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The Effect of Dye Spy and Sable Seek Caries Detectors on Microleakage of Composite Restorations

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ABSTRACT

Background: Micro leakage following restoration using caries detector diesis one of the usual and important problems in dentistry. This leakage contributes to a range of clinical problems such as post operation sensitivity and pulp necrosis which can be minimized by using caries detectors and complete washing of the surfaces after each application. So, the aim of this study was to determine the effect of two types of caries detectors, Dye Spy and Sable Seek, on micro leakage of Z-100 composite in class V composite cavities. Materials and Methods. This experimental study was performed on 45 intact human premolars without any crack or caries that were categorized into 3 groups of 15 teeth. After creating cavities with 3 mm long and 2 mm width, the premolars in first group were stained by Sable Seek [manufactured by Ultradent, USA] and second group were stained by Dye Spy [manufactured by Germphene, Canada]. After 20 seconds of applying the caries detectors with water and air as instructed by the manufacturer [10 seconds for Sable Seek and 20 seconds for Dye Spy], they were washed out. Then all samples were etched, washed and soaked with 2 layer single bond and Z-100 composite. Then samples were cured and placed in thermo cycling while the apex end of all teeth was sealed. Then all teeth surfaces [except for 1mm around restoration and the restoration area itself] were covered with nail varnish. After placing the samples in silver nitrate for 2 hours and then in processing solution for 6 hours, they were cut in buccolingual direction and the amount of micro leakage was evaluated by stereomicroscopy [40]. Results. The micro leakage at gingival surface of restoration after Dye Spy application was 40% grade 2, and 13.3% grade 3 and 4; while Sable Seek showed 46.7% grade 1 and 6.7% grade 3 and 4. Regarding the amount of micro leakage at occlusal surface, there was no statistically significant difference between the groups [P<0.05]. However, on the gingival surface, there was statistically significant difference between Dye Spy with control group and also Sable Seek [P<0.05]. Conclusions: This study showed that using the caries detectors increases the chance of micro leakage. Regarding the amount of micro leakage in the groups, a significant difference was noted at gingival surfaces compared to occlusal surfaces.

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INTRODUCTION

Dental caries is a microbial disease of calcified tissues of the tooth which is characterized by demineralization of non-organic [mineral] parts and degradation of organic substances of the teeth [1,2]. The studies have shown that carious dentin consists of 5 layers which 2 of them are of interest to the dentists. The outer layer consists of an infectious demineralized layer with irreversible degraded collagen fibers, and the inner layer consists of carious dentin that is not infectious and involves denatured collagen fibers and live odontoblastic cells [3]. In fact, the caries detectors are applied to stain the outer layer of infectious and demineralized dentin. Sometimes, these dyes may cause the carious dentin to be remained after clearance of stained dentin or cause misdiagnosis of the caries and ensuing micro leakage [4,5]. Micro leakage is defined as

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the passage of bacteria and chemical substances between restoration material and the tooth. Following the micro leakage, secondary caries may occur [6]. Marginal micro leakage is always a main concern of the dentists and also provides an accessible and enriched food source for the bacteria. These bacteria grow and cause secondary caries; so cleaning carious dental structures before restoration is an important goal in dentistry. For a long period of time, tactile and visual criteria have been the main tools for diagnosis of decayed and normal tooth [1]; but currently, caries detector dyes are considered as objective tools for diagnosis of carious dentin; because elimination of carious layer and not over-removing the normal tissues are the most important factors in successful restoration [4]. Nowadays the application of caries detector dyes is increasing around the world. Understanding the presence or absence of micro leakage caused by these dyes, preventing associated complications such as pulp necrosis and sensitivity after restoration, evaluating probable causes of increased micro leakage and finally, finding solutions for the mentioned problems can determine the success or failure of restorations.

In fact, caries detectors are used for staining the outer layer of infectious and demineralized dentin. Historically, these dyes contained basic fuchsine but recent formulas contain primary substances in red and blue color on the basis of propylene glycol and water [7, 8]. These caries detectors are of different types including Snoop ,Seek, Carie, D. Tectand To Dye which impede over-removing of further layers and pulp exposure. The potential problems of such dyes are remained carious dentin after clearing the stained dentin, misdiagnosis of caries, possible staining of normal tooth and finally, incomplete clearance of dye from the tooth surface before placement of restorative substance which may lead to leakage, secondary dental caries, dentin sensitivity and pulp complications [9, 10].

There are some studies in the literature that compared the micro leakage of different caries detectors similar to present study in order to determine how caries detectors may increase gingival micro leakage [5]. However, in contrast to the present study, there is another study that indicates there is no significant difference in the amount of micro leakage caused by different substances used for caries detection [6].It should be notified that after application of caries detectors and removing the irreversible layer of caries, the dye may remain on the tooth surface which can affect the strength of composite and dentin attachment and cause further micro leakage [11, 12]. So, we decided to evaluate the effects of Sable Seek and Dye Spy caries detectors on micro leakage of composite restorations which both of them are widely used in Iran.

MATERIALS AND METHODS

This experimental study was performed on 45 human premolars using Z-100 composite [Bis-GMA manufactured by 3M-EspE, United State]. The caries-free samples were selected which had been cleaned by curette and Pamis-Rubber cap powder using a low rotation hand-piece. The samples were disinfected in 0.2% thymolfor 48 hours and then were maintained in distilled water in ambient temperature. The type V cavities were created using a diamond bur D8Z008, Germany. The cavities had 3mm length, 2mm width and 2mm depth. The gingival margin was 1 mm under CEJ and the occlusal margin was in the enamel. The enamel margins were bowled with candle flame bur [Teeskavan 012] at 45 degree angle for 0.5 mm. Then, the samples were randomly assigned into 3 groups of 15 teeth. The samples in first group were stained by Sable Seek [manufactured by Ultradent, USA] and second group were stained by Dye Spy [manufactured by Germphene, Canada]. After 20 seconds of applying caries detectors with water and air as instructed by manufacturer [10 seconds for Sable Seek and 20 seconds for Dye Spy], they were washed out. The samples in third group were considered as control group that caries detectors were not used for them. Both enamel and dentin in 3 groups were etched with 37% phosphoric acid [manufactured by 3m-Espe, USA] for 15 seconds and then were completely washed and dried with cotton ball so that a little moisture to stand on the surface. Then 2 layer [manufactured by 3m-EspE, USA]single bond based on manufacturer instructions were applied and were mildly purred and were cured for 20 seconds with 2.5 Coltulox [USA] from closed distance to surface [the beam intensity of the instrument was checked before use 400/400 mw/cm^2].

Each cavity was restored by A2 composite [3m-EspE, USA] in 2 horizontal layer and each layer was cured for 40 seconds. The samples polished and finished using diamond burs [D8z FF] and So flex disc [3m-EspE, USA] and were immersed within37° C distilled water. Then, thermo cycling was performed using thermo cycling instrument for 500 rotations in 55.5° C water bath for 30 seconds. After thermo cycling, all surfaces of the samples [except for restoration area and 1 mm around restoration] were covered by nail varnish and then were placed in silver nitrate [density 50%; pH=6.7]. Then, the samples were placed in complete darkness for 2 hours and then were washed under tap water and placed in radiology processing solution for 6 hours under fluorescent light so that silver to be reduced. Then the samples were irrigated under tap water and were longitudinally cut at center of restoration and the degree of dye penetration was graded based on the following criteria:

0 = No penetration of silver nitrate at interface of teeth and restoration.
1 = Dye penetration along with the cavity wall up to one third of the cavity depth

2 = Dye penetration more than one third and less than two third of the cavity depth
3 = Dye penetration more than two third of the cavity depth with small distance from axial wall
4 =Dye penetration with axial wall involvement

Results:

Our findings showed that micro leakage at gingival part compared to occlusal part was statistically and significantly different in all three groups. Also, micro leakage at gingival part showed significant difference compared to other 2 groups when Dye Spy was used. So, Mann-Whitney test and type 1 error adjustment was applied.

All statistical calculations were performed by SPSS 11.5 for Windows with regard to the type 1 error. Follow up tests were done by type 1 error adjustment.

The paired comparison of the groups revealed that the Sable Seek group was significantly different than Dye Spy group at gingival part; where the Sable Seek group was superior [P value = 0.048]. The Sable Seek group was not statistically and significantly different than control group [P value = 0.846], while the Dye Spy was significantly different than control group [P value = 0.033]; where control group was superior. At occlusal part, no group was significantly different than the other groups [P value = 0.526]. The comparison between occlusal and gingival parts within each group revealed that the occlusal part had significantly fewer micro leakage than gingival part [P value = 0.002].

Table 1: The comparison of gingival micro leakage based on the age groups.

Caries detector group	Gingival micro leakage grade					Total
	0	1	2	3	4	
Control	1 6.7%	10 66.7%	3 20%	1 6.7%	0 0%	15 100%
Dye Spy	0 0%	5 33.3%	6 40%	2 13.3%	2 13.3%	15 100%
Sable Seek	3 20%	7 46.7%	3 20%	1 6.7%	1 6.7%	15 100%
Total	4 8.9%	22 48.9%	12 26.7%	4 8.9%	3 6.7%	45 100%

Table 2: The comparison of occlusal micro leakage based on the age groups.

Caries detector group	Occlusal micro leakage grade					Total
	0	1	2	3	4	
Control	10 66.7%	5 33.3%	0 0%	0 0%	0 0%	15 100%
Dye Spy	9 60%	5 33.3%	1 6.7%	0 0%	0 0%	15 100%
Sable Seek	12 80%	3 20%	0 0%	0 0%	0 0%	15 100%
Total	31 68.9%	13 28.9%	1 2.2%	0 0%	0 0%	45 100%

Discussion:

This study was an experimental and in-vitro study that showed there was no significant difference regarding the amount of micro leakage among all three groups; but in the gingival part a significant difference was noted between Dye Spy and other 2 groups. Also significant difference was noted between occlusal and gingival parts within each group.

Our study was consistent with Owens *et al* study that showed gingival surface contributes to higher micro leakage than occlusal surface. They also showed that there was significant difference in the amount of micro leakage among groups of caries detectors [5] that application of similar methods and thermal cycles can be considered as possible causes.

On the other hand, our study was inconsistent with El-Housseiny *et al* study who showed that the application of caries detector dyes and chlorhexidine as cavity cleanser before H-acid had no impact on composite binding to enamel and dentin [13, 14]. Since in that study just one caries detector known as Sable Seek was used and in the other groups the agents such as chlorhexidine was used, so the results related to Sable Seek was similar to results of our study whereas the observed difference in other parts may be probably caused by application of other substances; however it is consistent with the results of Sable Seek at present study.

Another study by Evandro *et al* revealed that the dyes used for detecting caries, did not increase micro leakage of adhesive substances [6]. The possible cause of this phenomenon may be the application of methylene blue and also the small size of the particles [even smaller than the smallest bacteria]which can affect the results of micro leakage.

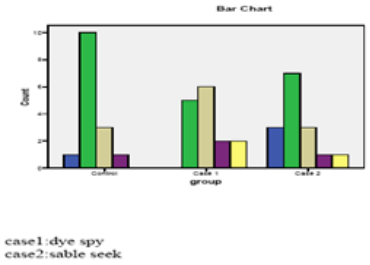

Fig. 1: Amount of gingival micro leakage based on the age groups.

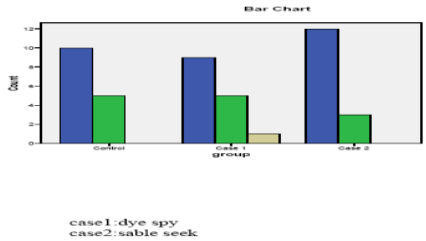

Fig. 2: Amount of occlusal micro leakage based on the age groups.

In the present study, 50% silver nitrate was used because of the appropriate size of particles for measuring the amount of micro leakage. On the other hand, Dejou *et al* showed that 50% silver nitrate has the best ability for visible penetration and provides the best criterion for measuring the micro leakage [15].

In many studies, the Enamel bowl has been suggested by many researchers in order to reduce the amount of micro leakage; such as the study by Oilie *et al* and also the study by Crime and Champmen who showed a reduction in micro leakage due to application of enamel bowl [16, 17]. Alsoin the studies that could not find significant difference between occlusal and gingival part of the cavities, the problem may be caused by lack of enamel bowl and consequently increased micro leakage at occlusal part and not necessarily decreased micro leakage at gingival part [6]. So, in the present study, the enamel bowl was performed at occlusal margin of the cavities for all samples [18, 19]. For the cavities that one part of them is located in the enamel and another part is in the dentin [like class V cavities which are extended under CEJ], if the incremental method is not used, during constriction of polymerization due to stronger bounding with occlusal enamel of composite, it is detached from gingival margins and leads to micro leakage and clinical failure. In order to prevent this problem, all samples in layered order [in 2 separated occlusal and gingival layers] were restored by composite and then cured. Again being inattentive to this issue in previous studies that were not consistent with the present study is an appropriate justification for the differences [20, 21].

To explain the cause of micro leakage in the group which carries detector was used for them, it can be notified that the aim of dental etching is to remove the smear layer with acid and to maintain in tertubular demineralized dentin in order to make a micromechanical attachment with that. It is known that this wet surface is soaked by hydrophilic polymers and then hydrophobic resin is applied so that micromechanical attachment is obtained. This interface zone is a very sensitive and intact region at molecular level. Retention of any polluting or external agents like molecules and ions may contribute to incomplete and inappropriate attachment and ensuing micro leakage. Caries detectors are not exceptional from this rule and if remained in the region, may result in a more extensive micro leakage [22, 23]. Therefore, one of the possible causes of increased risk of micro leakage in Dye Spy group can be attributed to more difficulties in its washing out of the region and/ or the simple washing of Sable Seek substance that is clinically obvious.

Following 10 seconds washing, a light pink color of Dye Spy still remains on the dentin surface that is not simply washable [maybe due to its components which is not disclosed by the manufacturer]. This issue at molecular level may lead to the mentioned problems.

The results of the studies by Anderson *et al* on 1985 revealed a tremendous difference in the quantity of available bacteria on stained dentin compared to the unstained dentin [10]. On the other hand it has been revealed that absence of staining does not warrant the elimination of bacteria from the area. Today, it has been cleared that these dyes do not stain the bacteria, but stain the organic matrix with low mineral substance in dentin [11]. Meanwhile, the remaining of infected dentin and no complete clearance of the dye out of the tooth

before placing the restoration are possible causes of micro leakage. Following the use of caries detectors and removing the irreversible layer of the caries, this substance may remain on the tooth surface which can affect the strength of attachment between composite and dentin and lead to the future micro leakage.

So, this study indicates that following the application of caries detectors, the area should be gently cleaned by bur and then be washed thoroughly. Thus, the caries detector is considered as an appropriate and very useful instrument for discovering the carious dentin.

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