Evidence-based efficacy of ozone for root canal irrigation

Question: As a follow-up to the recently published information on ozone as a means of caries treat- ment, how can we determine the evidence of ozone in root canal therapy?

Answer: Ozone has been proposed as a dental antiseptic agent based on its potential advantages. Numerous peer-reviewed studies have demonstrated the advantages of ozone in root canal irrigation. One such study showed that ozone, used as an irrigant in root canals, significantly reduced the number of microorganisms compared to other conventional irrigants. Ozone is effective against a wide range of bacteria, including those that are resistant to conventional antibiotics. Moreover, ozone gas can be delivered directly into root canals, making it a highly effective antimicrobial agent.

Proven antimicrobial efficacy of ozone

Ozone is one of the most powerful and versatile disinfectants known for use in medicine or dentistry. As failure of root canal therapy is mainly caused by microorganisms, it is not surprising that there are numerous advantages to killing these organisms. Several peer-reviewed research papers have proven the antimicrobial effectiveness of ozone as a gas and as ozonated water.3-9 In model dental unit water lines, ozone achieved a 97 per cent reduction in bis in reductans in a short time of application.6 Ozone rapidly kills otherwise hard to kill microorganisms.

Recommended use of ozone in root canal therapy

Ozone works best when there is little organic debris remaining. Therefore, the recommendation is to use either ozonated water or ozone gas at the end of the cleaning and shaping process. I personally still use my conventional irrigants during this earlier phase and I finally irrigate with ozonated water (Thermozone, Santa Monica, CA, USA) using ultrasonic. I also use ozonated water (Thermozone) and ozonated water and ozonated liquid (Lime Technologies Ltd., Cape Town, South Africa) as a medicament.

Comparison of the use of ozone and sodium hypochlorite

Oxygen has a dramatically toxic effect on microaerophilic and anaerobic bacteria. It inhibits cell respiration and induces sterile roots with open access cavi- ties and containing a paper point were cured by one volumen in the oral cavity for 1 week. After re- moval, the samples were taken for microbiological analysis. The root canals were then disinfected with the EndoTracter System (i.e., 5 per cent NaOCl, 3 per cent hypochlorite [NaOCl], or hydrozone, and thereafter, the samples were repeated several microbiology studies. The roots were then sealed and incubated for a further 2 weeks. A negative bacterial growth was again determined. After disinfection, there was a significant decrease in the absolute bacterial count between each disinfec tion method and the control group. There was statistically significant difference between the 3 per cent NaOCl, MTAD, and Hydrozone. The least effective agent was water.

I would speculate that the antimicrobial effect of the ozone would have been even greater if it had been used in a lower concentration. 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 ultrasonic.

Cardoso and colleagues concluded that the ozonated water, used as an irrigant agent, significantly reduced the number of Candida albicans in the root canals of teeth infected with Streptococcus mutans and Enterococcus fae- 
calis. A review identified four studies8-11 investigating the bactericidal effect of ozone as compared with 2.5 to 5 per cent sodium hypochlorite as irrigation solutions in endodontics.

Nagayoshi and colleagues 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. Therefore, ozone is known to act as a strong antimicro- bial agent against bacteria, fungi, and virus. In the present study, we examined the effect of ozonated water against Enterococcus faecalis and Streptococcus mutans in vitro in bone dentin. After irrigation with ozonated water, the concentration of viable bacteria significantly decreased. Notably, when the specimen was irrigated with ozonated water, the concentration of viable bacteria and invading dental tubules significantly decreased. Notably, when the specimen was irrigated with ozonated water, the concentration of viable bacteria and invading dental tubules significantly decreased. Moreover, we found that the cytotoxicity against L-929 mouse fibroblasts against ozonated water and NaOCl. The metabolic activity of fibroblasts in the presence of ozonated water was treated with ozonated water, whereas that of fibroblasts significantly reduced. The samples were treated with 2.5 per cent NaOCl. These results suggest that ozonated water is more effective for endodontic therapy.3,9

Muller and colleagues found 5 per cent NaOCl superior to gaseous ozone in eliminating mi- croorganisms organized in a cariogenic biofilm. This study reported less than one log reduction of bac- teria after ozonating in gaseous biofilms in culture media, which was only a similar reduction to that achieved with 2.5 per cent sodium hypochlorite or photofaceted disinfection.35 However, it should be noted that ozone is a potent ox- idant and will undergo a redox reaction with reductants in a culture media. In addition, the authors did not specify whether the ozonated water was ozonated in a gaseous or aqueous form. Therefore, the recommendation is that ozone should be used under pressure into a root canal irrigation system.30 In vivo canal contents and cultures, unlike artifi- cial biofilms, contain many mole- cules that can reduce ozone and in- crease the antimicrobial effectiveness of ozone in teeth and can help enhance the power of hydroxyl radicals in vivo to further increase the antimicrobial effectiveness of ozone.

Moreover, another study12 has found that the infection of infected infected root canals with ozonated water, 2.5 per cent NaOCl, 2 per cent chlorhexidine, or the applica- tion of gaseous ozone was not sufficient to inactivate E. faecalis. The methodology used was obviously different from that applied by these other researchers. It is highly probable that the ozone (oxidant) reacted preferentially with the re- ductants in the brain-heart infu- sion used for the inoculation of the boys. Therefore, the presence of these radicals in vivo to further increase the antimicrobial effectiveness of ozone.

Biocompatibility of ozone in root canal therapy

A high level of biocompatibility of aqueous ozone on human oral epithelial (BHE) cells, gingival fi- broblast (HGF-1) cells, and peri- odontal cells has been pub- lished.4,55-58

Huth and colleagues investigated whether gaseous ozone and aqueous ozone exerted any cytotoxic effec- tive on BHE cells and HGF-1 cells compared with established antiseptics (2 and 0.2 per cent chlorhexidine digluconate [CHX]; 5.25 and 2.25 per cent sodium hypochlorite [NaOCl]; 5 per cent hydrogen peroxide [H2O2]) over 1 minute and compared with the an- tibiotic control. Ozone gas was found to have toxic effects on both cell types. Essentially, no cytotoxic signs were observed for aqueous ozone. CHX (2 per cent, 0.2 per cent) was highly toxic to BHE cells, and HGF-1 cells (2 per cent and non toxic: 0.2 per cent to HGF-1 cells). NaOCl and H2O2 resulted in markedly reduced cell viability (BHE, HGF-1), whereas metronida- zole displayed mild toxicity only to BHE cells. Taken together, aqueous ozone at the low level of bio- compatibility of the tested antiseptic. Nonetheless, ozone gas performed well compared with the es- tablished endodontic irrigants, which showed equal or even higher cytotoxic potentials than ozone gas. In addition, ozone gas applied into the most root canal, as currently performed with the HealODe- vive, dissolves in canal fluids, thus reducing the negative effect on periodontal liga- ment cell proliferation.4,5 A clinical report regarding the healingaccel- erating effect of ozone water did not show negative detrimental effects on cells.31

Effect of aqueous ozone on the NF-κB system

The transcription factor NF-κB plays a crucial role in inflamma- tory/immune processes and apop- tosis. NF-κB is also thought to be involved in the regulation of mediators of inflammation, and regulates the response to environmental stress, and the immune system.

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 HealOZone, which delivers 2.100mpm ozone at a flow rate of 615 cc per minute and has been proven to be safe.59,60 This allows the clinician to deliver an excellent unit to produce ozonated water for root canal irrigation and numerous other applications. In addition, other systems are available (such as that supplied by Lime Technolo- gies) that blow ozone into root canals, but manufacturer’s direc- tions 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 sealing in the access cavity

Ozone has been proven to help reduce carious microorgan- isms and this could be beneficial to reduce potential contamination of the canal systems during instru- mentation.26-28

Enhanced healing associated with ozone use

Ozone also can play a key part in the healing process.2,3,29-32

Clinical
Conclusion

Of course, more research on the use of ozone in root canal therapy and its effect on microorganisms is needed. 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 anti-septics, 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,14 and we should use it properly. As ozone is powerful antimicrobial and oxidant it can reduce microorganisms during root canal therapy.

Disclosure

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References
