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Original article ■

Marginal GAP and Alteration of Enamel Around Adhesive Restorations of Teeth (*in vitro* SEM investigation)

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SUMMARY

There are three adhesive restorative systems: etch and rinse (total etch), self etch and glass ionomer systems. Marginal gap and alteration of marginal enamel around composite and glass ionomer restoration may be influenced by the use of adhesive restorative procedure.

The aim of this study was to evaluate the marginal integrity and morphology of the enamel surface around margins of composite and glass ionomer restorations, after storage in cariogenic-acid solution.

Seventy class V cavities were prepared with margins at enamel. Cavities were restored with: (I) 1. Single Bond + Z 250 and 2. Single Bond + Filek flow, using etch and rinse adhesive system; (II) 3. Prompt-L-Pop + Z 250 and 4. Prompt-L-Pop + Filtek flow, using self etch adhesive system; (III) 5. Vitremer, glass ionomer system.

After the restorative procedure, the teeth with restorations were subjected to demineralization for 7 and 28 days. Samples were stored in a demineralizing solution (lactic acid, pH 4.5, 0,1M) at 37^{0}C or in deionized water (control group). The margins of restorations (width of the gap) and perimarginal enamel were examined by scanning electron microscope (SEM). The data were analyzed using the ANOVA - Dunnet test.

Hybrid composite resin with etch and rinse adhesive system (Single Bond/ Z 250) showed the best adaptation to enamel margins. Glass ionomer restorations showed significantly bigger gap formation compared to etch and rinse and self etch systems ($p<0,01$). The SEM examination showed demineralized perimarginal enamel zone around all types of restorations as well. These zones were characterized by severe signs of erosion, alteration of rods, porosities. Slight alterations were found on the enamel surfaces not included in the perimarginal zone.

Marginal adaptation of restorations to enamel was more effective with etch and rinse adhesive system than self etch and glass ionomer approaches. Stronger demineralization of the perimarginal enamel was observed around composite restorations.

Key words: **marginal gap, demineralization, enamel, adhesive restorations**

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INTRODUCTION

The bond between materials and hard dental tissues may be achieved through mechanical, physical and chemical adhesion.

Clinical and laboratory tests have shown that there is no 'ideal' marginal closure or ideal adhesion, so that modern research is directed towards finding materials for final closure of cavities that would chemically bind to hard dental tissues, with mechanical properties similar to the properties of enamel and dentin and that would prevent the formation of microgap between the wall of the cavity and the filling (1, 2). In addition, the adhesion of the filling should also be resistant to cariogenic - acidic solutions (3-6).

Modern restorative dentistry applies minimally invasive procedures. The lost or diseased hard dental tissue is replaced by restorative material which directly binds to the remaining dental tissue. The principles at use lately (7) are based on the use of adhesive techniques in everyday practice. The basic principle of adhesion to dental tissues is based on the replacement of inorganic dental material by synthetic resin (8-10). This process has two phases. In the first phase, the calcium phosphate is removed in order to open the micropores of enamel and dentin. Phase two, hybridization, includes infiltration and subsequent *in situ* polymerization of resin. This micromechanical process of material bonding is based on the principle of diffusion. Researchers pay special attention to the role of micromechanical and chemical bonding mechanism through morphological and chemical characteristics of tooth - biomaterial interaction using various types of adhesives (1, 8, 11-14). Materials of choice in class V cavity restoration and wedge-shaped erosions are composites and glass ionomer cement (GIC). Since the end of the 80's of the last century, the development of composite materials has been advancing parallel to the development of glass ionomer cement. Despite the fact that new ideal materials are constantly being sought, there is still no material that completely matches the chemical, physical and biological properties of dental tissues.

The disadvantages of composite materials (inadhesion and polymerization contraction) have conditioned the development of adhesives that aim at forming firm adhesion of composites to the cavity walls without creating marginal microgaps. With the application of GIC, a pretreatment of tooth cavity with a conditioner (or primer) is recommended in order to obtain not only chemical bonding of GIC with dental tissue but also good micromechanical adhesion. The type of adhesive system (primarily the process of conditioning), as well as the quality and manner of applying restorative material, may induce the development of marginal gap around the restoration. Also, the conditioning procedure may damage the marginal enamel causing it to become more sensitive to the effects of acid.

AIM

This research has been performed with the aim of determining the effects of adhesive system on the development and width of marginal gap, as well as possible damage to the marginal enamel around restoration during adhesive procedure of conditioning. After the exposure of teeth with restorations to the effects of acidic solution, the bond of composites and GIC with the enamel, as well as the ultramicroscopic appearance of the marginal enamel were analyzed with a scanning electron microscope (SEM).

METHODS

Cavity Preparation

The material used in the research included human third molars of young patients, extracted for various reasons (total of 70 teeth). Until the experiment was performed, they were kept at 4^0C in a physiological solution. Before cavity preparation, the roots were cut off and a class V (3 x 2 x 2 mm) adhesive preparation was made on vestibular side of each tooth using a turbine handpiece and a pear-shaped diamond bur. All cavities were prepared above enamel-cement border in order for all the cavity margins to be within enamel. Cavity margins were slanted using flame diamond bur and micro-handpiece with slower rotation speed.

Teeth samples were then classified into 5 groups of 6 teeth (five restoration methods) during an observation period of 7 days (30 teeth), that is, for an observation period of 28 days (30 teeth).

Ten teeth, two for each restoration method, were used as controls and they were kept in deionized water after the placement of fillings.

Tooth Restoration

Five methods of restoration were used and all materials were placed according to manufacturer's instructions. The first two groups of teeth were restored using hybrid composite and the other two groups were restored with liquid composite. The 1^{st} and 3^{rd} groups of teeth were prepared using total etch (etch and rinse) system and the 2^{nd} and 4^{th} groups were prepared using self etch adhesives. The cavities in the 5^{th} group were restored with glass ionomer cement.

<u>*I system*</u>

1^{st} group: Acid + Adper Single Bond 2 + Filtek Z250 ***(Single Bond+Z 250)***

(etch and rinse technique + hydrophilic adhesive + hybrid composite)

*3^{rd} group: Acid + Adper Single Bond 2 + Filtek Supreme XT Flowable (**Single Bond+F Flow**)*

(etch and rinse technique + hydrophilic adhesive + liquid composite)

II system

*2nd group: Adper Prompt-L-Pop + Filtek Z 250 (**Prompt L Pop+Z 250**)*
(self etch adhesive + hybrid composite)
*4th group: Adper Prompt-L-Pop + Filtek Supreme XT Flowable (**Prompt L Pop+F Flow**)*
(self etch adhesive + liquid composite)

III system

*5th group - Glass ionomer procedure: Primer + **Vitremer** + Glaze*

I Etch and rinse system (The technique of total etch of enamel and dentin)

Enamel and dentin walls of class V cavities were etched by 35% phosphoric acid (3M ESPE - 7523/lot 5FR). The enamel was conditioned for 30s and the dentin for 15s. The cavities were then rinsed with water from oral irrigator for 10s. After drying, two layers of Adper Single Bond 2 (3M ESPE - 51202/lot 6GE) adhesive system were gently rubbed in for 15s (total of 30s) and then polymerized for 10s. The cavity was filled with composite material, either Filtek Z 250 (6020/lot 5UA) or Filtek Supreme XT Flowable (3913/lot 6AU), which was applied in two horizontal layers. Each layer was polymerized for 20s.

II Self etch system (Technique with self - etch primer)

Adper Prompt-L-Pop (3M ESPE 38183/lot 240116 -130) adhesive was applied in two layers to the enamel and dentin. The first layer was rubbed in for 15s and then air-dried. After the second layer was applied for 3s, the cavities were air-dried and the adhesive was polymerized for 10s. Restoration was performed using either Filtek Z 250 or Filtek Supreme XT Flowable composite material. The material was applied in two horizontal layers and each layer was polymerized for 20s.

III Glass ionomer system (Technique of cavity preparation with primer)

Vitremer primer (3M ESPE-MN 55144 1000/lot 6BE) was used for the preparation of enamel and dentin. The primer was applied with a brush onto the enamel and dentin for 30 seconds. It was then air-dried for 15s and it was not rinsed but polymerized by light for 20s. The powder (lot 6LG) and liquid of the Vitremer cement (lot 6EY) were mixed in 2:1 ratio for 45 seconds. According to manufacturer's instructions, glass ionomer cement was applied to dry cavity. The polymerization of glass ionomer was performed by lighting the whole area of the filling for 40 seconds with 2mm deep layer. After shaping and polishing, the filling was coated with Vitremer Glaze (3M ESPE-lot 6CR) which was then polymerized for 20 seconds.

Bonding agents and composites were polymerized with previously tested Visilux Command 2 lamp (3M) at 400 mW/cm2. Each layer of the material was exposed to light for 20s. All samples were then polished using diamond finisher, with obligatory water cooling, using Sof-Lex disks and rubbers with various grain fineness (3M ESPS).

The samples from all five groups of teeth were then submerged into the solution of lactic acid pH 4.5; 0.1M, at 37°C, in 20ml tubes. Six teeth samples from each group were kept in acidic solution for 7 and 28 days. Lactic acid solution (cariogenic solution) was changed every 24 hours. Control samples, two for each group (total of 10 teeth) were kept in deionized water (pH 6.7 at 37°C) for 7 days in 20ml tubes. At the end of observation periods, the experimental samples were rinsed in water and kept in deionized water for 24 hours before SEM testing.

Restoration margins and perimarginal enamel were tested by scanning electron microscope (SEM) JEOL - JSM 530 after gluing the samples to special stands and steaming in JOEL JFC - 1100F evaporator.

SEM analysis of marginal bond of composites and GIC with the enamel was performed directly from microscope's monitor. The width of marginal gap was measured using the scale on the scanning microscope monitor at 1000x magnification (according to the system by Roulet et al.) (12). The measurement was performed on four sides of the restoration (mesial, distal, occlusal and gingival) at the sites where the cavity was the widest. Four measured values were used for calculating the average width of the gap at the site of contact between the restorative material and enamel.

Following the exposure to acidic solution, ultramicroscopic testing of the surface of marginal enamel was performed in the same way as the one applied by Prati et al. (4).

The comparison of the values of average widths of marginal gaps around restorations was performed using One-way ANOVA and Post-hoc Dunnett test).

RESULTS

SEM findings of microgap width

Along the edge of the filling, there was a marginal gap of 10-20% length after the application of etch and rinse (total etch) system, 20-40% length after self etch primer and 100% with GIC restoration. During a seven-day observation period, the best bond was obtained with the 1st group of restorations (etch and rinse system and hybrid composite - Single Bond + Z 250). (Figures 1, 2, 3, 4, 5) (Graph 1).

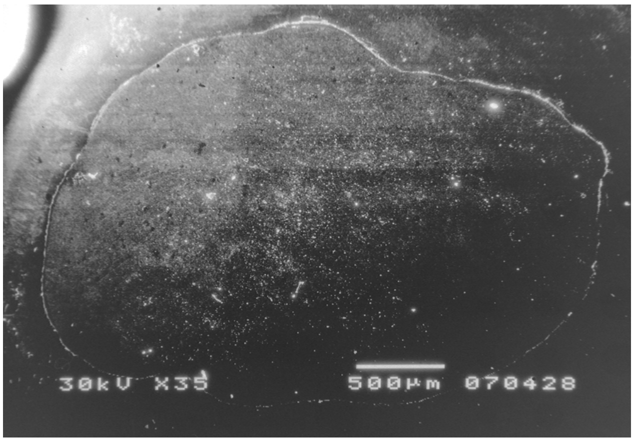


Figure 1. *Good marginal adaptation of hybrid composite-a whole circumference of restoration. There is no gap between composite and enamel (Group I from deionized water). Original scanning electron photo-micrograph (SEM) x35*

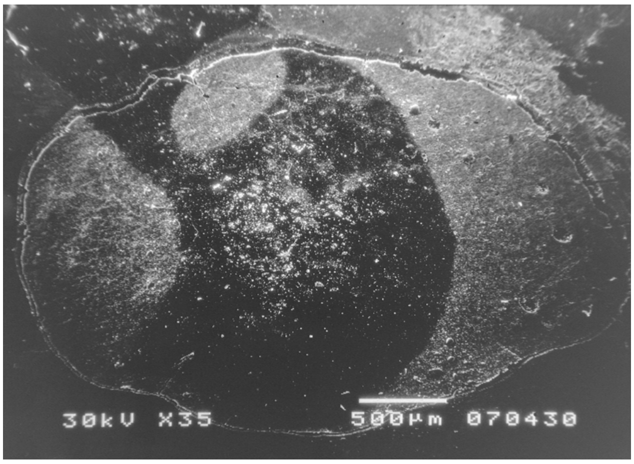


Figure 2. *Marginal adaptation of GJC to enamel-a whole circumference of restoration. The gap is noticed on whole GJC/enamel connection (arrows) (Group V from deionized water). Original scanning electron photo-micrograph x35*

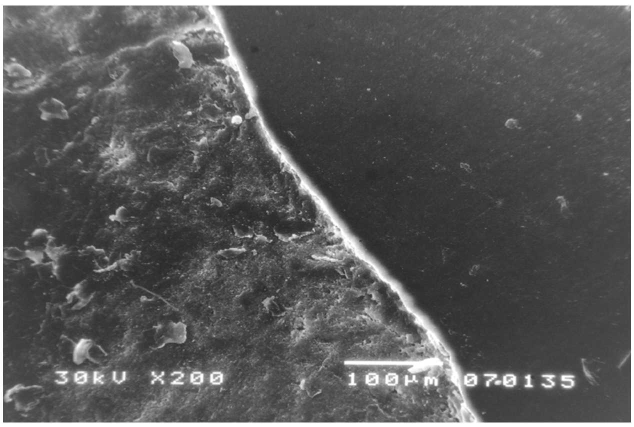


Figure 3. *Enamel margin of a restoration stored in acid solution for 7 days (I adhesive System, etch and rinse, Group I). No marginal gap was present between the composite resin and enamel. Original SEM photo micrograph x200*

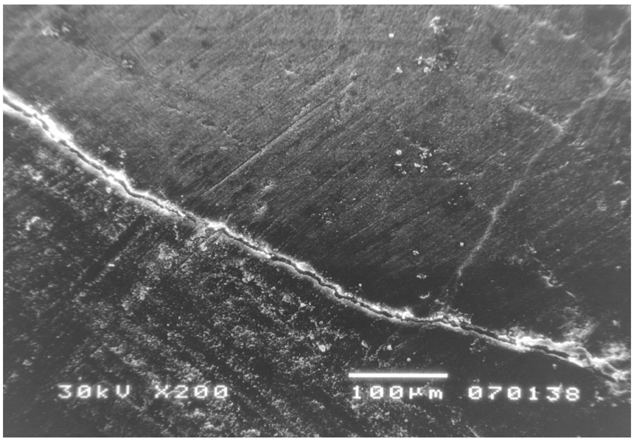


Figure 4. *Original SEM photo micrograph of specimen from adhesive System II, self etch, Group IV). Tooth specimen with restoration stored in acid solution for 7 days. A microcrack could be seen between the composite resin and enamel wall x200*

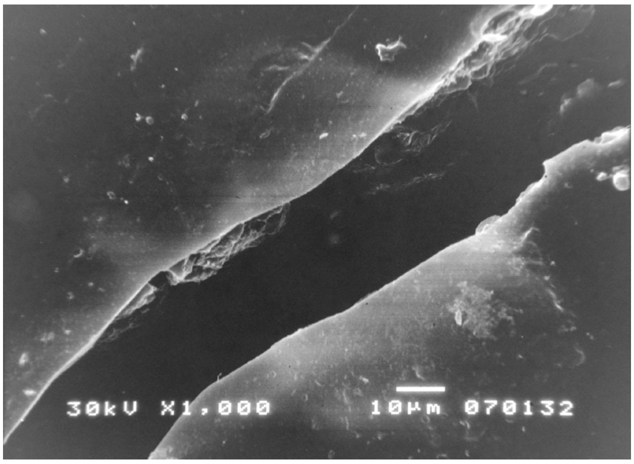
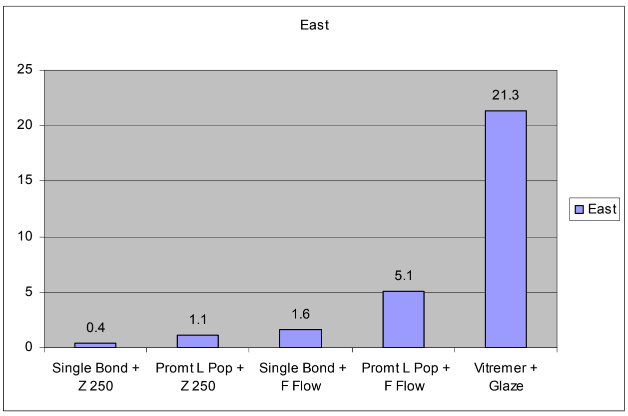


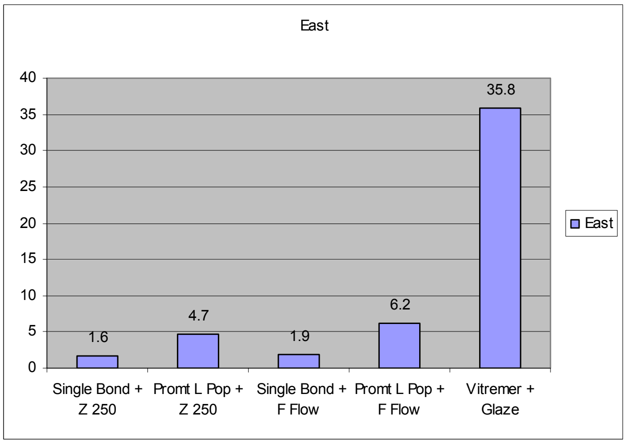
Figure 5. *A big marginal gap around GJC restoration (III adhesive System). Tooth specimen with restoration stored in acid solution for 7 days. Original SEM photo micrograph x1000*



Graph 1. *Comparison of average gap widths (µm) among the groups after exposure to acidic solution for 7 days*

The average gap width in the 5th group was 21.3 ±5.6μm and it was significantly larger than the width in other groups. Average gap width in the 4th group was significantly larger than the width in the first group (5.1 ±1.6:0.4±0.1μm and $p<0.05$). The differences among average gap widths in other groups were not significant.

After 28 days, the best bond between material and enamel was found in the 1st group of restorations (etch and rinse system - Single Bond + Z 250), followed by the 3rd group (Single Bond + F flow) and the 2nd group (Prompt L Pop + Z 250), whereas a significantly larger microgap was registered in the 4th group of restorations (self etch system - Prompt L Pop + F flow) and the largest was registered in the 5th group (Vitremer).



Graph 2. *Ratio of average gap width (μm) among groups after 28 days of acidic solution activity*

The average gap width in the 5th group 35.8± 9.2μ) was significantly larger than the width in other tested groups. The average gap widths in the 2nd (4.7± 1.8μm) and 4th (6.2±1.9μm) group were larger than the widths in the 1st (1.6±2.0μ) and 3rd group (1.9± 1.4μm) but these differences in values in the tested sample were not statistically significant (Figures 6, 7, 8).

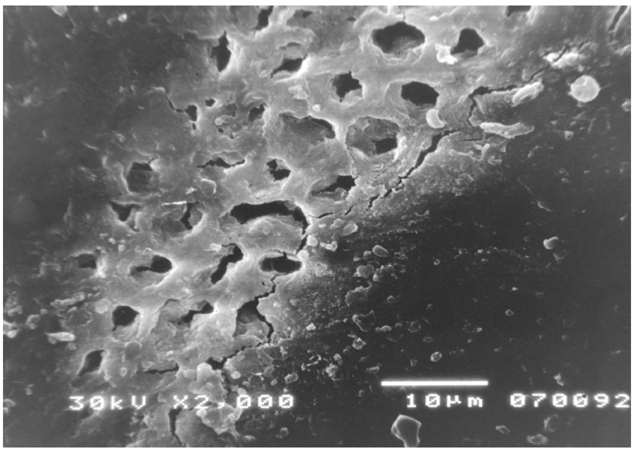


Figure 6. *Enamel margin of a restoration stored in acid solution for 28 days (I adhesive System, Group I). Perimarginal enamel was strongly demineralized as a cosequence of lactic acid solution acting. A great number of pores and one parallel micro fracture of enamel were visible along the margine of restoration. No marginal gap was present between the composite resin and enamel. Original SEM photo micrograph x2000*

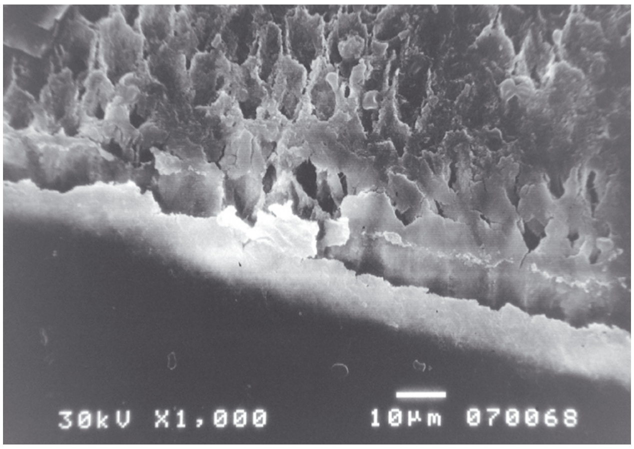


Figure 7. *Sample stored in acid solution for 28 days (II adhesive System, 4. Group). A considerable rate of demineralization was visible. The core and body of enamel prisms completly removed but interprismatic enamel was still in place. The honeycomb structure of demineralized enamel was evident along the perimarginal area. A marginal gap could be seen between the composite end enamel. Original SEM photo micrograph x1000*

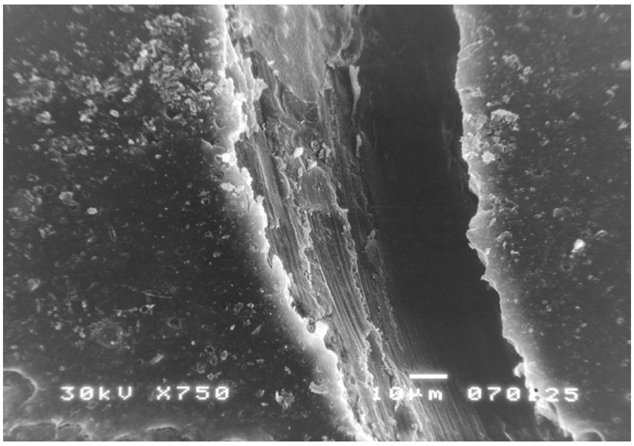
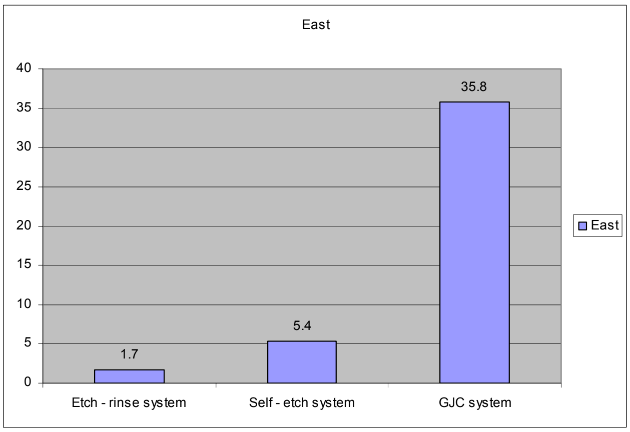


Figure 8. *A big marginal gap around GJC restoration (III adhesive System) Tooth specimen with restoration stored in acid solution for 28 days. Original SEM photo micrograph x750*

The largest average gap was found in III adhesive system (Graph 3).



Graph 3. *Ratio of average microgap widths (μm) between restoration systems after 28 days of teeth exposure to acidic solution*

The average gap width in system I, with etch and rinse, was 1.7±1.7 μm and it was significantly smaller than the width in system II with self etch primers (5.4± 1.9μm and $p<0.01$) and system III with GIC (35.8± 9.2 μm and $p<0.01$).

SEM findings of the morphology of marginal enamel zone

After the acidic solution reaction, a milky white halo around the edges of composite restorations was clearly seen. It was an evidence of a stronger dissolution of the enamel marginal field in the cariogenic solution in relation to the remaining enamel surface (Figure 9).

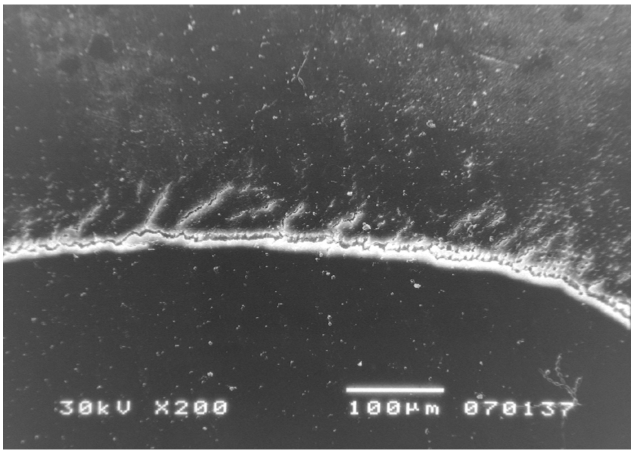


Figure 9. *Alteration of enamel margin around composite restoration (Group II - self etch). Demineralization of enamel was evident along the perimarginal area. Original SEM photo micrograph x200*

SEM testing showed significant demineralization and erosion of the marginal enamel zone around composite restorations (damage to the central part of the prisms, porosities) after acidic solution activity, particularly after the observation period of 28 days. The damage of the perimarginal enamel was evident on average 10-200 ηm from the restoration margins. Slight damage was perceived on the enamel surfaces outside the perimarginal zone.

Enamel demineralization around composite restoration margins, after the activity of cariogenic solution, was predominant in the 4th group of teeth samples (Prompt L Pop + F flow) where a wider gap around the fillings was determined (Figure 10).

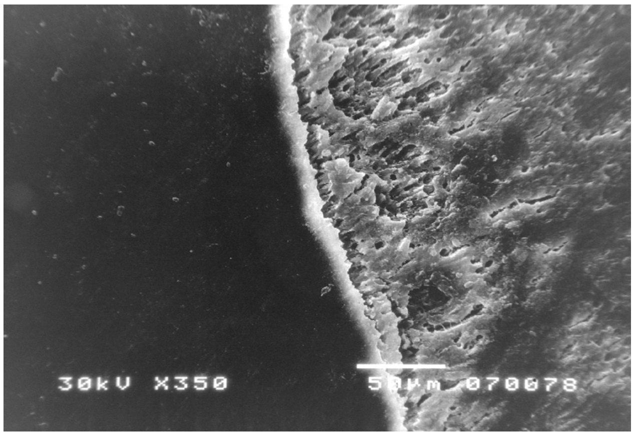


Figure 10. *Enamel margin stronglly demineralized as a consequence of acid solution storage for 28 days. (Group II - self etch). Erosion, cracks and interfacial gap were present. Original SEM photo micrograph x350*

Damage to the marginal enamel in GIC restorations was perceived only in some samples, particularly where protective glaze was damaged or missing, which was used to cover the fillings as well as perimarginal enamel during restoration procedure.

DISCUSSION

The bonding of modern restorative materials with dental tissues is achieved by the use of adhesive systems. The basic mechanism of bonding to the enamel and dentin is achieved by ultra-morphological and chemical tooth-biomaterial interaction (13, 14).

Today's adhesive systems are critically assessed in various laboratory studies and clinical trials. The comparison of data gathered in laboratories to clinical results shows that laboratory results may be related to clinical effectiveness of adhesive techniques. This *in vitro* research uses three current adhesive systems (etch and rinse, self etch and glass ionomer systems). Teeth with fillings were exposed to acidic solution in order to determine the resistance of restoration bonds with the enamel to the most significant cariogenic factor-acid.

In the application of current adhesives, the exchange between biomaterial and dental tissue takes place in one, two or three stages (applications). The adhesive etch and rinse procedure includes two or three stages: conditioner application (etching), primer application and finally, the application of bonding agent. The two-stage strategy combines the second and third application. This *in vitro* research is based on the application of etch and rinse system in two stages including: etching and application of Adper Single Bond.

The results obtained by SEM analysis of the bonds of fillings demonstrated a superior bond between composites and enamel using etch and rinse system. The etch and rinse system is currently the most effective in achieving a stable bond to the enamel and basically requires two procedures: selective dissolution of hydroxyapatite crystals through etching and resin polymerization *in situ* (15). In etch and rinse system, the most critical is first stage because the preparation of enamel for bonding is very important. When an acetone-based adhesive is used, the technique of wet bonding is obligatory, that is, the enamel and dentin are not air-dried (16). When water-based or ethanol-based adhesives are applied, air-drying of enamel and dentin is recommended for effective bonding.

According to Van Meerbeek *et al*, the application of etch and rinse system enables bonding to the enamel using two types of resin tags. Resin macro-tags penetrate the interprismatic enamel structure whereas micro-tags penetrate the inter-crystal enamel prism space. The strength of bond between resin and enamel, measured according to the methodology of Sano *et al* (ηTBS-microtensile bond strength), amounts up to 40 MPa in etch and rinse system. On the other hand, in self etch system a weaker bond to the enamel has been determined of up to 30 MPa, while the bonding of hybrid GIC is the weakest and amounts ~ 20 MPa (8).

The weaker bonding of self etch systems can be explained by the formation of weak micro-retention in the enamel with the use of mildly acidic primers. Self-etching primers enable the formation of micro-tags whereas resin macro-tags are missing. It is also believed that the primer is permanently incorporated into dental surface since it is not rinsed with water. This explains the lower bonding quality of self-etching enamel adhesive systems (17- 19).

The results of this *in vitro* research show that the quality of enamel-composite bond is mostly determined by the manner of conditioning. It has been confirmed that the treatment of cavities with phosphoric acid significantly improves the capacities of adaptation of adhesive to the enamel. A statistically significant difference has been determined considering the width of marginal gap among the systems of total etching and self- etching, with the development of a wider gap around composite fillings placed by self etch system.

It is thought that liquid composites, due to low elasticity module, act as elastic buffers of contraction stresses and improve the marginal integrity of the fillings. Lining the cavity with liquid composite was recommended for reducing contact stress at the position of the bond between material and teeth because liquid composite possesses the capacity of tension absorption (20, 21).

However, this research has shown a weaker bond between material and enamel with fillings in groups 2 and 4 where liquid composite was used as final filling compared to groups 1 and 3 where hybrid composite was used as filling.

Glass ionomer cement is based on the reaction between glass particles (capable of releasing ions) and polyacids. A combination of silicate glass powder which is firm, hard and capable of releasing fluorides and metal ions and polyacrylic acid fluids which possesses adhesive capability and biocompatibility provides a biocompatible, adhesive and anticariogenic cement. Anticariogenic properties of glass ionomer, along with considerable adhesivity, make up the advantages of these cements over other binders. RMGIC (resin-modified GIC) have shown lower sensitivity to early contamination and erosion compared to conventional GIC (22, 23).

Glass ionomers remain the only material capable of self-bonding to dental tissues without previous surface treatment, although treatment is desirable. The treatment with conditioner and primer significantly improves bonding (8, 23). GIC are prepared in one or two stages. The improvement of bonding effect is achieved by cleaning' or removing a layer of debris by partial demineralization and chemical interaction of conditioner or primer with the remaining hydroxyapatite.

Although this research conducts pretreatment of dentin and enamel (cavity surface was prepared with primer) before applying Vitremer, the largest marginal gap was noticed around GIC fillings. It may be associated with weaker bonding of GIC to dental tissues and with GIC sensitivity to water disbalance (23).

The dehydration of teeth samples with GIC fillings during their preparation for SEM testing may have caused the loss of bond between fillings and dental tissue and the creation of marginal gap.

Adhesive techniques require great precision and strict adherence to application stages. Non-adherence to manufacturer's instructions concerning the application of adhesive may, among other things, compromise the bond between material and dental tissues. In addition, the content of composite material, manner and type of polymerization, length of polymerization influence the degree of contraction of composite resin. Micro-gaps appear as a consequence of polymerization contraction of composite materials as well as incoordination between the coefficient of thermal expansion of composite and hard dental tissues and lack of appropriate bond between material and dental tissues. Microorganisms, their toxins and oral fluids may penetrate marginal gap and cause inflammatory reaction of the pulp tissue (1, 23).

Forces generated by polymerization contraction lead to the development of contact stresses and may damage the bond with dentin and enamel as well as cause the separation of materials. There are numerous methods of stress reduction: 1) use of materials with low elasticity module; 2) use of material with higher filling percentage; 3) use of liquid composites; 4) slowing down material polymerization. Polymerization can be slowed down in several ways: a) by the use of light source that gradually reaches maximum intensity within 30 seconds; b) by illuminating the restoration through tooth substance, c) by gradually bringing the light closer to the restoration, d) by using ceramic blocks for the reduction of the volume of shrinking material, e) by applying the composite in layers whereby each layer is in contact with only one cavity wall (24-26). The degree of composite material contraction and the width of contact gap can also be influenced by clinical procedures of cavity preparation and treatment of the filling: adhesive cavity preparation, slanting the cavity edges, appropriate application of adhesive materials, manner of final filling treatment (1, 25).

A high-quality bond between the fillings and dental tissues can be influenced by the therapist's competency, patient cooperation, choice and technique of use of composite materials, as well as other clinical factors: cavity contamination by saliva or blood, contamination by moisture or oil from the irrigator, roughness of the contact area, mechanical rods within cavity, fluoride content in dental tissues, use of fluoride after restoration, characteristics of dentinal canaliculi, presence of plaque, dental calculus, pigmentation, debris on teeth, presence of liner and base as protective surfaces, teeth dehydration, ingredients of temporary cavity closure materials (26).

The *in vitro* demineralization procedure used in this research was responsible for early erosion of enamel surface, particularly along composite restoration margins. Erosion on samples kept in distilled water was not noticed, which shows that damage to the enamel was associated with exposure to acid. The damage was mostly visible around restoration margins while enamel surface away from the margins was relatively undamaged.

The morphology of enamel surface was characterized by two distinct fields. The first field was immediately along the restoration margin and showed a large number of porosities, complete removal of enamel prisms or absence of intraprismatic enamel. The second field was a peripheral zone that showed mild signs of demineralization.

Prati *et al.* (3) stated that enamel decomposition was increased in places where enamel was subjected to high tensile stress along enamel margins which can cause enamel surface degradation (24, 25).

Gaps and fractures along restoration margins represent the most probable way of lactic acid penetration deep into the enamel. The penetration of acidic solution may cause the formation of deep porosities creating various types of subsurface lesions (3, 25).

Surface morphology of demineralized marginal enamel, determined by this SEM research, is comparable to previous descriptions of early artificial carious lesion (3, 27) and enamel erosion (28). Prior researches describe considerable damage to the enamel prisms as well as specific outlook resembling honeycomb, especially along marginal enamel erosion (4). Demineralization of marginal enamel can lead to the opening of a fine network of a great number of porosities responsible for microleakage and re-coloring of restoration margins under clinical conditions. Polymerization contraction, demineralization and microleakage are strongly connected to the development of secondary caries of the enamel (1, 3, 11, 26). Research by Prati *et al.* (4) confirms that the enamel near the margins of adhesive restorations becomes severely damaged by acidic cariogenic solutions and that fluoride-releasing materials can prevent marginal demineralization but only in limited field near restoration margins. Significant dissolution of marginal enamel under the effect of acids appears in composite restorations of class V cavities and wedge-shaped erosions. The reasons for this include: a) high C factor of class V cavities (maximum C=5) or the relation between bonded and not bonded surfaces of the fillings is unfavorable causing the development of high cohesive contraction stress along the bonding line; b) cervical enamel is more sensitive to stress and this region is easily subjected to fractures and splits of the enamel due to polymerization contraction of composites (29).

Although there are numerous listed factors affecting the quality of the bond between adhesive fillings and dental tissues, this research has confirmed that the type of adhesive system clearly influences the bonding of modern restorative materials to the enamel.

CONCLUSION

SEM analysis of marginal adaptation of adhesive materials to the tooth enamel has determined the widest marginal microgap in GIC restoration system (*Primer, Vitremer, Glaze*).

Compared to self etch, the application of each and rinse (total etch) adhesive system leads to a better adaptation of composite material to the enamel.

The best marginal bond was achieved by the *Adper Single Bond 2 + Filtek Z250* composite adhesive system, whereas a wider microgap was noticed in *Adper Prompt-L-Pop/ Filtek flowable* composite adhesive system.

After exposure to cariogenic solution, more significant demineralization of the enamel was perceived in samples conditioned by self etching primers where a wider microgap was also measured, compared to samples prepared by total etch system.

Demineralization of marginal enamel with GIC system could be observed only in places where glaze was missing.

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MARGINALNA PUKOTINA I OŠTEĆENJE GLEĐI OKO ADHEZIVNIH RESTAURACIJA ZUBA (*in vitro* SEM ispitivanje)

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Sažetak

Postoje tri adhezivna restaurativna sistema: nagrizanje uz ispiranje, "etch and rinse", samo nagrizanje "self etch" i glas jonomer sistem. Marginalna pukotina i oštećenje marginalne gleđi oko kompozitnih i glas jonomer restauracija mogu biti izazvani primenom adhezivne restaurativne procedure.

Cilj ovog ispitivanja je procena marginalnog integriteta i morfologije gleđne površine oko ivica kompozitnih i glas jonomer restauracija, posle držanja u kariogenom-kiselom rastvoru.

Sedamdeset kaviteta V klase preparisano je sa ivicama u gleđi. Kaviteti su restaurisani sa: (I) 1. Single Bond/ Z 250 i 2. Single Bond/ Filek flow, korišćenjem „etch and rinse" adhezivnog sistema; (II) 3. Prompt-L-Pop/ Z 250 i 4. Prompt-L-Pop/ Filtek flow, korišćenjem „self etch" adhezivnog sistema; (III) 5. Vitremer, glas jonomer sistemom.

Posle restaurativne procedure, zubi sa restauracijama bili su podvrgnuti demineralizaciji tokom 7 i 28 dana. Uzorci su držani u demineralizujućem rastvoru (mlečna kiselina, pH 4.5, 0.1M) na 37^{0}C ili u dejonizovanoj vodi (kontrolna grupa). Ivice restauracija (širina pukotine) i perimarginalna gleđ ispitivani su skening elektronskim mikroskopom (SEM). Rezultati su analizirani korišćenjem ANOVA- Dunnet testa.

Hibridni kompozit sa „etch and rinse"adhezivnim sistemom (Single Bond/Z 250) pokazao je najbolju adaptaciju za gleđne ivice. Glas jonomer restauracije pokazale su značajno veću pukotinu u komparaciji sa „etch and rinse" i „self etch" sistemima ($p<0,01$). SEM ispitivanje je otkrilo demineralizovanu perimarginalnu zonu gleđi oko svih tipova restauracija. Ove zone su se karakterisale jakim znacima erozije, oštećenjem prizmi i porozitetima. Blaga oštećenja otkrivena su na površinama gleđi koje nisu bile uključene u perimarginalnu zonu.

Marginalna adaptacija restauracija za gleđ bila je efikasnija sa „etch and rinse" adhezivnim sistemom u odnosu na „self etch" i glas jonomer postupak. Jača demineralizacija perimarginalne gleđi primećena je oko svih adhezivnih restauracija.

***Ključne reči*: marginalna pukotina, demineralizacija, gleđ, adhezivne restauracije**