Original Article

International Journal of Dental and Health Sciences
Volume 03,Issue 01

AN IN VITRO STUDY: EFFECT OF REFRIGERATING SILORANE AND METHACRYLATE-BASED COMPOSITES ON MICROLEAKAGE OCCURRENCE IN CLASS II RESTORATIONS

Maxim Hamama[1], Ali Marouf[2]

1.Master student at Operative and Endodontic Department - Faculty of Dentistry - Tishreen University – Lattakia- Syria

2.Associate Professor at Operative and Endodontic Department - Faculty of Dentistry - Tishreen University – Lattakia- Syria

ABSTRACT:

The aims of this study were to evaluate the effect of storing both methacrylate resin composite (Tetric Ceram HB) and silorane resin composite (Filtek P90) at refrigerator temperature on the microleakage occurrence in Class II restorations.

Thirty six intact human upper premolars were employed. Two Class II cavities with specific dimensions were prepared on the mesial and distal surfaces of all teeth. Teeth were restored by Methacrylate composite (Tetric Ceram HB) and Silorane composite (Filtek P90), under three different conditions according to temperature treatment: Group A: materials were stored at controlled room-temperature (24°C) for 24 h before restoration, Group B: materials were refrigerated for 24 h at (4°C) and were used immediately after removal from refrigerator, Group C: materials were refrigerated for 24 h at (4°C) and were used 30 minutes after removal from the refrigerator.

Results: This study observed a statistically significant increase in microleakage when applying each of (Tetric Ceram HB) and (Filtek P90) immediately after removal from refrigerator, while there was no significant differences in microleakage between composites in each subgroup.

Conclusion: The storage of methacrylate composite and silorane composite at low temperatures is an important factor affecting the occurrence of microleakage between restoration and tooth structure.

Keywords: Methacrylate Resin- Microleakage -refrigeration - Silorane Resin

INTRODUCTION:

Resin composites were introduced in the early 1970s and were widely used as direct esthetic restorations [1]. They have become one of the most commonly used direct restorative materials for both anterior and posterior teeth [2]. Good marginal seal, is a major requirement for restorative material in order to reduce or eliminate the possibility of microleakage [3]. microleakage following tooth restoration is considered one of the main reasons leading to weaknesses development in the structure of restoration [4]. Microleakage is a passage of fluid and bacteria in micro-gaps between restoration and tooth. It can result in damage to the pulp, and it can occur due to Polymerization shrinkage of composites, poor adhesion and wetting, thermal stresses and mechanical loading [2]. Achieving a good marginal seal depends on the formation of the bond

*Corresponding Author Address: Dr. Maxim Hamama Email: maxim.hamama@gmail.com

between composite and tooth structure with a minimum resin shrinkage during polymerization [3]. Resin composites materials have been undergone to several improvements and modifications to the particles fillers, bonding materials and curing techniques to provide optimal Marginal sealing, thus contributing to decrease the incidence of microleakage [4]. Silorane composite materials were developed in order to reduce the polymerization shrinkage. Its matrix consists of siloxanes and oxiranes, which differ from the conventional methacrylate (Bis-GMA) composite matrix. Manufactures claimed that the silorane based composites provided a high-performance bond to the tooth with significantly lower shrinkage than other methacrylate composites [5, 6]. Some factors such as temperature and humidity of the surrounding environment and materials can affect the success of bonding to tooth structure, thus they have an important impact that can lead to success or failure of restoration [7, 8]. Within this context, although most manufacturers recommend storing restorative materials at room temperature, many professionals store their restorative materials in the refrigerator, in order to extend shelf life of products, or even to maintain some of their characteristics. Some Studies indicated that using composite at low temperatures can lead to adverse effects on the bonding to tooth structure [7]. Some characteristics of using composites might change, considering that some composites are very sticky and tend to become less flow at low temperatures, as the fluidity of composites play an important role for the durability of restoration [9]. Also the viscosity change of adhesive system, and the potential impact on evaporation of solvent in adhesive systems composition, can weaken the penetration of bond into tooth tissue [10].

Aim:

Thus, this study evaluated the microleakage occurring in Class II restorations performed with both of methacrylate and silorane based composites stored at different conditions and temperatures.

MATERIALS AND METHODS:

Thirty six extracted carious free human upper premolars were collected. After collection of teeth, they were ultrasonically cleaned and stored in distilled water at room temperature until utilization. Seventy tow standard Class II cavities were prepared on the mesial and distal surfaces of all the teeth 1 mm above the cemento-enamel junction using a high speed handpiece (NSK, Japan) and a diamond bur (HI CARE SF – 21C) with following dimensions: 3mm in buccolingual direction, 1.5mm in mesiodistal direction and 4mm in cervicoocclusal direction, as measured by with a standard William's periodontal probe. Following preparation, the specimens were randomly divided into 2 groups (n=36) according to adhesive systems and composite resins used, as follows:

Group I: Filtek Silorane Adhesive System (3M ESPE®) and Filtek Silorane composite (3M ESPE) were applied according to the manufacturers' instructions.

Group II: Tetric N Bond (IVOCLAR VIVADENT®) and Tetric Ceram HB Posterior composite (IVOCLAR VIVADENT) were applied according to the manufacturers' instructions.

Groups I and II were subdivided into 3 groups (n=12) according to Storing temperature of composites, as follows:

Group A: Resin composites and adhesive systems were stored at controlled room-temperature (24°C) for 24 h before restoration.

Group B: Resin composites and adhesive systems were refrigerated for 24 h at (4°C), and specimens were restored immediately after removal of the materials from refrigerator.

Group C: Resin composites and adhesive systems were refrigerated for 24 h at (4°C), and specimens were restored 30 minutes after removal of the materials from refrigerator.

After accomplishment of the restorative procedures, the specimens were stored in a moisture medium at 37°C for 24 hours, followed by polishing with Soflex aluminum oxide discs (3M). All specimens were thermocycled in a thermocycling unit (SCHWABACH FRG, Germany GMBH+COKG. MEMMERT) for 200 cycles at 5°C and 55°C.

Preparing Teeth for Microleakage Test

All teeth were coated with two coats of nail varnish up to 1 mm from the cavity surface margins for ideal sealing of the areas outside the tooth/restoration interface and to standardize the amount of dental tissue to be exposed to the dye. After drying of the nail varnish, the specimens were placed in buffered 1% methylene blue aqueous solution at 37°C for 24 hours. After this period, the specimens were removed from the dye, washed in tap water, and allowed to dry for 24 hours at room temperature.

Following, the teeth were sectioned through the center of restorations in mesiodistal direction using a low-speed diamond saw under water spray.

The sections were evaluated as to the degree of marginal dye leakage at the dentin/restoration interface, with a stereomicroscope (MOTIC SFC-11B-N2GG Binocular Stereo Microscope) at 20x magnification. (Figure 1and 2)

Dye penetration along the cervical margins of the tooth restoration interface was evaluated and recorded based on the graded scoring system[11] given in below:

0= No dye penetration.

1= Dye penetration involving the half of gingival wall.

2= Dye penetration involving more than the half of gingival wall.

3= Dye penetration involving axial wall.

RESULTS:

The microleakage scores of all groups are listed in Table 1. The results for Subgroups were evaluated by Kruskal-Wallis test and Mann Whitney test for statically significant differences among the Subgroups in Tables 2 and 3.

The *P* value (according to Kruskal-Wallis test) is less than 0.05; indicative of statistically significant difference between the three subgroups for both composites, thus to find out which subgroup different from the other, Mann – Whitney test was used for bilateral comparison between subgroups.

For comparing between the two composites in the same subgroup Wilcoxon signed-rank test was used in Table 4.

DISCUSSION:

When bond strength between tooth and restoration material is weak, bonding failure can happen due to polymerization shrinkage followed by formation of microscopic gaps in the interface (tooth \ restoration)[12, 13]. Bonding to dentin is considered a major challenge for clinical practitioners because of its histological structure[14]. Some studies have shown many factors, such as temperature and humidity of the surrounding environment that influence the early bond strength to dentine [8, 15] .

This study showed that there is statically significant increase in microleakage when applying both Filtek Silorane (P90) and Tetric Ceram (HB) resin materials immediately after removal from refrigerator temperature (4°C) (P<0.05) compared with applying at room temperature (24°C) and 30 minutes after removal from refrigerator. This may be due to the high viscosity of the adhesive system after removing it from the refrigerator temperature, as have been shown that high viscosity of bond materials, increases the difficulty of wetting the substrate[16] . Another factor may have been influenced by refrigerating, is the organic solvent in the adhesive system which is water/ethanol in (P90) adhesive and ethanol in Tetric N bond. Maybe ethanol did not evaporate as required, affecting bonding to dentin. In other words, having a high level of solvent remaining in the hybrid layer can decrease bond strength [17, 18].

In contrary to Akbarian et al.[19] who showed that there is no significant statistical difference in microleakage between application Silorane adhesive system (P90) at refrigerating temperature (4°C) and room temperature (24°C). Maybe because of the method used to store the adhesive material, which have been stored within refrigerator temperature (4°C) for only half an hour before the restoration. Maybe this period is not enough to reach the effect of refrigerating temperature.

Also in contrary to Briso et al.[20] who found that there is no adverse effects were observed on the occurrence of microleakage when (TPH Spectrum) composite and (Prime & Bond NT) adhesive system were employed

immediately after or 30 minutes after storage in the refrigerator, or at room temperature. This may be due to the fact that adhesive system (Prime & Bond NT), which has acetone as its main solvent, did not suffer alterations by evaporation of this component.

We noticed also that there was no significant differences in microleakage when applying each of Filtek Silorane (P90) and Tetric Ceram (HB) at room temperature (24°C) or 30 minutes after the removal of materials from the refrigerator temperature. This may be explained that removal of materials from the refrigerator, and leaving these materials within the room temperature (24°C) for 30 minutes before restoration, was probably long enough to reduce the negative effects of low temperature on the characteristics of restoration materials used in this study.

This study also showed no significant differences between Filtek Silorane (P90) and Tetric Ceram (HB) in microleakage in each subgroup. Perhaps because of their similar characteristics of texture and viscosity when influenced by temperature during storing of materials, in addition to the organic solvent based on ethanol in both adhesive systems.

In agreement with Arslan et al[21] who showed that there is no significant differences in microleakage of methacrylate composite (Aelite LS) compared with Filtek Silorane (P90) in refrigerator temperature (4°C) and room temperature (25°C).

CONCLUSION:

Within the limitations of the present study, adverse effects were observed in the occurrence of microleakage at the dentin / restoration interface in Class II cavities, when Filtek Silorane (P90) and Tetric Ceram (HB) resin materials were employed immediately after removal from refrigerator temperature.

Based on the results of this study, removal of the restoration materials from refrigerator temperature for at least 30 minutes before restoration procedure is recommended.

REFERENCES:

1. Craig RG, Powers JM, Wataha JC. Dental Materials Properties and Manipulation, 10th ed.; Mosby: St. Louis, 2012.
2. Garg N, Garg A. Textbook of Operative Dentistry, 3rd ed.; Jaypee Brothers Medical Publishers: New Delhi, 2015.
3. McCabe JF, Walls AWG. Applied Dental Materials, 9th ed.; Wiley-Blackwell: Chicester, 2013.
4. Anusavice KJ, Phillips RW, Shen C, Rawls HR. Phillips' Science of Dental Materials, 12th ed Elsevier/Saunders: Philadelphia, 2013.

5. Weinmann W et al. Siloranes in dental composites. Dental materials : official publication of the Academy of Dental Materials 2005;21(1):68-74.
6. El-Mowafy O et al. Gingival microleakage of Class II resin composite restorations with fiber inserts. Operative dentistry 2007;32(3):298-305.
7. Hagge MS et al. Effect of refrigeration on shear bond strength of three dentin bonding systems. American journal of dentistry 1999;12(3):131-3.
8. Nystrom GP et al. Temperature and humidity effects on bond strength of a dentinal adhesive. Operative dentistry 1998;23(3):138-43.
9. Kaleem M et al. A method for assessing force/work parameters for stickiness of unset resin-composites. Dental materials : official publication of the Academy of Dental Materials 2011;27(8):805-10.
10. Tay FR et al. Variability in microleakage observed in a total-etch wet-bonding technique under different handling conditions. Journal of dental research 1995;74(5):1168-78.
11. Umer F et al. An in vitro evaluation of microleakage in class V preparations restored with Hybrid versus Silorane composites. Journal of conservative dentistry : JCD 2011;14(2):103-7.
12. Kubo S et al. Microleakage of self-etching primers after thermal and flexural load cycling. American journal of dentistry 2001;14(3):163-9.
13. Retief DH et al. Shear bond strength required to prevent microleakage of the dentin/restoration interface. American journal of dentistry 1994;7(1):44-6.
14. Roberson T, Heymann HO, Swift EJ. Sturdevant's Art and Science of Operative Dentistry, 5th ed., Elsevier Health Sciences, 2006.
15. Nakabayashi N, Takarada K. Effect of HEMA on bonding to dentin. Dental materials : official publication of the Academy of Dental Materials 1992;8(2):125-30.
16. Pazinatto FB et al. Influence of temperature on the spreading velocity of simplified-step adhesive systems. Journal of esthetic and restorative dentistry : official publication of the American Academy of Esthetic Dentistry 2006;18(1):38-45.
17. Reis AF et al. The effect of organic solvents on one-bottle adhesives' bond strength to enamel and dentin. Operative dentistry 2003;28(6):700-6.
18. de Alexandre RS et al. The influence of temperature of three adhesive systems on bonding to ground enamel. Operative dentistry 2008;33(3):272-81.
19. Akbarian S et al. Evaluation of the influence of three different temperatures on microleakage of two self-etch and one total-etch adhesives. The journal of

contemporary dental practice 2015;16(3):178-82.

20. Briso ALF et al. Sundefeld MLMM. Effect of refrigeration of resin materials on the occurrence of microleakage in class II restorations. Cienc Odontol Bras 2007;10(4):6-12.
21. Arslan S et al. The effect of pre-heating silorane and methacrylate-based composites on microleakage of Class V restorations. Eur J Gen Dent 2012;1(3):178-82.

FIGURES:

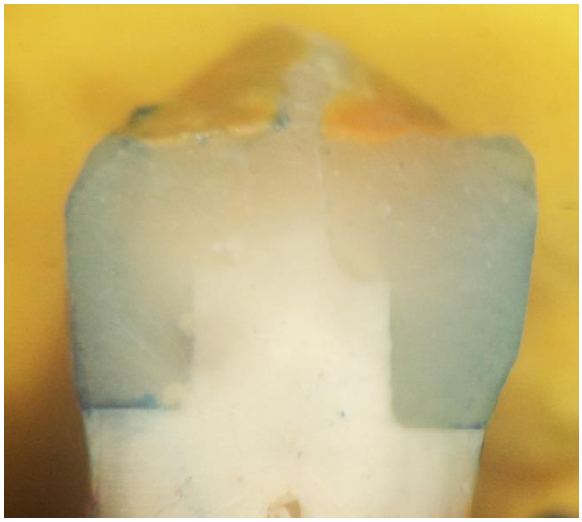

Figure 1

Figure 2

TABLES:

TABLE 1: MICROLEAKAGE SCORES

Composites	Storing Temperatures	Leakage scores			
		0	1	2	3
(Group I) Tetric HB	Group A controlled room-temperature (24°C)	9	3	0	0
	Group B Materials refrigerated at (4°C)	4	5	3	0
	Group C Materials removed from the refrigerator 30 minutes before restorations.	10	2	0	0
(Group II) Filtek silorane	Group A controlled room-temperature (24°C)	10	2	0	0
	Group B Materials refrigerated at (4°C)	5	7	0	0
	Group C Materials removed from refrigerator 30 minutes before restorations.	11	1	0	0

TABLE 2: RESULT OF THE KRUSKAL-WALLIS TEST

(Group I) Tetric HB				**(Group II) Filtek silorane**			
Subgroups	**n**	**Mean of Ranks**	**P Value**	**Subgroups**	**n**	**Mean of Ranks**	**P Value**
Group A	12	**16.13**	**0.013***	Group A	12	**16.50**	**0.015***
Group B	12	**24.63**		Group B	12	**24.00**	
Group C	12	**14.75**		Group C	12	**15.00**	
total	36			total	36		

TABLE 3: RESULT OF THE MANN-WHITNEY U-TEST

(Group I) Tetric HB				**(Group II) Filtek silorane**			
Subgroups	**Mean of Ranks**		**P Value**	**Subgroups**	**Mean of Ranks**		**P Value**
Group A vs. Group B	9.63	15.38	0.026*	Group A vs. Group B	**10**	**15**	0.039*
Group A vs. Group C	13	12	0.623	Group A vs. Group C	13	12	0.546
Group B vs. Group C	15.75	9.25	0.011*	Group B vs. Group C	15.50	9.50	0.011*

TABLE 4: RESULT OF WILCOXON TEST

(Group I) Tetric HB vs. (Group II) Filtek silorane		
Subgroups	**Z**	**P Value**
Group A	**- 0.577**	**0.564**
Group B	- 1.265	0.206
Group C	**- 0.577**	**0.564**