

# Ozone in Clinical Dentistry

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## ABSTRACT

Ozone is a gas occurs naturally in small amounts in the upper atmosphere. Ozone has a long history in research and medicine. In 1785, Van Marum found a special odor from the air near his electrostatic machine. In 1801, Cruick Shank observed the same odor at the anode during electrolysis of water. Finally in 1840 Shonbein named the substance that gave this odour, "ozone" from the Greek word "ozein" to smell.

**KEYWORDS: Ozone, Ozone Therapy, Atmosphere, Ultraviolet Light**

## INTRODUCTION

During World War I, ozone was used to treat wounds, trench foot, gangrene and effects of poisonous gas. The results indicated that ozone treatment can have an inhibiting effect on the development of pit and fissure caries, as well as on root surface caries and proximal carious lesions.<sup>1</sup>

Ozone is a gas made up of three oxygen atoms [O<sub>3</sub>]. It occurs naturally in a small amount in the upper atmosphere. Ozone protects the living organisms on the earth and prevents the Ultra Violet light entering directly on the earth. In the lower atmosphere [the troposphere] near the earth's surface, ozone is created by the chemical reaction between air pollutants from vehicle, exhaust, gas vapors and other emissions. At ground level, the high concentration of ozone are toxic to people and plants.<sup>2</sup>

## STRATOSPHERIC GOOD OZONE

Ninety percent of the ozone in the atmosphere is in the stratosphere, the layer of atmosphere between about 10 and 50 kilometers altitude. The level of the ozone is maintained by the balance between the sunlight creating ozone and the chemical reaction which destroys it. Ozone is created when the oxygen we breathe is (O<sub>2</sub>) split apart by sunlight into single oxygen atoms sunburn and can lead to skin cancer and eye damage.<sup>3</sup>

## TROPOSPHERIC BAD OZONE

Ozone in the stratosphere provides a cover to protect life on the earth, but direct contact with ozone is harmful to both plants and animals. When mixed with CO, N<sub>2</sub>O, and traces of acid, the ozone becomes toxic for the pulmonary tract.<sup>4</sup> The harmful effects can include throat and lung irritation or aggravation of asthma or emphysema.

## OZONE IS CREATED IN NATURE IN 3 WAYS

1. Lightening provides fresh smell of ozone after a thunderstorm.
2. Ozone accounts for the energetic feeling and calm experience in the waterfalls with crushing surf.
3. Nitrous oxide formed by combustion of hydrocarbons in the internal combustion engine interacts with photons from the sun producing ozone

## REACTION OF OZONE WITH BODY FLUIDS

On the other hand, ozone reacts immediately as soon as it is solubilized in biological water [Plasma, lymph and urine]. Where atomic oxygen is very reactive, contrary to incorrect belief that ozone penetrates through the mucosa or enters into the cells. It is emphasized that, after the mentioned reaction, ozone does not exist any longer.<sup>1,5</sup> Antioxidant capacity of the blood that can be measured and if necessary strengthened by administration of antioxidants before and during ozone therapy. Although O<sub>3</sub> has extremely powerful microbiocidal properties, such actions are not limited to these organisms.

## TOXICOLOGY OF OZONE WITH REFERENCE TO ITS REACTIVITY WITH BIOMOLECULES

In view of its powerful electron accepting properties, ozone can attract and chemically modify many biomolecules, both free and protein incorporated amino acids such as cysteine, methionine etc. It must be clear that if we want to use ozone in medicine, we must avoid its toxicity that can be controlled only operate cautiously.

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## MICROBICIDAL ACTIVITY

**OXIDATION OF BIO-MOLECULES IN DENTAL TISSUES:** Lower organisms such as bacteria and viruses do not possess enzyme coats. This allows ozone to easily penetrate their cell membranes. Higher organisms actively produce enzyme coats, which prevent reaction with ozone. The oxidizing properties of ozone not only removes protein protection and being bactericidal, it also oxidizes the biomolecules that allow the niche to survive and expand.<sup>6</sup> Ozone has:

- Immediate direct effect on carious lesion by eliminating the acid producing bacteria.
- Delayed indirect effect by promoting the remineralisation of the lesions.

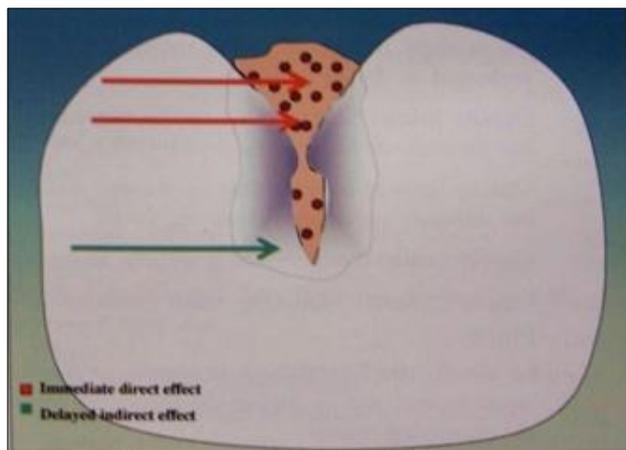


Fig.1: Ozone penetrates

Ozone penetrates into cracks and dentinal tubules where it seems to cleanse these channels allowing minerals to flood in without resistance. There are three common methods of producing ozone. They are Hot spark or corona discharge, ultraviolet and Cold plasma.

**HOT SPARK OR CORONA DISCHARGE:** Hot spark production was used mostly for industrial applications. But today corona discharge available is for personal applications. Ozone generation by corona discharge is most common.

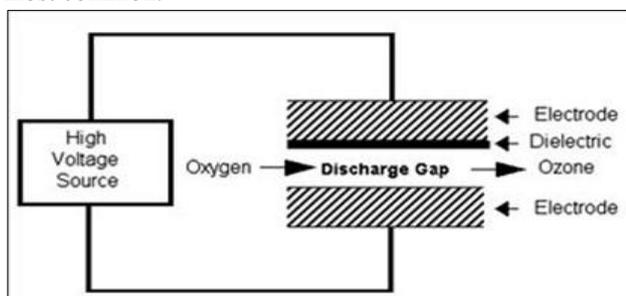


Fig.2 A Schematic diagram of the corona discharge generator

**Features:**

- Greater sustainability of the unit.
- Higher ozone production.
- Higher cost effectivity.

**ULTRA VIOLET:** This type of generator uses an ultraviolet lamp as its source. It produces a very small amount of ozone with a narrow frequency bandwidth of ultraviolet light. This method is suitable for air purification as ultraviolet reacts with oxygen and it is too weak for medical purposes. Also, UV lamp degrades over time and eventually burns out.

**COLD PLASMA:** Cold plasma technique is invented by Nikola Tesla. Here noble gases are enclosed in a glass vacuum tube and high voltage is applied. A clean flow of 50 Mg/ml is obtained from this technology with very long term reliability suitable for medical application. Ozone therapy should be used whenever orthodox medicine fails to solve the medical problem. Ozone therapy is used in:<sup>6</sup>

- Acute and chronic infectious diseases caused by antibiotic or chemoresistant bacteria virus and fungus.
- Osteomyelitis pleural empyema, peritonitis, chronic ulcers, diabetic foot, insect strings, infected wounds.
- Hepatitis, herpetic infections, and herpes zoster, papilloma virus infections, fungal and parasitic infections.
- Autoimmune diseases [multiple sclerosis, rheumatoid, arthritis, crohn’s disease].
- Ischaemic diseases [hind – limb- ischaemia, cerebral and heart ischaemia, venous stasis].
- Degenerative disorders; age- related macular degeneration, diabetic retinopathy, sudden hearing loss, tinnitus.
- Pulmonary diseases, emphysema, asthma, chronic obstructive pulmonary disease and acute respiratory syndrome.
- Skin diseases [psoriasis, atopic dermatitis].
- Chemoresistant metastatic cancer, therapy of cancer related fatigue.
- Orthopaedic diseases [problem of back – ache osteoarthritis]
- Trauma, burn injuries.
- Emergency surgery.
- Before transplantation and before elective surgery.

There are twenty four methods of administrating ozone therapeutically. They are as follows:

IN THE HOME OR CLINIC	IN THE CLINIC
Ear insufflations	Direct intra -venous injection
Vaginal insufflations	Auto hemo therapy
Rectal insufflations	Intra-arterial injection
Drinking water	Direct injection into tumor
Cupping with a funnel	Intracutaneous
External limb bagging	Subcutaneous
Bladder insufflations	Intramuscular
Ozonated bath	Intraarticular
Breathing through olive oil	Uterine insufflations
Steam cabinet	Subatmospheric bagging
Ozonated olive oil massage	Hyperbaric ozone
Ozonated water enema	Dental use of Ozonated water

Ozone side effects are typically minor irritations that are caused by the incorrect use and it will quickly disappear if used safely. Ozone has to be one of the safest treatments of the dental caries in mouth.

There is a currently only one device that has health and safety executive approval for the treatment of the dental caries in the mouth, and it is named as healozone.<sup>2</sup> It is manufactured and marketed by KAVO.



Fig.3 : The Heal Ozone unit

The heal ozone is essentially a self-contained device for the manufacture of ozone gas. There are plethora of devices that can produce ozone, but all depended on the positive pressure to push air or oxygen through a production unit.<sup>3</sup>

We need to check the handpiece seals and hose seals regularly, as worn or damaged seals, will cause a vacuum air leak and prevent ozone generation. Lub-rication of the fittings will help easy connections and prevent seal damage.

**BIOLOGICAL FILTERS:** The biological filters are designed to stop any oral fluids being drawn up through the cap, down the connecting hose and into the heal ozone unit. To collect any waste liquid that may be drawn through the vacuum system from the mouth. The hydrophobic membrane protects the destructor filter and vacuum pump from the liquid by shutting down when it comes into contact with the liquid. When changing the hydrophobic waste filter, be careful not to kink the pipes on fitting as this will prevent flow.

An outline of the method used by healozone to deliver ozone as an air drier with automatic moisture sensor ensures stable air humidity and thus a steady concentration of ozone through the tubing, hand-piece and silicone cup. A different pressure sensor detects leaks and controls the ozone generator. Ozone is generated from atmospheric oxygen by using an internal ozone generator. An ozone concentration of 2100ppm within the vacuum sealed silicon cup. A moisture separator prevents moisture from flowing into the ozone neutralizer. An ozone neutralizer reduces  $O_3$  to  $O_2$  and releases neutral air into the environment. A vacuum pump ensures negative pressure to prevent the system leaking ozone.<sup>6,7</sup>



Fig. 4: Heal Ozone Remineralization Kit

## MICROBICIDAL ACTIVITY

As ozone is a great sterilization medium, the ideal way to sterilize the inner surfaces of the handpiece and the tubing is simply start 60 seconds ozone cycle. Place a delivery cup on the handpiece (any size cup) use a hard surface like a glass slab, and once a seal has been obtained, run the healozone for 60 seconds. Clean the outer surface of the handpiece and the hose. Disconnect the handpiece from the hose. Sterilize the handpiece and hose separately, prior to use and between patients at  $134^{\circ}C$ .

Disinfection of the root canal during root canal treatment. Sterilization of tooth surfaces before making fillings or before inserting crowns or inlays. Disinfection of dental unit water lines. Very fast internal bleaching. Desensitizing the crown preparations.

## CLINICAL MANAGEMENT OF DENTAL CARIES

The curative and disinfecting effect of ozone "heal ozone" are used in dental care as a new mode of therapy for dental caries.

**DIAGNODENT:** Diagnodent operates by means of laser light. The light is passed via an optical fibre to the area of decay. The decayed area fluoresces and this fluorescence passes back to the probe and the decay is displayed and indicated both visibly and audibly.<sup>4</sup>

**NON CAVITED PIT AND FISSURE CARIES:** The lesions are first cleaned using prophylactic paste [prophyflex from kavo] before diagnodent and healozone application. This thoroughly cleans the surface, removing all extraneous plaque, calculus and extrinsic stain which will make the Diagnodent reading more reliable as well as allowing the ozone to penetrate the lesion more predictable. Ozone application of the caries lesion for 40 seconds.

**USE OF FISSURE SEALANTS IN COMBINATION WITH OZONE TREATMENT:** Sealants are recommended to be placed over the remineralized pit and fissure lesion with early dentinal involvement<sup>12</sup> usually at the 4 week recall visit. Ozone can be used to maintain or replace sealants and used in combination with sealant.

**USED TO REPLACE SEALANTS:** Application of sealants requires a dry area without saliva contamination and needs patient cooperation. Ozone treatment provides short application time and reduction of dental anxiety with minimal co-operation requirements.

**USED IN COMBINATION WITH SEALANTS:** For the high caries risk patients, ozone can be combined with fissure sealants to increase the preventive outcome. In erupting teeth, isolation is difficult. Ozone is not impeded by the gum margin and maintains the seal over these teeth while emerging from the gingival tissue. Their healthy status can be maintained until proper isolation procedures can be applied or till full maturation is reached.

**Advantages of Ozone Treatment:** The treatment is simple, less invasive, painless, time efficient, completely safe, no hazard for the environment, person treating and most important for the patient when used in correct dosage and method.

The considerable levels of patient anxiety associated with 'drilling and filling' techniques were significantly reduced. They can be the sole mode of treatment or may be combined with minimally invasive techniques to improve the treatment quality.

#### CLINICAL MANAGEMENT OF ROOT CARIES

**USING OZONE:** Root caries like other types of dental caries result from the interaction of three factors. Root caries is a significant problem in older patients. Reversal of root caries is associated with remineralisation and a corresponding reduction in acidogenic and aciduric microorganisms. Root caries cannot develop until the root surface is exposed to the oral environment. Once exposed the cariogenic microorganisms mainly mutants streptococci, lactobacilli accumulate in the plaque metabolize dietary carbohydrate to form acids, which set off a chain of events which results in the formation of a carious lesion. The properties of acidogenic microorganisms in plaque are generally higher in older people, mainly due to decrease in salivary secretion rate and a higher prevalence of removable dentures in the elderly. In addition, a gradual loss of manual dexterity in elderly people makes it hard for them to perform adequate oral hygiene.

#### OZONE AND REMINERALIZATION THERAPY:

Ozone enhances the remineralisation of the carious lesion<sup>6</sup>, by killing the microorganisms by damaging their cell membrane, so the local PH is raised. Being powerful oxidant ozone has the ability to remove proteins in the carious lesion and enable calcium and phosphate ions to diffuse through the lesion. Treating the deep carious lesion with healozone and using the benefits of remineralisation has great advantages like preservation of tooth substance, avoidance of pain and hypersensitivity lowering the long term risk for RCT, core and post, crown or even extractions. There are 2 treatment options in deep caries.



a) GIC is placed inside the cavity b) Shaping and contouring of GIC

## CLINICAL MANAGEMENT OF DENTAL CARIES

Sodium Hypochlorite [NaOCl] is widely used as irrigation solution for chemo mechanical preparation of root canals. It has also been proved that ozone kills all enterococcus faecalis when its concentration in suspension is lower, even at exposure times of only 10 seconds.

The technique used in root canal disinfection is to combine ozone with NaOCl during chemo mechanical root canal disinfection. Ozone has dramatically improved the predictability of root canal therapy and shortens the time required making one session root canal treatment an acceptable and predictable treatment technique.<sup>10</sup>

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

The Ozonated NaOCl acts: As a lubricant for instrumentation, Can flush loose debris from root canals. As a promoter, clearing and dissolving both vital and non vital tissues.

**MECHANISM OF ACTION:** When organic tissue comes in contact with ozonated NaOCl, hypochlorous acid is formed which reacts with insoluble proteins and produces soluble polypeptides, aminoacids and other byproducts.

**PROPERTIES OF OZONATED NaOCl:** Ozonated sodium hypochlorite acts as an organic and fat solvent, degrading fatty acids and transforming them into fatty acid salts and glycerol, which reduce the surface tension of the remaining solution. Various factors interfere with pulp tissue dissolution. Quantity of solution related to organic tissue, Contact surface, action time, solution volume, mechanical agitation, solution temperature, solution concentration.

The introduction of ozone in root canal disinfection has reduced action time of NaOCl Ozonated NaOCl offers a tremendous time benefit making root canal disinfection predictable.<sup>3</sup>

- The prototype of the needle (Kavo) to enhance the application of ozone into the canal.
- The needle is mounted to the Heal Ozone handpiece

## DENTAL UNIT WATER PURIFIER

An ozone generator injects and entrains ozone enriched air into water to be used to eliminate the mobility and viability of any microbes and pathogens present in the water or in biofilm present in the water.

**ULTRA VIOLET OZONE WATER PURIFIER FOR WATER DISINFECTION:** It is a single unit consisting of microfilter, ultraviolet radiation source, and ozone generating source, enhancing the disinfection efficiency of ozone.

**ULTRA VIOLET RADIATION SOURCE:** Ultra violet lamps produce free radicals such as hydroxyl radicals and hydroperoxy radicals. A wave length of 120 to 240 nanometer induce generation of sufficient amount of ozone in the oxygen containing gas. Oxygen containing gas is ambient air which has 21% by volume of oxygen.

## OTHER APPLICATIONS OF OZONE IN DENTISTRY

**DENTIN HYPERSENSITIVITY:** Exposure of dentinal tubules with related symptoms of sensitivity is an extremely common problem in common dental practice

**OZONE AND DENTAL MATERIALS:** Ozone applications on either dentin or enamel had no detrimental effect on the bond strength of the resin composite on enamel or dentin.<sup>8,9</sup> Dental prostheses are subject to the sorption of microbial bio films on their surfaces, which could cause long term infections.

**OZONE IN IMPLANT SURGERY PERI-IMPLANTITIS:** A sterile implant surface is necessary pre condition for the successful treatment of peri-implantitis. Ozone can easily be applied with the available silicone cups, where long suprag-ingival abutments are found, two silicone cups can be attached on the top of each other to generate vacuum.

**USE OF HEAL OZONE IN PAEDIATRIC DENTISTRY:** Heal ozone used in the treatment of temporary arrest of caries progression in deciduous teeth or permanent teeth.

**OZONE IN ORTHODONTICS:** 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

**OZONE- HALITOSIS:** In more than 90 % of all the cases, the origins of bad breath are found in the mouth and not in the stomach area. Quite often the bad breath of the patient is accompanied by periodontal disease. Ozone treatment totally corrects the halitosis.

**PROPHYLAXIS:** Apart from professional and continuous biofilm – management is of crucial importance for stability and health, professional tooth

cleaning to remove the biofilm, controlling the reinfection of the cleaned surfaces.

**OZONATED OILS [OLIVE, COCONUT OIL]:** Ozonated oils are also being introduced into alternative dentistry. Ozonated oils are used in healing abscesses of the gum, periodontal pockets and gingivitis. Regular use may also prevent plaque from forming.

**OZONE TOOTH WHITENING:** Tooth may whiten using ozone gas due to its strong oxidizing properties, ozone oil has been used in some Cuban studies in the filled teeth to lighten them. A study in 2003 by Holomes et al. (2003) showed that ozone could oxidize the components responsible for teeth discoloration.

**ORAPURE TOOTH BRUSH STERILIZER:** The orapure toothbrush sterilizer functions to eliminate unwanted and harmful bacteria fungi and viruses that reside on our tooth brush<sup>2</sup>. Using the patented UV and ozone sterilizing lamp, up to 99.99% of these germs are eradicated from your tooth brush in approximately 7 min.

**OZONE TOOTH BRUSH:** The ozone toothbrush was designed by Jonathan savitt (Managing director, Ozone LTD) and Dr. Charles taylor (General Dental Practitioner) in 1995. From 1996 to date, various prototypes and more production samples, of ozone tooth brush have been evaluated at the GKT dental institution kings college, London.

**Design of the ozone tooth brush:** The general dimension of the ozone toothbrush is similar to those popular competitors. The brush handle retains a conventional design with a soft silicon rubber grip, measuring approximately 102 mm in length and 15 mm in width. The head of the brush is elliptical shape measuring approximately 26 mm length and 16 mm at its greatest width.

## CONCLUSION

Ozone contains oxygen, without this living organism and cycle of human living chain get breaks. Ozone is essential for maintaining the ecology of the world. And in the modern world in all the systems of the living, ozone has a vital role in science and technology. In the above review study, ozone's properties in relation to clinical dentistry were discussed.

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