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RESEARCH ARTICLE

OZONE AN ENDODONTIC BLISS: A REVIEW.

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Abstract

Ozonated water is recognized to have an antiseptic, powerful oxidative and strong antimicrobial property towards bacteria, fungi, viruses and protozoa. Endodontics is mainly concerned about thorough root canal disinfection. Ozone is available in aqueous gaseous as well as ozonated oil. This paper gives brief review on the history, chemistry as well as its endodontic application as an endodontic disinfectant. Antimicrobial efficacy, effect on dentin bonding and contra indication of ozone is also covered in this article.

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Introduction:-

Ozein is Greek literature word from which the word ozone has derived, which means odor and was first coined in 1840 by German chemist Christian Friedrich Schonbein, who is known as "The father of ozone therapy". (1) Ozone is found in nature consisting of three oxygen atoms (O₃), a higher energetic form than normal atmospheric oxygen (O₂). (2) Ozonated water is recognized to have an antiseptic, powerful oxidative and strong antimicrobial property towards bacteria, fungi, viruses and protozoa. (3) Ozone in its aqueous phase as compared to its other phases has benefits that are its potency, lack of mutagenicity, rapid microbicide effects and simplicity of handling. (4) Oxygen/ozone therapy has been researched for clinical and therapeutic uses on humans. In 1857 Joachim Hensler, a German physicist and Hans wolf German Physician developed first Ozone generator for medical use. The first medical application was in 1870, when Lender purified blood in test tubes. Medical applications became widespread throughout Europe and America. As of 1929, more than 114 diseases were listed for treatment with oxygen/ozone. In World War I & II, Ozone was used to treat wounded soldiers in trenches. In 1950, the first dentist to use ozone therapy in practice was E. A. Fisch for disinfection and wound healing during dental surgeries. (5) Ozone has been advocated for treatment of gingival infection by Sandhaus in 1969 and root caries by Bayson et al, in 2000. (4) Ozone has so many applications (6-10) in dental practice like bleaching, vital tooth canal therapy, in hypersensitive tooth, necrotic root canal therapy, re-mineralization of root caries, dental water unit disinfection and this article principally emphasis on its endodontic application as root canal disinfectant.

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Chemical configuration and properties:-

Ozone (O₃) is a triatomic molecule with three oxygen atoms and molecular weight of 47.98 g/mol.(11) Thermodynamically, this molecule is a highly unstable compound that decomposes to pure oxygen with a short half-life of 40 min at 20°C. It is the strong oxidant after fluorine and per sulfate. Ozone is 1.6-fold denser and 10-fold more soluble in water (49 mL in 100 mL water at 0°C) than oxygen. (12)

Ozone is naturally produced in stratosphere by the photo dissociation of molecular oxygen (O₂) into activated oxygen atoms due to UV radiations, which then react with further oxygen molecules to form ozone. The characteristic of ozone that makes it so valuable that, its ability to absorb a range of UV radiation it will lead to destruction also. When an ozone molecule is exposed to UV energy it may revert back into O₂ and O.

Ozone is 1.5 folds more effective than chloride when used as an antimicrobial agent against bacteria, viruses, fungi, and protozoa. It also has the ability to stimulate blood circulation and the immune response. (13, 14)

Mechanism of action of ozone:-

Many bacterial species (15) have been examined to check the antimicrobial efficacy of ozone with the help of culture mediums. It has been stated that an exposure of about 60 s exhibited 99.9% killing efficiency against cariogenic bacteria such as *Actinomyces naeslundii*, *Streptococcus mutans* and *Lactobacillus casei*. However, exposure for such a long period will lead to degradation of salivary proteins and hence 10s – 30s of exposure was said to be effective in killing a significant number of bacteria.

Kshitish et al. (16) assessed the effectiveness of ozone and chlorhexidine against certain bacteria, viruses and fungi in vitro. The antifungal effect of ozone was better than that of chlorhexidine. They recorded a 25% fall in *A. actinomycetemcomitans* and no antimicrobial effects in relation to *P. gingivalis* or *Tannerella forsythensis* after application of ozone or chlorhexidine.

Muller et al, (17) studied the effect of influence of gasiform ozone with photodynamic therapy (PDT) and known antiseptic agents (2% Chlorhexidine, 0.5 and 5% sodium hypochlorite solutions) on a multispecies oral biofilm *in-vitro* (*Actinomyces naeslundii*, *Veillonella dispar*, *Fusobacterium nucleatum*, *Streptococcus (S.) sobrinus*, *S. oralis* and *Candida albicans*) They found that the microbial populations in biofilm are well secure against antimicrobial agents. Only 5% NaOCl solution was capable to eliminate all bacteria effectively.

Even it is said that ozone has ability to accelerate the healing rate by reducing the inflammation and stimulating the blood circulation as well as by activating the aerobic process like glycolysis and Krebs cycle. Stefan et al (2016), assessed the antibacterial efficacy and periapical healing with the 6 and 12 months follow up. They compared the ozone against NaOCl with chlorhexidine in two visit disinfection manner. Success rate was not significantly differ for both the groups, i.e. for ozone 96.2/95.5 % after 6/12 months and for sodium hypochlorite and chlorhexidine 95.5/95.2 % after 6/12 months. The difference between two groups in consideration with bacterial reduction and periapical healing was not statically significant.(18)

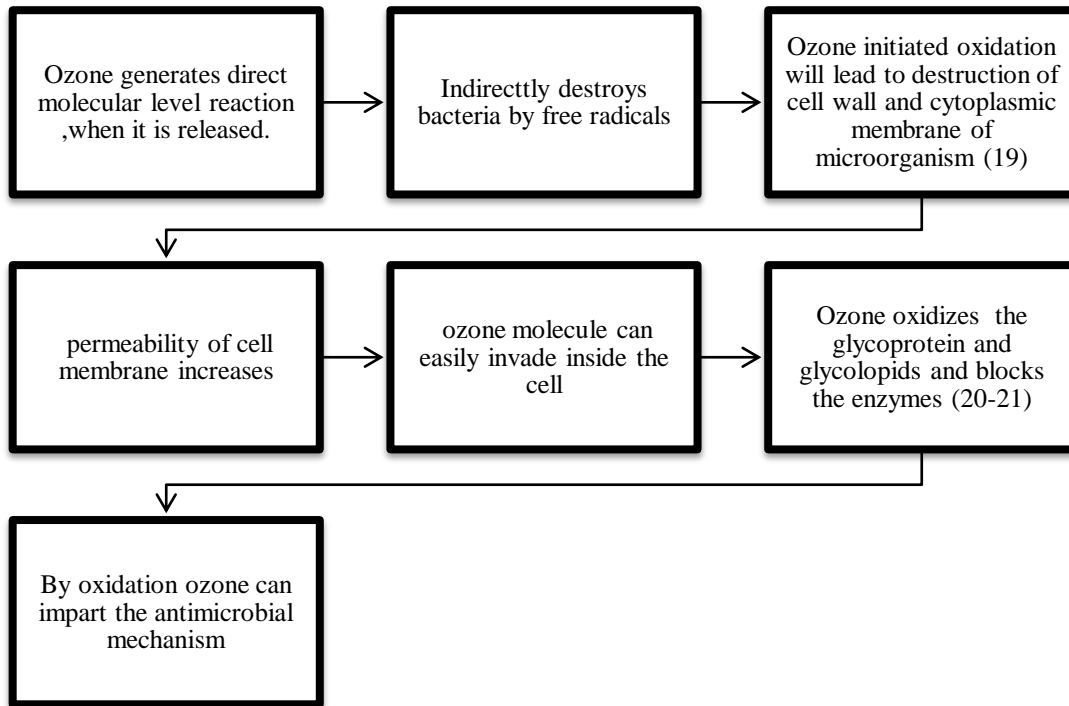


Table 1:- Antimicrobial mechanism of action of ozone

Ozone in endodontics:-

Application of ozone in endodontics is mainly concerned with its antimicrobial action. Ozone works more efficiently when there is less organic debris left inside the root canal, so in future the use of ozone is suggested, either as an ozonated water or ozone gas at the end of the biomechanical preparation. It is advised to use any conventional irrigant initially and finally irrigate with ozonated water using ultrasonic and ozonated oil as intracanal medicament.

Nagayoshi *et al.* (22) found that ozonated water (0.5–4 mg/L) was highly effective in killing both gram positive and negative micro-organisms. Gram negative bacteria, such as *Porphyromonas (P.) endodontalis* and *P. gingivalis* were substantially more sensitive to ozonated water than gram positive oral streptococci and *C. albicans* in pure culture. Hems *et al.* (23) evaluated the potential of ozone as an antibacterial agent using *Enterococcus (E.) faecalis* as a test species. Ozone was used both as gasiform and aqueous (0.68 mg/L). They concluded that ozone in solution was antibacterial against planktonic *E. faecalis* after 240 s treatment. However it was not effective against *E. faecalis* within a biofilm unless they were displaced into the surrounding medium by agitation.

Estrela *et al.* (24) studied antimicrobial effects of ozonated water, gaseous ozone and antiseptic agents (2.5% hypochlorite and 2% chlorhexidine) in infected human dental root canals. Over the 20 min contact time none of these substances had antibacterial effect against *E. faecalis* in the infected root canals. Silveira *et al.*, (25) (2007) showed that the success rate was 77% , when using ozonized oil as an intra-canal medicament. A further study done by Cardoso *et al* evaluated the effectiveness of ozonated water in the elimination of *C. albicans*, *E. faecalis*, and endotoxins from root canals. They concluded that ozonated water was effective against both *C. albicans* and *E. faecalis* immediately after treatment; however it did not have substantivity. Furthermore, ozonated water demonstrated no anti-endotoxin activity.

Recai zan *et al* (26) (2013), compared the ozone, 5.25% sodium hypochlorite and two different lasers for bacterial reduction count. They found that 100% bacterial reduction was with sodium hypochlorite. For ozone it was 90.4%, for Er.YAG laser it was 70.2% and KTP laser it was 66%. So to conclude ozone has higher antimicrobial efficacy as compared to Er.YAG and KTP lasers.

Ihsan Hubbezoglu et al(27) (2014), evaluated the antimicrobial action of aqueous ozone with different concentration(8ppm,12ppm,16ppm) against 5.25% sodium hypochlorite. The study revealed that antibacterial action of 16ppm aqueous ozone with ultrasonic agitation resulted in complete disinfection of the root canal. Whereas 16ppm ozone with manual irrigation was insufficient to disinfect the canal.

Rita Noites et al(28) (2014), tested the antibacterial action of ozone against sodium hypochlorite(1%,3% and 5%), chlorhexidine(0.2% and 2%), sodium hypochlorite followed by ozone and chlorhexidine followed by ozone. They have found that sodium hypochlorite, chlorhexidine and ozone alone were ineffective in removing complete micro-organisms, while irrigation with chlorhexidine followed by ozone was able to complete disinfection of the canal. Tanja Boch et al(29)(2015), evaluated the antibacterial efficacy of different agents, they stated that reduction in bacterial count was highest with sodium hypochlorite(99.98%), followed by sodium hypochlorite with ozone (99.95%), EDTA with ozone (91.33%), ozone alone (85.38%) and EDTA alone (80.64%).

Another study conducted by Domogoj Prebeg et al (30) (2016), assessed the ozone for bacterial reduction. Here the delivery of ozone was done with help of KP syringe. They found that 89.3% reduction in bacterial count. Tucay et al, compared the ozone, photoactivated disinfection with saline as positive control and sodium hypochlorite as negative control. The study projected that ozone and photo-activated disinfection both are equally efficient as an antimicrobial agent.

Effect of ozone on surface hardness of resin based sealer was studied by Oznur T. et al, (31) they used AH plus sealer and ENDOREZ sealer. Among the disinfection protocols for AH Plus sealer, ozone applied group had the highest surface hardness values, when compared with NaOCL and LAD applied groups.

Ozone ill-effects:-

Ozone inhalation can harmfully affect the pulmonary system and other organs. Known side-effects are epiphora, rhinitis, cough, headache, occasional nausea, vomiting, shortness of breath, blood vessel swelling, upper respiratory irritation, poor circulation, heart problems and even stroke. (11) Ozone should not be administered I.V as there would be a risk of air embolism. (32) However, in the event of ozone intoxication, the patient must be placed in the supine position and can be treated with vitamin E and Nacetylcysteine. (11)

Millar and Hodson(33) have evaluated the safety of two ozone delivery devices designed for use in dentistry. Ozi-cure and HealOzone devices were equated in a clinical simulation using a phantom head, whereas recordings of ozone levels were made in the pharyngeal and nasal regions of the patient and near the mouth of the operator. , they found that the Ozi-cure device when used without suitable suction permits ozone to reach a concentration beyond acceptable levels and therefore should not be used. The HealOzone device was safe to use. Study by Huth et al (34) scrutinized effect of gaseous as well as aqueous ozone on human oral epithelial (BHY) cells and gingival fibroblast (HGF-1) cells compared with different antiseptics. Cell counts, metabolic activity, Sp-1 binding, actin levels, and apoptosis were the assessed parameters. Ozone gas was found to have toxic effects on both cell types. Basically there is no cytotoxicity related to aqueous ozone. Aqueous ozone shown the highest level of biocompatibility of the verified antiseptics.

Conclusion:-

Studies (22-31) have been done to prove the effectiveness of ozone as a root canal disinfecting agent and they have shown that ozone is strong antibacterial and oxidant agent. So ozone should be incorporated into systematic irrigation protocol. An aqueous ozone shown highest level of biocompatibility with oral tissue. An adjuvant use of ozone to increase the effect of an irrigant solution like NaOCl can be suggested particularly in cases of resistant bacteria, persistent infection and where the NaOCl cannot be used i.e. open apex or apex is resorbed.

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