



OZONE THERAPY IN DENTISTRY: A LITERATURE REVIEW

Mohamed Abdelhamid Ahmed Ali^{1*}, Hisham Abdelmonem Soliman², S. Kaynat Nizami³, Reshmi Chandra⁴, Himanshu Thukral⁵ and Anuv Hrishu Phukan⁶

¹BDS, MDS Oral & Maxillofacial Surgery, Toronto, Ontario, Canada.

²BDS, MsC, Periodontology, Oral Medicine and Oral Radiology, Alexandria, Egypt.

³BDS, CEO Confident Smiles Dental Clinic, Delhi.

⁴MDS Oral Medicine & Radiology, Pacific Dental College and Hospital Udaipur, Rajasthan.

⁵MDS, Oral & Maxillofacial Surgeon, CEO Sarita Dental Care, Delhi.

⁶MDS, Pedodontics, Phukan Dental Clinic, Tinsukia, Assam.

***Corresponding Author: Mohamed Abdelhamid Ahmed Ali**

BDS, MDS Oral & Maxillofacial Surgery, Toronto, Ontario, Canada.

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ABSTRACT

This review of literature is an attempt to summarize different modalities of ozone application in dentistry. Ozone gas has a high oxidation potential and is effective against bacteria, viruses, fungi, and protozoa. It also has the capacity to stimulate blood circulation, platelets, and immune response. Ozone is used in dentistry in gaseous, ozonated water and as ozonated oils. Ozone was shown to be biocompatible and is used in all aspects of dentistry. It has been shown to stimulate remineralization of recent caries-affected teeth and is used as a preventive therapy in caries, root caries, and intracanal irrigants in endodontic treatment. It has been used in treatment of alveolitis, avascular osteonecrosis of the jaw, and herpes virus infection. It also inhibits plaque formation and can be used as an adjuvant in periodontal surgical and maintenance phase. Ozone has also been used in dental unit water line to disinfect water. Advantage of ozone therapy is it is an atraumatic, biologically based treatment. While laboratory studies suggest a promising potential of ozone in dentistry, less number of clinical studies were documented. More number of randomized, controlled trials need to be conducted to determine the precise indications and guidelines to treat various dental pathologies with this promising medical agent.

KEYWORDS: Ozone in caries, ozone in dental clinics, ozone in dentistry, ozone in endodontics, ozone in oral surgery.

INTRODUCTION

The word Ozone (O₃) is derived from the Greek word ozein (odorant). Ozone is one of the most powerful antimicrobial agents available for use in medicine and dentistry. In the 1920s Dr Edwin Parr, a Swiss dentist, started to use O₃ as part of his disinfection system.^[1] Ozone therapy is a well established alternative and complementary therapy in most of the European countries. A systematic review was performed on studies investigating the effects of ozone on oral tissues and microorganisms and unveil the uses of ozone in dentistry in all aspects.

Effect on bacteria, virus, fungus, protozoa

Bacteria

Ozone acts on bacterial cell membranes, by oxidation of their lipid and lipoprotein components. There is evidence for interaction with proteins as well.^[2,3] Ozone seems to render the spores defective in germination, perhaps because of damage to the spore's inner membrane.^[4]

Virus

All viruses are susceptible to ozone; yet differ widely in their susceptibility.^[5] Lipid-enveloped viruses are especially sensitive to ozone.^[6,7] Analysis of viral components showed damage to polypeptide chains and envelope proteins impairing viral attachment capability, and breakage of viral RNA.^[5]

Fungal and protozoa

Ozone inhibits cell growth at certain stages.^[1]

Effect on blood cells

Ozone reduces or eliminates clumping of red blood cells and its flexibility is restored, along with oxygen carrying ability.^[8] There is a stimulation of the production of glutathione peroxidase, catalase and superoxide dismutase which act as free radical scavengers.^[9]

Effect on leukocytes

Ozone behaves as a weak cytokine such as tumor necrosis factor- α (TNF- α), interleukin-2, interleukin-6,

interleukin-8, transforming growth factor- β [TGF- β] inducer.^[10-13] Ozone reacts with the unsaturated fatty acids of the lipid layer in cellular membranes, forming hydrogen peroxides (H₂O₂), one of the most significant cytokine inducers.^[14]

Platelets

H₂O₂ generated by blood ozonation activate phospholipase C, phospholipase A₂, cyclo-oxygenases and lipoxygenases and thromboxane synthetase, allowing a step increase of intracellular Ca²⁺, release of prostaglandin E₂, prostaglandin F_{2a} and thromboxane A₂ with irreversible platelet aggregation.^[15-17]

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.^[18]

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 s. The ozone in the silicone cup is collected again and reconverted to oxygen by the apparatus.

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.

Advantages of topical ozone therapy

There is always a chance of development of resistance against antibiotic. Pathogens on the other hand, cannot overcome oxidative challenges of ozone.^[19] In addition, there is evidence that ozone directly inactivates bacterial toxins, while antibiotics do not. Indeed, toxins are major contributors to bacterial tissue destruction.^[19]

Biocompatibility of ozone

A study investigated cytotoxic effects of gaseous ozone and aqueous ozone on human oral epithelial (BHY) cells and gingival fibroblast (HGF-1) cells compared with established antiseptics chlorhexidine digluconate (CHX)

0.2%; sodium hypochlorite (NaOCl) 5.25%, 2.25%; hydrogen peroxide H₂O₂ 3%. Aqueous ozone revealed the highest level of biocompatibility of the tested antiseptics.^[20] The metabolic activity of L-929 mouse fibroblasts was high when the cells were treated with ozonated water, whereas that of significantly decreased when the cells were treated with 2.5% NaOCl.^[21] Irrigation of the root surface of avulsed teeth did not reveal a negative effect on periodontal ligament cell proliferation.^[22] Another study demonstrated that odontoblastic cells exhibited inflammatory responses against bacterial lipopolysaccharides (LPS). Ozonated water improved LPS-induced inflammatory responses.^[23]

Uses in oral medicine

Herpes lesions have been studied with topical ozone administration.^[24,25] Ozonated oil applied on herpes labialis and mandibular osteomyelitis demonstrated faster healing times than conventional protocols.^[18] Ozone, in these cases, neutralizes herpes virions by direct action, thus inhibiting bactericidal suprainfections, 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.^[26]

Uses in oral surgery

Ozone is known to encourage wound healing as well as control opportunistic infection.^[27] It was shown that daily treatment with ozonized water accelerates the physiological healing rate.^[18] 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.^[18] 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.^[28-31]

Uses in periodontia

Ozonated water inhibited the accumulation of experimental dental plaque in vitro.^[32] Ozonated water had strong bactericidal activity against bacteria in plaque biofilm. It was found that ozonated water (0.5–4 mg/L) was highly effective in killing of both gram-positive and gram-negative microorganisms. Gram-negative bacteria, such as *Porphyromonas gingivalis*, *Porphyromonas endodontalis* were more sensitive to ozonated water than gram-positive oral streptococci and *Candida albicans* in pure culture.^[32] One study concluded that the addition of ozone to a ultrasonic cleaning system containing different experimental solutions resulted in antibacterial activity against *Staphylococcus aureus*.^[33] Ozonated water has an excellent anti-inflammatory capacity.^[20,34,35] Researchers choose the NF-kappaB system, a paradigm for inflammation-associated signaling/transcription.

Their results showed that that NF-kappaB activity in oral cells in periodontal ligament tissue from root surfaces of periodontally damaged teeth was inhibited following

incubation with ozonized medium. The use of ozone around implants is supported by published research showing that ozone not only effectively sterilizes the surfaces of both the implant and bone, but also initiates the reparative mechanisms allowing tissue regeneration around implant surface.^[36,37]

Ozone toxicity

Overwhelming evidence shows that the bronchial-pulmonary system is very sensitive to ozone and this gas should never be inhaled.^[38] 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 Ozonotherapy since 1983.^[38] Known side effects are epiphora and upper respiratory irritation, rhinitis, cough, headache, occasional nausea, and vomiting.

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. It used in dentistry in 3 forms, gas, oil, and with water. Used as a preventive agent in pit and fissure caries and as a therapeutic agent in primary root caries. Used as an irrigating agent in endodontic, an adjuvant in periodontal surgical and maintenance phase. It must be clear that if we want to use ozone, we must avoid its toxicity by using a precise ozone generator, by collecting a precise gas volume with a defined ozone concentration. Limitation of this study is that most of the conclusions were assessed from in vitro studies due to paucity of clinical studies. Laboratory studies suggest a promising potential of ozone in dentistry. Future of ozone therapy must focus on the establishment of safe and well-defined parameters in accordance with randomized controlled trials to determine the precise indications and guidelines in order to treat various dental pathologies with this promising medical agent.

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