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

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-
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 multipurpose (3M Dental products) + Z250 (3M ESPE, Seefeld, Germany) 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 multi-purpose 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 from 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;

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M=Mesial, D=Distal

Table 1. Assessment of marginal leakage according to depth of dye penetration.
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 inter-
face and was significantly higher than the
amalgam-enamel interface.
The differences between them were statisti-
cally significant (P<0.001) (Fig 1). Microleak-
age in gingival margins was more than that in
occlusal margins and the difference was statisti-
cally significant (P<0.05).

DISCUSSION
The present study was designed to determine
the extent of microleakage in amalgam- com-
posite 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 amal-
gam 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. How-
ever, varnish can interfere with the acid etch-
ing process if it is not totally removed from the
enamel before acid etching. In our study, bucco-
lingual 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 be-
haviors of three restorative materials in 2002
using the autoradiography method. The results
revealed that amalgam exhibited more micro-
leakage than composite resins [16]. Ziskind et
al [13] evaluated the effect of amalgam type,
adhesive system, and storage period on micro-
leakage of amalgam restorations. They found
that, in long term, the effect of adhesive does
not appear to be dominant in reducing micro-
leakage 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 oc-
curs 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 compos-
ite 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 bond-
ing agent in composite restorations. There was
no such statistically significant difference be-
tween 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 res-
toration is clinically acceptable regarding mi-
croleakage and the use of a dentin-bonding agent does not completely eliminate micro-leakage at the gingival margin when the cavity is filled with composite material alone.

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REFERENCES