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"Assessing the Influence of Different Cavity Disinfectants on Microleakage in Class V Restorations with Glass Ionomer Cement: A Stereomicroscopic In Vitro Study"

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ABSTRACT:
Background: Effective cavity disinfection is vital for successful restorations, preventing secondary caries and marginal adhesion failure. Chlorhexidine and Hydrogen peroxide are commonly used cavity disinfectants.Aloevera extract was used as novel cavity disinfectant due to increased trend of phytotherapeutics in dentistrty. The aim of this study was to compare effects of three different cavity disinfectants like chlorhexidinegluconate, Alovera extract and Hydrogen Peroxide on microleakage in Class V glass ionomer restoration using stereomicroscope.**Material and Methods:** 30 extracted mandibular molars weredecoronated andClass V cavities were prepared on the buccal surface with specific dimensionsand teeth were randomly divided into three groups based on cavity disinfectants used namely:ChlorhexidineDigluconate, Hydrogen Peroxide and Aloevera Extract. Cavities were disinfected, restored with glass ionomer cement and nail varnish was applied along the tooth surface. Specimens were immersed in toluidine blue dye and microleakage scores were assessed using digital stereomicroscope atocclusal and gingival margins.**Results:**SPSS 20.0 software version was used for statistical analysis. Chlorhexidine showed least microleakagefollowed by alovera extract and hydrogen peroxide respectively. Microleakage was more pronounced along the gingival wall in all groups. **Conclusion:**ChlorhexidineDigluconate was superior in microleakage reduction. Aloevera moderately effective; Hydrogen Peroxide minimally.

Keywords: alovera, chlorhexidine, class V, disinfectant, herbal, hydrogen peroxide,microleakage, stereomicroscope

I. INTRODUCTION:

Upto 90% of recurrent caries in Class V restorations occur at the cervical margins, irrespective of the restoration type; along with microbial, oral hygiene and dietary factors contributing to cervical caries formation.[1,2] The presence of bacterial residues during or after cavity preparation is a significant concern, as it can lead to issues such as secondary caries, marginal adhesion failure, pulp sensitivity and pulpal inflammation.[3]To ensure a successful restoration both mechanically and biologically, complete removal of infected dentin is essential. Following cavity preparation, using an antibacterial cavity disinfectant is advisable to eliminate any remaining microorganisms and prevent potential pulpitis.

Chlorhexidine (CHX) is widely recognized as the primary antimicrobial solution and a potent inhibitor of matrix metalloproteinases (MMPs). It interacts with the amino acids in dentin, exerting its bactericidal properties. 2% CHX solution kills bacteria by precipitating cytoplasmic components, leading to cell death. It also inhibits MMPs 2, 8, 9 and dentin cathepsins, preventing collagen degradation.[4]

Hydrogen peroxide (H_2O_2) is effective against a broad spectrum of pathogens, including viruses, bacteria, yeasts and bacterial spores. Certain bacteria have defense mechanisms, such as catalase or superoxide dismutase enzymes, against H_2O_2. It works by producing hydroxyl free radicals (OH), which target cellular components like proteins and DNA.[5]

In recent times, there has been an increasing inclination towards exploring natural remedies within the field of medical and dental treatments. This trend is often referred to as "phytotherapeutics" or "ethnopharmacology".[6]Aloebarbadensis miller (Aloevera), a succulent herb from the Aloeaceae family, is characterized by its cactus-like appearance with green, dagger-shaped leaves that are fleshy, spiny and have serrated margins.Aloin,

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known for its bitter taste and yellow color as a C-glycoside derivative of anthraquinone, has shown effective inhibition of stimulated granulocyte MMPs 2 and 9.[6]

Incomplete removal of infected dentin and inadequate disinfection of the prepared cavity can promote microleakage. Even when the restoration is effectively sealed from the oral environment, research has shown that residual bacteria within the smear layer can multiply beneath the restoration, posing a potential issue in the field of restorative dentistry.[7]

The ideal cavity disinfectant should possess potential antimicrobial effectiveness with the preservation of the sealing capability of restorative materials. This balance is essential for extending the longevity of the restoration. Disruption in sealing ability can lead to marginal leakage, ultimately reducing the lifespan of the restoration.[8]

The purpose of this study was to compare the effects of the use of three different cavity disinfectants like chlorhexidinegluconate, Alovera extract and Hydrogen Peroxide on microleakage in Class V glass ionomer restoration using stereomicroscope. The postulated null hypothesis was that there is no significant difference in microleakage among the three cavity disinfectants along the gingival and occlusal wall.

II. MATERIALS AND METHOD:

Total 30 extracted permanent mandibular molars were collected from the Department of Oral and Maxillofacial Surgery, Narsinhbhai Patel Dental College and Hospital, Visnagar, Gujarat. All the teeth were cleaned and tissue remnants were removed by using ultrasonic scaler. The inclusion criteria encompassed teeth extracted as a result of periodontal disease or orthodontic purpose with intact crown. The exclusion criteria comprised teeth with visible cracks, carious or previously restored teeth, developmental defects, noncarious cervical lesions and decalcified teeth. Disinfection was done with 0.2% thymol solution and tooth were stored in distilled water till further use.

Class V Cavity Preparation: Class V cavities were made on the buccal surface of teeth using a 245 no. diamond bur using saline as coolant with contra-angled handpiece attached to micromotor. The cavities had specific dimensions: a mesiodistal width of 4 mm, gingivo-occlusal width of 3 mm and depth of 2.5 mm. To maintain precision, a millimeter-tipped periodontal probe was utilized during cavity preparation to prevent deviations in cavity dimensions. After preparation of five cavities each, the bur was replaced to ensure effectiveness. After preparation, the teeth were divided randomly into three groups based on cavity disinfectants used namely: Group 1-ChlorhexidineDigluconate (n=10), Group 2-Hydrogen Peroxide (n=10) and Group 3- Alovera Extract (n=10).

Preparation of Aloevera Extract: Fresh aloevera plant leaf was collected and cut transversely and solid mucilaginous, thick straw-colored gel was collected in a sterile container. The collected gel was treated with ethanol and extract was placed in waterbath for 2 hours and after that it was used as stock solution.

Cavity Disinfection: Using an applicator tip, the disinfectant was applied for 20 seconds and then removed with compressed air for 5 seconds. All cavities were then filled in with glass ionomer cement as per the manufacturer's instructions. Excess amount of restorative material was removed and finishing and polishing was done with fine-grained diamond burs. Then all the teeth were kept at room temperature (37°C) for 24 hours.

Preparation for Microleakage Testing: To seal the tooth apices and occlusal grooves, sticky wax was used, followed by two layers of acid-resistant varnish applied to the tooth surfaces, leaving a 1 mm margin from the occlusal and cervical margins. The teeth were then individually placed in labeled glass beakers and submerged in toluidine blue dye at room temperature (37°C) for 24 hours.

After the immersion period, the teeth were removed from the dye solution and subjected to thorough rinsing using distilled water until complete elimination of residual dye was achieved. Subsequently, the teeth underwent a drying process facilitated by an air spray.

The radicular segments were removed by making a horizontal cut 2mm below the Cementoenamel Junction. Following this, the coronal portions were prepared by sectioning them mesiodistally and buccolingually at the center of the restoration using a slow-speed diamond disc mounted on a mandrel.

The occlusal and gingival margins were carefully inspected for microleakage using a digital stereomicroscope from Olympus in Tokyo, Japan, with a magnification of 40x by 2 different examiners. Dye microleakage scores were evaluated according to a following predefined scale: Score 0: No microleakage, Score 1: Dye penetration upto one-third of the cavity depth, Score 2: Dye penetration between one-third to two-thirds of the cavity depth and Score 3: Dye penetration into more than two-thirds of the cavity

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depth towards axial wall. The data was collected and suitable statistical analysis was done.

Statistical analysis: The statistical analysis involved the utilization of SPSS Version 20.0, employing the Mann-Whitney U test, Wilcoxon signed-rank test, and Kruskal-Wallis test, with a predetermined level of significance set at $P \leq 0.05$.

Results: Table 1 illustrates the distribution of microleakage among all groups at both the occlusal and gingival walls. For the occlusal wall, the mean rank of microleakage was significantly lower in the ChlorhexidineDigluconate group (7.80) compared to both the Hydrogen Peroxide group (23.15) and the Aloevera Extract group (14.80) ($P < 0.001$*). Similarly, for the gingival wall, the ChlorhexidineDigluconate group exhibited a significantly lower mean rank of microleakage (8.30) compared to the Hydrogen Peroxide group (23.40) and the Aloevera Extract group (15.55) ($P < 0.001$*).

Table 1: Microleakage wise distribution among all groups at Occlusal and Gingival Wall

Wall	Groups	Microleakage Score		P Value
		Number	Mean Rank	
Occlusal	ChlorhexidineDigluconate	10	7.80	< 0.001*
	Hydrogen Peroxide	10	23.15	
	Aloevera Extract	10	14.80	
Gingival	ChlorhexidineDigluconate	10	8.30	< 0.001*
	Hydrogen Peroxide	10	23.40	
	Aloevera Extract	10	15.55	

Level of Significance $P \leq 0.05$, * Significant, ** Non Significant

ChlorhexidineDigluconate had less microleakagethan Hydrogen Peroxide and Aloevera Extract at both occlusal and gingival walls. Aloe vera Extract showed less microleakage than Hydrogen Peroxide. Overall, ChlorhexidineDigluconate was most effective, particularly at the critical gingival margin for preventing secondary caries and maintaining restoration integrity.

III. DISCUSSION:

Cervical caries, often stemming from poor oral hygiene and cariogenic diets, present a prevalent dental issue. Presence of cariogenic microbes within the smear layer of restored teeth is a key factor in secondary caries and restoration failure. Therefore, cavity disinfection procedures are recommended to eradicate these residual bacteria. However, such disinfection can compromise the seal between dentin and restorative material, potentially resulting in microleakage.[7]

Microleakage is the infiltration of fluids, bacteria, and ions between a cavity and its restoration, often imperceptible clinically.[9]Consequences include tooth sensitivity, discoloration, recurrent caries, pulpal damage and premature restoration failure. Maintaining optimal marginal sealing is crucial, as evidence suggests complete removal of infected dentin may not be imperative. Yet, bacteria within dentin can persist post-tooth restoration, potentially proliferating beneath the restorative interface.

Traditional mechanical caries removal methods may not completely eliminate caries. Therefore, combining antibacterial disinfectants with mechanical strategies is acknowledged as an effective approach for thorough caries debridement, reducing the risk of secondary cavities.

In the current study, dye-penetration was selected for its well-documented efficacy. The utilization of organic dyes remains a longstanding

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and preferred method in microleakage studies, owing to its historical reliability. Solutions containing silver nitrate, methylene blue, crystal violet, erythrosin, rhodamine B, toluidine blue and basic fuchsine are employed.[1]In the current study, toluidine blue solution was employed to evaluate the microleakage of restorative material. Microleakage was evaluated by observing dye penetration under stereomicroscope.

In a study by Turkun et al. (2006), the effects of chlorhexidine, benzalkonium chloride, and iodine-based cavity disinfectants on dentin adhesive sealing capabilities were investigated. Their research revealed that chlorhexidine and benzalkonium chloride solutions did not affect microleakage, while iodine-based solutions increased it. However, Tulunoglu et al. (1998) found contradictory results, indicating that chlorhexidine-based cavity disinfectants had a negative effect on dentin adhesive systems.[10]

Chlorhexidinedigluconate (CHX) is a potent antimicrobial solution renowned for its ability to significantly inhibit streptococci growth, aiding in preventing dental caries. Its application on dentin surfaces impedes bacterial colonization due to sustained release of positively charged molecules, termed substantive antimicrobial activity (SAA). Research by Barsani et al. found that 2% CHX demonstrated strong disinfectant properties and effective SAA. Additionally, CHX's SAA helps prevent immediate collagen fibril deterioration during bonding procedures, potentially contributing to long-term dentin bond stability.[2]

Hydrogen peroxide (H_2O_2) has broad antimicrobial activity, targeting viruses, bacteria, yeasts, and bacterial spores by generating hydroxyl free radicals (OH). In dentistry, its use can reduce bond strength due to residual solution within dentin, hindering resin infiltration and polymerization. Studies by ErtugrulErcan et al. and CJ Soares et al. observed decreased bond strength with 3% hydrogen peroxide treatment, likely due to oxygen interference at the dentin/restorative interface, forming an inhibition layer that hampers polymerization.[5]

This study investigated the efficacy of ethanolic extracts from Aloevera for cavity disinfection prior to restorative procedures, aligning with the growing preference for natural products in phytotherapy. Aloevera's primary anthraquinones, aloin and aloe emodin, possess potent antibacterial and antiviral properties. The ethanolic extract boosts antimicrobial activity due to enhanced solubility. Coumaric acid and cinnamic acid inhibits microbial enzymatic activity and disrupt bacterial cellular processes. Moreover, Aloe vera demonstrates anti-MMP potential, particularly against MMP-2 and MMP-9, aiding in long-term stabilization of microleakage by enhancing collagen content and crosslinking.[4]

Studies on microleakage of Class V restorations, irrespective of disinfectant application, found that sealing effectiveness at occlusal margins was superior to cervical margins due to the thinner and more permeable enamel layer in the cervical region compared to the occlusal region.[10] The higher concentration of inorganic hydroxyapatite in enamel, in contrast to dentin's predominantly organic components, could disrupt micromechanical adhesion. In this study, microleakage scores were higher at gingival margins compared to incisal margins.

Utilizing cavity disinfectants has the capacity to diminish or eradicate bacteria within cavity preparations, thereby potentially enhancing the success and longevity of restorations.[11]

Achieving complete bacterial elimination before cavity restoration is clinically preferred. However, using cavity disinfectants before bonding procedures often decreases bond strength. Therefore, selecting a disinfectant that minimizes this impact is crucial. In this study, 2% chlorhexidine emerged as the most suitable disinfectant, exhibiting minimal microleakage and preserving bond strength between the restorative material and the tooth.

IV. CONCLUSION:

The study highlights the importance of selecting cavity disinfectants in restorative dentistry. While ChlorhexidineDigluconate demonstrated superior performance in reducing microleakage, practitioners should consider various factors such as antimicrobial efficacy and bond strength when choosing a disinfectant. Subsequently, evidence-based guidelines should be developed to assist dental professionals in selecting and applying cavity disinfectants across various clinical scenarios, thus improving patient outcomes.

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