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Microleakage in Primary Teeth Restored by Conventional or Bonded Amalgam Technique

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The aim of this *in vitro* study was to evaluate marginal leakage in class V restorations in primary teeth restored with amalgam, using three different techniques. Thirty maxillary anterior primary teeth, clinically sound and naturally exfoliated, were used. In group 1 (n=10), two thin layers of a copal varnish (Cavitine) were applied. In group 2 (n=10), Scotchbond Multi-Purpose Plus, a dual adhesive system, was used according to manufacturer instructions. In group 3 (n=10), One-Step adhesive system in combination with a low-viscosity resin (Resinomer) were used according to manufacturer instructions. All samples were restored with a high-copper dental amalgam alloy (GS 80, SDI). After restoration, the samples were stored in normal saline at 37ºC for 72 h. The specimens were polished, thermocycled (500 cycles, 5º and 55ºC, 30-s dwell time) and impermeabilized with fingernail polish to within 1.0 mm of the restoration margins. The teeth were then placed in 0.5% methylene blue for 4 h. Finally, the samples were sectioned and evaluated for marginal leakage. The Kruskal-Wallis test showed that the filled adhesive resin (group 3) had the least microleakage. There was no significant difference between groups1 and 2.

Key Words: dental amalgam, microleakage, primary teeth.

INTRODUCTION

Dental amalgam remains the most widely used restorative material for both primary and permanent teeth, despite the great advancement of new products. Among the advantages are ease of handling, low cost, excellent physical properties and good clinical results for over 150 years.

Restorations with conventional amalgam alloy require two coats of cavity varnish to reduce marginal leakage at the tooth/restoration interface. The varnish must be applied prior to amalgam condensation. Nevertheless, it is known that the copal varnish dissolves over a period of time making this region susceptible to microleakage. Conventional amalgam alloy undergoes corrosion and the resulting products have a tendency to improve the sealing at the interface (1,2).

Amalgam alloy with high-copper content has eliminated the gamma-two phase. Thus, corrosion requires either a longer period of time to occur or does not take place at all. The ability of the amalgam to resist corrosion can cause microleakage at the tooth-restoration interface (3,4). Microleakage and subsequent marginal breakdown can result in pulp irritation, tooth discoloration and secondary caries (5).

Several authors have reported that the adhesive resin/amalgam combination prevents this situation. This technique includes the application of an adhesive system prior to restorative procedures. The result is a physical and chemical union between amalgam and tooth structure (6-16). Despite the large amount of research on the efficacy of bonded amalgam technique in permanent teeth, little research has addressed bonded amalgam technique in primary teeth (17,18).

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The aim of this *in vitro* study was to evaluate microleakage in primary teeth by comparing conventional and bonded amalgam restorations using two different adhesive resin systems.

MATERIAL AND METHODS

Thirty human clinically sound and naturally exfoliated primary teeth were selected for analysis. The samples were stored in a saline solution at room temperature. The specimens were cleaned with a rubber cup in a low-speed handpiece with pumice and water, washed with air/water spray and air dried.

Class V cavity preparations (approximately 3.0 x 2.0 x 1.5 mm) were prepared in the cervical third of each tooth on the buccal surface surrounded by enamel. The cavities were made with a #1342 round bur (KG Sorensen, Barueri, SP, Brazil) with a high-speed handpiece using air/water spray.

Following these procedures, the samples were divided into three experimental groups: Group 1: conventional amalgam restoration, with two thin layers of a copal cavity varnish (Cavitine, SS White, Rio de Janeiro, RJ, Brazil), applied previously. Group 2: adhesive system/amalgam combination (or bonded amalgam restoration). Before amalgam condensation, an adhesive system composed of an unfilled resin of high viscosity (Scotchbond Multi-Purpose Plus, 3M Dental Products, St Paul, MN, USA) was applied. Both the enamel and the dentin surfaces were etched with 35% phosphoric acid for 15 s, rinsed thoroughly, and air dried for 2 s to remove excess water but still leaving the dentin moist. This was followed by application of activator, primer and dual-cure adhesive system (one drop of adhesive resin plus one of catalyst), and amalgam restoration. Group 3: adhesive system/amalgam combination with application of a single-component adhesive system (One-Step, Bisco, Inc, Itasca, IL, USA) and a filled low-viscosity resin (Resinomer, Bisco). Both the enamel and the dentin surfaces were etched with 32% phosphoric acid for 15 s, rinsed thoroughly, and air dried to remove excess water but still leaving the dentin moist. Two coats of the adhesive system were applied and left undisturbed for drying for 10 s and then light cured for 10 s. This was followed by two more coats of the adhesive system, undisturbed drying and light curing for 10 more seconds. Before Resinomer application, one more layer of the adhesive system was applied and not followed by polymerization. Resinomer was manipulated (equal parts of catalyst and base paste) for 15 s and placed into the cavity with a disposable microbrush. Amalgam was condensed before light curing of the composite resin. After the conclusion of amalgam restoration, the resin was light cured for 20 s.

A high-copper dental amalgam alloy was used in all restorations (GS 80, Southern Dental Industries Limited, Bayswater, Vic., Australia). An Optilux 150 light curing unit (Demetron Research Corp, Danburry, CT, USA) with 500 mW/cm^2 light intensity was used throughout all polymerization procedures.

Once restored, the specimens were stored in saline at 37ºC for 72 h. The restorations were sequentially polished with brown, green and blue abrasive rubber cups (KG Sorensen) in a low-speed handpiece. All teeth were thermocycled in distilled water (5º and 55ºC, 500 cycles, 30-s immersion time).

Root surfaces were sealed with an autopolymerizing epoxy resin (Araldite, Brascola Ltda, São Bernardo do Campo, SP, Brazil). Other tooth surfaces were painted with two coats of fingernail polish (Colorama, Ceil Coml. Ind. LTDA, São Paulo, SP, Brazil) to within 1.0 mm of the restoration margins. The teeth were immersed in 0.5% methylene blue (pH =7.2) for 4 h, and then rinsed in water and air dried.

The samples were sectioned from buccal to lingual surface using a carboril disc in a low-speed handpiece. The specimens were subsequently polished with sequential silicon carbide papers (grits 220, 320, 400 and 600).

Slides taken from all samples at X3 magnification were used for microleakage evaluation by five calibrated examiners. Microleakage scores were based on the degree of dye penetration according to Retief et al. (19): 0 = no leakage; 1 = leakage extending to the dentinoenamel junction; 2 = leakage extending to the axial wall of the preparation; 3 = leakage extending along the axial wall of the preparation.

Statistical analysis was performed using the Kruskal-Wallis test at a 0.01 level of significance.

RESULTS

The treatment performed before amalgam condensation did not avoid dye penetration in groups 1 or 2. Group 1 had two coats of copal cavity varnish and group 2 had application of a fourth generation adhesive system.

Group 3 pre-treatment had the least dye penetration. It received application of a fifth generation adhesive system (One-Step), followed by Resinomer that is a filled low-viscosity and dual-curing resin. The average microleakage scores are reported in Figure 1. There was significant statistical difference when comparing group 3 to groups 1 and 2.

DISCUSSION

This *in vitro* study was made with anterior primary teeth. The group that received One-Step/Resinomer before amalgam condensation had significantly lower microleakage values compared to previous application of a cavity varnish (Cavitine) or application of an unfilled high-viscosity dual-curing adhesive system (Scotchbond Multi-Purpose Plus).

The finding that application of copal varnish prior to amalgam condensation exhibited high rates of dye penetration agrees with other studies that have shown that copal varnish is dissolved after a certain span of time; thus, offering only temporary marginal sealing (2,20).

Resinomer is a commercial filled low-viscosity, dual-curing resin. It is prepared by manipulating equal parts of two pastes (base and catalyst). The final mixture can be light cured, if it is used as a liner, or it can behave as a resin of dual cure, when used as a bonding agent between tooth structure and amalgam. In this case, manufacturer instructions recommend the application of a single component adhesive system (One-Step) prior to Resinomer. Amalgam condensation should be done before Resinomer polymerization.

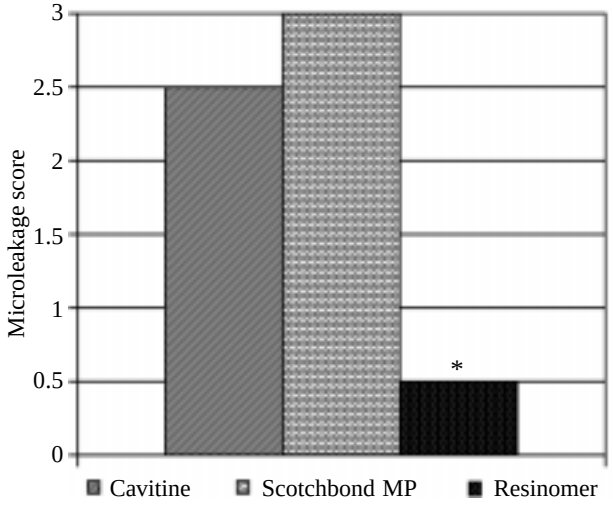

Figure 1. Average microleakage scores. *P<0.01 compared to Cavitine and Scotchbond Multi-Purpose Plus.

Diefenderfer and Reinhardt (13) reported that the low viscosity of Resinomer facilitates the formation of a mechanical union between amalgam and resin. This union occurs while the resin is cured and reduces microleakage as was also shown in the present study.

Bagley et al. (6) and Diefenderfer and Reihardt (13) demonstrated that the use of a filled adhesive system in permanent teeth increases the resistance of amalgam adhesion to teeth surfaces, comparing it to unfilled high-viscosity adhesive systems.

Scotchbond Multi-Purpose Plus is an unfilled fourth generation high-viscosity adhesive system (with primer and adhesive in separate bottles). In this mode of usage it is light cured and can also offer the dual-cure option, that is desired when the adhesive is used for bonded amalgam technique. In this way, activator and catalyst must also be used. These additional components do not alter its classification as an unfilled high-viscosity adhesive. The same cannot be said about other adhesive systems (Amalgambond with HPA, All-Bond 2 with Liner F or Optibond), because when used in their dual mode, they become filled low-viscosity ones.

The high-viscosity of Scotchbond Multi-Purpose Plus makes its mechanical union with amalgam less efficient. This characteristic may explain why this adhesive system did not avoid dye penetration and showed high microleakage patterns in several samples of this study. However, Royse et al. (17) described that the use of a high-viscosity adhesive system (Probond - Caulk/Dentsply) placed under the amalgam restoration showed statistically less microleakage than did specimens lined with copal cavity varnish.

Despite the limitations of an *in vitro* study, it can be affirmed that it is possible to reduce microleakage in class V amalgam restorations of anterior primary teeth. For this purpose, a single component adhesive system (One-Step) associated with a filled low-viscosity dual-curing resin (Resinomer) should be used before amalgam condensation. Similar results were not obtained using either a copal cavity varnish (Cavitine) or an unfilled high-viscosity dual-curing adhesive system (Scotchbond Multi-Purpose Plus).

Cannon et al. (18) performed a 3-year follow-up clinical study to evaluate the efficacy of bonded amalgam technique using All-bond 2 adhesive system and

Resinomer in combination with Tytin amalgam in primary teeth. The study showed a statistical superiority of bonded amalgam in comparison to the control group (with no bonding materials). However, further studies are necessary for evaluating bonded amalgam technique with One-Step and Resinomer in primary teeth.

RESUMO

Myaki SI, Rodrigues CRMD, Raggio DP, Flores TAP, Matson MR. Infiltração marginal em dentes decíduos restaurados pela técnica convencional ou do amálgama adesivo. Braz Dent J 2001;12(3):197-200.

O objetivo deste estudo foi de avaliar *in vitro* a infiltração marginal em restaurações classe V em dentes decíduos restaurados com amálgama, utilizando-se três técnicas restauradoras. Foram utilizados 30 dentes decíduos anteriores superiores, hígidos, esfoliados naturalmente. No grupo 1 (n=10) aplicou-se 2 camadas de verniz (Cavitine). No grupo 2 (n=10) utilizou-se o sistema adesivo Scotchbond Multi Uso Plus, do modo *dual*, segundo as recomendações do fabricante. No grupo 3 (n=10) utilizou-se o sistema adesivo One-Step e após uma resina composta de baixa viscosidade (Resinomer) segundo as recomendações do fabricante. Todas as amostras foram restauradas com amálgama (GS 80-SDI) de alto teor de cobre. Após o procedimento restaurador as amostras foram armazenadas em solução fisiológica a 37ºC durante 72 horas. Após polimento com pontas de borracha abrasiva, foram termocicladas (500 ciclos - 5º e 55ºC) e impermeabilizadas com esmalte de unha, deixando-se uma janela de 1,0 mm nas margens das restaurações. A seguir foram imersas em solução de azul de metileno a 0,5% durante 4 horas. Finalmente as amostras foram seccionadas e avaliadas quanto à infiltração marginal. Os resultados obtidos, após submetidos à análise estatística (Teste de Kruskal-Wallis a 1%), demonstraram que o grupo 3 apresentou os melhores resultados quanto à infiltração marginal. Não houve diferença estatisticamente significante entre o grupo 1 e grupo 2. Concluiu-se que a combinação de adesivo e resina de baixa viscosidade proporcionou menor infiltração marginal em restaurações de amágama adesivo em dentes decíduos.

Unitermos: amálgama, infiltração marginal, dentes decíduos.

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