

Ozone Therapy: A New Exemplar in Dentistry

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Abstract:- The general well-being of the individual is directly associated with oral health. Presently most patients are getting more resistant to antibiotics, and ozone has emerged as an adjunct treatment modality in dentistry. Ozone therapy is non-traumatic, painless, and noninvasive, increasing the patient's acceptability. Ozone could be a sort of oxygen, composed of three oxygen atoms that act as an antioxidant which has an efficient role in the management of oral diseases. Ozone therapy has proven to be more effective than conventional modalities in various aspects of dentistry. This review article aims to highlight the role of ozone in the treatment of certain conditions in the oral cavity and its possible clinical applications in the future.

Keywords:- Ozone, Ozone therapy, gingivitis, periodontitis.

I. INTRODUCTION

Oral health is interlinked with the overall well-being of the individual. In the present era of dentistry, ozone has emerged as a new beneficial approach in dentistry specifically in patients with antibiotic resistance.⁷

In 1839, Christian Friedrich Schonbein, also regarded as "The father of ozone therapy" first noticed the emanation of a pungent gas with an electric smell and introduced it as ozone. The word ozone originates from the Greek word "ozein" which means smell.⁷ In the 1930s, ozone was employed in dental treatment by Dr. EA Fisch. Ozone (O₃) presents itself as a colorless gas and comprises three oxygen atoms. Ozone gas is introduced in the clinical field because of its solid oxidant property that oxidizes about all surfaces to the best oxidation stage. Ozone because of its gaseous property enters into inaccessible tissues and spaces and is therefore utilized for killing disease-causing microorganisms, circulatory enhancement, incitement of oxygen metabolism, and disturbance of tumor metabolism.¹⁸ Ozone is comprised of pure oxygen (95% to 99.95%) and pure ozone (0.05% to 5%). Ozone must be prepared immediately before use because of the unstable nature of the O₃ molecule. Storage of ozone is impossible for longer periods as within half an hour or an hour ozone is transformed into oxygen.⁶

Ozone therapy is a non-invasive, non-traumatic, and painless procedure that leads to high patient acceptability. Ozone therapy has been widely utilized in various oral and dental associated problems such as dental caries, plaque, and

biofilms, halitosis, gingivitis and periodontitis, dentin hypersensitivity, teeth whitening, oral lichen planus, wound healing, osteonecrosis of the jaw, post-surgical pain.¹⁰ This article reviews the implication of ozone therapy, mechanism of action, indications, and contraindications in the dental field.

II. HISTORICAL BACKGROUND

The German chemist who is regarded as the Father of ozone therapy, Christian Friedrich Schonbein (1840) subjected oxygen to electrical discharges and noticed a strange smell which he called ozone. The word Ozone is derived from the Greek word 'Ozein' (odor). A German physicist Joachim Hansler (1857) along with German physician Hans Wolff, developed the primary Ozone generator for medical use. Dr. C. Lender (1870) purified blood in test tubes by using O₃ and first time applied O₃ in the field of medicine. In the early 20th century Food and Drug Act updated the use and efficacy of O₃ in the field of medicine. In (1950), a German dentist, Dr. E.A. Fisch used ozone on a regular basis in his dental practice in Zurich, Switzerland. Mariniak and Delarive showed that it is an allotropic variety of oxygen, and Mulliken and Dewar clarified its molecular structure. In 2007 Karapetian VE et al conducted a study and concluded that gasiform ozone or ozonized water shows increased healing compared to wound healing without ozone therapy. In 2011, Huth et al compared ozone effectiveness with the established antiseptic CHX against periodontal microorganisms.

To explicate the nature and actions of ozone numerous types of research have still been carried out.^{2,13}

III. SYSTEMS FOR GENERATING OZONE GAS

In 1857 Werner Von Siemens in Germany developed the first ozone generator. There are three basic systems to generate therapeutic-grade ozone.

- **Ultraviolet system:** Low concentrations of ozone are produced by the ultraviolet system and used in aesthetics and for the purification of air.
- **Cold plasma system:** Ozone generated in this system is utilized in air and water purification.
- **Corona discharge system:** The most common system used in the medical/dental field is the corona discharge system. High concentrations of ozone are produced by this system. It has the benefits of easy handling and a controlled production rate of ozone.^{2,15}

IV. RATIONALE OF OZONE THERAPY⁵

The objectives of using ozone therapy are -

- Reduction of inflammation and pain
- Eradication of pathogens.
- Stimulation of the humoral anti-oxidant system.
- Activation of the immune system.
- Restoration of proper oxygen metabolism.
- Induction of a friendly ecologic environment.
- Enhanced circulation.
- Arrest of bleeding.

V. MECHANISM OF ACTION OF OZONE^{11,5}

Ozone treatment possesses distinctive properties and has plausible applications to the clinical practice of dentistry and medicine. Ozone has certain effects ranging from antimicrobial, immune stimulant, analgesic, and antihypnotic to detoxicating, bio energetic, and biosynthetic activities and enhanced wound healing. A number of them are listed here-

A. Antimicrobial effect

Ozone acts selectively on microbial cells but not on human body cells because of their antioxidative nature. The antimicrobial effect of ozone may be a result of its action on cells by disturbing the integrity of the cytoplasmic membrane by the oxidation of phospholipids and lipoproteins. Ozone also inhibits fungal cell growth as well as bacterial growth at certain stages.

B. Anti-inflammatory and analgesic action

Ozone has beneficial action in the reduction of inflammation and pain due to the synthesis of biologically active materials such as interleukins, leukotrienes, and prostaglandins.

C. Anti-hypoxic action

Ozone leads to the increase of PO₂ in tissues due to which transportation of oxygen in the blood increases, which further leads to differences in cell metabolism of aerobic processes. The metabolism of inflamed tissues is improved due to a rise in oxygenation and inflammatory processes are reduced.

D. Bioenergetic and biosynthetic action

A protein synthesis mechanism is activated which increases the number of ribosomes and mitochondria within the cells. Changes on the cellular level lead to a rise in the functional activity and regeneration potential of tissues and organs.

E. Immunostimulating action

Ozone in high concentrations shows an immune depressive effect whereas in its low concentration immune stimulating effect. Ozone modulates the cellular and humoral immune systems. It induces the multiplication of immune competent cells and further the synthesis of immune globulins. It also triggers the function of macrophages and enhances the sensitivity of microorganisms to phagocytosis.

F. Remineralization of tooth structure

Ozone causes tooth remineralization as it allows the diffusion of calcium and phosphorus ions to the inner layer of a decayed tooth and by the opening of dentinal tubules.

G. Enhancing wound healing^{7,20}

Ozone application enhances wound healing by improving the properties of erythrocytes and facilitating oxygen release within the tissues. Ozone increases blood supply to the ischemic zones thus resulting in a reduction of inflammation and wound healing.

H. Indications of ozone therapy¹⁴

Ozone therapy is indicated within the field of medicine likewise to dentistry

- Arterial circulatory disorders
- Immunodeficiency
- Inflammatory conditions
- Rheumatic diseases
- External ulcers and skin lesions
- Dentistry

I. Contraindications¹⁴

The ozone therapy is contraindicated in-

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

VI. MODES OF OZONE ADMINISTRATION

Ozone is often administered in various forms like ozone gas, an aqueous solution, oil, or ozonated water for therapeutic purposes.

A. Gaseous ozone

Ozone is used in the gaseous form via an open system or a sealing suction system. Inhalation should be avoided to scale back the possibilities of air embolism. Ozone is produced by passing air through high voltage in a polyurethane console. Several commercially available Ozone Units for medical use are:

- Curozone (W&H)
- HealOzone TEC 3 (Eurozone, USA).
- O3 obscure ozone device

Application of ozone is done through a handpiece that gets adapted to teeth through a silicon cup and is exposed for a minimum period of 10 seconds. The used ozone is converted back to oxygen through a reducing agent and then led back to the generator.

Ozonated water is incredibly effective against bacteria, fungi, and viruses. Ozonated water is used as a mouthwash for the eradication of bacteria, viruses, and fungi for various issues such as halitosis, gingivitis, etc.

It is a safer replacement for gaseous ozone. Ozonated water is indicated for disinfection and sterilization. It also shows a hemostatic effect in cases of hemorrhage.

B. Ozonized oil

*Ozonized oil is more convenient to use as compared to gaseous and aqueous forms. Ozone is passed through plant extracts to form a thick gel containing ozonides.*¹²

C. Forms of application in dentistry⁵

- It is used as an infusion into the infected jaw bone (cavitation).
- It is used as an irrigant during new root canal therapy to disinfect the involved tooth.
- It is used as an infusion into the temporomandibular joint for the treatment of pain and inflammation.
- It is used as adjunctive therapy with Ozonated olive oil for periodontal disease.

D. Applications of ozone in dentistry^{1,2,12}

Ozone is indicated in various dental treatment modalities. Ozone therapy presents itself as an alternative to traditional therapeutic modalities with great advantages. The use of ozone in dentistry can be a good alternative or it can be used as a disinfectant to standard antiseptics.

According to German dentist Fritz Kramer, ozonated water can be used in various ways because of its disinfectant action, its ability to regulate bleeding, and to cleanse wounds in bones and soft tissues.

Ozonated water increases the local supply of oxygen to the wound area and can increase the temperature in the area of the wound which further accelerates the wound healing.

Dr. Kramer suggested the application of ozonated water in several different ways:

- It can be used as a mouth wash (especially in cases of gingivitis, thrush, or stomatitis);
- It can be used as a spray to cleanse the affected area, and disinfect cavities, oral mucosa, etc.
- It can be used in root canal therapy, and cases of gingivitis and stomatitis.²

Ozone therapy has emerged as a minimally invasive and conservative approach to dental treatment, for instance, dental caries, periodontal procedures, and endodontic treatment in the various field of dentistry.¹⁹

E. Ozone in endodontics

Ozone is extremely utilized in root canal therapy because of its strong disinfection and antimicrobial properties. Irrigation from ozonated oil is quicker and more efficient in canal sterilization as compared to standard irrigation by sodium hypochlorite and sodium peroxide combination. Ozone therapy is additionally effective in bleaching procedures and offers patients content and healthier-looking smile.^{9,12,16}

F. Ozone in oral surgery

The idea to varied research, ozone therapy has been found to accelerate wound healing even without systemic medication. Application of ozone therapy after tooth extraction especially after third molar surgery reduces post-extraction complications like pain, swelling, trismus, or dry socket. Studies have shown that intra-articular ozone gas injection may be utilized in the treatment of certain temporomandibular joint disorders.^{11,12}

G. Ozone in Oral medicine

Topical administration of ozonated oil on soft tissue lesions like aphthous ulcers and herpes labialis demonstrated faster healing as compared to traditional procedures. Gaseous ozone has proven to be effective in cases of oral lichen planus following high-dose radiotherapy. Ozone therapy has shown successful results thus increasing the probability to substitute steroid treatment.^{11,12}

H. Ozone in Prosthodontics

Topical application of ozonated oil over the tissue surface and denture surface is useful to reduce denture stomatitis which is caused mainly due to *C. albicans*. Ozone therapy has been proven to reinforce bone regeneration. In implant dentistry, ozone usage is currently under research as this can be used for implant surface decontamination. After socket preparation for the placement of the implant, ozone is bubbled into the socket for about 40s. Ozone may be used as gas or within the aqueous form in cases of peri-implantitis.^{11,12}

I. Ozone therapy in Periodontics

Periodontal disease is a multi faceted disease process. There is a complex interplay of microorganisms and host response in the pathogenesis of the periodontal disease. The disinfectant power of ozone as compared to antiseptics and antimicrobial action as well as anti-inflammatory capacity makes ozone therapy a good alternative to standard mechanical debridement procedures. Ozonated water (4 mg/l) was found effective for killing gram-positive and gram-negative bacteria in plaque bio film and hence is often used as a mouth rinse.

Ozonated water can be used in different ways as in the ultrasonic water reservoir, to reduce the initial pathogenic load as a pre-treatment rinse before scaling, and root planning, and can be used to irrigate pockets in non surgical treatment as ozone gas directly penetrates the tissue and sterilizes the area. Various studies have proven the beneficial effects of ozone in cases with gingivitis, periodontitis, halitosis and dentinal hypersensitivity. Ozonated water may be used as an irritant during the surgery and/or as a final surgical site lavage. Ozonized oil is often applied at the surgical site and has shown positive results in post-surgical pain management.^{8,11,17}

J. Advantages

- Painless procedures
- Disinfectant.
- Hemostasis in capillary bleedings.
- Anti-inflammatory.
- Activation of intracellular metabolism of oral mucosa and dental wounds.
- Improvement of regional circulation.
- Stimulation of regenerative processes.

K. Disadvantages

- Instability.
- Not readily available.

L. Ozone toxicity

Ozone has certain benefits like non-invasiveness, simplicity, less time consuming and elimination of dental phobia but at times the ozone inhalation can be toxic to the pulmonary system and other organs. The European cooperation of Medical Ozone Societies banned the intravenous injections of ozone gas to avoid the risk of air embolism. Ozone toxicity occurs if the level increases at 0.0007% per application. A few known side effects include shortness of breath, epiphora, upper respiratory irritation, rhinitis, cough, headache, occasional nausea, vomiting, blood vessel swelling, poor circulation, heart problems, and at times stroke. Ozone intoxication includes the following measures -the patient should be placed in the supine position, inhalation of humid oxygen, and administration of ascorbic acid, Vitamin E, and n-acetylcysteine. Because of ozone's highly oxidative power, all materials that come in contact with the gas must be ozone resistant like glass, silicon, and Teflon.^{5,11,15}

VII. CONCLUSION

In the epoch of dentistry, ozone therapy has been proven a brand new therapeutic modality with great benefits to patients and is considered an alternative therapy to certain conventional medical modalities like antibiotics and disinfectants. Ozone therapy triggers the circulatory system and regulates the immune logic response. Ozone therapy kills microorganisms more precisely because it has antimicrobial properties. Ozone therapy is taken into account as a healing agent of choice within the treatment of medical pathologies and infectious oral diseases. Ozone should be used with all precautions to avoid ozone toxicity by employing a precise ozone generator and collecting a precise gas volume with an outlined ozone concentration. Ozone therapy reduces the treatment time and renders a trouble-free experience for the patients thus increasing the patient's acceptability and compliance with minimal side effects. In the field of dentistry, Ozone has been indicated in various treatment procedures like bleaching of discolored teeth, root canal treatment, desensitization, and treatment of some soft tissue infections as well as disinfection.

Further clinical research needs to be done to systematize the applications and treatment procedures of ozone therapy, which can help bring a regime change in dental practice in the future.^{3,4}

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