REVIEW ARTICLE
OZONE IN DENTISTRY

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Abstract
Ozone (O₃), also known as triatomic oxygen, is a naturally occurring compound consisting of three oxygen atoms. Ground level ozone is an air pollutant with harmful effects on the respiratory system; in the upper layers of the atmosphere it filters the potentially damaging UV light from reaching the earth’s surface. In the era of antibiotic resistance, we need a naturally occurring substance like ozone to treat infection without any toxicity. The versatility of ozone therapy, its unique properties, noninvasive nature, are responsible for its widespread use in the various fields of dentistry. The purpose of this article is to understand its mechanism of action and specific uses in the practice of dentistry. (2018, Vol. 02; Issue 01: Page 43 - 47)

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Introduction
The word ozone originates from the Greek word ozein, which means odor and was first used in 1840 by German chemist Christian Friedrich Schönbein “The father of ozone therapy” (1). Ozone is a natural allotrope of oxygen. Its molecular weight is 47.98 gm/mol. It is a blue gas, with strong odor. It is a thermodynamically unstable compound that depending on the temperature & pressure decomposes to pure oxygen with a short half-life. Ground level ozone is an air pollutant with harmful effects on the respiratory system. Ozone in the stratosphere filters potentially damaging ultraviolet light from reaching the earth’s surface (2). In nature, ozone is formed by combination of oxygen in the air, under the influence of factors such as UV radiation, electrical discharge, and intense physical stress on water (3).

Structure
The structure of ozone consists of 3 oxygen atoms, bound by equal oxygen-oxygen bonds at an obtuse angle of 116°8’ (Fig 1). The steric hindrance prevents it from forming a triangle with each oxygen atom forming the expected 2 bonds (4). Instead each oxygen forms only one bond with the remaining negative charge being spread throughout the molecule.
Mechanism of action
Ozone therapy has a wide range of applications in treating various diseases owing to its unique properties including antimicrobial, immunostimulant, analgesic, antihypnotic, detoxicating, bioenergetic and biosynthetic actions (2).

Antimicrobial action
Ozone acts by damaging the bacterial cell membranes by ozonolysis and oxidates intra cellular proteins leading to loss of organelle function (5). This action of ozone is selective to microbial cells and thus does not affect human body cell as the later have good antioxidative ability. Only unhealthy cells like cancer cells which have lost their protective mechanism and organisms such as bacteria, viruses, fungi and parasites which are devoid of antioxidants are destroyed (3).

Anti-inflammatory and analgesics
Ozone stimulates release of interleukins, leukotrienes and prostaglandins. Infection or inflammation is positively charged and ozone is negatively charged reducing pain and inflammation (6).

Immune stimulating action
The electromagnetic action of ozone reactives the immune system through lymphocytes producing interleukins, macrophage activation and cytokine release which in turn boost immune system; hence making it useful in patients with low immune status and immunodeficiency (7).

Anti-hypoxic action
Ozone causes secretion of nitrous oxide, vasodilator. It prevents clumping of red blood corpuscle and increases partial pressure of oxygen. It also activates aerobic processes like glycolysis and Krebs cycle at cellular level thus stimulating circulation of blood and hence used in treatment of circulatory disorders.

Bioenergetic and biosynthetic action
Ozone activates mechanisms of protein synthesis, increases amount of ribosomes and mitochondria in cells, thus increasing regeneration potential of tissues (8).

Production of ozone
The most common methods of ozone production used for therapeutic purposes are given below.
- Ultra-Violet System: Useful for purifying air but generates less concentration of ozone.
- Cold Plasma System: Useful for purifying water and air.
- Corona Discharge System: Most popular systems in medicine and dentistry. It has controlled production rate and easily generates high ozone concentration (9).

Forms of ozone
Ozone may be available in 3 forms-(2)
1. Ozone gas
2. Ozone oil
3. Ozonated water

Application of ozone in dentistry
ORAL MEDICINE
1. In the treatment of oral viral lesions—Ozone has a potential of stimulating antibodies and cytokines in body thus helping in the treatment of herpes simplex
and herpes zoster infections. It also neutralizes herpes virions and prevents bacterial super infection (1).

2. In the management of Temporomandibular joint disorders (articulation and inflammatory diseases) — Ozone gas is used because of its bio stimulation and anti-inflammatory effects (1).

3. In treatment of soft tissue lesions (all kinds of infectious, inflammatory, traumatic, burns, wounds & soft tissue lesions including aphthae, denture stomatitis) – Ozone has a disinfectant healing properties which are brought to use here (1).

4. In the management of Chronic mandibular osteomyelitis - Macedo and Cardoso described a case report of the application of ozonated oil on mandibular osteomyelitis and demonstrated faster healing times than conventional protocols as ozone has a positive influence on bone metabolism and reparative process of the bone and moreover it promotes complete and rapid normalization of non-specific resistance and T- cellular immunity (10).

ENDODONTICS

1. Dental caries: Ozone is used in the treatment of early tooth, pit and fissure and proximal caries. Reversal of caries is associated with remineralisation and a corresponding reduction in acidogenic and aciduric microorganisms. Ozone enhances the remineralisation of the carious lesion by killing the microorganisms by damaging their cell membrane, so that the local PH is raised. Being a powerful oxidant, ozone has the ability to remove proteins in the carious lesion and enable calcium and phosphate ions to diffuse through the lesion (11).

2. It is used for disinfecting root canals and dentinal tubules. Ozone is effective against E.Faecalis, Candida albicans etc. The ozonated air can get to the narrowest places in the canal and periapical region where conventional liquids may not be able to reach, disinfect the area and accelerate healing.

3. Bleaching: Strong oxidizing properties causes tooth whitening- ozone helps in breaking the bonds which makes the enamel lighter in colour and helps in bleaching.

4. In the treatment of dentinal hypersensitivity- Ozone removes the smear layer, opens up the dentinal tubules, broadens their diameter and allows calcium and fluoride ions flow into tubules easily, deeply and effectively to plug dentinal tubules, preventing the fluid exchange through these tubules (3).

PERIODONTICS

1. Effective in the treatment of halitosis and ANUG— Ozone reduces the requirement of antibiotics as the region is disinfected locally.

2. Inhibition of dental plaque formation— Ozonated water can be used in the ultrasonic water reservoir, also as a pretreatment rinse before scaling, root planning and the sulci, pockets are irrigated using syringe and canula in nonsurgical pocket curettage. This process will reduce the initial pathogenic load on the patient locally and systemically. After treatment, each pocket & sulcus is inflated with ozone gas which directly goes into tissues, sterilizing the area (3).

IMPLANT DENTISTRY

1. Helps in bone regeneration

2. Used in sterilization and prevents infection— A sterile implant surface is necessary pre condition for the successful treatment of periimplantitis. Ozone can easily be applied with the available silicone cups, where long supragingival abutments are found, two silicone cups can be
attached on the top of each other to generate vacuum (11).

ORTODONTICS

1. 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 (11).

**Contraindications (8, 12)**

- Pregnancy
- Glucose 6 phosphate dehydrogenase deficiency
- Hyperthyroidism
- Severe anemia
- Severe Myasthenia
- Acute alcohol intoxication
- Recent Myocardial Infarction
- Haemorrhage from any organ
- Ozone allergy

**Ozone toxicity**

- Ozone gas should not be inhaled as the bronchial pulmonary system is very sensitive to ozone.
- Ozone should not be administrated I.V as there would be a risk of air embolism.
- Other side effects include
  - Epiphora
  - Upper respiratory irritation
  - Rhinitis, Cough, Nausea
  - Vomiting,
  - Shortness of breath,
  - Blood vessels swelling,
  - Heart problems
  - Stroke.

In the event of ozone intoxication patient must be placed in SUPINE POSITION and treated with Vitamin- E, ascorbic acid, N-acetyl cysteine and inhaled humid oxygen (9).

**Conclusion**

Ozone is used in almost all aspects of dentistry. There are good evidence of ozone biocompatibility, and effectiveness in removing the microorganisms from dental unit water lines, the oral cavity, and dentures. There are various advantages of ozone therapy as it is a biological and atraumatic treatment modality. Therapeutically it acts as a stimulant on the circulatory system which makes it a good treatment modality of medical pathologies, the cost effectiveness is another good property of ozone. Further research in ozone would bring a revolution in dental practice.

**References**