Cervical Microleakage in Class II Chemically Conditioned Cavities

MIHAI ROMINU[1], ZENO FLORITA[2], COSMIN SINESCU[1], LAURA CRISTINA RUSU[3], MARIUS ENESCU[1], ANCA TUDOR[4], ROXANA OTILIA ROMINU[1]*

[1] "Victor Babes" University of Medicine and Pharmacy Timisoara, School of Dentistry, Department of Dental Material and Prostheses Technology, 9 Revolutiei Blvd, 300070, Timisoara, Romania

[2] Private Practitioner, SCM Lumident, 5 Regele Carol Blvd, 300172, Timisoara, Romania

[3] Victor Babes" University of Medicine and Pharmacy Timisoara, School of Dentistry, Department of Material Technology and Devices in Dentistry, 9 Revolutiei Blvd, 300070, Timisoara, Romania

[4] Victor Babes" University of Medicine and Pharmacy Timisoara, Deparment of Medical Informatics, 14 Spl. Tudor Vladimirescu, 300173, Timisoara, Romania

In class II cavities the marginal adaptation and clinical succes rate are influenced by the position of the gingival margin, which can either be in enamel, or, as it often occurs in everyday practice, in dentine or cementum. Adhesion to dentine and cementum is significantly lower than to enamel and despite employing modern adhesives, restorations bonded to these substrates are frequently subject to failure due to marginal leakage. Marginal leakage occurs as a consequence of gap formation which represents a widening of the interface between dental hard tissues and the restorative material initially due to the polymerization shrinkage of the resin and further increased by thermally and mechanically induced stresses. The aim of our study was to investigate whether the use of chemical adhesion promoters such as silanes would lead to lower microleakage in class II cavities with gingival margins in dentine/cementum. Standardized mesial class II cavities were prepared on 30 extracted human third molars. The teeth were randomly assigned to three groups restored as follows: group 1 – application of a self –etching adhesive (Adper Prompt L-Pop, 3M ESPE) and filling with Filtek Supreme composite resin (3M ESPE); group 2 - total acid etch with phosphoric acid (Total Etch, Ivoclar) for 15 s, application of an adhesive (Adper Single Bond 2, 3M ESPE) and filling with composite resin (Filtek Supreme, 3M ESPE); group 3 - total acid etch with phosphoric acid (Total Etch, Ivoclar) for 15 seconds, application of a silane solution (Clearfil Ceramic Primer, Kuraray), application of an adhesive (Adper Single Bond 3, 3M ESPE) and filling with composite resin (Filtek Supreme, 3M ESPE). The samples were stored in distilled water at 37°C C for 7 days, thermocycled and then immersed in dye (2% basic fuchsin). After dye penetration, the samples were sectioned with a water cooled diamond disc and examined under an optical microscope. All samples showed microleakage to various extents. The microleakage scores were statistically analyzed and revealed significant differences among groups. The lowest mikroleakage scores were obtained for group 3, thus concluding that the application of silanes prior to the adhesive significantly reduces microleakage in class II composite filled cavities with margins in dentin.

Keywords: microleakage, 3-trimethoxysilylpropyl methacrylate, dentine

In the past decades, tooth colored restorations have been increasingly employed to treat posterior teeth. The major problem that arises in time is gap formation. Thermally induced stresses tend to separate the composite resin from the dental hard tissues due to the different thermal expansion factors of these two structures [1,2]. This leads to marginal leakage which in time leads to the failure of the restoration and jeopardizes the underlying dental hard tissues.

Silanes are adhesion promoters that play a major role in creating a chemical bond between 2 substances that wouldn't normally interact. The purpose of our study was to investigate whether the use of silanes on dental hard tissues had an effect in creating a higher adhesion and therefore reducing the occurance of marginal leakage.

Experimental part

Materials and method

We collected 30 crack- and caries free human third molars that were kept in distilled water at 4° C until sample processing. On each tooth we prepared a mesial class II cavity of known size (3 mm width and 2 mm depth) with the gingival margin located 1 mm under the cement-enamel junction [3]. The teeth were then randomly divided into 3 groups of ten each. The prepared cavities were restored as follows:

Group 1 – application of a self-etching adhesive (Adper Prompt L-Pop, 3M ESPE) and filling with composite resin (Filtek Supreme (3M ESPE), dentin A3 shade).

Group 2 - total acid etch with phosphoric acid (Total Etch, Ivoclar) for 15 s , application of an adhesive (Adper Single Bond 2, 3M ESPE) and filling with composite resin (Filtek Supreme (3M ESPE),dentin A3 shade).

Group 3 - total acid etch with phosphoric acid (Total Etch, Ivoclar)for 15 s, application of a silane solution (Clearfil Ceramic Primer, Kuraray), application of an adhesive (Adper Single Bond 2, 3M ESPE) and filling with composite resin (Filtek Supreme (3M ESPE),dentin A3 shade). The silane solution was generously applied on the gingival margin of the cavity, left for 60 s and then gently air dried. All surfaces were left moist prior to adhesive application as in group 2.

Each cavity was filled with composite using the horizontal layering technique, each layer being aproximately 2 mm thick. The lightcuring of the adhesive and composite was performed according to the manfacturer's instructions using the Elipar Trilight LED unit (3M ESPE). The finishing and polishing procedures were

* email: roxanarominu@yahoo.com

Table 1
THE MICROLEAKAGE SCORES FOUND AFTER DYE PENETRATION

Sample nr.	Group 1	Group 2	Group 3
	PLP	ADP	SIL-ADP
1	2	3	1
2	3	2	0
3	3	1	1
4	3	2	2
5	1	2	1
6	2	2	2
7 8	3 3	3 2	1 2
9	3	2	0
10	1	1	2
Median	**3**	**2**	**1**

performed with a fine grit diamond bur (no. 858F, ISO 806 314 165 514 014) and PoGo polishing discs (Dentsply DeTrey).

The samples were stored in distilled water at 37° C for 7 days and then thermocycled (1000 cycles between 5° C and 55° C with a dwell time of 25 s between baths) [4]. After thermocycling all the surfaces were covered with a double layer of nail varnish except for a two milimeter wide area around the gingival interface. The specimens were immersed in dye (2% basic fuchsin) for 24 h with the roots pointing upwards, so that the cavity margins were covered by dye. By placing the samples this way we made sure to avoid improperly isolated root areas that would lead to false positive results.

After dye penetration, the samples were sectioned with a water cooled fine grit diamond disc (no. 916F, ISO 806 900 329 514 220), following a mesio-distal direction. The gingival interfaces were examined under an optical microscope (Euromex Netherlands, model FT MIC 2665) at two magnifications (40x and 100x, respectively) by two experienced examiners. The following microleakage scores were chosen [5] :

0 – no dye penetration
1 – dye penetration extended less than 1/2 of the cavity depth
2 – dye penetration extended to the full cavity depth (not including the axial wall)
3 – dye penetration beyond the junction of the gingival and axial wall

Results and discussions

Each of the three sample groups showed microleakage (table 1). The results gathered were statistically analyzed using the Kruskall-Wallis test ($\alpha = 0.05$, $p<0.05$). In order to further refine the results, they were also evaluated using the Mann-Whitney test, which revealed statistically significant differences between groups 1 and 3 and between groups 2 and 3 whereas no statistically significant differences where found among the results of groups 1 and 2 respectively.

Several previous studies [6-8] reported that the leakage in gingival margins located in dentine is higher than at the occlusal ones in class II composite filled cavities. This might be explained by the ultrastructural features of dentin in the cervical area of the teeth of which we state the low number of dentinal tubules, their orientation on the gingival wall and the high organic contents [9].

In order to overcome this substrate-related disadvantages some authors have investigated the use of silanes in reducing microleakage [10]. In this study the use of a silane solution (3-trimethoxysilylpropyl methacrylate in ethanol and 10-Methacryloyloxydecyl dihydrogen phosphate) has been proved to lower microleakage. This is presumably due to the formation of hydrogen bonds between the silicon (Si) and the hydroxyl groups in dentinal collagen.

Conclusion

Within the limitations of this study, the following conclusions can be drawn:

Self-etching adhesives lead to poor adhesion between composite filling materials and dentine.

The use of 3-trimethoxysilylpropyl methacrylate significantly reduces microleakage in class II composite filled cavities.

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