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# OZONE THERAPY IN DENTISTRY: BOON OR BANE

**[1]*Dr. Samarth Kumar Agarwal, [2]Dr. Romil Singhal, [3]Dr. Riya Gugale, [4]Dr. Prakhar Khurana, [5]Dr. Kumari Kalpana and [6]Dr. Amogh Gulwe**

[1,2]Professor, Department of Prosthodontics and Crown & Bridge, Kothiwal Dental College and Research Centre.
[3,4,5,6]Post Graduate Student, Department of Prosthodontics and Crown & Bridge, Kothiwal Dental College and Research Centre.

***Corresponding Author: Dr. Samarth Kumar Agarwal**
Professor, Department of Prosthodontics and Crown & Bridge, Kothiwal Dental College and Research Centre.
**Email ID:** dr.samarthagarwal@yahoo.co.in

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## ABSTRACT

Ozone therapy has successfully being used in the field of dentistry and medical for treatment since past. Ozone has unique properties that provide a wide range of application. Ozone can be applied in in aqueous, gaseous, and oily form in varied concentration. In dentistry it is used in various field like oral surgery, conservative dentistry, endodontics, orthodontics, oral medicine, prosthodontics, periodontics for various treatments and has shown to be biocompatible. This review of literature enlightens biocompatibility of ozone and application of ozone therapy in dentistry respectively.

**KEYWORDS:** Ozone, ozone therapy, application in dentistry, biocompatibility.

## INTRODUCTION

Ozone is a colorless gas form of oxygen. One of the most important gases in the stratosphere. Ozone is naturally occurring gaseous molecule made up of three oxygen atoms. It is an unstable gas and quickly gives up nascent oxygen molecules to form oxygen gas.[1] Ozone therapy is increasingly piquing the interest of healthcare professionals.[2] Introduction of oxygen/ozone therapy has truly revolutionized dentistry.[3] Because it is a chemical compound with high capacity for oxidative reactions that are lethal to bacteria, viruses and fungi, its therapeutic use is valuable.[2] This newer concept addresses the multifactorial infective states within the oral cavity in an effective, safe, non-toxic manner.[3] Ozone therapy can be applied to dental pathologies in patients of all ages, taking into account the form of administration. Ozone can be administered in three ways i.e, ozone gas, ozonated water and ozonated oil.[2] In the last decade a number of therapeutic protocols and studies have been developed to address common dental infections associated with periodontal disease, root canal therapy, caries, disinfection of denture surfaces, wound healing, and as antimicrobial, antiviral and antifungal agent in oral cavity.[1,3,4] Its molecular weight is 47.98g/mol.[5,6] 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.[6] The Ozone Generators work on one of the three principles: Ultra-violet light lamp, Corona discharge or Cold plasma.[7,8] Therefore, this review aimed to analyze its considerations and clinical application invarious treatment procedures in dentistry.

### Application/ Role/ Use of ozone therapy in dentistry

Ozone is developed into a new noninvasive tool for the treatment of diseases in medicine and dentistry.[3] The use of ozone has been proposed in dentistry because of its antimicrobial, disinfectant, biocompatibility and healing properties.[1]

**Ozone therapy in Oral Surgery:** Ozone has a positive influence on bone metabolism and reparative processes of the bone.[1,20,23] Ozone is known to encourage wound healing as well as control opportunistic infection.[15] Ozonated water was found to accelerate the healing of the wounds.[3,4,7,9,13,15,16,20] Use of ozonated water as a cooling and rinsing medium during surgical removal of third molar can reduce the occurrence of infection complications after the procedure.[1,4,25] Ahmedi et al. concluded that the ozone gas has a positive effect on reducing the development of dry socket and pain following third molar surgery depending on metabolic capabilities of ozone for promoting hemostasis, increasing the supply of oxygen, and inhibiting bacterial proliferation.[17] Ozone therapy is found to be beneficial for the treatment of the refractory osteomyelitis in the head and neck in addition to treatment with antibiotic, surgery and hyperbaric oxygen.[3,4,9,12,13,16,19,21,23] In patients with chronic mandibular osteomyelitis it was observed that medical ozone exposure promoted more complete and rapid normalization of non-specific resistance and T cellular immunity, thus accelerating clinical cure and reducing the incidence of complications.[1,7,19,20,23] Ozone therapy consisting of eight sessions lasting 3 minutes each besides antibiotics

and antifungal therapies in the management of bone necrosis or in extraction sites during and after surgery in patients treated with bisphosphonates may stimulate cell proliferation and soft tissue healing.[1,3,4,13,16] Akdeniz et al. concluded that ozone gas plasma therapy significantly decreased the genotoxic damage and this application provided 25%, 29%, and 27% less genotoxic damage, respectively, in bisphosphonate groups and improved the wound closure rate on human gingival fibroblasts.[17] When a combination therapy of a course of antibiotics, surgery and ozone therapy was given to patients with osteonecrosis of jaw in patients with multiple myeloma there was a decrease in both the incidence of osteoradionecrosis of the jaw and the extent of the lesions.[1] Guerra et al. stated that the use of ozonated oil might be effective in the treatment of alveolitis.[8,15,20] Kazancioglu et al. concluded that ozone application effectively reduced postoperative pain; however, it had no effect on swelling and trismus.[17]

**Ozone therapy in Conservative Dentistry:** Ozone in gaseous and aqueous phase has a disruptive effect on cariogenic bacteria like *streptococcus mutans* and *streptococcus sobrinus*.[1] Aqueous form of Ozone was found to be less cytotoxic than gaseous Ozone.[13,16,21] Ozone is effective against microflora associated with root caries lesions.[9] Treatment of caries with ozone is simple, fast and involves little preparatory work. Ozone is applied in the lesion, wetted with the CurOzone remineralising wash and then the glass ionomer can be applied.[14] Ozone causes oxidation of bacterial cell wall and also leads to the oxidation of pyruvic acid to acetate and $CO_2$ due to which it is effective in the treatment of pit and fissure caries , root canal treatment and interproximal caries.[1,4,10,16,21] Ozone is delivered to the affected area through a special hand piece equipped with a silicon cup, which is kept in contact with the tooth to form a tight seal.[9,13,16,21] Ozone treatment alone or combined with a remineralizing solution was found to be effective for remineralization of pit, fissure caries, root caries and interproximal caries.[1,3,4] Ozone gas applied to carious lesions for a period of ten to 20 seconds in vivo resulting in the reduction of the number of microorganisms present in the lesions by 99%.[1,8] There is no deleterious effect on bond strength of resin-dentin bond.[1,4] Huth et al. concluded that ozone application significantly improved non-cavitated initial fissure caries in patients at high caries risk over a 3- month period.[7]

**Ozone therapy in Endodontics:** In endodontic treatment instead of using irrigation chemicals (NaOCl), Ozonated water can be used for irrigation.[3,13,14,16] A Japanese study (2004) demonstrated the antimicrobial activity of Ozone in root canal treatment without any tissue toxicity and used as an antimicrobial in endodontics.[3,7,13,16] Its antimicrobial action has been demonstrated against bacterial strains such as: *Micobacteria*, *Staphylococcus*, *Streptococcus*, *Pseudomonas*, *Enterococcus* and *Escherichia coli* (Seshi et al.), *Staphylococcus aureus* (Velano et al.), *Enterococcus faecalis* (Hems et al.), and *Candida albicans* (Arita et al.) using in vitro research models.[8,21] In endodontics, files lubricated with ozonated oils, gas and use of ozonated water is recommended instead of sodium hypochloride.[3,7,9,13,16] Before filling, a slow insufflation 45-60 sec into each canal should be done with concentration of Ozone using about 30 ml.[3,9,12,13,16] Ozonated oils like Ozonated sunflower oil, olive oil and ground nut oil was efficient in canal sterilization than the conventional irrigation by the Sodium hypochlorite and Sodium peroxide combination.[3,10,12,13,16] In a study on permeability of oral microorganisms and dental plaque, both gram +ve *Streptococci* and *Candida albicans* and gram –ve bacteria *Porphyromonas endodontalis* and *Porphyromonas gingivalis* were killed by Ozonated water (0.5-4 mg/l). Antibacterial effect on *Enterococcus Faecalis* was not reported even after 20 min.[3,13,16] Intra canal gas circulation of ozone at a flow rate of 0.5–1 l/min with net volume of 5 gm/ml for 2–3 min. Ozonated water can be used as an intracanal irrigant and in infected necrotic canals, ozonized oils can be used as an intra-canal dressing reducing the marked anaerobic odor emanating from infected teeth. Also when a root canal was disinfected by ozone water with sonification, the antimicrobial efficacy was comparable to 2.5% NaOCl.[7] Single visit treatment of infected root canals with and without ozone therapy has resulted in complete remission of periapical lesions.[3,13,16] Ozone is also used for bleaching of endodontically treated tooth.[9]

**Ozone therapy in Orthodontics:** Diffuse opacity, visible white spot lesions have been seen to develop within 4 weeks of orthodontic treatment.[7,17] Although enamel bracket interface is the most susceptible area for white spot lesion formation, microleakage can invade beneath the bracket in killing both gram positive and gram negative microorganisms. Gram negative being more sensitive as compared to gram positive bacteria.[7] Ghobashy et al. concluded that ozonized olive oil gel with traditional oral hygiene instructions had significantly lessen decalcification areas during the orthodontic treatment.[17] Ozone also has a strong oxidizing effect that might cause weak adhesions between tooth and resin due to the negative effect of oxygen inhibition of polymerization. Cehreli et al. revealed that ozone pretreatment of enamel did not have an effect on the shear bond strength of adhesive systems. Shear bond strength values of specimens in ozone group were even slightly higher.[17] Fixed orthodontic devices are particular retention niches for a cariogenic biofilms. Therefore patient undergoing an active orthodontic treatment must be regarded as high caries risk patient.[22]

**Ozone therapy in Oral Medicine:** The disinfectant and healing properties of ozone helped in treating soft tissue lesions.[3] Ozonated water or oils can treat lesions like Herpes, Aphthae, Removable denture ulcers, Cuts, Cheilitis, Candidiasis, Cysts, Mandibular Osteomyelitis and Traumatic wounds.[1,3] Ozone neutralizes herpes

virions by directly inhibiting bactericidal suprainfections, and also help in healing of the tissues through circulatory prompting.[3] Shenberg and Blum involved application of aqueous and gaseous ozone for mucositis secondary to chemotherapy and radiotherapy. Ozone in a gaseous form was provided at 40 to 60 sec per lesion. The gaseous ozone concentration was 2100 ppm, with a flow rate of ozone/air mix at 5 meter/sec. The aqueous solution of ozone bubbles and water is 2 to 4 ppm. The patient gargled with the aqueous solution for 1 to 2 minutes and responded positively, enabling her to eat normally eliminating pain, medication and improved the quality of life.[1] Holmes et al. treated patients with oral lichen planus by tissue insufflation, injection, cupping and ozonated oil applications with no markable adverse effects.[7] Clavo et al. concluded that there is a marked improvement in blood flow and oxygenation in tissues and positive outcome was found in head and neck tumors.[21]

**Ozone therapy in Prosthodontics:** Ozone was shown to be biocompatible and is used in all aspects of dentistry.[18] Microbial plaque collecting on the dentures is composed of several microbial organisms, primarily *C. albicans*.[1] Cleansing of dentures is fundamental to avoid denture stomatitis. The introduction of dentures to Ozonated water and ultrasonication had antimicrobial action against C. albicans. Gaseous ozone was demonstrated to be more beneficial for disinfection of dentures.[2,5] Ozone can be used for cleaning the surface of removable partial denture alloys with small affect on the quality of alloy in terms of reflectance, surface roughness, and weight.[3] The ozone gas is used to disintegrate the smear layer developed in shrink-wrap veneers temporization use to the presence of bacteria.[5] The application of the ozone to the TMJ locale with uncommon tests created for deep tissue incitement permits for get to profound tissue beneath the skin. Ozone application increases the oxygenation of muscle and cartilage tissue and the creation of anti-inflammatory effect. This can be utilized as a noninvasive treatment strategy in patients with TMD.[17] A sterile implant surface is necessary as a precondition for the fruitful treatment of periimplantitis. Ozone can effectively be connected with the available silicone glasses, where long supra-gingival abutments are found, two silicone glasses can be attached on the beat of each other to produce vacuum.[22]

**Ozone therapy in Periodontics:** Ozone in periodontics utilizes antimicrobial activity against the gram positive and gram negative microflora, infections and parasites.[11,21] Ozone acts as an bactericidal and healing agent in subgingival irrigants.[20,24] Ozone can also be used in periodontal pocket with different tips of generators, ozonated water, or ozonated oil.[11,17,24] Abundance gas is emptied by a small evacuator which is connected to the outlet valve.[16] Nagayoshi et al. stated that Gram -ve microscopic organisms (*Porphyromonas gingivalis, Porphyromonas endotalis*) was found to be more delicate to ozone than *streptococci* and *Candida albicans*. In addition, the ozonated water has solid bactericidal activity against *Streptococcus mutans* microbes within the plaque biofilm.[17] The study of impact of ozonated water on multiplication of cells in periodontal ligament has come about within the cleaning of root surface, without negative impact on the remaining periodontal cells on root surface. Additionally there's reduction within the plaque index, gingival record and bleeding index by utilizing ozone water system when compared to chlorhexidine.[16] Ozone application has been found to reduce sensitivity of exposed enamel and dentin along with root sensitivity.[7] Ozonated oils have shown improvement in acute necrotizing ulcerative gingivitis.[7]

**Ozone And Dental Unit Water Lines:** Dental unit water line (DUWL) contamination has become a concern. Water becomes stagnant when the units are not in use. Detachment of microorganisms, splatter, and aerosols from dental procedures may possibly infect health care personnel.[3,13] In the dental clinic, bioaerosols are an important consideration for infection control and occupational health, since infectious agents could be transmitted via aerosols to patients or staff in the confines of the dental unit. DUWL can be purified with ozone. Chlorhexidine and Povidone iodine showed similar effects in reducing the aerobic and anaerobic CFU's at all the three levels. Though Ozone showed lesser CFU reductions in both aerobic and anaerobic colonies. Preprocedural rinsing may also be of value in protecting patients and dental professionals from the transmissible diseases. In model dental unit water lines, Ozone achieved 57% reduction in biofilms and 65% reduction in viable bacteria inspite of being used in a very low dose and with a short time of application.[3,13,21] Szymanska identified moulds, bacteria, and yeasts in biofilms which are hazardous to the health care worker and other patients during treatment. Opportunistic pathogens were cultured from the mains water. Another study suggested that DUWL biocides may adversely affect adhesion of resin to enamel. Kohno et al. results revealed that, acidic electrolyzed water could be applied as an appropriate measure against bacterial contamination of the DUWL. Dental unit water lines are known to carry hard to remove biofilms inside them. Besides the bad odors coming out of these dirty water lines, the microbial biofilm may represent a source of infection to patients. Many studies showed almost complete disintegration and elimination of dental unit water lines biofilms with ozonated water.[5]

**Biocompatibility of Ozone[3,15]**

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 $H_2O_2$ 3%. Aqueous ozone revealed the highest level of biocompatibility of the tested

antiseptics. 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. Irrigation of the root surface of avulsed teeth did not reveal a negative effect on periodontal ligament cell proliferation. Another study demonstrated that odontoblastic cells exhibited inflammatory responses against bacterial lipopolysaccharides (LPS). Ozonated water improved LPS-induced inflammatory responses.

## CONCLUSION

Ozone can be used in various concentration in dentistry. Application of ozone therapy invarious field should be done cautiously.

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