Review Article

OZONE APPLICATIONS IN PROSTHODONTICS

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Abstract

Restoration of primary teeth, severely destroyed by trauma or caries is a commonly faced problem in a pediatric dental clinic. In the past, the only option would have been to extract the affected teeth and replace them with prosthetic substitutes. Anterior tooth loss eventually leads to speech disturbances, development of parafunctional habits and psychological problems. Satisfactory restoration of these teeth, improving esthetics, along with the management of function has always been a challenge for pediatric dentist. An ever increasing demand for esthetics has led to innovation and development of newer treatment modalities for these problems. In an attempt to widen the treatment options as biologically and conservatively as possible, tooth structure is used as a restorative material to rehabilitate severely destroyed tooth crowns. This technique consists of bonding sterile dental fragments, obtained either from the patient or from a tooth bank, to the teeth. Such a technique was termed as 'biological restoration'. This article aims at reviewing the evolution, techniques and outcome of such biological restorations.

Key words: Biologic restoration, Natural teeth, Pediatric dentistry, Tooth fragment.

Introduction

Ozone (O_3) is a highly reactive molecule with antibacterial properties of which have been proven in different studies.[1,2] Ozone has been used in medicine for years because in addition to its antibacterial properties, it works as immune system stimulator, anaesthetic, detoxificator and activator of metabolic reactions.[3] Recently, the application of ozone has been introduced in various fields of dentistry such as ozonated water in dental chairs, mouthwashes and ozone producer generators like Heal Ozone.[4,5] In a study on oral mucosa, ozone was more effective in treating oral lichen planus than diode laser and had similar efficacy as corticosteroid.[6]

Ozone is produced through three mechanisms: The first method is the Ultraviolet system in which produces ozone in low concentrations and is applied for purposes of beauty care and air purification. The second method is called Corona Discharge system which produces ozone in high doses but in a controlled manner and is mostly used in medicine and dentistry. The third method is Cold plasma system which is used for air and water purification.[7]

Since ozone molecule is very unstable, it must be produced at the required area. This molecule is also very oxidative. In addition, if it is combined with carbon monoxide in the air, it will be completely harmful to the respiratory tract.[8] The main applications of ozone in dentistry is accelerating hemostasis, improving oxygen supply to organs and prevention of bacterial growth.[3] The destructive mechanism of this molecule works by degradation of bacterial cell wall and plasma membranes. In this process, the cellular enzyme system is impaired, the relative permeability of the bacteria is eliminated and the bacterial lysis occurs.[9] This antibacterial effect of ozone has led us to use this molecule in various fields, although its usage in dental prosthesis is more limited. According to innovative usage of ozone in dentistry and extending of its use to the field of prosthetic dentistry, comprehensive assessment of the reported studies should be made in this area, which is the main reason we began this review study.

Methods

We searched the literature using PUBMED and google scholar library from 1 January 1990 to 1 April 2017. English articles were chosen. Also, a search was manually managed in references of the selected articles. We structured this review article by the question: "Is ozone applied specifically in dental prosthesis?"

Over all, the final search command for advanced search was: (ozone*) AND ((prosthodontic*) OR (prosthetic*) OR tooth OR dentin OR enamel OR (caries OR decay OR white spot) OR (bleaching OR whitening) OR (oral*) OR (implant*) OR osseointegration)

Results

1071 articles were found in the initial search. After reviewing the title and abstract of the articles and removing duplicated articles, 42 articles that examined the application of ozone in dental prostheses were selected. After excluding review articles and adding the articles found in the manual search, 33 articles were found based on the full text of the articles, which were divided into "dental caries", "bacterial plaque", "enamel", "dentine", "denture", "dental discoloration" and "osseointegration" according to their issue.

Discussion

In the present review article, different fields of application of ozone in dentistry that are related to dental prosthodontics have been investigated. The results of the studies showed some contradictions. One of the causes of this issue can be addressed by different conditions and various designs of studies. In summery the following results are deduced from.

Dental Caries and Ozone

Early studies showed that ozone molecule reduces or even eliminates the number of cariogenic bacterial in carious lesions. By eliminating microorganisms, lesions tend to remineralize and improve.[4] This remineralization effect appears to be due to the decarboxylative effect of ozone on

acids produced by bacteria. By converting pyruvic acid to acetic acid and increasing pKa, it is possible to remineralize the lesions.[10] In an in vitro study conducted by Ximenes *et al*, antibacterial effect of chlorhexidine and sodium fluoride on Streptococcus mutans was compared with ozone antibacterial effect. Both methods were effective but, statistically, chlorhexidine with sodium fluoride was more effective.[11] Not all conclusions of studies were consistent with the previous study. Kalnina *et al*. compared the effect of using fluoride varnishes and fissure sealants with ozone application. Although all three methods resulted in reduction of dental caries, their difference was not significant with control group.[12] In a recent systematic review study, following conclusions were made by differentiating *in vitro* and *in vivo* studies: Despite the fact that *in vitro* studies showed a significant effect of ozone on primary dental carious lesions, *in vivo* studies did not show a high degree of effectiveness and cost-effectiveness.[13]

Bacterial Plaque and Ozone

Although the number of bacterial plaque has been decreased according to different studies, ozone was not able to completely eliminate bacteria.[14,15] Ramzy *et al*. concluded that ozone application accompanied with SRP is effective in removing subgingival plaques in patients with aggressive periodontitis.[16] Studies which investigated plaque accumulation on implants associated with peri-implantitis are non-comprehensive. Hauser-Gerspach *et al*. observed that ozone gas reduces the formation of bacterial plaques on titanium and zirconium plates, containing Porphyromonas gingivalis and Streptococcus sanguinis. However, there was no adverse effect on the activity of the osteoblasts or the titanium and zirconium plates. Therefore, ozone selectively decontaminates the surface of titanium and zirconium materials. Moreover, this process is dose-dependent.[17] In a study by Krozer *et al*. application of ozone following application of a solution containing alcohol amine, removed both bacterial plaques and amine layer, provided a good surface for soft tissue adhesion.[18] Bezirtzoglou *et al*. showed that placing toothbrush for 30 minutes in ozonated water after routine brushing effectively removed bacterial plaques adhered to toothbrushes.[19] So it seems that ozone can effectively eliminate bacteria with minimal impact on the properties of underlying materials.

Enamel and Ozone

Ozone has the ability to change the properties of various surfaces, including enamel. In prosthetic treatments, it is important that bonding ability of enamel to restorative materials be of superior quality. In a study by Celiberti *et al*. the use of ozone did not make a difference in the physical properties of enamel, while by eliminating microorganisms, it seems feasible to increase the longevity of restored teeth.[4] In another study by Cehreli *et al*, ozone reduced microleakage in all specimens by improving the bonding of composite resin to enamel in the treatment of pit and fissure lesions.[20] Therefore, the use of ozone in caries limited to enamel seems to be effective, but more clinical studies appear to be necessary.

Dentin and Ozone

Rodrigues *et al*. observed that the application of ozone on dentin leads to a reduction in tensile bond strength of restorative materials to dentin, however, antioxidant application reverses this effect.[21] In another study by Schmidllin *et al*. application of ozone did not affect bond strength of restorative materials to dentin,[22] Ozone, on the other hand, increased the lifespan of restored teeth by removing microorganisms from the dentin layer.[23] A study by Azarpazhooh *et al*. examined the effect of ozone on dentin hypersensitivity. All treatments presented in this study, including the placebo group, resulted in decreasing dentin hypersensitivity, but the difference between the groups was not significant.[24] Therefore, ozone appears to have a positive effect on dentine but more clinical studies are needed to be carried out in this field.

Denture and Ozone

Arita *et al*. observed that accumulation of microorganisms, especially C. Albicans, on acrylic resin denture surfaces was significantly reduced by rinsing with ozonated water accompanied by ultrasound. This effect depends on the concentration of ozone and the highest effect is with ozone concentration of 4 mg/ml.[25] Suzuki *et al*. showed that ozone is successfully used in dental casting alloys, such as a removable partial denture which unlike other detergent materials in the markets, it does not have any negative effect on the surface and weight properties of these alloys.[26] Oizumi *et al*. showed that ozone gas is more effective in removing denture microorganisms than ozonated water.[27] A study by Ekren *et al*. showed the effect of ozone on bond strength of soft liners to acrylic resin materials. Ozone reduces the bond strength of soft liners such as mollosil and molloplast B to acrylic resin dentures and the higher the exposure to ozone is, less bond strength will be obtained.[28]

Dental Discoloration and Ozone

Ozone is more effective in treatment of external discoloration than internal discoloration. By removing the smear layer, ozone allows the penetration of calcium and fluoride ions into the enamel and dentin.[3,29] A study by Al-Omiri *et al*. on comparison of hydrogen peroxide and ozone showed that application of ozone for 60 seconds after using hydrogen peroxide is more effective than hydrogen peroxide alone and it creates brighter colors.[30] An animal study by Tessier *et al*. showed that usage of ozone was able to remove yellowish color from teeth that were affected by tetracycline. This process is time-dependent and the application of the 5-minute ozone is more effective than 3-minute.[31] Further studies are needed to determine the method and time of ozone application to achieve optimal color in dental bleaching treatments.

Ozone and Osseointegration

Sunarso *et al*., Functionalized the superhydrophilic surfaces of implants by applying ozone gas to increase osseoconductivity and reduce inflammatory responses around the implant. After 24 hours, the contact angle of the

water to the implant surface was zero degree. Also, hydroxyl groups increased and carbon pollution decreased significantly at the implant surface. Then, by adding rat bone marrow cells, the adhesion and growth of these cells were investigated after 1 day and 4 days in in vitro. The number of cells and cellular characteristics was better in implants that were treated with ozone molecules.[32] Hadary El *et al*., investigated the effect of using topical ozone-containing oils on osseointegration of implants in an *in vivo* animal study on rabbit population which were receiving cyclosporine A. Radiographic, histopathologic and electron microscopic scans were performed to evaluate the bone formation around implants. There was no difference in the amount of bone formation in the control group and the group received ozone-containing vegetable oil but the writers suggested that ozone could promote bone formation.[33]

Conclusion

Although several studies have examined ozone in various fields of dentistry, this is still a novelty and further studies are needed. It seems that ozone can effectively remove bacterial plaques and create a suitable environment for the performance of different dental restorations and dentures. Also, adding ozone to topical treatments appears to be effective in whitening (bleaching) methods.

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