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ORIGINAL ARTICLE

Comparative Evaluation of Microleakage in Class 2 Cavities Restored with A Nanohybrid Composite Using Three Different Increment Techniques- An *in vitro* Stereomicroscopic Study

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ABSTRACT

Context: Purpose of the study was to compare the microleakage in class II cavities using Horizontal oblique increment (G1), Centripetal oblique increment (G2) and Oblique increment (G3), techniques

Aims: To determine ideal incremental placement technique in restoring class II cavity.

Methods and Material: Class II cavities were prepared in 45 extracted permanent molars. The teeth were restored with nanohybrid composite (Ceram X) and bonding with adhesive systems (Xeno V). Microleakage evaluated after thermocycling of the specimens.

Statistical analysis used: ANOVA test at the 0.05 level of significance.

Results:Mean microleakage score of group G1, G2 and G3 was 2.86 $\pm$ 1.43, 1.86 $\pm$ 1.65 and 2.46 $\pm$ 1.50 respectively.

Conclusions: None of the insertion techniques used in this study was able to prevent microleakage, though the lowest microleakage values were obtained when the centripetal oblique technique was used.

Keywords: Horizontal oblique increment, Centripetal oblique increment, Oblique increment

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INTRODUCTION

Composites were specifically advocated for use in posterior teeth in the early 1980s and have become increasingly popular in restorative dentistry (1). Despite significant improvements in the composition and performance of composite resins, these materials still exhibit a considerable degree of polymerization shrinkage, which limits their use in direct restoration of composite resin(2).

Modern posterior resin composites undergo 2.6 to 7.1 % volumetric contraction during polymerization. This problem is distinct for class II composite resin restorations because such polymerization shrinkage creates the gap formation, result in the passage of bacteria, fluids, molecules, or ions between the cavity wall and the resin composite, a process defined as micro-leakage and endangering the longevity of the restoration(3).

Composite restorations rely on adhesive systems which form a micromechanical bond with tooth structure. Adhesion is required to oppose and withstand the contraction forces during polymerization of composite resin and ensure retention and marginal integrity during functioning of the restored teeth (4,5).

To reduce shrinkage stress effects various incremental techniques have been used like occlusogingival layering(6), oblique layering(6,7), faciolingual layering (6) & centripetal placement technique(7). Centripetal technique was better than incremental technique as reported by Duarte S *et al* (2008)(7). It had advantages like proper proximal contact and smooth proximal surfaces, provision of adequate light exposure for polymerization and better marginal adaptation to the gingival floor(7).

The aim of this study is to compare the microleakage in proximal region in class II cavities restored with nanohybrid composite (Ceram X) and bonding with single bottle self etch adhesive systems (Xeno V) using three composite placement techniques – the horizontal oblique increment, centripetal oblique increment and oblique increment.

MATERIAL & METHODS:

A total number of 45 freshly extracted molars (caries and restoration free) were selected. The teeth were cleaned by ultrasonic scaler and were washed thoroughly before being stored in 1% Chloramine-B-Hydrate solution at room temperature.

Ninety standardized Class 2 cavities were prepared, at the mesial and distal surfaces of each tooth. The cervical wall was placed at the cementoenamel junction. The preparations were made with a No. 245 carbide bur (SS White), under copious water coolant, in a high-speed handpiece. After 5 preparations, the bur was discarded and a new one selected for use. The final preparations had the following dimensions: 2.0-mm occlusal extension, 3.0-mm buccolingual extension, and 5.0-mm occlusocervical extension.

To simulate clinical situation during restoration placement, a "restoration template" was fabricated. Two molars were embedded in dental stone to the level of CEJ, approximately 12 mm apart. Test specimen was embedded between these two teeth in polyvinylsiloxane impression material. The samples were divided into three groups of fifteen teeth each according to the type of incremental technique used to restore the cavities.

Xeno-V (Dentsply DeTrey-GmbH 78467 Konstanz, Germany) bonding agent was applied according to the manufacturer's instructions and light cured for 20 seconds. All specimens were restored with a nanohybrid composite resin (Ceram X mono M1, Dentsply) using Palodent sectional matrix system (Dentsply Caulk, Milford, DE, USA).

The control group (G1) was restored with the horizontal oblique incremental technique in three increments (Figure 1). The first increment was horizontally placed at the cervical wall and light cured for 40 seconds. The second increment was obliquely placed contacting the buccal and axial walls and the previously cured increment, followed by light curing for 40 seconds. The third increment was obliquely placed, filling the preparation, and light cured for 40 seconds.

Group G2 was restored with the centripetal oblique incremental technique (Figure 2) in five increments. A thin layer of composite (0.5mm thickness) was applied from the gingival floor to occlusal marginal ridge of the proximal box and packed proximally in contact with the inner surface of the matrix band. This increment of the restoration was light cured for 40 seconds and then the metallic matrix band was removed. The resultant class 1 cavity was filled with subsequent four oblique increments as shown in figure 2.

Group G3 was restored with oblique incremental technique (Figure 3) in four increments. The first layer of the composite was placed obliquely contacting buccal and axial walls and the gingival floor, followed by light curing for 40 seconds, then subsequent layers were placed obliquely as shown in the figure 3.

After 24 hour storage in 1% Chloramine-B-Hydrate solution at room temperature, the restored teeth were subjected to thermocycling. All the

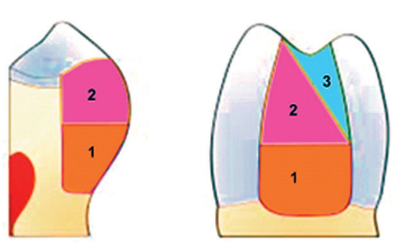

Figure 1: Horizontal oblique incremental technique, (left) Cross sectional view; (right) Proximal view

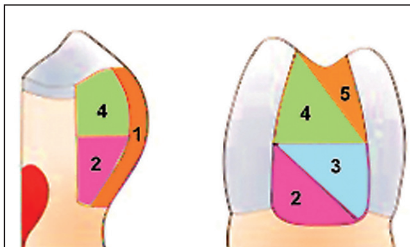

Figure 2: Centripetal oblique incremental technique, (left) Cross sectional view; (right) Proximal view

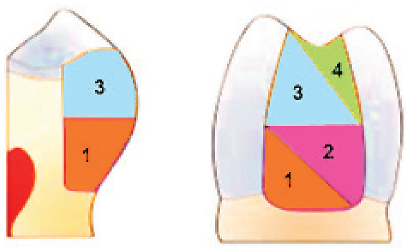

Figure 3: Oblique incremental technique, (left) Cross sectional view; (right) Proximal view

specimens were immersed alternatively in water baths at 5±2°C & 55±2°C for 500 cycles with a dwell time of 15 seconds. The teeth surfaces were isolated with 2 layer of fingernail varnish, except for 2.0 mm around the restoration and then immersed in a 2% methylene blue for 24 hours. The nail varnish was removed and the specimens sectioned through the center of the restoration with water cooled slow speed diamond disk. The sections were analyzed with a stereomicroscope and scored for the degree of dye penetration at cervical walls using the scores described below (Figure 4):

0 = no dye penetration, 1 = dye penetration extending to 1/3rd of the cervical wall, 2 = dye penetration extending to 2/3rd of the cervical wall, 3 = dye penetration into whole of the cervical wall, 4 = dye penetration into the cervical wall & axial walls toward the pulp.

The data obtained were submitted to statistical analysis.

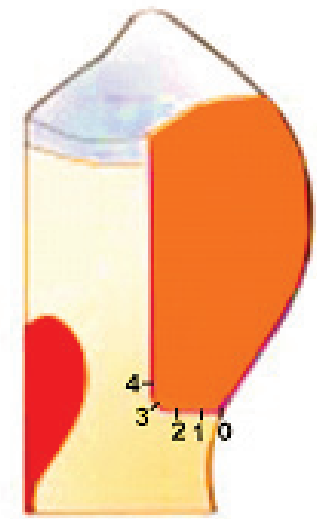

Figure 4: Shows score for evaluation of microleakage

RESULTS

None of the techniques studied were capable of eliminating marginal microleakage. Mean microleakage score of group G1, G2 and G3 were 2.86 ± 1.43, 1.86 ± 1.65 and 2.46 ± 1.50 respectively (Table 1).

DISCUSSION

Polymerization shrinkage of resin composites remain a clinical concern due to associated residual stresses that are thought to play a role in marginal failures, microleakage and recurrent caries. A correlation between leakage and contraction stress has been found and microleakage is shown to be an indicator of polymerization shrinkage(8,9).

Control of polymerization shrinkage stresses during a direct composite resin restoration is important for achieving a perfect adaptation between restoration and cavity wall. In order of importance, the factors involved in shrinkage stresses are cavity C-factor, cavity size, incremental technique, intensity and position of curing light, and properties of composite(10). In this study, attempts were made to keep all these variables constant, except for the composite placement technique.

Versluis A. *et al*. (1996)(11) recognized incremental placement techniques as a major factor in reducing polymerization shrinkage. Incremental techniques ensured the complete polymerization of the composite resin(9). Duarte S *et al*. (2008)(7) reported that most common technique to restore class 2 preparations is the incremental oblique technique. Bichacho N (1994) (12) introduced the technique of a centripetal build up for Class II composite resin restoration. This technique is faster than conventional technique and creates an appropriate embrasure, better contour and essential contact points.
A 'gapfree' direct composite restoration is possible only if the adhesive forces to the tooth overcome the interfacial stresses generated during the curing and afterwards. It has been reported that a minimum dentine adhesion of 20 MPa is required to ensure gap free margins(13). No restorative technique appears yet to be able to ensure a hermetically sealed restoration.

Table 1: Inter comparison of microleakage between the groups by one way ANOVA

Group	N	Mean	Std. Deviation	Std. Error Mean	Mean Diff	T	P Value
G1	30	2.8667	1.43198	.26144	1.0000	2.502	0.015
G2	30	1.8667	1.65536	.30223			Significant (P<0.05)
G1	30	2.8667	1.43198	.26144	0.40000	1.056	0.296
G3	30	2.4667	1.50249	.27432			Insignificant (p>0.05)
G2	30	1.8667	1.65536	.30223	0.60000	1.470	0.147 Insignificant (P>0.05)
G3	30	2.4667	1.50249	.27432	0.60000	1.470	0.147 Insignificant (P>0.05)

When Groups 1 and 2 were compared, results were statistically significant ($p < 0.05$). Most important principles for incremental placement is to reduce the V/A ratio (where V is the cavity volume and A is the area of the cavity walls) by applying the first increment to only one cavity wall(14). Through the use of the centripetal technique the V/A ratio could be reduced. This differed from the horizontal oblique incremental technique, where the complete apical area of the cavity was filled with the first layer of composite resin material. In the horizontal oblique incremental technique the contact of first increment with the lateral walls was more than in the first increment of the centripetal technique. Alternatively, the first increment in the centripetal technique did not have any contact to the pulpoaxial walls and thus had less tendency to contract towards 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 in horizontal oblique incremental technique. The second layer in the horizontal oblique 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 the centripetal buildup technique(15). The results of these two groups were statistically significant probably because the number of increments used were more with centripetal technique (5 increments) than horizontal oblique techniques (3 increments).

When the results of Group 2 and Group 3 were statistically compared, these were insignificant ($p > 0.05$). The probable reason for this is that although oblique incremental filling decreases shrinkage stresses due to minimal contact with the cavity walls during polymerization as well as due to the reduced shrinkage produced by a small volume of the material, the total residual shrinkage is higher for an oblique incremental filling method. This occurs because the polymerization contraction of each individual filling increment causes some deformation of the cavity, decreasing the cavity volume and hence resulting in a cavity which is volumetrically filled with less composite material than the original volume of the cavity. Another explanation for the above result is that in oblique incremental technique, the first layer has less contact with the lateral walls than the resin in the centripetal technique. Also the first layer in the centripetal technique had no contact to the pulpoaxial wall and thus had less tendency to contract toward this wall and away from the cervical wall during polymerization which leads to less microleakage as the second layer was able to cover the first layer in the cervical area(15). This also reduces the V/A ratio and hence fewer contraction gaps appear at the margins using the centripetal technique versus the oblique technique. The second layer in the oblique technique, which was also a diagonal layer, was not able to cover the first diagonal layer in the cervical area, which did occur with the second layer of the centripetal build up technique(15). Duarte S *et al* (2008)(10) reported that polymerization shrinkage was less in the centripetal technique compared to oblique incremental technique. Though the results of these two techniques of composite placement were statistically insignificant but centripetal technique showed less microleakage then the oblique increment, probably because the number of increments used were more with centripetal technique (5 increments) than oblique techniques (4 increments).

When Groups 1 and 3 were compared, results were statistically insignificant ($p > 0.05$) but the group 3 showed less microleakage as compared to group 1. In group 1 the first increment was the horizontal which contacted the axial, buccal, lingual, and cervical walls simultaneously which creates more adhesive surfaces than free ones (C-factor 4). This horizontal increment does not interfere to decrease the high configuration factor of the cavity as the oblique increments do. As the resin shrinks, its strong bond to the lateral enamel walls causes it to contract away from the cervical floor, at which there is either no enamel present or only a thin border of prismless enamel. In oblique incremental technique the first increment was placed obliquely which contacted the axial, buccal and cervical walls which creates less adhesive surfaces than the horizontal oblique technique. Though the results of these two techniques of composite placement were statistically insignificant but oblique incremental technique showed less microleakage then the horizontal oblique increment, probably because the number of increments used were more with oblique techniques (4 increments) than horizontal incremental technique (3 increments).

Upon inter comparison of three groups, the centripetal incremental technique showed minimum microleakage (Mean 1.86 ± 1.65) followed by oblique incremental technique (Mean 2.46 ± 1.50) and horizontal oblique incremental technique (Mean 2.86 ± 1.43).

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