Review
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Novel Cavity Disinfectants and Their Effects: A Review

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Abstract

Objective: This review aims to assess the efficacy of various materials and systems, including Chlorhexidine Digluconate, Benzalkonium Chloride, Hydrogen Peroxide, Sodium Hypochlorite, Iodine, Aloe Vera, Hyaluronic Acid, Propolis, Ozone, Photoactivated Disinfection, Lasers, and Antibacterial Dentin Adhesives, in cavity disinfection.

Methods: A comprehensive review of literature and studies was conducted to evaluate the effectiveness of the mentioned materials and systems for cavity disinfection.

Results: The review revealed diverse effects of Chlorhexidine Digluconate, Benzalkonium Chloride, Hydrogen Peroxide, Sodium Hypochlorite, Iodine, Aloe Vera, Hyaluronic Acid, Propolis, Ozone, Photoactivated Disinfection, Lasers, and Antibacterial Dentin Adhesives on cavity disinfection. The findings highlight the potential of these agents and technologies in enhancing disinfection protocols in dental practice.

Conclusion: This review underscores the importance of exploring various materials and systems for cavity disinfection to improve dental treatment outcomes. Further research and clinical trials are warranted to validate the efficacy and safety of these agents and technologies in dental settings.

Keywords: Cavity disinfectants, lasers, ozone, hyaluronic acid, propolis

Main Points: Dental caries is the most prevalent pathology in the oral cavity, affecting most of the world population. Caries results from the interaction between dental structure and microbial biofilm, highly organized and formed on its surface, being characterized by the alternating phenomena of demineralization and remineralization.

Cavity disinfection is known as cleaning the dental cavity with antimicrobial agents before the use of adhesive systems, making it as innocuous as possible.

Introduction

Dental caries is a pathological process that occurs with localized destruction of dental hard tissues by microorganisms.[1] While the traditional cavity preparation involved the complete removal of caries and caries-affected tissues, today there is no need to remove the caries-affected dentin layer. During the preparation of the tooth, it is accepted to clean the soft and denatured caries layer by leaving the part that has changed color due to caries but does not contain bacteria, in other words, the affected but uninfected part. However, it is not possible to evaluate with objective criteria whether the infected tissue is completely removed during the preparation of the cavity. In the research carried out on the teeth that were thought to have been cleaned of caries, dyes were used to determine the caries tissue and it was seen that most of the teeth were painted. It is stated that microorganisms cannot be completely destroyed despite the infected tissues cleaned after the staining process. It has been shown that microorganisms can survive by multiplying in the dentinal tubules, enamel-dentin border and smear layer. The toxins produced by the microorganisms diffuse into the pulp and cause the infection, causing the treatment to fail.[2] The primary goal of restorative treatment is the complete removal of infected dentin in cavity preparation. Elimination of residual bacteria that may remain in the cavity walls, enamel-dentin junction, smear layer and dentin tubules after cavity preparation and cause secondary caries, postoperative sensitivity, and even pulpal inflammation is important for the continuity of the restoration. For this purpose, the use of cavity disinfectants is recommended.[3]

Researchers have reported that fermentative organisms can survive up to 139 days under non-antiseptic restorations. It has been suggested that antibacterial solutions should be applied to the cavity after mechanical cleaning of carious dentin in order to destroy all organisms in the cavity preparation and to reduce the risk of caries in the cavity.[4]

While products and methods with different active ingredients are used in the market under the name of cavity disinfectants, recently an antibacterial dentin-bonding system has also been introduced to the market.[5] Today, studies on this subject are still continuing, different methods are being tried and the effects of cavity disinfection materials on current restoration techniques are also being investigated.

Cavity Disinfection Materials

Chlorhexidine Digluconate (CHX)

Chlorhexidine is one of the most frequently used antiseptic agents in mucous membranes and skin tissue. In dentistry, it is used as a mouthwash, oral irrigation agent and slow-release protective agent.[6] It has been used in the form of antibacterial mouthwash that prevents plaque formation since the 1970s.[7]

Chlorhexidine, one of the bis-biguanide compounds, with its broad-spectrum antibacterial effect, acts on Gram (+) and to a lesser extent Gram (–) facultative anaerobic and aerobic microorganisms, and this effect is more limited when the pH is between 7–8 and below 5 exhibits structure. Due to its positive charge, it is cationic and shows affinity for negatively charged surfaces such as bacterial cell wall, extracellular polysaccharides, hydroxyapatite, pellicle, salivary mucins and oral mucosa.[6,8]

Chlorhexidine, acts on Gram (+) and to a lesser extent Gram (–) facultative anaerobic and aerobic microorganisms with its broad-spectrum antibacterial effect. The chlorhexidine gluconate in chlorhexidine compound, binds to amino

acids in dentin and maintains its effect providing a good antibacterial effect.[4] Chlorhexidine gluconate; shows long-term activity by being slowly released from the tissues to which it is attached. It is bacteriostatic at low concentration, and bactericidal at high concentration because it irreversibly precipitates its cellular contents.[3] In low concentrations, it inhibits cell membrane enzymes and increases cell membrane permeability. This effect is called 'bacteriostasis. In high concentrations, it has a bactericidal effect by causing precipitation of cytoplasmic organelles. The most important feature that distinguishes chlorhexidine from other antiseptics is its ability to bind to anionic substrates (hydroxylapatite, pellicle, salivary glycoproteins and mucous membranes).[9]

Chlorhexidine digluconate solution is an effective antiseptic against fungi and Enterecocus faecalis. The microorganisms most sensitive to chlorhexidine gluconate are gram (+) cocci and especially S. mutans. It has been reported that lactobacilli, especially L. casei, are highly resistant to chlorhexidine and that higher concentrations of chlorhexidine gluconate are required for their elimination.[3,10] Its very effective when pH is 7–8, but its effect decreases considerably below 5.2. Its activity decreases in the presence of serum, blood and other organic compounds, and its activity can also be inhibited in the presence of soap and anionic compounds.[6,11]

Corsodyl gel, Cervitec gel, Consepsis are the products that are used in the clinics.[12]

Benzalkonium Chloride

Benzalkonium chloride is a disinfectant of detergent origin, with both cleaning and antiseptic effects.[13] Although Benzalkonium Chloride is known as a strong antibacterial agent, especially against S.mutans, Streptococcus salivarius, and Streptococcus Aureus microorganisms, its activity is reported to be less than Chlorhexidine Digluconate. It has also been reported to be effective on Actinomyces viscosus and Lactobacillus acidophilus.[3,7]

The material acts on gram (+) bacteria by cationic binding to the phosphate groups of teichoic acids of the bacterial cell wall. It is thought to be effective against gram (–) bacteria through cationic binding to phosphate groups in their cell walls and membrane lipopolysaccharides. It is bactericidal against gram (+) and some gram (–) bacteria. Benzalkonium chloride exerts a bactericidal effect on microorganisms with a cell wall predominantly in lipoprotein structure by affecting this structure and impairing the selective permeability of the cytoplasmic membrane. It has either weak or no effect against Mycobacterium tuberculosis, spore-forming microorganisms and viruses.[14]

Benzalkonium chloride; It is mutan-free with soaps, other anionic surfactants, citrates, nitrates, permanganates, salicylates, silver salts, zinc oxide and sulfate. Although rare, hypersensitivity reactions have been reported in the areas of use of Benzalkonium chloride, which is stated to have residual antimicrobial activity like chlorhexidine, other than cavity disinfection.[14]

Tubulicid Red and Tubulicid Plus Corsodyl gel, Cervitec gel, Consepsis are the products in the market.[15]

Hydrogen Peroxide (H_2O_2)

Hydrogen peroxide, with the formula H_2O_2, is a colorless, odorless liquid. Hydrogen peroxide is abundantly soluble in water and alcohol. It easily decomposes to give water and oxygen. The release of oxygen from its melt and the formation of water at the end enabled this liquid to be used as a safe and effective antiseptic.[16]

Hydrogen peroxide has antimicrobial activity against viruses, bacteria, yeast and bacterial spores (especially gram (+) bacteria). While microorganisms with catalase or other peroxidase activity provide resistance to low concentrations of H_2O_2, it has been shown that its high concentrations abolish this defense mechanism. It shows its antibacterial effect as an oxidant that attacks the cellular components of bacteria such as DNA, protein, and lipid with the free hydroxyl radicals it creates.[3]

Before placing any restorative material in the cavity, it is often preferred to clean the cavity walls with a cotton pellet impregnated with 2–3% H_2O_2. Besides its antibacterial effect, it also has foaming effect that it helps to clean the cavity walls. The main antibacterial effect of H_2O_2 is based on its oxidation property.[16]

Sodium Hypochlorite (NaOCl)

The best known property of NaOCl is its antibacterial activity. NaOCl is a broad spectrum antimicrobial agent that can be effective against bacteria, bacteriophages,viruses, spores and yeasts. 5.25% concentration has been shown to be effective on S. mutans. Hypochlorous acid (HClO), which is formed when water is added to NaOCl, is a strong oxidizing agent containing active chlorine. The resulting active chlorine impairs the metabolic functions of the cell by causing irreversible oxidation in the sulfhydryl groups of important enzymes in the bacterial cell. It can kill bacteria very quickly even at low concentrations. It is an extremely effective dissolver for necrotic tissues. NaOCl shows its antibacterial effect both by direct contact and by evaporation. The tissue-dissolving effect and antimicrobial properties of NaOCl are attributed to its ability to hydrolyze and oxidize cell proteins, its germicidal activity as a result of hypochlorite acid formation by releasing chlorine gas from the solution, and its ability to osmotically draw fluid out of the cell. It neutralizes the acidity of the cavity at high pH (11.8) and prevents the proliferation of bacteria.[3,17]

It has been reported that a 15-second application of a 5.25% solution of NaOCl successfully eliminated Staphylococcus aureus, Candida albicans, Porphyromonas endodontalis, Porphyromonas gingivalis, and Prevotella intermedia[7]. However, the use of NaOCl as a cavity disinfectant has a disadvantage, as it removes the collagen in the dentin and prevents the hybridization achieved with adhesive systems.[17]

Iodine

It shows a rapid antimicrobial effect against bacteria, fungi and viruses. It has been reported that iodine has antibacterial activity on S. mutans, L. acidophilus and S. aureus[3]. Molecular iodine is responsible for the antibacterial effect, while its aqueous solutions are unstable. For this purpose, iodine carrier or iodine releasing agents (iodophor) have been developed. The most commonly used are povidone iodine and poloxamer iodine. Iodine disinfectants are bactericidal biocides. Iodine has the ability to destroy bacterial cells by attacking their proteins, nucleotides and fatty acids.[7] It has been reported that iodine has antibacterial activity on S. mutans, L. acidophilus and S. aureus.[3]

Aloe Vera

In recent years, medicinal plant extracts and oils with antimicrobial or anti-inflammatory properties are also being used to prevent various oral infections. Aloe vera is a well-known cactus-like plant from the Liliaceae family with medicinal uses that grows in dry and hot climates. The sticky gel in the middle of the leaf is frequently used in gastrointestinal system diseases, burns and wounds.

Today, more than 75 different ingredients have been identified in aloe vera gel. 98–99% of the gel consists of water. The main substances in aloe vera that provide disinfection effect are anthraquinone, aloin, aloe-emodin, aloetic acid, anthracene, aloe mannan, aloeride, anthranol, chrysophanic acid, resistanol and saponin. It shows its antibacterial effect by inhibiting bacterial protein synthesis or by stimulating tissue phagocytosis. Forever Bright is an example for the products in clinical use.[15,18]

As a result of in vivo and in vitro studies, anti-inflammatory, antibacterial, immune-enhancing, antioxidant and hypoglycemic effects of aloe vera gel have been reported within the pharmacological usage areas.[18]

Hyaluronic Acid (HA)

Hyaluronic acid (Hyaluronan, HA) is a naturally occurring substance in all living organisms, from the simplest bacteria to the most advanced.[19]

HA is one of the main components of the extracellular matrix and is synthesized by synoviocytes, fibroblasts and chondrocytes and plays a role in cell proliferation, tissue repair, cell migration and progression of some malignant tumors.[19]

HA is obtained either from animal sources, either by fermentation from bacteria or by direct isolation. The animal sources from which it is obtained are amaranth, spinal cord, skin and joint fluid. Because of its high HA content compared to other animal tissues, the most commonly used source is amaranth. HA obtained from microorganisms by fermentation is of high purity. Its molecular size varies according to the source from which it is obtained.[20]

The main functions of HA; slowing down the effects of inflammation in wound healing, supporting cell proliferation and re-epithelialization, and reducing scar formation by preventing collagen formation.[19]

According to a study conducted by Pirnazar et al., recombinant HA has a bacterostatic effect in every bacterial species to which it is applied, depending on its molecular weight and concentration. It has been determined that high concentrations of medium molecular weight HA have the highest bacteriostatic effect especially on Actinobacillus Prevotella oris, actinomycetemcomitans, Staphylococcus aureus and Propionibacterium acnes groups.[21]

Propolis

The use of propolis dates back to 300 BC.[22] The name propolis is a Greek word meaning "in front of the city", emphasizing the protective effect of propolis on bee colonies. The medical literature mentions many potential effects of propolis such as anti-inflammatory, antioxidant, anti-ulcer, anti-tumor, anti-diabetic, cardiovascular system protective and local anesthetic effects.[23]

Propolis is a sticky gum-like resin that can vary in color from yellow-green to dark brown and is a complex mixture used by bees to seal their hives. It is like an aromatic glue and is quite difficult to remove from human skin. It forms a strong bond with the proteins and fats in the skin. It is hard and brittle when cold, and becomes soft and sticky when heated.[22] It contains vitamins, mineral salts, phenolic compounds such as flavonoids, fatty acids, aromatic acids and esters, 30% waxes, 5% pollen, 4–15% volatile materials and 13% unknown substances, and the most important substances in its antibacterial activity are chrysin and cinnamic acid. It is used in medicine and dentistry due to its anti-inflammatory, antiseptic, therapeutic, antibacterial, antiviral, antifungal and antiprotozoal properties. Propolis causes destruction in bacterial cell walls and cytoplasm, prevents bacterial adhesion by inhibition of glycosyltransferase enzyme and inhibits bacterial cell division.[15]

Its caries preventive and anti-plaque effect is also reported. It is said to do this by two mechanisms, by its antimicrobial effect against cariogenic bacteria and by inhibiting gluxyltrasferase enzyme activity.[23]

Ozone (O_3)

Ozone was first used therapeutically in 1870 to purify the blood. During the First World War, ozone was used in the treatment of wounds, foot ailments that cause gangrene.[24] Ozone is a strong and effective antibacterial agent that plays an active role in the destruction of bacteria with its high oxidation strength. Since it is obtained by the breakdown of oxygen in the air, it turns into oxygen, which is its raw material, after completing its disinfection task due to its unstable structure. Ozone, either in liquid or gas form is a strong oxidant against bacteria, fungi, protozoa and viruses.[25]

Ozone is the high-energy state of normal atmospheric oxygen (O_2), consisting of three oxygen (O_3).[26] It is a powerful and effective antimicrobial agent that plays an active role in the destruction of bacteria with its high oxidation strength. While 10 and 30 seconds of ozone application in the presence of saliva cannot reduce the numbers of S. mutans and L. casei, it has been reported that it is effective by changing the salivary proteins when the application time is increased up to 60 seconds. The name of the ozone product used in the clinic is Healozone.[15]

Ozone is used for various purposes in the field of dentistry; biofilm cleaning, periodontal pocket and bone disinfection, bleaching, prevention of dental caries, endodontic treatment, tooth extraction, tooth sensitivity, temporomandibular joint treatment, gingival recession, pain control, infection control, delayed healing, tissue regeneration, control of bad breath, remineralization of tooth surface and tooth. Ozone transforms the microbial flora consisting of acidogenic and aciduric microorganisms into normal oral flora and provides the remineralization process by diffusion of calcium, phosphate and fluorine ions into the caries lesion.[27] Ozone is an oxidizing agent used for cavity disinfection and healing of herpetic lesions.[28]

It shows its oxidizing effect by destroying the bacterial cell wall and cytoplasmic membranes. During this process, ozone traps glycoprotein, glycolipid and other amino acids and blocks the enzymatic control systems of these cells and increases membrane permeability, which is a key factor for bacterial cell viability. Ozone molecules enter the cell and cause the death of microorganisms. At the same time, ozone molecules oxidize protein biomolecules such as cysteine,

methionine, histidine. The oxidation of biomolecules has an harmful effect on cariogenic bacteria and eliminates acidogenic bacteria thus stopping acid production. The strongest acid produced by acidogenic bacteria is pyruvic acid. Ozone decarboxylates this acid and turns it into acetic acid (acetate) and carbon dioxide. Acetate is less acidic than pyruvic acid, and this decarboxylation aids mineral uptake of alkaline environment in the carious lesion.[3,7]

Photoactivated Disinfection (PAD)

Photoactivated Disinfection (PAD) is a system that destroys bacteria as a result of activating a photoactive compound with light of a certain wavelength and releasing oxygen-based free radicals.[29] Low-power lasers, which do not have a disinfection effect when used alone, can have a bactericidal effect when used together with some chemical dyes. The most commonly used agent for this purpose is tolonium chloride. Red light with a wavelength of 630–700 nm activates most photosensitive agents. The diode laser emitting red light at a wavelength of 635 nm is most commonly used.[15]

The applied light splits the oxygen present in these light-sensitive molecules into negative ions (O^{2-}) and free radicals. When ions are negatively charged in the form of anions, they want to combine molecularly with positively charged particles. Free radicals are molecules that lack electrons in the outer shell of their atoms. However, electrons are always in pairs, so they seek to complete the electron pair. The PAD system first creates negative ions and free radicals from oxygen and causes these molecules to attack the electrons in the cells of live bacteria, viruses and fungi for disinfection. Bacteria, viruses and fungi whose cell membranes are broken are destroyed in this way. Photosensitive molecules applied to the cavity bind to the bacterial cell wall. Oxygen radicals are released from the molecules after light is given at a wavelength that the light sensitive molecules will absorb. The released oxygen radicals have a bactericidal effect by breaking down the cell wall.[30]

The products used in the clinics are; Phenothiazine dyes (Toluidine blue O, methylene / dimethylene blue), Phthalocyanines, Chlorines, Porphyrins, Xanthenes, Monoterpenics, Methylene blue loaded polynanoparticles.[15]

Laser

The first devices to be marketed for intraoral applications were CO_2 lasers. The first device specifically designed for dentistry was the Nd:YAG laser. For dental laser devices, FDA approval was obtained for resin composite polymerization, tooth whitening, subgingival curettage, caries removal and cavity preparation and selective ablation of caries.[7]

Various types of laser systems have been developed depending on the usage area of lasers. Laser types used in dentistry are carbon dioxide (CO_2), Neodymium:Yttrium-Aliminum: Garnet (Nd:YAG), Erbium YAG (Er:YAG), Erbium, chromium: Yttrium: Scandium-Gallium-Garnet (Er,Cr: YSGG) are laser types.[31]

CO_2 and Nd:YAG lasers, which were first preferred in laser studies, have been reported to cause damage to surrounding tissues due to their high energies. Especially with 10.6 micron of CO_2 laser, a strong absorption occurs in the tooth enamel and it has been reported that it creates cracks and polished areas on the tooth surface.[32]

While removing the smear layer, lasers eliminate the residual bacteria and thus play an important role in cavity disinfection.[33] Laser application causes the expansion of the water in the intratubular dentin, exerting a thermal effect on the bacterial cells in this region, stopping the growth of the cell and causing its lysis.[7]

The negative aspects of carbon dioxide and Nd-YAG lasers are that they can only evaporate hard tissues with high-intensity energy, causing carbonization, melting, crack formation and heat increase in the pulp in these tissues. Therefore, lasers are preferred in cavity preparations at higher doses of 3.3W and above. However, less damage occurs when removing the caries. During this application, the cavity is sterilized. In the process of removing the rotten tissue, the underlying healthy tissue is preserved.[34]

Today, cavity preparation with the use of erbium, chromium: yttrium, scandium, gallium, garnet (Er,Cr: YSGG) laser is an interesting application. This type of laser, which emits 2.78 μm beams, also works with a hydrokinetic system and cuts the hard tissue by interacting with the water on the tissue surface. It has been shown in SEM studies that laser cuts cause less damage to prisms than bur cuts and less smear layer is observed in dentinal tubules. This situation can be counted as an advantage in the complete cleaning of the smear layer, which may be a source of residual carious tissue and bacteria.[35]

There are also studies of cavity disinfection with potassium titanyl phosphate (KTP) laser, which is frequently used in bleaching processes, in the literature.[36]

Antibacterial Dentin Adhesives

It is necessary to develop adhesives with antibacterial activity to prevent the destruction of the bonded interface caused by extrinsic bacteria.[37] Similarly, the development of adhesives with matrix metalloproteinase (MMP) inhibitory effects to optimize the durability of resin-dentin bonds is highly sought after.[38]

In 1994, Imazoto et al. developed an antibacterial monomer that they had been working on for a long time. This monomer was synthesized by combining an antibacterial agent and a polymerizable methacryloyl group.[39] Since the antibacterial monomer named 12-Methacryloyloxydodecylpyridiniumbromide (MDPB) is copolymerized with other monomers, it is immobilized in the polymer network at the end of the curing reaction. It can show antibacterial activity without releasing antibacterial component. While MDPB, which has a bactericidal effect before polymerization, can inactivate residual bacteria in the cavity, it becomes stable after polymerization and acts as a contact inhibitor and prevents bacterial colonization.[40]

In clinical use, it is available under the name of Clearfil Protect Bond (Kuraray Medikal, Tokyo, Japan).[40]

Adhesives with antibacterial activity may help reduce the formation of secondary caries.[41] Quaternary ammonium methacryloxy silane was added to the experimental adhesives and it was observed that the modified adhesives showed antibacterial activity without negatively affecting dentin bond strength.[38] Experimental antibacterial adhesives also showed inhibitory effects on soluble MMP-9 and cathepsin K activities.[38] An antibacterial peptide called nişin was mixed with commercial adhesives and antibacterial activity was observed without compromising binding properties.[42] The antibacterial

activities of nisin-containing adhesives depend on the nisin concentration.[42]

Nisin is an antibacterial peptide produced by Lactococcus lactis and is widely used in food preservation. Nisin contains lanthionine (lantibiotic) and is effective in inhibiting the microbial growth of Gram-positive bacteria, especially those associated with high food risk such as Staphylococcus aureus and S. epidermidis, Clostridium botulinum, Listeria monocytogenes and Streptococcus species.[43] The bactericidal activity of nisin is based on the depolarization of bacterial cytoplasmic membranes. Membrane depolarization results in the formation of transmembrane pores, which results in membrane lysis and cell death.[38]

More research is needed regarding the antibacterial effects of nisin-containing adhesives against other bacteria with cariogenic potential, as well as the ability of nisin-containing adhesives to maintain dentin bond integrity over time.

Studies on the Effects of Cavity Disinfectants

In a study conducted by Ağaçkıran in 2009, the effectiveness of 5 different cavity disinfection materials on 3 different microorganisms were investigated. In the study Consepsis, Tubulucid Red, Clearfil Protect Bond, NaOCl, Hydrogen Peroxide materials were used and their antibacterial activities on C. Albicans, S.mutans, L. Acidophilus bacteria were investigated.The results showed that the difference between the antibacterial activities of the test materials on 3 different microorganisms were statistically significant. Accordingly, it was understood that the effect of the materials differed according to the type of microorganism. It has been reported that Clearfil Protect Bond, which has the least effect on C. albicans, has the highest effect on the other two microorganisms.[44]

In the study conducted by Arslan et al. in 2011, they showed that the application of CHX, NaOCl, Propolis, Ozon, Er, Cr:YSGG for laser cavity disinfection did not have statistically significant effects on the bonding of silorane-based resin composite.

In another study conducted by Ercan et al. in 2009, they reported that various cavity disinfectant applications had a significant effect on the bonding of 'self-etch' and 'etch and rinse' adhesives. they have suggested.

In another study conducted by Campos et al. in 2009, it was determined that the application of CHX-containing cavity disinfectant and Er,Cr:YSGG had effects on both the 'self-etch' and 'etch end rinse' systems.

In another study, in which various cavity disinfection applications (CHX, Propolis, Ozone, Er,Cr: YSGG laser) and 2 different (self-etch and etch and rinse) bonding applications were evaluated in enamel and dentin. It was found that the CHX group had statistically significantly higher microleakage values than the Laser group. There was no statistically significant difference in the etch and rinse group.[12]

In a study comparing the effects of KTP laser, 2% CHX and Clearfil Protect Bond applications on microleakage in Class V cavities; the lowest microleakage values were reported in the KTP laser group.[36]

In a study conducted by Nayagoshi et al. in 2004, the effectiveness of ozonated water and 2.5% NaOCI in contaminated dentinal tubules with Enterococcus faecalis and S.mutans were compared. At the end of the study, it was found that ozonated water reduced the number of microorganisms more.

In the study of Sharma et al. in 2009 with three cavity disinfectants containing chlorhexidine gluconate, benzalkonium chloride and iodine; although there was no negative effect on the microleakage value in the chlorhexidine gluconate and benzalkonium chloride applied group, an increase in the microleakage value was observed in the iodine applied group.[29] Baysan and Lynch found that ozone therapy significantly reduced the number of microorganisms and provided remineralization in root rot. In the study, the antimicrobial activity of ozone on S.mutans and S.sobrinus was investigated and it was reported that more than 99% of microorganisms were destroyed in both applications as a result of 10 and 20 second ozone applications in extracted teeth with early stage of root surface caries.[45]

In the study conducted by Güneş in 2013, it was reported that the group with the least microleakage in cavity disinfection application was the group in which ozone was applied.

Acid application and rinse are not performed in self-etch adhesive systems. For this reason, the smear layer and demineralized dentin, which allows the presence of bacteria are not removed. This situation led researchers to investigate the antibacterial efficacy of self-etch adhesives. The antibacterial agent named MDPB, developed by Imazoto et al. in 1998, was added to the primer of the self-etch adhesive system. It has been reported that the self-etch adhesive system with a primer containing 1–5% MDPB is effective against S.mutans, A.viscocos and lactobacilli.

Clearfil Protect Bond (Kuraray, Japan), one of the adhesive systems developed and released by adding MDPB, is a two-stage self-etch adhesive system. Self-etching primer; antibacterial agent MDPB (12methacryloyloxydodecylpyridiniumbromide), MDP (10-methacryloyloxydecyl dihydrogen phosphate), HEMA (Hydroxy ethyl methacrylate) and water; bonding agent; It contains MDP, HEMA (2-hydroxyethylmethacrylate) and sodium fluoride. It has been reported that the MDPB-added adhesive system prevents the proliferation of bacteria reaching the cavity as a result of polymerization shrinkage and can protect the tooth against secondary caries for a long time.[46]

In the study conducted by Karaarslan et al. in 2010 using the PAD system, the microleakage values in the PAD applied group were significantly lower than the non-administered group.

In a study examining the effect of two different cavity disinfectants containing benzalkoniome chloride (Bisco Cavity Cleanser) and chlorhexidine (Tubulicid Red) on the sealing of the restoration in Class II cavities, it was found that the cavity disinfectant containing chlorhexidine reduced the tightness, but the cavity disinfectant containing benzalkonium chloride increased the sealing.[47]

Microtensile bond strength was tested in another study in which various cavity disinfection methods were applied, chlorhexidine (CHX), propolis (PRO), ozonated water (OW), gaseous ozone (OG) and KTP. The results were reported as OW > KTP > CHX > PRO > CONT > OG.[48]

In a study comparing the antimicrobial activities of Aloe Vera and CHX, the total number of countable live microorganisms decreased by 2% in CHX application, while this number decreased by 1% in Aloe Vera.[49]

In another study comparing the antimicrobial efficacy of Aloe Vera and Propolis, it was reported that Aloe Vera and Propolis significantly reduced the amount of bacteria, but there was no statistically significant difference in efficacy between each other.[50]

Researchers examined the effects of these gels on micro-tensile bonding and reported the bond strength values after antibacterial gel application as CER>COR>GEG>FOB, respectively. There was no statistically significant difference between the groups.

Conclusion

During the removal of infected dentin from the cavity in operative dentistry, the residual presence of bacteria in the cavity is stated as one of the most important problems in this field. The approach of disinfecting the cavity with antibacterial solutions, gels or various other applications after the removal of caries in the cavity seems to be very useful in reducing the residual bacterial population.

However, although it is a useful procedure, it has been observed that the use of cavity disinfection methods before the application of the bonding material has often led to failure in the connection of the restorative materials to the dentin. Researchers state that the problem in the connection can be solved by using a total-etch system compared to self-etch adhesive systems.

As a result, it will be possible to achieve success and make restorations with longer use as a result of choosing the appropriate dentin adhesive system with the appropriate cavity disinfection method.

Disclosures

Conflict of Interest

The author have no conflicts of interest to declare.

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