

Ozone- Treating Dental Infections

Sameer Makkar¹, Monika Makkar²

Abstract

The continuing research and development in the field of medicine and dentistry has brought about changes in knowledge and approach to various treatment modalities. Integrating oxygen/ozone therapy into dental practice is truly a revolution. In dentistry we are in a continuous battle with infection, soft tissue, and/or hard tissue.

Instead of treating the whole body with antibiotic, viral, fungal, or parasitic agents, why not treat the infection with a naturally occurring substance that is truly broad spectrum with no toxicity or side effects? That substance is oxygen and its energized form, ozone. Since ozone is a powerful oxidizer- it effectively kills bacteria, fungi, viruses, and parasites at a dramatically lower concentration than chlorine, without any side effects. In the last decade a number of therapeutic protocols with ozone have been developed to address common dental infections associated with periodontal disease, root canal therapy, and caries. Also, incorporation of ozone in dental clinic set-ups would eradicate the feeling of pain during dental treatment and also cut off the treatment time, significantly. This article discusses the concepts and implementation of oxygen/ozone therapy in dentistry.

Keywords: Ozone, dentistry, medicine, caries.

Introduction

Oxygen and water are the two primary nutrients of life. Now imagine what if only with these two elements we are able to maintain our overall health and well-being. With this concept in mind hydration therapy and oxygen/ozone therapy were introduced.

Introduction of oxygen/ozone therapy has truly revolutionized dentistry. This newer concept addresses the multifactorial infective states within the oral cavity in an effective, safe, nontoxic manner. Also, initial carious lesions can now be remineralized without any drilling or cutting of tooth structure, thus comforting the patient of dental phobia during dental treatment as well.

In the last decade a number of therapeutic protocols have been developed to address common dental infections associated with periodontal disease, root canal therapy, and caries.¹ This article discusses the concepts and implementation of oxygen/ozone therapy in dentistry.

Evolution of ozone in medicine

Oxygen/ozone therapy has a long history of research and clinical application with humans. The German chemist, C.D. Schonbein, first discovered ozone in 1840. The first medical application was in 1870 when Dr. C. Lender purified blood in test tubes with ozone. As of 1929, more than 114 diseases were listed for treatment with oxygen/ozone therapy.^{2,3}

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.³

Joachim Hänsler, a German physicist and physician, joined another German physician, Hans Wolff, to develop the first ozone generator for medical use. Their design continues to be the basis for modern equipment.

Extensive research continued with the publication of Dr. Siegfried Rilling's and Dr. Renate Viebahn's text, "*The Use of Ozone in Medicine*" and Dr. Velio Bocci's publica-

tion "*Oxygen/Ozone Therapy- A Critical Review.*"³

After more than 130 years of use, oxygen/ozone therapy is currently the standard of care in over 20 countries in the world. Ozone's medical/dental use is started in the United States and is perfectly legal to use in many other countries as well.

Today, ozone is used not only to disinfect wounds and improve blood circulation, but also as a treatment for carcinomas, leukemia, rheumatism and multiple sclerosis. In dentistry, application of ozone gas has been advocated for sterilization of cavities,^{1,2,4-6} root canals,^{7,8} periodontal pockets⁹ and herpetic lesions.

Ozone- What it is and what does it do ?

Ozone is a chemical compound consisting of three atoms of oxygen. It is the elemental form of oxygen that forms naturally as a result of ultraviolet energy or lightning, causing a temporary recombination of oxygen atoms into groups of three. Ozone protects living organisms by surrounding the earth at altitudes of 50,000 to 100,000 feet. The ozone layer absorbs the sun's harmful ultraviolet rays, thus allowing for survival of plant and animal life. Ozone forms near ground level as a result of the reaction of ultraviolet light with hydrocarbons, nitrogen oxide, and sulphur compounds to produce photochemical smog. Ozone is not the cause of smog, but it is a by-product. Since ozone is a powerful oxidizer, it actually helps clean the atmosphere of these dangerous compounds. Ozone is used as a measuring device for smog levels- to reiterate, it is not smog, but nature's way of cleaning up the smog.³

Since ozone is a powerful oxidizer, it effectively kills bacteria, fungi, viruses, and parasites at a dramatically lower concentration than chlorine, with none of the toxic side effects. One molecule of ozone is equal to about 3,000 to 10,000 molecules of chlorine and it kills pathogenic organisms 3,500 times faster.³

In a medical/dental ozone generator, the medical grade O.

¹Professor, Deptt. of Conservative Dentistry and Endodontics, Rayat Bahra Dental College, Mohali, ²Assoc. Professor, Deptt. of Prosthodontics, Yamuna Institute of Dental Sciences, Jagadhri, India.

Correspondence: Dr. Sameer Makkar, email: drsameermakkar@yahoo.com

is converted to O₃ in special tubes via a corona discharge reaction (similar to lightning). This type of generator is able to control the concentration of ozone, critical to delivering the correct dose in micrograms/milliliters (mcg/ml).³ Concentration is determined by exposure and contact time of the medical-grade oxygen to the 5 to 13 millivolts [Bocci] sealed-corona discharge tubes.¹⁰ Because of ozone's physical properties in the dental model, the ratio of ozone to oxygen is extremely low. The typical average concentration of ozone used in treatments is 25 micrograms of ozone per milliliter 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.³

Due to the instability of the O₃ molecule, medical grade ozone must be prepared immediately before use. Within less than an hour after preparation only half of the mixture is still ozone while the other half is transformed into oxygen. As a result, it is impossible to store ozone over long periods of time. In order to control the decomposition of O₃ into oxygen it can be associated with a vehicle with aqueous properties to promote the conversion more quickly or with a vehicle with more viscous properties to retard the conversion.³

In the clinical setting, an oxygen/ozone generator simulates lightning via an electrical discharge field. There are three different systems for generating ozone gas:²

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.

Ozone in dental infections

Attempts to eliminate oral infections have been minimally successful due to the interrelated nature of the multiple causative factors. These factors include microorganisms, diet, saliva, and immune responses. Treatments such as prophylaxis, rinses, fluoride, sealants, restorations, surgical procedures, diet, and lifestyle modification have altered risk factors. The result is the adaptation to the acute infection and the infection then converts to a subclinical chronic infection. These pathogenic organisms being opportunistic, eventually, clinically "re-infect" the afflicted tissue. Instead of treating the whole body with antibiotic, viral, fungal, or parasitic agents, why not treat the infection with a naturally occurring substance that is truly broad spectrum with no toxicity or side effects? That substance is oxygen and its energized form, ozone.

The commonality of all the pathogenic organisms is the weak antioxidant/enzyme systems in the cell membranes of these organisms. The ozone will punch a hole in the membrane of the organism, thus resulting in the organism's death.² Now the contents of the pathogen are exposed to the internal environment that allows the immunologic system to start its physiologic cascade.

One of the most amazing biochemical and physiological studies conducted at Scripps Institute recently showed how antibodies actually produce ozone to kill invading micro-

organisms. Now antibodies, in addition to identification of pathogens, also kill them with ozone.^{5,6} So in reality, we are now doing nature's work within our dental standard of care. In oxygen/ozone therapy in dentistry, the aim is:

- Elimination of pathogens
- Restoration of proper oxygen metabolism
- Induction of a friendly ecologic environment
- Increased circulation
- Immune activation
- Simulation of the humoral anti-oxidant system

Oxygen/ozone therapy in dentistry contains a multiplicity of protocols to deal with dental infection. Three basic forms of application to oral tissue are -

- 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, which is an ideal delivery system. These forms of application are used singly or in combination to treat dental disease.^{2,3}

Indications of Ozone in dental treatments

Very recently, in dentistry, ozone has got its role in various dental treatment modalities. Interest in ozone use in dentistry is due to the infectious diseases associated with the oral cavity. Ozone therapy presents great advantages when used as a support for following treatments-

- Prophylaxis and prevention of caries
- Remineralization of pit and fissure caries
- Remineralization of root and smooth surface caries
- Restoration of open cavitations along with conventional conservative measures
- Bleaching of discoloured root canal treated teeth
- Endodontic treatment
- Desensitization of extremely sensitive tooth necks
- Soft tissue pathoses
- Implantology

Caries prevention and remineralisation

Various studies by Dr. Edward Lynch et al.,^{5,11,12} have shown that oxygen/ozone therapy has an inhibiting effect in the development of pit and fissure caries, root caries, and interproximal carious lesions. Studies also have shown reversal of caries in lesions with exposure to oxygen/ozone in as little as 10 seconds.

Oxygen/ozone can be utilized for pit and fissure sealants, caries removal, cavity preparations, dentinal hypersensitivity, crown and bridge preparations, and reduce carious exposures.^{1,4,6,13-15} For example, in a Class II lesion, after a standard preparation place the matrix band in position for restoration placement. Just before restoration placement, the prepared area is covered with oxygen/ozone gas with proper evacuation for 20 to 30 seconds. This simple process dramatically reduces the post-operative sensitivity, kills any possible microbe at the site, and eliminates the possibility of leaving infected dentin.

In cases of incipient caries, ozone can kill bacteria in the demineralized part and this demineralized tooth structure then, can be remineralized using a special remineralization kit, containing Calcium, Fluorine, Phosphorus and Sodium

m, all in their ionic forms.^{1,11}

By effectively sterilising the lesion, minerals from the patient's own saliva will re-enter the areas of mineral loss to harden them. Once hardened, it is more resistant to future bacterial attack and mineral loss.¹³

Role in periodontology

Using the standard protocol (e.g. generalized Type III moderate periodontitis) for oxygen/ozone therapy, the patient is placed on a four week protocol, with follow-up after one month, and then scheduled for three-month recalls. Each week following anesthesia, the sulcus/pockets are irrigated using a canula with a syringe of ozonated water followed by root-planing, scaling, and curettage. This process reduces and eliminates the pathogenic load within the pockets and sulcus areas.^{2,9}

After the quadrant is completed, reirrigation is performed for the entire pocket/sulcus of all quadrants.

In the following procedure each pocket/sulcus is insufflated with a mixture of oxygen/ozone gas. Due to the physics of a gas entering into a liquid, the crevicular fluids and the epithelial tissues lining the sulcus absorb the oxygen/ozone mixture, ensuring complete anaerobic pathogen load elimination. In addition, the tissue responds with increased perfusion and immunologic activity, allowing for enhanced healing. The patient is given standard home-care instruction with one added item- ozonated olive oil.

After the patient performs all home-care hygiene, he or she applies the oil to the soft tissue. Once the oil melts, it again releases oxygen and ozone supporting the current therapy. If the dentist has any stubborn areas, the oxygen/ozone can be injected directly into the area, and the gas goes immediately into solution. This resolves the local issue.

The methods applied are safe and efficacious with no toxicity or side effects.^{2,9,15,16}

Role in endodontics

The problem in endodontics is that some root canals are in a chronic state of infection. A tooth is made up of numerous little lateral canals or tubules. These tubules are colonized by microbes from the infected main canals. Studies have shown that bacteria from infected teeth have been found all the way to the cemental junction. The vast majority of the microbes found in tubules are obligate anaerobes, such as viruses, bacteria, and fungi.^{7,9,17}

Many forms of therapy have been developed and used to solve this problem with varying degrees of success. Nagayoshi M et al., reported that the use of ozonated water had the same antimicrobial activity as 2.5 percent sodium hypochlorite with none of the toxicity and also the metabolic activity in the associated fibroblasts was high with exposure to ozonated water, indicative of a healing process occurring.⁷

Another interesting fact is that anaerobic-type microbes produce a positive-charged infection environment. Since oxygen is the only gas that can carry an electrical charge, this opposite charge phenomena attracts ozone to the area and the pathogens are killed. Taking into consideration the routes of oxygen/ozone application, root canal therapy goes through a paradigm change.^{7,8,9,16,17} The additions to treatment are as follows:

- Files are coated with ozonated olive oil for lubrication and disinfection.
- The canals are prepared, irrigated with ozonated water,

and dried.

- The final step before filling each canal is slow insufflation with oxygen/ozone gas. The insufflation process allows the molecular oxygen/ozone to travel into the canals, lateral canals, and tubules. The molecular oxygen/ozone can travel through the tubules and kill the positively charged microbes and perform a true sterilization.

The results following the use of the above steps has shown less post-operative complaints from patients, fewer re-treatments, and monitored assay showing no reinfection of the dentition.

Bleaching

In discoloured non vital teeth, ozone finds a role in bleaching too. After removing the root canal filler material from the pulp chamber, the canal is sealed tight at the level of cemento-enamel junction. Then, the chamber is cleansed with sodium peroxide solution to remove any debris, cement particles and the smear layer, leaving the dentinal tubules opened-up. Now, a bleaching paste or a cotton pellet moistened in bleaching solution is packed in the chamber and the orifice is sealed with the Glass-ionomer cement. After placing the bleaching agent in to 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.^{2,15}

Desensitization of sensitive root necks

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 expose root surface prevents the penetration of ionic calcium and fluoride 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 results last longer than those by conventional methods.¹⁸⁻²⁰

Soft tissue pathoses

Ozone has been reported to accelerate the healing of soft tissue conditions, i.e. aphthous ulcers, herpes labialis, ANUG and other gum infections. It also reduces the post-extraction healing time by forming a pseudo-membrane over the socket, so protecting it from any physical and mechanical insults.^{2,3,15}

Implantology

The use of ozone in implantology helps in bone regeneration. The socket is prepared conventionally, and ozone is bubbled into the prepared socket for about 40 sec. This is followed by placement of implant into the socket. This prevents infection and enhances bone regeneration.

Also in cases of peri-implantitis, the studies have shown promising reports of regeneration and eliminate infection around the implant.

Ozone toxicity

Ozone transformation can be poisonous to the pulmonary complement as good as pick organs. Complications caused by ozone caring have been sparse during 0.0007 per appli-

cation. Known side-effects have been epiphora, upper respiratory tract irritation, rhinitis, cough, headache, occasional nausea, vomiting, crispiness of breath, blood vessel swelling, bad circulation, heart problems as good as during the time of stroke.

Ozone therapy contraindications

Ozone therapy is still being ignored by most of medical establishment because of facts that gaseous ozone is quite toxic and has strong oxidative properties.²¹ Along with the specified uses of ozone, there are certain conditions where ozone therapy is contraindicated, namely^{2,10,21,22}

- Pregnancy
- Glucose-6-phosphate-dehydrogenase deficiency (favism)
- Hyperthyroidism
- Severe anaemia
- Severe myasthenia
- Active hemorrhage

Conclusion

The use of ozone has opened new vistas in treatment modalities. Now, one can focus on the site of infection rather than the whole body. Also, most people suffer anxieties about being treated for tooth decay or more precisely; they fear the injections and drills. But, now, with ozone treatment, this is all the thing of past. Studies have shown that 99 percent of all the bacteria causing tooth decay have been eliminated after 10 seconds of ozone exposure and even 99.9 percent bacteria after 20 seconds exposure. Thus, treating patients with ozone cuts off the treatment time with a great deal of difference, eliminates the bacterial count more precisely and moreover, it is completely painless, so increasing the patients' acceptability and compliance.²³ Ozone can now be incorporated in various other treatment modalities also, like bleaching of discoloured teeth, root canal treatment, desensitization and treatment of some soft tissue infections. Ozone, definitely, seems to be a promising treatment modality for various dental problems, in future. On the other hand we have to keep in mind that presently ozone is an adjunct to other conventional treatment modalities and should be used in combination until more research shows its benefits in independent usage.

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