JMSCR Volume||2||Issue||12||Page 3352-3358||December-2014 2014

www.jmscr.igmpublication.org Impact Factor 3.79
ISSN (e)-2347-176x

IGM Publication Journal Of Medical Science And Clinical Research
An Official Publication Of IGM Publication

Ozone Therapy in Periodontics: A Review

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ABSTRACT

Periodontitis is a inflammatory disease of the supporting tissues of the teeth and is caused by specific microorganisms or by a group of specific microorganisms, resulting in progressive destruction of periodontal ligament and alveolar bone with periodontal pocket formation, gingival recession.[1]Bacteria are the prime etiological agents in periodontal disease. The mechanical removal of the biofilm and adjunctive use of antibiotic disinfectants or various antibiotics have been the conventional methods for periodontal therapy.[2][3] Ozone therapy is one of the modern non-medication methods of treatment. Ozone is an unstable gas and it quickly gives up nascent Oxygen molecule to form Oxygen gas. Ozone gas has a high oxidation potential and is effective against bacteria, viruses, fungi, and protozoa. It has the capacity to stimulate blood circulation, platelets, and immune response. Ozone is used in dentistry in gaseous, ozonated water and oils. Ozone is biocompatible and can be used in all aspects of dentistry.

HISTORY

The word Ozone (O_3) is derived from the Greek word ozein (odorant). Ozone is one of the most powerful antimicrobial agents available for use in medicine and dentistry. The word ozone was first used by Schonbein in 1840. He subjected oxygen to electrical discharges and noted "the odour of electrical matter". In 1856, just 16 years after its discovery, ozone was first used in a health care setting to disinfect the operating room and sterilize surgical instruments.[4] Earlier, ozone therapy was difficult and limited due to the lack of ozone-resistant materials, such as Nylon, Dacron, and Teflon, until 1950 when ozone-resistant materials were manufactured. Joachim Hänsler, a German physicist and physician, joined another

German physician, Hans Wolff, to develop the first ozone generator for medical use. Their design continues to be the basis for modern equipments. In early 20 th century Food and Drug Act, revised its use and effect in the field of medicine. A German dentist, Dr. E.A. Fisch, in 1950, used ozonated water for dental procedures and pioneered its use in medicine.[5]

OZONE THERAPY: CHEMISTRY AND APPARATUS.

Ozone (O3) is a triatomic molecule, consisting of three oxygen atoms. Molecular weight of (O3) is 47, 98 g/mol. Thermodynamically it is highly instable compound that, dependend on conditions like temperature and pressure, and it can decompose to pure oxygen with a short half-life.[6] Ozone is an unstable gas that cannot be stored and should be used at once as it has a half-life of 40 min at 20 °C.[7] Ozone gas has a high oxidation potential and is 1.5 times greater than chloride when used as an antimicrobial agent against bacteria, viruses, fungi, and protozoa. It also has the capacity to stimulate blood circulation and the immune response. Such features justify the current interest in its application in medicine and dentistry.[8]

The first ozone generator for medical use was developed by German physicians named Joachim Hansler and Hans Wolff. There are three different systems for generating ozone gas:

Ultraviolet System: produces low concentrations of ozone, used in esthetics, saunas, and for air purification.

Cold Plasma System: used in air and water purification.

Corona Discharge System: produces high concentrations of ozone. It is the most common system used in the medical/ dental field. It is easy to handle and it has a controlled ozone production rate.

Goals of Ozone Therapy:

1. Elimination of periodontal pathogens.
2. Restorating the oxygen metabolism.
3. Induction of a friendly ecologic environment.
4. Increased blood circulation.
5. Activation of immune system
6. Activation of the humoral anti-oxidant system

Mechanism of Action

There are several actions of ozone such as anti-microbial, anti-inflammatory, analgesic, immune-stimulating, anti-hypoxic, detoxicating, bio-energetic, and biosynthetic (activation of the metabolism of carbohydrates, proteins and lipids) actions.[9]

Immuno Stimulating Effect:

Ozone influences humoral and cellular immune system. It stimulates the proliferation of immune competent cells and synthesis of immune globulins. It activates the function of macrophages and increases the sensitivity of microorganisms to phagocytosis. Ozone causes the synthesis of biologically active substances such as interleukins, leukotrienes, and prostaglandins which reduces the inflammation and helps in wound healing. Ozone in high concentrations causes immune depressive effect whereas in its low concentration causes immune stimulating effect.[10]

Anti-Microbial Action: The anti-microbial effect of ozone results from oxidation of microbial cellular components. It do 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 inhibits 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 which are devoid of these antioxidants and scavengers are destroyed. The oxidant potential of ozone induces the destruction of cellular walls and cytoplasmatic membranes of bacteria.

APPLIANCES PRODUCING OZONE FOR DENTAL USE:

1. **Heal Ozone by KaVo is air-** It is air based and application of gas takes place in a closed circuit. The concentration of ozone in the cap adjacent to the tissue amounts to 2100 ppm. Perfect air tightness of the cap is necessary for the application of ozone. The application is only possible on the surfaces where air tightness can be provided.

2. Ozony Tron By MYMED Gmb H.

Oxygen activation generator uses the power of high frequency and voltage. Activated oxygen (ozone) concentration can be adjusted in 5 levels via current strength. Inside the glass probe, which is formed by a double glass camera, is a noble gasses mixture that is conducting and emitting electromagnetic energy. When the tip of the probe gets in contact with the body it emits energy around the treated area and splits environmental diatomic oxygen in singular atomic oxygen and ozone. The concentration of ozone in the operation field is 10 to 100 μg/ml (becomes a fungi, virus, and bactericide at the intensity of 1–5 μg/ml). There is no closed circuit here, therefore, ozone can be applied to the places that are difficult to reach, e.g. gingival pockets or root canals.

Product photo (Prozone) by W&H –

Prozone ensures a hygienic procedure during the gassing of the pockets due to its exchangeable plastic attachments (Perio tips or Endo tips).

ROUTES OF ADMINISTRATION

Gaseous ozone - Ozone can be used in gaseous form via an open system or via a sealing suction system to avoid inhalation and its adverse effects.

Ozonated water - Ozonated water has been shown to be very effective against bacteria, fungi and viruses. **Ozonized oil** - In addition to gaseous and aqueous form, oils that are ozonized also seems extremely convenient. Though gaseous ozone was shown to have more effective microbicidal properties than aqueous form, due to its toxic effects if inhaled, ozonated water is the most preferred form for use in dentistry. Therefore a safe system for applying gaseous ozone into the periodontal pocket that avoids inhalation still needs to be developed. [11]

OZONE THERAPY IN PERIODONTICS:

Ozonated water (4 mg/l) is effective in killing gram-positive and gram-negative oral

microorganisms and oral Candida albicans in pure culture as well as bacteria in plaque biofilm and therefore it can be used as a mouth rinse to control oral infectious and microorganisms in dental plaque. Thanomsub et al. 2002 tested the effects of ozone treatment on cell growth and ultra-structural changes in bacteria (Escherichia coli , Salmonella sp., Staphylococcus aureus and Bacillus subtilis). It was discovered that ozone at 0.167 mg/min/l can be used to sterilize water, which is contaminated with up to 105 cfu/ml bacteria within 30 min. Destroying of bacterial cell membrane was observed, subsequently producing intercellular leakage and eventually causing cell lysis. These ozone concentrations have no significant effect on the cell viability in bacterial cultures at higher concentrations of 106 and 107 cfu/ml.[12] Ebensberger et al. in 2002 evaluated the effect of irrigation with ozonated water on the proliferation of cells in the periodontal ligament adhering to the root surfaces of 23 freshly extracted completely erupted third molars. The teeth were randomly treated by intensive irrigation with ozonated water for 2 min or irrigation with a sterile isotonic saline solution, serving as a control group. The periodontal cells of these teeth were studied immune histochemically to mark proliferating cell nuclear antigen. It was observed that the labeling index (the number of positive cells compared to the total number of cells suggesting enhancement of metabolism) was higher among the teeth irrigated with ozone (7.8% vs. 6.6%); however, the difference was not statistically significant (P = 0.24). They concluded that the 2 min irrigation of the avulsed teeth with non-isotonic ozonated water might lead not only to a mechanical cleansing, but also decontaminate the root surface, with no negative effect on periodontal cells remaining on the tooth surface.[13] Nagayoshi et al. 2004 tested the efficacy of ozonated water on survival and permeability of oral micro-organisms. Gram negative bacteria, such as Porphyromonas endodontalis d Porphyromonas gingivalis substantially more sensitive to ozonated water than gram positive oral streptococci and c. albicans in pure culture. Furthermore ozonated water had strong bactericidal activity against bacteria in plaque biofilm. In addition, ozonated water inhibited the accumulation of experimental dental plaque in vitro.[14] Ramzy et al. in 2005 irrigated the periodontal pockets by ozonized water in 22 patients suffering from aggressive periodontitis. Periodontal pockets were irrigated with 150 ml of ozonized water over 5-10 min once weekly for a clinical 4 weeks study using a blunt tipped sterile plastic syringe. High significant improvement regarding pocket depth plaque index gingival index and bacterial count was recorded related to quadrants treated by scaling and root planing together with ozone application. They also reported significant reduction in bacterial count in sites treated with ozonized water. [15]

Huth et al. in 2006, in their study declared that the aqueous form of ozone, as a potential antiseptic agent, showed less cytotoxicity than gaseous ozone or established anti microbials (chlorhexidine digluconate [CHX]: 2%, 0.2%; sodium hypochlorite 5.25%, 2.25%; hydrogen peroxide-H 2 O 2 3%) under most conditions.

Thus the aqueous ozone fulfills optimal cell biological characteristics in terms of biocompatibility for oral application.[16]

Muller et al. in 2007 compared the influence of ozone gas with photodynamic therapy (PDT) and known antiseptic agents (2% chlorhexidine, 0.5 and 5% hypocholrate solutions) on a multispecies oral biofilm in vitro. Actinomyces naeslundii, Veillonella dispar, Fusobacterium nucleatum, Streptococcus sobrinus, Streptococcus oralis lbicans were studied. Gasiform ozone was produced by vacuum ozone delivery system Kavo Healozone. They concluded that the matrix-embedded microbial populations in biofilm are well protected towards antimicrobial agents. Only 5% hypochlorate solution was able to eliminate all bacteria effectively. Usage of gasiform ozone or PDT was not able to reduce bacteria in the biofilm.[17]

Brauner has demonstrated that the combination of professional tooth cleaning and daily rinsing of the mouth with ozone water can improve clinical findings in cases of gingivitis and periodontitis. Plaque indices and a tendency to bleed, however, quickly return if the professional measures are interrupted. Rinsing the mouth with ozone water without any mechanical procedures for plaque reduction were unsuccessful.[18]

Kshitish and Laxman in 2010 conducted a randomized, double-blind, crossover split-mouth study on 16 patients suffering from generalized chronic periodontitis. The study period of 18 days was divided into two time-intervals, i.e., baseline (0 days) to the 7 th day, with a wash out period of 4 days followed by a second time-interval of 7 days. Subgingival irrigation of each half of the mouth with either ozone or chlorhexidine was done at different time intervals. They observed a higher percentage of reduction in plaque index (12%), gingival index (29%), and bleeding index (26%) using ozone irrigation as compared to chlorhexidine. The percentile reduction of Aggregatibacter actinomycetemcomitans (Aa.) (25%) using ozone was appreciable as compared to no change in Aa occurrence using chlorhexidine. By using O 3 and chlorhexidine, there was no anti-bacterial effect on Porphyromonas gingivalis (Pg) and Tannerella forsythensis. The anti-fungal effect of ozone from baseline (37%) to 7 th day (12.5%) was pronounced during the study period, unlike CHX, which did not demonstrate any anti-fungal effect. No anti-viral property of ozone was observed. The anti-viral efficacy of chlorhexidine was better than that of ozone. They concluded that despite the substantivity of chlorhexidine, the single irrigation of ozone is quite effective to inactivate microorganisms.

Contraindications For Ozone Therapy:

The following are contraindications of ozone therapy

1. Pregnancy
2. Glucose- 6- phoshate dehydrogenase deficiency (favism)
3. Hyper thyroidism
4. Severe anemia
5. Severe myasthenia
6. Active hemorrhage

Ozone Toxicity:

Overwhelming evidence shows that the bronchial-pulmonary system is very sensitive to ozone and this gas should never be inhaled. The respiratory tract lining fluid is constituted by a very thin, watery film containing a minimal amount of antioxidants that makes mucosal cells extremely vulnerable to oxidation. Pulmonary embolism, which occurred during direct intravenous administration of O 2 /O 3, an application prohibited by the European Society of Ozone therapy since 1983. [19] Known side effects are epiphora and upper respiratory irritation, rhinitis, cough, headache, occasional nausea, and vomiting.

CONCLUSION

In contrast with traditional medicines and modalities such as antibiotics and disinfectants, ozone therapy is quite inexpensive, predictable and conservative. The ozone therapy has been more beneficial than present conventional therapeutic modalities. Treating patients with ozone therapy lessens the treatment time with an immense deal of variation and it eradicates the bacterial count more specifically. It is completely painless and increases the patients' acceptability and compliance with minimal adverse effects. Although more clinical research has to be done to standardize indications and treatment procedures of ozone therapy, still many different approaches are so promising, or already established, that hopefully the use of ozone therapy becomes a standard treatment for disinfection of an operation sites in dentistry.

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