European Annals of Dental Sciences
Official Publication of Ankara University, Faculty of Dentistry

EADS, 2024, 51 (1), 20–27

e-ISSN : 2757-6744
doi : 10.52037/eads.2024.0004

Article Received/Accepted : November, 11 2023 / April, 20 2024
Ethical Committee No : 2021-23

ORIGINAL RESEARCH ARTICLE

Effect of Chlorhexidine Treatment on Microleakage of Glass Ionomer, Giomer and Methacrylate-Based Composite Restorations in Class V Cavities

Ayşe Aslı Şenol [1,*], Seda Özmen [2], Büşra Karabulut Gençer [3], Bilge Tarçın [1] and Pınar Yılmaz Atalı [1]

[1]Department of Restorative Dentistry, Faculty of Dentistry, Marmara University, Istanbul, Turkey and [2]Department of Restorative Dentistry, Faculty of Dentistry, Yeditepe University, Istanbul, Turkey and [3]Department of Restorative Dentistry, Faculty of Dentistry, İstanbul Nişantaşı University, Istanbul, Turkey

[*]Corresponding Author; asli.tuncer@marmara.edu.tr

Abstract

Purpose: The aim of this in vitro study was to evaluate the effects of three restorative materials and chlorhexidine digluconate (CHX) pretreatment on microleakage in Class V cavities.
Materials and Methods: Thirty freshly extracted sound human molars were cleaned and stored in distilled water. Sixty standard Class V cavities were prepared on gingival 1/3 of buccal and lingual surfaces of each tooth. Teeth were randomly assigned into 3 groups corresponding to the selected restorative material (Fuji II LC Capsule/FC, GC; Beautifil Flow Plus/BF, Shofu; and GrandioSo Flow/GF, VOCO). Lingual cavities were pre-treated with CHX (Cavity Cleanser, Bisco). The cavities were restored according to manufacturer's instructions using the materials' own adhesive systems. Teeth were stored in distilled water (24°C) for 6 months for aging. Specimens were immersed in 2% methylene blue solution for 1 h and sectioned longitudinally in buccolingual direction. Occlusal/gingival margins were examined for dye penetration and scored under x8 and x20 magnification using stereomicroscope (Leica MZ7.5, Leica Microsystems). Statistical analysis was performed using chi-square test with a significance level of $p<0.05$.
Results: There was no statistically significant difference between the amount of microleakage of GF, FC and BF restorations in CHX-treated and untreated cavities ($p>0.05$). CHX pretreatment did not result in a significant difference between microleakage values in gingival and occlusal margins of cavities restored with different materials ($p>0.05$).
Conclusions: Application of CHX as cavity cleaner has no effect on the microleakage in Class V cavities restored with giomer, glass ionomer, and resin composites.

Key words: chlorhexidine gluconate; composite resin; glass ionomer; microleakage

Introduction

Teeth with raised survival, increased awareness of the patients, and physicians who are open to new treatment approaches cause maximum adhesion and maximum clinical life goals in restorations to remain at the forefront. Until today, no restorative material has been able to entirely seal and adhere to dentin throughout its clinical practice. One of the consequences of this situation is microleakage.[1] Microleakage is one of the factors in the failure of restorations accomplished to restore the lost tissues of teeth. It is described as the passage of fluid, bacteria, ions and molecules through gaps between the cavity wall and restorative material.[2] Microleakage may occur as a result of polymerization shrinkage in some restorative materials, high thermal expansion coefficient difference between tooth and restorative material, and occlusal forces on the restoration. This causes the deterioration of esthetics over time, discoloration of the margins, secondary caries, and many problems such as failure in restorations.[3–5]

In the formation of secondary caries lesions, microorganisms remaining in the smear layer, formed on the dentin surface after cavity preparation, are as effective as microleakage. Microleakage occurring in cavities close to the gingiva with the borders exceeding cemento-enamel junction, and bacteria remaining in the smear layer will also increase the risk of secondary caries formation.[6–8]

In restorative applications, there are two main approaches to

How to cite: Senol AA, Ozmen S, Karabulut Gencer B, Tarcin B, Yilmaz Atali P. Effect of Chlorhexidine Treatment on Microleakage of Glass Ionomer, Giomer and Methacrylate-Based Composite Restorations in Class V Cavities. EADS. 2024;51(1): 20-27

preserve adhesion and provide complete seal: reducing polymerization shrinkage and preventing hydrolytic degradation of the interface.[9] Considering the results of the studies, it was concluded that the matrix metalloproteinases (MMPs) in dentin accelerate the deterioration of the organic matrix of the dentin organic matrix and accordingly, prevent the formation of a durable and robust hybrid layer and cause an increase in microleakage.[2] In order to achieve a successful restoration, using an MMP inhibitor and antibacterial agent is recommended for the elimination of microorganisms remaining in the cavity. For this purpose, chlorhexidine (CHX) is applied to the cavity surfaces. There is a wealth of in vitro and in vivo research data demonstrating the positive effect of CHX on the lifetime of hybrid layer and bond strength.[10–12] CHX is used to prevent autodegradation of the dentin collagen matrix, where the resin cannot penetrate completely.[12,13] At the same time, CHX has a wide spectrum of action against Streptococcus mutans, which is especially effective in the formation of secondary caries lesions.[11]

The material to be preferred in the restoration of Class V cavities is determined according to the function, esthetic and mechanical properties expected from the restoration. Giomer, glass ionomer and resin composites are among these materials and provide different advantages to the restoration as a result of their chemical structures.

Glass ionomers show antibacterial properties with fluoride release and also have low technical sensitivity. They are preferred especially in the restoration of Class V cavities close to the gingiva, because of their ability to create direct chemical bonds with the tooth, due to the difficulty of providing ideal adhesion in restorations with the borders exceeding cemento-enamel junction.[14]

Composite resins have been developed over the years and used in the restoration of many kinds of lesions. The advantages of having many color types, minimal cavity preparation, and good marginal compatibility are among the advantages.[15,16] Low-viscosity resin composites have much greater shrinkage, and their use in areas of high functional stress is avoided. However, low-viscosity properties perform them easy to apply. Composite resins are preferred for esthetic satisfaction, especially in Class V lesions occurring in the cervical region of the teeth.[17]

In order to combine the properties of composite resins and glass ionomers, pre-reacted glass filler particles were incorporated into the matrix of the composite material and hybrid products known as giomers were obtained. Giomers represent a special class of restorative materials that offer protection against caries while providing function and esthetics.[17]

The current study aimed to compare the microleakage amounts in Class V cavities restored with different types of restorative materials including glass ionomer, giomer and methacrylate-based composite and to evaluate the effect of CHX cavity disinfectant application on microleakage. The null hypotheses of the study are; 1)The effect of chlorhexidine digluconate (CHX) pretreatment on microleakage does not differ depending on the restorative material. 2)Chlorhexidine pretreatment will not affect the microleakage values of the Class V restorations.

Material and Methods

Ethical approval for this study was obtained from the ethics committee of the institutional review board (IRB) (Application No. 2021-23/Date 07.10.2021), and the project was conducted at Marmara University Faculty of Dentistry, Istanbul, Turkey. The minimum sample size required to detect a significant difference using this test should be at least 10 in each group, considering type I error (alfa) of 0.05, power (1-beta) of 0.85, and effect size of 0.529. Thirty freshly extracted sound human molars were included in the study.

Teeth were cleaned with a rubber bur and a fluoride-free paste. After disinfection with 0.1% thymol solution, the teeth were stored in distilled water for 24 hours. Standardized Class V cavities (2 mm depth, 4 mm wide mesiodistally, and 2 mm height) were prepared with round and tapered diamond burs on the gingival 1/3 of buccal and lingual surfaces of each tooth. The cervical margins of the cavity extended approximately 1 mm coronal of the cement-enamel junction (CEJ). Class V cavity prepared teeth were randomly assigned into 3 groups, according to the restorative materials (Fuji II LC Capsule, GC, Tokyo, Japan; Beautifil Flow Plus, Shofu Inc., Kyoto, Japan; GrandioSo Flow, VOCO GmbH, Cuxhaven, Germany) used (Table 1, Figure 1).

Chlorhexidine [Cavity Cleanser (2% chlorhexidine digluconate), Bisco Inc., Schaumburg, IL, USA] was applied to the Class V cavities on the lingual surfaces of the teeth. Following completion of the restorations, teeth were stored in distilled water at room temperature (24°C) for 6 months for the ageing procedure. Afterwards, samples were coated with nail polish except 1 mm around the tooth-restoration interface. Samples were immersed in 2% methylene blue solution for 1 h and then rinsed under copious water. The specimens were sectioned through the center of the restorations in buccolingual direction, using Isomet 1000 (Buehler) precision cutting device (Figure 2).

Occlusal and gingival margins were examined for dye penetration and scored under x8 and x20 magnification using a stereomicroscope (Leica MZ7.5, Leica Microsystems, Germany). The same observer repeated the scoring twice to eliminate any optical illusions. The extent of the dye penetration was scored according to a scale from 0 to 4 (Scoring criteria for occlusal margin; Score 0, no dye penetration; Score 1, dye penetration limited to ½ or less of the occlusal wall; Score 2, dye penetration exceeding ½ of the occlusal wall; Score 3, dye penetration limited to ½ of the cavity base; Score 4, dye penetration exceeding ½ of the cavity base. Scoring criteria for gingival margin; Score 0, no dye penetration; Score 1, dye penetration limited to ½ or less of the gingival wall; Score 2, dye penetration exceeding ½ of the gingival wall; Score 3, dye penetration limited to ½ of the cavity base; Score 4, dye penetration exceeding ½ of the cavity base.)

Statistical Analysis

Data were analyzed with SPSS V23 (IBM, New York, USA). The Chi-square test was used to compare microleakage according to restorative material and CHX application. Analysis results were presented as frequency (percentage) for categorical data. The results were evaluated with a significance level of $p<0.05$.

Results

Dye penetration at the occlusal and cervical interfaces of the restorations for various group samples are shown in Figure 3. The microleakage values obtained according to CHX pretreatment of the studied restorative material groups were presented in Table 2.

A comparison of restorative materials reveals that the highest number of samples with a score of 0 and no dye penetration is observed in the GrandioSo Flow resin composite group. When comparing restorations with and without CHX application, the number of samples with a score of 0 and no dye penetration is higher in restorations without CHX application.

No statistically significant difference was found between the occlusal/gingival microleakage values of CHX-treated and untreated Class V cavities in restorations using Beautifil Flow Plus, GrandioSo Flow and Fuji II LC Capsule ($p=0.380$, $p=0.579$ respectively) (Table 2). There was no statistically significant difference between the distributions of microleakage in restorations according to CHX pretreatment ($p=0.488$) (Table 2).

The interaction between restorative materials and CHX application was not statistically significant for gingival and occlusal microleakage ($p>0.05$) (Table 3).

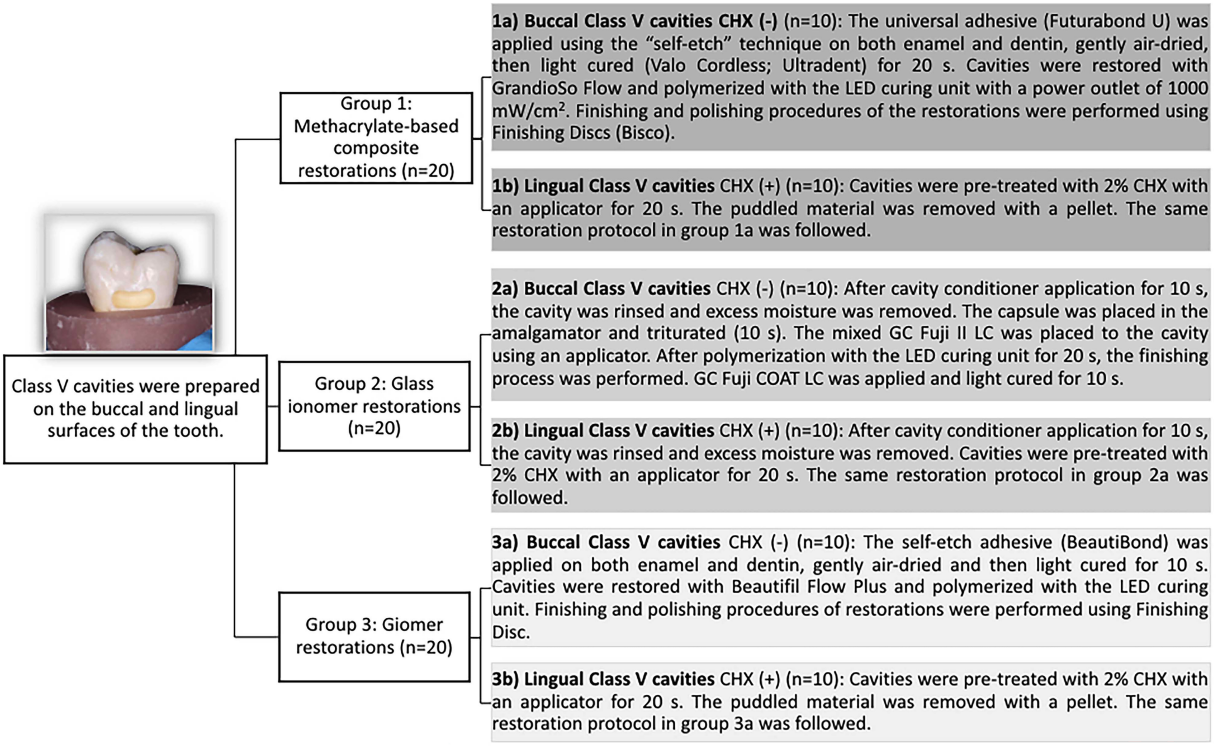

Figure 1. Schematic representation of study groups according to restoration stages and CHX pretreatment.

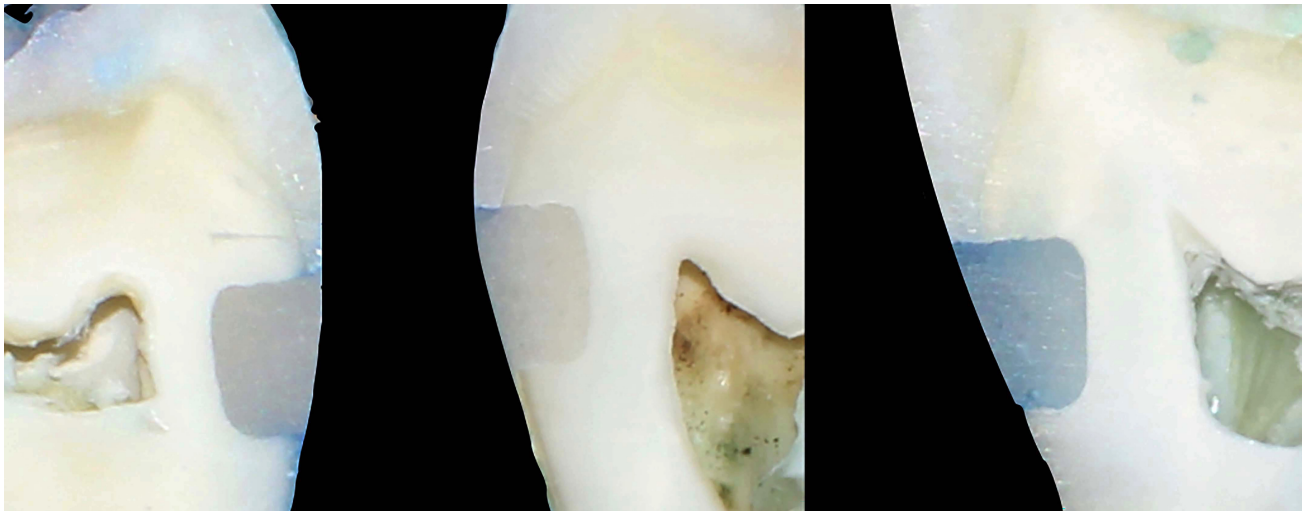

Figure 2. Specimens sectioned longitudinally in the buccolingual direction.

According to the use of materials with different structures in Class V cavities, there was no statistically significant difference between the occlusal/gingival microleakage distribution in the restorations (p=0.433, 0.062, respectively) (Table 4).

No statistically significant difference was found between the microleakage values of the occlusal and gingival margins of the cavities (p = 0.801) (Table 5).

Discussion

This study was designed to compare the microleakage values of composite materials with different compositions in cervical region restorations and to observe the effect of CHX cavity disinfectant usage on microleakage. According to the results of this study, no statistically significant difference was found between the microleakage values of CHX-treated and untreated Class V cavities in different restorations. Additionally, there was no statistically significant difference between the distributions of microleakage in restorations according to CHX pretreatment. Based on the results obtained, "The effect of CHX pretreatment on microleakage does not differ depending on the material." and "CHX pretreatment did not affect the microleakage values of Class V restorations." hypotheses were accepted.

One of the most essential criteria for the success of dental restoration is to prevent the leakage of contaminants by creating a seal. Oral bacteria and by-products entrapped or infiltrated between the dentin and the restoration can result in secondary caries caused by oral microbiome dysbiosis. Thus, the resin-dentin interface can be compromised.[18,19] In contemporary minimally invasive operative management of caries, studies suggest that selective caries removal should be preferred to complete caries removal.[20,21] This may lead to questioning the necessity of additional antimicrobial

Table 1. Compositions of the materials used in the study.

Restorative and adhesive material	Manufacturer	Type	Contents
Fuji II LC Capsule	GC, Tokyo, Japan	glass ionomer	Liquid: PAA, HEMA, UDMA, proprietary ingredient, 2,2,4-trimethylhexamethylene dicarbonate, TEGDMA. Powder: (fluoro) Aluminosilicate glass. Filler Content (wt%): 76
Beautifil Flow	Shofu Inc., Kyoto, Japan	giomer	Base resin: Bis-GMA (15 wt%)/TEGDMA (13 wt%). Filler: Multifunctional glass filler and fluro boro aluminosilicate glass. Particle size range: 0.01-4.0 μm, mean particle size: 0.8 μm. DL-Camphorquinone. Filler Content (wt%): 67.3
GrandioSo Flow	VOCO GmbH, Cuxhaven, Germany	methacrylate-based composite	HEDMA, Bis-GMA, TEGDMA, BIS-EMA, glass ceramic (filler size:1 μm), silicon dioxide (filler size:20–40 nm). Filler Content (wt%): 80.2
Beautibond	Shofu Inc., Kyoto, Japan	self-etch adhesive	Acetone, Bis-GMA, TEGDMA, 4MET, 6MHPAc, pure water.
Futura Bond U	VOCO GmbH, Cuxhaven, Germany	universal adhesive	Bis-GMA, HEDMA, acidic adhesive monomer, HEMA, UDMA, catalyst.

Abbreviations: 4-MET: 4-methacryloxyethyl trimellitic acid; 6MHPAc: 6-methacryloyloxyhexyl phosphonoacetate, Bis-GMA: bisphenol-A-diglycidyl methacrylate; HEDMA: hexamethylenedimethacrylate, HEMA: 2-hydroxyethyl methacrylate; PAA: polyacrylic acid; TEGDMA: triethyleneglycol dimethacrylate; UDMA: Urethane dimethacrylate.

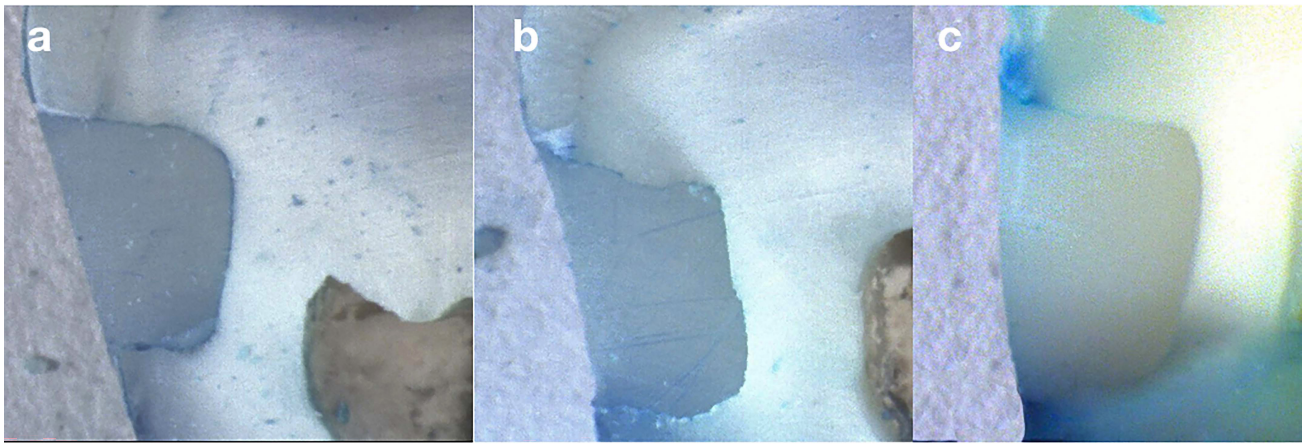

Figure 3. a. Gingival margin score as 1, b. Gingival and occlusal margin scores as 0, c. Gingival and occlusal margin scores as 1.

treatment. Based on the previous studies, the use of 2% CHX as a disinfectant was preferred in the current study. [22,23]

One of the factor that bond degradation is an endogenous dentin proteases, which compromise the continuity of the hybrid layer. [24] Endogenous dentin proteases and cysteine cathepsins embedded in the collagen matrix are exposed by acid etching of dentin, and their activity increases with the adhesive application. [25–27] Activated proteases degrade denuded collagen fibrils in the hybrid layer and lead to the deterioration of adhesive-dentin bonds over time. [28] CHX pretreatment is expected to increase the durability of the hybrid layer by inhibiting matrix metalloproteases. Previous studies have concluded that CHX pretreatment reduces microleakage or has favorable effect on the adhesive system, and no adverse effects on dentin bonding have been reported. In the study of Pradhan et al., [29] cavities treated with CHX (2%) and restored with universal adhesive and composite resin showed lower microleakage values than the control group. Loguercio et al., [30] demonstrated that CHX is still present in the hybrid layers after 5 years and the use of a 2% CHX on dentin may improve the long-term stability of adhesive interfaces.

In contrast to previous studies, Suma et al. [1] showed that pretreatment of 2% CHX with a self-etch adhesive would significantly reduce the shear bond strength of the composite to dentin. Fernandes et al. [31] attributed the lower bond strength values following 2% CHX pretreatment to the precipitation of CHX, which can bind to anionic molecules such as phosphate in hydroxyapatite, exhibiting a barrier behaviour that reduces the maximum contact between restoration and dentin. Kimyai et al. [32] concluded that CHX pretreatment results in more significant marginal gaps, irrespective of the bonding method used. Boaru et al. [33] evaluated the effect of 2% CHX on the composite restoration-dentin interface using a universal adhesive system applied with self-etch and etch-and-rinse techniques and reported that, application of CHX to the dental substrate before using a universal adhesive system had no effect on the adhesive interface. The SEM images obtained in their study were consistent with the study outcomes of Kimyai et al., [32] resulting in a thinner, less uniform and less resin-buffering hybrid layer were formed on dentin treated with CHX. Bin-Shuwaish et al. [22] obtained similar results by showing that dentin microleakage was unaffected by CHX pretreatment when teeth were restored with the "self-etch" protocol of the universal adhesive system and conventional resin-based composite.

In this study, flowable resin-based composite constitutes one of the study groups in the restoration of Class V cavities. According to the results of this study, CHX application had no statistically significant effect on the microleakage values of Class V cavities

Table 2. Comparison of gingival and occlusal microleakage values according to CHX pretreatment in Class V cavities restored with different materials.

	Restorative material	Dye penetration	CHX (-) (%)	CHX (+) (%)	Total (%)	p*
Gingival	Beautifil Flow Plus	Score 0	0 (0)	0 (0)	0 (0)	0.164
		Score 1	5 (50)	4 (40)	9 (45)	
		Score 2	1 (10)	5 (50)	6 (30)	
		Score 3	2 (20)	0 (0)	2 (10)	
		Score 4	2 (20)	1 (10)	3 (15)	
	GrandioSo Flow	Score 0	1 (10)	2 (20)	3 (15)	0.955
		Score 1	2 (20)	2 (20)	4 (20)	
		Score 2	2 (20)	1 (10)	3 (15)	
		Score 3	2 (20)	2 (20)	4 (20)	
		Score 4	3 (30)	3 (30)	6 (30)	
	Fuji II LC Capsule	Score 0	0 (0)	0 (0)	0 (0)	0.753
		Score 1	5 (50)	5 (50)	10 (50)	
		Score 2	0 (0)	1 (10)	1 (5)	
		Score 3	3 (30)	2 (20)	5 (25)	
		Score 4	2 (20)	2 (20)	4 (20)	
	Main effect **	Score 0	1 (3.3)	2 (6.7)	3 (5)	0.579
		Score 1	12 (40)	11 (36.7)	23 (38.3)	
		Score 2	3 (10)	7 (23,3)	10 (16.7)	
		Score 3	7 (23.3)	4 (13.3)	11 (18.3)	
		Score 4	7 (23.3)	6 (20)	13 (21.7)	
Occlusal	Beautifil Flow Plus	Score 0	1 (10)	0 (0)	1 (5)	0.273
		Score 1	1 (10)	4 (40)	5 (25)	
		Score 2	3 (30)	2 (20)	5 (25)	
		Score 3	3 (30)	4 (40)	7 (35)	
		Score 4	2 (20)	0 (0)	2 (10)	
	GrandioSo Flow	Score 0	2 (20)	0 (0)	2 (10)	0.534
		Score 1	3 (30)	4 (40)	7 (35)	
		Score 2	2 (20)	4 (40)	6 (30)	
		Score 3	1 (10)	1 (10)	2 (10)	
		Score 4	2 (20)	1 (10)	3 (15)	
	Fuji II LC Capsule	Score 0	0 (0)	0 (0)	0 (0)	0.566
		Score 1	5 (50)	3 (30)	8 (40)	
		Score 2	1 (10)	3 (30)	4 (20)	
		Score 3	2 (20)	1 (10)	3 (15)	
		Score 4	2 (20)	3 (30)	5 (25)	
	Main effect **	Score 0	3 (10)	0 (0)	3 (5)	0.380
		Score 1	9 (30)	11 (36.7)	20 (33.3)	
		Score 2	6 (20)	9 (30)	15 (25)	
		Score 3	6 (20)	6 (20)	12 (20)	
		Score 4	6 (20)	4 (13.3)	10 (16.7)	
Total	Beautifil Flow Plus	Score 0	1 (5)	0 (0)	1 (2.5)	0.404
		Score 1	6 (30)	8 (40)	14 (35)	
		Score 2	4 (20)	7 (35)	11 (27.5)	
		Score 3	5 (25)	4 (20)	9 (22.5)	
		Score 4	4 (20)	1 (5)	5 (12.5)	
	GrandioSo Flow	Score 0	3 (15)	2 (10)	5 (12.5)	0.972
		Score 1	5 (25)	6 (30)	11 (27.5)	
		Score 2	4 (20)	5 (25)	9 (22.5)	
		Score 3	3 (15)	3 (15)	6 (15)	
		Score 4	5 (25)	4 (20)	9 (22.5)	
	Fuji II LC Capsule	Score 0	0 (0)	0 (0)	0 (0)	0.452
		Score 1	10 (50)	8 (40)	18 (45)	
		Score 2	1 (5)	4 (20)	5 (12.5)	
		Score 3	5 (25)	3 (15)	8 (20)	
		Score 4	4 (20)	5 (25)	9 (22.5)	
	Main effect **	Score 0	4 (6.7)	2 (3.3)	6 (5)	0.488
		Score 1	21 (35)	22 (36.7)	43 (35.8)	
		Score 2	9 (15)	16 (26.7)	25 (20.8)	
		Score 3	13 (21.7)	10 (16.7)	23 (19.2)	
		Score 4	13 (21.7)	10 (16.7)	23 (19.2)	

CHX: chlorhexidine digluconate, *Chi-square test, , **restorative material type main effect regardless of the CHX application

Table 3. Evaluation of microleakage values according to restorative materials and CHX pretreatment.

	Source	Test Statistics *	Sd	Sig.
Dependent Variable: Occlusal	(Intercept)	197.955	1	0.000
	Restorative material	1.421	2	0.491
	CHX	0.000	1	1.000
	Restorative material* CHX	0.973	2	0.615
Dependent Variable: Gingival	(Intercept)	172.463	1	0.000
	Restorative material	0.779	2	0.677
	CHX	0.379	1	0.538
	Restorative material* CHX	0.063	2	0.969

* Wald Chi-square test statistic, Sd: degrees of freedom.

Table 4. Comparison of microleakage in restorations according to the use of restorative materials with different structures in Class V cavities.

	Dye penetration	Beautifil Flow Plus (%)	GrandioSo Flow (%)	Fuji II LC Capsule (%)	Total (%)	p*
Occlusal	Score 0	1 (5)	2 (10)	0 (0)	3 (5)	**0.433**
	Score 1	5 (25)	7 (35)	8 (40)	20 (33.3)	
	Score 2	5 (25)	6 (30)	4 (20)	15 (25)	
	Score 3	7 (35)	2 (10)	3 (15)	12 (20)	
	Score 4	2 (10)	3 (15)	5 (25)	10 (16.7)	
Gingival	Score 0	0 (0)	3 (15)	0 (0)	3 (5)	**0.062**
	Score 1	9 (45)	4 (20)	10 (50)	23 (38.3)	
	Score 2	6 (30)	3 (15)	1 (5)	10 (16.7)	
	Score 3	2 (10)	4 (20)	5 (25)	11 (18.3)	
	Score 4	3 (15)	6 (30)	4 (20)	13 (21.7)	
Main effect **	Score 0	1 (2.5)	5 (12.5)	0 (0)	6 (5)	**0.113**
	Score 1	14 (35)	11 (27.5)	18 (45)	43 (35.8)	
	Score 2	11 (27.5)	9 (22.5)	5 (12.5)	25 (20.8)	
	Score 3	9 (22.5)	6 (15)	8 (20)	23 (19.2)	
	Score 4	5 (12.5)	9 (22.5)	9 (22.5)	23 (19.2)	

*Chi-square test, **Cavity margin main effect regardless of the CHX application and restorative material

Table 5. Comparison of microleakage amounts between the occlusal and gingival margins of the cavities.

Dye penetration	Occlusal (%)	Gingival (%)	Total (%)	p*
Score 0	3 (5)	3 (5)	6 (5)	0.801
Score 1	20 (33.3)	23 (38.3)	43 (35.8)	
Score 2	15 (25)	10 (16.7)	25 (20.8)	
Score 3	12 (20)	11 (18.3)	23 (19.2)	
Score 4	10 (16.7)	13 (21.7)	23 (19.2)	

restored with flowable methacrylate-based composite (GrandioSo Flow) and universal adhesive (Futura Bond U) using the "self-etch" technique.

These outcomes were in agreement with the results of studies that evaluated CHX as a cavity cleaner and did not result in a significant effect on microleakage.[22,33] The controversial results obtained with the other studies on CHX can be attributed to different adhesives, differences in the methodology, restorative material, and operator factors.

Due to the limited number of existing studies, giomer and glass ionomer materials were preferred as restorative materials as the experimental groups. According to the results of this study, CHX pretreatment had no effect on microleakage values in Beautifil Flow Plus and Fuji II LC Capsule restorations groups. The results aforementioned in the current study were in accordance with the results of the previous studies. In the study of Gupta et al.,[34] CHX pretreatment did not cause any significant effect on the microleakage and bond strength values of Class V RMGIC restorations. Mutluay and Mutluay[35] demonstrated that disinfection with 2% CHX of the cavity had no effect on the microleakage of Class V Giomer restorations.

In this study, microleakage values in the occlusal and gingival margins of the cavities were scored in a manner similar to the method employed by Santini et al.[36] It is thought that the presence of enamel in the occlusal margin would result in higher micromechanical adhesion and lower microleakage values compared to the gingival margin which contains less mineralized hard tissue/dentin and more permeable cementum.[37] In their study evaluating the effect of protective coating application on microleakage, Thomas et al.[38] reported that in the group restored with GIC and modified GIC where the coating was applied, lower microleakage values were observed at the occlusal margin compared to the cervical margin. Contrary, the result of this study indicated that there was no statistically significant difference in the microleakage distribution between the occlusal and gingival margins of the restorations when materials with different structures were used in Class V cavities. Similarly, there was no statistically significant difference in microleakage values between CHX-treated and untreated Class V cavities in restorations utilized three different materials. It could be argued that the bonding performance induced by universal adhesive systems on enamel and dentin is not sufficiently different enough to induce significant changes in microleakage amount of gingival and occlusal margins.

The influence of the restorative material, bacterial presence and number on continued caries progression is considered limited, whereas adaptation of the restoration, patient caries risk, and physician experience is considered more relevant.[39] Therefore, CHX pretreatment may be considered to impose additional cost and application steps, as the evidence regarding clinical behavior is uncertain.

Yao et al.[40] stated that, evaluation of shear bond value and microleakage provides a more comprehensive examination of bonding performance and demonstrates the mutual importance of these values. However, the relationship between multifactorial microleakage and bond strength is not clear.

The limitations of this study were that it could partially mimic natural oral conditions due to the lack of saliva, microbiota, hygiene habits, diet, and chewing forces. In the current study, only the effect of restorative material and cavity disinfectant on microleakage was evaluated. Limited data are available to correlate the marginal sealing achieved in vitro conditions with the clinical performance of the materials. Consequently, the effect of CHX on the hybrid layer and secondary caries needs to be investigated with further in vivo and in vitro studies.

Conclusion

The use of EQ, characterized by its superior VHN and FS values, along with similarly reinforced GICs, has the potential to enhance clinical success. A limitation of this study is that the oral environment was not simulated. Long-term in vitro and in vivo studies are required to comprehensively evaluate the biological effects as well as the various physical and mechanical properties of the materials used.

Acknowledgements

The study was presented as an oral presentation at the "III. Prevent From Caries Symposium" (13-14 November 2020; Online; International).

Author Contributions

Study Idea / Hypothesis: B.T. and P.Y.A Study Design: B.T. and P.Y.A. Data Collection: A.A.Ş., S.Ö., and B.K.G. Literature Review: A.A.Ş., S.Ö., and B.K.G. Analysis and/or Interpretation of Results: B.T. and P.Y.A. Article Writing: A.A.Ş., S.Ö., B.K.G., B.T. and P.Y.A. Critical Review: B.T. and P.Y.A

Conflict of Interest

The authors do not have any financial interest in the companies whose materials are included in this article.

Authors' ORCID(s)

A.A.Ş. 0000-0003-3542-4877
S.Ö. 0000-0002-5958-8828
B.K.G. 0000-0002-2856-0662
B.T. 0000-0002-9220-8671
P.Y.A. 0000-0003-3121-360X

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