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A COMPARISON OF MICROLEAKAGE SCORES OF FIVE DIFFERENT TYPES OF COMPOSITE RESINS

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ABSTRACT

This study aimed to perform a comparative assessment of microleakage in Class V cavities among five different composite resins. For this purpose 100 fresh caries-free human permanent molars were randomly assigned to one of five groups (n=20). Clearfil Majesty Esthetic + Clearfil S3 Bond (Group I), TPH Spectrum + Xeno V (Group II), Gradia Direct Anterior + G Bond (GC) (Group III), Premise + Optibond All in One (Group IV) and Charisma + iBond (Group V) were applied and polymerized under LED. Specimens were varnished, immersed in 0.5% methylene and sectioned bucco-palatally/lingually, and microleakage scores were determined.

Gingival and occlusal microleakage scores among groups were statistically significant ($p < 0.05$) ($p = 0.043$, $p = 0.005$). Occlusal microleakage scores for Clearfil Majesty Esthetic and Premise were lower than in the other groups. Charisma had the highest microleakage scores, with no difference among the other groups ($p > 0.05$).

In conclusion occlusal and gingival microleakage scores were satisfactory except for Charisma.

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Keywords: microleakage, different composite resins, self-etching adhesive systems, methylene blue, cervical lesion

Introduction

Esthetic appearance has acquired as much importance as function in modern dentistry. Due to the increasing importance of esthetic appearance, studies in restorative dentistry aimed to respond to the expectations of patients and physicians. Such studies have concentrated on improving tooth-colored restoration materials and techniques in order to be used in the elimination of losses that arise in dental tissue for a variety of reasons.

Adhesive systems play important role in the clinical success of esthetic restorative materials (27). Structural and regional differences in enamel and dentin tissues are also important for the success of adhesive systems (28). Cervical defects, decay and cavities arising from abrasions in the cervical region are indicators for Class V restorations. Material selection is of considerable importance in Class V restorations, which have complex morphologies and terminate in enamel, dentin or cement (9, 26).

In addition, the fact that occlusal forces cause stress accumulation in the cervical area and that cavities terminate in dentin on the gingival margin, both lead to restoration permeability in this region (15, 19). Bacteria, oral fluids, molecules, ions and air pass through these micro gaps between restoration materials and the cavity wall (5), in what is known as microleakage. All restorative materials result in

post-procedural voids in the tooth structure and gaps due to polymerization shrinkage. Bacteria are able to infiltrate these gaps and multiply in the oral environment (4, 10).

One of the fundamental factors for success of a Class V restoration is the adhesive type and method of application (21). Advances in bonding technology provide opportunities for greater adhesion and easier application. Great progress was achieved in the 1980s compared to adhesive agents that were previously developed. Three-step acid, primer and bonding were applied in the fourth generation bonding systems that were used in that decade (29). The function of the primer in this system, as an active surface material, was to reduce surface tension by covering the tooth surface and to permit easier adhesive infiltration by increasing wetting capability (3).

Primer and bonding agents were combined in fifth generation bonding systems in the following years (17). Successful results have since been obtained in single bottle systems with the application of primer and bonding agents together following acid abrasion (17, 20). Sixth generation bondings have recently been developed after single bottle systems replace these in the form of "self-etching adhesive systems" (2).

Self-etching adhesive systems are also known as "all-in-one" or "no-bottle," in which all stages in clinical practice are combined together and no acid, primer and bonding, washing or drying procedures are performed (1, 11, 23).

Self-etching adhesive systems are able to abrade the tooth surface, thus preparing it for adhesion (25). The tooth surface is prepared using primers containing unwashed monomers

capable of polymerization. These monomers contain an acidic group that dissolves or converts the smear layer (25). The adhesive is penetrated through water filled channels forming between the particles of the smear layer and thus enters into a reaction on the surface of the dentin layer beneath (30). The smear layer is thus included in the adhesive layer (24).

The aim of this *in vitro* study was to perform a comparative analysis of microleakage in Class V cavities in five different composite resin restorations using new generation self-etching adhesive systems.

Materials and Methods

One hundred caries-free adult molars extracted for various orthodontic and periodontal reasons were used. Post-extraction, tissues above the roots were removed with the help of a scaler, and teeth were cleaned using pumice and a polywire brush. Teeth were kept in distilled water at room temperature. Standard Class V cavities were prepared on the buccal surfaces of all teeth using cylindrical diamond burs (Diatech, Swiss Dental Instruments, Heerbrugg, Switzerland) under water cooling. Each cavity was prepared with a mesio-distal width of 3 mm, an occlusal-gingival width of 2 mm and a depth of 1.5 mm. The gingival margins extended 1 mm beneath the enamel-cement junction. Teeth were divided randomly into five groups of 20 teeth each.

Group I (Clearfil Majesty Esthetic)

Clearfil S3 Bond (Kuraray Medical Inc., Japan), a one-step self-etching adhesive, was applied to the surface of the Class V cavity using an application brush. Excess solvent was removed using an air spray for 5 sec, and polymerization was performed using a LED (Light Emitting Diode-Elipar Freelight, 3M ESPE, Germany) light source for 10 sec at 1000 mW/cm². Clearfil Majesty Esthetic (Kuraray Medical Inc, Japan), a nanofil composite, was applied later as a restorative material and polymerized with LED light for 20 sec.

Group II (TPH Spectrum)

Xeno V (Dentsply DeTrey, Konstanz, Germany), a one step self-etching adhesive, was applied using the same method. Excess solvent was removed using an air spray for 5 sec and polymerization was again performed using a LED light source for 10 sec at 1000 mW/cm². TPH Spectrum (Dentsply DeTrey, Konstanz, Germany), a sub-micron hybrid composite, was later applied as a restorative material and polymerized under LED light for 20 sec.

Group III (Gradia Direct Anterior)

G Bond (GC America), a one step self-etching adhesive, was applied to the surface as described above. Excess solvent was removed using an air spray for 5 sec, and polymerization was also performed as above. Gradia Direct Anterior (GC America), a micro-hybrid composite, was later applied as a restorative material and polymerized under LED light for 20 sec.

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Group IV (Premise)

Optibond All In One (Kerr Corporation), a one step self-etching adhesive, was applied to the surface as described. Excess solvent was removed and polymerization was performed as outlined above. Premise (Kerr Corporation), a nanohybrid composite, was later applied as a restorative material and LED light was used for polymerization for 20 sec.

Group V (Charisma)

The self-etching adhesive iBond (Heraeus Kulzer, Germany), a one step self-etching adhesive, was applied in the same way. Excess solvent was removed and polymerization was performed as in the other groups. Charisma (Heraeus Kulzer, Germany), a microfill composite, was later applied to the cavities as a restorative material and polymerized with LED light for 20 sec.

Teeth were kept in a drying oven for 24 h at 37°C (Nuve Incubator EN 120, Ankara, Turkey) before finishing. The finishing and polishing procedures for all restorations were completed 24 h after the completion of the restorations with diamond finishing burs (Diatech Dental AG, Heerbrugg, Switzerland) under water cooling. Restorations were polished using aluminum oxide covered discs. Samples were kept in distilled water in a drying oven for 24 h at 37°C (Nuve Incubator EN 120, Ankara, Turkey) and then subjected to 10 000 thermal cycles in baths between 5±2°C and 55±2°C with an immersion time of 30 sec. Specimen root ends were then sealed with composite resin, and teeth were twice coated with acid-resistant nail varnish extending 1 mm beyond the restoration margins. All specimens were immersed in 0.5% methylene blue solution and kept in a drying oven for 24 h at 37°C (Nuve Incubator EN 120, Ankara, Turkey). They were then placed on prepared, rectangular cold acrylic blocks, allowing the teeth to be inserted into an Isomet device (Isomet 1000 Precision Saw, BUEHLER, USA) with a cyanoacrylate adhesive material; teeth were divided into two sections in the Isomet device so as to divide the restorative materials along the bucco-palatinal/lingual plane. Each restoration was examined under a binocular stereomicroscope (Olympus SZ 40, SZ-PT, Japan) with the help of a digital camera at x15 magnification, photographed with the digital camera fixed to the stereomicroscope, and then scored (Fig. 1, Fig. 2, Fig. 3, Fig. 4, Fig. 5, Fig. 6).

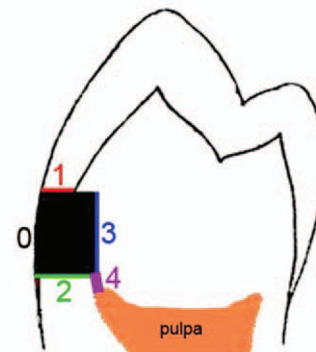


Fig. 1. Analysis of microleakage scores

Microleakage scores:

- 0. No dye leakage
- 1. Dye leakage up to half of the cavity walls
- 2. Dye leakage in the entire cavity wall
- 3. Dye leakage in the cavity wall and floor
- 4. Dye leakage partly or fully extending to the pulp

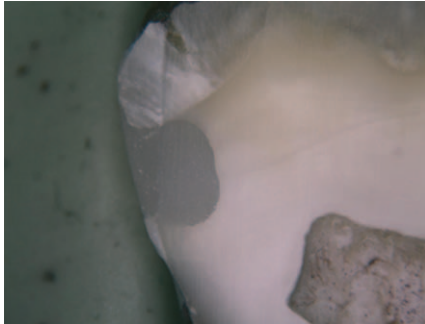


Fig. 2. Microleakage in Clearfil Majesty Esthetic Group (Occlusal score 0, gingival score 0)



Fig. 3. Microleakage in TPH Spectrum group (Occlusal score 1, gingival score 0)

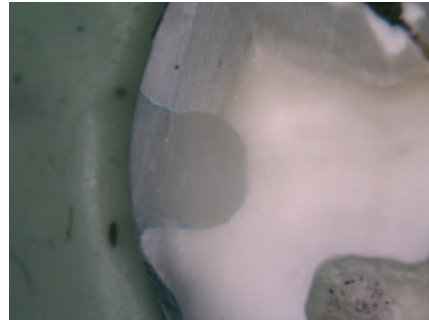


Fig. 4. Microleakage in Gradia Direct Anterior group (Occlusal score 1, gingival score 1)

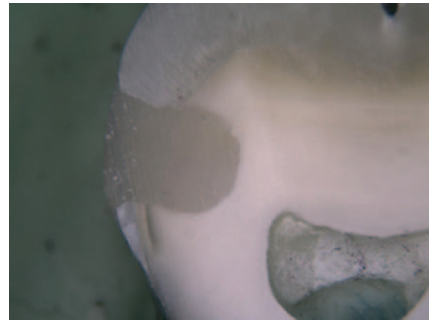


Fig. 5. Microleakage in Premise group (Occlusal score 0, gingival score 0)

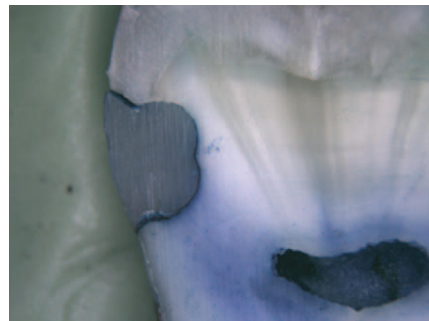


Fig. 6. Microleakage in Charisma group (Occlusal score 1, gingival score 4)

TABLE 1

Group distribution of microleakage scores

GROUP		Microleakage Scores				
		0	1	2	3	4
GROUP 1	Gingival	10	5	-	2	3
	Occlusal	9	9	1	1	-
GROUP 2	Gingival	9	2	1	-	8
	Occlusal	4	13	1	-	2
GROUP 3	Gingival	9	8	-	1	2
	Occlusal	4	15	-	1	-
GROUP 4	Gingival	13	4	-	-	3
	Occlusal	10	9	1	-	-
GROUP 5	Gingival	1	-	3	5	11
	Occlusal	1	19	-	-	-

The tooth hard tissue and restorative material interface was then examined under a scanning electron microscope (SEM) (JSM-5600 JEOL SEM, Jeol Co., Tokyo, Japan) and photographed (Fig. 7).

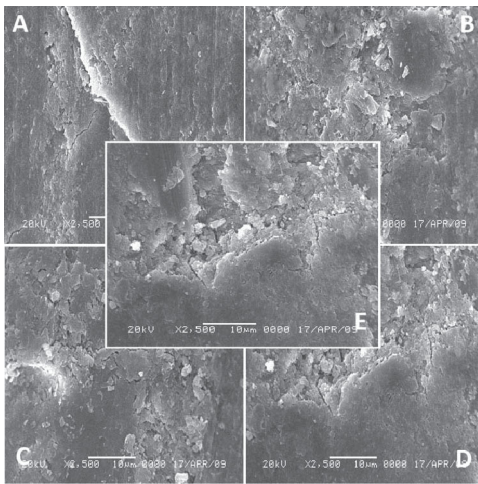


Fig. 7. SEM images from all groups

- A: SEM image from Clearfil Majesty Esthetic group (x2500)
- B: SEM image from TPH SPectrum group (x2500)
- C: SEM image from Gradia Direct Anterior group (x2500)
- D: SEM image from Premise group (x2500)
- E: SEM image from Charisma group (x2500)

Results and Discussion

Group distributions of microleakage according to the Cruskall Wallis and Mann Whitney U tests, as used by Demirçi et al. in their study (8), are shown in **Table 1**. The differences between occlusal and gingival microleakage levels among groups were statistically significant ($p < 0.05$) ($p = 0.043$, $p = 0.005$). Occlusal microleakage values for the Clearfil Majesty Esthetic and Premise groups were lower than those in the other three groups. Microleakage levels were highest in the Charisma group, while statistically there was no significant difference between the TPH Spectrum and Gradia Direct Anterior groups ($p > 0.05$). Microleakage at the gingival margin was highest in the Charisma group, while there was no statistically significant difference among the other groups ($p > 0.05$).

Due to structural and anatomical differences, restorative treatments of Class V cavities are more difficult than those in other regions. Various techniques and different restoration materials are therefore used in order to raise the levels of success of such restorative materials. Recently developed different composite types are now starting to be used. We therefore aimed to determine which material were more efficient using different composite types with new generation self-etching adhesive agents.

Decay lesions and defects such as erosion and abrasion are frequently seen in the cervical region of teeth in the clinical practice (14, 26). Cervical lesions generally have margins that can terminate in three different tooth tissues, enamel, dentin or cement. The lack of a restorative material that is capable

of equally binding powerfully to all three tissues makes the restoration of this kind of cavities difficult (16, 18, 26).

Restorative procedures to minimize microleakage in the treatment of Class V lesions have become the most important objective of modern-day research (9, 28). Since their proximity to the gum tissue makes moisture control difficult, and because they are exposed to intense abfraction forces, cervical restorations are regarded as procedures in which high, long-term success is difficult (5, 28).

In an *in vivo* study (12) in which the clinical performances of four different restorative materials in the treatment of cervical lesions following two years of observation was compared, Folwaczyn et al. reported that composite restorations provided the most successful results.

In a comparable *in vitro* study, De Magelhaes et al. reported similar microleakage performances in Class V cavities of composite, compomer and traditional glass ionomer cement (6).

Deliperi et al. reported that one-step self-etching adhesives exhibited a significant level of microleakage compared to total-etch and two-step self-etching adhesive systems (7).

Sensi et al. reported in a similar study that one-step self-etching adhesives exhibited a lower bonding force to dentine compared to total-etch and two-step self-etching adhesive systems (25).

Gale and Darwell reported that the application of a lower thermal cycling number might be insufficient for obtaining an aging effect.

We performed 10 000 thermal cycles based on series previously published by Gale and Darwell. These researchers reported that the application of 10 000 thermal cycles equates to an *in vivo* function of approximately one year (13).

In a recent *in vitro* study similar to this one, the coronal and apical microleakage levels of iBond, G Bond, Xeno IV and Clearfil S3 Bond self-etching adhesive systems were evaluated in Class V cavities on the lingual and buccal surfaces of molar teeth. Following 1000 thermal cycles, Xeno IV produced the least leakage in the coronal group and Clearfil S3 Bond in the apical group (22). In a similar study planned by us, the occlusal and gingival microleakage scores of Clearfil S3 Bond with Clearfil Majesty Esthetic were lowest following 10 000 thermal cycles.

Conclusions

Different scores were obtained among composite resins in this study of microleakage with 0.5% methylene blue in which Class V cavities were restored using five different self-etching adhesives and composite resins following 10 000 thermal cycles. Clearfil Majesty Esthetic and Premise were the most efficient, while Gradia Direct Anterior exhibited the greatest microleakage. No statistically significant difference was determined between Clearfil Majesty Esthetic and Premise. In addition, analysis of occlusal microleakage showed that the TPH Spectrum and Charisma groups were statistically

inefficient. Charisma gingival microleakage levels were also high. No statistical difference in gingival microleakage was determined among the other four groups. In the light of all these findings, we think that the obtained results need to be supported by further clinical studies.

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