Evaluation of Marginal adaptation at Interfaces Using Composite Resin to Different Setting Amalgam Filling in Class II Cavity Preparation

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Abstract

Aim: The objective of the present study was to evaluate the microleakage of composite restorations alone or with amalgam base in proximal box of class II cavity preparation.

Methode: Eighty proximal cavities (Mesio-occlusal and disto-occlusal) were prepared in 40 premolars with carbide bur and randomly divided into four groups. Group A restored with composite resin; the other three groups restored with combined amalgam-composite restoration as follows. Group B the composite inserted immediately after insertion of amalgam, group C the composite inserted after 5 minutes of amalgam insertion while in group D the composite inserted after two days of amalgam insertion. Marginal adaptation was evaluated at the following interfaces: tooth-amalgam(T-A), tooth-composite resin (T-C) and amalgam-composite (A-C). Microleakage was evaluated by means of methylene blue infiltration after 21 days water storage and thermocycling aging. Microleakage was assessed by measuring the depth of horizontal dye penetration. Image J analysis software was used to measure the penetration of dye in the tooth- filling interface and in the amalgam- composite interface. One-way ANOVA and post-hoc Tukey HSD tests (α =0.05) were used statistically for analyzing gather data.

Results: There were a significant statically showed by ANOVA test between teeth -fillings interface, according to Tukey's test there were a significant difference between teeth-composite interface and teeth-amalgam interface ($p<0.05$), while between composite- amalgam interface, ANOVA test showed a significant difference between groups and Tukey's test showed a significant difference between groups according to time of placement of composite on amalgam filling ($p<0.05$).

Conclusion: Using of amalgam at the cervical base of the box in Class II combined amalgam-composite restoration has better result than using of composite from marginal leakage view.

Keywords: *microleakage, marginal adaptation, Class II cavity, amalgam-composite restoration.*

Introduction

The restorations of amalgam have good mechanical properties and many advantages such as relatively easy of insertion, resistance to fracture are adequate reasonably, after a period of time it allows good marginal sealing in the mouth, relatively economical and its less sensitive technique than direct tooth colored composite restorative materials [(1)]. Historically, it was used for long time clinically with proven longevity [(2)]. In spite of initial marginal adaptation of composite resin restoration is better than amalgam [(3)], amalgam restorations occasionally fail because of secondary caries [(4)] and this due to deposition of oxides by surface corrosion which leads to enhance marginal self-sealing over time [(5)]. The chief complaint of amalgam restorations is the darkness of color of these restorations which presents an unpleasant aesthetically [(6)]. On the other hand, tooth colored composite resin material represents an aesthetically pleasant materials for restorations which have many advantages such as

requiring less sacrificing of sound tooth structure and enhance fracture resistance of teeth [7]. In spite of the failure rate of composites is similar to amalgam [8] but there are many shortcomings such as; it's technique sensitive, it's survival rate in larger cavities is less when compared to smaller cavities [9]. It's bonding in the gingival margins of proximal restorations are critical because of little enamel in this area or even diminished of it [10] and it's failure may occurs due to marginal gaps that results due to polymerization shrinkage which leads to breakdown of adhesive bonding [11]. This shortcoming of composite fillings in the gingival margin of proximal boxes are opposite to the good marginal seal of amalgam fillings in this area because of gradual oxide deposition [12]. To benefits from the advantages of composite resin restorations and amalgam restorations and to minimize their shortcomings, a combined of composite and amalgam restorations can be an alternative for them separately [13]. The advantage of this combination restorations; the amalgam ensures the cervical marginal auto-sealing with aging while composite strengthen residual dental structures in addition to it's esthetically acceptance [14,15]. Another advantage of this possible combination is the repair of fractured of old amalgam restoration without the need for removing the remaining intact amalgam [16].

Materials and Methods

Forty readily available intact human caries-free maxillary premolars were collected and stored in distilled water. All teeth were cleaned and polished using pumice and rubber cups. The teeth were mounted in the acrylic resin to within 2 mm apical to the cementoenamel junction to facilitate the handling and control of the samples. on these teeth eighty standardized mesio-occlusal (MO) and disto-occlusal (DO) Class II box cavities were prepared with gingival margins located 1 mm above the CEJ. Each tooth received two proximal cavities using a high-speed handpiece with air/water spray. A new bur was used for each four teeth. The bucco-lingual width of the cavities was approximately one-third of the intercuspal distance, and the depth were 2.5 millimeters.

The samples were randomly divided into four groups (n=10 (20 proximal cavities) /group) to receive the following treatment:

Group A: Restored with Composite resin.

Group B: Restored with combined amalgam-composite (composite placed immediately after insertion of amalgam).

Group C: Restored with combined amalgam-composite (composite placed after 5 minutes of insertion of amalgam).

Group D: Restored with combined amalgam-composite (composite placed after 2 days of insertion of amalgam).

The Composite resin used in treatment was (SonicFill 2, Kerr A2), the amalgam was (F-400, SDI), the Bonding agent was (Scotchbond™ Universal Adhesive, 3M-ESPE), the light cure used for polymerization of composite was (SDI Radii-Plus), the amalgamator used for trituration of amalgam was (SDI Ultramat 2, Victoria, Australia) and the matrix bands used were (SuperMat Adapt SuperCap Matrix, Kerr) which were used for all teeth before starting treatment.

In group A: the cavities were etched using phosphoric acid 37% for 15 seconds then thoroughly rinsed with water and dried then bonding applied as recommended by manufacturer's instruction then SonicFill 2 composite resin were applied in two increments to fill the hole cavity and each increment was light cured as manufacturer's instruction recommendation.

In group B: after etching the cavities, the alloys were mixed according to manufacturer instructions using an amalgamator. A standardized technique was used to transfer the amalgam to cavities using amalgam carrier until reaching the height of pulpal floor. Bonding agent was applied and cured immediately after insertion of amalgam and then composite resin was applied to the remaining cavity in one increment and cured as recommended by manufacturer's instruction.

In group C: after etching of cavities, the alloys were mixed, transferred to cavities until reaching the height of pulpal floor. After 5 minutes of amalgam insertion, bonding agent was applied and cured and then composite resin was applied to the remaining cavity in one increment and cured as recommended by manufacturer's instruction.

In group D: after etching of cavities, the alloys were mixed, transferred to entire cavities with minimal carving and after setting of amalgam the samples were stored in distilled water. After two days of amalgam insertion, 1.5 mm of amalgam filling was removed then bonding agent was applied and cured and then composite resin was applied to the new remaining cavity in one increment and cured as recommended by manufacturer's instruction.

All the samples were stored in distilled water after restorations for 21 days, then thermocycling were performed at 5 ± 1°C to 55 ± 1°C for 500 cycles, with 30 seconds dwell time. The teeth were coated with two layers of nail varnish except for the restoration and 1 mm of peripheral area, then stored in container containing 2% Methylene Blue for 24 hours at room temperature. After removal from the dye solution, teeth were rinsed under running tap water and left at room temperature for 2 hours for dryness and dye fixation then embedded in clear resin. The specimens were sectioned in mesio-distal direction at the middle of the restorations with special diamond sectioning bur (Renfert, Germany) mounted in dental engine (Marathon 3, Korea) with water cooling. Microleakage was evaluated using Image analysis (Image J) software by measuring the linear penetration of the dye in micrometer from the external surface of interfaces using a stereomicroscope with a reflected light under magnification of 45x. Marginal adaptation was evaluated at the following interfaces: tooth-composite resin interface (T-C), tooth-amalgam interface(T-A) and amalgam-composite resin interface(A-C). Descriptive statistics including means and standard deviations were calculated for the microleakage analysis. The obtained data were subjected to one-way analysis of variance (ANOVA) and Tukey HSD test to determine significant differences among the three interfaces. The level of significance was set at p =0.05. All statistical analyses were performed using SPSS 15.0 (SPSS Inc., Chicago, IL, USA).

Results

A total of 80 sections were examined for evaluation of the dye penetration quantitatively at the tooth-filling interface and amalgam-composite interface with different periods of placement of composite. All the groups exhibited microleakage between the tooth-filling interface and amalgam-composite interface.

In the tooth-filling interface; The descriptive statistic (mean, standard deviation and standard error) are represented in (table 1). One-way ANOVA showed that the difference between the experimental groups was statistically significant ($p<0.05$) (Table 2). The post hoc Tukey multiple comparison tests showed the following results: tooth-composite interface exhibited statistically significant results compared with the three others amalgam-tooth interfaces($p<0.05$), There was no statistically significant difference between groups of amalgam-tooth interfaces ($p>0.05$) (Table 3).

In the amalgam-composite interface; the descriptive statistic (mean, standard deviation and standard errors) are represented in (table 4). One-way ANOVA showed that the difference between the experimental groups was statistically significant ($p<0.05$) (Table 5). The post hoc Tukey multiple comparison tests showed the following results:- the microleakage between fillings when composite inserted after two days of amalgam insertion exhibited statistically significant results compared with the others two groups ($p<0.05$), There was no statistically significant difference in microleakage between fillings whether the insertion of composite immediately or after 5 minutes of amalgam insertion ($p>0.05$) (Table 6).

Table 1

Descriptives

Filling_Tooth

	N	Mean	Std. Deviation	Std. Error	95% Confidence Interval for Mean		Minimum	Maximum
					Lower Bound	Upper Bound		
composite immediately after A.F.	20	124.65	30.491	6.818	110.38	138.92	55	190
composite after 5 minutes of A.F.	20	131.65	48.409	10.825	108.99	154.31	16	211
composite after 2 days of A.F.	20	164.20	48.911	10.937	141.31	187.09	94	285
composite only	20	526.15	315.016	70.440	378.72	673.58	45	1000
Total	80	236.66	231.825	25.919	185.07	288.25	16	1000

Table 2

ANOVA

Filling_Tooth

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	2252565	3	750855.012	28.631	.000
Within Groups	1993111	76	26225.143		
Total	4245676	79			

Table 3

Multiple Comparisons

Dependent Variable: Filling_Tooth
Tukey HSD

(I) Groups	(J) Groups	Mean Difference (I-J)	Std. Error	Sig.	95% Confidence Interval	
					Lower Bound	Upper Bound
composite immediately after A.F.	composite after 5 minutes of A.F.	-7.000	51.210	.999	-141.52	127.52
	composite after 2 days of A.F.	-39.550	51.210	.867	-174.07	94.97
	composite only	-401.500*	51.210	.000	-536.02	-266.98
composite after 5 minutes of A.F.	composite immediately after A.F.	7.000	51.210	.999	-127.52	141.52
	composite after 2 days of A.F.	-32.550	51.210	.920	-167.07	101.97
	composite only	-394.500*	51.210	.000	-529.02	-259.98
composite after 2 days of A.F.	composite immediately after A.F.	39.550	51.210	.867	-94.97	174.07
	composite after 5 minutes of A.F.	32.550	51.210	.920	-101.97	167.07
	composite only	-361.950*	51.210	.000	-496.47	-227.43
composite only	composite immediately after A.F.	401.500*	51.210	.000	266.98	536.02
	composite after 5 minutes of A.F.	394.500*	51.210	.000	259.98	529.02
	composite after 2 days of A.F.	361.950*	51.210	.000	227.43	496.47

*. The mean difference is significant at the .05 level.

Table 4

Descriptives

Amalgam_Composite

	N	Mean	Std. Deviation	Std. Error	95% Confidence Interval for Mean		Minimum	Maximum
					Lower Bound	Upper Bound		
composite immediately after A.F.	20	87.95	39.276	8.782	69.57	106.33	46	179
composite after 5 minutes of A.F.	20	85.60	30.684	6.861	71.24	99.96	32	150
composite after 2 days of A.F.	20	125.50	35.277	7.888	108.99	142.01	60	181
Total	60	99.68	39.250	5.067	89.54	109.82	32	181

Discussion

Silver amalgam was widely used for restorations of posterior teeth due to their unique properties but with the improvement of tooth colored restorations, the drawback of amalgam fillings mostly due to their unpleasant color. In spite of composite bind micro-mechanically to enamel and dentin but unfortunately, it's inherent polymerization shrinkage leads to leakage of oral fluids and toxins of bacteria leading to secondary caries especially in proximal cavities at cervical areas [17]. One of the methods to overcome this shortcoming of composite is the combined amalgam composite restoration in which the amalgam inserted in the base especially in the cervical area under the composite [18] in order to combining the aesthetic properties of composite and required properties of amalgam cervically.

In the present study, the interfaces between tooth-composite, tooth-amalgam and composite-amalgam were evaluated using dye penetration test which considered one of the most commonly employed test used in microleakage studies. The linear penetrated dye was measured using Image J analysis software to have quantitative outcomes rather than subjective scoring.

Eighty interfaces between teeth and fillings were investigated to measure dye penetration, analyzed data showed that the composite have more leakage than amalgam and this may be due to the presence of little

or even no enamel in the cervical area which is the main cause of decreasing bond strength in this area. In spite of the advancement in composite and bonding system which may be the cause of not extending the dye more than 1 mm in the interface between tooth and composite but still this may leads to caries which subsequently jeopardize the longevity of tooth integrity; in contrast, the gap sealing between tooth and amalgam restoration may be time dependent.

On the other hand, the extent of microleakage in the amalgam-composite interfaces in the present study showed that the leakage when insertion of composite immediately after insertion of amalgam was less than leakage when insertion of composite on set amalgam or even less than waiting five minutes, and this may be due to penetration of bonding agent into the freshly placed amalgam inside the irregularities and porosities of it's surface and as a consequence decreasing of microleakage in the interface by creating bonding with composite resin filling and this in agreement with Mertz-Fairhurst& Newcomer 1988 [19] and Sharafeddin & Moradian 2008 [20].

The maximum amount of dye penetration in the amalgam-composite interface in the present study was 179 micron which may be considered as an acceptable value especially in a freshly placed amalgam because there is a possibility of sealing of this gap by oxide layer with time. The result of this study indicates that the repairing of existing amalgam filling restoration by composite resin materials would be more advantageous from the view of conservative dental treatment and from the view of esthetic consideration and this in agreement with Çehreli *et al*. [21].

Conclusions

Although all interfaces of restored specimens in the present study showed some degree of microleakage but the findings may be clinically acceptable especially in placement of composite on freshly placed amalgam in class II combined amalgam-composite restoration which also may indicate a reliable method for restoring defective amalgam restoration.

Financial Disclosure: There is no financial disclosure.

Conflict of Interest: None to declare.

Ethical Clearance: All experimental protocols were approved and all experiments were carried out in accordance with approved guidelines.

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