Proven antimicrobial efficacy of ozone

Ozone is one of the most powerful disinfectants available for use in medicine or dentistry.1 As failure of root canal therapy is mainly caused by microorganisms, it is not surprising that there are numerous advantages to killing these opportunistic pathogens.2–4 Published reviews and reviewed research papers have proven the antimicrobial effects of ozone as a gas and as ozonated water.5–9 In model dental unit water lines, ozone achieved a 57 per cent reduction in viable bacteria in spite of being used in a very low dose and reduction in bacterial regrowth after 1 week of incubation was detected in all specimens of the control group, whereas the tests groups showed several bacteria-free specimens. The authors concluded that ozone has great potential in endodontic disinfection.2 Ozone, and that MTAD and HealtOzone seem to be as effective as 5 per cent NaOCl in reducing mixed bacterial infection in the root canal system.20

I would speculate that the antimicrobial effect of the ozone would have been even greater if it had been used in the same study. Above, I personally feel that conventional irrigation (including NaOCl) should be used during cleaning and shaping, and ozonated water (ideally with ozone gas) should be used as the final irrigant with ultrasonics.

Cardoso and colleagues21 concluded that the ozonated water, used as an irrigant agent, significantly reduced the number of Candida albicans and Enterococcus faecalis in root canals in human teeth. A review22 identified four studies23–26 investigating the bactericidal effect of ozone as compared with 2.5 to 5 per cent sodium hypochlorite as irrigation solutions in endodontics.

Nagayoshi and colleagues27 found nearly the same antimicrobial activity (against E. faecalis and Streptococcus mutans) and a lower level of cytotoxicity of ozonated water as compared with 2.5 per cent NaOCl. They stated that ozone is known to act as a strong antimicrobial agent against bacteria, fungi, and viruses. In the present study, we examined the effect of ozonated water against Enterococcus faecalis and Streptococcus mutans in vitro in broin dentine. After irrigation with ozonated water, the viability of the bacteria was reduced by 99.8 per cent. Inhibiting dental tufts significantly decreased. Notably, when the specimen was irradiated with ozonated water, the viability of the bacteria increased by 8.5 per cent. A similar study in mice showed that ozone had nearly the same antimicrobial activity as 2.5 per cent sodium hypochlorite (NaOCl). We also compared the cytotoxicity against L-929 mouse fibroblasts against ozonated water and NaOCl. The metabolic activity of fibroblasts is quantified using tetrazolium salt (MTT). We treated with ozonated water, whereas that of fibroblasts significantly decreased. The viability of the fibroblasts was treated with 2.5 per cent NaOCl. These results suggest that ozone is very useful for endodontic therapy.28

Muller and colleagues24 found 5 per cent NaOCl superior to gaseous ozone in eliminating microorganisms organized in a cartilaginous biofilm. This study reported less than one log reduction of bacteria after ozonated water treatments in biofilms in culture media, which was only a small reduction to that observed in the ozone-treated group. In vivo, no bacterial counts or virulence factors were reduced. Its antibacterial efficacy was not reported when embedded in biofilms. This study reported less than one log reduction of bacteria after ozonated water treatment in biofilms in culture media, which was only a small reduction to that observed in the ozone-treated group. In vivo, no bacterial counts or virulence factors were reduced.

Moreover, another study29 has found that the irradiation of infected roots with root canals with ozonated water, 2.5 per cent NaOCl, 2 per cent chlorhexidine, or the application of gaseous ozone was not sufficient to inactivate E. faecalis. The methodology used was obviously different from the one used by previous researchers. A high probability that the ozone (oxidant) reacted preferentially with the reductants in the brain-heart infusion used for the inoculation in a simple redox reaction rather than with the bacterial strain. Hema and colleagues30 concluded that ozone had an antibacterial effect on planktonic E. coli cells and those suspended in fluid, but little effect when embedded in biofilms. Its antibacterial efficacy was not comparable with that of NaOCl under the test conditions used.40 Ozone gas is extremely low dose of ozone in their experiments. The concentration of ozone mentioned in the paper was only 0.68 ppm. This concentration was immediately after production and Streptococcus mutans in vitro in the time it was used. This was clearly a biased comparison as the ozone concentration was varied in comparison to the ozone. Surprisingly, immediately following ozone sparging, 1mL of this broth was centrifuged, and the supernatant was added into 5mL of neutralizing broth. This neutralization does not appear to have been similarly used with the NaOCl again biasing the experiment. Given the methodology used in this paper, and the low dose and time of application of ozone used, it is surprising that ozone was found to be as effective as it was reported.

Use of ozonated oils as medicament

In an investigation evaluated histologically and histochemically the response of periapical tissues to ozonated oil,12 ozonated oils are effective,13–15 and that MTAD and HealtOzone included that ozone has great potential in endodontic disinfection. ozone mentioned in the paper was extremely low dose of ozone in their experiments. The concentration of ozone mentioned in the paper was only 0.68 ppm. This concentration was immediately after production and Streptococcus mutans in vitro in the time it was used. This was clearly a biased comparison as the ozone concentration was varied in comparison to the ozone. Surprisingly, immediately following ozone sparging, 1mL of this broth was centrifuged, and the supernatant was added into 5mL of neutralizing broth. This neutralization does not appear to have been similarly used with the NaOCl again biasing the experiment. Given the methodology used in this paper, and the low dose and time of application of ozone used, it is surprising that ozone was found to be as effective as it was reported.

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Effect of aqueous ozone on the NF-κB System

The transcription factor NF-κB plays a crucial role in inflammatory/immune processes and apoptosis.31,32 NF-κB is also thought to be of clinical significance in relation to the origin of periodontal/periapical inflammatory reactions and the development of periodontal and apical periodontitis.33 Huth and colleagues34 reported that ozone gas exerts inhibitory effects on the NF-κB system, suggesting that it has anti-inflammatory and immune-modulatory capacities.

Ozone is a potent oxidizer

Ozone has been proven to be one of the most powerful oxidants we can use in dentistry.

Ozone systems available for use in root canal therapy

KaVo produces the HealtOzone, which delivers 2.100ppm ozone at a flow rate of 615 cc per minute and has been proven to be safe.35,36 This device is designed to allow the dentist to use ozonated water for root canal irrigation and numerous other applications. In addition, other systems are available (such as that supplied by Lime Technologies) that deliver ozone into the root canal, but manufacturer’s directions must be followed in order to prevent any potential lung inhalation. Lime Technologies also sells ozonated oils for use as root canal medicaments.

Use of ozone to manage and prevent contamination in the access cavity

Ozone has been proven to help reduce caries-inducing microorganisms and this could be beneficial to reduce potential contamination of the canal system during instrumentation.37–39

Enhanced healing associated with ozone use

Ozone also play a key part in the healing process,39,40–44

Guest expert Edward Lynch and Edward Swift discuss evidence-based efficacy of ozone for root canal irrigation.
Conclusion

Of course, more research on the use of ozone in root canal therapy will add to our knowledge in endodontics. Thousands of dentists worldwide use ozone in root canal therapy and it is claimed that millions of teeth have received root canal therapy with ozone having been used as the final irrigant. No adverse event has been recorded after use of the HealOzone or ozonated water in root canal therapy.

Ozone is an effective, easy, cheap, and fast treatment to help disinfect root canals. Ozone is much stronger than chlorine and acts 5,000 times faster without producing harmful decomposition products. As ozone is the most powerful antimicrobial and oxidant we can use in endodontics, and as aqueous ozone revealed the highest level of biocompatibility compared with commonly used antibiotics, then it is fairly obvious that ozone should be used to help combat the microorganisms associated with infected root canals. Ozone has a place in the 21st century oral health care, and we should use it, as our previous powerful antimicrobial efficacy and potent oxidant ability to reduce microorganisms during root canal therapy.

Disclosure

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References