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Microleakage evaluation of silorane based composite versus methacrylate based composite and Glass-ionomerin Class I Restorations. (Ex vivo Study)

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Abstract: *This research compared the microleakage of a low-shrinkage resin composite Filtek P90 (Silorane, 3M ESPE) and hybrid resin composites Filtek Z350 (3M ESPE) by means of dye penetration after thermocycling.Although composites are now the material of choice for most restorations, their polymerization shrinkage remains a problem. The contraction stress associated with this shrinkage can cause debonding at the composite/tooth interface and can contribute to postoperative sensitivity, enamel fracture, recurrent caries, marginal staining and eventual failure of the restoration.Silorane exhibited significantly decreased microleakage compared with any other resin based composite and Glass ionomer filling material. The cavities restored with Fuji Gc Glass ionomer displayed nonsignificantly higher microleakage than with Filtek Z350.Although all of the restorative systems had microleakage, silorane technology showed less microleakage comparable to clinically successful methacrylate-based composite. This will improve the clinical performance and extend the composite durability.*

Keywords: *Microleakage, polymerization shrinkage, silorane, stress*

I. Introduction

Light cure composite resins are being widely used for the restoration of posterior teeth. This is not only because of their more favorable esthetic properties, but also due to their adhesion to the dental tissues. Although amalgam has served dentistry for over a century, the clinicians have become more in favor of composites in the recent times. This transition is due to the alleged health concerns and environmental considerations regarding amalgam, the dental professions desire for an adhesive material that demands less invasive cavity preparations, and the patient demand for tooth-coloured restorations even in the posterior teeth.[1]

Although composites are now the material of choice for most restorations,[2] their polymerization shrinkage remains a problem.[3,4] The contraction stress associated with this shrinkage can cause debonding at the composite/tooth interface and can contribute to postoperative sensitivity, enamel fracture, recurrent caries, marginal staining and eventual failure of the restoration.[4]

Currently, in the direct dental operation sector, high-demand aesthetic and functional restorations for the back of the mouth are basically made with composites. Microleakage is one of the most common causes of failure for the majority of restorative materials, as this leakage contributes to secondary decay and irritation of the dental pulp [5,6].

There is currently a growing interest in finding a material that has better adhesive characteristics, can minimise the possibility of microleakage and reduce the development of decay in the tooth-restoration interface [7]. Developing materials made from glass ionomers has been the subject of various studies due to the various advantages they provide. Glass ionomers are still considered to be the only self-adhesive materials for the dental structure [8,9].

II. Materials and methods

Forty extracted intact upper premolars were selected. The teeth were scaled with ultrasonic, cleaned with pumice by a rotary brush and stored in distilled water until use.

The teeth received standardized class I cavity preparations, approximately 4 mm in length, 2.5 mm in width and 3 mm in depth. We used diamond burs (#837 KometGebr.,Brasseler, Lemgo, Germany) in a high speed handpiece, under constant water irrigation for all cavities (the bur is changed every five preparations). The cavosurface margins were prepared at 90°.

The teeth were randomly divided into three groups (N = 30) according to the restorative material used,

as follows.

Group A: Low shrinkage resin composite Filtek P90 (lot 9BY, 3M ESPE, St.Paul, MN, USA) with LS System Adhesive Primer and Bond (lot 8BA, 3M ESPE, St.Paul, MN, USA) were used. The tooth was blot-dried, leaving a moist structure. The P90 Primer was applied using a micro-brush with agitation for 15 seconds, gently air-dried, then light-cured for 10 seconds, then the P90 Bond was applied followed by a gentle stream of air, and light-cured for 10 seconds. The composite was applied in two wedge shaped incremental layers. The first composite increment was placed on the pulpal floor and buccal wall, then light activated according to the manufacturer's instructions for 20 seconds. Second composite increment was placed obliquely on the palatal wall and extended on the occlusal surface, and then light-cured. Immediately after the filling procedure, the restorations were finished and polished. Finishing and polishing were done under simultaneous water-cooling to avoid drying out of the teeth.

Group B: Filtek Z350 resin composite (lot 8CP, 3M ESPE, St.Paul, MN, USA) with Adper SE Plus Self-Etch Adhesive (lot 8BJ, 3M ESPE, St.Paul, MN, USA) were used. The composite Filtek Z350 was applied using the same protocol as described before.

All composite increments were light-cured using an EliparFreelight 2 light-curing unit (3M ESPE, Seefeld, Germany) at a power density of 1000 mW/cm2 for 20 seconds in a continuous mode, while all adhesive systems were light-cured using the same light-curing unit, power density and mode for 10 seconds. The light intensity was constantly monitored by its integrated radiometer. All adhesive systems used in this study were two steps self-etch adhesive systems and all the composites were micro-hybrid A2 shade.

Group 3: The GC Fuji Glass ionomer filling material are use to restore the prepared cavities, the prepared wall are treated with cavity conditioner for 20 seconds and Before activation, shake the capsule or tap its side on a hard surface to loosen the powder. To activate the capsule, push the plunger until it is flush with the main body. Put it in amalgamator for 10 seconds and immediately place the capsule into a metal GC Capsule Applier and click the lever once. The capsule is now activated.

The filling material are placed in increments, each increment are 1.5 mm and light cured for 20 seconds after finishing the restorations with GC Fuji COAT LC (light cure for 10 sec.)

After specimens were stored in distilled water for 24 hours at 37°C, the teeth were subjected to a thermo-cycling regime (200 cycles) with a dwelling time of 30 seconds and transfer time of 5 seconds, between 5°C and 55°C. For microleakage evaluation, the root apices were sealed with sticky wax, and the root and crown surfaces of the teeth were sealed with two coats of nail varnish, except for 1 mm around the restoration margins. The teeth were then immersed in 2% Methylene Blue dye (pH = 7) for 30 minutes,[5] washed and dried. Next, the teeth were sectioned mesio-distally into two slabs using a slow-speed diamond saw (KometGebr.). Four sites per tooth (cavosurface angle to pulpal floor from mesial and distal walls for each slab) were examined under an optical stereomicroscope at 20× magnification and dye penetration was scored as described in Table 1.

T**able 1**

In-depth dye penetration scores

Score	Definition
0	No dye penetration at all
1	Dye penetration up to one-third of the vertical cavity wall
2	Dye penetration up to two-thirds of the vertical cavity wall
3	Dye penetration up the pulpal floor
4	Dye penetration extends in the pulpal floor

III. Results

Kruskal-Wallis test shows significant difference in one group at least ($P< 0.05$). Mann-Whitney *U* test was used to make a pairwise comparison between the three studied groups; it shows significant difference between silorane and the two other methacrylate and GC Fuji Glass ionomer as showen in [Table 2]

Table2. Mann-Whitney *U* test exhibits significant difference between the groups

Group A	*U* value	P value (two-tailed)	Significance difference
Silorane P90	1300.0	0.0014	Yes
GC Fuji GI	1200.0	0.0024	Yes
Filtek Z350	1800.0	0.392	No

The mean for leakage scores and means ranks for each group are listed in [Table 3]

Table 3 Mean of ranks as in Kruskal-Walls test

Variable studied	Tooth colored restoration type	*N*	Mean rank	Chi square	Degree of freedom	P value	Significandifferences
Leakage degree	**Silorane P90**	60	73.62	10.32	2	0.0022	Yes
	Filtek Z350	60	89.1				
	Fuji GC Glass ionomer	60	90.13				
	Total	180					

Referring to mean rank values, we conclude that microleakage scores in Filtek P90 (silorane) were significantly lower than those of both (Z350 and Fuji GC Glass ionomer) ($P< 0.05$). There is no significant difference in microleakage scores between Filtek Z250 and the two other groups ($P> 0.05$).

IV. Discussion

The present study compared the microleakage of a novel low-shrinkage resin composite to other clinically successful methacrylate resin composites and Glass ionomer filling material. Class I cavities were used due to the high C-factor that causes greater polymerization stresses [10] as a result of restrained contraction by the large number of bonded surfaces. Microleakage evaluation is the most common method of assessing the sealing efficiency of a restorative material. Since there is no gold standard for this method, we used 2% Methylene Blue for 30 minutes as was previously used by Ernst [11] who concluded that this immersion period in this concentration had a good correlation with the marginal gaps evaluated using Scanning Electron Microscope.

The non-significant differences in microleakage of cavities restored with Fuji GC Glass ionomer and Filtek Z350 may be associated with the similarities in the methacrylate chemistry and the utilization of self-etch adhesive systems for both methacrylate Glass ionomer. As resin composites still undergo contraction stress over time and damage of marginal sealing after water storage, [12] long-term data are still necessary. In addition, it has been demonstrated that the association of mechanical loading with thermal cycling may significantly increase leakage values. [13] Thus, further studies evaluating the influence of storage and mechanical loading on microleakage are required.

Owing to the high p/l ratio and reduced glass particle size (13.43 m) [14] GC Fuji IX GP is highly viscous material. The microleakagebehaviour would probably have been due to its high viscosity, not allowing the wetting of the tooth surface properly, preventing the formation of good seal between tooth restoration interface[15].

V. Conclusion

Dental glass ionomer filling material (GC Fuji IX GP) displayed statistically significant lower values as compared to the other restorative materials. Although all of the restorative systems had microleakage, silorane technology showed less microleakage comparable to clinically successful methacrylate-based composite. This will improve the clinical performance and extend the composite durability.

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