

AVALIAÇÃO CLÍNICA DO TRATAMENTO DA DENTINA COM CLOREXIDINA EM RESTAURAÇÕES DE LESÕES CERVICAIS NÃO CARIOSAS

*Clinical Evaluation of Chlorhexidine-Treated Dentin in Non-Carious Cervical Lesion
Restorations*

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RESUMO

O objetivo deste estudo é realizar uma avaliação clínica de longo prazo do efeito do uso de 2% de digluconato de clorexidina após o condicionamento com ácido fosfórico, na qualidade de restaurações de lesões cervicais não cariosas realizados com um sistema adesivo convencional simplificado. Métodos: Dez pacientes com lesões cervicais não cariosas bilaterais foram selecionados. Em cada paciente, restaurações de controle foram

realizadas em um hemiarco, e no sentido oposto do hemiarco, restaurações de teste foram feitas com aplicação de clorexidina após o condicionamento com ácido fosfórico a 37%, antes da aplicação do sistema adesivo. Todas as restaurações foram realizadas sob as mesmas condições clínicas pelo mesmo profissional utilizando o sistema adesivo convencional simplificado (Adper Single Bond 2 / 3M-ESPE) e resina composta microhíbrida (Opallis / FGM). Os pacientes retornaram para avaliação clínica em quatro intervalos de tempo: 1 semana, 1, 3 e 6 meses. Em cada intervalo de tempo, os critérios de avaliação foram os seguintes: retenção da restauração, integridade e descoloração marginal, lesão de cárie secundária e a sensibilidade pós-operatória. Os dados obtidos foram tabulados e analisados estatisticamente (Friedman / Wilcoxon, alfa = 5%). Resultados: Entre os parâmetros clínicos, integridade marginal e descoloração marginal diferiram significativamente entre os grupos teste e controle em 6 meses; e os piores resultados foram encontrados no grupo de controle. Conclusão: A aplicação de 2% de digluconato de clorexidina antes da utilização do sistema adesivo convencional simplificado resulta em maior qualidade e durabilidade da adesão aos substratos dentais, notado especialmente a partir de seis meses de observação clínica.

Palavras-chave: adesivos dentinários, Restauração Dentária Permanente, clorexidina.

ABSTRACT

The aim of this study was to make a clinical and long-term assessment of the effect of using 2% chlorhexidine digluconate after phosphoric acid etching, on the quality of non-carious cervical lesion restorations performed with a simplified conventional adhesive system. Methods: Ten patients with bilateral non-carious cervical lesions were selected. In each patient, control restorations were made in one hemi-arch, and in the opposite hemi-arch, test restorations were made with chlorhexidine application after 37% phosphoric acid etching, before application of the adhesive system. All restorations were performed under the same clinical conditions by the same professional using the simplified conventional adhesive system (AdperSingle Bond 2/3M-ESPE) and microhybrid resin composite (Opallis/FGM). Patients returned for clinical assessment at four time intervals: 1 week, 1, 3 and 6 months. At each time interval, the assessment criteria were as follows: retention of restoration, integrity and marginal discoloration, secondary caries lesion and post-operative

sensitivity. The data obtained were tabulated and statistically analyzed (Friedman/Wilcoxon, $\alpha=5\%$). Results: Among the clinical parameters, marginal integrity and marginal discoloration differed significantly between the test and control groups at 6 months; and the worst results were found in the control group. Conclusion: The application of 2% chlorhexidine digluconate before the use of the simplified conventional adhesive system results in a higher quality and durability of the bond to dental substrates, noted especially as from six months of clinical observation.

Keywords: Dentin-Bonding Agents, Dental Restoration, chlorhexidine.

INTRODUCTION

In spite of the continuous development of adhesive restorative materials, there are still limitations in contemporary restorative dentistry as regards good marginal sealing of the cavity preparation, particularly in the presence of dentin at these margins, a fact directly responsible for the clinical success of restorations (CARRILHO, CARVALHO *et al.*, 2007; SHIMADA, ICHINOSE *et al.*, 2009).

During bonding procedures, dentin surface demineralization is essential for hybrid layer formation, this being the structure responsible for the micromechanical retention of the adhesive system to the tooth structure. The adhesive system bond to dentin occurs through infiltration and polymerization of the adhesive into the collagen fibrils exposed by decalcification resulting from the acid etching (NAKABAYASHI, KOJIMA *et al.*, 1982).

However, the reduction in bond strength to dentin may occur due to progressive degradation of the hybrid layer under clinical conditions (NAKABAYASHI, KOJIMA *et al.*, 1982). The mechanism of deterioration of the components at the adhesive interface is still controversial. Studies have shown that the phenomenon involves two substrates, resin and dentin, and that it is adversely affected by the action of water (hydrolytic degradation)

and proteolytic enzymes of dentin (enzymatic degradation) (CARRILHO, CARVALHO *et al.*, 2007; REIS, PELIZARO *et al.*, 2007).

This premature degradation of the hybrid layer appears to result from series of factors, including poor infiltration of resin monomers into the demineralized dentin surface and the presence of unpolymerized monomers in the adhesive layers. As a result, there are zones of exposed collagen fibrils, and these become more predisposed to being hydrolyzed and attacked by proteolytic enzymes (CARRILHO, TAY *et al.*, 2009). Collagenolysis occurs through the action of dentin matrix metalloproteinases (MMP), which are proteins present in the human body even under normal conditions (BARCELLOS, BATISTA *et al.*, 2012; HEBLING, PASHLEY *et al.*, 2005; RITTER, HEYMA *et al.*, 2005). Persistent collagenolytic activity may be impaired by the use of protease inhibitors, such as chlorhexidine, which preserve the structural integrity of the collagen fibrils (BARCELLOS, BATISTA *et al.*, 2012; HEBLING, PASHLEY *et al.*, 2005). There are other factors that may also influence further degradation of polymerized adhesive resins, such as their polarities, and the incorporation of ionic functional and more hydrophilic groups into the polymer mesh, which may allow more permeable and unstable adhesive layers, that are more prone to water absorption, lixiviation and hydrolysis over the course of time (HEBLING, PASHLEY *et al.*, 2005; TAY, PASHLEY *et al.*, 2006).

A previous study suggested the use of chlorhexidine as a MMP inhibitor within adhesive interfaces, observing that such procedure could arrest the *in vivo* degradation of the hybrid layers (HEBLING, PASHLEY *et al.*, 2005; RITTER, HEYMA *et al.*, 2005). According to Lessa *et al.*, 2009, using chlorhexidine on dentin etched with phosphoric acid before the application of the adhesive system appears to retard degradation at the resin-dentin interface, maintaining the integrity of the restoration for a longer period of time. This

effect could be related to the ability of chlorhexidine to inhibit the action of dentin enzymes - the metalloproteinases - on degradation of the adhesive interface after placement of the restoration (HEBLING, PASHLEY *et al.*, 2005). Furthermore, chlorhexidine may be a complementary method for rehydrating dentin after acid etching, washing and drying, preserving the humidity necessary for maintaining the collagen network expanded (CHANG e SHIN, 2010).

Therefore, the hypothesis tested in this study was that the application of 2% chlorhexidine digluconate after phosphoric acid etching may contribute to the clinical success of resin composite restorations when a simplified conventional adhesive system is used. Thus, the aim of this study was to assess the action of 2% chlorhexidine digluconate in non-carious cervical lesion restorations made with a simplified conventional adhesive system and resin composite by observing the following clinical parameters at different time intervals: retention, marginal integrity, marginal discoloration, presence of caries lesion adjacent to the restoration, and post-operative sensitivity.

MATERIAL AND METHODS

Sample Selection

Ten patients of both genders with adequate oral conditions and with bilateral non-carious cervical lesions in homologous teeth were selected for this study. The non-carious cervical lesions should possess similar geometric characteristics and were selected according to the inclusion and exclusion criteria (Table 1). The patients signed a term of free and informed consent and they were aware of the procedures to be performed in the research. This study was approved by the Research Ethics Committee of the Federal

University of Bahia under protocol N° 19/09.

Table 1 - List of criteria for inclusion and exclusion of research volunteers

INCLUSION CRITERIA
<ul style="list-style-type: none">• Having more than 18 years of age• Having more than 20 natural teeth in the mouth• Introduce two to four non-carious cervical lesions in different quadrants (2 mm to 3 mm apart occlusal-gingival and less than 2 mm in depth)• The non-carious cervical lesions could not be retentive, in addition to having at least 50% margin in enamel and more than 75% of the total area in dentin• The antagonist teeth should be present or rehabilitated• The cervical margin of the lesion should be in dentin• Good oral hygiene pattern (presence of plaque visible in less than one quarter of the teeth)
EXCLUSION CRITERIA
<ul style="list-style-type: none">• Pregnant patients• Smokers• Patients under treatment analgesic and / or anti-inflammatory• Diseases or who used medications that could induce xerostomia• Individuals undergoing orthodontic treatment, used fluoride supplement or some kind of desensitizing agent• Presented cervical injuries with subgingival margins or evidence of significant occlusal stress (wear facets)• Presence of periodontal or gum disease• Presence of cavities, longitudinal cracks, fractures, premature contact or unsatisfactory restorations in the tooth to be restored

Restorative Procedures

The experimental groups (test and control) were formed according to the adhesive

technique used. Following a split-mouth design, the bilateral cervical lesions were randomly distributed into two experimental groups.

For the two groups, the restorative procedures were performed under the same clinical conditions and by the same professional. Firstly, the internal walls of the cervical lesion were finished using a laminated spherical bur compatible with the cavity size under constant cooling (KG Sorensen, Sao Paulo, SP, Brazil). These procedures were carried out under local anesthesia whenever necessary.

In both groups, the restorations were performed under relative isolation using lip and cheek retractors (ArcFlex, FGM, Joinville, SC, Brazil) and cotton wool rolls placed at the outlets of salivary glands and at the bottom of the vestibule, close to the working area. In addition, a gingival retraction cord (Prortract n.00, FGM, Joinville, SC, Brazil) moistened with 25% aluminum chloride-based hemostatic gel (Hemogel, FGM, Joinville, SC, Brazil) was inserted into the gingival sulcus region of the tooth being restored.

- Control group: after preparation and isolation of the region close to the cervical lesion, acid etching with 37% phosphoric acid (Condac 37 FGM, Joinville, SC, Brazil) was applied on the enamel margins for 30 seconds and on dentin for 15 seconds. Next, the cavity was rinsed for 30 seconds and blotted using absorbent paper. After this, the simplified conventional adhesive system Adper Single Bond 2 (3M ESPE, St Paul, MN, EUA) was actively applied following the manufacturer's recommendation in two consecutive coats with a disposable brush for 15 seconds, followed by evaporation of the solvent for 10 seconds and application of air spray and light activation for 20 seconds using an halogen light-curing unit (Optilight 600, Gnatus Equipamentos Médico-Odontológico, Sao Paulo, SP, Brazil) at power density of 600mW/cm². Next, a microhybrid resin composite (shade A3) (Opallis, FGM, Joinville, SC, Brazil) was inserted into the cavity in

oblique increments of a maximum of 2 mm so that the two opposite walls were not united, and they were separately light activated for 20 seconds.

- Test group: The test restorations were made in the opposite hemi-arch, only adding 2% chlorhexidine digluconate (Clorhexidina S, FGM, Joinville, SC, Brazil) after etching the cavity with 37% phosphoric acid. The 2% chlorhexidine digluconate was applied with a cotton ball, for 30 seconds. After this period, the cavity was blotted with absorbent paper. Application of the adhesive system following the manufacturer's recommendation and insertion of resin composite were performed in the same manner as used for the control restorations.

After concluding the restoration of the two groups, the excess adhesive and restorative materials were removed with a scalpel blade n° 12 (Lamedid Comercial e Serviços Ltda, Sao Paulo, SP, Brazil), followed by finishing and polishing with medium, fine and extra-fine grain flexible aluminum oxide disks (Sof-Lex Pop-on, 3M ESPE, St Paul, MN, USA) used in a decreasing sequence of abrasiveness.

Clinical Evaluation

Patients returned for clinical evaluation at four time intervals: 1 week, 1, 3 and 6 months. The analyses were performed by a previously researcher without prior knowledge of which teeth belonged to the control and test groups, characterizing a blind evaluation. For analysis of the clinical evaluation criteria, the teeth were air dried with a triple syringe and analyzed using an oral mirror and a new exploratory probe under adequate lighting. The margin of each restoration was completely analyzed and the clinical finding was considered in the presence of at least one site with a noteworthy record. The clinical findings were analyzed according to the criteria included in Table 2.

Table 2 - Description of clinical evaluation criteria.

Variable	Criterion
Retention	1 = Present: retained restoration 0 = Lost: Presence of mobility, partial or complete loss
Marginal integrity	1 = Absence of step perceived with an exploratory probe. 0 = Positive or negative step perceived with an exploratory probe
Marginal discoloration	0 = Absence of discoloration 1 = Marginal discoloration present
Post-operative sensitivity	After stimulation with air for 1 second at 1 cm distance from the restoration, the response was recorded as: 0 = Absent or 1 = Present
Secondary caries lesion	0 = Absence of lesion 1 = Presence of clinically unacceptable lesion

After data collection, if any restoration needed recontouring and repolishing because of marginal defects or discoloration, the procedure was performed using the same technique and materials used previously. When a repair was needed, it was performed at any time interval of evaluation.

RESULTS

The data obtained from qualitative variables were analyzed using nonparametric tests; the Wilcoxon test was used to compare groups at each evaluation time interval, and the Friedman test for comparison among the time intervals for each experimental group. The analysis was performed in the BioEstat program, version 5.0, at a level of significance

of 5%.

The frequency of the clinical findings obtained for each evaluation is described in Table 3. According to the results of the study, it was found that all restorations of the 10 patients performed with 2% chlorhexidine digluconate remained in position during the six months of evaluation. In the Control group, some restorations showed total or partial loss over the period of evaluation, however, no statistical significance was detected for these losses. No significant difference in postoperative sensitivity was found between the two groups in the time intervals of the study. There was no presence of secondary caries lesions in any restorations.

Table 3 - Frequency of clinical findings according to experimental group and time interval of evaluation (n=10).

Clinical variable	Experimental group	Evaluation period			
		1 week	1 month	3 months	6 months
Restoration retention	Test	10	10	10	10
	Control	10	8	7	6
Marginal discoloration	Test	0	0	0	0
	Control	1	2	2	5*
Post-operative sensitivity	Test	1	2	1	3
	Control	2	3	5	6
Marginal integrity	Test	9	10	10	10
	Control	8	8	5*	4*
Secondary caries lesion	Test	0	0	0	0
	Control	0	0	0	0

Asterisks (*) indicate statistically significant differences within groups (Friedman/Wilcoxon, alpha-5%).

The analysis of marginal discoloration indicated that within the time interval of 6

months, Test and Control groups showed a statistically significant difference, with the largest number of defects found at the margins in the Control group ($p = 0.04$). Significant differences were also observed between the marginal integrity findings of the two groups at the time intervals of 3 months ($p = 0.04$) and 6 months ($p = 0.03$). At both time intervals, the lowest number of restorations with complete marginal integrity was observed in Control group.

DISCUSSION

The present study was conducted in order to clinically determine whether the application of 2% chlorhexidine digluconate after phosphoric acid etching contributed to the success of resin composite restorations performed using the simplified conventional adhesive system. For this purpose, the split mouth experimental design was used, in which the patient functions as his/her own control. Notably, individual particularities such as oral microflora, degree of oral hygiene, dietary habits and biomechanical behavior of teeth during chewing contribute to the largest source of variation in a clinical trial, leading to the need for including a larger sample to generate scientific evidence. In the split mouth design, this larger source of experimental variability is minimized, ensuring the reliability of the data, even when a smaller sample size is used (HEBLING, PASHLEY *et al.*, 2005).

Non-carious cervical lesions are frequently used in the clinical analysis of restorative procedures (KARAMAM, YAZICI *et al* 2012; HAMMADEH e REIS., 2001; LOGUERCIO, STANISLAWCZUK *et al.*,2009). These cavities might present alterations in the dentin substrate due to the degree of mineralization or sclerosis, causing a decrease in bond strength to this surface (NAKABAYASHI, KOJIMA *et al.*,1982). Because they provide a substrate with a complex bonding mechanism, restorations of non-carious

cervical lesions enable evaluations that compare the clinical criteria of quality and success, playing an important role in the conduction of the present study (HAMMADEH e REIS., 2001).

Chlorhexidine digluconate is a biocompatible solution with a broad antibacterial spectrum, and has low toxicity with high substantivity and positive charge (LESSA, NOGUEIRA *et al.*, 2010). This antimicrobial agent has high affinity for tooth structures, which may be increased after the formation of microporosities created by phosphoric acid etching, probably resulting in better bonding to dentin (CHANG e SHIN, 2010). In a previous study, authors have observed through scanning electron microscopy that chlorhexidine left debris on the dentin surface when applied after acid etching. Nonetheless, such debris didn't lead to a decrease in bond strength values, and it was pointed out the important influence of chlorhexidine on wetness control during adhesive procedures on dentin substrates.

When analyzing the data of this investigation, a more satisfactory behavior of the restorations performed after the application of 2% chlorhexidine digluconate is noted with regard to the marginal integrity after 3 and 6 months of evaluation. This finding indicates the greater effectiveness of marginal sealing of the restorations in which chlorhexidine was used, particularly during long-term clinical follow-up. Knowing that the degradation of the hybrid layer is one of the major causes of restoration loss and that according Carrilho *et al.*, 2007, the use of chlorhexidine in restorative treatments maintains bond strength and the morphological characteristics of the hybrid layer for a longer period time, it is highly suggestive that the application of 2% chlorhexidine digluconate as an inhibitor of metalloproteinase enzymes, which participate in the degradation of collagen, appears to contribute to the maintenance of the long-term quality of restorations (CARRILHO,

CARVALHO *et al.*, 2007; CARRILHO, TAY *et al.*, 2009; LOGUERCIO, STANISLAWCZUK *et al.*, 2009).

When assessing marginal discoloration, less staining of the restorations performed after using 2% chlorhexidine digluconate was also observed. This result may be justified by the existence of more evident marginal cracks and/or gaps in the control restorations, especially after the sixth month of clinical evaluation. This in turn, allowed the incorporation of pigments from the diet causing subsequent staining of the polymers present in the adhesive systems. Moreover, as these polymers are more exposed to the oral environment, they may become rapidly degraded, leading to the superficial defects.

One of the recognized side effects associated with the use of 2% chlorhexidine digluconate is its capacity to stain the teeth (ADDY e HUNTER, 2003; ADEYEMI, JARA *et al.*, 2006; ATTIN, BUCHALLA *et al.* 2006; de CASTRO, de ANDRADE *et al.*, 2003). For this reason, the marginal discoloration criterion was also included in the present investigation in order to analyze whether the chlorhexidine-treated dentin would provide composite restorations with more stained surfaces and margins. Despite initial caution in restricting the indication of prior use of 2% chlorhexidine digluconate before adhesive restorations in areas highly involved in esthetics, the results of this study indicated an opposite direction, since only restorations that did not receive previous application of chlorhexidine showed marginal discoloration. However, further studies that consider a longer clinical evaluation period must be conducted to confirm such data.

With respect to pulp response, which considered the presence of postoperative sensitivity, the use of 2% chlorhexidine digluconate before the application of the adhesive system did not appear to be a factor directly related to sensitivity. This evaluation is important since postoperative sensitivity may be due to the impairment in the quality of the

hybrid layer formation, which leads to an increase in microleakage and pulpal irritation (BARCELLOS, BATISTA *et al*, 2012). Nevertheless, when it comes to restorations performed in the cervical region of teeth, false-negative results may be possible due to the stimulus caused by the passage of fluids in areas of exposed dentin, and thus, this evaluation criterion must be improved in future investigations.

CONCLUSION

In accordance to the findings and limitations of the present investigation, the use of 2% chlorhexidine digluconate for 30 seconds, after acid etching and before performing resin composite restorations with a simplified conventional adhesive system, may contribute to the improvement in clinical parameters such as marginal integrity and marginal color stability in a period of up to six months of clinical evaluation. Therefore, the addition of this new clinical step can be advised, given the possibility of increasing the predictability and longevity of adhesive restorative procedures.

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