Ozone Caries Management

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It is unreasonable to expect any individual technique or material to be capable of performing all functions under all circumstances. While the clinical use of ozone has many advantages and applications, it is not a panacea. Ozone has been proven to be effective when it has been prescribed in sufficient concentration, for adequate lengths time and delivered into lesions directly. Any treatment that is uses in doses that are too low or delivered incorrectly, cannot be effective. Ozone treatment should be used as part of the individualized preventive and healing oral care process for patients who are affected with active caries.

ANTIMICROBIAL EFFICACY OF OZONE

Ozone is one of the most powerful antimicrobial agents that is currently used in medicine or dentistry. Dental caries is caused by an ecological niche of caries producing organisms (Fig. 1). Thus it is not surprising that eliminating these carilogical organisms provides tremendous clinical and long term preventive advantages for patients. Peer reviewed dentistry research papers2-have shown the antimicrobial effectiveness of ozone as a gas and in the form of ozonated water.

One study reported bacterial reduction similar to that achieved by using 0.2 percent chlorhexidine or photoactivated disinfection using ozone gas above biofilms in culture media. It should be noted that ozone is a potent oxidant and will form a redox reaction with reductants in a culture medium. The authors did not bubble the ozone into the biofilm as the treatment required. Ozone should be delivered under pressure into a lesion by pressing the delivery cap onto the carious surface so that ozone can penetrate the lesion (Fig. 2). In vivo lesions, unlike artificial biofilms, contain many molecules such as iron which increase the antimicrobial effectiveness
of ozone in caries and can help to produce the powerful hydroxyl radicals that further increase the antimicrobial effectiveness in vivo.

In dental unit water lines ozone achieved a 57 percent reduction in biofilm and a 65 percent reduction in viable bacteria in spite of a very low dosage and short time of application. In addition, a high level of biocompatibility of aqueous ozone on human oral epithelial cells, gingival fibroblast cells and periodontal cells has been published.

**OZONE AS AN OXIDIZER**

Pyruvic acid (Ka = 3.20 mMol) contributes substantially to the lowered pH values associated with active caries lesions. Pyruvic acid is oxidatively decarboxylated to acetate and carbon dioxide by ozone as in the following equation.

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\text{CH}_3\text{COCO}_2 + \text{O}_3 \rightarrow \text{CH}_3\text{CO}_2 + \text{CO}_2 + \text{O}_2
\]

Aciduric (acid loving) microorganisms prefer an acidic ecological niche in order to prosper. Remineralization of incipient carious lesions can be encouraged by buffering plaque fluid by the production of acetate, or other high pKa acids found in resting plaque. Baysan et al study did not follow the manufacturer's recommendation and did not fully clean the fissures. Not surprisingly, they reported that Ozone treatment of non-cavitated occlusal lesions for 40 seconds failed to significantly reduce the numbers of viable bacteria in infected dentin beneath the de-mineralized enamel.

**MANAGEMENT OF PIT AND FISSURE CARIES**

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Ozone treatment of enamel caries lesions within pits and fissures in caries active situations should receive PROPHYflex (Ka- Vo, Lake Zurich Illinois) or similar cleansing out of the fissures prior to ozone treatment (Fig. 3). This permits the ozone to readily access the caries and after the ozone treatment, sealing of the clean fissures should be encouraged.

The same study used only ozone to treat non-cavitated caries involving the middle third of dentin, again a procedure neither recommended by the manufacturer nor commonly used by clinical dentists. Clinical recommendations involve opening the lesions and caries removal leaving only up to 1mm of caries on the pulpal floor prior to ozone treatment and subsequent restoration (Fig. 4). Another published article reported: "From the data it can be concluded that ozone application significantly improved non-cavitated initial fissure caries in patients at high caries risk over a 3- month period."

**PROPHYLACTIC OZONE TREATMENT FOR FISSURE AND RESTORATIVE TREATMENT**

There is good evidence for the in vitro application of ozone as a prophylactic antimicrobial treatment prior to etching and the placement of dental sealants and restorations. Significantly, there is no negative interaction with the physical properties of the enamel, dentin or the adhesive restorative materials.

Photo activated disinfection is also available to provide antimicrobial treatment of cavity preparations prior to restoration. The Aseptim Unit (SciCan, Toronto Canada) has ability to penetrate caries to the depth of approximately 300 (Fig. 5).
MANAGEMENT OF ROOT CARIES

The HealOzone unit has been shown to reverse and arrest shallow non-cavitated root caries lesions when used as part of a full preventive care regimen (Fig. 6). This process includes reducing the frequency of consumption of fermentable carbohydrates, increased use of fluoride-containing products and improved oral hygiene.

This is the most reasonable use for ozone treatment. Ozone is most effective when it has the ability to penetrate shallow lesions which were about 1mm deep at the maximum and the HealOzone must also be used correctly; the ozone cap must be held against the caries lesion allowing the ozone to penetrate the decay and biofilm. In the case where there is a cavitated 4mm deep root caries lesion adjacent to the gingival margin simply using ozone treatment would probably not be effective. To manage this kind of a situation the outer caries must first be removed, leaving about 1mm of caries over the cavity floor. Then ozone treatment followed by routine restoration is indicated.

Dahnhardt et al study treated open carious lesions with ozone in anxious children, a commonly seen problem. In fact the children who will not get treatment of a very early stage of dental caries are most likely the ones who can be the most anxious and not cooperative during routine dental procedures. With ozone treatment "94 percent of the children were treatable and 93 percent lost their dental anxiety. The hardness values improved significantly in the ozone-treated test lesions after 4, 6 and 8 months compared with baseline, while the control lesions had no significant change in hardness at any recall interval".

It is important to note that hardness of dental caries is our best clinical tool to reflect the activity of dentine caries.

OZONE REVERSAL OF DECIDUOUS CARIES

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COMMERCIALLY AVAILABLE OZONE SYSTEMS

KaVo produces the HealOzone which has had almost a decade of clinical study, research and development. It has been shown to be very safe when used in the oral cavity.

There are other systems that are available such as the unit supplied by Lime Technologies (CMU3 Lime Technologies, Parkview, South Africa). This apparatus provides ozone that is blown into carious lesions. However, manufacturer's directions must be followed very closely in order to prevent potential lung damage from inhaled ozone inadvertently reaching the bronchi and the alveoli of the lungs.

A slightly different approach is offered by TherOzone (Santa Monica, USA) (Fig. 7). This unit provides ozonated water for disinfection purposes.

CONCLUSION

First and foremost, it is important that additional research on surface disinfection be done both with ozone and photo activated disinfection modalities.
Neither Cochrane nor NICE (National Institute for Clinical Excellence) would pass the majority of treatments carried out in dental practices. Cochrane sets very high standards, reflected in the fact that Cochrane classifies up to 95% of all the research studies it assesses as being flawed, biased or not fulfilling their criteria. Cochrane34 only assessed Ozone as an alternative, rather than an addition, to current methods for the management and treatment of dental caries. This misses the point; ozone should not be used in isolation of our usual preventive methods. Most importantly, ozone should be considered an adjunct to existing treatment and preventive methods rather than an isolated treatment modality. The vast majority of the dentists that are using ozone therapy treatments today use the treatment in conjunction with plaque and diet control, chemotherapeutic approaches such as fluoride or chlorhexidine, sealants, and stepwise excavation. It is thus clear that clinical dentistry has adopted ozone to be used in conjunction with other clinical approaches, not as an alternative.

NICE35 set a hypothesis asking if ozone was more effective than existing treatments for decay in 2003. This again missed the point. Ozone should be used in conjunction with our methods of managing caries and should be used in conjunction with our existing treatments for decay.

Ozone is clinically easier, less expensive and faster when compared with other antimicrobial and oxidant caries treatments. Ozone should not be compared to conventional drilling and filling approaches. Since ozone is the most powerful antimicrobial and oxidant that can be used in dentistry thus fairly obvious that Ozone should be used in combating the microorganisms associated with dental caries. Since aqueous ozone exhibits the highest level of bio-compatibility compared to commonly used antiseptics13 it should be considered for extensive use in this area of dentistry.

THE "CARIES BALANCE"

The "caries balance" concept from Professor John Featherstone36 is an excellent starting point. The balance between pathological and preventive factors can be swung in the direction of caries intervention and prevention by the active role of the dentist and the auxiliary staff. Ozone has a key part to play in this healing process.

Ozone has a place in 21st century oral health care: its proven powerful antimicrobial efficacy and undoubtedly potent oxidant ability, reduces cariogenic microorganisms and provide beneficial effects against organic acids30 in lesions, in conjunction with existing management strategies for dental caries to tip the "caries balance."

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**REFERENCES**


*Oral Health welcomes this original article.*

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