

Evaluation of Microleakage in Composite-Composite and Amalgam-Composite Interfaces in Tooth with Preventive Resin Restoration (Ex-viva)

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Abstract

Objective: This study addresses the question of whether conservative methods of restoration may be applied efficaciously in permanent posterior teeth with proximal lesions and intact occlusal preventive resin restoration (PRR). The purpose of the present study was to assess the microleakage at amalgam-composite interface and composite-composite interface in permanent tooth with PRR.

Materials and Methods: Thirty-five premolar teeth extracted for orthodontic reasons were selected. The occlusal surfaces were sealed as preventive resin restoration. Then the teeth were stored in incubator for 6 months. After this period, two single boxes were prepared in mesial and distal surfaces in each tooth and filled with amalgam. Another class I composite restoration was prepared in occlusal surface in contact with the first PRR. Then samples were thermocycled and marginal leakage was assessed by the degree of dye penetration on sections of the restored teeth. Friedman and Wilcoxon signed-rank tests served for statistical analyses.

Results: In 51.4% of amalgam-composite interfaces the dye reached the pulpal wall. The corresponded figures for amalgam-tooth and composite-composite interfaces were 31.4% and 14.3%, respectively. The differences in microleakage among the three interfaces were statistically significant ($P < 0.05$).

Conclusion: In the teeth restored with PRR technique, restoring proximal lesions with a conservative technique may lead to favorable results concerning microleakage.

Key Words: Microleakage; Composite; Amalgam; Preventive Resin Restoration

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INTRODUCTION

One of the widely accepted techniques for restoring pit and fissure caries and prevention of

caries development in adjacent pit and fissures is preventive resin restoration (PRR) [1-4]. In this technique, decayed tooth tissue is replaced

with composite resins and at the same time, intact pit and fissures are sealed with fissure sealants. Thus, this conservative technique is based on the "sealing for prevention" principle instead of the "extension for prevention" concept [2, 5].

The most prominent advantage of PRR is that it is a minimally invasive technique [4]. This advantage has led to popularity of this technique. However, a six-year follow up of these restorations has revealed a 20% failure [6]. The main cause for PRR failure has been reported to be microleakage [1, 5, 7]. Retreatment of failed PRRs can be done with composite resins or amalgam. Moreover, it can be performed either conservatively without removing intact fissure sealants or traditionally through class I or class II cavity preparation. An important factor influencing decision making on material and technique in these cases is the amount of microleakage in amalgam-composite and composite-composite interfaces [1, 5, 7]. Microleakage in these two interfaces, when reaching the pulpal floor, can raise concerns regarding recurrent caries and adverse effects on the pulp [7-10].

The majority of the studies in this rarely investigated field are in vitro studies. In a study about assessment of marginal leakage of combined amalgam-sealant restorations on the occlusal surface of permanent posterior teeth, it has been shown that when the occlusal surface had been sealed prior to amalgam filling, dye penetration was significantly less than that in amalgam filling alone [5]. A similar in vivo study about the assessment of marginal leakage of class II amalgam-sealant restoration on primary molar teeth showed that no statistically significant differences existed in marginal microleakage between class II amalgam restoration in contact with occlusal fissure sealant and classic class II amalgam restoration [1]. Another study on microleakage in hybrid amalgam-composite restoration concluded that if amalgam filling had been done before com-

posite filling, microleakage was significantly less than that in the reverse situation. Moreover, amalgam-tooth had most marginal microleakage and composite-tooth had least marginal microleakage [7]. A study assessing the effect of various adhesives and preparation on microleakage in amalgam-resin and resin-tooth interfaces showed that in all cases microleakage in amalgam surfaces was more than that in tooth surface [11].

The aim of the present study was to investigate microleakage in amalgam-composite and composite-composite interfaces in teeth restored with PRR technique.

MATERIALS AND METHODS

This in vitro study was performed on 35 newly extracted intact human premolars. The teeth were cleaned and polished with pumice and rinsed with water. The teeth were then stored in 0.5% chloramine solution for one week. Class I cavities (1.5 mm depth, 1.5 mm bucco-lingual width) were prepared in mesial sections of the teeth. The cavity surfaces were etched with etching gel (IvoclarVivadent) for 20 seconds and rinsed for 20 seconds. The teeth were dried and then a bonding agent (Excite, IvoclarVivadent) was applied and light cured (Arialux light curing system, Iran) for 20 seconds. The cavities were restored with flowable composite (IvoclarVivadent). All the teeth were then placed in distilled water and were incubated at 37° C for six months. After this period, two single-box class II cavities (4 mm bucco-lingual width, 1.5-2 mm mesio-distal width, 3-3.5 mm height) were prepared in both mesial and distal sections of each tooth. The axial wall of the mesial cavity was in previously restored class I cavity. Two retention grooves were prepared in axio-pulpal and axio-lingual line angles of each class II cavity. These cavities were then restored with spherical high copper amalgam (Faghihi, Iran) using matrix band. Margins of the cavities were burnished with a small burnisher and the amalgam

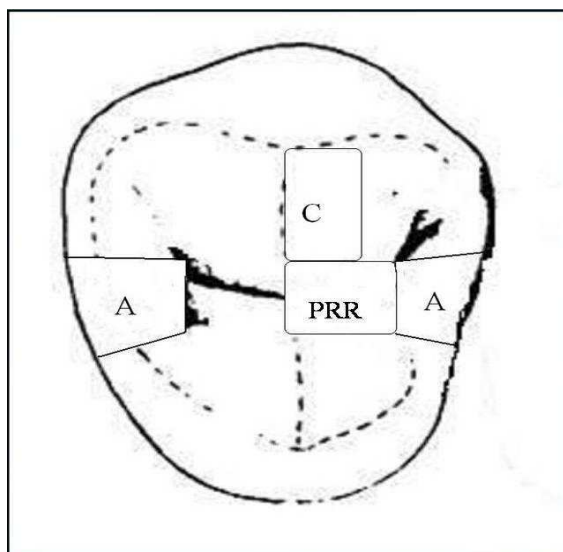


Fig 1. Schematic illustration of restorations on the teeth.
PRR: Preventive Resin Restoration, A: Amalgam restoration, C: Composite restoration

restorations were polished using rubber cap 30 minutes after restoration.

Another class I cavity with the same dimension as the first class I cavity was prepared in the buccal section of occlusal surfaces of the teeth. The lingual wall of this cavity was in previously restored class I cavity. The second class I cavities were restored exactly similar to the first class I cavities (Figure 1).

The samples were stored in distilled water at 37° C for 24 hours. The teeth were then thermocycled ($\times 750$, 5-55°C, 25-second dwell time, and 5-second transition time) [12]. The whole surfaces of the samples except one mm around the filling margins were covered with nail varnish. The samples were immersed in 2% basic fuchsin solution for 10 minutes and then rinsed under tap water for 10 minutes. The samples were embedded in acrylic resin and then sectioned using microtome. Two 1-mm thick mesio-distal slices (to examine amalgam-composite and amalgam-tooth interfaces) and one 1-mm thick bucco-lingual slice (to examine composite-composite interface) were obtained per tooth. The three interfaces were examined with a stereomicroscope ($\times 10$ magnification) and the amount of dye penetra-

tion was recorded as an estimation of microleakage according to ISO guideline (12): 0 = No penetration; 1 = Penetration into the enamel part of the cavity wall; 2 = Penetration into the dentine part of the cavity wall but not including the pulpal floor of the cavity; and 3 = Penetration including the pulpal floor of the cavity.

Friedman test was used for comparison of microleakage among three interfaces and the significance level was defined as 0.05. Wilcoxon signed-rank test served for two-by-two comparisons; Bonferroni adjustment for multiple comparisons was obtained at 0.017 significance level.

RESULT

As it can be seen in Table 1, the dye had reached the pulpal wall of the cavity in more than half of the amalgam-composite interfaces. In 31.4% of the amalgam-tooth interfaces the dye penetration was limited to the enamel layer and in 31.4% the dye reached the pulpal wall.

No dye penetration was observed in 80% of the composite-composite interfaces. In the 20% remainder, the dye penetration was mostly restricted to the dentinal layer without pulpal involvement (85.7%).

Composite-composite interface represented the least microleakage among the three interfaces ($\chi^2 = 25.327$, $P < 0.001$, Friedman test).

Two-by-two comparisons (Table 2) also confirmed that this interface had the best seal (AC-CC: $P = 0.0001$, AT-CC: $P = 0.003$, Wilcoxon signed-rank test). Although microleakage in amalgam-tooth interface was less than that in amalgam-composite interface, the difference was not statistically significant ($P = 0.02$).

DISCUSSION

The present in vitro study compared microleakage in the three interfaces of amalgam-tooth, amalgam-composite, and composite-composite

in a sample of premolar human teeth. According to the results, composite-composite interface showed the least and amalgam-composite represented the highest microleakage.

Generalization of the results from in vitro studies to those from in vivo studies has been a matter of concern. A study investigating the results of in vitro and in vivo studies on microleakage concluded that it seems impossible to directly compare the results of these two types of studies since several factors influence the amount of microleakage [13]. On the other hand, a review study concluded that microleakage findings from these two studies show a high correlation and consequently, the results from an in vitro study can serve as a good estimation of real life situation [14]. In the present study, we tried to increase generalizability of the results through implementation of some strategies. First, to simulate aging phenomenon and real conditions of the mouth, the samples were first incubated for six months and were then thermocycled. Each of these two strategies can simulate aging according to the current ISO standard requirements [12]. These requirements entail either a six-month incubation period or a 500-cycle thermocycling to simulate aging. Second, in our study, the three investigated interfaces were produced in the same tooth.

This method is expected to provide more valid results since the teeth differ from each other in characteristics such as mineral contents and arrangement of enamel and dentine tubes. These differences may have potential effects on microleakage.

To deal with such confounding factors, the previous studies have mainly focused on the randomization approach [14, 15].

Third, to increase reliability of the findings, all the preparations, restorations and observation processes were performed by the same researcher (SR). Intra-examiner calibration was achieved through a pilot study on seven teeth.

In our study, no significant difference was seen in microleakage between amalgam-composite and amalgam-tooth interface. This finding differs from the results of a previous study by Fuks and Shey reporting more microleakage in amalgam-tooth compared to amalgam-sealant interface [5]. This difference may be due to more aging in our sample since we performed 750 cycles of thermocycling compared to 25 cycles in that study [5].

Kossa in a study on combined amalgam-composite restorations concluded that when amalgam restoration was done first, the microleakage was less than the situation in which the composite-restoration precedes amalgam restoration [7].

Table 1. Frequency of Dye Penetration Status in Amalgam-Composite, Amalgam-Tooth and Composite-Composite Interfaces in an In-Vitro Study on 35 Extracted Human Premolars

Dye Penetration Scores*	Amalgam-Composite (n=35)	Amalgam-Tooth (n=35)	Composite-Composite (n=35)
0	4 (11.4%)	9 (25.7%)	28 (80%)
1	7 (20%)	11 (31.4%)	1 (2.9%)
2	6 (17.1%)	4 (11.4%)	1 (2.9%)
3	18 (51.4%)	11 (31.4%)	5 (14.3%)

*0 = No penetration; 1 = Penetration into the enamel part of the cavity wall; 2 = Penetration into the dentine part of the cavity wall but not including the pulpal floor of the cavity; and 3 = Penetration including the pulpal floor of the cavity

This is in line with our findings since we first performed composite and then amalgam restorations.

Kossa's results on comparison of microleakage between amalgam-tooth and amalgam-composite interfaces are similar to the study by Fuks and Shey [5]. However, we should notice that the samples in Kossa's study were restored in a wet place only for two weeks and were thermocycled only for 50 cycles [7], which does not meet the current minimum standard requirements to simulate aging process in such studies [12]. Moreover, the type of the materials in those studies differs from ours. For example, restorative composite in Kossa's study was self-cured [7], while we used flowable light-cured composite. Both of the studies mentioned used dispersed phase (spherical in addition to lathe cut) amalgam [5, 7] whereas we used spherical amalgam. It has been shown in many previous studies that the type of amalgam and composite and their manipulation manner influence the amount of microleakage [9, 15, 16].

The other influencing factor is the duration of sample's immersion in fuchsin solution, which was 24 hours in the mentioned studies [5, 7], but 10 minutes in our study according to ISO standard requirements [12].

Table 2. Comparison of Microleakage in Amalgam-Composite (AC), Amalgam-Tooth (AT) and Composite-Composite (CC) Interfaces in an In-Vitro Study on 35 Extracted Human Premolars Based on Wilcoxon Signed-Rank Test

Compared Interfaces	Test Statistic (z)	P Value
AC-AT	-2.206	0.02
AC-CC	-4.166	0.0001
AT-CC	-3.021	0.003

In a study by Cehreli et al. on amalgam repair and quantitative evaluation of amalgam-resin and resin-tooth interfaces with different surface treatments, they concluded that all the adhesive materials exhibited more microleakage at the amalgam interface than the tooth interface [11].

This is different from our findings since we found no significant difference between microleakage in amalgam-composite and amalgam-tooth interfaces. In their study, the samples were thermocycled for 1000 cycles and finally immersed in 0.5% basic fuchsin solution for 24 hours, which may influence the findings. Moreover, in our study the difference in microleakage between these two interfaces was near to significant and with a greater sample size the difference might become significant. Our objective of comparing microleakage in old composite-new composite interface with that in amalgam-tooth and amalgam-composite interfaces was to consider whether aging process in old composite could increase microleakage in composite-composite interface to the same level as that in the other two interfaces.

The findings showed that it could not. Perhaps unpolymerized monomers of old composite and their reaction to new composite monomers is the reason [17].

However, based on the results of this study, there are three different restoration techniques to restore the failed PRRs:

- Single box composite restorations (composite-composite interfaces)
- Class II amalgam restorations (amalgam-tooth restorations)
- Single box amalgam restorations (amalgam-composite restorations)

It should be noted that such a decision is subject to many other considerations including pros and cons of each technique, possibility and feasibility of tooth isolation, clinical skills of the operator and the socio-economic status of the patient.

CONCLUSION

According to the results of the present study regarding microleakage, treatment options to repair PRR may be ranked as follows:

1. Removing caries, leaving intact parts of PRR and performing a class II composite restoration. In this case, we will have composite-composite interface which showed the least microleakage among the three interfaces. However, gingival microleakage should be taken into account.
2. Removing caries and the whole PRR and performing a class II amalgam restoration. In this situation an amalgam-tooth interface with less microleakage than amalgam-composite interface is developed.
3. Removing caries, leaving intact parts of PRR and performing a single-box amalgam restoration. In this case an amalgam-composite interface is developed which, according to our findings, had the most microleakage.

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