

The Effect of Two Dentin Bonding Agents on Microleakage of Ceramic Crown

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الخلاصة

الأهداف: تحادف الدراسة إلى مقارنة ودراسة تأثير اثنين من أنظمة الترابط (بمجموع الحفر وذاتي الحفر) عوامل الربط الذي يسبق الفيروولنك على التسرب المجهرى لتيجان السيراميك. **المواد والطرائق المستخدمة:** استخدمت ثلاثون من اضراس العقل انتزعت حديثا خالية من تسوس الأسنان تم تنظيفها وخرنمها في الماء المقطر لحين استخدامها ثم تم تقسيمها و بشكل عشوائي الى ثلاث مجموعات (عشرة أسنان لكل مجموعة). كتبت الحسور السيراميكية مع المعدن في المجموعة الاولى (بالفيروولنك). وفي المجموعة الثانية تثبتت (بالايكسايت) مع (الفيروولنك). وفي المجموعة الثالثة ترسخ مادة (ال جي بوند) مع (الفيروولنك). **النتائج:** كشف تحليل نتائج الفرق احصائيا أن أعلى قيمة من التسرب المجهرى هي لمجموعة الفيروولنك. بينما الاقل نسبة من التسرب كانت لمجموعة ال جي بوند مع الفيروولنك. واطهرت النتائج الى ان استعمال أنظمة الترابط قبل الفيروولنك يختلف معنويا عن استخدام الفيروولنك لوحده في ترسيخ حسور السيراميك. **الاستنتاجات:** يوجد فرق معنوي بين المجموعة الاولى (الفيروولنك لوحده) والمجموعتين الثانية (الايكسايت مع الفيروولنك) والثالثة (جي بوند مع الفيروولنك) في التسرب المجهرى. وهذا مما يدل على أن استخدام أنظمة الترابط مع اتمتت الفيروولنك تقلل من التسرب المجهرى لحسور السيراميك مقارنة مع استخدام (الفيروولنك) لوحده..

ABSTRACT

Aims: The study aims to compare and investigate the effect of two bonding systems (total-etch and self-etch) bonding agents preceding the use of luting cement Variolink II Refill (Ivoclar Vivadent Schaan Liechtenstein) on the microleakage of ceramic crowns. The bonding systems compared are Excite (Ivoclar Vivadent Schaan Liechtenstein) (total-etch) and G bond (GC corporation, Tokyo, Japan) (self-etch) bonding agents. **Materials and Methods:** Thirty recently extracted caries-free wisdom teeth were used in this study. The teeth were cleaned and stored in distilled water until use. The molars were assigned randomly into three groups (n=10). Crown restorations were constructed by means of an indirect laboratory technique by a specialist. In group A the crown were cemented with Variolink II Refill resin luting cement alone. In group B, crowns were luted with Excite bonding agent +Variolink II Refill. In group C, G bond bonding agent+Variolink II Refill was applied prior to cementation. **Results:** The results showed that the higher value of microleakage with Variolink II Refill cement alone. While the least value was for the G bond+Variolink II Refill group. The results of this study revealed that the use of adhesives prior to Variolink II Refill significantly different from the use of Variolink II Refill alone in cementation of ceramic crown at (p< 0.05). **Conclusions:** The analysis of results revealed statistical difference in microleakage between the first group (Variolink II Refill) cement and second ,third groups (Excite +Variolink II Refill) and (G bond + Variolink II Refill) respectively. This may indicate that, the use of adhesives prior to cementation with Variolink II Refill luting cement may decrease but not prevent microleakage.

Key words: Microleakage, Crown cementation, Variolink II Refill, G bond, Excite bond..

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INTRODUCTION

The use of bonded ceramic restorations in dentistry has increased appreciably due to the development of adhesive materials that allow for more conservative restorative techniques as well as the ability of achieving excellent esthetic appearance and adequate strength.⁽¹⁾

The cementation technique, which is a time-consuming and technique-sensitive procedure, is key to the long-term success

of these types of restorations. The strength and the durability of the bond between the porcelain, the luting cement and the enamel/dentin interface play an important role in the outcome of ceramic crown.⁽²⁾

The clinical success of cemented restorations has been evaluated by measuring marginal fit and microleakage for many years, in spite of the fact that there is no restoration or luting material able to achieve a complete marginal seal.

(3,4) In the case of all-ceramic restorations, microleakage has been correlated with the loss of the integrity of the bond to tooth structure, and this has been associated with other problems such as secondary caries, post-operative sensitivity, pulpal inflammation, staining and plaque accumulation.^(4,5,6) Modern adhesives can be grouped into two categories according to their etching technique: total-etch and self-etch products.⁽⁷⁾ Total-etch systems have shown high bond strength to dentin. A self-etch system contains a simultaneously acidic and hydrophilic monomer and does not need to be rinsed away after etching. Effective demineralization provides sufficient adhesive penetration into enamel and

dentin.⁽⁸⁾ Self-etch adhesive systems were produced as an alternative for total-etch systems to reduce the technique sensitivity and application time.⁽⁹⁾

This study aims to compare and investigate the effect of two bonding systems (total-etch and self-etch) bonding agents preceding the use of luting cement (Variolink II Refill) on the microleakage of ceramic crowns.

MATERIALS AND METHODS

The materials used in this study are Variolink II Refill resin luting cement, Excite (total-etch adhesive), G bond (self-etch adhesive) was shown in Table (1).

Table (1): The components and application protocols of the materials used in the study.

Materials	Main component	Application protocol
Luting Cements	Variolink II resin luting cement (Ivoclar, Vivadent, Schaan, Liechtenstein)	UrethanDimethacrylate (UDMA) and Bis phenol Glycedial methacrylate (BisGMA), inorganic fillers barium glass filler and silicon dioxide filler, Ytterbium trifluoride, catalysts stabilizers and pigments.
		2 paste system (total-etch approach). Base:Urethanedimethacrylate,Catalyst: Dimethacrylates.
Adhesives	1.Excite (Ivoclar, Vivadent, AG FL-9494 Shaan, Liechtenstein)	2-Hydroxyethylmethacrylate (HEMA), dimethacrylates, phosphoric acid acrylate, silicon dioxide, initiators and stabilizers in an ethanol solution.
	2.G-Bond (GC corporation, Tokyo,Japan)	Methacryloyloxyethyl Trimellitate (4- MET), phosphoric ester monomer, UDMA, acetone and camphorquinone.
		Apply to moist dentin for 10 seconds. Dry gently for 1-3 seconds. Light cure for 20 seconds. Apply to entire dried surface. Leave undisturbed for 10 seconds. Dry thoroughly under maximum air pressure for 5 seconds. Light cure for 10 seconds.

Thirty recently extracted caries-free wisdom teeth were used. The teeth were cleaned and scaled with ultrasonic scaler (Guilin Woodpecker Medical scaler, China) and checked under stereomicroscope to exclude cracking, then were stored in distilled water. The teeth were centrally inserted into PVC cylinders (25-

mm height x 20-mm internal diameter; Tigre, Joinville, SC, Brazil) containing self-curing acrylic resin (Jet; Classico Artigos Odontologicos Ltda., Slo Paulo, SP, Brazil). The acrylic resin was contoured 2 mm below the cemento-enamel junction and the samples stored in distilled water until use. The molars were assigned

randomly into three groups (n=10). The preparation of teeth were made with a diamond burs of 1.2 mm diameter (Cerinlay Set, Intensiv, Viganello, Lugano, Switzerland) to achieve a 6-degree converge angle using a stationary high-

speed handpiece secured in a clamp attached to a surveyor with sufficient water cooling were used to perform preparations of metal-ceramic crown on each tooth. As shown in Figure (1).



Figure(1): Sample with stationary hand piece secured in a clamp attached to a surveyor.

The preparation will be a shoulder margin of 0.5 mm buccally with chamfer margin lingually, and an occlusal reduction of 1.5 mm from the tip of the buccal cusp for each preparation with 4 mm in height were made.^(10,11) All line angles were rounded, the margin was located in dentine at the level of the cement-enamel junction. An impression was made for each tooth with light hydrocompatible Oral wash^(®) (Zhmack^(®)) impression material. Ceramic crowns were constructed by means of an indirect laboratory technique by a specialist. The preparation was cleaned using rotary brush and pumice in low-speed hand piece, washed and then dried using sterile cotton.⁽¹²⁾ The crowns were cemented in

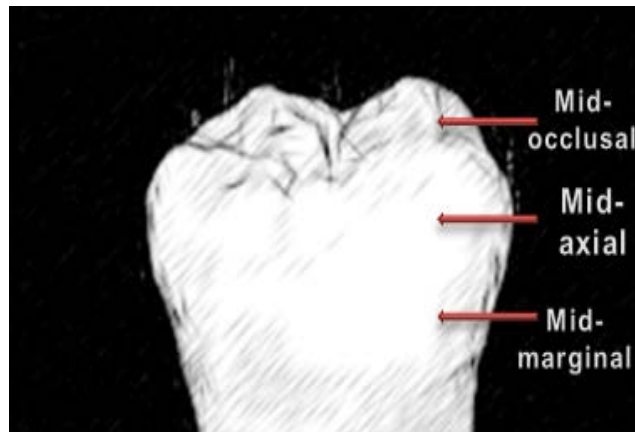
group A with Variolink II Refill resin luting cement on unsealed tooth preparations, The Variolink II Refill resin cement was mixed according to the manufacturer's instructions and applied to the internal walls of the crown restorations, seat the restoration on tooth preparation with slow even pressure for cementation and light cured by LeditonIvoclarVivadent light-curing unit, remove the excess cement then the margins of the preparation were then light-cured for 30s at each face. In group B, Excite+Variolink II Refill was used (E+V). The Excite bonding agent was applied according to the manufacturer's instructions, then Variolink II Refill resin cement was mixed according to the manufacturer's instructions and applied to

the internal walls of the crown restorations for cementation, then after seating light cured by Lediton Ivoclar Vivadent light-curing unit. In group C, G bond +Variolink II Refill was applied (G+V), the application of G bond on untreated dentin according to the manufacturer's instructions. Then Variolink II Refill resin cement was mixed according to the manufacturer's instructions and applied to the internal walls of the crown restorations after seating, light cured by Lediton Ivoclar Vivadent light-curing unit.

During the entire experiment, specimens remained in distilled water at room temperature. The samples were immersed into 1% methylene blue solution for 24 hours at 37°C, rinsed, dried

specimens and cut the specimens using 1 mm thick diamond gauge disc parallel to the axial tooth axis mesio-distally of each sample for measurement of dye penetration degree. Penetration depth was measured with digital stereomicroscope (Motic Incorporation LTD. Hongkong) at 40× magnification.

The amount of dye penetration and microleakage measurement was measured in millimeters for three treated groups. The distance between the prepared tooth surface and the crown's fitting surface was measured at 3 different locations (mid-marginal, mid-axial and mid-occlusal).⁽¹³⁾ As shown in Figure (2). Penetration depth measured was shown in Figure (3,4,5) respectively.



Figure(2): Schematic representation of mid-occlusal, mid-axial, and mid marginal points of the tooth.



Figure(3): A dye penetrations for Variolink II Refill cement.



Figure(4): A dye penetrations for Excite bond +Variolink II Refill cement.



Figure(5): A dye penetrations for G bond+Variolink II Refill cement.

RESULTS

Table (2) showed the mean and standard deviations of the tested groups. One-way ANOVA (Table -3) and Duncan's Multiple

Range Test (Table - 4) and Figure (6) revealed that there was a significant difference between the tested group.

Table (2): The mean and standard deviations, minimum and maximum values of microleakage for the tested groups.

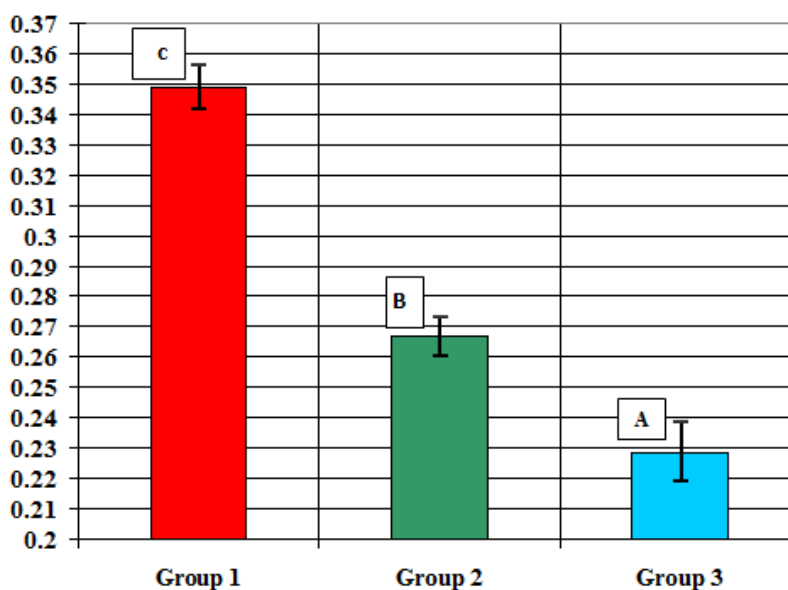
	No.	Mean	SD	SE Mean	Minimum	Maximum
Group 1	10	0.3490	0.00721	0.00228	0.34	0.36
Group 2	10	0.2667	0.00648	0.00205	0.26	0.28
Group 3	10	0.2287	0.00984	0.00311	0.21	0.24

Table (3): One-way analysis of variance of the tested groups.

	Sum of Squares	df	Mean Square	F	p-value
Between Groups	0.076	2	0.038	595.124	0.000
Within Groups	0.002	27	6.358E-5		
Total	0.077	29			

Table (4): Duncan's Multiple Range Test of microleakage for the tested groups.

Group	No.	Duncan's Grouping		
		A	B	C
Group 3	10	0.2287		
Group 2	10		0.2667	
Group 1	10			0.3490



Means with different letters were statistically significant at $p < 0.05$.

Figure(6): Means of microleakage in (mm) of tested groups.

Success of any indirect dental restorations depends on many factors, among them the cementation techniques and procedures. Dental cement must act as a barrier against micro-leakage, holding the tooth and restoration together mechanically and/or chemically. The behavior of the cement and bonding systems is complex and partly depends on the properties and quality of the component parts of each system.⁽¹⁴⁾ An

ideal dental adhesive should be able to wet, infiltrate dentin and provide a durable bond between the unhomogeneity of enamel and dentin and the restoration.⁽¹⁵⁾

The bonding systems used in this study were dual cured cements, their polymerization reaction is chemically and photoinitiated. This ensures higher conversion rate of curing, leading to better mechanical properties, i.e the force will be distributed over a large area, as the whole

assembly: the crown, the adhesive and the tooth structure would act as one unit.⁽¹⁶⁾ Treatment with G bond prior to Variolink II Refill decrease the microleakage value as the presence of methacryloyloxyethylTrimellitate 4MET formulated with fillers in the G-bond system produce nano particles responsible for the formation of extremely thin layer of nano interaction zone containing insoluble calcium compound with dentin characterized by the exposure of little amount of collagen fibrils.⁽¹⁷⁾ According to the adhesion-decalcification concept, the less soluble the calcium salt of an acidic molecule, the more intense and stable the molecular adhesion to a hydroxyapatite-based substrate.⁽¹⁸⁾ The application of G bond (self-etch) to dentin prior to Variolink II Refill may resulted in increased resin tag formation in a bundler appearance. They are connected with resin infiltrated dentin surface. Resinous layer was thick, long coagulated pattern. This may be responsible for better results concerning microleakage compared with total-etch system. This study agree with ElGuindy et al⁽¹⁹⁾ who demonstrated that the use of self-etch adhesives is very efficient and reduce vertical marginal gap and subsequent microleakage.

2-Hydroxyethylmethacrylate HEMA present in Excite (total-etch) bonding creates a hydrogel within the hybrid layer and adhesives. In some cases, the hydrogel may provide a channel for water permeation that has the potential to affect the durability of bonds.⁽²⁰⁾ Total-etch systems utilizing 30–40% phosphoric acid are efficient in the removal of smear layer components, causing demineralization of the inorganic enamel surface, which is composed primarily of hydroxyapatite crystals, thus creating microporosities for a micro-mechanical bond. Etching dentin by utilizing etch and rinse procedures completely demineralizes the dentin substrate (intertubular and peritubular dentin), with this process over-conditioning of the organic (collagen) and inorganic (hydroxyapatite) components can occur, causing a collapse and shrinking of the collagenous fibular network due to loss of structural, inorganic support. Following removal of the dentinal

hydroxyapatite, incomplete diffusion and penetration of separate adhesive and primer components can occur, producing a resin deficient zone. As a result, exposed collagen fibrils and lack of support by partially infiltrated resin monomers may result in a significant reduction in material-tooth structure adhesion.^(21,22)

This study disagree with Yesilyurt and Bulucu⁽²³⁾ who demonstrated that the total-etch systems had higher bonding strength to dentin than did the two-step and one-step self-etch systems, as self-etch primer, which has weak acid, dissolves smear layer, demineralites superficial dentin, and penetrates adhesive resin. But when the smear layer is thick, the weak acid's effectiveness is not sufficient and has a limited adhesive resin penetration. This may affect adhesion and subsequent microleakage.

The use of dentin bonding agents proceeding the luting cement may be responsible for better results in reducing microleakage comparing to the use of luting agent alone for cementation of ceramic crown. The better results obtained with the use of self-etch dentin bonding agents prior the luting cement. This may be due to the ability of bonding agents to seal the cut dentinal tubules and protect the pulp from possible consequences of leakage which ensures adhesion and resistance to various stresses. By the use of two different dentine-bonding agents i.e. Excite and G bond, it was hoped that a more comparison could be made between the extent of microleakage and the effect of the bonding agents used.

CONCLUSIONS

*Self-etching systems provided a greater reduction in microleakage dentine than that of total-etch systems.

*Ceramic restorations luted with (self-etch and total-etch) dentin bonding agent systems plus (Variolink II Refill) resin luting offer better reduction in microleakage compared to the use of Variolink II Refill resin alone.

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