

Review Article

The Application of Ozone in Dentistry: A Systematic Review of Literature

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Abstract: In the era of antibiotic resistance, we need a naturally occurring substance like Ozone to treat infection without any toxic side effects. Interest of Ozone use in Medicine and Dentistry is due to its Anti-microbial, Disinfectant, Biocompatibility and Healing properties. Since ozone is a powerful oxidizer, it effectively kills Bacteria, Fungi, Viruses and Parasites. Ozone therapy has opened new vistas in treatment modalities of Dental pathologies for patients of all ages. It is used for treatment of early carious lesions, sterilization of cavities, disinfection of root canals, periodontal pockets, bleaching of discolored teeth, desensitization of extremely sensitive teeth, peri-implantitis, enhancing epithelial wound healing, as a denture cleaner and decontamination of tooth brush. Scientific support for Ozone therapy presents a potential for a traumatic, biologically-based treatment for conditions encountered in Dental practice. The purpose of this article is to summarise the mechanism of action and different modalities of Ozone therapy in the practice of Dentistry.

Keywords: Antibacterial activity, Dentistry, Ozonated oils, Ozonated water, Ozone therapy, Ozone therapy, Root caries.

INTRODUCTION

For over 130 yrs, millions of people have benefited from the effects of Ozone to eliminate disease and encourage natural healing. The word Ozone was first introduced by Christian F.Schonbein, a German Chemist in 1840. [1] and he is considered as the Father of ozone therapy [2]. He subjected oxygen to electrical discharges and noted "the odour of electrical matter". Schonbein concluded that odour was due to a gas which he named Ozone, from the Greek Ozein [3, 4].

It also stimulates blood circulation and the immune response. [5] Ozone therapy is one of the modern non-medication methods of treatment. It is being used for more than 100 years. Even though Ozone therapy is still being ignored by most of medical establishment because of facts that gaseous Ozone is quite toxic and has strong oxidative properties [6]. There are several known actions of Ozone on human body, such as anti-microbial, immunostimulating, anti hypoxic, analgesic, detoxicating, bioenergetics and biosynthetic (activation of the metabolism of carbohydrates, proteins & lipids) etc. [7].

HISTORY

Ozone therapy has been in use since the 1800's and in 1896 the genius Nikola Tesla patented the first Ozone generator in the US, later forming the 'Tesla Ozone Company'. After that the Institute for Oxygen Therapy-Healing was formed in Berlin and the man credited with founding naturopathy, Dr. Benedict

Lust, began practicing in New York, and wrote many articles on Ozone. This form of treatment is highly popular in Germany and in 1959; an ozone machine called "Ozonosan" was patented by Dr. Joachim Hansler which formed the basis of the expansion in German Ozone therapy [8-12].

APPLICATION OF OZONE IN DENTISTRY

The use of Ozone has been proposed in the Medical and Dental field. Ozone therapy was used extensively to treat infections, battle wounds and in routine treatment of cancer up to 1950's. In Dentistry, Ozone is used as a chair side disinfectant because of its synergistic part of the treatment, both in eliminating bacteria and oxygenating chair side environment [13-18].

Anti –Microbial action:

Ozone has got a high oxidation potential which is 1.5 times greater than chloride when used as an antimicrobial agent [19]. The antibacterial effect of Ozone occurs as a result of its oxidant action on cells by damaging its cytoplasmic membrane due to ozonolysis of dual bonds and also Ozone-induced modification of intracellular contents because of secondary oxidant effects. It does not damage healthy human body cells because they have free radical scavengers like superoxide dismutase, catalase, hydrolase and antioxidant nutrients like vitamin C, E, beta-carotene, selenium, methionine, glutathione which inhibit the uncontrolled activity of free radicals and thus all

healthy cells are protected. Only unhealthy cells such as cancer cells which have lost this protective mechanism and organisms such as Bacteria, viruses, Fungi, Parasites which are devoid of these antioxidants and scavengers are destroyed [20].

Ozone is very efficient in antibiotic resistant strains. In viral infections, Ozone action lies in the intolerance of infected cells to peroxides and change of activity of reverse transcriptase, which takes part in synthesis of viral proteins. AIDS, Herpes, Hepatitis, Epstein Barr, Cytomegalovirus and other lipid envelope viruses are readily destroyed by Ozone. [20].

Anti-inflammatory & analgesic action:

Ozone helps in the synthesis of biologically active substances such as Interleukins, leukotrienes and prostaglandins which is beneficial in reducing inflammation and pain. The infection or inflammation is positively charged (acidic) and Ozone is negatively charged (basic) so the chemistry of infection and inflammation attracts Ozone to the area [19].

Immune-stimulating action:

The electromagnetic action of Ozone stimulates and modulates immune system particularly lymphocytes producing interleukins. It also activates the function of macrophages and increases sensitivity of microorganisms to phagocytosis. So the application of medical Ozone is extremely useful for immune activation of patients especially with a low immune status & or immune deficit [19].

Anti-hypoxic action:

Ozone brings about the rise of P_{O_2} in tissues and improves transportation of oxygen in blood, which results in change of cellular metabolism activation of aerobic processes (Glycolysis, Krebs's cycle, β -oxidation of fatty acids) and use of energetic resources. Ozone acts as a super-oxygenator, bringing oxygen to tissues, assisting body in its natural healing process [20].

Bioenergetics and biosynthetic action: Ozone activates mechanisms of protein synthesis, increases amount of ribosomes and mitochondria in cells, elevating functional activity and regeneration potential of tissues and organs. [20].

Dental unit water lines disinfection:

According to Montebugnoli *et al.*; (2004) DUWL's are ideal environment for the growth of microorganisms entering Dental units from the municipal water supply and from previously treated patients. [21] Wirthlin *et al.* (2003) concluded that controlling DUWL biofilm would have beneficial effects on nosocomial infections. [22] The high frequency, deleterious effects and infection parameters of HIV and Hepatitis Viruses highlight the importance of effective infection control measures in Dentistry.

Ozone can be used for DUWL's purification and to minimize cross infection due to its antimicrobial efficiency and lack of side effects [20].

Role in Endodontics:

Until recently, the Dental profession relied on chemical irritants reaching the main and lateral canals to disinfect and dissolve organic debris where it is impossible to instrument mechanically. Ozone was found to be effective against endodontic pathogenic microorganisms like *E. Faecalis*, *Candida albicans*, *Peptostreptococcus micros* and *Pseudomonas aeruginosa* disinfecting of root canals and dentinal tubules [23]. Ozone also eliminates the distinctive anaerobic odor associated with some chronically infected teeth.

Wound healing:

Ozone has been reported to accelerate the healing of soft tissue conditions i.e.: aphthous ulcers, herpes labialis, ANUG another gingival infections because Ozone encourages physiological healing rate as well as control opportunistic infections.[24] It also reduces the post extraction healing time by forming a pseudo membrane over the socket and protecting it from any physical and mechanical insults [25].

In alveolitis, there is accelerated healing by irrigation with Ozonated water after removal of the necrotic plug and debris under antibiotic coverage. After radiotherapy in the jaw, oxygen supply may be considerably reduced in the affected area due to the obliteration of intraosseous vessels. Such compromised bone heals slowly compared to healthy bone, after surgical interventions like tooth extractions or implants. Ozone might be successfully used to treat such wound healing impairments after radiotherapy [23].

Role in periodontics:

Ozonated water can be used in the ultrasonic water reservoir, also as a pre treatment rinse before scaling, root planning and the sulci, pockets are irrigated using syringe and canula in non surgical pocket curettage. This process will reduce the initial pathogenic load on the patient locally and systemically. After treatment, each pocket & sulcus is insufflated with ozone gas which directly goes into tissues, sterilizing the area [20].

Role in Prosthodontics:

A common occurrence found in full denture wearers is denture stomatitis, mainly due to *Candida albicans*. This can be controlled by topical application of Ozonated oil over tissue surface and over denture surface. The disinfecting action of Ozone is also used to clean denture. Advise patients to soak dentures in Ozonated water for at least 10min after removal and also rinse them before inserting into mouth. [20].

Ozone therapy in Implantology:

It helps in bone regeneration. The socket is prepared conventionally and Ozone is bubbled into the socket for about 40sec, followed by placement of implant into the socket. This prevents infection and enhances bone regeneration. [26].

Matsamura K *et al.*; treated implants with ozone and found that there was regeneration of periodontal cells similar to that around natural teeth [28].

Use of ozone therapy in child patients:

Most of the child patients have fear and anxiety towards Dental treatment. Dahnhart J E et al evaluated the anxiety level of children (and their parents) treated with Ozone and found that all children & parents reported significant anxiety prior to Ozone treatment. [20].

Dental caries prevention and management:

The commonly used Ozone application device is a portable novel Ozone delivery system with an ozone generator which delivers Ozone gas at a concentration of 2100 ± 200 ppm (615ml/min of Ozone at a low concentration of $4 \mu\text{g/ml}$) and this device delivers Ozone through a hand piece directly to the carious lesion. A silicon cup determines the area covered which tightly seals the area and if there is any leak in the system, the Ozone delivery system would automatically stop. After cavity preparation, just before restoration placement, the prepared area is covered with ozone gas for 20-30 sec. This simple procedure dramatically reduces the post-operative sensitivity & eliminates the possibility of leaving infected dentin. [20].

With ozone therapy and demineralization, only minimal quantities of Dental tissue need to be removed to facilitate a restoration of the tooth. This makes the restorative treatment much simpler, less time-consuming and much more cost effective. [20]

1. Ozone toxicity:

- a. Even though ozone has certain benefits likening-invasiveness, simplicity, less time consumption.
- b. Known side effects are epiphora and upper respiratory irritation, rhinitis, cough, headache, occasional nausea, and vomiting.
- c. However, complications caused by Ozone therapy are infrequent at 0.0007 per application.
- d. In the event of an Ozone intoxication the patient must be placed in the supine position, inhale humid oxygen, and take 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, such as glass, silicon, and Teflon. [10, 27].

2. Ozone in metabolism:

- a. One of the major ozone effects on cell metabolism is its impact on NADH and NADPH coenzymes, giving rise to their oxidation (glycolysis, gluconeogenesis, synthesis and β oxidation of fatty acids, citric acid cycle, electron transport chain). The ozone effect is manifested in all three metabolic pathways, i.e. the ones involving carbohydrates, proteins and fats. [28].

DISCUSSION

The first ozone generator was developed by Werner Von Siemens in Germany in 1857 and C. Lender in 1870 used it therapeutically for purifying blood. Edward Fisch (1932) was the first to use ozone to control infection in regular dental practice. Ozone (O_3 , molecular weight of 47.98g/mol) is energized form of oxygen which is unstable and dissociates readily back to oxygen (O_2) and singlet oxygen (O) which is a strong oxidizing agent. [19]. It is a blue gas, with strong odor and most important gas in the stratosphere due to its ability to filter UV rays which is critical for maintenance of biological balance in the biosphere. In nature, ozone is formed by combination of oxygen in the air under the influence of factors such as UV radiation (from the sun), electrical discharges (lightening) and intense physical stress on water (such as water falls & ocean waves crashing onto rocks). Occupational exposure to ozone occurs through its production by office photocopying equipment, electric arc welding, mercury vapour lamps, laser printers, X-ray generators and high voltage electrical equipment etc. The ozone concentration used may vary between 1 and 100gm/ml (0.05-5%) according to the medical/dental indication and the patient's condition.[28,29]. Controlled Ozone application has been found to be extremely safe, free from side effects and far free from most medications, including antibiotics.

Forms of ozone administration, There are three basic forms of ozone application.

- 1) Ozone gas
- 2) Ozonated water
- 3) Ozonated oil.

These forms of application are used singly or in combination to treat dental disease. [28].

Ozone gas has a half life of about 5-30 min and Ozonated water has a life span of about 10hrs if the water is kept cold.

Ozone is also used in the pharmaceutical industry, food processing industry, fabrics and cosmetics. Dental ozone generators [20]. Ozicure device (which is no longer available and is not licensed

for use in Europe) and Heal Ozone developed by CurOzone USA Inc. The Heal Ozone generator was found to be safe to use following the manufacturer's recommendations. After the treatment, a special filter in the generator turns the residual ozone back into oxygen.

Ozonated oil produces a stable product (zooids) with a longevity exceeding 15 yrs indications [20].

1. Arterial circulatory disorders.
2. Immunodeficiency and immunity balance - Additive therapy in carcinoma patients- Diseases caused by viruses (e.g.: Hepatitis)
3. Inflammatory condition
4. Rheumatic diseases
5. External ulcers and skin lesions
6. Dentistry

There are three different systems for generating ozone gas.

1. Ultra violet system: produces low concentrations of Ozone, used in aesthetics & for air purification
2. Cold plasma system: used in air and water purification
3. Corona discharge system: produces high concentrations of Ozone.

CONCLUSION

There is growing interest in the use of ozone in Dentistry. Anecdotally, many clinicians believe that the superiority of ozone therapy over conventional Dental treatment has not yet been proven. Ozone therapy has opened new vistas in treatment modalities for Dental patients of all ages and applicable to a wide range of conditions of intra oral hard and soft tissues. It is especially suitable to the younger patients who are often scared of 'drilling' and find conventional treatment unacceptable. For the elder people having medical problems, that can complicate conventional treatment, ozone therapy is easier and more efficient. Treating patients with Ozone cuts off treatment time, eliminates bacterial count more precisely and moreover, it is completely painless resulting increased acceptability and compliance of the patient. Further research in Ozone would bring a revolution in dental practice in near future.

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