

Ozone Therapy – A Boon to Periodontics

¹Dr. Jaishree Tukaram Kshirsagar, MDS, Professor, Department of Periodontics, Government Dental College and Hospital, Chennai, Tamilnadu - 600003.

²Dr. Priyanga PT, III year Post Graduate Student, Department of Periodontics, Government Dental College and Hospital, Chennai, Tamilnadu - 600003.

³Dr. Kalaiselvan D, III year Post graduate student, Department of Periodontics, Government Dental College and Hospital, Chennai, Tamilnadu - 600003.

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Corresponding Author: Dr. Priyanga PT, III year Post Graduate Student, Department of Periodontics, Government Dental College and Hospital, Chennai, Tamilnadu - 600003.

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Abstract

Ozone gas is a medically versatile blue gas which is a potent antibacterial and antiviral agent in nature. It is widely being used in the field of general medicine and dentistry due to its antioxidant property. Ozone gas serves as a potent antimicrobial agent nonsurgically, both for home care and professional practice. Due to the increased antibiotic resistance, ozone therapy serves as a better alternative in non-surgical treatment. This review article is an attempt to summarize the benefits of ozone therapy and its various uses in dentistry especially in periodontics.

Introduction

Ozone also known as triatomic oxygen and trioxigen, is a naturally occurring compound with three oxygen atoms, and it is formed as a result of

combination of three oxygen atoms on exposure to ultra violet rays [1].The word ozone is derived from the Greek word “ozein” meaning odorant[2].Ozone therapy is a bio-oxidative therapy in which oxygen/ozone is administered in the form of gas or dissolved in water or oil base to obtain desired benefits. Ozone is used as a powerful sterilizing agent as it effectively destroys bacteria, fungi and viruses by rupturing their cell membranes immediately. Ozone releases nascent oxygen molecule quickly to form oxygen gas. This nascent oxygen, is bactericidal and inactivates viruses [3]. Ozone is one of the most unstable gas,so it is not possible to store ozone for longer duration and it must be prepared immediately before use .Ozone has highest oxidation potential, 150% greater than that of chlorine

when used as an antimicrobial agent. This quality of ozone has led to its use in various specialities of dentistry and especially periodontics.

History

Ozone was first discovered by Christian Friedrich Schonbein a German chemist in the University of Basel in Switzerland in 1840. Ozone gas was used to treat post-traumatic gangrene, wounds, burns and inflammations in German soldier during the first world war. In 1920's the best technology for producing ozone gas was designed by Nikola Tesla. Wolff was the first person to expose blood directly to a gaseous mixture of oxygen and ozone and that's how ozonated autohemotherapy was invented. A Swiss Dentist Dr. E.A. Fisch was the first to use ozonated water as a disinfectant. Ozone was used in a vapor-phase in 1942 to reduce airborne bacterial infections. Until 1950 ozone therapy was restricted due to the lack of manufacture of ozone resistant materials.

Mechanism of Action

- a. Antimicrobial action[4]: Ozone destroys bacteria, fungi, and viruses by causing direct damage to the cytoplasmic membrane of cells and modifies intracellular substances due to its secondary oxidant effect which leads to oxidation of protein and loss of organelle function. The antioxidative ability does not damage human body cells and is selective to only the microbial cells. The ozone penetrates the gram-positive bacteria more than the Gram-negative bacteria.
- b. Immunostimulating effect[4,5]: The ozone application to the immune system stimulates the immunocompetent cell proliferation and immunoglobulin synthesis. The macrophages are activated due to which phagocytosis occurs at a faster rate. This leads to production of biologically

active substances such as interleukins, prostaglandins, and leukotrienes, at an increased pace which helps in reduction of inflammation and accelerates wound healing.

- c. Anti-hypoxic effect [5]: Ozone raises partial pressure of oxygen in tissues and improves the transportation of oxygen in blood. It increases remineralization potential and permits diffusion of calcium and phosphorus ions into the deeper layers of carious cavities by opening of the dentinal tubules.
- d. Ozone at low concentrations of 0.1 ppm, inactivates bacterial cells and their spores and is immune stimulating and at high concentrations causes immune depressive effects.

Ozone Generating Systems

The three ozone generating systems are:[6]

1. UV system: UV light is emitted at 185 nm and low concentrations of ozone are produced. On UV light exposure light energy is absorbed by oxygen molecule in ground state and it dissociates. This oxygen atom reacts further with other oxygen molecules to form ozone in a chain like reaction.
2. Cold plasma system: In this system, an electrostatic field is formed when the voltage jumps between the anode and the cathode rods. The applications of this system are air and water purification
3. Corona discharge system: This system is simple and ozone production rate can be controlled here and as well as high concentration of ozone can be produced. Using a dielectric, an electrical discharge is diffused over an area to create a corona discharge. Oxygen is passed through this and it is converted into ozone. This is the most common system applied in medical and dental field.

Application Modalities

Gaseous form: It is administered topically in an open system or in a sealing suction system to prevent inhalation toxicity. Gaseous form is applied in restorative dentistry. It is noninvasive and used in the treatment of dental caries and hypomineralized teeth. It acts as an effective dental disinfectant when applied for 3 min.

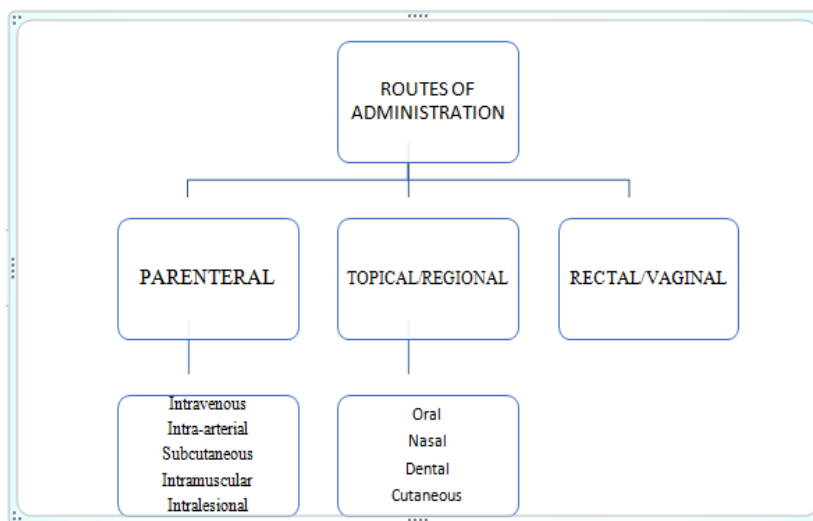
Ozonated water: It is less expensive and more efficacious against Gram-positive and Gram-negative

oral microorganisms and bacteria in plaque biofilm. Commercially available as ultra-pure, tripple ozone treatment system.

Ozonized oil: It is competitive antimicrobial agent and obtained from sunflower oil and present worldwide. It is found efficacious against many bacteria such as Streptococci, Staphylococci, Escherichia coli especially Mycobacteria and also used for the cure of fungal infections. Commercially available as Oleozone, Bioperoxoil.

Routes of Administration [7]

Flow Chart 1: Routes of Administration



Dosage in Ozone Therapy

The dosage of ozone used in therapy is denoted in gammas. The dosage range varied from .00001

gammas used in Ionozone therapy to 100 gammas used in autohemotherapy

Table 1: Ozone doses (µg/ml per gram of blood)

| | INITIAL | FINAL |
|----------------------|---------|-------|
| Vascular disease | 20 | 40 |
| Respiratory disease | 20 | 40 |
| Metastatic cancer | 25 | 80 |
| Infectious disease | 25 | 70 |
| Autoimmune disease | 20 | 40 |
| Degenerative disease | 20 | 40 |

Medical Applications of Ozone

1. Used in the treatment of Bacterial, viral and fungal disinfection.
2. Increases wound healing ability of tissue by enhancing oxygenation.
3. Stimulation of KREB's cycle by increasing the production of adenosine triphosphate and thus increasing cell energy and involved in balancing of several metabolic reactions.
4. Helps to treat arteriosclerosis by clearing arterial plaque and in the treatment of rheumatoid arthritis.
5. Used to treat acne, allergies and furunculosis and in the treatment of hepatitis A, B and C [8].

Ozone Applications in General Dentistry:

Ozone in the Management of Dental Caries

Ozone is a powerful antimicrobial agent and it eliminates acidogenic bacteria. Pyruvic acid is the strongest acid, produced during cariogenesis by acidogenic bacteria. Ozone decarboxylates this acid to acetic acid which in turn increases remineralization of carious lesions [9]. It also reduces caries progression in patients with high caries risk.

Ozone in Conservative Dentistry and Endodontics

By the application of ozone, the removal of dental caries has become an atraumatic dental procedure. The ozone gas when applied to carious lesion for 10-20 sec, reduced 99% of microorganisms. For root canal disinfection sodium hypochlorite has been used mainly and it has been proved that ozonated water is equally effective antimicrobial as 2.5% sodium hypochlorite [10]. When ozonated water is used accelerated healing of periapical tissues is observed due to the high metabolic activity of fibroblasts. Ozonated oil is proved to be a more effective intra canal medicament than calcium hydroxide.

Ozone in Management of Hypersensitivity

In hypersensitivity, the smear layer present over the exposed root surface prevents the penetration of calcium and fluoride ions deep into the dentinal tubules. Ozone gas opens up the dentinal tubules by removing the smear layer, allows the calcium and fluoride ions to flow into the tubules thereby plugging the dentinal tubules and prevents the fluid exchange through these tubules. It has been observed from clinical studies that gaseous ozone provides desensitization of dentine for a longer period of time [11].

Ozone in Prosthodontics

C. albicans is the most common microorganism found on the denture surfaces. Ozonated water due to its antimicrobial efficacy has proved to be an effective denture cleanser. Ozonated water (2 or 4 mg/L) when used for 1 min on the surface of dentures is found effective against Methicillin - resistant *S. aureus* and viruses [12]. Gaseous ozone disinfection of removable prosthesis has less damage on the quality of alloy and serves as a better denture cleanser.

Ozone Therapy in Oral and Maxillofacial Surgery

After surgical tooth extraction ozone gas is used in the irrigation of the socket region and aids in faster wound healing with less postoperative complications. It was observed that in patients with chronic mandibular osteomyelitis, ozone application promoted normalization of nonspecific resistance and T-cell immunity, thus reducing complications. Ozone therapy is also found to be beneficial in the treatment of the refractory osteomyelitis in the head and neck region along with antibiotics, surgery and hyperbaric oxygen. Ozone therapy in the management of bone necrosis induced by bisphosphonates stimulates cell proliferation and soft tissue healing thus ozone therapy is recommended as therapeutic support in the treatment

of bisphosphonate related osteo necrosis of the jaws[13].

Ozone Therapy in Oral Medicine

Ozone due to its antimicrobial capacity modifies immune system and used in the treatment of hepatitis, herpes simplex, herpes zoster, ANUG and aphthous ulcers[14]. Ozone due to its properties like immunomodulation, analgesic, antimicrobial and ability to promote blood circulation has been found to be effective to treat aphthous stomatitis. Ozone due to its anti-immunological and anti-inflammatory properties can also be used in the treatment of oral premalignant conditions like oral lichen planus.

Ozonated Water in Decontamination of Avulsed Teeth

Irrigation of the avulsed teeth for two minutes with non-isotonic ozonated water provides mechanical cleansing and decontamination of the root surfaces with no damage to the periodontal cells remaining on the tooth surface before replantation[15]. An increased level of biocompatibility of aqueous ozone on human oral epithelial cells, gingival fibroblast cells, and periodontal cells has been found prior to reimplantation after treatment with ozone.

Effect of Ozone on Wound Healing

Filippi has observed that ozone-water accelerates the wound healing rate in the oral mucosa. The healing effect was noticeable in the first two postoperative days. Studies reveal that in patients under ozone therapy, quick healing is observed without the need for systemic medication, compared to the control group. Ozone application in the tooth extraction site reduced the post-extraction complications.

Ozone in Periodontics

Periodontal diseases are treated by various treatment modalities. During scaling and periodontal

surgical procedures, ozonated water is used as an irrigant solution in the sulci and pockets to reduce preoperative pathogenic bacterial load[16]. Ozonated water has proved to be bactericidal to both gram positive organisms such as streptococci and *Candida albicans* and gram negative micro-organisms such as *P. endodontalis* and *P. gingivalis*. Ozonated water has strong bactericidal activity against bacteria in plaque biofilm. In Laser therapy with the Periolas, ozonated water is used during ultrasonic used as topical application for home applications to the patients which helps to decrease infection recurrence. Ramzy et al used ozonized water 150ml, for 5 to 10 minutes once weekly, for four weeks to irrigate the periodontal pockets in patients suffering from aggressive periodontitis and has found that pocket depth, gingival index, plaque scores and bacterial count has reduced. Huth et al. examined the Nuclear factor- κ B system, a paradigm for inflammation-associated signalling/transcription and proved that that NF κ B activity in oral cells of periodontal ligament tissue from root surfaces of periodontally damaged teeth was inhibited after incubation in ozonized medium, proving that it has anti-inflammatory capacity. Kronusova used ozone in patients with periodontal abscesses, chronic gingivitis, periodontitis and purulent periodontitis and observed no exudation discharge. Application of ozone for the decontamination of the implant surface in Peri-implantitis has been studied. Ozone gas is bubbled into prepared socket and implant is placed which reduces the percentage of post operative infection[17]. In periimplantitis, ozone due to its antimicrobial action kills the microorganisms causing periimplantitis and shows positive wound healing effect and increases tissue circulation. Ozonized water shows an accelerated healing compared to the wound healing occurring

without ozone therapy. Topical application of ozonized oil can also be advised for accelerated healing.

Literature Review

- M. Y. M. Shoukheba et al. (2014) evaluated the effect of subgingival application of ozonated olive oil gel in aggressive periodontitis as an adjunct to SRP for 6-month duration and found significant reduction in PI, GI, BOP, probing depth, and CAL.
- Gianluca Sacco et al. (2016) evaluated the clinical and microbiological effectiveness of local oxygen-ozone therapy in chronic periodontal disease and found out significant reduction in probing depth and BOP
- Durga Kshitish and Vandana K Laxman compared the effects of oral irrigation with 0.2% chlorhexidine and ozonated water in periodontitis patients and observed improvement in PI, GI, and bleeding index.
- Selcuk Yilmaz et al. (2013) evaluated the clinical and microbiological results of treatment with Er:YAG laser and topical gaseous ozone application twice a week for 2 weeks as adjuncts to initial periodontal therapy in chronic periodontitis patients for 3-month durations and significant improvement in probing depth and clinical attachment levels was observed
- Skurska A et al. compared the clinical status and salivary MMP levels after SRP alone and in combination with ozonotherapy in patients with aggressive and chronic periodontitis for 2-months duration and observed significant reduction in PI, PPD, Sulcular Bleeding Index, and clinical attachment loss.
- Nagayoshi et al., [2004] described that 4 mL of ozonated water for 10s effectively destroys

Gram-positive and negative microorganisms and candida albicans present in plaque biofilm.

- Hauser-Gerspach et al., 2012 reported that the adherent bacteria on titanium and zirconia was reduced when treated with gaseous ozone for 6 to 24s without affecting adhesion and proliferation of osteoblastic cells.
- SaeHayakumo et al. (2013) used nano bubble water irrigation as an adjunct to subgingival debridement for periodontal treatment and found out that there were improvement in clinical and microbiological parameters.
- Martinez Abreu & Abreu Sardinias [2005] for the treatment of moderate periodontitis used ozonated oil (Oleozon) for 9 months and observed faster improvement in the signs and symptoms in the test group treated with ozonated oil.
- Huth et al (2007) investigated the effects of aqueous ozone on the nuclear factor kappa beta system and observed inhibition of the NF-KB system, due to its anti-inflammatory properties.

Contraindications for the Use of Ozone Therapy [17, 18]

1. Pregnancy, severe anemia, thrombocytopenia,
2. Hyperthyroidism, severe myasthenia,
3. Acute alcohol intoxication, recent myocardial infarction.
4. Glucose-6-phosphatedehydrogenase deficiency
5. Ozone allergy.
6. Continued inhalation of ozone is harmful to the lungs and other organs so well adjusted therapeutical doses should be administered. According to the European Cooperation of Medical Ozone Societies direct intravenous injections of ozone gas should not be given due to the risk of air embolism

Ozone Toxicity

Ozone when given in right amounts does not cause any adverse effects. The complications caused by ozone is very infrequent and is about 0.0007 per application. In oral cavity the maximum concentration of ozone is found to be 0.01 ppm. The side effects of ozone therapy are nausea, vomiting, shortness of breath, epiphora, rhinitis, upper respiratory irritation, heart-related problems, blood vessel swelling and poor circulation [19]. As the oxidative power of ozone is very high the materials which come in contact with the gas must be ozone resistant. Vitamin E and n-acetylcysteine are used as antidote for ozone intoxication the patient is placed in supine position. [20].

Conclusion

Ozone is a versatile blue gas which has numerous advantages. Ozone therapy plays a vital role to improve the quality of treatment for various diseases as it is minimally invasive and cost effective with minimal side effects. The acceptability and compliance of patient is also increased since it's a painless therapy. Local ozone application serves as a supportive periodontal therapy due to its antimicrobial action. Subgingival ozone irrigation serves as a successful adjunct to periodontal treatment. Ozone therapy plays a vital role in reducing subgingival bacterial count effectively. However, further research is still needed to justify the routine uses of ozone in periodontics.

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