nascent oxygen molecule to form oxygen gas. The liberation of nascent oxygen has multiple beneficial effects due to its strong oxidant property. Ozone having an ingenious bio-oxidative therapy which is why it is being used extensively in the medical and dental field today.

### **History**

The ozone gas was first discovered by a German chemist Christian Friedrich Schonbein in 1840 when he distinguished an odour on passing electrical discharge through water and named it from a Greek word "ozein" which means odor or smell. Thus he is designed as father of Ozone therapy. In 1857, Joachim Hensler, a German physicist and Hans wolf a German Physician generated first Ozone generator for medical use. Dr. C. Lender introduced O<sub>3</sub> into the medical field for purifying blood in test tubes in 1870. In 1885 Dusbaden, in Holland was the first city to use Ozone in its water treatment plant. During World War I and II, ozone was used to treat wounded soldiers in trenches. By early 20th century, Food and Drug Act recalibrate its use and effect in the field of medicine and legalized in USA.

Dr. E.A.Fisch, a German dentist was the first to use Ozone in his dental practice in 1950. Since then Ozone has been the topic of interest to many researchers. In 2001, Dr. Siegfried wrote a textbook about the use of Ozone in Medicine. In 2004, Prof. Edward Lyrich published "Ozone- The Revolution in Dentistry"(3,4).

### **Mechanism of Action**

Ozone possesses the ability to react with blood components and positively affect the oxygen metabolism, cell energy, immune modulatory and microcirculation (5). It revives the immune system through macrophage activation and the release of Cytokine. This helps in improving the immune system in patients with low immunity (6).

It also has shown to be a powerful antimicrobial (bactericidal, viricidal and fungicidal) in the gaseous or aqueous state. The oxidant property of ozone damages the bacterial and fungal cell membranes by invading glycoproteins, glycolipids and other amino acids and suppresses the enzymatic activity of the cell. This leads to increase in the membrane permeability that causes the microbial cells to die (5). Since human body cells have good anti-oxidative property only the microorganisms are affected (7). In viral cells, this triatomic oxygen makes it intolerant to peroxides and alters the activity of reverse transcriptase thus viral protein synthesis is restrained (3).

Ozone molecules also oxidize Biomolecules such as cysteine, methionine and histidine being the residues of proteins. The advantage of oxidizing biomolecules involved in dental diseases, ozone has the potential to terminate cariogenic bacterias. During cariogenesis, an acidogenic bacterium produces pyruvic acid, which is the strongest naturally occurring acid (5,8). Ozone decarboxylates pyruvic acid to acetic acid, which helps in buffering plaque fluid (5).

Besides that, ozone has anti-inflammatory and analgesic action. Ozone helps in the production of biologically active substances such as interleukins, leukotrienes and prostaglandin, which is useful in reducing inflammation and pain.

Ozone is negatively charged (basic) and the infection or inflammation is positively charged (acidic) and so ozone is magnetized to the site of inflammation (9).

### **Modes of Ozone Generation in Dentistry**

1. Ultraviolet system: Used in aesthetics and for air purification but produces low concentration of ozone
2. Cold plasma system: Used in air and water purification
3. Corona discharge system: Most favored systems in medical and dental field. It produces high concentrations of ozone in a controlled production rate(4).

**Ozone Toxicity:** Ozone inhalation can be lethal to the respiratory system and other organs in the body though complications caused by it are infrequent. Upper respiratory irritation, epiphora, rhinitis, cough, headache, nausea and

vomiting are the most common side effects. In the event of ozone intoxication, the patient must be placed in a supine position and made to inhale humid oxygen and take ascorbic acid, vitamin E and acetyl cysteine (10).

### **Ozone Therapy Contraindications**

Ozone therapy is contraindicated in (10):

- Pregnancy
- Hyperthyroidism
- Severe anemia
- Glucose-6-phosphate-dehydrogenase deficiency
- Severe myasthenia
- Active hemorrhage
- Acute alcohol intoxication
- Recent Myocardial Infarction
- Ozone allergy

### **Clinical Applications of Ozone in Dentistry**

Ozone has a wide application in dentistry as it presents great advantages than the present conventional therapeutic modalities. This modernized technology enables us to take a minimally invasive and conservative way to dental treatment.

### **Treatment of Dental Caries**

Many studies have been extensively done on the application of ozone therapy in the treatment of dental caries and ozone shows encouraging results in treating pit and fissure caries, root caries and inter proximal caries. Ozone is delivered through a hand piece where a silicon cup is attached to its head. The cup is placed directly on the tooth and made sure that it has taut contact at the application site. The mechanism of action as mentioned above is due to its strong antimicrobial activity and its ability to oxidize pyruvic acid to acetic acid and carbon dioxide, which stops the progression of caries. This therapy can be used in treating non-cavitated lesions, which are confined to enamel. On the other hand, if its an established carious lesion restorative therapy should be done along with ozone therapy. Antimicrobial effect of ozone is established with an exposure time of 10 sec but increasing it to 20 sec gives a transition from disinfection to sterilization. Increasing the exposure time to 40 sec is sufficient to kill different concentrations of *S. mutants*, whereas 60 sec exposure virtually eliminates cariogenic microorganisms such as *S.*

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mutants, *L. casei* and *A. naeslundii*. Ozone therapy is also effective against the microbes associated with primary root caries lesions. Application of remineralising agents immediately after ozone therapy can restrain the progression of non-cavitated root caries (11). Carious lesions detected on x-rays, should be exposed to 60-120sec of ozone therapy followed by a restoration. The use of ozone is easy and efficient in treating carious lesions but patients should be educated on proper oral hygiene techniques and balanced diet to maintain their dentition.

### **Treatment of Hypersensitive teeth**

Hypersensitivity is one of the most common problems faced by patients. This hypersensitivity could be due to attrition, abrasion, erosion, and trauma from occlusion where the enamel and dentin loss is seen or it could be due to exposed root surfaces. After eradication of the cause, application of gaseous ozone for 40 to 60 sec reduces pain immediately and the desensitization of dentin tends to last for a longer period of time (12). The mechanism behind this is that the ozone removes smear layer, opens the dentinal tubules, and broadens their diameter thus allowing the calcium and fluoride ions to flow into the dentinal tubules and plug the dentinal tubules preventing the fluid exchange through these tubules. Hence, sensitivity is no longer a problem with the help of ozone therapy (13,14).

### **Role in endodontic**

Retention of microorganisms in the dentinal tissue of the root canals is one of the reasons for persistent endodontic infection. Dentinal tubules of root canal walls have shown to harbor microorganisms despite proper biomechanical preparation (BMP) have been done, due to the presence of multiple canals and accessory canals (15). Lately, endodontic professionals depended on irrigants to disinfect and dissolve organic debris where it was impossible to instrument mechanically. *Enterococcus faecalis* has been the most common pathogenic microorganism identified in cases with infections post-endodontic treatment (16). Instead of using irrigation chemicals such as sodium hypochlorite (NaOCl), ozonized water is effective when it is prescribed in sufficient concentration. Ozone was found to have anti-microbial action against endodontic pathogenic microorganisms such as *e.coli*, *enterococcus*, *Pseudomonas*, *staphylococcus*, *mycobacteria*, *e.faecalis*, *peptostreptococcus* and *Candida albicans* (17). Once BMP is done, before filling the canals, the files are coated with ozonized olive oil as an intra-canal dressing. This lubricates and disinfects the canals. Ozonized water should be used for irrigation and dried. Before obturation, slow insufflations of moderate to high concentration of ozone gas for 45 to 60 sec into each canal should be done. This will allow the gas to reach the lateral canals, dentinal tubules and the apical foramen and kill the microbes present there (11).

## **Bleaching**

Crown discoloration is a major aesthetic problem in root canal treated teeth especially in anterior teeth. Tooth preparation followed by full veneer crown is usually done to treat crown discoloration. In certain cases bleaching can also be done using acids. Nowadays, we have alternatives such as ozone therapy. Due to its strong oxidizing property, bleaching can be done. Teeth whitening with the help of ozone therapy are easy to perform. Once the root canal filler material is condensed up to the cemento-enamel junction, a bleaching paste or cotton pellet soaked in bleaching solution is packed in the chamber and sealed with glass ionomer cement and the crown is exposed to ozone for minimum 3 to 4 mins. Tray technique can be used to bleach the entire dentition (18).

## **Use of ozonized water in decontamination of avulsed teeth before replantation**

Dental avulsion is the complete displacement of tooth from its socket in the alveolar bone due to trauma. The immediate treatment for dental avulsion would be replantation. Usually deciduous teeth are not replanted due to the risk of damaging the permanent tooth germ. The success of replantation depends on the vitality of cells (periodontal ligament cells) present on the root surface. Normally, saline, saliva or cold milk is used to retain the vitality of the periodontal ligament cells. Recent studies have shown that ozonized water helps in the decontamination of avulsed teeth before replantation. Two-minute irrigation of non-isotonic ozonized water provides a mechanical cleansing and retains the vitality of the periodontal cells. Ozone water is very biocompatible with human oral epithelial cells, gingival fibroblast cells and periodontal cells (19).

## **Cracked tooth syndrome**

Cracked tooth syndrome is a type of dental trauma, which gives a sharp pain, but the pulp is not involved. Ozone therapy has a solution to this syndrome. The tooth should be exposed to ozone for 60 to 120 sec and the sealed with intermediate restoration like glass ionomer cement (12).

## **Water line disinfection in dental unit**

65% reduction of the total viable bacterial counts was seen on application of ozone for 10 minutes but it was not very effective in completely eliminating the unwanted biofilm from the tubing surfaces (20).

## **Conclusion**

In the era of modern science and technology, ozone has indeed brought a new perspective in treating dental diseases in a more conservative and painless approach alternative to the conventional treatment. It is definitely the present and future treatment modality in dental practice due to its unique properties. Its ability to arrest the progression of dental

caries and to reverse the lesion is definitely a remarkable turn in dentistry as it provides a non-invasive way to treat dental caries. Besides that, its antimicrobial action on endodontic microorganism is truly effective in reducing post treatment failures. Nevertheless, further research needs to be carried out to authenticate its use in dentistry without any complications.

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