

Ozone in Dental Therapy: An Outlook

Jyoti P.,¹ Veeresh M. Nagathan,² Subramaniam M. Rao,³ Bheemappa F.B.⁴

ABOUT THE AUTHORS

1. Dr. Jyoti P. M.D.S.
Reader
Department of Periodontics
P. M. N. M. Dental College and
hospital, Bagalkot
India

2. Dr. Veeresh M. Nagathan M. D.
Professor
Department of obstetrics and
gynaecology
S. N. Medical College and H. S.
K hospital
Bagalkot, India
dr.nagathan@yahoo.com

3. Dr. Subramaniam M. Rao M.D.S.
Reader
Department of Periodontics
P. M. N. M. Dental College and
hospital, Bagalkot
India
drsubramaniamrao@gmail.com

4. Dr. Bheemappa F. B. M.D.S.
Senior Lecturer
Department of Oral &
Maxillofacial Surgery
P. M. N. M. Dental College and
hospital, Bagalkot
India
dr.bheemab@yahoo.com

Corresponding author -

Dr. Jyoti P.
Reader
Department of Periodontics
P. M. N. M. Dental college and
hospital, Bagalkot
Karnataka, India
Telephone no. +919448645903

E mail –
drjyotip1811@gmail.com

Abstract

Dentistry is in a continual battle with infection, soft tissue, and/or hard tissue. These infections come from bacteria, fungi, viruses, and parasites. An infection can be of a single organism or a combination of all the above. The use of ozone in dentistry is gaining place in every day's dental practise and is used in almost all dental applications with no toxicity and side effects. The undisputed disinfection power of ozone in dentistry is a very good alternative and/or additional disinfectant to standard antiseptics. Ozone therapy in dentistry is now the new standard of care in all disciplines of dentistry. Ozone therapy holds great potential as an atraumatic treatment modality to incorporate into dental practice.

Key words: Ozone, Ozone therapy, Ozone application

Introduction

Ozone (O₃) is a gas with a characteristic, penetrating odour that is present in small amounts in atmospheric air. Ozone molecules are composed of three oxygen atoms and present naturally in the upper layer of atmosphere in abundance as long as sun is shining.^{1,2,3} It protects living organisms by surrounding the earth at altitudes of 50,000 to 100,000 feet from the ultra-violet rays.^{1,4,5} As it falls downward to earth, being heavier than air, and combines with any pollutant it comes in contact, and cleans the air. It has many different applications in various fields; one of them is usage of ozone in medicine. Medical Ozone is made when medical grade oxygen is electrically activated (using an Ozone Generator) to form ozone.² It is a mixture of the purest oxygen and purest ozone. According to its application, the ozone concentration may vary between 1 and 100 g/ml (0.05-5%). The ozone therapist determines the complete dosage according to the medical/dental indication and the patient's condition.^{6,7}

Ozone is an unstable gas and it quickly gives up nascent oxygen molecule to form oxygen gas. The release of nascent oxygen has beneficial effects on every part and organ.¹ It has been used in medical field since long back due to its extremely strong oxidant property that oxidises nearly all surfaces to the highest oxidation stage. It is used as a circulatory enhancement and stimulation of oxygen metabolism, disruption of tumor metabolism and to kill pathogens.^{1,4} O₃ is a powerful oxidant capable of interacting as metabolic & immune modulator as well as anti-microbial agent. Multiple microbiological & the biochemical studies justified that there are no doubts about the effectiveness of ozone in bacterial reduction.⁸ Among other things, ozone is used to purify drinking water and water in dental equipment and for sterilising instruments for medical use.⁹ Although relatively simple as regards application forms and active mechanisms, the use of ozone in dental medicine developed very modestly.

BRIEF HISTORY

The German chemist Christian Friedrich Schönbein (1840), of the University of Basel in Switzerland is regarded as the Father of ozone therapy.^{6,10} When he passed an electrical discharge through water, a gas strange smell was produced, which he called

Ozone, derived from the Greek word ozein which means odor.^{1, 4, 5} In 1857 Joachim Hänsler, a German physicist and physician, along with German physician, Hans Wolff, developed the first ozone generator for medical use. Dr. C. Lender in 1870, for the first time applied Ozone into medical field. A German dentist, Dr. E.A. Fisch, in 1950 was the first dentist to use ozone on regular basis in his dental practice in Zurich, Switzerland and published numerous papers on its application. He used ozone to treat Ernst Payr, a renowned Austrian surgeon, who then became an ozone enthusiast and began a line of research dedicated to its use in healthcare. Numerous researchers since that time have worked to elucidate the nature and actions of ozone. It was not until the end of the 1980s, though, that medical ozone once more became a subject of dental research and dental practice.^{5, 11}

BIOLOGICAL ACTIONS OF OZONE

There are several known actions of ozone on human body, such as immunostimulating and analgesic, antihypoxic and detoxicating, antimicrobial, bioenergetic and biosynthetic (activation of the metabolism of carbohydrates, proteins, lipids) etc.⁵

1. The antimicrobial effect of ozone as a result of its action on cells by damaging its cytoplasmic membrane (oxidation of proteins-loss of organelle function) because of secondary oxidants effects. This action is non-specific and selective to microbial cells; it does not damage human body cells because of their major antioxidative ability.

2. Immunostimulating – ozone stimulates proliferation of immunocomponent cells and synthesis of immunoglobulins. At low concentration ozone reactivates immune system. Ozone causes the synthesis of biologically active substances such as interleukins, leukotrienes and prostaglandins which is beneficial in reducing inflammation and wound healing.

3. Ozone improves transportation of oxygen in blood, also it has the ability to stimulate the circulation is used in the treatment of circulatory disorders and makes it valuable in the revitalizing organic functions.

4. Ozone causes secretion of vasodilators such as NO, which is responsible for dilatation of arterioles and venules.

5. Ozone also helps in protein synthesis.

A high concentration of ozone kills bacteria very quickly and is thousand times more powerful than other bacterial killing agents. The average concentration of ozone used in treatments is 25 gm of ozone per millilitre of oxygen/ozone gas mixture that translates into 0.25 parts of ozone to 99.75 parts of oxygen. Evidence-based research has shown that at this concentration, ozone effectively kills bacteria, fungi, viruses and parasites. Studies have revealed that it only takes 10 sec to kill 99 % of bacteria, fungi and viruses.¹² It can oxidize many organic compounds and it is a powerful germicide.¹³ Some of the other effects are circulatory enhancement,

disruption of tumor metabolism and stimulation of oxygen metabolism.¹⁴

Systems for generating ozone gas:^{1, 4}

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.

Forms of application of ozone in dentistry^{6, 7}

1. **As an infusion into infected jaw bone (cavitation).**
 2. **As an infusion into the temporomandibular joint for the treatment of pain and inflammation.**
 3. **As an irrigant during new root canal therapy [RCT] to disinfect the involved tooth.**
 4. **Adjunctive therapy with the use of Ozonated Olive Oil for periodontal disease.**
-

In dentistry, ozone has got its role in various dental treatment modalities. The main use of ozone in dentistry is relies on its antimicrobial properties. It is proved to be effective against both Gram positive and Gram negative bacteria, viruses and fungi. Ozone therapy presents great advantages when used as a support for conventional treatments. Indications^{1, 6} and contraindication^{1, 4, 5} for the use of ozone in various dental procedures [refer Table 1]

OZONE THERAPY IN PROSTHODONTICS

Microbial plaque accumulating on the dentures is composed of several oral microorganisms, mainly *C. albicans*. Denture plaque control is essential for the prevention of denture stomatitis. In an attempt to solve this problem Arita et al. assessed the effect of ozonated water in combination with ultrasonication on *C. albicans*. Following exposure to flowing ozonated water (2 or 4 mg/l) for one minute they found no viable *C. Albicans* suggesting the application of ozonated water might be useful in reducing the number of *C.albicans* on denture bases.¹⁵

OZONE THERAPY IN ORAL SURGERY

The influence of ozonized water on the epithelial wound healing process in the oral cavity was observed by Filippi. It was found that ozonized water applied on the daily

Table 1: Indication and contraindication of ozone in various dental procedures

Indications	Contraindications
Prophylaxis and prevention of dental caries.	Pregnancy
Remineralisation of pit and fissure, root and smooth surface caries.	Glucose-6-phosphate-dehydrogenase deficiency (favism).
Restoration of open cavitations along with conventional conservative measures.	Hyperthyroidism.
Bleaching of discoloured RCT teeth.	Severe anaemia.
Endodontic treatment.	Severe myasthenia.
Desensitization of sensitive tooth necks.	Acute alcohol intoxication
Soft tissue pathoses.	Recent myocardial infarction.
The treatment of infected, badly healing wounds and inflammatory process.	Haemorrhage from any organ.
	Ozone allergy.

basis can accelerate the healing rate in oral mucosa. This effect can be seen in the first two postoperative days. The comparison with wounds without treatment shows that daily treatment with ozonized water accelerates the physiological healing rate.¹⁶ Patients treated with ozone got healed more quickly without the need for systemic medication when compared to the control group. This finding suggested ozonated oil might be effective in the treatment of alveolitis.¹⁷ Application of ozone therapy after tooth extraction and in case of post-extraction complications, was found quite useful.¹⁸

OZONE THERAPY IN ENDODONTICS

Current research has been focused on determining guidelines for ozone use. The principle line of study has evolved using the ozone to determine its effect on several kinds of caries (pit and fissure¹⁹ noncavity²⁰, and primary root caries^{19, 21, 22, 23}). The oxidative impact on this microbiota has been recognized in several studies; however, there is a divergence of opinion regarding the amount of time that ozone gas should be applied. One study suggests application of ozone gas for a period of 10 to 20 seconds resulted in 99% of the microorganisms being destroyed^{22, 23}. Another report states 40 seconds of application was insufficient to decontaminate the area and failed to act on underlying infected dentin²⁴. Interesting data shows ozone does not affect the sealing ability of the bonding-system. Ozone therapy was also used in prevention of dental caries in fissures of the first permanent molars in children.¹⁷ An interesting data shows ozone does not affect the sealing ability of the

bonding-system²⁵. Polymicrobial infections complicate cases of apical periodontitis. As a result, current research is focused on finding treatment solutions with a high antimicrobial effect while minimizing injury to the periapical tissues. The oxidative power of ozone characterizes it as an efficient antimicrobial and its indication for use in endodontic therapy seems quite appropriate. Its antimicrobial action has been demonstrated against bacterial strains such as: Mycobacteria, Staphylococcus, Streptococcus, Pseudomonas, Enterococcus and E. Coli^{26, 27} S. aureus²⁸, E. Faecalis^{29, 30} and C. albicans¹⁵ using in vitro research models. The ozone showed effectiveness over most of the bacteria found in cases of pulp necrosis, but not when the bacteria are organized in biofilm²⁰ in vitro studies.

Bleaching¹

In root canal treated teeth, crown discoloration is a major aesthetic problem, especially in anterior teeth. Conventional walking bleaching requires much more time and results are not often satisfactory. Also, capping the tooth with ceramic crown is not always a good idea. But, now ozone has the answer to all these questions. After placing the bleaching agent into the inner of the tooth, the crown is irradiated with ozone for minimum of 3-4 minutes. This ozone treatment bleaches the tooth within minutes and gives the patient a happy and healthier-looking smile.

Desensitization of Sensitive Root Necks¹

Quick and prompt relief from root sensitivity has been documented after ozone spray for 60 seconds followed by mineral wash onto the exposed dentine in a repetitive manner. This desensitization of dentine lasts for longer period of time. Smear layer present over the exposed root surface prevents the penetration of ionic Calcium and Fluorine deep into the dentinal tubules. Ozone removes this smear layer, opens up the dentinal tubules, broadens their diameter and then Calcium and Fluoride ions flow into the tubules easily, deeply and effectively to plug the dentinal tubules, preventing the fluid exchange through these tubules. Thus, ozone can effectively terminate the root sensitivity problem within seconds and also lasts longer than those by conventional methods.

OZONE THERAPY IN PERIODONTICS

Dental biofilm makes it difficult for antibiotics in targeting putative periodontal pathogens. Higher concentrations of antibiotics are required to kill these organisms which are inevitably associated with toxic adverse effect on the host microbial flora. The application of ozone therapy in periodontics showed promising results. Both gaseous and aqueous ozone are used as a substitute to mechanical debridement. Ozonated water (4mg/l) strongly inhibited the formation of dental plaque and reduced the number of sub gingival pathogens both gram positive and gram negative organisms. Gram negative bacteria, such as P. endodontalis and P. gingivalis were 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. Aqueous ozone was found to be more biocompatible than gaseous ozone. It resulted in toxic effect on human oral epithelial and fibroblast cells compared to antiseptics such as chlorhexidine digluconate, sodium hypochlorite and hydrogen peroxide during a 1-minute time period.^{31, 32} Ozone gas found to be toxic to the human oral epithelial and gingival fibroblast cells and aqueous ozone was more biocompatible than gaseous ozone.³³ The application of ozone therapy in chronic gingival and periodontal diseases, showed subjective and objective improvement of their status, as well as patients with periodontal abscess, with no exudation was observed.¹⁷

OZONE THERAPY IN STOMATOLOGY

Sechi et. al evaluated the effect of ozonized sunflower oil on different bacterial species isolated from different sites. Ozone proved to be effective against all bacteria when tested, while mycobacteria were shown to be the most susceptible to the oil.²⁸ Macedo and Cardoso described a case report of the application of ozonated oil on herpes labialis and mandibular osteomyelitis and demonstrated faster healing times than conventional protocols.³⁴

OZONE TOXICITY

Ozone inhalation can be toxic to the pulmonary system and other organs. Complications caused by ozone therapy are infrequent at 0.0007 per application. Known side-effects are epiphora, upper respiratory irritation, rhinitis, cough, headache, occasional nausea, vomiting, shortness of breath, blood vessel swelling, poor circulation, heart problems and at a times stroke.³ Because of ozone's high oxidative power, all materials that come in contact with the gas must be ozone resistant, such as glass, silicon, and Teflon. However, in the event of ozone intoxication the patient must be placed in the supine position, and treated with vitamin E and n-acetylcysteine.⁴

CONCLUSION

Dentistry is changing as we are now using modern science to practice dentistry. The ozone therapy has been more beneficial, as it eliminates the use of drills, filling, eliminates the use of anaesthesia and reduces inflammation and enhances wound healing than present conventional therapeutic modalities. This state of the art technology allows us to take a minimally invasive and conservative approach to dental treatment. The elucidation of molecular mechanisms of ozone further benefits practical application in dentistry. Treating patients with ozone therapy reduces the treatment time with a great deal of difference and it eliminates the bacterial count more precisely. The treatment is completely painless and increases the patient's acceptability and compliance with minimal adverse

effects. Further research is needed to standardise indications and treatment procedures of ozone therapy in dentistry.

REFERENCES

1. Garg R, Tandon S. Ozone: A new face of dentistry. The Internet Journal of Dental Science 2009 ; 7: 2
2. Kagan J. Are You Ready For This - Ozone therapy. In: Ozone Information for Clinicians [online]. 2003 [cited 2010 January 13]. Available from: URL:<http://www.the-ozone.cc/HTMLOzoneF/ch37.html>.
3. Ozone therapy. Diseases and conditions, complementary and alternative medicine. [Online]. [cited 2010 January 13] Available from: URL:<http://www.intelihealth.com/IH/ihtIH?d=dmContent>
4. Nogales C G, Ferrari P A, Kantorovich EO, Lage-Marques JL. Ozone therapy in Medicine and dentistry. J Contemp Dent Pract 2008 May; (9)4:075-084.
5. Seidler V, Linetskiy I, Hubálková H, Staňková H, Šmucler R, Mazánek J. Ozone and Its Usage in General Medicine and Dentistry A Review Article. Prague Medical Report 2008; 109(1): 5–13
6. Seaverson K, Tschetter D, Kaur T. Patient guide to oxygen/ozone therapy. Health centered cosmetic dentistry. [Online]. [Cited 2010 January 13]. Available from: URL:http://www.toothbythelake.net/ozone_therapy.html
7. Johnson R D. Oxygen/ ozone therapy. Alternative approach to dental health. [Online]. [Cited 2010 January 13]. Available from: URL:[Dr.runarjohnson. Com/ozone. Htm](http://Dr.runarjohnson.Com/ozone.Htm)
8. Dr. Oh Y H. Ozone therapy in dentistry. Osstem implant. [online]. [cited 2010 January 13]; [2 screens]. Available from: URL:<http://cms.sda.org.sg/pdf/Ozone.pdf>
9. Ekstrand K. Ozone therapy for the treatment of dental caries. Danish Center for Evaluation and Health Technology Assessment health technology alert 2005 March; 4:1 [online]. [cited 2010 January 13]; [4 screens].
10. Health technology assessment report. Ozone therapy [online] December 2005 [cited 2010 January 13]. Available from: URL:<http://www.moh.gov.my>
11. Razumovskii S D, Zaikov G E. Ozone and Its Reactions with Organic Compounds. Elsevier, New York. 1984.
12. Ozone dental therapy. [Online]. [cited 2010 January 13] [1 screen]. Available from: URL: [http://www. SafeDentistry. Co. uk / ozone – dental therapy. html](http://www.SafeDentistry.Co.uk/ozone-dental-therapy.html)
13. Dr. George P. Gum and Bone Regeneration Procedures. Australian Institute of Implant dentistry [online]. [Cited 2010 January 13]; [1 screen]. Available from: URL:<http://www.implantdentistry.com.au/html/gumbone.html#wrap>.
14. Ozone therapy Oxygen Therapies. Applied ozone systems. [Online]. [Cited 2010 January 13]. Available from: URL:<http://www.appliedozone.com/medical.html>.
15. Arita M, Nagayoshi M, Fukuizumi T, Okinaga T, Masumi S, Morikawa M. Microbicidal efficacy of ozonated water against *Candida albicans* adhering to

acrylic dentures plates. *Oral Microbiol and Immunol* 2005; 20:206-10.

16. Filippi A. The influence of ozonised water on the epithelial wound healing process in the oral cavity. *Clinic of Oral Surgery, Radiology and Oral Medicine, University of Basel, Switzerland*. Available at: URL:<http://www.OXYPLUS.NET>

17. Guerra O C, Cepero S M, Jordan M, Vazquez T C. Aplicación de la ozonoterapia en el tratamiento de la alveolitis. *Revista Cubana de Estomatología* 1997; 34(1):21-4.

18. Kronusová M. Aplikace atomárního kyslíku v ordinaci praktického zubního lékaře. *Progresdent* 2007;3: 34–36.

19. Brazzelli M, McKenzie L, Fielding S, Fraser C, Clarkson J, Kilonzo M, Waugh N. Systematic review of the effectiveness and cost-effectiveness of HealOzone for the treatment of occlusal pit/fissure caries and root caries. *Health Technology Assessment* 2006; 10(16): iii-iv, ix-80.

20. Baysan A, Beighton D. Assessment of the ozone-mediated killing of bacteria in infected dentine associated with non-cavitated occlusal carious lesions. *Caries Res.* 2007; 41:337-341.

21. Baysan A, Whaley R, Lynch E. Antimicrobial effects of a novel ozone generating device on microorganisms associated with primary root carious lesion in vitro. *Caries Res.* 2000; 34:498-501.

22. Baysan A, Lynch E. The use of ozone in dentistry and medicine. *Primary Dental Care* 2005; 12(2):47–52.

23. Baysan A, Lynch E. The use of ozone in dentistry and medicine. Part 2. *Primary Dental Care* 2006; 13(1):37-41.

24. Polydorou O, Pelz K, Hahn P. Antibacterial effect of an ozone device and its comparison with two dentin-bonding systems. *Eur J Oral Sci.* 2006; 114:349-353.

25. Celiberti P, Pazera P, Lussi A. The impact of ozone treatment on enamel physical properties. *Am J Dent.* 2006; 19(1):67-72.

26. Sechi L A, Lezcano I, Nunez N, Espim M, Duprč I, Pinna A. Antibacterial activity of ozonized sunflower oil (Oleozone). *Journal Applied Microbiology* 2001; 90:279-84.

27. Thanomsub B, Anupunpisit V, Chanphetch S, Watcharachaipong T, Poonkhum R, Srisukonth C. Effects of ozone treatment on cell growth and ultrastructural changes in bacteria. *J. Gen. Appl. Microbiol.* 2002;48(4): 193–199.

28. Velano H E, Nascimento L C, Barros L M, Panzeri H. In vitro evaluation of the antibacterial activity of ozonized water against *Staphylococcus aureus*. *Pesquisa Odontológica Brasileira* 2001; 15(1):18-22.

29. Hems R S, Gulabivala K, Ng Y L, Ready D, Spratt D A. An in vitro evaluation of the ability of ozone to kill a strain of *Enterococcus faecalis*. *Int Endod J.* 2005; 38:22–9.

30. Estrela C, Estrela C R A, Decurcio D A, Hollanda A C B, Silva J A. Antimicrobial efficacy of ozonated water, gaseous ozone, sodium hypochlorite and chlorhexidine in infected human root canals. *Int Endod J.* 2007; 40:85-93.

31. Sorokina S, Lukinych L. Ozone therapy as a Part of a Complex Treatment of a Parodontium Disease. 2nd International Symposium on Ozone Applications Havana, Cuba - Mach 24-26, 1997.

32. Nagayoshi M, Kitamura C, Fukuzumi T, Nishihara T, Terashita M. Antimicrobial effect of ozonated water on bacteria invading dentinal tubules. *J Endod.* 2004; 30(11):778-81.

33. Huth K C, Jacob F M, Saugel B, Cappello C, Paschos E, Hollweck R, Hickel R, Brand K. Effect of ozone on oral cells compared with established antimicrobials. *European Journal of Oral Sciences* 2006; 114:435-440.

34. Macedo S B, Cardoso C C. The use of ozone in dentistry. 16º Campinas International Conclave 2005; 115.