EVALUATION OF THE ADHESIVE INTERFACE OF COMPOSITE RESTORATIONS SUBJECTED TO DENTAL BLEACHING - SEM STUDY

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ABSTRACT
The aim of the study was to observe the interface between composite restorations and dental tissues in restored teeth subjected to dental bleaching. Materials and method: 20 class V composite restorations were applied in extracted teeth using a universal adhesive system in both self-etch and total-etch technique. Half of the restorations were bleached using a whitening agent containing 40% hydrogen peroxide. The teeth were axially sectioned through the restorations and the morphology of the interfaces at the margins of the restorations was analyzed using a scanning electron microscope. Results: The images showed the preservation of a tide contact between the composite resin and the dental tissues after the bleaching procedures. An adhesive joint involving a constant layer of resin was observed between composite resin and both enamel and cervical margins regardless of the chosen technique (self-etch or total etch). In rare situations, limited gaps were observed, most of them being related to cohesive failures of the material or adjacent dental tissues. Conclusions: The marginal adaptation and the morphology of the interface did not significantly change after bleaching. If bleaching affected the interface between composite resin and dental tissues, it seemed that the adverse effects could not be observed by electron scanning microscopy. Other investigation methods should be used to assess the influence of the sealing ability of the adhesives when the restored teeth undergo bleaching procedures.
Key words: universal adhesive, bleaching, adhesive interface

INTRODUCTION

Dental bleaching techniques have become very used nowadays due to the increasing aesthetic demands of patients. Therefore, as a result of patients' desire to achieve visible results as soon as possible, materials with high levels of active substance have become available on the market. Scientific studies and clinical experience have shown that improving aesthetic function also attracts side effects such as pulp inflammation or increased dentinal sensitivity [1,2]. An important aspect in preventing these complications is to treat carious and non-carious lesions by restorative treatment before starting the dental bleaching. In posterior teeth, the restorations may be preserved after the bleaching procedure even if the shade is visibly different from the adjacent dental. The ability of the restoration to seal the adjacent tissues is of utmost importance during bleaching and after this aggressive procedure [3-6]. Therefore, it is important to assess if dental bleaching has any detrimental effects on the sealing abilities of

bonding systems in order to decide if these materials adequately protect the teeth during bleaching and if these restorations should be preserved or replaced after the procedure.

The aim of the study was to evaluate the interface between the tooth and the composite resin bonded with a universal adhesive, immediately after subjecting the restored teeth to bleaching with 40% hydrogen peroxide.

MATERIALS AND METHODS

20 extracted teeth were cleaned by manual scaling and stored in distilled water at a temperature of 4 Celsius degrees. The class V cavities were prepared with high speed, using a cylindrical diamond bur with water cooling. The dimensions of the cavities were 2 mm deep, 3 mm wide and 2 mm high. The margins of all the cavities were made butt-joint in the enamel, and the gingival margins were placed at 1 mm bellow the junction between the enamel and the cement.

The teeth were randomly distributed in 4 groups and restored with a light-cured micro-hybrid composite - Gradia Direct and a universal adhesive - G-Premio Bond (GC Corporation, Tokyo, Japan) as follows. In two of the groups the bonding system was applied using a total etch technique (A, C); while in the other two groups the adhesive was applied using self-etch technique (B, D). For the total etch technique, an etching gel containing phosphoric acid 35% was placed for 15 seconds on the margins and the walls of the cavities prior to the application of the adhesive. Then the cavities were rinsed and gentle dried. The adhesive was applied on the walls of the cavity for 10 seconds then dried thoroughly for 5 s and light-cured for 10 s using a high-power LED curing unit. The composite resin was applied using the bulk technique and light-cured for 40 seconds. A Mylar matrix was applied in order to shape the restoration during polymerization. The restorations were finished for at least 10 seconds with a diamond extra-fine tapered bur (Mani Inc., Japan) and then ultra-fine straight-cut 30-blades carbide bur (NTI Kahla GmbH, Germany) in order to simulate the clinical procedures and to remove any excess material from the restoration margins. The specimens were preserved in distilled water at 4 Celsius degrees for 30 days.

Two groups (A, B) were used as control groups while the specimens in group C and D were exposed to bleaching procedures. The whitening agent Opalescence Boost 40% (Ultradent Products Inc.) was activated by pressing the plunger 25 times each direction. The gel was applied for 20 min on the surfaces of the teeth including restorations' surfaces and at least 2mm outside the margins. The bleaching gel was completely removed, and the teeth were cleaned with water spray and axially sectioned through the restorations using a diamond disc. The surfaces were evaluated using a scanning electron microscope (VEGA II LSH –TESCAN).

RESULTS AND DISCUSSIONS

Most of the SEM images showed a tide contact between the composite resin and the dental tissues before and after the bleaching procedure in both enamel and cervical margins (fig.1-4).

In the control groups, the adhesive joint included a constant layer of resin which was observed between composite and both enamel and dentin regardless of the bonding technique (fig. 1,2).

Group A (control group; total etch technique)		
Overview	**Occlusal margin**	**Cervical margin**

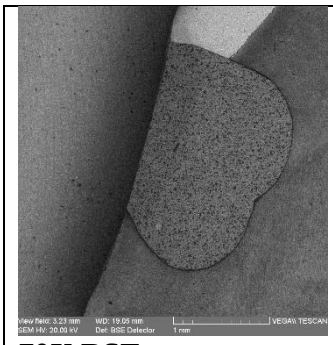
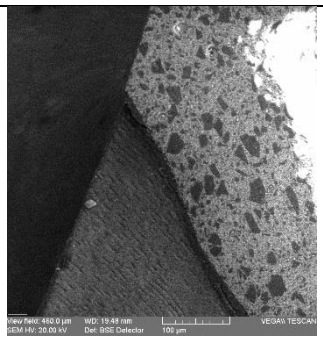
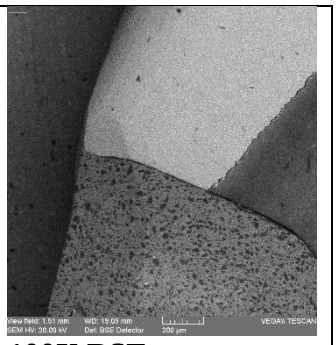
		
70X BSE	**500X BSE**	**100X BSE**
a	**b**	**c**

Fig. 1. SEM images of enamel and cervical margins of a sample from Group A.

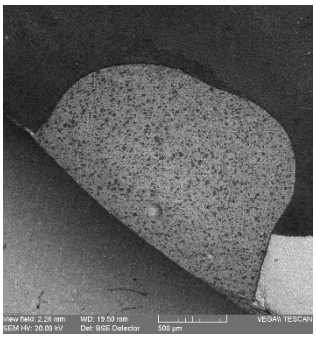
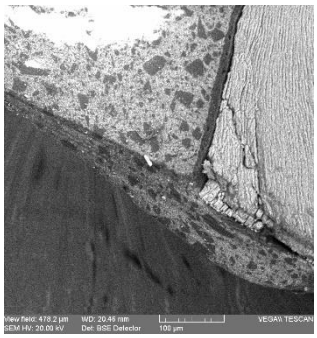
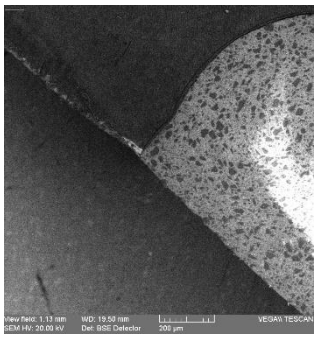
Group B (control group; self-etch technique)		
Overview	**Occlusal margin**	**Cervical margin**
		
70X BSE	**500X BSE**	**200X BSE**
a	**b**	**c**

Fig. 2. SEM images of enamel and cervical margins of a sample from Group B.

In the study groups, most images revealed a morphology of the adhesive joint similar to that observed in the control groups. A tide contact between the dental tissues and the composite resin, mediated by a uniform adhesive layer was present in most sections, suggesting the preservation of an adequate sealing regardless the bleaching application. The images of the adhesive joints at the margins and walls of the cavities were similar in the self-etch and total-etch groups (fig. 3,4).

Group C (study group, total etch technique)		
Overview	**Occlusal margin**	**Cervical margin**

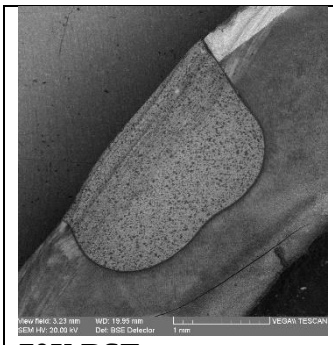
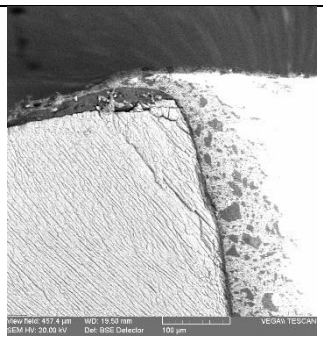
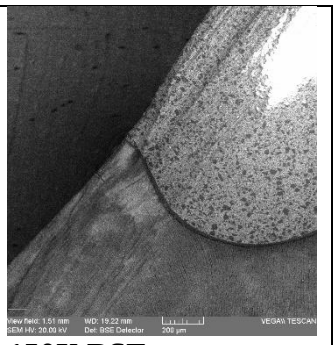
		
70X BSE	**500X BSE**	**150X BSE**
a	**b**	**c**

Fig. 3. SEM images of enamel and cervical margins of a sample from Group C.

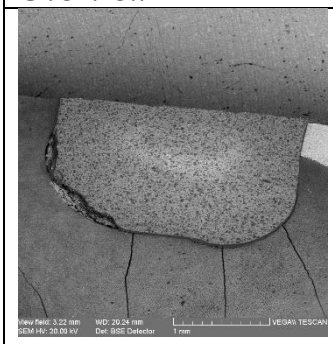
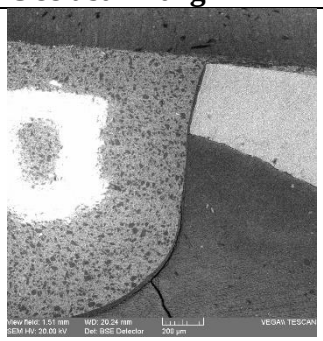
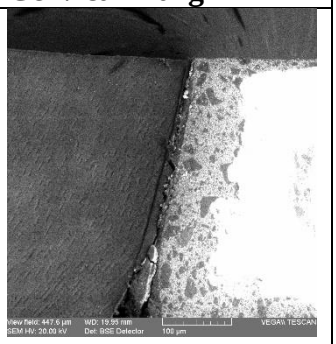
Group D (study group, self-etch)		
Overview	**Occlusal margin**	**Cervical margin**
		
70X BSE Overview	**150X BSE**	**500X BSE**
a	**b**	**c**

Fig. 4. SEM images of enamel and cervical margins of a sample from Group D.

In rare situations, small gaps were observed at the interfaces in all the groups. Most of the gaps were related to cohesive failures of the enamel (fig. 2.b; 3.b) or fractures within the composite resin (fig. 4.a). In most situations, the adhesive layers were preserved on the dental surface, still sealing the dental substrate. These defects might not be the result of bleaching procedures since they were observed in all the groups and might be related to the exposure of the samples to cutting and vacuum stress during the preparation of the specimens.

The bleaching process consists in the release of free radicals of hydrogen peroxide or carbamide peroxide with concentrations up to 40%, which have the capacity to interfere with chromophore molecules and thus reduce both their adhesion and size [7, 8]. At the same time, the oxygen radicals released from the peroxide, show a high non-specific reactivity and thus may influence both enamel and composit reactivity and interfere with the bonds between dental tissues and restorative materials [9-12].

The material used for bleaching was Opalescence which contains the maximum accepted concentration of hydrogen peroxide (40%). According to the producer, this material should be applied for 20 minutes and it is activated chemically; in

addition, it can be reapplied on the teeth during the same session or during a subsequent session.

Most of the data regarding the effects of bleaching on marginal adaptation of composite resins are the result of microleakage studies. Our study evaluated the marginal adaptation by investigating the morphology of the adhesive interface. The results were contrary to some previous researches that reported alterations of marginal adaptation and sealing ability of composite resin to both enamel and dentin after dental bleaching [13-15]. Another microleakage study showed the impairment of the sealing abilities especially for self-etching adhesives after bleaching procedures [16]. On the contrary, another study has demonstrated that the application of a bleaching agent with 30% hydrogen peroxide over a restoration with nanofilled composite resin applied with a self-etch adhesive led to a decrease in marginal microleakage at the gingival margin and no difference at the occlusal margin, however, the authors demonstrated insignificant changes when another type of methacrylate-based composite resin was applied in the same areas [17], which suggest that the effect of bleaching on the marginal adaptation might depend upon the composite resin that had been used.

The results of our study come in agreement with a previous study in which we evaluated the marginal microleakage of the same composite resin after bleaching and found no significant differences comparing to the unbleached samples at both enamel and cervical margins [3]. Similarly, White and coworkers demonstrated that bleaching using 20% carbamide peroxide for one hour or 6% hydrogen peroxide for 30 minutes, twice a day for 14 days, did not significantly change the occlusal margins of the restoration [White, 18]. Another study evaluating in office- bleaching with 35% hydrogen peroxide did not found significant changes in leakage or Knoop hardness score [19]. The lack of increase in marginal microleakage was also observed when photo-activated or chemical activated bleaching systems with similar concentrations of hydrogen peroxide were used [20, 21]. The results of our study are also supported by one study assessing the changes registered after the use of the self-etch and etch-and-rinse systems, where the control group presented lower microleakae scores compared with the groups treated with bleaching agents, except for chemically activated in-office bleaching. The authors concluded that the microleakage differed according to bleaching methods and no difference was found between the adhesive systems [22].

Although the SEM images in our study did not showed any significant alteration of the interface and marginal adaptation after bleaching, the changes might be too subtle to be revealed when using scanning electron microscopy. In addition, morphological defects caused by scaling or root planning can occur in the cervical area, which can lead to denudation of the dentinal tubules [23] and increase the risk for sensitivity and bacterial leakage after bleaching. Bleaching might also influence the bond strength and make the interface more susceptible to degradation on long term. Further studies evaluating the interface after artificial ageing by thermo- and mechanical cycling should be conducted in order to investigate this issue. The existence of significant differences between bleaching after self-etch and after total – etch techniques remains a topic for further studies. As for our study, we used a bleaching agent containing buffers for maintaining a neutral pH. This may be one of the reasons why the differences between the morphologies of the adhesive joints were

similar when different techniques of etching had been applied for restoration.

A series of studies aiming to assess the adhesive joint, support the idea that the influence of bleaching on marginal adaptation not only depends on the type of bleaching agent or adhesion technique, but also on the qualities of composite resin. Also, the quality of the initial bonding appears to be much more important than degradation induced by the bleaching agent [16, 17, 24, 25]. All these variables might explain the controversial results of the data regarding this issue. As regarding the materials that we have tested, the bleaching method seemed to be safe in terms of preservation of marginal adaptation of composite restoration since no significant deleterious effects have been noticed on the interface, however, the effect of bleaching on marginal sealing ability should be further evaluated.

CONCLUSION

1. The morphology of the interface between the composite resin and the margins of the cavity was not significantly influenced by the technique of application of the adhesive (self-etch/total-etch technique).
2. The results of the study showed that the marginal adaptation and the morphology of the interface did not significantly change after bleaching with the tested 40% hydrogen peroxide system. If the bleaching procedure affected the interface between composite resin and dental tissues, it seemed that the defects were too low to be observed by electron scanning microscopy.
3. As regarding the materials that we have tested, the bleaching method seemed to be safe in terms of preservation of marginal adaptation of composite restoration, however further investigation is necessary in order to assess the impact of dental bleaching on the restorations ability to protect the adjacent dental tissues on long term.

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