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Microleakage of Aesthetic Restorations Following Functional Simulation and Immersion in Saudi-Traditional Mouth Rinses

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Abstract

AIM: The study is aimed to assess the effect of 3 Saudi-traditional types of mouth rinses (Karadah, Myrrh, salted water) on the microleakage of composite and glass-ionomer restorations subjected to thermal cycling and cyclic loading.

MATERIAL AND METHODS: Class V cavities in both buccal and lingual surfaces of eighty extracted premolars were restored with both nano-filled composite and glass-ionomer restoratives. Half the number of restored teeth (group 1, n = 40) were subjected to further thermal cycling and cyclic loading to mimic the in-service functional stresses. The rest of the teeth were left as control with no functional simulation (group 2, n = 40). Teeth of each group were then stored wet for one month in 4 subgroups (n = 10) according to the storage media (distilled water, salted water, Myrrh and Karadah extracts). Following wet ageing, all teeth were immersed in methylene blue solution for 24 hrs, followed by sectioning in Bucco-lingual direction. The microleakage was inspected using stereomicroscope and rated from 0-4 according to its penetration depth. The collected non-parametrical data was then analysed statistically using Kruskal-Wallis One-way ANOVA at α = 0.05.

RESULTS: There was no statistically significant difference observed in microleakage between specimens treated with any of the mouthwashes for both glass ionomer and composite restorations in the presence and absence of thermal cycling and cyclic loading (p = 0.889).

CONCLUSION: Given the results of the present study, the Saudi-traditional types of mouth rinses are not contributory to microleakage in aesthetic-based composite and glass-ionomer restorations.

Introduction

Tooth aesthetic usually governs the healthy appearance of an individual. Accordingly, many carious and non-carious tooth defects of the aesthetic areas should be restored with materials that mimic the regular tooth appearance [1], [2]. Both resin composites and glass-ionomer-based restoratives show a respectable degree of success doing that job [1], [2], [3]. However, incidences of microleakage had been reported at restorations-tooth interfaces in response to materials' setting contraction and deteriorated bonding to tooth tissues [4], [5], [6]. This drove the attention of dental manufacturers to modify their bonding products and to develop self-adhesive and minimal-shrink restoratives [5], [6], [7]. Although these new developments seem promising, their bonding performance could be affected by both thermal and mechanical stresses that are generally developed on function [7], [8]. Also, individuals in different communities may depend on traditional, cultural-known medicines and topicals to cure certain oral diseases [9], [10] and the influence of these agents on restorations is not yet known.

Microleakage has been detected in different types of aesthetic restorations. It is generally due to questionable material-tooth bonding, and sometimes, mismatch of material-tooth properties. Microleakage either from small or microscopic openings between the margins of the composite restoration and tooth was considered a significant cause of restoration failure [11], [12]. Thus, it can result in bacteria penetrating the tooth-restoration space and dentinal tubules, where secondary decay may occur, and bacterial toxins will irritate the pulp. The oral environment (including occlusal forces and temperature variation) and several differences between the physical properties of teeth and restorative materials (including polymerisation shrinkage, the coefficient of thermal expansion, and modulus of elasticity) can additionally contribute to microleakage [13], [14]. Therefore, microleakage can create clinical problems, including hypersensitivity, recurrent caries, staining of restoration margins, pulp irritation and failure of the restorative material. Thus, prevention of microleakage is of paramount consideration in the development of adhesive systems, for application in tooth restorative [15]. Although recently-developed materials and techniques seem promising with respect to the incidence of microleakage, the privilege of their excellent bonding and accordingly, the rate of microleakage could be affected in function and in contact with different fluids.

The use of chemical plaque control methods has been on the rise in the past couple of decades. However, the adverse effects of chemical products, as well as the widespread antimicrobial resistance, have diverted the attention of clinicians and patients towards more traditional methods specifically in specific communities. Nonetheless, how these alternative products interact with the oral environment and dental restorations needs investigation.

Hence, the present study was conducted to assess the effect of 3 Saudi-traditional types of mouth rinses (Karadah, Myrrh, salted water) on the microleakage of composite and glass-ionomer restorations subjected to thermal cycling and cyclic loading. The tested null hypothesis was that the Saudi-traditional based mouth rinses have no additional adverse effect on the rate of microleakage in both composite and glass-ionomer restorations.

Material and Methods

An in vitro comparative study was conducted to test the stated null hypothesis. Eighty freshly extracted, caries-free premolars were collected out of the orthodontic outpatient clinic, College of Dentistry, King Khalid University. Ethical clearance was obtained from the Institutional Review Board, King Khalid University (2013-2014 / 28).

Study Protocol

After cleaning both soft and hard deposits off, all teeth received standardised cervical cavities on both buccal and lingual surfaces using # 811 FG 033 diamond abrasives. All buccal cavities were restored with nano-filled composite (Feltik Z350, 3M ESPE, St.Paul, MN) restorative and Single Bond Universal (3M ESPE, St.Paul, MN) 7^{th} generation resin adhesive. Following poly-acrylic acid conditioning, all lingual cavities were restored with glass-ionomer restorative (Ketac Fil Plus Aplicap, 3M ESPE, St.Paul, MN). Half the number of restored teeth (Group 1, n = 40) were subjected to cyclic fatigue loading under a standardised weight of 5kg for 10,000 cycles followed by thermal cycling at 4, 37 and 60°C for 3500 cycles with 60s dwelling time, while the rest remained with no functional conditioning (Group 2, n = 40). Teeth of each group were then subjected to one month of wet ageing at 37°C in 4 different solutions (water, salted water, Myrrh and Karadah, n = 10 for each) (Table 1).

Table 1: Specimen test groups

	Restorative Material	Groups (n = 40) (Conditioning)	Subgroups (n = 10) (Storage media)
80 Extracted premolars (buccal and lingual)	Nano-Filled composite (n = 80)	Functional Simulation (n = 40)	Water
			Salted water
			Myrrh
			Karadah
		No Simulation (n = 40)	Water
			Salted water
			Myrrh
			Karadah
	Glass-ionomer (n = 80)	Functional Simulation (n = 40)	Water
			Salted water
			Myrrh
			Karadah
		No Simulation (n = 40)	Water
			Salted water
			Myrrh
			Karadah

Teeth of all subgroups were incubated in methylene blue solution at 37°C for 24 hours before their longitudinal sectioning in buccolingual direction. The sectioned specimens were then inspected under low angle illumination using stereomicroscope (0.8 x) to detect the degree of stain ingress (microleakage) at the restoration-tooth interface. The detected leakage was ranked for each restoration from 1-4 depending on the depth of stain penetration. The scoring criteria used was as follows: Score 0 = No leakage; Score 1 = Stain ingress limited to enamel thickness; Score 2 = Stain ingress along the side walls of restored cavities; and Score 3 = Stain ingress to the pulpal wall of the restored cavities.

Statistical Analysis

The data was entered in a Microsoft Excel worksheet and analysed using IBM SPSS v. 21 (IBM Statistics, Chicago, USA). Since the data did not follow a normal distribution (assessed using the Shapiro-Wilk test), a non-parametric test was used for analysis. The data were analysed using Kruskal Wallis One-way ANOVA with $\alpha = 0.05$.

Results

Table 2 shows the percent microleakage scores in the different aesthetic restorations investigated in the present study. Restorations immersed in salt-water showed higher microleakage compared to all the subgroups. Also, the aged restorations showed higher scores of microleakage as compared to their non-aged counterparts.

Table 2: Percent microleakage scores in different aesthetic restorations

Mouth rinses	Ageing	Aesthetic Restorations							
		Composite				Glass-ionomer			
		Score 0	Score 1	Score 2	Score 3	Score 0	Score 1	Score 2	Score 3
Water	Non-aged	50	40	10	0	70	30	0	0
	Aged	40	50	10	0	50	50	0	0
Salted water	Non-aged	40	30	20	10	50	20	30	0
	Aged	50	10	20	20	40	20	40	0
Myrrh	Non-aged	50	50	0	0	70	20	10	0
	Aged	40	60	0	0	70	20	10	0
Karadah	Non-aged	50	30	20	0	50	40	10	0
	Aged	60	20	10	10	50	20	30	0

The microleakage scores in different subgroups are presented in Table 3. Kruskal-Wallis One-way ANOVA comparing microleakage scores in different subgroups did not identify statistically significant differences in the scores between groups (p = 0.889). Thus, ageing showed no statistically significant effect on microleakage in all composite and GI subgroups subjected to various mouth rinses. Since Kruskal-Wallis One-way ANOVA observed no statistical significance, further multiple comparisons using post-hoc analysis were not indicated.

Table 3: Microleakage scores in different test groups

Study Group	Subgroups		Median (IQR)	p-value
Composite	No Ageing	Water	0.5 (1)	0.889
		Salted Water	1 (2)	
		Myrrh	0.5 (1)	
		Karadah	0.5 (1)	
	Ageing	Water	1 (1)	
		Salted Water	0.5 (2)	
		Myrrh	1 (1)	
		Karadah	0 (1)	
Glass Ionomer	No Ageing	Water	0 (1)	
		Salted Water	0.5 (2)	
		Myrrh	0 (1)	
		Karadah	0.5 (1)	
	Ageing	Water	0.5 (1)	
		Salted Water	1 (2)	
		Myrrh	0 (1)	
		Karadah	0.5 (2)	

Kruskal-Wallis One-way ANOVA, $p < 0.05$ is significant.

Discussion

The present study evaluated the effect of 3 Saudi-traditional types of mouth rinses (Karadahah, Myrrh, salted water) on the microleakage of composite and glass-ionomer restorations subjected to thermal cycling and cyclic loading. According to the results of the current study, the null hypothesis tested was accepted since none of the tested mouthwashes increased the microleakage of both composites and glass ionomer in the absence and presence of functional stimulation. An extensive literature search revealed no studies evaluating the effect of herbal mouth rinses on microleakage of aesthetic restorations.

Microleakage tests provide invaluable data on the sealing ability of adhesive resins. Dye penetration technique is the most commonly used technique for microleakage evaluation [15], [16]. Hence, it was used in the present study. Microleakage of aesthetic restorations is attributed to mechanical stresses as a result of polymerisation shrinkage. There are several factors involved in polymerisation stress, for instance, C-factor, cavity size, the technique of placement, the light-curing technique employed, and the mechanical properties of the composite resin [15]. In the present study, efforts were made to maintain all these variables at the same level for both groups. Cavity preparation was standardised and restored, using the same composite resin and one light-curing unit and glass ionomer cement. Also, to simulate oral conditions, all the samples underwent a uniform thermocycling procedure.

In the present study, statistically significant microleakage was not observed with any of the mouthwashes as compared to control. This is in contrast to a study conducted by Ajami et al., [15] where they evaluated the effects of commercially available mouth rinses on microleakage of composite resin restorations bonded with two adhesive systems [15]. This contrast could be attributed to the fact that they used commercially available mouthwashes (Listerine, Oral-B and Rembrandt plus) which have a higher alcoholic content as compared to the traditional mouthwashes used in our study. Furthermore, they also studied the samples after subjecting them to bleaching with 10% carbamide peroxide, as one of the objectives of their research, which could have been the reason for the higher microleakage observed in their study.

The use of antimicrobial mouth rinses is an approach to limit the accumulation of dental plaque, with a primary objective to control the development and progression of periodontal diseases and dental caries [17], [18]. However, the frequent use of mouth rinses may have adverse effects on oral and dental tissues [19], [29]. Despite the increased use of mouth rinses, research comparing resin composite microleakage associated with the use of mouth rinses is limited. Villalta et al., [21] have shown that low pH and alcohol concentration of solutions might affect the surface integrity of composite resins and cause staining.

Myrrh is a natural gum or resin extracted from some small, thorny tree species of the genus *Commiphora*. In Saudi Arabia, myrrh was as an antiseptic in mouthwashes, gargles, and toothpaste. Myrrh has also been recommended as an analgesic for toothaches and can be used in liniment for bruises, aches, and sprains. Myrrh is a common ingredient of tooth powders. Myrrh and borax in the tincture can be used as a mouthwash [22].

It is estimated by the World Health Organization that about 4 billion people in the world are using the Karad plant (Arabic: Karad, Latin: Acacia nilotica L) for its therapeutic properties. The tender twig of this plant is used as a toothbrush in south-east Africa, Pakistan and India. The extract of *Acacia* can be used in dental products like mouthwash to prevent gingivitis. A. nilotica is a medicinal plant acknowledged to be rich in phenolics, consisting of condensed tannin and phlobatannin, gallic acid, protocatechuic acid, pyrocatechol, (+)-catechin, (-) epi-gallocatechin-7-gallate and (-) epigallocatechin-5, 7-digallate [23]. The simulation of all clinical factors that influence the effects of mouthwashes on aesthetic restorative materials is not possible in vitro. Saliva, salivary pellicle, foods, and beverages may affect the physical properties of resin restorative materials. Further, in vivo studies are necessary to determine the effects of different types of mouth rinses. Also, in the present study, we did not observe any significant microleakage with the traditional mouthwashes as compared to the control (water). Therefore, it may be hypothesised that the traditional mouthwashes are safer as compared to the commercially available ones. Further research comparing traditional and commercially available mouthwashes is also warranted.

In conclusion, within the limitations of the present study, the Saudi-traditional types of mouth rinses are not contributory to microleakage in aesthetic-based composite and glass-ionomer restorations. However, the results of the present study should be used with caution since in-vitro results need to be corroborated with clinical studies, as the oral environment cannot be entirely simulated in laboratory settings.

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