



## DENTAL OZONE - A REVOLUTION IN PEDIATRIC DENTISTRY

## Dental Science

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## ABSTRACT

New treatment protocols and newer materials are being developed at a rapid pace. Ozone dental therapy falls into the category of new treatment protocols in dentistry, yet ozone is no new at all. Minimal invasive procedures, a part of recent trends in dentistry have demanded the use of ozone. This article markedly emphasize different modalities of ozone applications in pediatric dentistry.

## KEYWORDS

Ozone, HealOzone, OzoTop, bio-energetic, anti-microbial, biosynthetic.

## INTRODUCTION

Ozone was first introduced by a German chemist Christian Friedrich Schonbein in 1840. The word ozone originates from the Greek word 'ozein', which means odorant.<sup>1</sup> It is a blue gas with a strong odor and absorbs the harmful ultraviolet rays present in the light spectrum from the sun.<sup>2</sup> It has got a high-oxidation potential which is 1.5 times greater than chloride when used as an anti-microbial agent. It also stimulates blood circulation, and the immune response.<sup>3,4</sup> Ozone used for medical purposes is a gas mixture comprised of 95 to 99.95% oxygen and 0.05 to 5% pure ozone.<sup>5</sup> Ozone is a gas, so it penetrates very well even into tissues and spaces that are not easily accessible. It is used as a circulatory enhancement and stimulation of oxygen metabolism, disruption of tumor metabolism and to kill pathogens.<sup>5</sup>

Ozone therapy can be defined as a versatile bio – oxidative therapy in which oxygen/ozone is administered via gas or dissolved in water or oil base to obtain therapeutic benefits ( Bayson A et al., 2004).<sup>7</sup>

## STRUCTURE

Ozone is a tri-atomic molecule constituting of three oxygen atoms. Oxygen- oxygen bonds bound together at an obtuse angle of 116°C. The internal steric hindrance prevents it from forming a triangular structure. Thus, instead of forming the expected double bonds each oxygen atom forms a single bond with the other resulting in a negative charge throughout the ozone molecule.<sup>8,9,10</sup>

## MODES OF OZONE ADMINISTRATION

Ozone is administered in various forms like ozone gas, as an aqueous solution or oil. These forms of application are used singly or in combination to treat dental disease.

1. **Ozone gas:** There are three different systems for generating ozone gas:
  - a) Ultraviolet system: This type of generator uses an ultraviolet lamp as its source. It produces low concentration 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. It is commonly used in esthetics and for air purification.
  - b) Corona discharge system: Produces high concentration of ozone and is the one commonly used in medical/ dental field. It is easy to handle and it has a controlled ozone production rate.
  - c) Cold plasma : Cold plasma technique is invented by Nikola Tesla and is used for air and water purification.<sup>11,5,12</sup>
2. **Ozone aqueous solution:** The following properties of ozone are used: disinfectant and sterilizing effect; haemostatic effect; especially in cases of hemorrhages, accelerated wound healing, improved oxygen supply and support of metabolic processes.
3. **Ozone oil:** Ozonated oils are pure plant extracts, through which pure oxygen and ozone are passed. The plant extracts undergo a chemical reaction to form a thick, viscous oil, or in some cases, a petroleum jelly-like product. The final products contain ozonides. This method of external application is harmless.<sup>13</sup>

## MECHANISM OF ACTION

Ozone therapy has a wide range of applications in treating various diseases owing to its unique properties including anti-microbial, anti-inflammatory, analgesic, immune-stimulating, anti-hypoxic, detoxicating, bio-energetic, and biosynthetic (activation of the metabolism of carbohydrates, proteins and lipids) actions. **Anti-microbial action:** Ozone causes inactivation of bacteria, viruses, fungi, yeast and protozoa. It disrupts the integrity of the bacterial cell envelope by oxidation of phospholipids and lipoproteins. The anti-microbial effect of ozone results from oxidation of microbial cellular components.<sup>8, 14</sup> **Anti-inflammatory and analgesic action:** Ozone helps in the synthesis of biologically active substances such as interleukins, leukotrienes and prostaglandins which is beneficial in reducing inflammation and pain. The infection or inflammation is positively charged (acidic) and ozone is negatively charged (basic) so the chemistry of infection and inflammation attracts ozone to the area.<sup>15</sup> **Immune-stimulating action:** The electromagnetic action of ozone stimulates and modulates immune system particularly lymphocytes producing interleukins and the greatest output of tumor necrosis factor and interleukin-2 that launches an entire cascade of subsequent immunological reactions.<sup>8</sup> **Anti-hypoxic action:** Ozone brings about the rise of PO<sub>2</sub> in tissues and improves transportation of oxygen in the blood, which results in a change of cellular metabolism, activation of aerobic processes (Glycolysis, Krebs's cycle, oxidation of fatty acids) and use of energetic resources. Ozone acts as a super-oxygenator, bringing oxygen to tissues, assisting the body in its natural healing process. **Bio-energetic and biosynthetic action:** Ozone activates mechanism of protein synthesis, increases amount of ribosomes and mitochondria in cells, elevates functional activity and regeneration potential of tissues and organs.<sup>16</sup>

## APPLICATIONS IN PEDIATRIC DENTISTRY

## Caries

Many studies have proved the effectiveness of ozone therapy in the treatment of pit and fissure caries, root caries and interproximal caries. Ozone is delivered through a hand piece, which is equipped with a silicon cup. The cup is applied directly to the tooth so that it forms a tight seal at the application site. Due to the reactive potential of the ozone gas and its high ability of oxidation, it is able to destroy bacterial membranes. Pyruvic acid produced by bacteria is oxidized by ozone to acetate and carbon-di-oxide. This treatment is an alternative therapy to conventional drilling and filling for noncavitated deciduous carious lesion.<sup>17,18</sup>

- a) **Incipient caries:** 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, all in their ionic forms. Huth et al (2007) conclude that a single 40-second application of ozone gas on non-cavitated fissure caries in permanent molars showed reduced caries progression when compared to the untreated control lesions.<sup>19</sup>
- b) **Pit and fissure caries:** Deep pits and fissures which are not self cleansable are likely to cause food lodgement resulting in bacterial growth. Ozone application in such cases has been found to be

highly effective. Cleansing the fissures prior to ozone treatment permits the ozone to readily access the caries. After the ozone treatment, application of remineralizing agent and sealing of the clean fissures is encouraged.<sup>8</sup>

- c) **Cavitated carious lesions:** Clinical application of ozone appears to be attractive for treatment of cavitated caries lesions in cases where conventional restorative treatment is not possible, e.g. anxious children. Dahnhardt et al (2006) reported that 94% of the children were treatable and the vast majority lost their dental anxiety.<sup>5</sup>
- d) **Root caries:** Baysan et al (2000) assessed antimicrobial effect of HealOzone on primary root caries lesions (PRCL) and evaluated the efficiency of ozone. Ozone exposure to either 10 or 20 s under experimental conditions reduced the total levels of microorganisms in the PRCLs to < 1 % of the control values.<sup>20</sup>

#### Remineralization Therapy:

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, thereby enhancing the remineralization of carious lesion.<sup>12</sup>

#### Restorative Materials:

Studies testing the efficacy of ozone on dental materials justifies the use of ozone prior to the placement of etchant and sealant. There was no alteration observed on the physical properties of enamel, dentin including knoop, surface microhardness or contact angle of adhesive restorative materials.<sup>21</sup> When applied for prolonged duration ozone gas has a strong bactericidal effect on microorganisms within the dentinal tubules of deep cavities, consequently improving the clinical success of restorations.

#### Root Canal Therapy:

Ozone was found to be effective against endodontic pathogenic microorganisms like *Enterococcus faecalis*, *Candida albicans*, *Peptostreptococcus micros* and *Pseudomonas aeruginosa* disinfecting the root canals and dentinal tubules and thus can be used as an intracanal irrigant. When used as an irrigant, ozone encourages tissue regeneration and bone healing. Nagayoshi and colleagues,<sup>22</sup> found nearly the same antimicrobial activity (against *E. faecalis* and *Streptococcus mutans*) and a lower level of cytotoxicity of ozonated water as compared with 2.5% NaOCl. The cytotoxicity against L-929 mouse fibroblasts between ozonated water and NaOCl was compared. The metabolic activity of fibroblasts was high when the cells were treated with ozonated water, whereas that of fibroblasts significantly decreased when the cells were treated with 2.5% NaOCl. Ozonized oils can be used as a temporary intra-canal dressing to clear the canals of necrotic debris by virtue of ozone's bactericidal and effervescent properties. In peri-apical lesions, ozone gas infiltration contributes in the non-surgical management of these lesions. Ozone oils are ozonated sunflower oil or olive oil or groundnut oil.<sup>5,6</sup> Ozonizing the NaOCl makes NaOCl into an even more effective oxidant. Ozone oxidizes the cell walls of the microorganisms and thus destroying them and speeds up the dissolution activity reducing the time required for routine root canal therapy. The Ozonated NaOCl acts as a lubricant for instrumentation and can flush loose debris from root canals.<sup>12,13,23</sup>

#### Periodontal Treatments :

Ozonated oil is used as a safe therapeutic alternative in patients with Acute Necrotizing Ulcerative Gingivitis. Healing and bactericidal properties makes it useful as a subgingival irrigant. Ozone accelerates the healing of soft tissue conditions, i.e. aphthous ulcers, herpes labialis, ANUG and other gum infections. Nagayoshi et al., (2004) tested the efficacy of ozonated water on survival and permeability of oral micro-organisms and dental plaque. They confirm that ozonated water (0.5–4 mg/l) was highly effective in killing of both aerobic and anaerobic microorganisms.<sup>22</sup>

#### Healing Of Wounds :

Ozone has been reported to accelerate the healing of soft tissue conditions like aphthous ulcers, herpes labialis, Acute necrotizing ulcerative gingivitis (ANUG) and other gum infections. It enhances wound healing, improves several properties of erythrocytes and facilitates oxygen release in the tissues. This causes vasodilatation and hence improves the blood supply to the ischemic zones. Therefore, it can be successfully used in cases of wound healing impairments following surgical interventions like tooth extractions. 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.<sup>8,1</sup>

#### Decontamination Of Avulsed Tooth :

Ebensberger et al (2002) observed two-minute irrigation of the avulsed teeth with non-isotonic ozonated water and concluded that ozone was found to be effective in mechanical cleansing and decontamination the root surface.<sup>1</sup>

#### Decontamination Of Tooth Brush:

Ozone application was found to remove the toothbrushes bristles microbiota following conventional brushing. The orapure toothbrush sterilizer functions to eliminate harmful bacteria, fungi and viruses that reside on our 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.<sup>13,12</sup>

#### Bleaching:

Crown discoloration is one of the major aesthetic problem in root canal treated teeth. Tooth whitening can be done using ozone gas due to its strong oxidizing properties. The bleaching effect with ozone is seen when the bleaching agent is placed in the access cavity and crown is exposed to ozone for a minimum of 3 to 4 minutes.<sup>5,24</sup>

#### DENTAL OZONE GENERATORS

In dentistry, there are two widely used ozone units : the HealOzone<sup>25</sup> and OzoTop.<sup>26,8</sup> The ozone unit for dental use was initially developed by CurOzone USA Inc. (Ontario, Canada) and distributed by KaVo Dental (Biberach, Germany) under the name "HealOzone."<sup>27</sup> Millar and Hodson compared the safety of two ozone generating systems namely, Ozicure device and HealOzone. The HealOzone generator was found to be safe to use following the manufacturer's recommendations whereas Ozicure allows ozone to reach concentrations above the permitted levels when used without adequate suction.<sup>28</sup>

The OzoTop is a free-flow ozone delivery system using a corona discharge. It is a compact, easy to use table top unit. High-volume suction is required as this is an open system. Due to the compact delivery system of the OzoTop, root canals and periodontal pockets can be penetrated easily.<sup>6,29</sup>

#### ADVANTAGES

- Non-invasive / minimal intervention technique.
- Induction of an eco-friendly environment.
- Improves metabolism of infected tissues by means of its oxidizing effect.<sup>30</sup>

#### OZONE TOXICITY

Ozone inhalation can be toxic to the pulmonary system and other organs. Prolonged inhalation of ozone can be deleterious to the lungs as the respiratory tract lining fluid is constituted by a very thin, watery film containing a minimal amount of antioxidants that makes mucosal cells extremely vulnerable to oxidation. Known side-effects are upper respiratory irritation, rhinitis, cough, headache, occasional nausea, vomiting, shortness of breath, blood vessel swelling, poor circulation, heart problems and epiphora.<sup>31</sup>

In the event of ozone intoxication the patient must be placed in the supine position and treated with vitamin E, ascorbic acid and n-acetylcysteine.<sup>32</sup>

#### CONCLUSION

Ozone therapy is truly a paradigm shift in dental practice which complies the demands of the public for non-invasive, effective dental care. It is especially suitable to the pediatric patients who are often scared of drilling and find conventional treatment unacceptable. The ozone therapy has been more beneficial than present conventional therapeutic modalities that follow a minimally invasive and conservative application to dental treatment.

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