ORIGINAL ARTICLE

IN-VITRO COMPARISON OF MICRO-LEAKAGE BETWEEN NANOCOMPOSITE AND MICROHYBRID COMPOSITE IN CLASS V CAVITIES TREATED WITH THE SELF-ETCH TECHNIQUE

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Background: When a light cure composite resin is used to restore a class V lesion, certain stresses are generated at the tooth-restoration interface. If these stresses exceed the bond strength of the restorative material, microscopic gaps are formed which eventually cause micro-leakage at the tooth-restoration interface. The objective of the present study was to compare the micro-leakage values at the tooth-restoration interface using dye penetration method between a Nano filled and a Micro hybrid light cured composite resin in class V cavities using the self-etch technique. **Methods:** Sixty class V cavities were made coronal to the cemento-enamel junction in the extracted premolars. These were then randomly divided into two study groups. Group A: Self-etch; filled with P-60 (micro-hybrid) n=30. Group B: Self-etch; filled with Z-350 (nano-filled) n=30. Specimens were subjected to thermo-cycling at 5–55 °C±2 °C with a 30 seconds dwell time. After which they were stained with 2% methylene blue. Later, sectioned bucco-lingually and examined using a stereo microscope (magnification X4) at the occlusal, axial and gingival surfaces. Micro-leakage around the tooth-restoration interface was assessed by using the degree of dye penetration in millimetres. **Results:** There was 100% micro leakage seen at both the occlusal and gingival surfaces when using the P-60 composite. With the Z-350 composite 84% occlusal and 88% of the gingival surfaces exhibited micro-leakage. **Conclusions:** With respect to micro-leakage in class V cavities, Z-350 was found to be a superior restorative material compared to P-60 on the occlusal surface. Overall, there is no statistically significant difference in the micro-leakage exhibited by the two restorative materials in class V preparations subjected to self-etch protocol.

Keywords: Class V lesions; self-etch; nanocomposite and micro-hybrid composite.
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INTRODUCTION

Whether the aetiology is caries, tooth wear or excessive tooth brushing, restoring a class V lesion remains a clinical challenge. The location of the lesion makes selection of the material, isolation, retention of the restorative material a hard task. The changes in composite placement technique have significantly improved since the advent of the material. Till date composites are the preferred choice of materials when it comes to properties like aesthetics, adhesion to and conservation of the tooth structure.[1] Mostly due to these reasons, bonded composites are the common choice for aesthetic restoration of class V lesions.[2]

When a light cure composite resin in packed in a cavity and cured, certain stresses are generated at the tooth-restoration interface. If these stresses exceed the bond strength of the restorative material, microscopic gaps are formed which eventually cause micro-leakage at the tooth-restoration interface.[3] In terms of volume, a contemporary resin based composite restorative material can undergo polymerization shrinkage ranging from 2.6–7.1%.[4–7] One of the ways to overcome this problem is to restore the cavity in multiple but small increments.[8] A study carried out by Mahapatra *et al*[9] revealed that the micro-leakage scores for micro-hybrid composites were 0.9±0.7 but for nano-composites, it was 0.4±0.5 (*p*-value of <0.05). In another study conducted by Abdul Majeed *et al*[10] showed that the mean rank of micro-leakage seen in cavities restored with micro-hybrid composites was 2.36±0.74 and for restorations done with nano-composites in dentine and cementum it was 1.68±0.82. Thus, the nano-composites exhibited significantly reduced micro-leakage (*p*-value <0.001). The non-retentive, non-carious Class V lesions are often used to clinically appraise the effectiveness of the various available adhesive systems. Self-etch adhesives were primarily developed to promote ease of use by reducing the number of steps to completing a restoration. Manipulation errors are reduced by a single step application, since there is no more need to mix separate components together. Besides this main advantage, there is also a reported reduction and/or elimination of post-treatment sensitivity possibly because of the proposed increase in dentin substrate adhesion and enhanced marginal integrity.[11]

Most of the micro-leakage comparison studies[12–17] between nano-composite and micro-hybrid composites in Class V cavities have used a rank order scale to grade the degree of micro-leakage. The precise measurement of micro-leakage around composite restorations is scarce. Takahashi *et al.*[17] are one of the few who have used this methodology. The amount of

micro-leakage around the tooth-restoration interface when measured in millimetres will provide accurate results that can help the clinician to choose the best restorative material and the etching protocol for restoring class V lesions. We speculated that there is a difference in the micro-leakage between micro-hybrid composites versus nano-filled composites. The objective of the present study was to compare the micro-leakage values at the tooth-restoration interface using dye penetration method between a nano-filled and a micro-hybrid light cured composite resin in class V cavities using the self-etch technique.

MATERIALS AND METHODS

An *in-vitro* experimental study was conducted at the dental clinics, dental prosthetics laboratory and the basic sciences laboratory at the Aga Khan University Hospital, Karachi. A non-probability consecutive sampling was done to collect the extracted human maxillary and mandibular first and second premolars. We excluded teeth which were previously cervically restored or grossly decayed or fractured.

The WHO sample size calculator was used to calculate the sample size. The required number turned out to be 30 teeth per group. Since we had two groups in our study, the total number was 60 teeth. The extracted teeth were cleaned with an ultra-sonic scaler to remove all soft tissue and debris, and stored at room temperature in distilled water after the manual cleaning and disinfection with 3% Hydrogen Peroxide. These sixty teeth were randomly divided into the following two study groups: Group A: self-etch; filled with P-60 (micro-hybrid) n=30. Group B: self-etch; filled with Z-350 (nano-filled) n=30.

Once the class V restorations were complete, the teeth were then subjected to thermo-cycling at 5–55 °C±2 °C (150 cycles) with a 30 second dwell time, air dried and covered with two layers of nail polish, except around the restoration. Methylene blue (2%) was placed over the prepared restoration at 37 °C and 100% humidity for 10 minutes, followed by washing and drying. After sectioning the teeth bucco-lingually with a slow speed diamond saw, the split segments (two equal halves) were examined at 4x magnification using a stereo microscope along the restoration at three tooth surfaces (occlusal, axial and gingival) labelled as 'O' 'A' &'G' respectively. Micro-leakage around the tooth-restoration interface was assessed by the primary investigator using the degree of dye penetration in millimetres. The co-investigator also measured the micro-leakage in millimetres and the inter-examiner reliability was determined. The Ethical Review Committee of the institution approved the protocol (Ref. 3269-SUR-ERC-2014).

SPSS 19.0 was used for data analysis. Mean and standard deviation of dye penetrations (in mm) was determined. ANOVA was applied to determine the mean difference in dye penetration at the three surfaces (occlusal, gingival and axial) restored with P-60 versus Z-350 composites. Pearson Correlation test was applied to determine the inter-examiner reliability of the two assessors. A *p*-value of 0.05 was taken as statistically significant.

RESULTS

Out of the 60 specimens, ten specimens (five of each Z-350 and P-60) were damaged resulting in 50 readable specimens. Each specimen was subjected to three readings occlusal, gingival and axial respectively. The presence or absence of micro-leakage is shown in table-1 while micro-leakage values (in mm) are shown in table-2. Table-3 depicts the inter-examiner reliability.

Table-1: Presence of micro-leakage on tooth surface with the two composite materials

Material	Surface	Micro-leakage		Total
		No	Yes	
		n (%)	n (%)	
P60	Occlusal	0	25 (100)	25
	Gingival	0	25 (100)	25
	Axial	25 (100)	0	25
	Total	25 (33.3)	50 (66.7)	75
Z350	Occlusal	4 (16)	21 (84)	25
	Gingival	3 (12)	22 (88)	25
	Axial	25 (100)	0	25
	Total	32 (42.7)	43 (57.3)	75
Total	Occlusal	4 (8)	46 (92)	50
	Gingival	3 (6)	47 (94)	50
	Axial	50 (100)	0	50
	Total	57 (38)	93 (62)	150

Table-2 Comparison of micro-leakage (in mm) at the three surfaces in the two study groups using the self-etch technique

Surface	Material	Etch technique	n	Mean	SD	*p*-value
Occlusal	P60	Self-etch	25	0.97	0.58	0.015
	Z350	Self-etch	25	0.58	0.52	
Gingival	P60	Self-etch	25	0.72	0.39	1.00
	Z350	Self-etch	25	0.72	0.67	
Axial	P60	Self-etch	25	0.00	0.00	N/A
	Z350	Self-etch	25	0.00	0.00	
Total	P60	Self-etch	75	0.56	0.58	0.168
	Z350	Self-etch	75	0.43	0.57	

Level of significance was set at 0.05.

Table-3: Inter-examiner reliability assessment for micro-leakage

Correlations			
		Examiner A	Examiner B
Micro-leakage Examiner A	Pearson Correlation		0.941**
	p-value		<0.001
Micro-leakage Examiner B	Pearson Correlation		1
	p-value		1

**Pearson correlation coefficient was applied. Level of significance was set at 0.05.

DISCUSSION

Micro-leakage around dental restorations is a phenomenon that has been assessed, evaluated and

documented in numerous in-vitro experiments.[12,13,16,18] As documented in these studies the extent of micro-leakage varies, depending on the type of material used for the restoration, the etching protocol, the adhesive/bonding system used, the design of the cavity preparation, the clinical situation and the skill of the operator. In the present study, two different types of packable light cured composites, i.e., micro-hybrid composite (61% by volume fillers with particle size 0.01–3.5 μm) and nano-composite (75.8% by volume fillers with particle size 4–11 nm) were compared for the micro-leakage in class V lesions using the self-etch adhesive system. It was observed that the mean value of micro-leakage for nano-composite in dentine/the gingival surface of the class V restoration was 0.72±0.67 and for micro-hybrid composite the values were 0.72±0.39 (Table-2).

Several techniques have been developed to assess the cavity-sealing properties of restorations both *in vitro* and *in vivo*. A conventional method for the determination of micro-leakage *in vitro* is by using the dye penetration. Methylene blue in varying concentrations (0.5–5%) is a commonly used dye for this purpose[14,18] but basic fuchsine[19] and silver nitrate[13] have also been used. In the present study, 2% methylene blue staining was done after thermos-cycling the specimens for 150 alternating cycles of 5–55 °C±2 °C at a 30 sec dwell time.

Awliya & El-Sahn [13] assessed micro-leakage in class V lesions using flowable nano-composite and micro-hybrid composites. They reported that the mean micro-leakage score around the tooth-restoration interface with the micro-hybrid composite was 2.10±7.2 and for a nano-filled composite, it was 25.8±7.5. There was a statistically significant difference between the micro-leakage at the occlusal surfaces of micro-hybrid samples 0.97±0.58 and the nano-composite samples 0.58±0.52 in our study (Table-2). Some in-vitro studies[16,20] have compared etching protocols in-terms of micro-leakage or retention of restoration respectively, whilst others have assessed different generations of the same protocol, i.e., self-etch[21]. In another study conducted[22] both etching protocols were assessed in terms of micro-leakage around the tooth-restoration interface and they found no statistically significant difference between them (*p*-value 0.46).

In-vitro studies on the micro-leakage around the tooth-restoration interface have predominantly used an ordinal scale[10,16,23–25] (grades assigned to the amount of micro-leakage present) to document their results; fewer studies have used a continuous scale to document the micro-leakage, i.e., mm or μm[13,26,27]. The strength of the present study is that the extent of leakage was measured in millimetres by calibrating digital images captured through the microscope. This methodology has been used in very few studies.[28] The quantitative measurements aid in a more accurate determination of the micro-leakage. The only limitation faced was that the specimens were not subjected to the occlusal loading. Thus, the intra-oral environment was not absolutely mimicked.

Despite of a plethora of micro-leakage studies, restoration of class V lesion still remains a clinical challenge. The probable reason could be the variability in the protocols being followed in these studies. In order to evaluate the clinical success and survival of such restorations, more clinical trials should be performed for both carious and non-carious Class V cervical lesions.

CONCLUSIONS

- With respect to micro-leakage in class V cavities, Z-350 was found to be a superior restorative material compared to P-60 on the occlusal surface.
- There was no difference in the two materials for micro-leakage at the gingival surfaces.
- No micro-leakage was detected on the axial surface in the either restorative material.
- Overall, there is no statistically significant difference in the micro-leakage exhibited by the two restorative materials.

AUTHORS' CONTRIBUTION

SMH conceived the idea, conducted the experiment and wrote the manuscript. FRK supervised the project, carried out the statistical analysis and critically reviewed the manuscript.

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