



## COMPARATIVE EVALUATION OF THE EFFECT OF TWO LINERS ON MICROLEAKAGE OF CL V AMALGAM RESTORATIONS WITH ENAMEL MARGIN

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### Abstract

The aim of this study was to compare the effect of cavity varnish and a 7<sup>th</sup> generation bonding agent on microleakage of amalgam CL5 restorations. **Materials and Methods:** 60 human premolar teeth were divided into 3 groups after creating Class V conventional cavities on the Buccal surface of each tooth (group1:Control group, Group2:Copal varnish, group3:clearfil S<sup>3</sup>bond).The teeth were thermocycled and stored in 1% Methylene Blue. A Buccolingual section were created and the microleakage was evaluated by the measurement of dye penetration in the Occlusal and Gingival Margins. **Results:** GLM analysis results showed that microleakage in Occlusal wall using Clearfil S<sup>3</sup> bond and Copal Varnish is less than Control group significantly(P-value<0.001 and P-value=0.002 respectively) and Clearfil S<sup>3</sup> bond showed a non-significant decrease in microleakage compared with varnish (P-value=0.16). Clearfil S<sup>3</sup> bond reduced marginal microleakage significantly compared to Control group(P-value=0.004) while there was a non-significant increase in microleakage using Cavity varnish compared with Control group(P-value=0.199). **Conclusion:** The results showed that Clearfil S3 bond can be more effective than copal varnish reducing Marginal microleakage of amalgam restorations. Due to progressive use of amalgam, it is recommended to do further studies about the long term effects of different Liners on the microleakage of amalgam restorations.

**Keywords:** Microleakage, Class V amalgam restoration, 7<sup>th</sup> generation adhesive, Cavity Varnish.

### Introduction

Amalgam is still the most used restorative material despite invention newer restorative methods and materials. Amalgam does not bond tooth tissue; therefore restorations using such material are prone to leakage despite the deposition of corrosion products (1). Microleakage is a major factor contributing to the occurrence of secondary caries around amalgam restorations (2). Interfacial gap formation and micro leakage because of inadequate adaptation may result in recurrent decay, tooth-marginal discoloration, pulpal irritation and postoperative sensitivity (3). The gamma2 phase of conventional amalgam linked to corrosion of dental amalgams is partially or completely suppressed

so decrease in microleakage due to deposition of corrosion products will lately occur(4).

Many lining materials have been rendered in order to seal dental tubules including varnish and adhesive systems.

Cavity varnishes are reported to reduce microleakage of amalgam restorations for only a short period of time, as they are prone to dissolve in oral fluids (5). Several studies have shown that adhesive liners perform better than copal varnish sealing amalgam restorations(2, 6-10).

The purpose of this study was to evaluate the effect of Copal varnish and a 7<sup>th</sup> generation adhesive liner on microleakage of CL V amalgam restorations compared with unlined amalgam restorations.

## Materials and Methods

30 fresh human premolar teeth that were extracted for orthodontic Purpose (free of cracks, caries and restorations on visual inspection )were selected for the experiment. The teeth were stored in distilled water prior to use and all teeth were used within 3 month of extraction. Conventional Class V cavity preparations were made on both buccal and lingual surfaces of each tooth using 0.8mm diamond fissure bur. cavities were approximately 3mm mesiodistally, 2mm occlusogingivally and 1mm buccolingually ending 1mm upper the CEJ. All cavities were dried using air spray prior to placement of amalgam restorations. The specimens were divided into 3 experimental groups (n=20):

**Group I (Control Group):** Amalgam restoration, using no lining material

**Group II:** Amalgam Restoration, lined with cavity copal varnish (Sultan Healthcare, USA).

Two coats of Copal varnish was applied on each inner wall using microbrush and then was gently air-dried after each application.

**Group III:** Amalgam restoration, lined with 7<sup>th</sup> Generation adhesive (Clearfil S<sup>3</sup>, Kuraray Noritake Dental INC, Japan)

Two coats of the adhesive was applied on each inner wall using a microbrush. Each layer was thinned using air-spray and left 20 s undisturbed after second application and then cured for 10s.

Following these procedures all the specimens were restored with high copper amalgam (Contour™, Kerr Corporation, USA). Amalgam was placed using a small carrier and the alloy was condensed by both a

small and a large Condenser. Restoration surface was pre-carve burnished and the margins were re-burnished after carving.

After the initial alloy setting time all the samples were thermocycled (100 cycles, 5-55±2°C water). Submergence time was 20 s at each temperature with a 5 s delay at room temperature between each bath. The root apices were then sealed with sticky wax and two layers of nail polish were applied to the entire external surface of the teeth except for an area 1 mm away from the cavity margins and the restoration. Each layer of nail polish was allowed to dry before the next layer was applied. The teeth were then immersed in 1% Methylene blue dye solution for 24h at room temperature. At the end of the period, the teeth were removed from the solution, washed with copious amounts of water to remove any surface traces of dye and were sectioned in a buccolingual plane by using a rotating diamond cutting wheel. Dye penetration at the occlusal and gingival tooth-restoration interface was evaluated under a stereomicroscope at a magnification level of 20x according to the following scoring system(3):

- 0 -no dye penetration,
- 1 -dye penetration less than half the length of the occlusal or gingival wall,
- 2 -dye penetration more than half the length of the occlusal or gingival wall,
- 3 -dye penetration up to axial wall

## Results

60 human premolar teeth were considered as *in vitro* in three control groups (including 20 teeth), treatment with Copalite Varnish (including 20 teeth) and treatment with banding Self-etch of 7 generation Clearfil S<sup>3</sup> (including 20 teeth) and following results obtained:

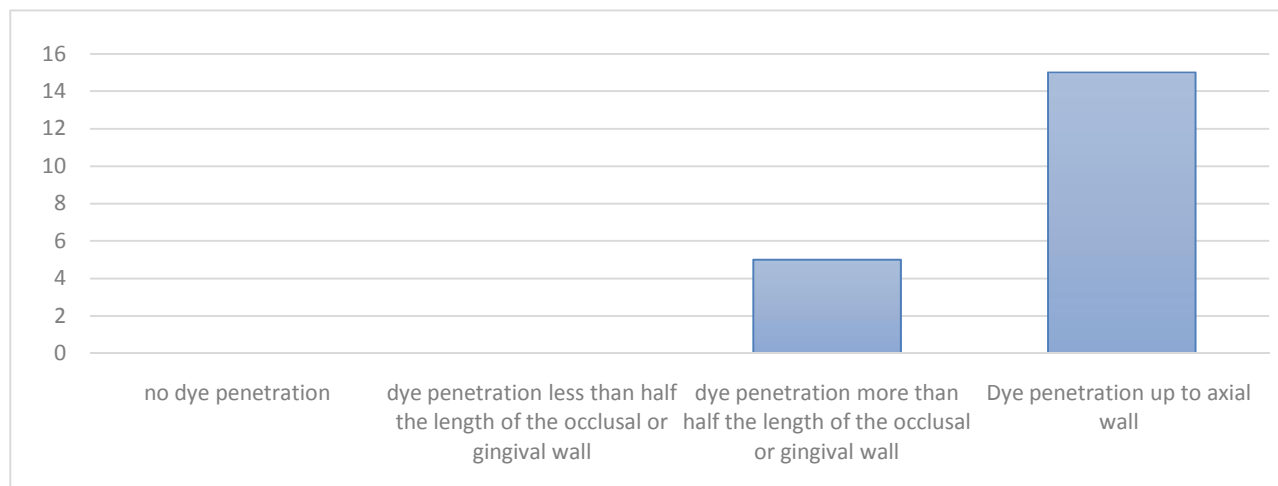
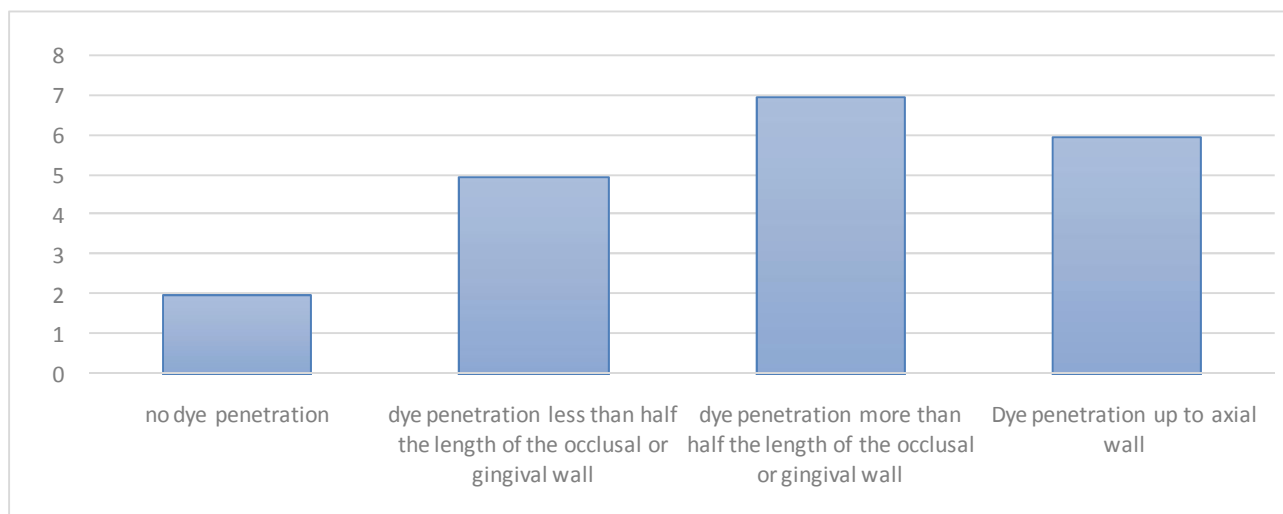
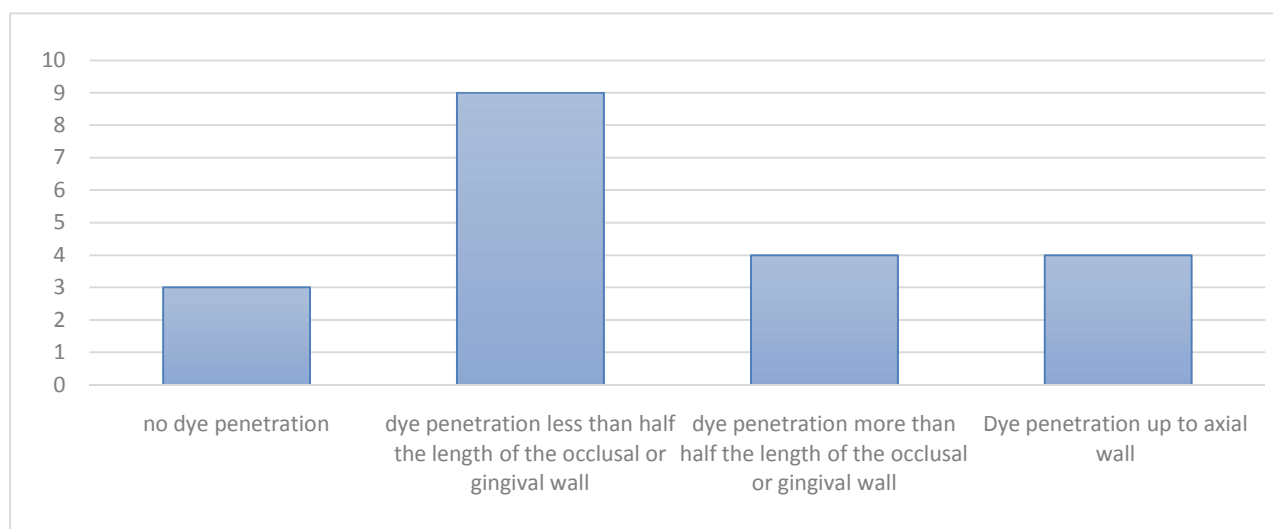


Figure 1 Occlusal Microleakage values; No liner



**Figure 2** Occlusal Microleakage values; Sultan™ Copal varnish



**Figure 3** Occlusal Microleakage values; Clearfil S³ Bond

**Table 1** Occlusal microleakage analysis

	<b>B</b>	<b>SE</b>	<b>OR</b>	<b>P-value</b>
1 to 3	2.91	0.71	18.37	<0.001
2 to 3	0.84	0.59	2.31	0.16
1 to 2	2.07	0.67	7.94	0.002

The OR<sup>1</sup> of more microleakage in Group1 to Group3 is 18.37 and this is a significant difference statistically. (OR=18.37, p-value<0.001)

The OR of more microleakage in Group1 to Group2 is 7.94 and this is a significant difference statistically. (OR=7.94, P-value=0.002)

The OR of more microleakage in Group 2 to Group 3 is 2.31 and this is not a significant difference statistically. (OR=2.31, P-value=0.16)

<sup>1</sup>**Odds Ratio (OR)** is a measure of association between an exposure and an outcome. The OR represents the **odds** that an outcome will occur given a particular exposure, compared to the **odds** of the outcome occurring in the absence of that exposure.

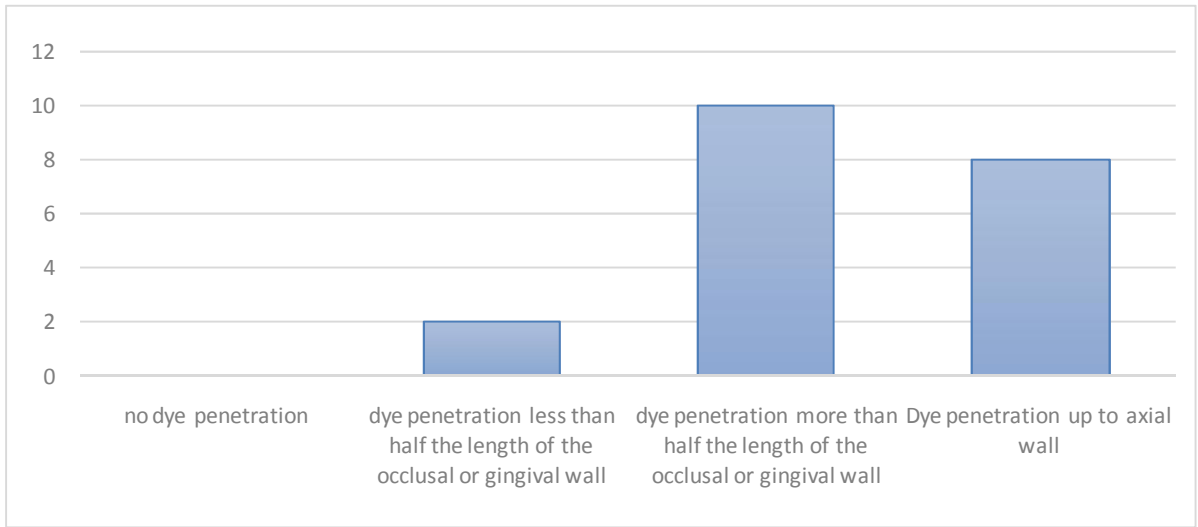


Figure 4 Gingival microleakage values; No liner

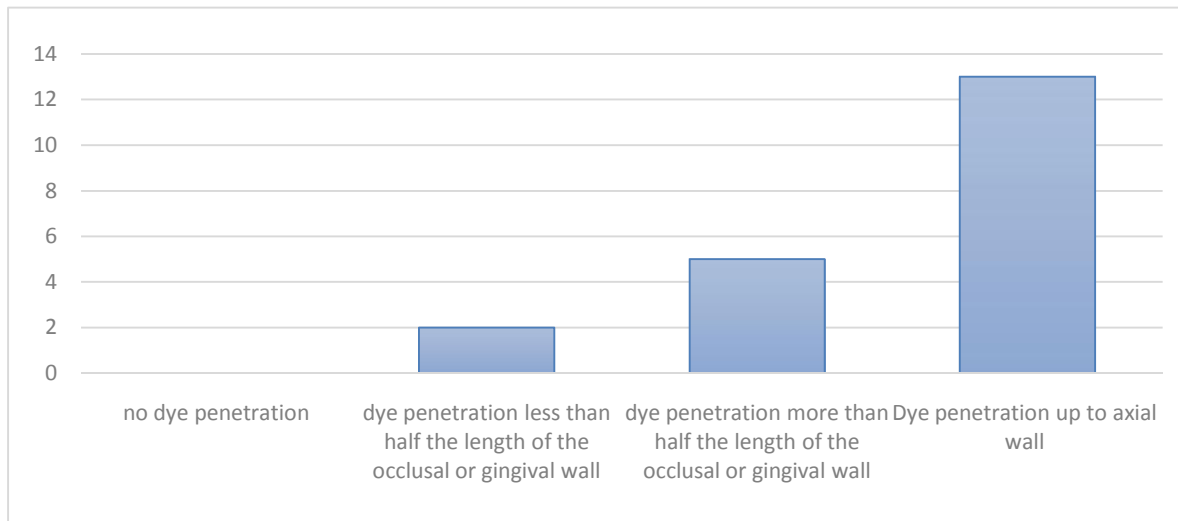


Figure 5 Gingival microleakage values; Sultan™ copal varnish

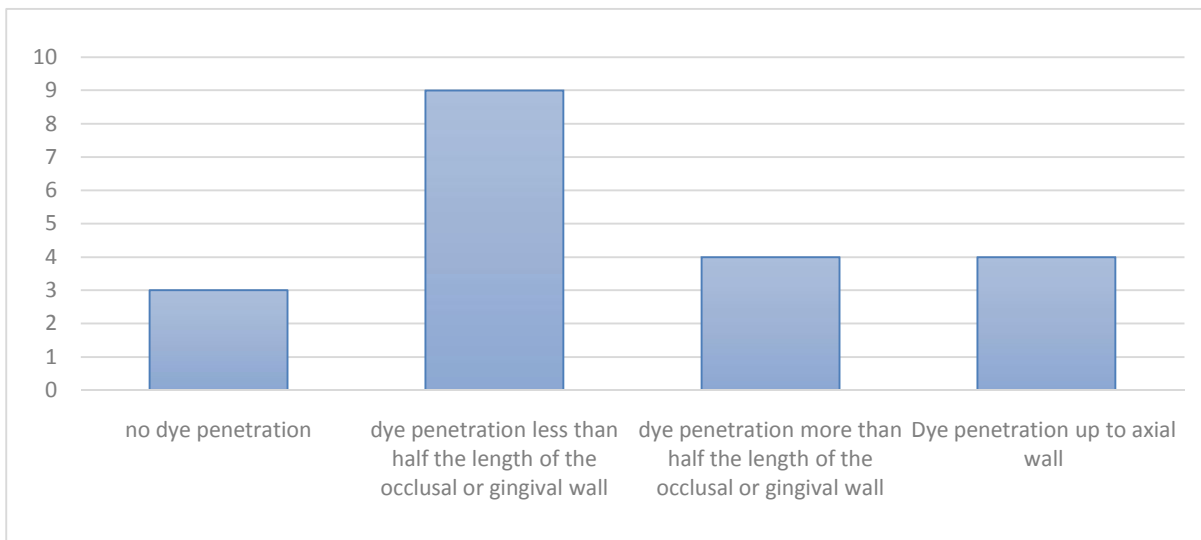


Figure 6 Gingival microleakage values; Clearfil S<sup>3</sup> bond

	<b>B</b>	<b>SE</b>	<b>OR</b>	<b>P-value</b>
1 to 3	1.83	0.64	6.24	0.004
2 to 3	2.62	0.69	13.71	<0.001
1 to 2	0.79	0.62	0.45	0.199

The OR of more microleakage in Group1 to Group3 is 6.24 and this is a significant difference statistically. (OR=6.24, p-value=0.004)

The OR of more microleakage in Group1 to Group2 is 0.45 and this is not a significant difference statistically. (OR=0.45, P-value=0.199)

The OR of more microleakage in Group2 to Group3 is 13.71 and this is a significant difference statistically. (OR=13.71, P-value<0.001)

### Comparison between occlusal and gingival microleakage values in group 1; no liner

**Table 3** analysis of occlusal to gingival leakage ratio in group1; no liner

	<b>B</b>	<b>SE</b>	<b>OR</b>	<b>P-value</b>
OCC to GIN	1.576	0.685	4.84	0.021

The OR of more microleakage in occlusal to gingival wall is 4.84 and this is a significant difference statistically. (OR=4.84, P-value=0.021)

### Comparison between occlusal and gingival microleakage values in group 2; Sultan™ Copal varnish

**Table 4** analysis of occlusal to gingival leakage ratio in group2; Sultan™ Copal varnish

	<b>B</b>	<b>SE</b>	<b>OR</b>	<b>P-value</b>
OCC to GIN	-1.526	0.636	0.217	0.016

The OR of more microleakage in occlusal to gingival wall is 0.217 and this is a significant difference statistically. (OR=0.217, P-value=0.016)

### Comparison between occlusal and gingival microleakage values in group 2; Clearfil S<sup>3</sup> bond

**Table 5** analysis of occlusal to gingival leakage ratio in group3; Clearfil S<sup>3</sup> bond

	<b>B</b>	<b>SE</b>	<b>OR</b>	<b>P-value</b>
OCC to GIN	$-8.23 \times 10^{-17}$	0.581	1	1

The OR of more microleakage in occlusal to gingival wall is 1 and this is not a significant difference statistically. (OR=1, P-value=1)

## Discussion

Clearfil S<sup>3</sup> bond and Sultan™ copal varnish were used as liners in this study. Clearfil S<sup>3</sup> showed less leakage than Cavity Varnish in both occlusal and gingival margins that it was significant in gingival wall.

The findings of this study about the performance of different Liners are consistent with results of *Belli et al (3)*, *Royse et al (11)*, *Gallato et al(2)*, *Myaki et al (12)*, *Cenci et al (13)* and *Berry et all (14)*.

Clearfil S<sup>3</sup> is classified as a 7<sup>th</sup> generation bonding or in the other words as a self-etch adhesive. Self-etch adhesives have weak acidic monomers (mostly phosphoric acid esters), so there is no need for a separate etchant acid element and rinse process. It seems that the marginal integration can be improved

by these adhesives and they can reduce the patient signs or even remove them after treatment (15). Cavity varnish can form none bond neither with amalgam nor with tooth structure and it can only seal the cracks and microgrooves however bondings can seal dentinal tubules and form a bond with tooth structure (16,17). Clearfil S<sup>3</sup> Bond includes the functional monomer methacryloxyloxydecyl dehydrogen-10 phosphate (MDP-10) which has two Hydroxyl factors that may bond to Calcium (18). Furthermore, MDP-10 can cause to minimal dissolving of Smear layer and limited opening the Dentinal tubules and as the result reducing the permeability of dentin (19). MDP-10 Monomer, can also facilitate the penetration, saturated polymerization and involving the monomer with demineralized dentin to form a thick hybrid layer (20). Recently, a report published by *Youshida et al*

showed that MDP-10 can bond to Hydroxyapatite strictly and its Calcium Salt can hardly dissolve in fluids (21) so that it can be one of the reasons for the less microleakage observed using adhesive system than Copal Varnish.

Moreover, cavity varnish is applied on the dentin which covered by Smear layer, thus there will be always an Interstitial space where the liquids can flow through and also wetting of tooth surface can cause to more microleakage. However, bondings are applied on the etched surface that result to remove or modify Smear layer and improve the wetting of tooth surface.

High-copper amalgams were used in this study since they are more common. Suppressing Gama2 phase, the initial corrosion is not observed in this type of amalgam somarginal gap remains unsealed causing increase in varnish solubility.

Another possible explanation is that the effect of thermocycling can reduce the ability of copal varnish to prevent microleakage due to its disintegration. Unlike copal varnish, Adhesive bonding create a stable and immanent layer so that it could pass thermocycle process without disjoining (22).

Our findings are not in consistent with those of *Morrow et al* (1), *Ulukapi et al* (23) and *Eichmiller et al* (24).

The results of Morrow's study can be explained only by considering the high technical sensitivity of the adhesive materials and their negative impressionability against the moisture in the dentin and oral cavity (1). According to *Eichmiller et al* the possible reason of such results can be related to the function of the used acid in this restorative alloy that can lead to dissolve and remove the adhesive liner. Dissolution of unfilled Resin has been more than filled resin (24).

Some comparisons have also been conducted between occlusal and gingival margins in this study.

In the copal varnish group, the significant increase of microleakage in gingival wall, can be attributed to the difference between deep and superficial dentin structure. Deeper dentin tubules become shorter in length, thicker in diameter and more numerous than they are in areas closer to the DEJ so deeper dentin structure becomes weaker in rolling as a barrier(art).Due to the same depth of the occlusal and gingival margins and decrease in the enamel thickness from occlusal to Gingival, it can be concluded that the dentin depth in the gingival margin is more than it is in the occlusal margin so the gingival wall consists mainly of deep dentin structure. Considering the mentioned structure it could be clear that the number and average diameter of dentinal tubules are higher in gingival wall and besides, because of disintegration and dissolution of varnish

caused by thermocycle process, there will be more microleakage in the gingival wall and it is justifiable.

The same microleakage level in both occlusal and gingival margins In Clearfil S<sup>3</sup> liner group and can be attributed to the strong and stable bonding of this liner to enamel and partly to dentin so despite the less thickness of enamel in gingival wall, no difference in the microleakage level between occlusal and gingival wall is observed.

## Conclusion

According to disability of amalgam in bonding with tooth structure, microleakage would be inevitable in these restorations.

Over the years considering and studying about reduction of microleakage, various materials have been introduced and evaluated to use as liner under the amalgam restorations. Cavity Varnish is one of the liners which has been using in dental offices for years, despite of many disagreements about its efficiency and especially long-term effects. Various studies have showed that adhesive materials are better than Copal varnish sealing amalgam restorations (2, 6-10).

In this study, we've tried to evaluate sealing ability of applying an adhesive self-etch 7<sup>th</sup> generation (Clearfil S<sup>3</sup> Bond, Kuraray Noritake Dental Inc, Japan) as a liner compared to copal varnish. The results showed that Clearfil S<sup>3</sup> bond was more effective than cavity varnish and the control group (without liner) reducing microleakage of Class V amalgam restorations in both Occlusal and Gingival margins. On the other hand cavity varnish had a positive effect on reducing micro leakage in Occlusal margin when compared to control group but there had been a non-significant negative effect when considering gingival margin.

Further studies are suggested to compare long term effect of cavity varnish and adhesive liners on microleakage of amalgam restorations with enamel and dentinal margins and also to compare the effect of other types of self-etch and total-etch adhesives on microleakage of amalgam restorations.

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