

# Ozone in Dentistry

**Dr. Amarnath Shenoy**

Associate Professor,  
Dept. of Conservative Dentistry & Endodontics,  
Yenepoya Dental College, Mangalore

**Dr. Shruti D Nayak**

Senior Lecturer  
Department of Oral Pathology,  
Yenepoya Dental College, Mangalore

**Dr. Arjun Nayak**

Nayak's Specialty Dental Clinic  
& Orthodontic Centre  
Mangalore

## Abstract

Ozone therapy is slowly capturing increasing attention in our country since recent developments have clarified biochemical mechanisms of action and the real possibility of taming ozone toxicity. The potential toxicological actions of ozone should not preclude its employment for dental and medical purposes.

## Introduction

Ozone is normally present as a gas which contains 3 atoms of oxygen. During the last few years ozone therapy has been explored in an elaborate manner. Ozone is a controversial gas. It is very useful in the stratosphere because it absorbs ultraviolet radiations which are very harmful. At the same time it is toxic for the pulmonary tract in troposphere, particularly mixed with carbon monoxide, nitrous oxide, and traces of acids as it occurs in smog.

## Potential applications of ozone in dentistry<sup>1</sup>

Ozone water has been reported to serve as an effective agent in the dental surgery. It is reported to promote haemostasis, enhance local oxygen supply and inhibit bacterial proliferation. So it can be of help during oral surgical procedures or dental extractions.<sup>1</sup> A study has proved a denture cleanser containing O<sub>3</sub> to be biologically safe with strong disinfecting and deodorising power.<sup>2</sup> The level of *Candida albicans* were found to decrease to about one tenth of their initial value after 30 minutes and to a still lower level after an hour. Exposure of carious dentine specimens to ozone with the help of a novel generating device for ten to twenty seconds substantially reduced the levels of pathogenic microorganisms in these samples.<sup>1</sup>

Humans experience a lot of continuous ozone exposure throughout their life. Occupational hazards include photocopying machines, mercury vapour lamps, laser printers, x-ray generators, water purification process and employment of O<sub>3</sub> in bleaching

process.

O<sub>3</sub> is a highly powerful microbicidal agent. Its action is not limited to only few microorganisms but to all living systems. We have to consider its potent oxidising capacity towards a range of biomolecules. Toxic products arise from chemical reactions in which ozone molecules are involved.<sup>1</sup>

## Toxicology of Ozone

Having a powerful electron accepting property makes it very dangerous. It can attack and modify many biomolecules chemically. Cysteine, methionine, histidine are all attacked. The attack of unsaturated fatty acids (UFAs) is one of the most well known ozone reaction with biomolecules. A complex series of products are formed from the ozonization of both mono and poly unsaturated poly acids.<sup>1</sup>

The adverse biological effects exerted by ozone depend upon the dynamic equilibrium between the concentration of this reactive oxygen species (ROS) the duration of exposure and the nature and concentration of intra and extra cellular antioxidants. Notwithstanding, the low levels of O<sub>3</sub> experienced during only limited periods of exposure to this oxidant can be prevented from inducing the self perpetuating, autocatalytic lipid oxidation process by the availability of sufficient levels of antioxidants. Aldehydes derived from oxidation of PUFAs have been implicated in the pathogenesis of atherosclerosis and its associated pathological sequelae such as ischaemic heart disease and peripheral vascular diseases. These agents also have shown to have genotoxicological and proinflammatory actions.<sup>1</sup>

## Ozone and DIAGNOdent

Ozone has the capability to replace antibacterial gels and varnishes used on teeth for prevention of caries. DIAGNOdent is an instrument developed for caries detection and it is laser fluorescence based. During ozone treatment cavity will remineralise and often extrinsic stains will discolour it. This colour change could lead to false positive

DIAGNOdent readings. In such situations the hardness of the cavity floor should be evaluated and considered rather than DIAGNOdent readings.<sup>1</sup>

## Ozone therapy and the ecological niche environment<sup>1</sup>

Caries reversal of remineralisation occurs after Ozone treatment. This has been proved by the studies. This remineralised tissue can support a restoration and can bring back tooth to normal function. A number of important changes occur during ozone treatment in a carious lesion. Firstly, the infection is reduced dramatically. Pyruvic acid produced by the microorganisms is converted to acetate and carbon dioxide. Some natural mineralisation inhibiting proteins may be reduced in number, possibly and dentine channels may be opened. These changes allow bio available minerals from supersaturated saliva, aided by rinses, tooth pastes, to remineralise the lesion. This morphological change along with the inability of the ecological niche of acidogenic and Aciduric microorganisms to re-establish easily creates a favourable environment for remineralisation and prevention of further decay.<sup>1</sup>

## Mode of action of ozone

Ozone destroys bacteria by oxidising bacterial cell walls and membranes and may destroy these microorganisms by rupturing their membranes. It oxidises the biomolecules that allow the niche to survive and expand. This has a severely disruptive effect on bacterial population in the carious lesion and obliterates the caries producing bacteria and their ecological niche. Thus no more acid is produced and equilibrium is reverted to remineralisation side.<sup>3,4,5</sup> Oxidation of salivary biomolecules that supply the plaque and carious lesions are also proven.<sup>6</sup> ozone also has dissociated volatile methionine products responsible for bad odour and oxidative reactions are present in plaque as well.<sup>1</sup>

## Clinical Effectiveness Results

In studies involving root caries treated

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with Ozone for 10 to 40 seconds, it either stabilised or reversed the demineralisation and none progressed or worsened. Even the worse of the root caries responded by not progressing. In comparison the control caries worsened.<sup>7</sup> Several other studies also showed positive results either with single application of Ozone or multiple.<sup>1</sup> The non cavitated pit and fissures also showed caries reversal and remineralisation in both permanent and deciduous teeth.<sup>8</sup> The post operative sensitivity associated with Ozone treatment compared with conventional treatment proved the O<sub>3</sub> to be much better. Ozone is useful in treating child patients as there is reduced anxiety compared to conventional treatment.<sup>1</sup>

#### Ozone and the dental water unit lines

The dental unit waterlines (DUWs) is a subject of concern as the amount of harmful microorganisms it harbours is much above the safety limits. Such water quality is perceived as potential risk for the health of patient and personnel.<sup>9</sup> Ozone has been successfully employed for the treatment of the infected DUWs. This has been found to be more effective than hydrogen peroxide or silver ion solution in vitro or in vivo.<sup>10</sup> A study done on the effect of Ozone on Pseudomonas aeruginosa, one of the most potentially pathogenic microbe showed that O<sub>3</sub> was very highly effective in the total destruction of the microbes. Furthermore ozone did not create any air pollution and was not detected in the water taken from DUWs.<sup>1</sup>

Thus Ozonated water was considered to be an alternative to a sterile isotonic solution for rising oral cavity during dental surgery procedures. It was also concluded that influence of ozone lead to a higher expression of cytokines that are important in wound healing.<sup>1</sup>

Root sealant application in conjunction with ozone application failed to show any significant additional benefits. Root sealants in the ozone and sealant group performed better when compared to those in sealant group only.<sup>1</sup>

#### ART and Ozone<sup>1</sup>

Incorporating ozone care into atraumatic restorative treatment (ART) is a combination of two good technologies. Air abrasion is

used for initial cavity preparation in cases where it depth of caries is below dentin and cannot be penetrated by ozone alone. Here there is no need for local anaesthesia. Ozone is then used to eliminate the ecological niche of carious microorganisms. The cavity is then restored with a fluoride releasing cement.<sup>1</sup>

#### Ozone in Endodontics and Orthodontics

Complete sterilisation of root canals will lead to success of the pulp space therapy. The option of a reliable sterilisation would also have an effect on the future of root canal treatments. With any of the present methods it is very much impossible to achieve complete sterilisation and ozone could be the answer for that.

Fixed orthodontic devices are particular retention niches for a cariogenic biofilms. Ozone therapy can be made use of here.

Ozone can be used for the following:

1. Reversal of incipient caries
2. Prevention of pulp infection in deep caries affected dentin
3. Disinfection during root canal treatment.
4. Disinfection of cavity preparation prior to restorations.
5. Treatment of cervical sensitivity.
6. Prior to all fissure sealant placements
7. Bleaching teeth
8. Combined with other approaches to manage caries such as the atraumatic restorative technique.

#### Ozone in Root Canal Disinfection<sup>1</sup>

- Ozonizing the NaOCl makes NaOCl into an even more effective oxidant.
- Ozone oxidises the cell walls of microorganisms and destroys them.
- Ozone speeds up the dissolution activity and reduces the time required for routine root canal therapy.

Ozonated NaOCl acts as an organic and fat solvent, degrading fatty acids and transforming them into fatty acids and glycerol, which reduces the surface tension of the remaining solution. It also neutralise amino acids forming water and salt.

#### System for Ozone Delivery

One system that has CE approval for the treatment of caries in the mouth is the Heal Ozone (KaVo GmbH). It is a self contained device for the manufacture of ozone gas. There are a lot of devices that produce ozone,

but all depend on positive pressure to push air or oxygen through a production unit. This uncontrolled production of ozone is unsuitable for the use in mouth.<sup>1</sup>

#### Conclusion

The use of ozone can be cost effective, cost efficient and time efficient. The economic consequences of simpler and less prolonged dental treatment would clearly be beneficial. Ozone treatment can be easily applied to the general population. Use of ozone can be considered especially appropriate for medically compromised patients; domiciliary care patients and house bound elderly people. No injection involved in ozone treatment and ozone delivery system is portable. Still we are in the early days of ozone therapy and a lot more improvements in every aspect are needed for it to be fully accepted.

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