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Effect of Centripetal and Incremental Methods in Class II Composite Resin Restorations on Gingival Microleakage

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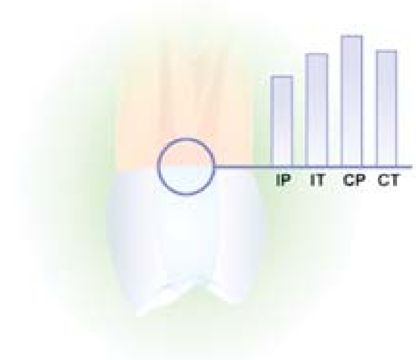

Abstract

Aim: The aim of this study was to evaluate the microleakage at gingival margins below the cementoenamel junction (CEJ) of Class II composite restorations using various placement techniques.

Methods and Materials: Sound human maxillary premolars were selected. Eighty slot-style cavities on the mesial or distal surfaces were prepared with the cervical margins located apical to the CEJ. The specimens were divided into two groups based on the restorative technique utilized (centripetal or incremental). Each group was then categorized into two subgroups according to the type of matrix used resulting in a total of four experimental groups as follows: IP=Incremental and Palodent matrix, IT = Incremental and Transparent matrix, CP = Centripetal and Palodent matrix, and CT = Centripetal and Transparent matrix.

Following restoration with a total etch adhesive (Single Bond) and a resin composite (Z100), the teeth were thermocycled. Then specimens were immersed in 0.5% basic fuchsin dye for 24 hours at a temperature of 37ºC. Sectioned restorations were examined under a stereomicroscope (40X magnification), and the extent of the microleakage was scored and recorded. Data were analyzed using the Kruskal-Wallis non-parametric statistical test (P=0.05).

Results: In the four groups of the study no significant differences in the mean rank of microleakage were observed (p>0.05).

Conclusion: When the gingival margin was located on cementum, the kind of matrix and filling technique did not reduce the microleakage.

Keywords: Centripetal, incremental, microleakage, Class II restoration

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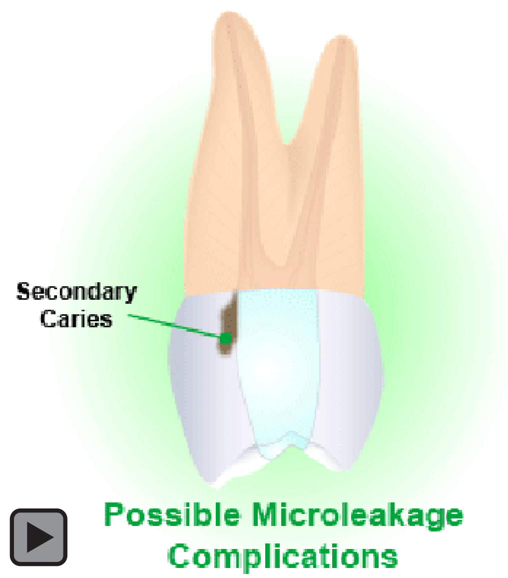
Introduction

Restoration of the gingival margin of Class II cavities with composite resin continues to be problematic, especially where no enamel exists for bonding to the gingival margin.[1] Recently, resin-based composites have been used more often as a restorative material for posterior teeth because of growing patient interest in tooth colored restorations and concern for mercury release from amalgam restorations.[2] The coefficient of thermal expansion of composite resin material is higher than the tooth structure and the polymerization shrinkage of composite induces stresses at the tooth-restoration interface. Generally these factors cause a resultant gap formation at the interface; therefore, polymerization shrinkage and the different ion coefficient of thermal expansion for these restorative materials have been suggested as major causes of microleakage.[3] The higher organic component, tubular structure, fluid pressure, and permeability along with lower surface energy of dentin make bonding of the composite to dentin more difficult than to enamel.[4] Poor adhesion between dentin and composite restorative materials predisposes the interface to gap formation which leads to microleakage. Microleakage may be responsible for secondary caries, marginal discoloration, pulpal inflammation, and hypersensitivity.[5]

Several techniques have been introduced to improve the sealing of light cured composites.[6] One of these methods is the use of transparent matrix bands and reflective wedges known as the "three-sited light curing technique."[7] It has been suggested the effect of the three-sited light curing technique should not be attributed to guided polymerization, but to a reduction of light intensity through the reflective wedge and dental structure.[8] Because the transparent band and reflective wedges are highly unstable due to their design, it is difficult to adjust them to prepared teeth resulting in gap formation at the margins. With respect to adaptability,



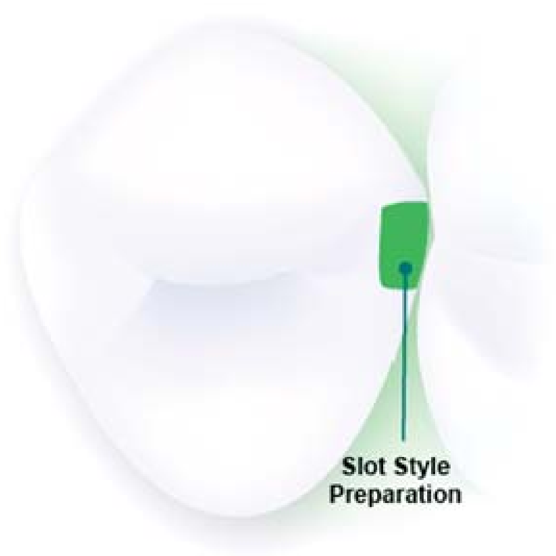
metal matrices, especially the Palodent sectional matrix system, (DENSPLY Caulk, Milford, DE, USA), are superior since they can be properly contoured and firmly applied to the tooth surface.[9] Multilayer insertion techniques in contrast to bulk packing methods have usually decreased marginal gap formation. The size reduction of the composite material filler particles, the diminution of polymerization shrinkage, and the enlargement of the free surface area in relation to the volume (C-factor) are all of great importance in this context.[10] Bichacho[11] introduced the technique of a centripetal build-up for Class II composite resin restorations. The advantages of this technique are it facilitates easier placement and allows the stratification of the dentin and enamel layers. In this technique composite resin is inserted and cured incrementally from the periphery toward the center of the preparation. Class II restorations are essentially converted to Class I restorations using this technique. This technique is faster than conventional techniques and creates an appropriate embrasure, better contour, and essential contact points.[11] While promising results have been achieved with centripetal buildups, several comparative microleakage tests have not been conducted. The aim of this interventional parallel study was to determine the microleakage of Class II restorations using two filling techniques (incremental and centripetal) and two kinds of matrices (Palodent and transparent).

Methods and Materials

In this in vitro study intact human maxillary premolars, extracted for orthodontic purposes, were selected. The teeth were thoroughly scaled using curettes to remove calculus and remaining tissue tags, then the teeth were polished with a slurry of pumice and water using a conventional speed handpiece. The specimens were stored in normal saline; they were subsequently placed in formalin 12 hours before cavity preparation. The specimens were mounted in silicone models in contact with adjacent natural teeth to simulate periodontal ligament functions and movement during separation. Class II cavities were prepared at the mesial or distal surfaces of each tooth. Using a slot style cavity preparation, buccal and lingual walls were parallel and the gingival floor was surrounded by dentin. The preparations were prepared using a #48537 KR diamond bur (Brasseler, Savannah, GA, USA) in a highspeed handpiece with water coolant. After five preparations, a new bur was used. A periodontal probe was used as a guide to place the gingival margin 1 mm below the cementoenamel junction (CEJ). The occlusogingival length and mesiodistal depth were measured to be 6/5±1 mm and 1/75±0/5 mm, respectively. The buccolingual extensions were estimated to be 3 mm. No bevels were used in the cavity preparations. The samples were divided into two groups based on the type of restoration method used (incremental or centripetal). The teeth were restored with Single Bond (3M ESPE, St. Paul, MN, USA), a total-etch, single-bottle adhesive, and Z100 (3M ESPE Dental Products), a hybrid resin composite, according to the manufacturers' instructions.

Incremental Technique (I): In this group the first layer of resin composite was placed on the gingival floor, and the second, third, and the fourth layers were placed horizontally to complete the filling.

Centripetal Technique (C): In this group, the first increment of the composite resin was applied on the gingival wall of the proximal box and



packed cervically near the axial wall causing the resin to climb upward in contact with the inner surface of the matrix band. This increment of the restoration was sculpted and light-cured, and the metallic matrix band was removed. Subsequent increments (2 mm) were applied horizontally toward the occlusal surface of the cavity. The same numbers of increments were used for the two buildup techniques. Then each group was divided into two subgroups according to the kind of matrix.

Palodent® Sectional Matrix System

Sectional Metal Matrix bands with BiTine Ring retainers [Palodent® Sectional Matrix System (DENSPLY Caulk, Milford, DE, USA)] and wooden wedges (TDV, Pomerode, SC, Brazil) were placed on the specimens (P). Post curing was performed following the removal of the opaque matrices and wooden wedges for 40 seconds from both the buccal and lingual aspects of the specimens.

Transparent Matrix/Wedge System (T):

Precontoured transparent #773 matrix bands (Hawe Neos, Bioggio, Switzerland) with a reflective wedge (Hawe-Neos, DFL, RJ, Brazil) were used on this group of specimens (T).

Each increment of composite was light cured for 40 seconds using an Optilux 500 curing unit (Demetron-Kerr, Orange, CA, USA) at 500mW/ cm^2. After storing the specimens in distilled water at 37°C for 24 hours, the restorations were finished and polished. The specimens were then

Table 1. Dye penetration for marginal microleakage on the cervical wall.

Score	Description
0	No dye penetration.
1	Dye penetration into half extension of the cervical wall.
2	Dye penetration into complete extension of the cervical wall.
3	Dye penetration into the cervical and axial walls toward the pulp.

Table 2. Frequency of dye penetration scores as an indicator of marginal microleakage in the cervical wall.

	Number of Restorations			
Group	Score 0	Score 1	Score 2	Score 3
1P	10	1	0	9
IT	3	2	4	11
CP	4	0	0	16
CT	4	1	3	12

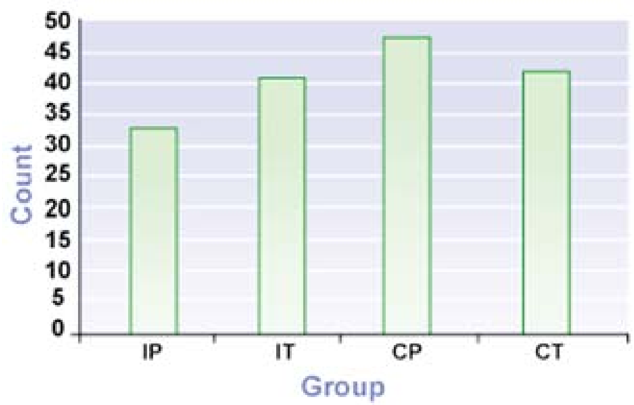


Figure 1. Mean rank microleakage within each group.

removed from their mountings and thermocycled for 500 cycles (5°C to 55°C) with a dwell time of one minute in each bath. Next, two coats of fingernail varnish were applied to all parts of each specimen extending 1/5 mm beyond the margins of restoration. Then the teeth were immersed in 0.5% basic fuchsin dye for 24 hours at 37°C. They were then embedded in self-curing, transparent polyester resin. More than three longitudinal sections were made using a saw in a mesiodistal direction at the proximal box of each restoration. Dye penetration in gingival margins was evaluated under a stereomicroscope (PZO, Warsaw, Poland) with a magnification of 40X and scored (Table 1). Data were analyzed with a nonparametric statistical analysis using the Kruskal-Wallis test (P=0.05).

Results

The scores (zero to three) and mean rank of marginal microleakage in Class II cavities at cervical walls for the four experimental groups are shown in Table 2 and Figure 1. None of the systems tested in this study, completely eliminated microleakage.

The highest value of microleakage was observed as a score of three in all of the experimental groups. The Kruskal-Wallis test showed no statistically significant differences among experimental groups (P>0.05) (Table 3).

Discussion

The marginal seal is one of the most important factors for a successful restoration. The

Table 3. Kruskal-Wallis test for the comparison of microleakage mean rank of the four groups.

Results of Kruskal-Wallis Test	Microleakage
Chi-Square	5.787
Df	3
Asymp.Sig.	.122

restoration of cavities having margins partly or totally located in the dentin is an unresolved problem with composite resin restorations.[12] Factors contributing to the optimization of the marginal adaptation of composite resin restorations might be related to the type of polymerization of the composite material, cavity shape, light curing procedure, placement technique, as well as the skill of the clinician.[10,13]

The purpose of this research project was to evaluate the microleakage of Class II restorations using two filling techniques and two kinds of matrices. It has been reported the microleakage pattern of direct restorations is very complex and irregular because tooth sections may not always capture areas of deep penetration of the tracer dye.[14] In this study more than three sections in each tooth were used in accordance with the suggestion of Raskin et al.[15] who reported the in vitro assessment of microleakage using less than three sections is not representative of the efficacy of adhesive systems tested.

Reduction of the bulk of directly polymerized resin in composite restorations increases the free surface to volume ratio to reduce microleakage at the cavity margin.[16] One of filling techniques in the present study was incremental. Versluis et al.[17] argued an incremental technique may produce more interfacial stresses than the conventional bulk placement, and the successively loaded layers do not always bond well together.

The centripetal technique used in this study differed from the incremental technique in which the complete apical area of the cavity was filled with the first layer of composite resin material. This first layer had less contact with the lateral walls than did the resin in the first layer of the centripetal build up technique. Szep et al.[18] claimed the first layer of the centripetal technique had no contact with pulpoaxial walls and, thus, had fewer tendencies to contract toward this wall and away from the cervical floor during polymerization. In the proximal box the polymerization shrinkage tended to pull this first horizontal increment away from the cervical margin. The second layer of the incremental technique, which was a diagonal layer, was not able to cover the first portion in the cervical area, which did occur with the second layer of centripetal buildup technique.

The results of this study revealed the two techniques of composite placement used had no statistically significant difference with respect to marginal microleakage. This is probably because the number of layers was the same in both techniques. Therefore, this study showed the centripetal technique is not superior with respect to the prevention of microleakage than is the incremental method. However, the centripetal method has advantages such as the facilitation of a Class II buildup; establishment of a proper proximal contact and smooth proximal surfaces; provision of adequate light exposure for polymerization; achievement of better marginal adaptation to the gingival floor as well as the minimization of overfilling the preparation and rotary finishing.[11]

Single Bond, an unfilled adhesive, was used in this study and applied in multiple layers according to the manufacturer's instructions. The lack of nanofillers may have been responsible for the formation of a thin hybrid layer. Filler particles may also reduce the shrinkage of the adhesive, thus, preventing microleakage and increasing the modulus of elasticity and rigidity for the adhesive system. This means the filler size and content may play an important role in the clinical performance of adhesive systems. It has been demonstrated the collagen network filters out nanofillers by holding them at the hybrid layer surface, thus, acting as an intermediate shock absorber.[19] Therefore, an absence of filler content may be responsible for the increased score of level three microleakage in this study.

Wooden wedges enhance the adaptation of the matrix band to the cavity walls and provide firm contact areas and anatomical proximal contours. Scherer et al. [20] suggested restorations placed with the aid of transparent matrices and reflective wedges exhibited less microleakage than those placed with opaque matrices and wooden wedges. In this study, there were no statistically significant differences between types of wedges and matrices. Regarding the different filling techniques and different adhesive systems used for Class II composite restorations, it appears the problem of microleakage along dentinal margins remains an important issue.

Conclusion

Within the limitations of this in *vitro* study, it can be concluded:

1. None of the systems used in this study completely eliminated microleakage.
2. A microleakage score of three was the highest value in all of the experimental groups.
3. There was no significant difference in microleakage between experimental groups.

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