ISSN PRINT 2319 1775 Online 2320 7876

Research paper UGC CARE Listed (Group -I) Journal Volume 11,Iss 7, Oct 2022

Cavity Disinfectant Effects and Effectiveness in Operative Dentistry: A Literature Review

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ABSTRACT

The extent to which bacteria are removed from the area during cavity preparation and before a restoration is placed may increase the lifetime of the restoration and, consequently, the success of the restorative treatment. During cavity preparation, it is seen to be a challenging clinical procedure to completely eradicate microorganisms from a tooth that has been afflicted by caries. The vitality of the pulp may be harmed by attempts to totally dig significant carious tissue using just mechanical techniques, which could also compromise the tooth structure. Therefore, after caries excavation, disinfecting the cavity preparation can help remove bacterial leftovers that may be to blame for recurrent caries, postoperative sensitivity, and restoration failure. However, dental practitioners and academics have been quite concerned about the effects of disinfectants on the restorative procedure. In order to assist dental professionals in making the clinical decision to use cavity disinfectants during restorative procedures, this review aims to explore the body of existing literature, provide information about various materials and techniques that have been used for disinfecting cavity preparations, and describe their effects and effectiveness in operative dentistry. This research assessed the effectiveness of antimicrobials, their impact on dental restorations and pulp, as well as any potential negative consequences.

Keywords: Bond strength, Cavity disinfectants, Microleakage, Operative dentistry.

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INTRODUCTION

Bacterial residues in the cavity walls can impact the efficacy of restorative treatment during cavity preparation. It is known that bacteria that remain after restorative procedures may thrive and grow, particularly in the presence of microleakage, which may cause pulpal irritation, [1,2] a risk of recurrent caries, [3,4], and/or postoperative sensitivity,5 and ultimately result in the failure of the dental restoration. [4] Brännström and Nyborg's [5] emphasis on the significance of eradicating bacteria that remained on cavity walls, including dentin and enamel, after caries excavation, and their recommendation that the cavity preparation be cleaned before placing the restoration, sparked interest in the study of antimicrobial agents and their effects on the pulp in the early 1970s. [6]

Following that, anti-bacterial washing of the cavity preparation to aid in bacterial removal gained widespread favor among dental professionals.

13 In clinical dentistry, a variety of disinfectants have been utilized in an effort to decrease or remove microorganisms during cavity preparation and before dental restorations are placed. Some of these substances have been documented to create pulpal discomfort as a result of their ingrained compounds, leading to their disuse. [7] The approaches discussed in this research and their effectiveness as antibacterial agents as well as documented effects on dental restorations have all been reported to be employed during cavity preparation.

CAVITY DISINFECTANTS

Chlorhexidine

Since the 1970s, chlorhexidine digluconate (CHX), a biguanide biocide, has been used as an oral antibacterial agent. CHX prevents the development and advancement of dental plaque. [8] At the moment, CHX is regarded as the "gold standard" of oral antiseptics and is one of the most often used antimicrobial agents in oral health16. [9]

Chlorhexidine digluconate has been shown to have high antibacterial activity against both Gram-positive and Gram-negative bacteria, particularly Streptococcus mutans, but its effects on Gram-negative bacteria were less pronounced than those on Gram-positive bacteria [10]. [11] Additionally, it has been noted that CHX inhibits S. mutans' development. [12] However, it has also been noted that Staphylococci are less susceptible to CHX. [13] At high quantities, chlorhexidine digluconate is bactericidal; at low amounts, it is bacteriostatic. [14] CHX affects the cytoplasmic membrane after destroying the cell wall at low doses. It causes intracellular components to coagulate at high

ISSN PRINT 2319 1775 Online 2320 7876

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concentrations, which results in cytoplasmic congealing. [15] Chlorhexidine digluconate has been regarded as a biocompatible [16] and toxicologically safe disineftant in the form of a 2% aqueous solution. [17] Following contamination of the exposed pulp, Pameijer and Stanley [18] discovered that 2% CHX administered for 60 seconds was an efficient hemostatic agent and promoted the creation of dentin bridges.

According to the type of adhesive system utilized, the form and concentration of CHX, as well as the aging process, different concentrations of CHX have been observed to have diverse impacts on restorative treatments. Prior to composite bonding, a 2% solution of chlorhexidine digluconate wash has been found to successfully maintain the bond strength for up to 6 months when etch-and-rinse adhesive solutions were employed. 34-36 Furthermore, after 12 months of aging, Manfro et al [19] and Breschi et al [20] observed that this binding in the CHX-treated samples was substantially stronger than the nontreated ones. When self-etch adhesive systems rather than etch-and-rinse adhesive systems were utilized following CHX pretreatment, several studies have found that the bond strengths of resin composite to dentin were increased. [21-23] In the dentin margins, Arslan et al. [24] discovered no appreciable differences between self-etch and etch-and-rinse. The etch-and-rinse adhesive, however, showed considerably reduced microleakage in enamel margins. In contrast, a single-bottle self-etching adhesive was found to increase the microleakage of nanohybrid composite restorations in an in vitro investigation by Singla et al10 on samples that had previously been treated with 2% CHX cavity disinfectant. It has been demonstrated that pretreatment with 2% CHX before amalgam insertion on amalgam restorations reduces microleakage and postoperative sensitivity. [25]

There have been reports of teeth discoloration caused by chlorhexidine digluconate. However, like with the usage of mouthrinses, this impact only became apparent after prolonged use. 58,59 Even though CHX allergies are uncommon, the chemical can nonetheless result in taste changes, desquamative gingivitis, or contact dermatitis. 28 Additionally, a high concentration of CHX (18%) has been reported to have hazardous consequences. However, tissue could be in touch with concentrations as high as 10%. [26]

Sodium Hypochlorite

Since its introduction (1920) in endodontics as an antibacterial irrigant, sodium hypochlorite (NaOCl), an efficient organic solvent, has been widely utilized in clinical dentistry as a cleaning agent. [27] NaOCl transforms into sodium chloride and oxygen when it comes into contact with the dentin surface, oxidizing the dentin matrix. [28]

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It is widely known that sodium hypochlorite has great tissue-dissolving properties and powerful antibacterial efficacy against lingering germs. 27,63,64 According to Vianna et al. [29], Staphylococcus aureus, Candida albicans, Porphyromonas endodontalis, Porphyromonas gingivalis, and Prevotella intermedia can all be eradicated by using 5.25% NaOCl solution for 15 seconds. However, it has been noted that the concentration of the solution affects the antibacterial action of NaOCl. [30]

In cell cultures, sodium hypochlorite has been shown to be cytotoxic. [31] Hilton [32] observed a heightened pulpal inflammatory response following the application of NaOCl in a review on the effectiveness of pulp-capping. Additionally, NaOCl was not advised to be used to disinfect cavities by Pascon et al [33].

On the impact of NaOCl on resin bond, conflicting results have been reported. Some scientists discovered that this treatment had a negative impact on the hybrid layer, and as a result, the resulting bond strength and microleakage [34], whilst other authors discovered no effects on bond strength. [35] However, it is thought that the adhesive technique in use affects how well composite resin bonds when NaOCl is pretreated. [36] Since 2.5% NaOCl pretreatment had a detrimental effect on the shear bond strength (SBS) of self-etching bonding systems, Ercan et al. [37] advised using NaOCl disinfectant with etch-and-rinse bonding systems. A 10% NaOCl gel pretreatment followed by Single Bond, Prime & Bond NT, or Gluma One Bond, on the other hand, dramatically increased the microleak- age at the dentin interface, according to Shinohara et al. [38].

Since sodium hypochlorite solution is a potent oxidant that causes a corrosive reaction, it must be applied carefully. In addition to its propensity to bleach clothing, it also has an unpleasant taste and can irritate nearby tissue, especially at high doses. [39]

Benzalkonium Chloride

A combination of alkylbenzyl-dimethyl ammonium chlorides make up benzalkonium chloride (BAC), a nitrogenous cationic compound with significant antibacterial action. [40]

BAC has been touted as a potent antibacterial agent that is effective against bacteria including S. mutans, Streptococcus salivarius, and S. aureus.

83,84 According to reports, this activity was lower than CHX. [42] Dental pulp has been reported to be compatible with the cavity disinfectant benzoalkonium chloride. [41]

ISSN PRINT 2319 1775 Online 2320 7876

Research paper UGC CARE Listed (Group -I) Journal Volume 11,Iss 7, Oct 2022

Similar to CHX, BAC has been shown to be an effective MMP inhibitor that may maintain the resin restoration's adhesive attachment to the dentin. [43] Using two etch-and-rinse adhesives, Sabatini and Patel [44] assessed the impact of various BAC concentrations on the preservation of adhesive surfaces (Optibond Solo Plus and All-Bond 3). In groups prepared with 0.5% BAC and 1.0% BAC and using Optibond Solo Plus, as well as in groups prepped with 0.25 and 0.5% BAC and utilizing All-Bond 3, they reported an improvement in the bond strength. After 18 months, they discovered that BAC increased bond stability at all concentrations.

When consumed at a dosage of 10% or above, significant complications may arise that may potentially result in death. Benzalkonium chloride solutions at high concentrations can cause toxic and allergic reactions.88 [45]

Ozone

The photodissociation of oxygen into activated oxygen atoms, which then react with additional oxygen molecules, results in the production of ozone (O3), a pale, unstable gas. [46] Strong oxidation is a characteristic of ozone. As a result, it has antibacterial properties that cause bacteria's cell walls and cytoplasmic membranes to rupture, which results in the microorganism's demise. [47]

It is well known from the literature that O3 has antibacterial activity against oral microorganisms, particularly against S. mutans. [48] O3 application times of between 10 and 60 seconds have been observed to have efficient antibacterial activity. [49] O3 administration for 20 seconds can kill 99.9% of bacteria in primary caries lesions, according to Baysan et al. [50]. O3 was able to lower the levels of S. mutans and Streptococcus sobrinus after a 10-second application.

The impact of O3 on the cohesive strength of dental composites has been documented in a number of investigations. With regard to pit-and-fissure sealants, some of these investigations assessed the impact of O3 pretreatment on the enamel bond but found no differences in the enamel bond strength or microleakage. [51] In addition, solid evidence has been cited in favor of applying O3 as a preventative measure prior to closing pits and cracks. [52] Marchesi et al [53] looked at the impact of an O3 application for 80 seconds on fissure sealants. In their study, Concise and UltraSeal XT Plus fissure sealants, with or without O3 pretreatment, did not significantly differ in their immediate enamel SBS and microleakage, and O3 did not negatively impact the enamel bond strength or enhance microleakage.

O3 was determined to be more effective as a cavity disinfection than conventional techniques by Günes

ISSN PRINT 2319 1775 Online 2320 7876

Research paper UGC CARE Listed (Group -I) Journal Volume 11,Iss 7, Oct 2022

et al. [54] after testing O3 with various cavity disinfectants. When compared to the control group, groups treated with CHX, BAC, NaOCl, and diode lasers, the O3-treated group in their study had the least microleakage. However, there was no statistically significant difference between the other disinfectants, including O3.

O3 is a promising therapeutic option in clinical dentistry, just like lasers, however these equipment costs are higher than those of conventional disinfectants. O3 devices should be handled carefully because to its severe toxicity114 and powerful oxidizing action; as a result, the manufacturer's recommended administration technique should be properly followed.

Naturally based Disinfectants

There has reportedly been an increase in interest in recent years in using natural treatments in dental applications as a complement to conventional medicine. [55] For their antibacterial properties and impacts on restorative operations, many disinfectants with naturally derived ingredients have been employed and studied. Propolis, Salvadora persica, and Morinda citrifolia are only a few of these.

Propolis, often known as bee glue, is a resin-like substance that honeybees collect from various tree buds; as a result, it contains bee products.

Along with the potential to treat some medical ailments, propolis has been shown to be effective against S. mutans and other oral pathogens due to its antibacterial properties. [56] In a recent study by Akca et al., [38] it was discovered that the effects of propolis and CHX against Streptococci biofilms were comparable. The researchers also discovered that propolis was more effective than CHX at inhibiting Gram-positive than Gram-negative bacteria. Nieva Moreno et al. [39] and Kujumgiev et al. [40] have also reported on the propolis' effectiveness against Gram-positive bacteria. [40] A number of research have examined the impact of propolis extract disinfectants on restorative therapy. [57] Arslan et al [55] discovered that when the etch-and-rinse adhesive system (Adper Single Bond 2) was utilized, 30% propolis extract did not significantly vary from other disinfectants. However, in groups using the self-etch adhesive technique (All Bond SE), the propolis group showed higher microleakage on the dentin margins than the control group.

Perote et al. [42] have studied the MMP inhibitory effects of propolis extracts. In their investigation, they applied several propolis extracts for 60 seconds after acid-etching and before applying Adper Single Bond 2. These extracts included 10% ethanol, aqueous extract, and 70% ethanol extract.

ISSN PRINT 2319 1775 Online 2320 7876

Research paper UGC CARE Listed (Group -I) Journal Volume 11,Iss 7, Oct 2022

CONCLUSION

Different disinfectants' antibacterial efficacy has been widely documented; nevertheless, the anti-microbial potency of some agents varies depending on the application rate and duration. The type of adhesive system protects the choice of cavity disinfectant. The literature strongly recommends the use of 2% CHX solutions when etch-and-rinse adhesive systems are utilized, despite the fact that it is thought that the effect of disinfection pretreatment on the tooth/restoration bond is material-based. There is solid evidence to support the use of 1% CHX gel as a cavity disinfection when a self-etch adhesive method is employed. To assess its biocompatibility with diverse systems, more study is required. The biocompatibility of contemporary disinfection techniques like laser and O3 devices with adhesive systems and restorative materials shows promise. To prevent any negative effects, these gadgets should only be handled carefully. More research is necessary to assess organically based disinfectants because there is little clinical and laboratory evidence to support their usage.

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