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A Review of Ozone's Use in General Medicine and Dentistry

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Abstract:
Since more than a century ago, ozone, an allotropic form of oxygen, has been used to treat many ailments. It has many beneficial impacts on biological systems, including antibacterial, antihypoxic, analgesic, and immune stimulating properties. These methods of action, which are backed by numerous case reports and scientific investigations, enable its use in a variety of medical specialties. This literature study is an additional attempt to list the various methods of using ozone to dental problems. Standardizing the indications and treatment guidelines for this intriguing medicinal agent will require additional research.

1. INTRODUCTION

A triatomic molecule called ozone (O3) is made up of three oxygen atoms. It has a molecular mass of 47,98 g/mol [1]. Ozone is a chemical molecule that, depending on system variables like temperature and pressure, decomposes quickly to pure oxygen [2]. Ozone is thermodynamically very unstable. Ozone at ground level is an atmospheric contaminant that harms the respiratory system. Potentially harmful ultraviolet light is prevented from reaching the surface of the Earth by ozone in the upper atmosphere. Ozone is used in medicine as one of its many applications in a variety of sectors [3].
One of the contemporary non-drug forms of treatment is ozone therapy. It has been in use for almost a century. Medical reports on the effective use of ozone in treating various diseases and research of its effects led to a quick increase in interest in it. Other elements including ease of use, patient toleration, the lack of side effects or adverse reactions, and excellent medical-social and economic efficiency also contributed to its widespread adoption.
Ozone therapy is still largely disregarded in the medical community despite the fact that gaseous ozone is very poisonous and has potent oxidizing effects [4].
Schonbein coined the term "ozone" in 1840. He electrically discharged oxygen and observed "the fragrance of electrical stuff." Schonbein came to the conclusion that smells were caused

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by a gas, which he called ozone (from the Greek ozein, "odorant"), and he identified a number of its characteristics. Since then, a large number of researchers have sought to clarify the characteristics and functions of ozone. Its allotropic form of oxygen was demonstrated by Mariniak and Delarive, while Mulliken and Dewar confirmed its molecular structure.

Ozone has emerged as a viable substitute for chlorination because of its capacity to eliminate hazardous industrial impurities (such as phenols, cyanides, and tetraethyl lead, among others) and inactivate bacterial pathogens in sewage. Wiesbaden, Germany was the first city to employ ozonation to purify its drinking water in 1901, and other cities that followed included Zurich, Florence, Brussels, Marseille, Singapore, and Moscow (home to the largest installation in the world). The beginnings of the history of ozone's medical uses are hazy and anecdotal. A. Wolff, Payr, and Aubourg's names will forever be associated with groundbreaking study, particularly in the area of locally administered medicinal ozone [5]. One of the earliest trustworthy designs of medicinal ozone generators was created by J. Hansler. During the First World War, A. Wolff effectively treated putrescent wounds, suppurating bone fractures, fulminating inflammations (phlegmons), and abscesses. He published his findings in 1915.

The work of the surgeon and ozone therapist Erwin Payr, who presented his groundbreaking article "Ozone Treatment in Surgery" (Über Ozonbehandlung in der Chirurgie), at the 59th Meeting of the German Surgical Society (Deutsche Gesellschaft für Chirurgie) in 1935, gave this discipline a significant boost. This might be considered the official start of ozone therapy. However, the usage of medicinal ozone didn't become obsolete until much later in the 20th century, specifically not until the 1950s. It was particularly challenging for the practitioner to administer ozone locally to treat wounds or by rectal insufflation in the absence of ozone-resistant materials like plastics because any detectable amount of ozone in the surrounding air rendered the task all but impossible. Hänsler unveiled his first medical ozone generator in 1958, which could create an ozone/oxygen combination at therapeutically adjustable doses (concentrations). They established ozone therapy as we know it today along with H. Wolff [9].

Rokitansky, a surgeon, presented the first thorough studies on the topical and systemic treatment of diabetic gangrene. Werkmeister developed local treatment methods in the form of "subatmospheric ozone gas application." H. Wolff, following in his research the large number of publications by Payr and Aubourg, was the next to introduce extracorporeal blood treatment into medical practice. In proctology, Knoch next introduced rectal ozone insufflation.

Many of the Payr-described indications had been abandoned in favor of other, more potent treatments; nonetheless, in other cases, medical ozone could be used in addition to a standard medication. This was especially true for inflammatory joint illnesses like rheumatism and arthritis, for which Fahmy has created a comprehensive therapeutical paradigm [9].

The use of ozone in dental treatment has advanced extremely slowly, while being quite straightforward in terms of application forms and active mechanisms. The Swiss therapist A. Fisch, who introduced Payr to ozone and presented a PhD thesis (1952) and the first publication on the use of ozone in dental medicine in 1935 [9], must be mentioned here as mentor. But it wasn't until the end of the 1980s that dental research (Kirschner, Filippi) [6] and dental practice (Lynch) [7] once again turned to the topic of medical ozone.

Ozone has a variety of known effects on the human body, including immunostimulating, analgesic, antihypoxic, detoxicating, antimicrobial (bactericidal, viricidal, and fungicidal), bioenergetic, and biosynthetic (activating the metabolism of carbohydrates, proteins, and lipids) effects, among others [8].

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The most researched aspect of ozone's antimicrobial activity. The primary cause of cell death is localized cytoplasmic membrane damage from secondary oxidants' effects on dual bonds, as well as ozone-induced changes in intracellular contents (such as protein oxidation and the loss of organ function). The main antioxidative ability of human body cells prevents them from being negatively impacted by this action, which is non-specific and selective to microbial cells.

In bacteria that are resistant to antibiotics, ozone is particularly effective. In a liquid environment with an acidic pH, it becomes more antibacterial. Studies on the little mutagenic impact of ozone on bacteria regarding a slow uptick in ozone-resistant germs must be mentioned. The mechanism of ozone action in viral infections is based on the intolerance of infected cells to peroxides and a change in reverse transcriptase activity, which is involved in the creation of viral proteins [5, 6].

Bioactive compounds such interleukins, leukotrienes, and prostaglandins are produced as a result of ozone exposure. Ozone has an impact on the cellular and humoral immune systems; it promotes the growth of immunological-competent cells and the production of immunoglobulins. Additionally, it promotes macrophage activity and raises the susceptibility of microorganisms to phagocytosis.

Ozone causes a rise in pO_2 in tissues and enhances oxygen delivery in the blood, which changes cellular metabolism by triggering aerobic processes (glycolysis, the Krebs cycle, and B-oxidation of fatty acids) and utilizing energy sources. Additionally, it enhances the erythrocytes' contact surface for oxygen transport and reduces the formation of erythrocyte aggregates. Arterioles and venules dilate as a result of the release of vasodilators like NO that are brought on by ozone. Additionally, it increases the number of ribosomes and mitochondria in cells and activates pathways for protein synthesis. The increased functional activity and organ and tissue regeneration potential are explained by these cellular alterations. [6]

Indications and contraindications for using ozone in medicine

The main benefits of ozone therapy were based on several case reports from clinics and hospitals. From a scientific perspective, other research on its methods of action corroborated those conclusions.

The following conditions are listed in the medical literature as contraindications to ozone therapy: acute alcohol intoxication, recent myocardial infarction, bleeding from any organ, pregnancy, hyperthyroidism, thrombocytopenia, and ozone allergy [6].

There is evidence that patients with pre-existing allergic airway illnesses can benefit from repeated exposure to 125 p.p.b. ozone in terms of improved lung function and reduced inflammatory airway responses to allergen inhalation [10].

Direct intravenous injections of ozone/oxygen gas are discouraged by the European Cooperation of Medical Ozone Societies due to the potential danger of air embolism [3].

Due to the peculiar nature of medication forms of ozone in gaseous form, new application techniques have had to be created for ozone safety. Its usage as a transcutaneous O_3 gas bath in local applications, such as the treatment of external wounds, has been proven as a very practical and useful procedure, for instance at low (subatmospheric) pressure in a closed system insuring no escape of ozone into the surrounding air.

Autohaemotherapy [or auto (haemo) transfusion] has become the preferred systemic therapy, replacing rectal insufflation, which is primarily used to treat intestinal problems but is also utilized systemically. In a sealed, pressure-free system, a similar dosage of ozone gas is passed through or, more accurately, transferred (in the form of microbubbles) to 50 to 100 ml of the patient's blood, obtaining the best distribution to reach the most red and white blood cells and activate their metabolism.

Ozone can be used as a supportive treatment for pain in the locomotor system through intramuscular or intraarticular injections [6].

Application of ozone in dentistry

The primary application of ozone in dentistry depends on its antibacterial qualities. It has been shown to be effective against fungi, viruses, and bacteria that are Gram positive and Gram negative. [12]

In an in vitro study, Muller et al. [11] examined the effects of ozone gas, photodynamic therapy (PDT), and well-known antiseptics (2% chlorhexidine, 0,5, and 5% hypochlorate solutions) on a multispecies oral biofilm. Actinomyces naeslundii, Veillonella dispar, Fusobacterium nucleatum, Streptococcus sobrinus, Streptococcus oralis, and Candida albicans were among the microbes examined.

Vacuum ozone delivery device Kavo Healozone produced gasi-form ozone. They came to the conclusion that the biofilm's matrix-embedded bacteria populations were well shielded from antimicrobial agents. All bacteria may be successfully eliminated by 5% hypochlorite solution only. The number of bacteria in the biofilm could not be reduced or eliminated by using gasiform ozone or PDT [11].

Using the Kavo Healozone device, Baysan et al. [13] examined the antibacterial effect on primary root caries lesions (PRCL) and the effectiveness of ozone in particular on Streptococcus mutans and Streptococcus sobrinus. The total amount of microorganisms in the PRCLs was consequently decreased to 1% of the control values after either a 10- or 20-second exposure to ozone in an experimental setting. Streptococcus mutans and Streptococcus sobrinus populations might be decreased in vitro by applying ozone for a duration of 10 s [13].

After applying a professionally applied remineralizing solution containing xylitol, fluoride, calcium, phosphate, and zinc, Holmes [14] investigated the effect of the KaVo Healozone device on PRCL. 89 individuals, ranging in age from 60 to 82, received this form of treatment. 100% of PRCLs that had been treated with ozone improved after 18 months. Only one PRCL had improved in the control group when lesions were not treated. In 37% of PCRLs, the condition worsened from leathery to soft, whereas the status remained leathery in 62% of cases [14].

The effects of ozone therapy on bacterial cell development and ultrastructural alterations in Escherichia coli, Salmonella sp., Staphylococcus aureus, and Bacillus subtilis were examined by Thanomsub et al. [20]. It was found that water polluted with up to 105 cfu/ml bacteria can be sterilized in 30 minutes using ozone at 0.167 mg/min/l. It was discovered that the bacterial cell membrane was being destroyed, which led to intercellular leaking and ultimately led to cell lysis.

However, at greater concentrations of 106 and 107 cfu/ml, these ozone concentrations have no appreciable impact on the survival of the cells in bacterial cultures [15].

When treating patients with chronic gingivitis, periodontitis and periodontal abscesses, herpes labialis, purulent periodontitis, dentition difficilis, etc., Kronusová [16] used ozone in the following situations: prevention of dental caries in fissures of the first permanent molars in children, application of ozone in a prepared cavity, after tooth extraction, in case of postextractional complications. Nearly all gingivitis patients saw subjective and objective improvements in their condition, as did patients with periodontal abscesses in whom no

exsudation was seen. Application of ozone following tooth extraction was discovered to be quite beneficial as well; even in situations where alveolitis sicca complications occurred, which affected only 10% of patients, the clinical course was shorter and more mild [17].
Filippi [22] noted that ozonated water had an impact on the oral cavity's epithelial wound healing process. It was discovered that using ozonized water every day could hasten oral mucosa recovery. The first two postoperative days allow for the observation of this effect. Daily therapy with ozonized water speeds up the physiological healing process as compared to untreated wounds [18].

2. CONCLUSIONS

Ozone therapy is fairly affordable compared to traditional medical treatments like antibiotics and deodorants, and several case reports and academic studies indicate that it is quite effective. Standardizing ozone therapy's indications and treatment processes will require more research.
It's important to remember this controversial method's contraindications.

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