MICROLEAKAGE IN CLASS V NANOFILLED COMPOSITE COMPARED WITH TRADITIONAL HYBRID AND FLOWABLE COMPOSITE RESTORATIONS; AN IN VITRO STUDY

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ABSTRACT

Microleakage in class V restorations (in enamel and cementum), restored with a nanofilled composite was compared to a traditional hybrid resin and flowable composite. Thirty class V cavities were prepared on buccal and lingual surfaces of 15 human premolar teeth, with occlusal and gingival margins at the enamel and cementum / dentin levels, respectively. Specimens were divided into 3 groups with 10 samples of each. Group 1: filled with Cavex composite, Group 2: filled with Premise composite and Group 3: filled with Synergy Flow composite. After being stored in distilled water and finished, the teeth were thermocycled, immersed in a buffered 2% aqueous solution of methylene blue for 2 hours and then embedded in clear resin. They were sectioned and the depth of tracer penetration was measured with periodontal probe and magnifying lens. The results were analyzed using one way ANOVA at the 0.05 level of significance. All the composite materials showed statistically insignificant differences in occlusal dye penetration ($P \geq 0.05$) and significant differences in gingival dye penetration ($P < 0.05$) and exhibited little or no occlusal leakage. None of the composites completely sealed the tooth / restoration interface at gingival margins and the nanofilled composite being tested exhibited the highest gingival leakage.

Key word: *Composite, Micro leakage, Class V restorations, Dye penetration.*

INTRODUCTION

Dental composite are used as restorative material since early 1960.[1] The use of composite in posterior teeth has been recommended for more than 2 decades.[2] The demand for posterior resin composite restorations has dramatically increased in recent years, because of their ability to match tooth color, absence of mercury, biocompatibility and bond to tooth structure.[3] Modern posterior resin composites undergo 2.6 to 7.1% volumetric contraction during polymerization.[4] This shrinkage can result in a gap formation between the composite material and tooth structure, particularly if the restoration margin is placed in dentine or cementum.[5] Bacteria, fluids, molecules, or ions can pass through this gap between the resin composite and the cavity wall.[4] This microleakage may leads to hypersensitivity, secondary caries, pulpal pathosis and failure of restorations.[6] Many attempts have been made to prevent the occurrence of microleakage in tooth restoration interface, in order to maintain the integrity of restorations which gives rise to their longevity.[7]

Several changes have been made in formulation to produce materials for adequate clinical success. The latest innovations are the development of dental composites based on nanotechnology. The newly available nanomaterials, such as nanofillers and nanohybrids enable the dental composites to be improved.[8] These materials have a very low degree of polymerization shrinkage and excellent esthetic properties. Their physical properties are comparable to other composite materials (hybrids and packables) and can be used for anterior and posterior restorations.[9] Direct composite restorations can be placed to an acceptable standard if the gingival margin is on sound enamel; however, the

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quality of the marginal sealing of adhesive restorations located below the cementoenamel junction is still questionable.[1]

Present study was designed to compare micro leakage in class V restorations (enamel and cementum), restored with a nanofilled composite to a traditional hybrid resin and flowable composite.

METHODOLOGY

Three light-activated resin composite materials (shade A3.5 for all): Cavex (hybrid) (Quadrant Universal LC, CE 0197, Germany), Premise (nanofilled) (Kerr, orange , CA 92867, U.S.A.) and Synergy Flow (flowable) (Coltene / Whaledent, Switzerland) were selected for occlusal and gingival class V microleakage evaluation in this study. The composition of the selected composites is summarized in Table 1 according to manufacturer's data. The specimens were divided into three groups of 5 teeth each (n = 10) and assigned as follows:

G 1: 10 samples using Cavex light activated composite.

G 2:10 samples using Premise light-activated composite.

G3: 10 samples using Synergy Flow light-activated composite.

Fifteen human premolar teeth, extracted in a period of six months, were selected. After being stored in saline solution at room temperature, teeth surfaces were cleaned with pumice stone and water. Two class V cavities were prepared in each tooth, one in the buccal surface and the other in the lingual surface, with occlusal margins at the enamel and gingival margins at the cementum/dentin level. Dimensions of the cavities were 3 mm wide, 2 mm high, and 2 mm deep, prepared with a FG 329 carbide bur in a water-cooled high-speed handpiece. A periodontal probe used to measure cavity dimensions. Cavities were finished with burs in a low-speed handpiece and manual sharp instruments. They also received a 0.5 mm wide bevel at a 45° angle on their occlusal margins with a diamond bur and 90° on their gingival margins. The total-etch technique was used on enamel and cementum/dentin surfaces, with 37% phosphoric acid (Cica) for 30 s for enamel/cementum etching and 15 s for dentin conditioning. The acid was applied initially to the enamel margins and then extended from the superficial to deep dentin. After application of the acid gel, the substrate was washed with an air/water spray for 20 s and excess humidity was removed by an absorbent paper applied on the dentin. A thin, uniform coating of Exite adhesive (Ivoclar, Vivadent AG, FL-9494 Schaan/Liechtenstein, Austria) was applied into the cavities with bonding brushes and gently air dried and light-cured for 20 seconds.

All the composites were applied into the prepared cavities in increments and each increment was light-cured for 40 s. The teeth were maintained in distilled water for 24 h at 37°C. After this period, the restorations were finished and polished and then thermocycled 500 times (0°C-55°C), with a dwell time of 30 s. After thermocycling, coronary and radicular surfaces of the teeth (except the restorations and 1 mm around their margins) were isolated with two layers of nail varnish. The apices of the teeth received four layers of nail varnish, to avoid penetration of the tracer towards the pulp. After the completion of the restorative procedures, the specimens were stored in a buffered 2% aqueous solution of methylene blue for 2 hours. The specimens were then removed from the dye solution, rinsed in running tap water for 20 minutes, and allowed to air dry for 24 hours. The specimens were then mounted in clear acrylic resin and sectioned buccolingually through the center of the restorations. After the sectioning, the dye penetration depth measurements were done for each specimen occlusally and gingivally, from each restoration, with a periodontal probe in mm with the aid of magnifying lens. Mean dye penetration depth values were expressed in mm and data were analyzed by one way ANOVA and t-test at the 0.05 level of significance.

RESULTS

Means and standard deviations of dye penetration of the tested composites in mm are summarized in Table 2. In general occlusal dye penetration values were much lower than that of gingival dye penetration values for all types of composites being tested Fig 1. For occlusal dye penetration, Premise light- activated composite exhibited the lowest dye penetration values while the other two composites (Cavex and Synergy flow) exhibited approximately comparable dye penetration values (Figure 1). For gingival dye penetration, Cavex light-activated composite exhibited the lowest dye penetration values while the other two composites

TABLE 1: COMPOSITION OF THE SELECTED COMPOSITES AS PER MANUFACTURER'S DATA

Composite	Classification	Composition
Cavex	Fluoride releasing radiopaque microglass composite for universal application	Bis-GMA matrix and contains 60% filler by volume (72% by weight) which are • Ba-Al-F-silicatc glass (0.02-2µm) • Highly dispersed silicon dioxide (0.02-0.07 µm)
Premise	Nanofilled composite	The ethoxylated Bis-GMA matrix and contains 69% filler by volume which are • Non-agglomerated silica nanoparticles (0.02 µm) • prepolymerized filler, 0.4 micron barium glass
Synergy Flow	Flowable composite	Methacrylates matrix and contains 32% filler by volume which are • Barium glass, silanized (0.6 µm average particle size) • Amorphous silica, hydrophobed (0.04-2.9 µm) range of particle size)

TABLE 2: DYE PENETRATION MEANS AND STANDARD DEVIATIONS OF THE TESTED COMPOSITES IN mm

Composite	Cavex		Premise		Synergy Flow	
	0	G	0	G	0	G
Mean	0.7 (0.67)	1 (0.57)	0.2 (0.42)	1.85 (0.88)	0.75 (0.71)	1.7 (0.42)

O: Occlusal G: Gingival Standard Deviation: in parenthesis

TABLE 3: ONE-WAY ANALYSIS OF VARIANCE (ANOVA) FOR OCCLUSAL DYE PENETRATION

Source	DF	SS	MS	F	P
Factor	2	1.850	0.925	2.42	0.108
Error	27	10.325	0.382		
Total	29	12.175			

TABLE 4: ONE-WAY ANALYSIS OF VARIANCE (ANOVA) FOR GINGIVAL DYE PENETRATION

Source	DF	SS	MS	F	P
Factor	2	4.117	2.058	4.78	0.017
Error	27	11.625	0.431		
Total	29	15.742			

(Premise and Synergy flow) exhibited approximately comparable dye penetration values (Figure 1). For occlusal dye penetration, statistical analysis of data by using one-way analysis of variance (ANOV A) revealed that, there was statistically insignificant difference ($P \geq 0.05$) in dye penetration values between the three composites being tested as shown in Table (3). For gingival dye penetration, statistical analysis of data by using one-way analysis of variance (ANOV A) revealed that, there was statistically significant difference

TABLE 5: t-TEST OF GINGIVAL DYE PENETRATION BETWEEN DIFFERENT PAIRS OF THE TESTED COMPOSITES

Paired Samples Test

	Paired Differences					t	df	Sig. (2-tailed)
	Mean	Std Deviation	Std Error Mean	95% Confidence Interval of the Difference Lower	Upper			
Pair 1 PG - FG	.1500	1.0814	.3420	-.6236	.9236	.439	9	.671
Pair 2 PG - CG	.8500	.9443	.2986	.1745	1.5255	2.847	9	.019
Pair 3 FG-CG	.7000	.5375	.1700	.3155	1.0845	4.118	9	.003

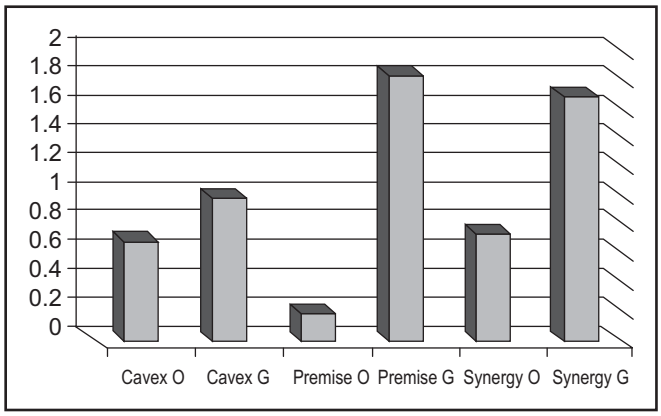

Fig 1: Mean occlusal and gingival dye penetration values in mm for the tested composites

(P<0.05) in dye penetration values between the three composites being tested as shown in Table 4. Further analysis of data (gingival dye penetration) by t-test, indicated that only pair 1 (between Premise and Synergy Flow composites) showed statistically insignificant difference (P≥0.05) in gingival dye penetration values as shown in Table 5.

DISCUSSION

One of the factors that contribute to marginal micro-leakage in composite restorations is the contraction of the material during polymerization (10, 11). Thermo-cycling may also contribute to the dislodgment of the restoration from the cavity walls,[10] although an in vivo study demonstrated that mastication had a greater influence on the marginal integrity of composite restorations than did thermal stress.[12] Polymerization contraction may cause a break in the adhesion between the tooth and restorative material, resulting in microscopic gaps in the tooth/restoration interface.[10,11,13] Thermocycling causes contraction and expansion of the tooth and the restoration, and because they have different coefficients of thermal expansion, the adhesion between them may be broken.[10,14]

Microleakage is more critical m margins with little or no enamel, which characterizes most of the non-carious class V cavities.[15] The cervical margins of such restorations may be at cementum or dentin surfaces. The adhesion between composites and dentin is not as strong as with enamel, therefore the material can be dislodged towards occlusal during polymerization contraction, causing a bad adaptation of the restoration at the gingival margins.[10]

In the present study, when comparing the gingival and the occlusal margins of the restorations, the gingival margins of most samples showed the greatest amount of microleakage, which is in agreement with the literatures.[10,15,16] When comparing the flowable composite with the hybrid and nanofilled resin, there was no statistically significant difference between them at occlusal Margins Table 3 and this finding is in agreement with Mazer and Russell.[17] However, our findings have shown a statistically significant difference between flowable composite with the hybrid and nanofilled resin at gingival margins (Table 4). This finding is not in agreement with Mazer and Russell.[17]

The incremental technique may have influenced the results as well as the low elastic modulus of the flowable composite and its adaptation to tooth structure that may also have contributed to a smaller polymerization contraction. Differing from the present results, Ferdianakis[18] observed a better marginal sealing of a flowable composite in comparison with a combination of two traditional hybrid composites.

The present results showed that the cavities restored with Synergy Flow composite showed both occlusal and gingival leakage higher than that of Cavex hybrid composite and lower (except for occlusal higher) than that of premise nanofilled composite. (Figure 1) The difference between Cavex and Premise could be due to the amount of filler loading by volume (Table 1) as increasing the amount of filler loading above a critical point results in increasing the stiffness of the material and reducing its ability to flow during polymerization.

CONCLUSIONS

The study has concluded the following;

All the composites tested exhibited little or no occlusal leakage.

None of the composites completely sealed the tooth/restoration interface at the gingival margins.

The nanofilled composite exhibited the highest gingival leakage.

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