the Journal of CONTEMPORARY DENTAL PRACTICE at www.thejcdp.com
Volume 8 Number 7 November 1, 2007

Effect of a Resin-based Desensitizing Agent and a Self-etching Dentin Adhesive on Marginal Leakage of Amalgam Restorations

Marjaneh Ghavamnasiri, DDS, MS; Mohammad Alavi, DDS; Samin Alavi, DDS

Abstract

Aim: The purpose of this study was to compare the marginal leakage of Class II amalgam restorations whose preparations were lined with a resin-based desensitizing agent, a self-etching adhesive system, and copal varnish.

Methods and Materials: Fifty-six freshly extracted human premolar teeth were divided into four groups. A Class II preparation was prepared with only a proximal box on the mesial and distal surfaces of each tooth. The cavities in one group were lined with a desensitizing agent (VivaSens™) and a second group with an adhesive (Clearfil S^3 Bond™). A third group was lined with copal varnish (Copalite™) and a fourth group was used as the control without any cavity liner. Spherical high copper amalgam was hand-condensed into each preparation, specimens were thermocycled, stained, and sectioned. Microleakage was graded using a stereomicroscope. Microleakage scores were calculated and analyzed using the Kruskal Wallis and the Mann-Whitney tests (α=0.05).

Results: Less microleakage was indicated with the VivaSens™ liner when compared with the other groups ($P<0.05$). Clearfil S^3 Bond™ showed less microleakage than the control group ($P<0.05$), but the leakage with copal varnish and Clearfil S^3 Bond™ was similar ($P>0.05$).

Conclusion: VivaSens™ reduced the microleakage of Class II high copper amalgam restorations significantly more than the Clearfil S^3 Bond™ and copal varnish.

Keywords: Amalgam, resin-based desensitizing agent, self-etching adhesive system, cavity varnish

Citation: Ghavamnasiri M, Alavi M, Alavi S. Effect of a Resin-based Desensitizing Agent and a Self-etching Dentin Adhesive on Marginal Leakage of Amalgam Restorations. J Contemp Dent Pract 2007 November; (8)7:054-061.

Introduction

The use of adhesive systems as cavity liners under amalgam restorations have been in common use instead of copal varnish.[1] Cavity varnishes have been used for many years for amalgam restorations. However, they are reported to reduce the microleakage of amalgam restorations for only a short period of time as they are prone to dissolve in oral fluids.[2] Such findings are mainly due to the solubility of the material and dissolution of the underlying smear layer.[3]

The methods used to treat cavity surfaces prior to placement of an amalgam restoration have changed over the years. This may be considered a direct response to a better understanding of the cause of pulpal damage, the hydrodynamic theory of pulp pain, and the development of new dental materials.[4] The presence of bacteria has been recognized as the most important determinant factor of pulp inflammation.[4] Use of liners and bases under amalgam restorations have been used to limit post-operative sensitivity and to provide thermal insulation.

Several studies have demonstrated the achievement of a better seal using adhesive materials rather than copal varnish under amalgam restorations.[3,5-9] Different intermediate adhesive materials have been employed in such bonded techniques but demonstrated different sealing properties. However, not all bonded amalgam restorations are able to simultaneously provide both sealing and retention of amalgam restorations.[10]

It is not uncommon for a patient to experience varying degrees of pain from mild to even sharp excruciating pain upon exposure of a tooth to hot/cold solutions after placement of an amalgam restoration.[11] Topical application of fluorides, oxalates, or other agents with an occlusive effect on dentin tubules may therapeutically treat hypersensitivity.[12]

More recently, resin-based desensitizing agents have been proposed. The resin-based desensitizing agents are generally acidic resins which bond to dentin to form a resin-dentin-hybrid layer to the occlude dentin tubules with resin plugs.[13]

The present study was designed to compare the microleakage of one resin-based desensitizing agent and one self-etching adhesive material with a copal varnish as lining materials under a high copper amalgam restoration. The null hypothesis tested was microleakage around an amalgam restoration at the cervical margin is not affected by the type of cavity liner used.

Methods and Materials

Fifty-six freshly extracted human first and second maxillary premolar teeth, free of cracks, caries, and restorations, were selected. The teeth were stored in physiological saline at room temperature prior to use, and all teeth were used within one month of extraction. Class II preparations were made on mesial and distal

surfaces of each tooth using a high speed handpiece with air-water coolant and a #245 carbide plain fissure bur (Midwest, Des Plaines, IL, USA). The bur was replaced after seven cavity preparations. The buccal-lingual width of cavities was at least one-third of the intercuspal dimension both occlusally and interproximally, and the gingival floor of the box only extended onto enamel. The depth of the gingival floor was placed approximately 2 mm axially. The teeth were then randomly assigned to four groups of 14 each and restored as follows (Table 1):

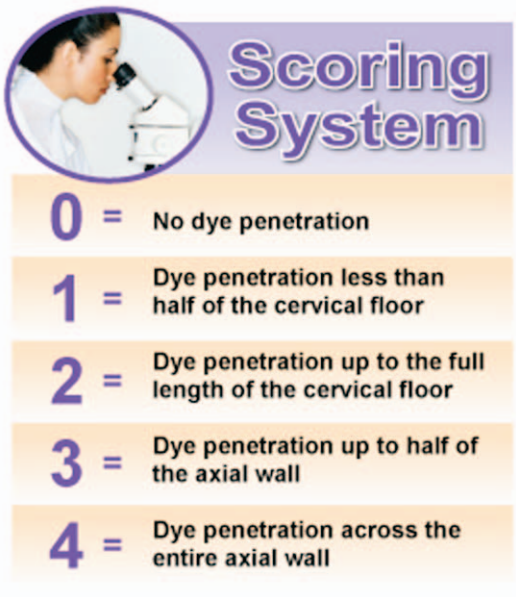
- **Group A:** A desensitizing agent, VivaSens™ (Ivoclar Vivadent AG, Benderestrass, Schaan, Liechtenstien), was used. A single dose was applied for each cavity preparation. The foil lid was removed then the applicator was dipped into the chamber containing the VivaSens liquid in order to mix the liquid with the ingredients embedded in the applicator brush. The mixture was rubbed on all surfaces of the cavity for ten seconds and gently air dried for ten seconds.
- **Group B:** One coat of Clearfil S^3 Bond™ (Kuraray Europe GmbH, Frankfurt am Main, Germany) was applied to the enamel and dentin surfaces. After 20 seconds, it was thinned by blowing air on the material and light cured for 20 seconds.
- **Group C:** Two coats of cavity varnish, Copalite™ (Cooley and Cooley LTD, Houston, TX, USA), was applied to enamel and dentin surfaces. After each coating, the cavity was gently air dried.
- **Group D:** This group was used as a control, and 14 cavities were restored with amalgam fillings without any lining material.

A metal matrix was applied to each specimen, and the cavities were restored with Oralloy™, a high copper amalgam filling material (Coltene Whaledent, Cuyahoga Falls, OH, USA). All specimens were placed in a thermocycling apparatus at the same time and subjected to 500 cycles.[7] The temperature of the water bath was maintained at (5ºC±2ºC and 55º±2ºC). The dwell time in each bath and the time interval at room temperature baths were one minute each. Following thermocycling, all specimens were aged for one week in tap water at room temperature.

The root apices were then sealed with a self-cure composite resin, Degufil™ (Degussa, Düsseldorf, Germany), and two layers of nail varnish were applied on the entire external surface of the teeth except for an area 1 mm away from the cavity margins and the restoration.

The specimens were immersed in 0.5% basic fuchsine dye solution for 24 hours at 37ºC. The teeth were then rinsed with a copious amount of water to remove any surface traces of dye and embedded in Vertex Dentimex BV™ autopolymerizing resin (Zeist, Utrecht, The Netherlands).

Two mesial-distal sections were obtained by serially sectioning the embedded tooth parallel to the long axes. Each section was examined under a stereo zoom microscope using 10X magnification (Catima Program Deltalogic Automatisieruengs Technik GmbH, Schwabisch, Germany) according to the following scoring system:



The data were statistically analyzed using the non-parametric Kruskal-Wallis and Mann-Whitney tests (α=0.05).

Results

Distribution of the degree of leakage associated with sections from individual teeth in the four test groups ranged from 0 to 4. Score frequency for microleakage results are shown in Table 2 and Figure 1.

Table 1. Composition of liners used in the study.

Materials	Composition
VivaSens™	**Liquid Varnish:** • Ethanol • Water • Hydroxypropyl cellulose • Polyethylenglycol dimethacrylate • Methacrylate modified polyacrylic acid • Potassium fluoride • Aroma **Microbrush:** • Phosphoric acid • Methacrylate
Clearfil S Bond™	• 10 Methacyloyloxydecyl dihyrogen phosphate (MDP) • Bis-phenol A diglycidylmethacrylate (Bis-GMA) • 2- Hydroxyethyl methacrylate (HEMA) • Hydrophobic dimethacrylate • dl-Camphorquinone • Ethyl alcohol • Water • Slianated colloidal silica
Copalite™ Varnish	• Copal varnish • Chloroform • Acetone

The Kruskal Wallis test indicated a significant difference among the four groups ($p<0.05$). The Mann-Whitney test for comparison of the mean rank of microleakage in each of two groups showed a statistically significant difference between groups A and B; A and D; B and D; and A and C ($p<0.05$); but, there was no significant difference between B and C ($p>0.05$) as shown in Table 2 and Figure 1.

Discussion

Based on the results of the present study, the null hypothesis tested was rejected since the liners evaluated showed different values in microleakage around amalgam restorations.

The results also showed the desensitizing agent Viva Sens™ reduced microleakage when compared with Clearfil S^3 Bond™, Copalite™

Table 2. Score frequency and mean ranks for microleakage each group (n=14/group).

Group	Scores					Mean rank	Statistical analyses (★)
	0	1	2	3	4		
Group A	5	10	11	2	0	25.86	α
Group B	-	4	6	11	7	56.59	β
Group C	3	2	5	4	14	62.39	β
Group D	-	1	2	3	22	81.16	γ

(★) Groups with different letters are statistically different (P<0.05).

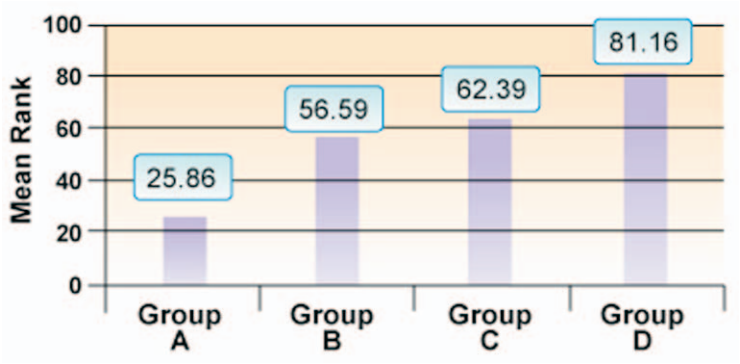
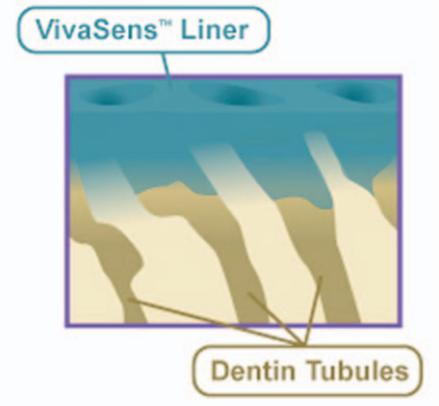


Figure 1. Mean rank of microleakage in the four groups.

varnish liner, and the control (no liner). This is probably because VivaSens™ contains phosphonic acid and methacrylate modified polyacrylic acid which forms calcium salts of low solubility which precipitates into the dentin tubules. It is believed the fluoride ion also has a strong adsorption by dentinal tubules.[14]

In this study Clearfil S^3 Bond™, a self-etching adhesive system, was selected which dissolves the smear layer allowing the penetration of hydrophilic adhesive into the modified dentin. Pereria et al.[15] recognized self-etching materials do not completely remove the smear plugs and may have the potential to promote less post-operative sensitivity and undergo less disturbance by changes in moisture levels of the dentin substrate. Less microleakage was observed with Clearfil S^3 Bond™ (Group B) in comparison with the unlined group (Group D). This result supported the conclusion of several previous studies.[2,9,16] Copal varnish (Group C) showed no significant difference with respect to microleakage in comparison with Clearfil S^3 Bond™. Several investigations have reported significant reductions in marginal leakage when adhesive liners were placed under amalgam restorations compared to those with varnish (Copalite™) or no liner.[2,7,17] One limitation of the Clearfil S^3 Bond™ might be the solubility of the materials which could reduce the effectiveness of the technique over time. Using the previous versions of the adhesive system, Cenci et al.[7] and Belli and Ozer[16] found



less microleakage with Clearfil liner Bond 2V™ compared to copal varnish. However, the varnish has a low adhesion to the smear layer.[18] Fitchie et al.[19] reported Copalite™ was effective in preventing microleakage around Class I amalgam restorations for six months.

Oliveria et al.[20] showed the smear layer to be important in the adhesion of a self-etching primer (Clearfil SE Bond™), but a thicker smear layer seemed to interfere with the adhesive capabilities of self-etching primers. In the present study a carbide bur was used for preparation of cavities. Oliveria et al.[20] also showed the carbide bur capable of creating a thinner smear layer than a coarse diamond bur. Using the previous versions of the adhesive system, Cenci et al.[7] and Belli and Ozer[1] found less microleakage with Clearfil liner Bond 2V™ compared to copal varnish.

The specimens were submitted to 500 thermalcycles which is probably a limitation of this study. However, comparison of the results from different studies is critical since there are no generally accepted standards for experimental parameters such as type and concentration of the storage solution, time of storage, temperature during storage, or the type and duration of thermal cycling.[21]

Conclusion

Within the limitation of this *in vitro* study, less microleakage was observed with VivaSens™ when compared with Cleafil S^3 Bond™, copal varnish, and without the use of any liner. The microleakage of Clearfil S^3 Bond™ was similar to that of copal varnish, but less than the control group.

Notwithstanding the limitation of the present study and the debate regarding the significance of leakage, the influence of the resin-based desensitizing agents on the adhesion of amalgam and dentin needs further evaluation. Clinical investigation would be required to evaluate the effectiveness of the materials tested.

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About the Authors

Marjaneh Ghavamnasiri, DDS, MS

Dr. Ghavamnasiri is a Professor in the Department of Operative Dentistry of the Mashhad Dental School and Dental Research Center of the Mashhad University of Medical Sciences in Mashhad, Iran. Her research interests include dental bleaching, microleakage, and dental adhesives.

e-mail: dr_marjaneh@yahoo.com

Mohammad Alavi, DDS

Dr. Alavi is an Assistant professor in the Department of Operative Dentistry of the Mashhad Dental School and Dental Research Center at the Mashhad University of Medical Sciences in Mashhad, Iran. His research interest is in adhesive restorative materials.

Samin Alavi, DDS

Dr. Alavi is a graduate student in the Department of Operative Dentistry of the Mashhad Dental School at the Mashhad University of Medical Sciences in Mashhad, Iran.

e-mail: Unique_d79@yahoo.com

Acknowledgments

This study was supported by a grant from the Research Council of the Mashhad University of Medical Sciences in Mashhad, Iran.

The authors would like to express their sincere appreciation to Dr. Arezou Habibi, Assistant Professor of Ferdowsi University in Mashhad, Iran for performing the statistical analysis for the present study.