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Influence of Artificial Aging in Marginal Adaptation of Mixed Class V Cavities

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ABSTRACT

The aim of this study was to investigate whether the artificial aging by thermal cycling had influenced the marginal adaptation of class V restorations with/without chlorhexidine application in the bond process. Twelve intact human third molars were used. Class V cavity preparations were performed on the buccal surface and the teeth received 35% phosphoric acid-etching procedure (Ultradent Products Inc., South Jordan, Utah, USA). Subsequently, the samples were divided in two groups: Untreated acid-etched dentin and chlorhexidine application as an adjunct in the bond process. The adhesive Single Bond 2 (3M ESPE, St. Paul, MN, USA) was used after 2% chlorhexidine application, and the restorations were performed with Filtek™ Z350 XT (3M ESPE) composite resin. The specimens were submitted to artificial aging by thermal cycling with 3,000 cycles. Analyzes were performed on scanning electron microscopy using replicas of marginal adaptation in percentage of continuous margin before and after the artificial aging. The data were analyzed by paired test and the results showed statistically significant differences in the percentage of continuous margin with/without chlorhexidine treatment before and after thermal cycling. This study concluded that the artificial aging by thermal cycling influenced the marginal adaptation of mixed class V composite restorations.

Keywords: Artificial aging, Chlorhexidine, Dental marginal adaptation.

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INTRODUCTION

In the recent times the esthetics concept has been widespread in dental practice, a fact that is not restricted only to the dentists, but also reaches the patients. Thus, the light-cured composite resins have become the first choice in most of all restorations due to its esthetic, bonding properties and faster polymerization.[1] However, even the most perfect criteria restorations can be influenced by factors that act in the degradation of the bond interface. And this fact can produce failures in the adaptation, resulting in cracks between the restorative material and tooth tissue, resulting in improper restorations.[2,3]

The clinical success and the durability of adhesive restorations depend on the quality of the bond interface between the tooth and restoration, which depend on the correct use of the adhesive system. There are several alternatives procedures to promote the bond interfaces less susceptible to the biodegradation inside the oral cavity. The chlorhexidine has been shown effective to reduce the collagen fibers degradation, when it is applied to the etched dentin prior to bond system.[4-7] Studies have demonstrated that the hybrid layer integrity is preserved for a longer period after chlorhexidine pretreatment. This fact occurs once it works as an adjuvant for the bonding process[6,8] and does not interfere with the adhesive performance for short or long term.[5,7,9]

The artificial aging by thermal cycles is a viable and relevant option.[5] The samples were submitted to temperature variations, from the coldest to the hottest, in order to simulate the thermal stress that happens in the oral cavity.[10,11] The thermal cycling can influence the microleakage because there is a difference in coefficient of linear thermal expansion between the tooth structure and the restorative material. Furthermore, it allows the formation of 'gaps' in the interface tooth/restoration.[12,13]

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The purpose of this study was to evaluate the thermal cycling influenced marginal adaptation of class V composite restorations with/without application of chlorhexidine in the bonding process.

MATERIALS AND METHODS

Tooth Selection and Cavity Preparation

Twelve caries-free human third molars were selected and stored in 0.1% thymol solution at 4°C until its used. Standardized cavities class V were prepared at the buccal surface of each tooth and located in enamel and dentin using spherical diamond burs.

The dimensions of the cavities were 2.0 mm in depth, 2.0 mm in height, and 4.0 mm in width. Each bur was replaced with a new one after four cavity preparations. The standardization of the cavities preparation was performed with the aid of an adhesive template, probe millimeter, rubber stop, digital caliper and a stereoscopic magnifying glass (Model SZXL, Oympus, São Paulo, Brazil) in order to check the marginal imperfections analysis, such as fractures or cracks.

Dentin Treatment and Restorative Procedures

The teeth were randomly divided in two groups according to chlorhexidine treatment/without chlorhexidine treatment and adhesive system Single Bond 2(3M ESPE, St Paul, MN, USA) application. The adhesive system was applied following the manufactures recommendations. Groups with chlorexidine treatment for the dentin surface were conditioned with 35% phosphoric acid ultraetch (Ultradent Products Inc, South Jordan, Utah, USA) for 15 seconds on dentin and 30 seconds on enamel. The cavities were rinsed for 15 seconds and dried with absorbent paper and received 20 ml of 2% chlorhexidine for 60 seconds and then the adhesive system was applied in two layers and dried with an air spray for 5 seconds and light-cured for 10 seconds. The group without chlorhexidine treatment received the adhesive system according to the same humidity conditions described above. The Z350 XT (3M ESPE, St Paul, MN, USA) composite resin, shade A3 was inserted into the cavities according to the incremental technique. The increments were light-cured with LED (Radii Plus, with output intensity of 1,200 mW/cm^2) for 20 seconds each. All restorations were finished and polished by using abrasive wheels with different grits (Sof-Lex PopOn - 3M ESPE). Final polishing was performed by carbide brush (Brush Jiffy - Ultradent). The teeth were stored in water at 37°C in the dark.

Evaluation of the External Adaptation

After storage, impressions with a polyvinylsiloxane material (President light body, Coltène/Whaledent AG, Altstätten, Switzerland) were made and epoxy resin replicas were prepared (Epofix, Struers, Rodovre, Denmark). After the confection of the replicas, the teeth were submitted to artificial aging. The thermal cycling was performed in flushing water with temperatures changing 3.000× from 5°C to 55°C with a dwelling time of 2 minutes each. After the thermal cycling, another impression of the outer margin of each restoration and epoxy replicas were prepared for the computer-assisted quantitative analysis in a scanning electron microscope (XL20, Philips, Eindhoven, The Netherlands) at 200× magnification.

RESULTS

The differences between the percentages of continuous margin before and after thermal cycles loading in enamel and in dentin were evaluated using the Tukey´s test pairs comparison. There was significant difference before and after the thermal cycles and a lower value of continuous margin can be observed after thermal cycles loading. The data are shown in Tables 1 and 2 and the means demonstrated significant differences that are shown by different letters in the same line.

DISCUSSION

The microleakage between tooth/restoration interface is one of the most critical factors of esthetic restoration. The shrinkage polymerization, the stress provoked by masticatory efforts and the coefficient of linear thermal expansion lead to degradation of sealing marginal.[3,4] The involved and the uninvolved collagen fibers with the adhesive system degraded with the same proportion to the restoration aging.[14,15] Thus, collagen fibers can affect and influence the pathogenesis of the carious process because it destabilizes the acid-etched fibers through the action of metalloproteinases (MMPs).

These activated enzymes are responsible for the hydrolytic degradation of collagen which interfere with the integrity of the hybrid layer.[14,16] The pH values ranging from 2.3 to 5 can activate the MMP, this process is known as acid activation. Bacterial metabolism and acid etching result in acids which may activate the MMPs. However, studies have demonstrated that the chlorhexidine application to adhesive systems can prevent the degradation of collagen fibers and present antimicrobial properties.[4,6,7]

Carrilho et al, 2007[10] had shown that the hybrid layer was preserved in the specimens pretreated with 2% chlorhexidine after comparison to their respective controls without treatment. So the chlorhexidine has an antimicrobial function already recognized and also acts as an important potent MMP inhibitor.[4] The results obtained in this study

Table 1: Analysis of the enamel in pairs before and after thermal cycling with the averages and standard deviations (mean ± SD) of noncontinuous margin in % (5% significance level, by Tukey´s test)

Substratum	*Treatment*	*Marginal adaptation (%)*	
		Before thermocycling	*After thermocycling*
Intact	Without treatment	92.43 (4.76)[a]	85.16 (4.02)[b]
	Chlorhexidine	93.91 (5.29)[a]	84.25 (3.86)[b]
Decayed	Without treatment	88.35 (3.67)[a]	79.41 (5.71)[b]
	Chlorhexidine	89.40 (5.08)[a]	80.94 (5.32)[b]

Means followed by the same letters do not differ significantly

Table 2: Analysis of the dentin in pairs before and after thermal cycling with the averages and standard deviations (mean ± SD) of noncontinuous margin in % (5% significance level, by Tukey's test)

Substratum	*Treatment*	*Marginal adaptation (%)*	
		Before thermocycling	*After thermocycling*
Intact	Without treatment	87.98 (5.16)[a]	80.09 (5.27)[b]
	Chlorhexidine	88.14 (5.29)[a]	82.55 (4.09)[b]
Decayed	Without treatment	79.56 (4.72)[a]	71.86 (5.82)[b]
	Chlorhexidine	77.80 (4.86)[a]	71.48 (4.75)[b]

Means followed by the same letters do not differ significantly

revealed that the chlorhexidine treatment group showed no statistical differences in comparison to without treatment group. The minimal chlorhexidine concentration capable of inhibit MMP type 9 is 0.002%, while the MMP type 2 shows the more sensitive response and being inhibited as low as 0.0001%, and MMP type 8 is inhibited by 0.02%.[4] Pasheley et al, 2004[5] demonstrated that concentration of 0.2% chlorhexidine is sufficient to inhibit the collagenolytic activity to near-zero levels.

However, there is no standardization and most studies in the literature reports the use of 2% chlorhexidine,[6-10] as the concentration used in this study. *In vivo* evaluation is most appropriated way to obtain information regarding the oral conditions,[11] but this procedure consumes time, financial resources and the rapid evolution of restorative materials and adhesives lead to seek alternatives to simulate clinical conditions through *in vitro* studies.[12] Another condition to be simulated *in vitro* studies is the intraoral temperature variation, which happens during ingestion of food and beverages and can influence the restorations. The difference in the coefficient of thermal expansion between the tooth structure and restorative materials can induce stresses in the bond interface.[13] In order to simulate the oral conditions, the thermal cycling is the ideal test to be performed.[13-15] In these tests, the specimens are alternately dipped in solutions made of saliva or water and exposed to different temperatures (hot/cold). This study used the thermal fatigue by thermal cycling (3,000 cycles, from 5 to 55°C) with a dwelling time of 2 minutes each temperature according to ISO TR 11450 standardization.

The standard recommends that the thermal cycling is performed with at least 500 cycles in water from 5°C and 55°C. This study showed that the thermal cycling influenced the external adaptation in enamel/dentin in all groups in comparison to the initial situation. Lucena-Martín et al, 2001[13] found that dye leakage at the gingival margin in class V restoration was significantly increased after thermal cycling (500 cycles, from 5 ° to 55°C). However, according to these authors the same fact is not observed at coronary margins in enamel, which shows that the adhesive bond to enamel is more resistant to thermal stress. In this study, it was concluded that the class V composite restorations had an initial cracks and after artificial aging by thermal cycling, the cracks increased, independent of the application of chlorhexidine.

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