Original Article

Microleakage of Class II Combined Amalgam-Composite Restorations Using Different Composites and Bonding Agents

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Abstract:

Objective: The purpose of the present study was to assess the microleakage of composite restorations with and without a cervical amalgam base and to compare the results of different composites and bonding agents.

Materials and Methods: One hundred and twenty mesio-occlusal (MO) and disto-occlusal (DO) Class II cavities were prepared on sixty extracted permanent premolar teeth. The teeth were randomly divided into four groups of 30 and restored as follows:
In group A, the mesio-occlusal cavity (MO), Scotchbond multi purpose plus + Z250 and in the disto-occlusal (DO) cavity, Prompt-L-Pop + Z250 were applied. As for group B, in the MO and DO cavities, Clearfil SE Bond + Clearfil APX, and varnish + amalgam (In box) + Clearfil SE Bond + Clearfil APX were used respectively while in group C; the teeth were restored with amalgam and varnish mesio-occlusally and with amalgam only disto-occlusally. As for group D, varnish + amalgam (in box) + Scotchbond multi purpose plus + Z250 were applied mesio-occlusally and Varnish + Amalgam (in box) + Prompt–L–Pop + Z250 disto-occlusally.
Marginal leakage was assessed by the degree of dye penetration into various sections of the restored teeth. Chi-square and Fisher's exact tests were used for data analysis.

Results: Microleakage in gingival margin was more than that in occlusal margin ($P<0.05$) and microleakage of combined amalgam-composite restorations was significantly lower than that of conventional composite and amalgam restorations.

Conclusion: Marginal microleakage decreased by using amalgam at the base of the box in Class II composite restorations.

Key Words: Dental Leakage; Dental Restoration, Permanent; Dental Amalgam; Composite Resins

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INTRODUCTION

Composite materials have been regarded to for several years as esthetic substitutes for amalgam. However, creation of contraction gaps at the cervical margin of Class II restorations by polymerization shrinkage is a major drawback for the use of composite material in this type of restoration [1]. The use of horizontal and vertical increments, dentin bonding agents, reapplication of an unfilled resin and a "Sandwich" technique employing a glass-ionomer or amalgam have been suggested as methods to prevent microleakage and the development of secondary caries in Class II composite resin restorations. A method has been presented for Class II restorations using a layer of amalgam on the cervical part of the box covered by composite [2-7].

Baghdadi [8] evaluated whether differences in material composition between three restora-

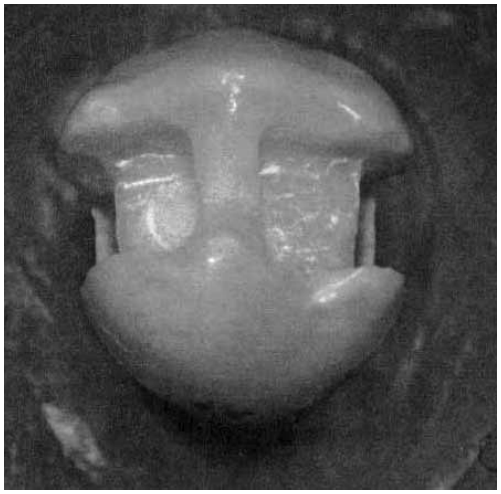

Fig 1. Cavity preparation in the mesial and distal surface of a premolar tooth.

tives (compomer, packable composite, and amalgam) can affect the amount of microleakage in Class II restorations. The results revealed that bonded amalgam restorations are more effective in reducing marginal microleakage, particularly at dentinal margin [8]. It is also mentioned that microleakage of the combined amalgam-composite restoration was lower than that of the conventional composite and amalgam restoration [9]. Mohandas and Reddy [10] found microleakage of amalgam and composite restorations to be reduced largely after application of cavity varnish, also composite resin was seen to be superior to silver amalgam in controlling microleakage.

In two studies Aguilar and colleagues investigated the marginal leakage of two light cured resin composites used for posterior restoration using two filling and curing techniques in 2002. They depicted that despite the lower amounts of leakage exhibited by medium viscosity composites, no restorative material was able to actually avoid the leakage [11,12].

Ziskind et al [13] evaluated the effect of amalgam type, adhesive system, and storage period on microleakage of amalgam restorations. They concluded that an adhesive bonding agent may affect the amount of microleakage in short term. However, in long term, the effect of the adhesive does not appear to be dominant [13]. Silva et al [14] reported that in bonded amalgam restorations, intermediate materials had a significant effect on the sealing ability.

The aims of this in vitro study were to evaluate microleakage at the cervical margins of Class II composite restorations filled by either amalgam followed by a composite material or a single composite or amalgam material. In addition, we assessed the amount of microleakage at both the filling-tooth structure and the amalgam-composite interface using different composites and bonding agents.

MATERIALS AND METHODS

Permanent premolars (n=60) kept in distilled water were used in this study. In each tooth, two separate conventional Class II cavities (mesial and distal; 120 cavities) were prepared using a #331 carbide bur with water spray coolant, ensuring that the cervical margins of the box remained in enamel (Fig 1).

For the Restorative procedure, the teeth were randomly divided into four groups of 30 and restored as follows:

Group A

Mesio-occlusal (MO): Scotchbond multi purpose plus (3M Dental products) + Z250 (3M ESPE, Seefeld, German) according to the manufacturers' instructions through incremental layering. Each increment was cured separately for 20 seconds from the direction closest to its location.

Disto-occlusal (DO): Prompt-L-Pop (3M ESPE, Seefeld, Germany) + Z250 composite according to the manufacturers' instructions, also using the same incremental layering.

Group B

MO: Clearfil SE bond (Kurary Co. Ltd. Tokyo, Japan) + Clearfil APX composite (Kurary Co. Ltd).

The restorative procedure followed the same steps as in the group A according to the manufacturers' instructions.

DO: Varnish (Harvard, Berlin, Germany) + amalgam (Cinalux Shahid Faghihi Co. Tehran, Iran) + Clearfil SE bond + Clearfil APX composite.

Group C

MO: Varnish + amalgam. Varnish was applied over the cavity walls and then the cavity was filled with non-gamma2 amalgam.

DO: Only amalgam without varnish. The restorative procedure followed the same steps as in MO cavity, except that varnish was not used.

Group D

MO: Varnish + amalgam + Scotchbond multipurpose plus + Z250 composite.

The restorative procedure followed the same steps as in the group B, DO cavity.

DO: Varnish + amalgam + Prompt-L-Pop + Z250. The restorative procedure followed the same steps as in MO cavity.

For groups A and B, following adaptation of a matrix band, a layer of non-gamma 2 amalgam was condensed on the gingival floor of the proximal box. The cavity walls and surrounding enamel were then primed and dried. Adhesive Clearfil SE bond was applied over the primed area according to the manufacture's instructions. Three vertical increments (buccal, lingual and middle) were used to fill the occlusal part of the cavity with Clearfil APX. The composite was trimmed and each increment was cured separately for 20 seconds from the direction closest to its location.

The restored teeth were kept in distilled water at room temperature for four months to prevent dehydration, thermocycled (1000 cycles between 60°C (SD=2) and 4°C (SD=2), dwell time: 30 s intervals between the baths at room temperature). Then, apices of the teeth were sealed with sticky wax. The surface of each tooth, apart form the restoration and 1 mm of the surrounding enamel was coated with two layers of nail varnish. The coated teeth were immersed in a 2% basic fuchsin solution for 24 hours, washed under running water, and sectioned mesiodistally through the restoration.

The depth of dye penetration between the restorative material and the tooth was evaluated under a stereomicroscope by two observers at x40 magnification and scored based on following criteria:

0: No dye penetration;

1: Dye penetration between the restoration and the tooth up to dentino-enamel junction;

Table 1. Assessment of marginal leakage according to depth of dye penetration.

Scores		Group A		Group B		Group C		Group D	
		M	D	M	D	M	D	M	D
Occlusal margin	**0**	7	5	7	9	4	2	14	10
	1	8	10	7	6	8	1	1	5
	2	0	0	1	0	1	1	0	0
	3	0	0	0	0	2	10	0	0
	4	0	0	0	0	0	1	0	0
Cervical margin	**0**	4	3	1	0	0	0	0	0
	1	9	5	5	0	0	0	1	1
	2	2	7	9	1	1	0	3	6
	3	0	0	0	6	7	2	7	5
	4	0	0	0	8	7	13	4	3
Amalgam-Composite interface	**0**	-	-	-	15	-	-	13	14
	1	-	-	-	0	-	-	2	1
	2	-	-	-	0	-	-	0	0
	3	-	-	-	0	-	-	0	0
	4	-	-	-	0	-	-	0	0

M=Mesial, D=Distal

2: Dye penetration between the restoration and the tooth up to the pulpal wall;
3: Dye penetration between the restoration and the tooth along the pulpal wall and into the dentin;
4: Dye penetration through the dentin into the pulpal chamber. Similar criteria were used to evaluate dye penetration between the amalgam and the composite material.
Dye penetration degrees at different interfaces were compared and the data were statistically analyzed using Chi-Square and Fisher's exact tests.

RESULTS

There was no or minimal leakage (degree 0 and 1) at the amalgam-composite interface (Table 1). The degree of microleakage at the composite-enamel interface was significantly higher than at the amalgam-composite interface and was significantly higher than the amalgam-enamel interface.
The differences between them were statistically significant ($P<0.001$) (Fig 1). Microleakage in gingival margins was more than that in occlusal margins and the difference was statistically significant ($P<0.05$).

DISCUSSION

The present study was designed to determine the extent of microleakage in amalgam- composite restorations in permanent posterior teeth, based on the good results of a previous study utilizing a similar technique [6].
The results of the present study showed that the amount of microleakage at the amalgam-composite interface was significantly lower than that in conventional composite and amalgam restorations. The amount of microleakage in amalgam restorations without varnish was more than those with varnish, particularly in the cervical margin.
Application of a Copal varnish and bonding resin might improve the marginal seal. However, varnish can interfere with the acid etching process if it is not totally removed from the enamel before acid etching. In our study, buccolingual increments were used. This method is believed to decrease the severity of marginal leakage as compared to bulk filling method [15].
Hersek et al [16] compared microleakage behaviors of three restorative materials in 2002 using the autoradiography method. The results revealed that amalgam exhibited more microleakage than composite resins [16]. Ziskind et al [13] evaluated the effect of amalgam type, adhesive system, and storage period on microleakage of amalgam restorations. They found that, in long term, the effect of adhesive does not appear to be dominant in reducing microleakage around amalgam restorations [14]. Hadavi et al [17] assessed microleakage at the junction between amalgam and composite resin in 1991; the results of the study implied that less microleakage occurs when bonding agent is applied directly to the roughened amalgam prior to placement of composite resin. The highest amount of microleakage occurs when roughened amalgam surface is acid etched before placement of bonding agent and composite resin [17].
The excellent interface between amalgam and composite material can be explained by the fact that the bonding agent penetrates into the irregularities and porosities of the amalgam surface, thus creating a bond with the composite material [18].Microleakage in the group A (composite restorations) was significantly lower than Group C (Amalgam restorations), that may be related to the use of dentin bonding agent in composite restorations. There was no such statistically significant difference between self etched bonding agents (Prompt-L-Pop & Clearfil SE Bond) and three-step one (Scotchbond Multi purpose plus).

CONCLUSION

A combined amalgam-composite class II restoration is clinically acceptable regarding mi-

croleakage and the use of a dentin-bonding agent does not completely eliminate microleakage at the gingival margin when the cavity is filled with composite material alone.

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