Effect of Sodium Hypochlorite on the Different Substrates – A SEM Analyses

Regina Maria Puppin-Rontani* and Angela Scarparo Caldo-Teixeira
Núcleo de Pesquisa em Odontopediatria. Faculdade de Odontologia de Piracicaba, Universidade Estadual de Campinas. Av Limeira 901, 13414-018- Piracicaba, SP, Brasil.
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Abstract

Objective: to evaluate the effect of the Carisolv™ system on the dentin substrate of human and bovine (permanent and primary). Methodology: 8 human teeth and 8 bovine teeth were selected. They were divided according to treatment [35% phosphoric acid gel(PA) for 15s and Carisolv™ system(C)] and substrate type into [human and bovine primary teeth, human and bovine permanent teeth]. The teeth were ground flat in SiC paper until dentin was reached. The C treatment was accomplished according to the manufacturer's instructions, followed by PA for 15s. The specimens were prepared to SEM analyses. Dentin tubules, intra and inter tubular dentin were analyzed. Based on the results found It could be concluded C system produced expressive alteration on the bovine teeth (permanent and primary ones) and permanent human teeth, with tubular disclosing and decrease of the peri an inter tubular dentin. Otherwise, the primary teeth just showed the tubules disclosing and slightly alteration of the peri and inter tubular dentin.

Introduction

Considering the difficulties of the restorative treatment in Pediatric Dentistry, concerning the carious tissue removal using rotative instruments, it has been proposed the development of a chemomechanical system, that at the same time offered the removal of the carious tissue, without the need of local anesthesia.

This system uses a mixture of 0.5% sodium hypochlorite and three amino acids (Lysine, Leucine and Glutamic Acid) in a gel preparation. Its action is attributed to the presence of sodium hypochlorite that removes the altered collagen.

Nowadays, the use of adhesive restorative materials has been diffused as a functional and aesthetic method for the recovery of dental structure lost by the decay. However, they have been used after the conventional removal of the carious tissue, that is, without the induction of chemical alterations in the dentin surface.

Nevertheless, with the development of the non traumatic removal of the carious tissue, through the Carisolv™ system its performance, in conjuction with the adhesive systems, has been questioned. As this system is based on the action of the sodium hypochlorite, and it (being considered percentage and time of performance in the dental tissue) is capable of removing collagen, which has a fundamental role in the adhesive process, there are some conflicting researches concerning bond values.1, 3, 6, 7, 14, 16, 17, 21

In order to achieve efficient bond of restorative materials to the dental tissues, according to Gwinnet4 and Nakabayashi *et al.*15 resin penetration should occur inside the tubules, as well as, in the inter tubular dentin, permeating the collagen net, in a phenomenon named hybridization.

Studies indicate that the removal or alteration of the smear layer, which is composed by debris of the dentin and bacteria, provoked by the mechanical removal of the carious tissue, promoting larger effectiveness in the bond between restorative material/tooth8. Furthermore, its excessive removal would provoke a collapse in the collagen zone weakening the bond between restorative material/tooth.13

The adhesive procedure has been found efficient in permanent teeth. However, in primary teeth there remains a doubt due to their morphology. Although, Yoshiyama *et al.*18 e Nör *et al.*12 have found that the dentin of the primary is conditioned more quickly than the one of the permanent teeth due to its morphology and composition, because they have less mineralized tubules, this suggests that the bond protocol is differentiated between permanent

and primary teeth. Consequently, the choice of the material to be used for the accomplishment of the adhesive process, as well as, for the removal of the carious tissue should be analyzed carefully, because there are countless factors that influence the success of the adhesive dentistry treatment.

This way, the objective of this study was to evaluate through Scanning Electron Microscopy (SEM), the effect of Carisolv™ system in the dentin micro morphology of human and bovine teeth (permanent and primary), observing the different morphologic patterns after its use.

Materials and Methods

Eight human teeth and 8 bovine teeth were selected and divided into two groups according to the treatment to be accomplished (control and experimental). The specimens were stored in timol solution, washed, and then stored in saline solution until the experiment was carried out.

After the teeth selection, the roots were sectioned it the cement-enamel junction (CEJ) and the crowns were sectioned in the mesio-distal orientation, using a saw machine (ISOMET 1000/Buehler UK Ltd), so two specimens were obtained from each tooth.

Soon after, 1mm deep crevice was made using a diamond tip at the enamel surface in order to guide the grinding. Then, the surface was polished using SiC paper (#240-600) under refrigeration.

After the wear, the surfaces were examined with Stereoscope Microscopy (Model XLT30 – New Optical System), with 25X magnification in order to verify the absence of any remaining enamel.

Then, the Carisolv™ system was applied according to the manufacturer's instructions, and the samples were maintained in distilled water, at 37°C in 100% of relative humidity until they be submitted to the dehydration process and sputter for analysis in SEM.

The prepared samples were analyzed in SEM, and classified according to the following scores: presence or absence of the smear layer, disclosing or not of the dentin tubules; and morphologic aspect of the inter tubular dentin surface.

Results

The results demonstrated that the Carisolv™ system acted with larger intensity in the bovine substrate when compared with the human ones. Its action provided accentuated alteration, with significant decrease of thickness of peri and inter tubular dentin, opening and enlarging of the dentin tubules, as well as determined significant increase in the conditioning of the inter tubular dentin. Considering the different human substrates (primary and permanent), the primary one was less affected than the permanent one. However, the bovine substrate, both primary and permanent presented the same conditioning characteristics.

The conventional treatment with 35% phosphoric acid (control group) showed similar morphologic pattern for all the groups, characterized by the opening of the dentin tubule, and in the permanent teeth it could be observed slight conditioning of the inter tubular dentin.

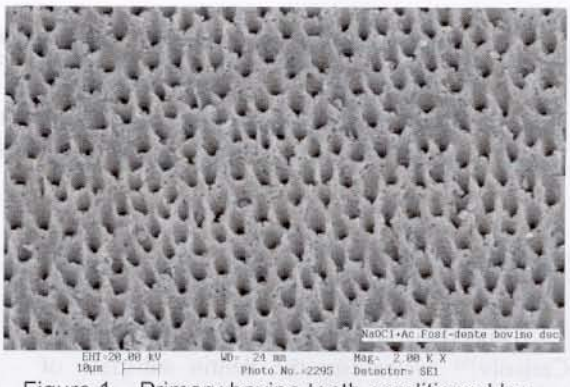

Figure 1 – Primary bovine teeth conditioned by Carisolv™ system (Mag. 2.0 K X)

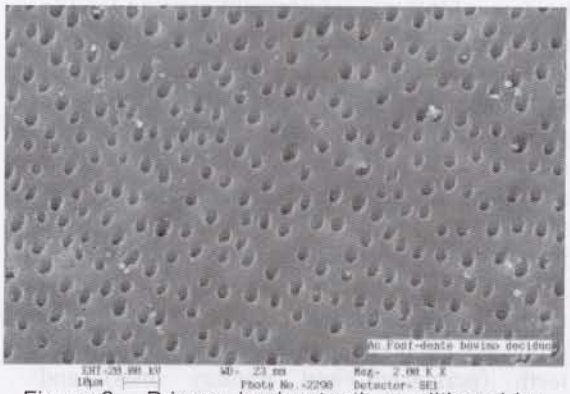

Figure 2 – Primary bovine teeth conditioned by 35% phosphoric acid (Mag. 2.0 K X)

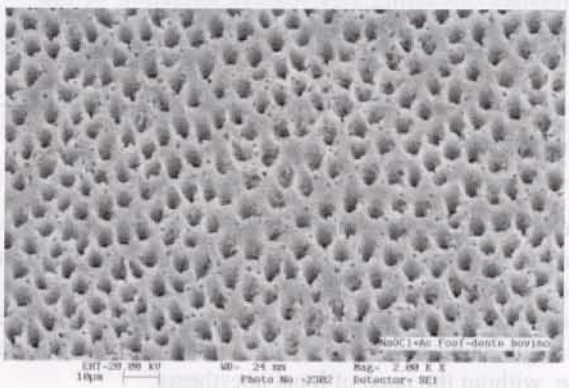

Figure 3 – Permanent bovine teeth conditioned by Carisolv™ system (Mag. 2.0 K X)

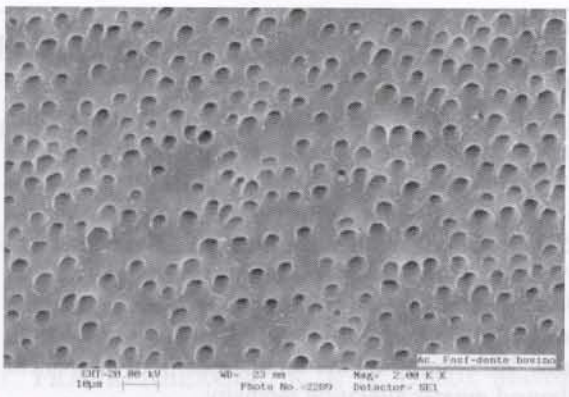

Figure 4 – Permanent bovine teeth conditioned by 35% phosphoric acid (Mag. 2.0 K X)

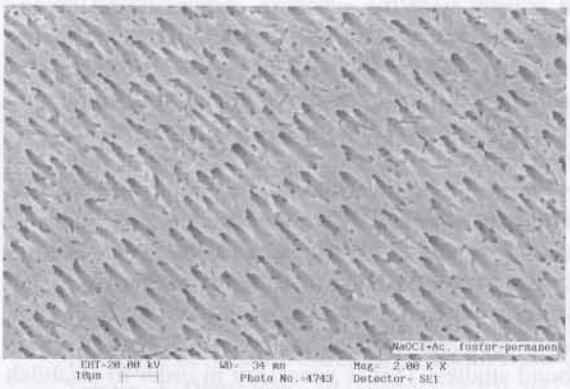

Figure 5 – Permanent human teeth conditioned by Carisolv™ system (Mag. 2.0 K X)

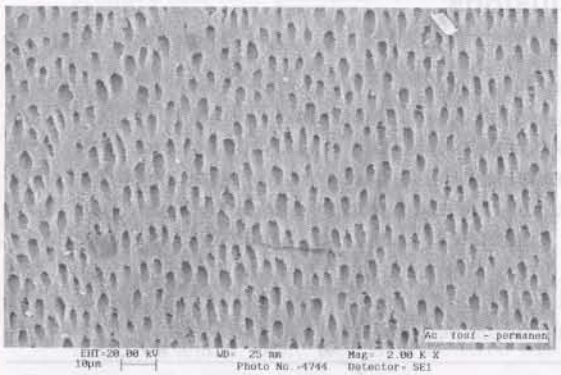

Figure 6 – Permanent human teeth conditioned by 35% phosphoric acid (Mag. 2.0 K X)

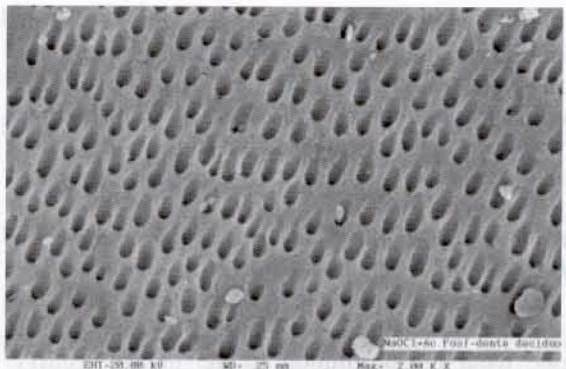

Figure 7 – Primary human teeth conditioned by Carisolv™ system (Mag. 2.0 K X)

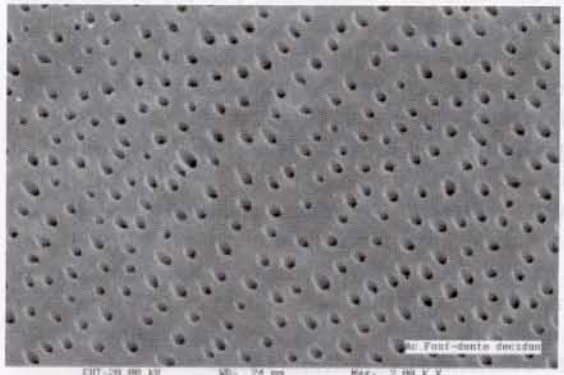

Figure 8 – Primary human teeth conditioned by 35% phosphoric acid (Mag. 2.0 K X)

Discussion

The conventional adhesive restorative technique consists of the removal of the carious tissue with sharp manual or rotating instruments proceeded by the cleaning of the cavity and conditioning of the dentin surface, increasing the substrate energy for a better flow of the adhesive system and consequently to increase the effectiveness of the adhesion. That stage also aims to create micro porosities, to remove or to treat the smear layer produced by the removal of the carious tissue and to enlarge the opening of the dentin tubules for a better mechanical interlocking of the restorative material to the substrate.

The use of a chemomechanical method to remove the carious tissue, for the performance of a proteolytic agent as the sodium hypochlorite, in substitution to the conventional method, would determine alterations in the adhesive properties of the substrate, because the adhesion suffers influence of both the mineral and organic content of the adherent.

Thus, it was chosen for this study the conventional treatment (etching acid) on the of the surface after

production of a smear layer Sic paper, grit 600, in the control group and on the layer of the experimental groups, the application of a chemomechanical system associated with the conventional process of adhesion, in the attempt of to reproduce the clinical steps of removal of altered tissue and to observe the morphologic patterns generated by the procedures.

Due to the difficulties in performing longitudinal clinical studies to evaluate restored teeth, and to get human dental elements for the verification of that same action *in vitro* the literature has reported the employment of bovine teeth in substitution to the human teeth11. However, the morphologic differences should be considered when comparing studies using human and bovine teeth.

The conventional conditioning process of the dentin surface with 35% phosphoric acid was similar for all the studied substrates (figs. 2, 4, 6, e 8), characterized by the disclosing of the tubules, for the total removal of the smear layer and opening of the dentin tubules. However, in the permanent human teeth (fig.6) slight conditioning the inter tubular dentin could just be evidenced. Those alterations represent important modifications in the hybridization of the resin monomers with the dentin surface etched, because this bases on the interaction of those monomers with the peri and inter tubular dentin, being of great influence in the shear bond of the restorative materials to the dental tissue.

When the action of the acid conditioning is compared between the different human substrates (primary and permanent), the permanent human dentin seemed to be more reactive than the primary human dentin (figs. 6 e 8). For the importance represented by the morphologic alterations of the dentin concerning the shear bond9, it can be inferred that the values found in the literature are in agreement with the morphological aspects found in this study.

Concerning the use of Carisolv™ system, whose action is mainly attributed to the presence of the sodium hypochlorite removing of the denatured collagen20, it could be observed that the human dentin substrate (fig.7) was less favorable to the action of the sodium hypochlorite, compared with the bovine dentin substrate (fig. 1). The action of Carisolv™ system could be observed through the total removal of the smear layer, through the larger conditioning of the inter tubular dentin, promoting great porosity to the area, as demonstrated by BRANNSTRON, JOHNSON E FRISKOPP2. They reported that the use of the Carisolv™ system opened the dentin tubules, demineralized the inter tubular dentin, but differently from our results they found intact the peri tubular dentin.

The efficiency of the etching acid on the dentin surface can be attributed to the amount of mineral present in the dentin substrate. The larger the amount of minerals like Mg, Ca, P and Zn19, the smaller will be the produced structural alterations for both the acid conditioning or the deproteinization produced by the application of sodium hypochlorite.

Thus, different substrates (from primary and permanent teeth dentin) could show different conditioning patterns. This study demonstrated that the use of Carisolv™ system in the primary and permanent dentin produced alterations of different intensity. The permanent teeth presented larger conditioning intensity. It was observed the removal of the smear layer, opening and the disclosing of the dentin tubules in a similar way for both substrates. However, the inter tubular dentin of permanent teeth showed greater alteration intensity.

The Carisolv™ system had greater effect on the dentin surface of primary bovine teeth than on the dentin surface of primary human teeth (figs. 1 and 7). The same did not happen with the substrate of human and bovine permanent teeth that demonstrated similar conditioning patterns. They had an increase in pororsity of the inter tubular dentin, disclosing and amplification of the dentin tubules, and removal of the smear layer (figs 3 and 5).

Therefore, the use of Carisolv™ system as a method for the removal of the carious tissue could influence the shear bond strength and affect the efficiency of adhesive restorative procedures, mainly in primary teeth. Studies should be accomplished in order to correlate the hybridization and the shear bond, of primary and permanent teeth, as well as the use of bovine teeth on shear bond studies. This is necessary in order to establish a comparison among the results to guarantee that they can safely substitute the human teeth in researches.

Conclusions

The Carisolv™ system produced a significant alteration on the bovine dentin substrate (permanent and primary), and human dentin substrate (permanent), with total removal of the smear layer, the opening of the dentin tubules, and the reduction of the area of peri and inter tubular dentin. On the other hand, in the the primary human dentin substrate there was the total removal of the smear layer, the opening of the tubules, and just a slight alteration of the peri and inter tubular dentin.

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