Evidence-based caries reversal using ozone

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Question: I read the recent ‘Ask the Experts’ article on ozone (J Esthet Restor Dent 2007;19:303–5). Can you provide more information and clarify the question about whether ozone is a useful means of caries treatment?

Answer: Thank you for the opportunity to comment briefly on the recent report published in the journal on research with the HealOzone (KaVo, Biberach, Germany). Ozone cannot do everything and certainly should not be a treatment isolated from our individualised preventive oral health care. To be effective, ozone must be prescribed in sufficient concentration for an adequate time and must be delivered into the lesions.

Antimicrobial effectiveness of ozone

Ozone is one of the most powerful antimicrobial agents we could use in dentistry and clearly, there are enormous advantages to kill pathogens. The recent piece in the Journal of Esthetic and Restorative Dentistry (JERD) correctly mentioned a few of the papers that have proven the antimicrobial effectiveness of ozone but does not discuss the limitations of the biofilm studies.

Less than one log reduction of bacteria was measured after using ozone gas above biofilms in the culture media, which was a similar reduction to that achieved by using 0.2% chlorhexidine or photoactivated disinfection. However, ozone will react immediately with the reductants in the culture media, and the authors did not bubble the ozone into the biofilm. It is recommended that ozone be delivered under pressure into a lesion by pressing the delivery tube onto the carious surface so that it can penetrate the lesion. In vivo lesions (unlike artificial biofilms) contain many molecules (such as iron) that increase the antimicrobial effectiveness of ozone in caries.

Ozone, even at a very low dose and a short time of application, achieved a 57% reduction in biofilm and a 65% reduction in viable bacteria in model dental unit water lines. Also, a high level of biocompatibility of aqueous ozone on human oral epithelial cells, gingival fibroblast cells, and periodontal cells has been found.

Management of root caries

Ozone reverses shallow non-cavitated root caries lesions as part of a full preventive care regimen, which includes reducing the frequency of consumption of fermentable carbohydrates, increased use of fluoride-containing products, and improved oral hygiene.

The recent JERD piece described one study that successfully treated root caries with the HealOzone. However, ozone would not be effective to manage, for example, a cavitated 3-mm deep root caries lesion adjacent to the gingival margin. The outer caries would need to be removed, leaving about 1 mm of caries over the pulpal floor prior to ozone treatment and restoration.

I am puzzled as to the concern about the lack of response of the control lesions despite the use of a 1,100-ppm fluoride toothpaste by the subjects in the root caries studies. Most of these subjects would have been using a 1,100-ppm fluoride toothpaste while they were developing the root caries, so it should not be expected to achieve more reversal of these lesions. Some had in fact been using toothpastes containing at least 1,450-ppm fluoride while their teeth were developing these root caries lesions, prior to enrolling in the study.

It was stated incorrectly that the large antimicrobial reduction in root caries after HealOzone treatment was because of the control samples of caries being ‘consistently larger than the posttreatment sample,’ which

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had been treated with ozone. This study assessed the total cultivable microbiota by counts of the colony-forming units (CFUs) recovered. The CFUs were dis- vided by the sample weights. There was a statistically signifi- cant difference between in the control and test samples for either 10 or 20 seconds in log10 (CFU + 1) shown per milligram.19

Management of pit and fissure caries

The JERD piece mentioned a study20 in which the fissures were not fully cleaned out (i.e., the man- ufacturer’s recommendation was not followed). In addition, that study used only ozone to treat noncavi- tated caries involving the middle third of dentine, which is also a pro- cedure that is neither recom- mended by the manufacturer nor attempted by dentists. Dentists in practice would open these lesions and remove caries and would only leave up to 1 mm of caries on the pul- pal those prior to ozone treatment and restoration.

The piece also mentioned a prospective published article22 that showed no overall significant differ- ences for the treatment of non- cavitated fissure caries with ozone. However, it did not mention the con- clusion of this study, which stated “from the data, it can be concluded that ozone application significantly improved noncavitated initial fissure caries in patients at high caries risk over a 3-month period.”18

Ozone is a potent oxidizer

Pyrivic acid (Ka = 2.50 mmol) contributes substantially to the de- creased pH values associated with active caries lesions.24 Pyrivic acid is oxidatively decarboxylated to ac- etate and carbon dioxide on reac- tion with ozone27 as in the following equation:

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

Remineralization of incipient carious lesions can be encouraged by buffering plaque fluid by the produc- tion of acetate or other high pH acids found in resting plaque.25

Conclusion

The earlier JERD piece stated that some of the ozone studies are promising but indicated that ‘ozone has not been proven to be superior to other clinical ap- proaches.’ All dentists using ozone use it in conjunction with plaque and diet control, chemotherapeu- tic approaches such as fluoride or chlorhexidine, sealants, and step- wise excavation, and therefore, use it with other clinical ap- proaches, not as an alternative. Of course, we all want more research on ozone. Cochranne and The Na- tional Institute for Clinical Ex- cellence (NICE) would not pass the majority of treatments carried out in dental practices. Cochranne correct- ly sets very high standards, re- flexed in the fact that Cochranne classifies up to 95% of all the re- search studies it assesses as being flawed, biased, or not fulfilling their criteria. Cochranne28 only as- sessed 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.

The JERD piece mentioned a study20 in which open carious lesions were treated with ozone in anxious children. Ninety- four percent of the children were treatable and 95% lost their dental anxiety. The hardness values im- proved significantly in the ozone- treated test lesions after 4, 6, and 8 months compared with the base- line, whereas the control lesions had no significant change in hard- ness at any recall interval.29 The hardness of dental caries is our best clinical tool to reflect the activity of dentine caries.30–32

Ozone reversal of deciduous caries

The previous piece correctly mentioned a study24 in which open carious lesions had been treated with ozone in anxious children. Ninety-four percent of the children were existing treatments for decay. This again missed the point. Ozone should be used in conjunc- tion with our methods of manag- ing caries. In addition, this ozone technique is much easier, cheaper, and faster than existing treatments and should not have to prove that it is more effective.

Ozone as an easier, cheaper, and faster treatment should be compared with comparable an- titubular and oxidant treat- ments for caries rather than be- ing compared with conventional drilling and filling approaches as reported by NICE and Cochranne.

The ‘caries balance’ concept from John Featherstone16 is ex- cellent. I believe that the balance between pathologic and preven- tive factors can be swung in the direction of caries intervention and prevention by the active role of the dentist and his/her auxil- iary staff and that ozone has a key part to play in this process.

Ozone’s place is for us to use its proven powerful antimicro- bial efficacy and un doubted poten- tial oxidant ability, to reduce car- iogenic microorganisms, and provide beneficial effects against organic acids as in lesions, in con- junction with our existing man- agement strategies for dental caries to tip the ‘caries balance.’

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References