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Review Article

Ozone in Dentistry- A review

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ABSTRACT:
Ozone therapy has a wide range of applications in treating various diseases owing to its unique properties including antimicrobial, immunostimulant, analgesic, anti-hypnotic, detoxicating, bioenergetic and biosynthetic actions. The present article covers various uses of ozone in dentistry.
Key words: Ozone, Endodontics, Periodontics

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INTRODUCTION

Ozone (O3) is a natural gaseous molecule made up of three oxygen atoms. The word ozone originates from the Greek word ozein, which means odor and was first used in 1840 by German chemist Christian Friedrich Schonbein ‘‘The father of ozone therapy.” The stratosphere layer of the atmosphere contains abundance of ozone and it protects the living organisms from the ultraviolet rays. Ozone is heavier than air and hence it falls downward to earth from such high altitudes. It cleanses the air and combines with any pollutant that it comes in contact. This is earth’s natural way of self-cleansing. Ozone therapy can be defined as a versatile bio-oxidative therapy in which oxygen/ozone is administered via gas or dissolved in water or oil base to obtain therapeutic benefits.[1]

HISTORY

In 1839, Christian Friedrich Schonbein, first noticed the emergence of a pungent gas with an electric smell. According to the Greek language, he called it ozone and presented a lecture entitled “On the smell at the positive electrode during electrolysis of water” at the Basel Natural Science Society. Oxygen/ozone therapy has a long history of research and clinical application with humans. The first medical application was in 1870 when Dr. C. Lender purified blood in test tubes. Medical applications became widespread throughout Europe and America. As of 1929, more than 114 diseases were listed for treatment with oxygen/ozone therapy. Interestingly enough, in 1930, a German dentist, Dr. E.A. Fisch, used ozone on a regular basis in his dental practice in Zurich, Switzerland, and published numerous papers on the subject.[2]

OZONE THERAPY: CHEMISTRY AND APPARATUS

Ozone (O3) is a triatomic molecule, consisting of three oxygen atoms. Its molecular weight is 47, 98 g/mol and thermodynamically highly instable compound that, dependent on system conditions like temperature and pressure, decompose to pure oxygen with a short half-life. Ozone is 1.6-fold denser and 10-fold more soluble in water than oxygen. Although ozone is not a radical molecule, it is the third most potent oxidant after fluorine and per sulfate. Ozone is an unstable gas that cannot be stored and should be used at once because it has a half-life of 40 min at 20 °C. Ozone (O3) is naturally produced by the photo dissociation of molecular oxygen (O2) into activated oxygen atoms, which then react with further oxygen molecules. This transient radical anion rapidly becomes protonated, generating hydrogen trioxide (HO3), which, in turn, decomposes to an even more powerful oxidant, the hydroxyl radical (OH). It is the fundamental form of oxygen that occurs naturally as a result of ultraviolet energy or lightning, causing a temporary recombination of oxygen atoms into groups of three. In the clinical setting, an oxygen/ozone generator simulates lightning via an electrical discharge field. 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 and have been indicated for the treatment of 260 different pathologies.[3]

MECHANISM OF ACTION

Ozone therapy has a wide range of applications in treating various diseases owing to its unique properties including antimicrobial, immunostimulant, analgesic, antihypnotic, detoxicating, bioenergetic and biosynthetic actions.

ANTI-MICROBIAL EFFECT

Ozone causes inactivation of bacteria, viruses, fungi, yeast and protozoa. It disrupts the integrity of the bacterial cell envelope by oxidation of phospholipids and lipoproteins. Ozone at low concentration of 0.1 ppm, is sufficient to inactivate bacterial cells including their spores. In fungi, O3 inhibits cell growth at certain stages, budding cells being the most sensitive. With viruses, the O3 damages the viral capsid and upsets the reproductive cycle by disrupting the virus-to-cell contact with peroxidation.[4]

MECHANISM OF ACTION OF O3 ON THE HUMAN LUNG

Ozone exposure induces a significant mean decrement in vital capacity. It significantly increases mean airway resistance and specific airway resistance but does not change dynamic or static pulmonary compliance or viscous or elastic work. It also significantly reduces maximal transpulmonary pressure. And further more significantly increases respiratory rate and decreases tidal volume.[5]

ACTIVATION OF IMMUNE SYSTEM

Ozone administered at a concentration of between 30 and 55 lg/cc causes the greatest increase in the production of interferon and the greatest output of tumor necrosis factor and interleukin-2 that launches an entire cascade of subsequent immunological reactions.

STIMULATION OF OXYGEN METABOLISM

Ozone therapy causes an increase in the red blood cell glycolysis rate. This leads to the stimulation of 2,3-diphosphoglycerate leading to an increase in the amount of oxygen released to the tissues. Ozone activates the Krebs cycle by enhancing oxidative carboxylation of pyruvate, stimulating production of ATP. It also causes a significant reduction in NADH and helps to oxidize cytochrome C.

DENTAL APPLICATION OF OZONE

The potential application of ozone therapy in human body and its biological horizons. Antimicrobial effect of ozone is the most studied. Oxygen/ozone therapy in dentistry contains a multiplicity of protocols to deal with dental infection. Three fundamental forms of application to oral tissue are applied- (1) ozonated water, (2) ozonated olive oil, and (3) oxygen/ozone gas. Ozonated water and olive oil have the capacity to entrap and then release oxygen/ozone, an ideal delivery system. These forms of application are used singly or in combination to treat dental disease.[6]

MODES OF OZONE ADMINISTRATION

The European Cooperation of Medical Ozone Societies warns from direct intravenous injections of ozone/oxygen gas that should not be practiced due to the possible risk of air embolism.

OZONE GAS APPLICATION

Ozone generating equipment converts oxygen to ozone. The ozone is thereafter led to a hand piece fitted with a silicone cup. Differently shaped silicone cups are available that correspond to the form of various teeth and their surfaces. This ensures close contact between the silicone cup and the carious area of the tooth so that the ozone does not escape. The ozone is led through the silicone cup over the tooth for a minimum of 10 seconds. The ozone in the silicone cup is collected again and reconverted to oxygen by the apparatus.[7]

OZONE AQUEOUS SOLUTION

The following properties of ozone are used in this case:

Disinfectant and sterilizing effect, Hemostatic effect, especially in cases of hemorrhages; Accelerated wound healing, improved oxygen supply and support of metabolic processes.

OZONE OIL

Ozonated oils are pure plant extracts, through which pure oxygen and ozone are passed. The plant extracts undergo a chemical reaction to form a thick, viscous oil, or in some cases, a petroleum jelly-like product. The final products contain ozonides. This method of external application is harmless.[8]

USES IN ORAL SURGERY

Ozone is known to encourage wound healing as well as control opportunistic infection. It was shown that daily treatment with ozonized water accelerates the physiological healing rate. In a study which compared the use of ozonated oil in an experimental group to a control group in which antibiotic therapy was used in the treatment of alveolitis, it was found that patients treated with ozonated oil healed more quickly. Ozone was used in the treatment of avascular osteonecrosis of the jaw (ONJ). There was complete healing of the lesions with the disappearance of symptoms.[9]

USES IN ORAL MEDICINE

Herpes lesions have been studied with topical ozone administration. Ozonated oil applied on herpes labialis and mandibular osteomyelitis demonstrated faster healing times than conventional protocols. Ozone, in these cases, neutralizes herpes virions by direct action, thus inhibiting bactericidal supra-infections, and stimulating the healing of tissues through circulatory prompting. Ozone has been proven to be one of the most powerful oxidants we can use in dentistry. In patients suffering from carinomatous lesions, chemotherapy and radiotherapy are routinely administered and it invariably causes mucositis. Ozone therapy applied in both aqueous and gaseous forms in cases of mucositis has shown positive results, enabling the patient to eat normally, and improves the quality of life during oncological therapeutic interventions.[10]

USES IN PEDODONTICS

The basic actions of ozone in almost all branches of dentistry have been discussed so far. The applications of ozone therapy in a pediatric practice rely mainly on the fact that ozone application is a very quick, effective, easy and especially a painless procedure to perform. These aspects of the treatment not only enhance the operator efficiency but also effectively improves the patient compliance and tolerance to the treatment procedure. Attaining a positive rapport with a child patient is the key to a successful pediatric treatment which can be very effectively accompanied by using ozone therapy.[11]

USES IN PROSTHODONTICS

Dentures are commonly inhabited by several micro-organisms especially C. albicans. Denture stomatitis is routinely encountered in clinical practice which is a manifestation of plaque accumulation on the surface of the denture and hence effective denture plaque control should be initiated to prevent such outcomes. One successful method to do so is the use of ozone as denture cleaner. It is effective against various microbes adhering on the denture surface including C. albicans methicillin-resistant S. Aureus and viruses. It has also been reported that ozone can be applied for cleaning the surface of removable partial denture alloys without compromising the physical properties of the alloy such as reflectance, surface roughness, and weight.[12]

USES IN ORTHODONTICS

Teeth bonded with bonding material are reported to have been affected by some form of enamel opacity after orthodontic treatment; diffuse opacity being the most common type identified. Also visible white spot lesions have been seen to develop within 4 weeks of orthodontic treatment. Although enamel bracket interface is the most susceptible area for white spot lesion formation, microleakage can invade beneath the bracket.[13]

USES IN ENDODONTICS

Germs, often from carious processes, enter the tooth and progress deeper into the pulp or ‘nerve'. There are multiple lateral canals and a periapical space that can all be inhabited by pathogenic bacteria. Conventional endodontic therapy does not reach into all the microtubules and interstices which may harbor bacteria and their toxins. Ozone offers some of the best results seen to date in the treatment of internal tooth infections. Enterococcus faecalis has been implicated as a major causative factor in endodontic disease and is particularly resistant to sodium hypochlorite, the antimicrobial most commonly employed in endodontic (root canal) therapy. Ozone has been shown to be effective in eliminating this organism as well as all others including viruses and fungi found inside roots.[14]

Ozone therapy is used as an atraumatic treatment modality in dental practice. Some of the in vitro studies with short-term follow-up assessed the effect of ozone on pit and fissure caries and primary root caries with results showing significant reductions in the number of microorganisms in the carious lesions. In small, non-cavitated lesions showed a greater reduction in number of microorganisms after the application of ozone than did larger lesions, and lesions closer to the gingival margin also showed less reduction in the number of microorganisms.

Tooth structure loss occurring due to multiple factors like attrition, abrasion, erosion, trauma from occlusion may cause wearing away of enamel and dentin thereby causing hypersensitivity. Ozone application has been found to effectively reduce sensitivity of not only exposed enamel and dentin but also in cases of root sensitivity. 40–60 seconds application of ozone is found to instantly reduce pain in these sensitive teeth. Ozone initiates removal of the smear layer, opens the dentinal tubules and widens them.[15]

Ozone is the most effective in cases of shallow lesions since it shows enhanced ability to penetrate lesions which are about 1mm deep at the maximum. The ozone unit must also be used correctly; the ozone cap must be held directly against the caries lesion allowing the ozone to penetrate the decay and biofilm. Where there is a cavitated 4mm deep root caries lesion adjacent to the gingival margin, simply using ozone treatment would probably not suffice. To manage this kind of a situation the outer caries must first be removed, leaving about 1 mm of caries over the cavity floor. Then the ozone treatment followed by routine restoration is indicated.[16]

Deep pits and fissures are difficult to clean and hence are highly likely to cause food lodgement resulting in bacterial growth. Ozone application in such cases has been found to be highly effective. After the ozone treatment, application of remineralizing agent and sealing of the clean fissures is encouraged. Ozone removes the smear layer leaving behind the exposed dentin that is occluded by the remineralizing agent applied.

USES IN PERIODONTICS

Periodontal (gum) disease is most commonly associated with halitosis. It ultimately results in the loosening and loss of teeth. This goes FAR beyond being just a dental problem. The infective process can easily lead to a lesion wrapping around the roots of the teeth in a highly contaminated area. Upon adding up all the pustulent, raw tissue it can quickly sum up to the surface area of the palm of the hand or even the entire forearm. The only saving grace is the lesion is generally hidden. If a patient walked into your office with a fungating lesion over half the face, it would probably demand immediate attention. But with periodontal attack, there's rarely no pain until the very end stages, so it's frequently out-of-sight, out-of-mind.[17]

Nevertheless, a large percentage of your patients present with periodontal lesions that leads to constant germ cascade directly into the entire circulation. Beyond direct infection, this incursion is highly inflammogenic and, among other consequences, attacks the endothelium of all vessels. Once damaged, the endothelium then admits pathogenic organisms into the intima and the stage is now set for atherogenesis.[18]

In a study by Nagayoshi et al[19] dental plaque samples were treated with 4 mL of ozonated water for 10 seconds. They observed that ozonated water was effective in killing gram-positive and gram negative oral microorganisms and oral C. albicans. This reflects its potential to control infectious micro-organisms in dental plaque.

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 O2/O3, an application prohibited by the European Society of Ozone therapy since 1983. Known side effects are epiphora and upper respiratory irritation, rhinitis, cough, headache, occasional nausea, and vomiting.[20]

CONCLUSION

Ozone is used in almost all aspects of dentistry. There are good evidence of ozone biocompatibility, and effectiveness in removing the microorganisms from dental unit water lines, the oral cavity, and dentures. Advantage of ozone therapy is it is an atraumatic, biologically based treatment. It is toxic when inhaled, and in intravenous administration.

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