

## Ask the Experts

### EVIDENCE-BASED CARIES REVERSAL USING OZONE

#### Guest Expert

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#### Associate Editor

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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 individualized 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<sup>1</sup> 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<sup>2–4</sup> that have proven the antimicrobial effectiveness of ozone<sup>5–9</sup> 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.<sup>10</sup> 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.<sup>11</sup> Also, a high level of biocompatibility of aqueous ozone on human oral epithelial cells, gingival fibroblast cells, and periodontal cells has been found.<sup>12,13</sup>

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## MANAGEMENT OF ROOT CARIES

Ozone reverses shallow noncavitated 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<sup>14</sup> that successfully treated root caries with the HealOzone. Other studies also have proven the successful reversal and arresting of root caries using the HealOzone.<sup>15,16</sup> 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 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 post-treatment sample,” which had been treated with ozone. This study assessed “the total cultivable microbiota by counts of the colony-forming units (CFUs) recovered. The CFUs were divided by the sample weights. There was a statistically significant difference between the control and test samples for either 10 or 20 seconds in  $\log_{10}$  (CFU + 1) shown per milligram.”<sup>14</sup>

## MANAGEMENT OF PIT AND FISSURE CARIES

The *JERD* piece mentioned a study<sup>17</sup> in which the fissures were not fully cleaned out (i.e., the manufacturer’s recommendation was not followed). In addition, that study used only ozone to treat noncavitated caries involving the middle third of dentine, which is also a procedure that is neither recommended 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 pulpal floor prior to ozone treatment and restoration.

The piece also mentioned a prospective published article<sup>18</sup> that showed no overall significant differences for the treatment of noncavitated fissure caries with ozone. However, it did not mention the conclusion 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.”<sup>18</sup>

## IF FISSURE SEALING OR RESTORING, THEN OZONE TREAT FIRST

There is good evidence for in vitro application of ozone as a useful prophylactic antimicrobial treatment prior to etching and the placement of dental sealants and restorations with no negative interaction with the physical property of enamel and adhesive restorations.<sup>19–23</sup>

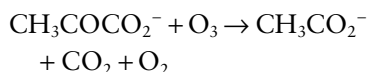
## OZONE REVERSAL OF DECIDUOUS CARIES

The previous piece correctly mentioned a study<sup>24</sup> in which open carious lesions were treated with ozone in anxious children. Ninety-four percent of the children were treatable and 93% lost their dental anxiety. The hardness values improved significantly in the ozone-treated test lesions after 4, 6, and 8 months compared with the baseline, whereas the control lesions had no significant change in

hardness at any recall interval.<sup>24</sup> The hardness of dental caries is our best clinical tool to reflect the activity of dentine caries.<sup>25–28</sup>

#### OZONE IS A POTENT OXIDIZER

Pyruvic acid ( $K_a = 3.20 \text{ mmol}$ ) contributes substantially to the decreased pH values associated with active caries lesions.<sup>29</sup> Pyruvic acid is oxidatively decarboxylated to acetate and carbon dioxide on reaction with ozone<sup>30</sup> as in the following equation:



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.<sup>31</sup>

#### 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 approaches.” All dentists using ozone use it in conjunction with plaque and diet control, chemotherapeutic approaches such as fluoride or chlorhexidine, sealants, and stepwise excavation, and therefore, use it with other clinical approaches, not as an alternative.

Of course, we all want more research on ozone. Cochrane and

The National Institute for Clinical Excellence (NICE) would not pass the majority of treatments carried out in dental practices. Cochrane correctly 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. Cochrane<sup>32</sup> 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.

NICE<sup>33</sup> set a hypothesis, asking if ozone is more effective than existing treatments for decay. This again missed the point. Ozone should be used in conjunction with our methods of managing 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 antimicrobial and oxidant treatments for caries rather than being compared with conventional drilling and filling approaches as reported by NICE and Cochrane.

The “caries balance” concept from John Featherstone<sup>34</sup> is excellent. I believe that the balance between

pathologic and preventive factors can be swung in the direction of caries intervention and prevention by the active role of the dentist and his/her auxiliary staff and that ozone has a key part to play in this process.

Ozone’s place is for us to use its proven powerful antimicrobial efficacy and undoubted potent oxidant ability, to reduce cariogenic microorganisms, and provide beneficial effects against organic acids<sup>30</sup> in lesions, in conjunction with our existing management strategies for dental caries to tip the “caries balance.”

#### DISCLOSURE

Professor Edward Lynch is a consultant and principal investigator for research grants from CurOzone USA (Aurora, Ontario, Canada) administered by Queens University Belfast, Northern Ireland.

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Editor's Note: If you have a question on any aspect of esthetic dentistry, please direct it to the Associate Editor, Dr. Edward J. Swift Jr. We will forward questions to appropriate experts and print the answers in this regular feature.

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