International Journal of Recent Advances in Multidisciplinary Topics
Volume 4, Issue 9, September 2023
https://www.ijramt.com | ISSN (Online): 2582-7839


# Ozone Therapy: A New Approach in the Dentistry – A Review

Anil K. Tomer[1], Shaik Muzammil Taj[2*], Ayan Guin[3], Nivedita Saini[4], Ayushi Khandelwal[5], Priyansh Saxena[6], Martina George[7], A. Pritish Kumar Reddy[8]

[1]*Head of the Department, Department of Conservative Dentistry and Endodontics, Divya Jyoti College of Dental Science and Research, Ghaziabad, India*

[2,3,4,5,6,7,8]*Post Graduate Student, Department of Conservative Dentistry and Endodontics, Divya Jyoti College of Dental Science and Research, Ghaziabad, India*

***Abstract*: Use of ozone in dentistry has become a new and alternative approach to improve dental health care. Use of ozone with the biological and digital information various means of treatment options for the oral cavity have been emerged. Ozone is a stable form of oxygen which has an effective role in management of oral disease. This review mainly focuses on use of ozone in the oral health care management and its therapeutic potential and its clinical application in various specialties such as oral pathology, endodontics, oral surgery, prosthodontics, orthodontics, restorative dentistry, tooth mineralization, wound healing as a treatment of choice are reviewed.**

***Keywords*: antimicrobial, dentistry, immune stimulating, ozone, dental caries, disinfection, wound healing, tooth remineralization, root canal treatment.**

## 1. Introduction

Ozone helps in protecting living organisms from harmful ultraviolet rays. It helps in self-cleansing of environment naturally. Sun light and storm helps in forming ozone. Various pathology in dentistry can be prevented and cured by the use of ozone therapy. In general wellbeing of the individual and oral health are correlated. Ozone has been emerging as a new adjunct in oral therapy as the people are getting resistance to antibiotics. Patients' acceptability is more as it is non-traumatic, painless and non-invasive.

Ozone came into emergence first in 1839, Christian Friedrich Schonbein noticed pungent gas with an electric smell and called it as ozone, because of its smell in Greek. It was introduced in 1940. As it has a rich oxygen content ozone it is used as an alternative medical treatment that increases the content of oxygen in the body by introducing ozone to the body surfaces. The biological properties of ozone are antimicrobial, immune-stimulating and biosynthesis effects which can be used in treating and maintaining good oral hygiene. Dr. EA Fisch first used ozone in dental treatment.

## 2. Ozone Generation Systems

Ultraviolent system, cold plasma system and corona discharge system are the three ozone generating systems used.

### *A. Ultraviolet System*

At 185nm wavelength ultraviolet light is emitted from the system producing ozone by disrupting the oxygen molecule and splitting it into two oxygen atoms. When exposed to ultraviolet rays in the ground state the oxygen molecules absorb light and gets dissociated. And then two oxygen atoms gets attached to another oxygen molecule. The attachment of the third oxygen atom creates ozone.

### *B. Cold Plasma System*

In this system, at 20 ºC gas is ionized. The two electrodes separated by the dielectric barrier helps in ionization of oxygen gas. When the voltage jumps between anode to cathode the electrostatic field is formed this causes splitting of oxygen molecule in into the oxygen atoms which then recombines with the other oxygen molecules to form ozone.

### *C. Corona Discharge System*

When the oxygen is passed through corona discharge system plasma is created in which free oxygen atom is produced from the plasma which is free to attach with other oxygen molecules which in turn produces ozone. Handling of this device is easy and the ozone production rate can be controlled. Ozone is a 10 – fold more soluble in water than oxygen and is much potent oxidant. Ozone is mixed with oil i.e., mostly olive oil and ozone gas.

Oil and water containing ozone have the ability to entrap and then release oxygen, which might be the suitable delivery system with greater viscous solution like olive oil are used for the better shelf life of the drugs. The common treatment varieties of ozone in patient oral care are through incorporating ozone water, ozone gas and ozone with olive oil. Making use of any of these three forms or a mixture can be used in dental practice to deal with most of the oral infections. The ozonated water is one of the fine irrigation solutions for gingival sulcus, periodontal pockets and during elimination of debris from the infected root canal. Ozone in the gaseous form has the potential penetrate deep and reach the floor of the carious dentin, dentinal tubules or accessory root canals where in the application of

*Corresponding author: muzammil.taj7@gmail.com

antibiotic or disinfectant can't reach.

## 3. Action of Ozone

### *A. To prevent and protect clinical environment and working instruments*

Liquid Ozone can be used to rinse oral cavity before the dental treatment.it can also be used as dental chair water supply, piezo reservoir and during ultrasonic scaling as it helps the operator and the assistants from aerosol contamination.it also prevents biofilm in the inner and the outer flow of dental chair.

### *B. Antimicrobial effects of ozone*

Diseases associated with bacteria, fungi and viruses such as dental caries, gingival diseases and other lesions from the oral cavity can be cured with ozone. The destruction of cytoplasmic membrane of the cell takes place primarily due to ozonolysis and secondarily it creates oxidant effect by oxidation of proteins and cell organelles function which leads to change in intracellular contents. It has a strong antioxidant property. Cells are not damaged and the actions are non-specific and selective against microbial cells. Gram positive bacteria are highly sensitive to ozone when compared to gram negative organisms. It helps in removal of acidogenic bacteria that causes dental caries by disruption of their cell structure.

### *C. Immuno stimulation effect*

Immunocompetent cell proliferation and synthesis of immunoglobulin are stimulated due to the effects of ozone on the cellular and humoral immune systems. Microorganisms gets phagocytose due to the activation of macrophages which leads to increased production of cytokines as a sequela to other immune reactions.

### *D. Anti-hypoxic effect*

As ozone can increase the oxygen transporting capacity in blood by raising the partial pressure of oxygen in the tissue. It activates enzymes such as dehydrogenase, superoxide dismutase, catalases and peroxidase when given in low dose for multiple times.

### *E. Effects on biosynthesis*

Ozone helps in increasing the tissue regeneration and functional activity by increasing the ribosomes and mitochondria. It helps in secreting vasodilators such as nitric oxide, which causes the arteries and veins to dilate.

### *F. Tooth structure remineralization*

By opening the dentinal tubules in the inner surface of decayed tooth ozone enables the diffusion of calcium and phosphorous ions. Ozone induces tooth remineralization by acting on its organic substance.

### *G. Wound healing enhancement*

Ozone synthesizes proteins which help in cell growth and cell differentiation such as interleukins, prostaglandin, and leukotrienes which leads to reduction of inflammation and enhance wound healing. Ozone improves wound healing in ischemic zone after surgical interventions such as dental implant placement and tooth removal.

### *H. Indications of ozone therapy in oral cavity*

1. Ozonated water is used as rinse before the treatment, as disinfectant, as water supply in dental chair to reduce biofilm and in ultrasonic unit for oral prophylaxis.
2. Ozonated gas is used for placement of sealants, treatment of root surface caries and after cavity preparation and crown preparation to sterilize the prepared tooth.
3. Ozone solution is used in removing the debris from the root canals, as irrigating solution for deep gingival and periodontal pockets, and to treat various intraoral lesions such as candidiasis, denture induced stomatitis, aphthous ulcers.
4. Ozone is also used in teeth whiting procedures as an adjuvant with hydrogen peroxide with the help of ozotop unit for 4- 5 min.

### *I. Contraindications*

It is contraindicated in various systemic conditions such as pregnancy, myocardial infraction, hyperthyroidism, severe anemia, thrombocytopenia, immunocompromised patients, alcohol intoxication, Ozone allergy and hemorrhage.

## 4. Applications of Ozone

### *A. In prevention of dental caries*

Ozone can reduce the bacterial count of various anaerobic bacteria when delivered into the carious lesion by causing cellular toxicity and oxidization of cell organelles. The demonstration done by M. Nagayoshi is to see the effect of ozone on the bacterial plaque. After exposure of the sample to ozonated water, there was a significant decrease in the number of bacteria including S. mutans, the main pathogen of dental caries. In the period of experiment, a decrease in the viability of S. mutans bacteria by 58% was noted after exposure to 0.5 mg/L of ozonized water for 10 s, when using concentrations of 2 mg/L and 4 mg/L, the reduction of bacteria was 100%. Other bacterial survival is important in the cariogenic process, such as S. sobrinus, S. sanguis and S. salivarius and was recorded at a similar level to that of S. mutans. While controlling the infectious microorganisms in the dental plaque ozone has been suggested as helpful source in studies.

In the current scenario, the utilization of ozone in the dentistry has been tested as a treatment for cavities of carious origin. One such attempt was made by Aylin Baysan and Edward Lynch. Ozone was applied to root caries lesions. The study demonstrated a statistically significant reduction in the number of bacteria in the caries lesion, which led to a change in the disease process to a stage where it could be concluded that further progression had stopped. Overall, however, the research results are inconclusive. Experiments by other scientists have found no effect of ozone therapy in stopping or delaying the progression of the disease.

### *B. Pediatric dentistry*

Nowadays disinfection of deep carious cavities in pediatric dentistry in done by Ozone. It can be applied to the cavity after removal of soft, demineralized and infected dentin, which, together with the application of demineralizers, helps to prevent irreversible damage to the pulp.

### *C. Teeth whitening*

Ozone's oxidizing properties have inspired scientists to use it as an alternative whitening agent for stained teeth. Tessier et al. demonstrated that yellowing of the incisors of tetracycline-stained rats was reduced after application of ozone for a minimum of 3–4 min. However, more recent reports indicate that the above study should not be considered sufficient evidence of the effectiveness of ozone in removing these stains due to differences in the size and chemical composition of rat and human dentition, their pigmentation and application technique.

Compared to hydrogen peroxide, ozone has not been shown to be a more effective bleaching agent, which may be due to the pH-lowering hydroxyl radicals produced by hydrogen peroxide. A higher pH is associated with more effective teeth whitening

However, it is debatable that the synergistic effect of ozone on bleaching with the simultaneous use of hydrogen peroxide. In a study by Naik et al. this effect was not demonstrated, while another study, Al-Omiri et al., showed that the use of 38% hydrogen peroxide together with ozone provided an improved whitening effect. Even more recent studies attribute the superior bleaching effect of hydrogen peroxide in combination with ozone to the possibility that ozone can produce peroxide that can contribute to the formation of additional hydroxyl radicals, and this is thought to be independent of the use of ozone before or after $H_2O_2$.

### *D. Endodontics*

Endodontics is a branch of dentistry that has seen remarkable progress in recent years. With the help of modern instruments and advance diagnostic aids such as magnifying lenses and other aids we can achieve good outcome results. The use of ozone also played a role. Ozone as a gas can reach inaccessible areas that are difficult to disinfect with standard chemical-mechanical preparations. These include apical deltas, anastomoses, accessory or lateral canals, dentinal tubules and periapical regions. Recent studies have shown the effectiveness of ozonated water as a disinfectant against E. faecalis, Candida albicans, Peptostreptococcus micros and Pseudomonas aeruginosa. While further studies have stated the effectiveness of ozone against Streptococcus mutans, Candida albicans and Staphylococcus aureus. Lempe et al. demonstrated 100% effectiveness of ozone against E. faecalis. In addition, using ozone for 40 seconds in the root canal also eliminated symptoms such as swelling, pain and discharge in the root canal. The antimicrobial effect of ozone is comparable to 2.5% NaOCl, but unlike NaOCl, ozone is not toxic to tissues during endodontic treatment. In addition, ozone has been shown to reach the surrounding bone through the apical foramen, promoting bone regeneration and healing. Estrela et al. had contradicted the effectiveness of ozone in root canal disinfection in his report. In an in vivo study of infected human root canals, the authors showed that application of ozone gas may not be sufficient to eliminate E. faecalis.

### *E. Periodontology*

Ozone shows its antimicrobial properties on anaerobic bacteria that play a role in the pathogenesis of periodontitis. E. Dengizek et al studied the effects of ozone therapy in periodontal procedures such as scaling and root planning (SRP) procedures. Ozone aids in hemostasis and stimulates the release of certain growth factors and antioxidant enzymes. forty patients with chronic periodontitis were taken in the study. In the experimental group, SRP therapy and ozone were used, while the control group received SRP with a placebo. A number of parameters were evaluated, including PI, GI and CAL. After treatment, all the above-mentioned parameters were similar in the experimental and control groups, with no statistically significant differences. Isler et al. have reported the positive clinical results on the effect of ozone in his literature and on the effect of ozone on the decontamination of implant surfaces in peri-implantitis. Patients were randomly divided into either a control group, where sterile saline was used to decontaminate implant surfaces during peri-implantitis SRT, or an ozone group, in which ozone was additionally applied. The system used in the study was an ozone generator Ozone DTA. In the 3 month follow up between the groups there was a significant difference in PD values which were in favor of the ozone group ($p < 0.05$). Mc Kenna et al. has reviewed the patient with peri-implant mucositis and given them ozone therapy and reported the positive effect by reducing the plaque formation and delays the development of peri-implant disease. Diseases of the oral mucosa such as herpes simplex virus infections, recurrent aphthous stomatitis (RAS), angular cheilitis or candidiasis can be very difficult for both the patient and the doctor. Their chronic and recurrent nature requires specifically designed therapy and often long-term treatment. The authors of this literature review achieved spectacular success in the treatment of chronic recurrent canker sores with three two-minute applications of ozone and also in three applications of ozone therapy, herpes simplex virus.

### *F. Tooth sensitivity*

According to various research findings, ozone has the potential ability in opening the dentinal tubules. This property is used in the treatment of cervical hypersensitivity, because ozone gas allows the diffusion of calcium and phosphate ions after opening the tubules. The bacterial elimination from the dentinal tubules is aided by the penetration of zinc and fluoride ions. By the use Ozone therapy there is gradual healing of lesion which were induced by the poorly fitting prosthesis.

### *G. Dental implants*

Damaged tissue regeneration and simulation of wound healing is done with help of Ozone therapy in the recent era of dental surgeries. In implantology, ozone is used to decontaminate the implant before implantation. The positive

effects of ozone have also been described in the prevention of postoperative complications such as edema, granulation tissue, dry beds and bone necrosis. Ozone therapy has significantly reduced the post-operative pain where opioids used for analgesia couldn't provide the same result.

A case study by G. Batinjan et al. described about the ozone therapie's positive effect in cases of serial extraction wound healing and prevention of osteoradionecrosis (ORN) in high-risk patients. Treating the patient with ozone in three stages who are at high-risk for ORN has been described by the various researchers. The first step was a pre-operative ozone treatment to reduce the number of bacteria in the operating space to a minimum, when ozone gas was applied to the respective gum area for 40 minutes with the help of a gingival probe. The next step was ozonation of the alveoli after extraction. The entire procedure was finished with ozonization after suturing to stimulate circulation and accelerate healing. The patient's wounds underwent clinical evaluation, which clearly showed that healing was without complications or signs of Osteoradionecrosis.

Jehona Ahmedi et al has investigated the effects of ozone on tissue behavior and the post-operative algesia. In their study, aimed at evaluating the effectiveness of ozone gas in reducing the occurrence of dry bed after surgical extraction of mandibular third molars, the influence of the indication for extraction and the difficulty of the procedure on the occurrence of dry throat, they demonstrated that in the experimental group in which ozone was used, the occurrence of dryness was in the neck about five times lower than in the control group (3.33% and 16.67%, respectively). The extraction site in the experimental group was treated with ozone for 12 hours using the Prozone device, and the control group received saline. After analyzing the results of the treatment, the researchers concluded that the use of $O_3$ can reduce the incidence of dry sinuses and shorten the recovery time after treatment. Based on the studies, ozone is advised for all patients, particularly those who are at risk of having xerostomia following extraction.

Sila Cagri Isler et al. also observed accelerated healing and the absence of uneventful complications. They conducted a study using ozone therapy to decontaminate implant surfaces during surgical regenerative therapy (SRT) in 41 patients with moderate to advanced peri-implantitis. At the end of the 12-month follow-up, they observed significantly better results in terms of gingival pocket probing depth and level of clinical gingival tissue attachment. They also noted significantly better filling of bone defects on radiographs in the ozone group. The results suggest that decontamination of the implant surface with adjunctive ozone therapy in the surgical regenerative therapy of peri-implantitis has demonstrated clinical and radiological significance.

The authors of this manuscript apply ozone gas therapy prophylactically before and immediately after surgery to avoid post-extraction complications in the form of swelling, trismus, hematoma formation or increased skin temperature.

## 5. Conclusion

In recent years, research in the field of ozone therapy has been actively conducted and the use of ozone in specialized dental treatments has become possible, and we support the use of ozone therapy with objective knowledge.

Despite the body of evidence that proves the safety and positive results of ozone therapy, many doctors still consider the use of ozone as an alternative, redundant and sometimes uncertain measure. Studies and their results conducted in recent years provide evidence of ozone's important medical potential, and further research is aimed not only at finding new uses, but also at reconfirming and validating already known uses. Encourage research. Ozone therapy is primarily used as an adjunctive therapy to primary clinical or drug therapy. It is effective as a first-line treatment in some cases of oral mucosal disease. During the literature analysis, still research is needed to evaluated the results of ozone therapy in dentistry as the results are inconsistent in this field. The large volume of literature on the application of ozone in dentistry reflects the exploration of the unexplored potential of ozone as an intraoral and extraoral physiotherapy modality in dentistry.

## References


[1] Saini, Rajiv, Santosh Saini, and Sugandha Sharma. "Periodontal disease linked to cardiovascular disease." *Journal of Cardiovascular Disease Research*, vol. 1, no. 3 (2010): 161.

[2] Nogales, Carlos Goes, Patricia Helena Ferrari, Efraim Olszawer Kantorovich, and José Luiz Lage-Marques. "Ozone therapy in medicine and dentistry." *J Contemp Dent Pract*., 9, no. 4 (2008): 75-84.

[3] Beggs, Russell. "Reliable caries reversal: another paradigm shift." *Dentistry today*, vol. 23, no. 2 (2004): 14-16.

[4] Komali, G. "Ozone Therapy-A Revolutionary Noninvasive Therapy in Dentistry. 1: 473.

[5] Makkar, Sameer, and Monika Makkar. "Ozone-treating dental infections." *Indian Journal of Stomatology*, vol. 2, no. 4 (2011): 256.

[6] Saini, Rajiv. "Ozone therapy in dentistry: A strategic review." *Journal of natural science, biology, and medicine*, vol. 2, no. 2 (2011): 151.

[7] Kumar, Anil, Sharnamma Bhagawati, Prashant Tyagi, and Prince Kumar. "Current interpretations and scientific rationale of the ozone usage in dentistry: A systematic review of literature." *European Journal of General Dentistry*, vol. 3, no. 3 (2014): 175-180.

[8] Moore, Ginny, Chris Griffith, and Adrian Peters. "Bactericidal properties of ozone and its potential application as a terminal disinfectant." *Journal of food protection* 63, no. 8 (2000): 1100-1106.

[9] Lynch E., "Pain relief using the Heal Ozon system," eDentico. 2004; 134:3.

[10] Seidler, V., I. Linetskiy, H. Hubálková, H. Stanková, R. Smucler, and J. Mazánek. "Ozone and its usage in general medicine and dentistry. A review article." *Prague Med Rep*, vol. 109, no. 1 (2008): 5-13.

[11] Garg, R., and S. Tandon. "Ozone: A new face of dentistry." *Int J Dent Sci*. vol. 7, no. 2 (2009).

[12] Müller, Philipp, Bernhard Guggenheim, and Patrick R. Schmidlin. "Efficacy of gasiform ozone and photodynamic therapy on a multispecies oral biofilm in vitro." *European journal of oral sciences*, vol. 115, no. 1 (2007): 77-80.

[13] Kshitish, Durga, and Vandana K. Laxman. "The use of ozonated water and 0.2% chlorhexidine in the treatment of periodontitis patients: A clinical and microbiologic study." *Indian Journal of Dental Research*, vol. 21, no. 3 (2010): 341.

[14] Dodwad, Vidya, Sonakshi Gupta, Kiran Kumar, Mallika Sethi, and Sujata Masamatti. "Changing paradigm in pocket therapy-ozone vs conventional irrigation." *Int J of Public Health Dent*., vol. 2, no. 2 (2011): 7-12.

[15] Hayakumo, Sae, Shinichi Arakawa, Yoshihiro Mano, and Yuichi Izumi. "Clinical and microbiological effects of ozone nano-bubble water irrigation as an adjunct to mechanical subgingival debridement in periodontitis patients in a randomized controlled trial." *Clinical oral investigations*, vol. 17 (2013): 379-388.

[16] Shoukheba, M. Y. M., and A. Ali. "The effects of subgingival application of ozonated olive oil gel in patient with localized aggressive periodontitis.

A clinical and bacteriological study." *Tanta Dental Journal*, vol. 11, no. 1 (2014): 63-73.

[17] Azarpazhooh, Amir, Hardy Limeback, Herenia P. Lawrence, and Edward D. Fillery. "Evaluating the effect of an ozone delivery system on the reversal of dentin hypersensitivity: a randomized, double-blinded clinical trial." *Journal of endodontics*, vol. 35, no. 1 (2009): 1-9.

[18] Hauser-Gerspach, Irmgard, Jasminka Vadaszan, Irma Deronjic, Catiana Gass, Jürg Meyer, Michel Dard, Tuomas Waltimo, Stefan Stübinger, and Corinna Mauth. "Influence of gaseous ozone in peri-implantitis: bactericidal efficacy and cellular response. An in vitro study using titanium and zirconia." *Clinical oral investigations*, vol. 16 (2012): 1049-1059.

[19] Kushmakov, Robert, Jason Gandhi, Omar Seyam, Wendy Jiang, Gunjan Joshi, Noel L. Smith, and Sardar Ali Khan. "Ozone therapy for diabetic foot." *Medical Gas Research*, vol. 8, no. 3 (2018): 111.

[20] Bocci, Velio, Emma Borrelli, Valter Travagli, and Iacopo Zanardi. "The ozone paradox: ozone is a strong oxidant as well as a medical drug." *Medicinal research reviews*, vol. 29, no. 4 (2009): 646-682.

[21] Jordan, Liz, Kinta Beaver, and Sharon Foy. "Ozone treatment for radiotherapy skin reactions: is there an evidence base for practice." *European Journal of Oncology Nursing*, vol. 6, no. 4 (2002): 220-227.

[22] Domb, William C. "Ozone therapy in dentistry: A brief review for physicians." *Interventional neuroradiology*, vol. 20, no. 5 (2014): 632-636.

[23] Naik, Saraswathi V., K. Rajeshwari, Shivani Kohli, Sayyad Zohabhasan, and Shekhar Bhatia. "Suppl-1, M7: Ozone-A Biological Therapy in Dentistry-Reality or Myth." *The open dentistry journal*, vol. 10 (2016): 196.

[24] Gupta, G., and B. Mansi. "Ozone therapy in periodontics." *Journal of medicine and life*, vol. 5, no. 1 (2012): 59.