THE EFFECT OF SILVER DIAMINE FLUORIDE ON MICROLEAKAGE OF RESIN COMPOSITE

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Abstract

The aim of this in vitro study was to investigate the effect of silver diamine fluoride (SDF) on the microleakage of resin composite.

Forty-five freshly extracted non-carious human mandibular third molar teeth were used in the study. Five of them were used as negative control. Two class V cavities (3x3x2mm) were prepared. The teeth were randomly assigned into two groups: Group 1: Dentin bonding (G-aenial bond,GC Corp., Tokyo, Japan) was applied and light-cured for 20 s. All cavities (n=40) were restored with resin composite (G-aenial posterior composite,GC Corp., Tokyo, Japan). Group 2: 38% SDF (Saforide, Toyo Seiyaku Kasei, Japan) was applied for three minutes, followed by a rinse for 30 seconds. Then the cavities (n=40) were restored as the same protocol in Group 1. The specimens then were submitted to 1000 thermocycles with 30 s baths at temperature of 5oC and 55°C and a dwell time of 10 s in a resting bath at 24°C. All samples were subsequently immersed in 0.5% basic fucsin solution for 24 hours. Marginal leakage was evaluated under stereomicroscope at x40 magnification. The significance between the groups was determined using Wilcoxon and Chi-square tests.

No significant difference in microleakage scores was found betwen control and experimental groups.

The findings of the present study revealed that using silver diamine fluoride did not effect the microleakage scores of resin composite. Further clinical studies with using potassium iodide to mask the staining effect of SDF must be needed.

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Introduction

Silver compounds have been used in dentistry since 1840.[1] Among them silver diamine fluoride [$Ag(NH_3)_2F$] (SDF) is a solution that has been used to arrest dental caries since 1970.[2] Although its mechanism of action is not well understood, it has been proposed that SDF's chemical components contribute the following benefits; silver salts stimulate dentin sclerosis/calcification, silver nitrate acts to kill bacteria, and fluoride aids in remineralization and prevention.[3] A number of *in vitro* studies have supported the clinical efficacy of SDF showing it to reduce the soubility of tooth tissue against chemical acid challenge, and facilitate enamel remineralization.[4,5]

In vitro studies reported that SDF can inhibit biofilm formation and matrix metalloproteinase (MMP) activities.[6,7] An *in vivo* study with rat molars demonstrated a significant reduction in progression of dentinal caries lesions with MMP inhibitors, a long with reduced salivary MMP activities. It was found that 38% SDF had a significant inhibition of MMP-2, MMP-8 and MMP-9 and the inhibition can be important in halting destruction of organic substance in dentin lesion.[8]

SDF also increases the microhardness of carious dentin, reduces loss of calcium and

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phosphate ions and lessens collagen damage.[6,9,10]

Another study reported that less soluble or virtually insoluble calcium fluoride, silver phosphate, and silver protein were formed and precipitated on the dentin surface when SDF was applied. This formed an insoluble protective layer that decreased calcium and phosphorous loss from the carious lesions.[11]

According to our knowledge no previous study have been reported about the effect of SDF on microleakage of resin composite. For this reason, the aim of this *in vitro* study was to investigate the effect of SDF on the microleakage of resin composite.

Materials and methods

Forty-five freshly extracted non-carious human mandibular third molar teeth were used with the approval of the Ethics Committee of Ege University, Izmir.

Five of them were used as negative control. Two class V cavities (3 mm in length x 3 mm in width and 2 mm in depth) were prepared using tungsten carbide burs at high speed. The burs were renewed after every fifth cavity preparation. The teeth were randomly assigned into two groups.

Group 1: Dentin bonding (G-aenial bond (GC Corp., Tokyo, Japan) was applied and light-cured with a LED device (Bluphase, Ivoclar Vivadent, Schaen, Liechtenstein) for 20 seconds. All cavities (n=40) were restored with resin composite (G-aenial posterior composite-shade: PA1, GC Corp., Tokyo, Japan) and light-cured for 40 seconds.

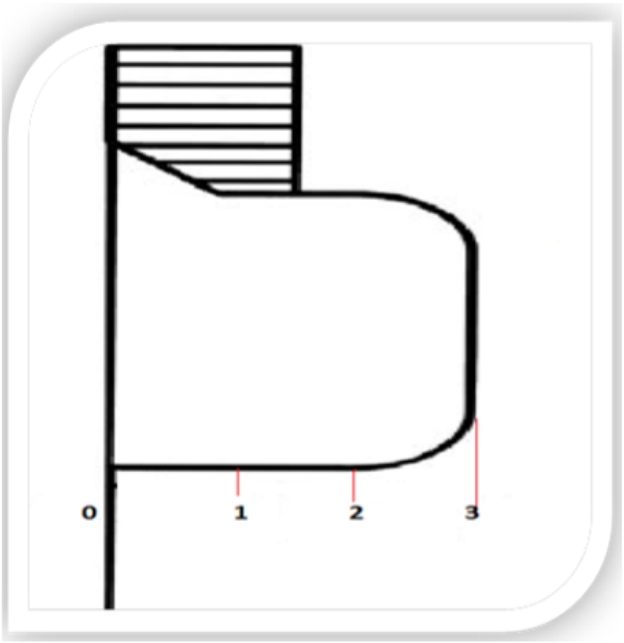
Group 2: 38% SDF (Saforide, Toyo Seiyaku Kasei, Japan) was applied for three minutes, followed by a rinse for 30 seconds. Then the cavities (n=40) were restored as the same protocol in Group 1.

Specimens were stored in distilled water at 37 ^{o}C for 24 hours after finishing and polishing procedures (PoGo, Dentsply/Caulk, U.S.A.).

The specimens then were submitted to 1000 thermocycles with 30s baths at temperature of 5^{o}C and 55^{o}C and a dwell time of 10 s in a resting bath at 24^{o}C. Root ends were sealed with a layer of composite resin and double-coated with nail varnish up to 1 mm from the restoration margins. All samples were subsequently immersed in 0.5% basic fucsin solution for 24 hours. After removal from the dye solution, the teeth were washed and sectioned longitudinally through the center of the restorations in a bucco/lingual plane with a diamond saw (Isomet, Buehler, Ltd, LakeBluff, IL, USA).

Marginal leakage, as indicated by the depth of dye penetration at the margins, was evaluated under stereomicroscope (Olympus, Tokyo, Japan) at x40 magnification. For each restoration, the section with greater leakage was selected for scoring. The evaluations were carried out blindly by an evaluator who was not aware of the groups. Figure-1 shows the scale that was used to assess the extent of dye penetration at the tooth-restoration interface.[12]

The significance between the groups was determined using Wilcoxon and Chi-square tests ($p<0.05$).



0 = No microleakage
1 = Dye penetration less than ½ of axial wall
2 = Dye penetration more than ½ of axial wall
3 = Dye penetration spreading along the axial wall.

Figure 1. The scoring method of dye penetration.

Results

Figure-2 summarizes the microleakage scores of class V resin composite restorations with and without pretreatment with 38% SDF.

The results of this study indicate no significant difference in microleakage betwen control group (no pretreatment with SDF) and experimental group (pretreatment with 38% SDF) ($p>0.05$).

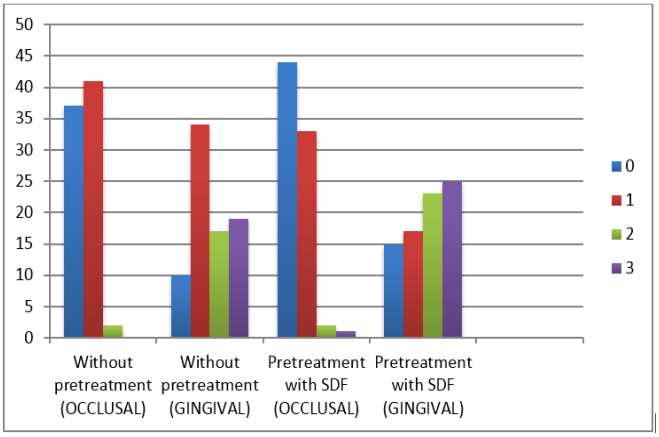


Figure 2. The distribution of occlusal and gingival microleakage scores. (No significant difference was detected in leakage scores between control (without pretreatment) and experimental (pretreatment with 38% SDF) groups at both occlusal and gingival margins. p>0.05)

Discussion

Microleakage is defined as the ingress of bacteria, its products, toxins, molecules, oral fluids and ions between the margins of the restoration and the walls of the cavity. Microleakage at the tooth-restoration interface is considered a major factor influencing the longevity of dental restorations. It may lead to staining at the margins of the restoration, recurrent caries at the tooth/restoration interface, hypersensitivity of the restored teeth, and the development of pulpal pathology.[13]

In the present study, the dynamic environment of the oral cavity was stimulated by exposing the restorations to thermal changes via thermocycling. Thermal cycles ranging between 200 to 5000 in many studies.[14,15] In this study,1000 thermal cycles between 5°C and 55 °C were applied.

Microleakage is usually evaluated by a dye penetration test and subsequent cutting of the specimens.[16-18] It is widely accepted and preferred method because it is readily avaiable, cheap and non-toxic.[19] The most effective dye for revealing microleakage is 0.5% basic fuchsin.[20] Therefore, this technique and 0.5% basic fuchsin was used in the present study.

Researches on dental caries has long been focused on preventing the progression of the initial caries and diminishing the risk for secondary caries. The major cause for failure of dental restorations is secondary caries. For this reason, many antimicrobial agents have been used with composite resins.[21,22] Among them, SDF has been used as a cariostatic agent. Various clinical studies have reported its utility in the treatment and prevention of caries. SDF helps in deposition of silver phosphate to restore mineral content, resulting in rehardning of tooth structure. It also releases fluoride.[23] It has been also reported that SDF prevents the formation of *Streptococcus mutans* or *Actinomyces naeslundii* mono-species biofilms.[6]

SDF can inhibit biofilm formation and MMP activities.[6,7] It also increases the microhardness of carious dentin, reduces loss of calcium and phosphate ions and lessens collagen damage.[6,9,10] Sinha et al. suggested that SDF can be used as potential substitutes to $Ca(OH)_2$ for indirect pulp capping.[24] Most laboratory studies have focused on changes in mineral content such as the calcium and phosphate level, fluoride content and microhardness of dental hard tissue.[10,25,26]

SDF releases fluoride and helps in the deposition of silver phosphate to restore the mineral content, resulting in rehardening of the tooth structure.[6,9-11] SDF has been shown to remineralize carious dentin and increase its microhardness.[6]

SDF is available in various concentrations such as 38%, 30% and 12%.[27-29] 38% SDF was used in this study because it is the most commonly used concentration.[30] It has been reported that 38% SDF could reduce mineral loss and collagen exposure from acid challenge by pH cycling.[31]

The most obvious disadvantage of silver compounds is the black staining effect on carious tissue.[27,29] This discolouration is caused by the oxidation of ionized silver into metallic silver. It is known that SDF stains the caries lesion with dark coloration[3,32] furthermore, our study also showed that non carious dentin treated with SDF will also stain after the resin adhesive is light-cured. The dark staining, whether in carious or noncarious dentin, may create an esthetic challenge when restorative material is composite.[2] Potassium iodide has been suggested to be applied after application of SDF to eliminate excess metallic silver in attempt to reduce discolouration.[26]

According to our knowledge, this is the first study in the literature that has been studied the effect of SDF on the microlekage of resin

material. In the present study, SDF application under resin restorations did not effect the microleakage of the restorations.

Conclusions

Previous studies showed many beneficial effects of SDF.[6,9,10,23,25,26] Therefore, we suggested that using SDF in operative dentistry may increase the achievement of the restorations. Further clinical studies with using potassium iodide to mask the staining effect of SDF must be needed.

Declaration of Interest

The authors report no conflict of interest and the article is not funded or supported by any research grant.

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