Introduction to Ozone in the Dental Practice
A Peer-Reviewed Publication
Written by Amber Pierce, EFDA

Abstract
With health-care costs on the rise, patients are becoming more aware of their treatment options and are looking for dental care that is cost effective and minimally invasive. Dental offices may receive calls from patients requesting information about or asking if the office provides ozone therapy. This article discusses ozone therapy and the practical applications for the dental office to prepare practitioners and staff to serve the needs of this growing population.

Educational Objectives
This article will define ozone and the practical applications for the dental practice. This information will enable the dental professional to answer questions from patients and decide if this is a therapy that can be adopted into their armamentarium.

After studying this course, the dental professional should be able to:
1. Define medical/dental ozone
2. Understand how ozone is generated and the modes of application
3. Identify clinical applications for ozone in the dental practice
4. Answer potential questions raised by patients about ozone therapy

Author Profile
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Abstract
With health-care costs on the rise, patients are becoming more aware of their treatment options and are looking for dental care that is cost effective and minimally invasive. Dental offices may receive calls from patients requesting information about or asking if the office provides ozone therapy. This article discusses ozone therapy and the practical applications for the dental office to prepare practitioners and staff to serve the needs of this growing population.

What is ozone?
Ozone is a naturally occurring gas that contains three atoms of oxygen versus two atoms in a normal oxygen molecule. This extra atom of oxygen acts as a hunter, killing pathogens such as bacteria, viruses, fungi, and parasites. Healthy cells are enveloped with an enzyme coating consisting of antioxidants that prevent them from being penetrated by ozone. Bacteria and viruses lack this protective coating. When subjected to ozone therapy, the cell wall of bacteria is disrupted, making it vulnerable to oxidation of the phospholipids and lipoproteins. This peroxidation process interrupts the reproductive cycle of viruses, damaging its viral capsid, and in the case of fungi, ozone inhibits cell growth. Destruction of the cell membrane of pathogens results in a disinfecting or sterilizing effect.

Due to its ability to eliminate pathogens, ozone is most commonly used in the sterilization of public water systems, the food and bottled beverage industry, as well as in air purification. Ozone therapy is being used in the medical, veterinary, and dental fields to prevent and treat many diseases and conditions. Use of ozone in controlled applications has been found to be safe and free from side effects.

History of ozone
The discovery of ozone in 1840 happened by chance from a strong smell produced when Professor Christian Schönbein was exposing oxygen to electrical charges in his lab. He realized that the odor was being caused by a gas, which he named ozone. During World War I, Dr. Hans Wolff used ozone to treat soldiers with gunshot wounds, inflammations, and abscesses; he published the successful results of his work in 1915. The first dentist to use ozone gas and ozonated water in his practice was Dr. E. A. Fisch in 1932. One of his patients was surgeon Dr. E. Payr, who was so impressed with the therapy that he applied its methods to general surgery and published “Ozone Treatment in Surgery” in 1935. The first medical ozone generator was presented in 1958 by Joachim Hansler, which made it possible for the therapeutic modalities of ozone used today.

Generation of ozone
In nature, ozone gas is present in atmospheric air. Reproducing this gas in industry and medicine involves three methods:
1. The ultraviolet method produces a low concentration of ozone and is used to purify air.
2. Cold plasma is used to purify water and air.
3. Corona discharge is used in medical and dental therapies. The operator is able to control the production rate, and this method is capable of generating high concentrations of ozone.

Application of ozone in dentistry
Ozone for dental therapies is administered to patients in three forms: gas, water, and oil. Ozone gas is created by taking pure medical grade oxygen and electrically charging it through a generator. It is delivered to the patient via a handpiece fitted with a small cannula, small cup, or by injection.

Ozonated water is used in water supply bottles to disinfect water lines that supply ultrasonics, high speed handpieces, and air/water syringes. Used as a pretreatment patient rinse, it reduces aerosol contaminants during procedures.

Ozone gas changes into ozonides when diffused into oil. When ozone gas is bubbled through different types of vegetable oils, it retains its healing properties for many years. Ozone oil is used topically for oral lesions, in endodontics to lubricate and disinfect canals, in periodontal therapy to treat pockets, and after extractions to promote healing.

Unlike many disinfectants available in dentistry, ozone has no side effects such as a bad taste or smell and is safe for the environment, making it an excellent treatment modality for every aspect of dentistry.
Dental caries

As health-care costs continue to rise, patients are looking for dental treatments that are more economical and minimally invasive. Ozone therapy meets these needs. Unlike traditional “drill and fill” dentistry that requires significant amounts of tooth structure to be removed to eliminate infected tissue, ozone therapy halts decay by killing acid-producing bacteria, which allows for natural remineralization to occur. Depending on the stage of the carious lesion, in many cases the patient requires no anesthetic, no high-speed drilling, and shorter appointment times. These factors create a pleasant dental experience for the patient and result in reduced costs for dentist and patient.

Simple treatment for a carious lesion is found would be as follows:
1. Remove loose debris until a leathery base is achieved with air abrasion, spoon excavator, or slow-speed handpiece.
2. Insufflate ozone gas for 30 seconds into preparation.
3. Apply a remineralizing solution to preparation.
4. Restore preparation with glass ionomer or traditional restorative material.

Insufflating ozone gas will reduce or kill any remaining acid-producing bacteria in the cavity preparation. This provides an environment for better bond strength and a decrease or elimination of postoperative sensitivity. Restoring the lesion with glass ionomer will provide long-term release of fluoride and minerals to the tooth to aid in remineralization. For a more extensive carious lesion, a patient may require anesthesia and excavation may be more involved; however, application of ozone gas and restoration with glass ionomer would still be applicable.

Long-term management of dental caries involves a partnership between dentist and patient. The dentist should provide quality dental treatment and education so that the patient can make changes to any habits that may contribute to the disease process and implement effective home-care strategies.

Endodontics

Unfortunately, many patients enter the dental office in severe pain with cavities that have infected the nerve space and require root canal treatment. The aim of conventional endodontic therapy is to sterilize the canals of an infected tooth to enable preservation of the tooth. Accomplishing this involves the cleaning of main and accessory canals by instrumentation and irrigation with chemicals to reach areas that the instrument cannot.

Ozone therapy has proved effective when used after traditional cleaning and shaping of canals. Coating files with ozonized oil not only lubricates but disinfects canals. When compared with calcium hydroxide, ozone oil was found more effective against bacterial species when used as an intracanal medication. Ozonated water used as an irrigant in endodontic procedures has shown to be nearly the same in antimicrobial activity against E. faecalis and Streptococcus mutans in comparison with 2.5% NaOCl. Before final fill of the canal space, insufflation of ozone into the canal space will allow the gas to penetrate into lateral canals and tubules, killing microbes. Due to its antimicrobial and oxidant capacity, ozone can be an excellent addition to conventional endodontic treatment without the harmful by-products produced by traditional chemical irrigation.

Oral surgery and lesions

The extraction of a tooth can be very traumatic for a patient during the procedure and in the post-op healing process. To prevent infection and to promote healing, ozone gas is insufflated into the socket postextraction, irrigated with ozonated water, and finally a gel-foam material saturated with ozonized...
oil is packed into the socket. Application of ozone as opposed to saline irrigation reduces postoperative pain and the potential for dry socket. Recovery periods for patients treated with ozone have proved to be shorter due to the formation of pseudomembranes in sockets that provide protection from mechanical or physical trauma.

Oral lesions such as aphthous ulcers, herpetic, candidiasis, lichen planus, and angular cheilitis are common conditions seen in the dental practice. Since these lesions result from bacterial, fungal, or viral means, ozone is a useful treatment option. Topical application of ozonized olive oil was studied on patients with oral lesions and showed 100% cure rates with no adverse side effects. This method may be preferred over gaseous ozone in that patients can use the oil at home when a lesion arises, saving them the additional cost of a dental visit.

Sensitivity
Tooth sensitivity is a common problem for many patients. It can cause frustration not only for the patient but also for the dentist or hygienist trying to alleviate the symptoms. Even after application of a variety of desensitizing agents or placing restorations over sensitive areas, patients may still have lingering sensitivity. As treatment methods become more invasive, the potential for increased sensitivity rises. Ozone therapy in combination with remineralizing agents can deactivate the stimulus causing the pain and allow remineralization deep into the tubules. Results from a clinical trial of patients with hypersensitive teeth treated with gaseous ozone for sixty seconds showed pain reduction of 55% immediately after treatment. Pain levels continued to decrease in the weeks following ozone treatment. Due to the multifactorial nature of dental sensitivity, anecdotal evidence supporting the efficacy of ozone in reducing or eliminating tooth sensitivity should be given due consideration.

Periodontal therapy
The oral environment is host to many complex bacteria that develop into communities and form a biofilm on solid surfaces. The aim of periodontal therapy is to remove biofilm and prevent the recolonization of pathogens in the treated areas. Conventionally this is done by scaling and root planing of the periodontal pockets and then subgingival irrigation with antimicrobial agents. Ozone has been found to be an effective nonmedication treatment option for periodontal therapy. A 2015 study concluded that subgingival irrigation with ozonized water reduced gingival inflammation, decreased pocket depth, increased attachment levels, and reduced bacterial count in periodontal pockets. To eliminate biofilm in the oral cavity is impossible, but disinfection of the biofilm with ozone is possible in combination with scaling and root planing.

Water lines
Just as biofilm forms on surfaces in the oral cavity, it also forms in the lines of dental water units. These water lines harbor bacteria that can be harmful to patients and the dental team. The biofilm buildup in water lines can be thick and is enclosed in a protective layer that makes it resistant to chemical agents. Since the majority of dental procedures require water, this is a real concern for the dental practice. Traditional agents used to eliminate bacteria in these lines are effective for bacteria that are suspended in the water but not on the biofilm layer. Ozone is widely accepted in the sterilization of public water systems, so its efficacy in treating dental water lines would be advantageous. In a study investigating the effectiveness of ozone in controlling the contamination of dental water lines, the initial bacterial count was just above 5,000 CFU/ml. After the first three-minute application of ozone and flushing of the water line, the bacterial count was reduced to 300 CFU/ml, and then to 0 CFU/ml after the second and subsequent applications. For five weeks after ozone treatment, the lines continued to be sterile. This dramatic reduction in the bacterial count and its long-term sterility demonstrate the usefulness of ozone in the treatment of dental water unit lines.

Special considerations of ozone treatment
Misuse of any pharmaceutical agent can have adverse or lethal effects to one’s health. To ensure the safety of practitioners and patients, ozone in the dental practice should be administered only by trained professionals in controlled applications. Safety limits set by the Occupational Safety and Health Administration of “0.10 ppm of ozone exposure for an 8-hour-day” should be monitored and enforced. Ozone gas should never be inhaled due to the sensitivity of the bronchial pulmonary system. Use of high-volume suction and proper ventilation is essential to protect both patient and operator during treatment.

Conclusion
Ozone is an excellent adjunct to all aspects of dentistry. Its effectiveness in disinfection and healing make it a therapy that contributes to the success of dental procedures. Patients are receptive to ozone because it is minimally invasive, shortens appointment times, and in most cases requires no anesthetic. Ozone research has opened up the way for exciting new treatment protocols that have not been taught in dental schools or clinical training and may change the way we treat patients in the future.

References
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1. Ozone is capable of eliminating which pathogens?
   a. Bacteria
   b. Viruses
   c. Parasites
   d. All of the above

2. Who was the first dentist to use ozone in his practice?
   a. Dr. Hans Wolff
   b. Dr. E. A. Fisch
   c. Dr. E. Payr
   d. Joachim Hansler

3. What method of ozone generation is typically used in dentistry?
   a. Ultraviolet
   b. Corona discharge
   c. Cold plasma
   d. None of the above

4. What can insufflating ozone gas into a cavity preparation achieve?
   a. Will kill acid-producing bacteria
   b. Can decrease or eliminate post-op sensitivity
   c. Can provide an environment for better bond strength
   d. All of the above

5. Irrigation with ozonated water during endodontic procedures is effective against which bacteria?
   a. E. faecalis
   b. E. coli
   c. Streptococcus mutans
   d. Both a and c

6. What oral lesions can be treated with ozone oil?
   a. Aphthous ulcers
   b. Lichen planus
   c. Herpes
   d. All of the above

7. What is the methodology of ozone for sensitive teeth?
   a. Opens dentinal tubules
   b. Deactivates the stimulus causing pain
   c. Prevents remineralization into dentinal tubules
   d. None of the above

8. What are the traditional methods for removing biofilm in periodontal therapy?
   a. Scaling and root planing
   b. Irrigation with antimicrobial agents
   c. Application of fluoride
   d. Both a and b

9. What can ozonated water in combination with scaling and root planing accomplish?
   a. Can reduce inflammation
   b. Will increase pocket depth
   c. Can decrease attachment levels
   d. None of the above

10. Why is biofilm harmful in dental water units?
    a. It harbors bacteria
    b. It is resistant to chemical agents
    c. It can harm patients and dental team
    d. All of the above

11. Why are patients receptive to ozone treatment?
    a. It is minimally invasive
    b. It requires longer appointment times
    c. The treatment is painful
    d. None of the above

12. How has ozone been effective in oral surgery?
    a. Reduces incidence of dry socket
    b. Reduces post-op pain
    c. Increases incidence of infection
    d. Both a and b

13. How is ozone gas delivered to a patient?
    a. Mask
    b. Handpiece
    c. Injection
    d. None of the above

14. What are the most commonly known uses for ozone?
    a. Sterilization of water systems
    b. Air purification
    c. Sterilization of food
    d. All of the above

15. Ozone is used to treat diseases in what fields?
    a. Astronomy
    b. Medical
    c. Veterinary
    d. Both b and c

16. Ozone contains how many atoms of oxygen?
    a. 0
    b. 1
    c. 2
    d. 3

17. The discovery of ozone occurred in what year?
    a. 1932
    b. 1915
    c. 1840
    d. None of the above

18. How was ozone used during World War I?
    a. To treat gunshot wounds
    b. To treat inflammations
    c. To treat abscesses
    d. All of the above

19. How is ozone different from traditional disinfectants used in dentistry?
    a. Has many side effects
    b. Is safe for the environment
    c. Has a bad smell
    d. Has a bad taste

20. Ozone oil can be used in what areas of dentistry?
    a. Dental water lines
    b. Periodontal therapy
    c. Endodontic procedures
    d. Both b and c
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