**Pesqui Odontol Bras**
2003;17(1):63-8



# Effect of prophylactic treatments on the superficial roughness of dental tissues and of two esthetic restorative materials

# *Efeito de tratamentos profiláticos na rugosidade superficial de tecidos dentais e de dois materiais restauradores estéticos*

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**ABSTRACT:** Dental prophylaxis is a common way to remove dental plaque and stain, both undesirable factors in most dentistry procedures. However, besides cleaning the tooth surface, prophylactic techniques may increase the surface roughness of restorations and dental tissues, which, in turn, may result in plaque accumulation, superficial staining and superficial degradation. This study evaluated the effect of three prophylactic techniques – sodium bicarbonate jet, pumice paste and whiting paste – on the superficial roughness of two restorative materials – a composite resin and a compomer – and on the superficial roughness of two dental surfaces – enamel and cementum/dentin – through rugosimetric and scanning electron microscopy (SEM) analysis. Statistical analysis of the rugosimetric data showed that the use of pumice paste on enamel produced a significantly smoother surface than the natural surface. However, comparing the effect of the three techniques, prophylaxis with the pumice paste produced a rougher surface than did the other techniques as regards enamel and cementum/dentin probably due to its abrasiveness. On composite resin, the pumice paste only produced a rougher surface than did the whiting paste. On compomer, all of the applied treatments produced similar results. Based on rugosimetric and SEM analysis, we could conclude that the prophylactic treatments employed did not improve roughness of the studied surfaces. As to the effects of the techniques, they were different depending on the surfaces on which the prophylactic treatments were applied.
**DESCRIPTORS:** Dental prophylaxis; Composite resin; Compomers; Dental enamel; Dentin.

**RESUMO:** A profilaxia dental é uma prática comum para a remoção de placa bacteriana e outros indutos que dificultam a realização dos procedimentos restauradores. Entretanto, como efeito secundário à limpeza, pode-se ter uma superfície mais rugosa e sujeita a manchamentos e degradações. O presente estudo avaliou os efeitos de três técnicas de profilaxia – jato de bicarbonato de sódio, pasta de pedra-pomes e pasta de branco de espanha – sobre a rugosidade superficial de dois materiais restauradores – resina composta e compômero – e de duas superfícies dentais – esmalte e cemento/dentina – através da análise rugosimétrica e de microscopia eletrônica de varredura. A análise estatística dos resultados rugosimétricos mostrou que a profilaxia com pedra-pomes sobre o esmalte produziu uma superfície estatisticamente mais lisa do que a natural. Entretanto, comparando-se o efeito dos três tratamentos, a rugosidade superficial produzida pela pedra-pomes foi maior do que a produzida pelos outros tratamentos tanto para esmalte quanto para cemento/dentina, provavelmente por ser mais abrasiva, sendo que para a superfície de resina composta a rugosidade produzida pela pedra-pomes foi maior apenas do que a produzida pelo branco de espanha. Já para o compômero, os três tratamentos se comportaram de maneira semelhante. Podemos afirmar, baseando-nos na análise de rugosimetria e nas imagens das micrografias eletrônicas de varredura das superfícies estudadas, que os tratamentos profiláticos empregados não aumentaram a rugosidade das superfícies tratadas. Comparando-se os efeitos das três técnicas, estes foram diferentes, dependendo das superfícies em que foram empregadas.
**DESCRITORES:** Profilaxia dentária; Resinas compostas; Compômeros; Esmalte dentário; Dentina.

## INTRODUCTION

The removal of dental plaque and stain are required in most operative dentistry procedures. In adhesive restorative procedures, dental cleaning before etching is essential for a full restorative technique[5,11]. The presence of organic debris covering the enamel surface, for example, hinders the complete etching of enamel, preventing the creation of a uniform pattern of demineralization[1].

Several investigations have shown that a sodium bicarbonate jet is more effective in removing dental stain than the application of abrasive pastes with rubber cups[7,13]. This conventional cleaning technique does not remove all organic debris from fissures whereas the sodium bicarbonate jet removes the organic debris over the entire surface of fissures, enabling etchants and sealants to fully penetrate them[6,10,13,14,16,17]. Some studies have

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shown that the sodium bicarbonate jet could cause clinically significant loss of enamel and root structure. However, recent studies have demonstrated that this kind of prophylactic technique did not result in a roughened enamel surface[9,13,14].

Sodium bicarbonate jet treatment produces a smoother radicular surface free of plaque, but it causes accentuated root erosion even after a short period of application[2,3,9]. Scanning electron microscopy revealed the presence of a well-formed smear layer produced by the action of the sodium bicarbonate jet during dentin abrasion. It has been demonstrated that when the dentinal tubules are occluded with a smear layer, patients have less dentin sensitivity than when the tubules are patent[9]. This fact and the possibility of reactive dentin formation caused by the application of a sodium bicarbonate jet[15] may explain why it can be used for the treatment of dentin hypersensitiveness.

A composite resin and a compomer are included in this study because these aesthetic restorative materials are commonly used in cervical areas, invariably more susceptible to the action of prophylactic treatments. Rugosimetric analysis is one of the most accurate quantitative methods for evaluating superficial roughness[8].

The aim of this research was to assess the effects of some commonly employed prophylactic techniques on the superficial roughness of dental surfaces – enamel and cementum/dentin – and on the superficial roughness of two aesthetic restorative materials – composite resin and compomer – through rugosimetric analysis. Scanning Electron Microscopy (SEM) was used to elucidate the results rendered by the rugosimetric tests.

## MATERIALS AND METHODS

Twenty-three extracted third molars from young adult patients were used with their consent and with the approval of the Ethical Committee, School of Dentistry, University of São Paulo. The teeth were examined to ascertain enamel soundness. Their roots were cut off 5.0 mm short of the cementoenamel junction. They were then half-sectioned and both fragments were embedded in acrylic resin so as to leave enamel and radicular surfaces exposed .

Using composite resin (Z 100®, 3M, St. Paul, USA) and compomer (Dyract®, Dentsply, Konstanz, Germany), 45 disc-shaped specimens of each material were made with 7.0 mm diameter and 3.0 mm thickness. The discs were embedded in acrylic resin leaving 1.0 to 1.5 mm of one of their surfaces exposed. They were then submitted to sequential Sof-lex• (3M, St. Paul, USA) disc finishing.

Before any treatment was applied, each specimen of composite resin and compomer was submitted to a first rugosimetric reading in 5 different areas; each specimen of the dental fragments (enamel and cementum/dentin) were also submitted to a rugosimetric reading, only now in 3 different areas. Roughness of these surfaces was measured with the Surftest 211 (Mitutoyo, São Paulo, Brazil) rugosimetric equipment. The point of the rugosimeter device was set at a 0.8 mm dislocation and to read millimeter units. After these first readings, 15 specimens of each material (composite resin and compomer) and of each dental fragment (enamel and cementum/dentin) received one out of three kinds of prophylactic treatments:

- sodium bicarbonate jet (SBJ) (Profi II Ceramic, Dabi Atlante, Ribeirão Preto, Brazil) - the nozzle orifice was positioned at a 90-degree angle and 5.0 mm away from the surfaces, during 20 seconds;
- pumice paste (PP), applied with a rubber cup directly on the surfaces, during 20 seconds;
- whiting paste (WP), applied with a rubber cup directly on the surfaces, during 20 seconds;

The water/powder proportion of the pastes was standardized in order to obtain a firm consistency so as not to allow dispersion of the material on the surface during application. After treatments were applied, the surfaces were washed with an air/water spray for 20 seconds, and each specimen was submitted to a new rugosimetric reading. The surface roughness values were submitted to statistical analyses (ANOVA and *t*-test). Two samples of each kind of specimen were processed for SEM analysis. The specimens were mounted on aluminum stubs and air dried. After sputtering with a 40 nm layer of gold in a Balzers SCD050 apparatus (Balzers, Liechtenstein, Germany), the surfaces were examined in a Jeol 6100 scanning electron microscope (Jeol, Tokyo, Japan) operating at 10-15 kV.

## RESULTS

The statistical *t*-test was used to compare the rugosimetric values produced by each prophylactic treatment on the specimen surfaces with the control values, and the results are as follows: compomer ($p = 0.524$, $p = 0.850$ and $p = 0.948$ respectively for PP, WP and SBJ); composite resin ($p = 0.179$,

p = 0.087 and p = 0.669 respectively for PP, WP and SBJ); and root surface (p = 0.282, p = 0.582 and p = 0.879 respectively for PP, WP and SBJ), The statistical analysis showed no differences between values of treated and non-treated surfaces. Nevertheless, on enamel, the PP produced a statistically smoother surface than that of the natural control sample (p < 0.001, p = 0.989 and p = 0.798 respectively for PP, WP and SBJ).

The effects of the three prophylactic treatments were compared with each other through the statistical ANOVA test (Table 1). The statistical analysis showed that the PP produced a rougher surface than did the others as regards enamel and root surfaces, probably due to its abrasiveness. On composite resin, the PP only produced a rougher surface than did the WP. On the compomer surface all treatments applied produced similar results.

Figures 1 through 6 show the effects of some of the prophylactic treatments employed.

**TABLE 1 -** Multiple comparison of surface effects produced by the different treatments applied.

| Surfaces treated | Group | Group | Significance (ANOVA) |
|---|---|---|---|
| Compomer | PP | WP | p = 0.328 |
| | | SBJ | p = 0.293 |
| | WP | PP | p = 0.328 |
| | | SBJ | p = 0.997 |
| | SBJ | PP | p = 0.293 |
| | | WP | p = 0.997 |
| Composite resin | PP | WP | p = 0.010 |
| | | SBJ | p = 0.415 |
| | WP | PP | p = 0.010 |
| | | SBJ | p = 0.185 |
| | SBJ | PP | p = 0.415 |
| | | WP | p = 0.185 |
| Enamel | PP | WP | p < 0.001 |
| | | SBJ | p < 0.001 |
| | WP | PP | p < 0.001 |
| | | SBJ | p = 0.639 |
| | SBJ | PP | p < 0.001 |
| | | WP | p = 0.639 |
| Cementum/dentin | PP | WP | p < 0.001 |
| | | SBJ | p = 0.001 |
| | WP | PP | p < 0.001 |
| | | SBJ | p = 0.883 |
| | SBJ | PP | p = 0.001 |
| | | WP | p = 0.883 |

## DISCUSSION

The necessity to carry out dental prophylaxis before clinical procedures in operative dentistry following one of the techniques used in this study has been proven by different studies[11,13,15,17].

The enamel surface presents a natural roughness due to the presence of Retzius grooves, pits and small deffects, besides mineral deposition that may take place in the oral environment. The latter,

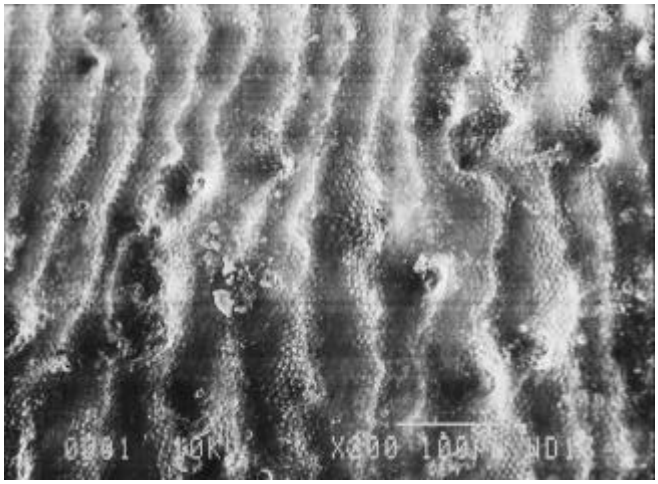

**FIGURE 1 -** Scanning electron micrograph of the enamel surface without superficial treatment (200 X).

**FIGURE 2 -** Scanning electron micrograph of the enamel surface treated with pumice paste (200 X).

**FIGURE 3 -** Scanning electron micrograph of the enamel treated with whiting paste (200 X).

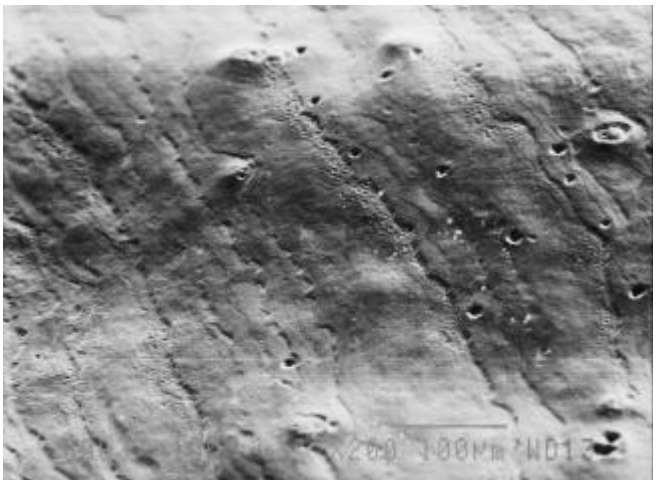

**FIGURE 4 -** Scanning electron micrograph of the enamel treated with sodium bicarbonate jet (200 X).

however, was not present in the experimental conditions of this study since the teeth used were unerupted. On enamel surfaces, the PP caused enamel erosion, resulting in a smoother surface than the natural one. The surface thus obtained, however, was rougher than that produced by the other prophylactic treatments. The statistical analysis showed that the PP has an erosion power capable of smoothing out the natural enamel surface, and the scanning electron micrographs also showed that the erosion power of the PP altered the enamel, leaving a more homogeneous surface than the natural one, in spite of the presence of marks produced by it. This aspect problably explains the lower rugosimetric values of the enamel surface treated with the PP as compared to the non-treated surfaces (control). The other treatments applied (WP and SBJ) were not able to cause a comparable erosion on the enamel surfaces, thus their rugosimetric values were not statistically different from those of the non-treated surfaces (controls)[9,13].

The scanning electron micrographs also showed that the enamel surfaces treated with WP and the SBJ have a smoother appearance than the non-treated surfaces (control). As these treatments maintained the general morphology of the enamel surface, they did not produce statistically significant differences when compared to each other and when compared with the non-treated surfaces (controls)[10,13,17].

On cementum/dentin surfaces the PP produced rougher surfaces than did others treatments, although it did not produce statistically significant differences when compared with the non-treated surfaces (controls). Special interest on the effects of these treatments on cementum/dentin surfaces is justified by cases of

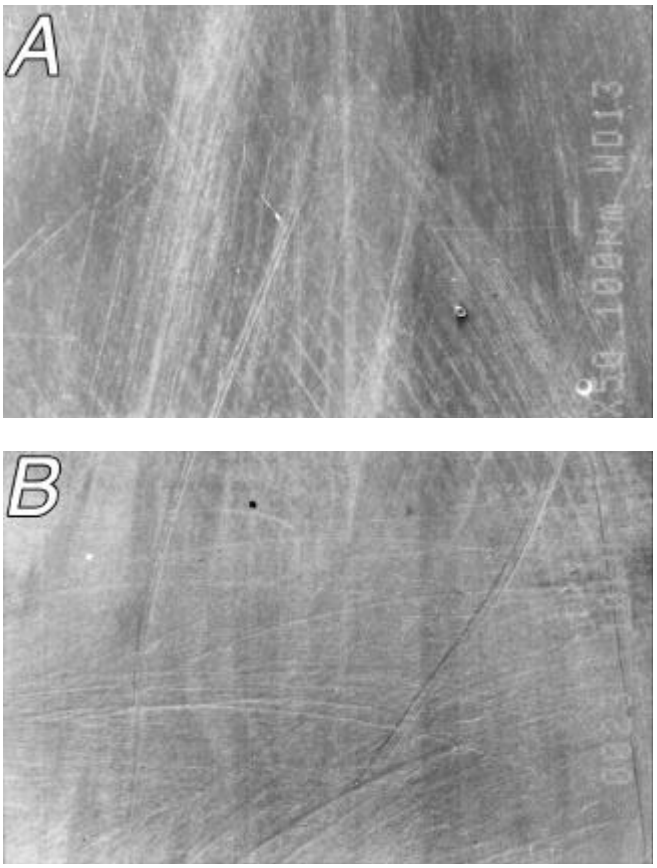


**FIGURE 5 -** Scanning electron micrograph of the composite resin. In **A** surface without treatment, and in **B** treated with pumice paste (50 X).

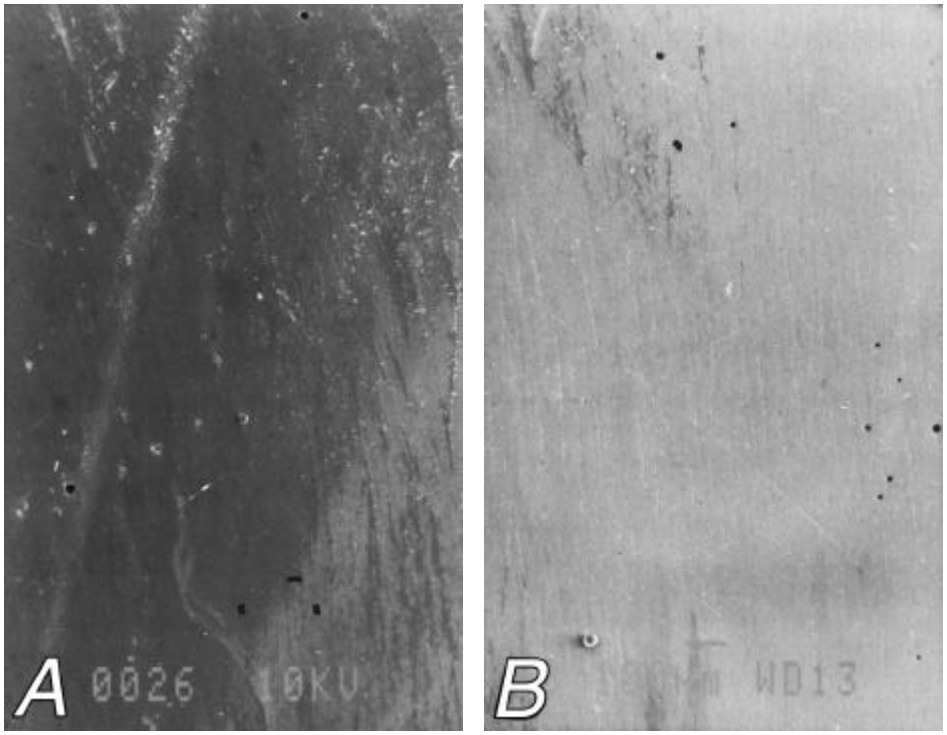


**FIGURE 6 -** Scanning electron micrograph of the composite resin. In **A**, surface without treatment and in **B**, treated with whiting paste (50 X).

gingival retraction in aged patients, where radicular dentin is exposed. In such cases, cementum is initially exposed and then quickly lost, resulting in dentin exposure on the radicular surface. In addition, these areas retain more plaque and stain more than other areas of the tooth because of the porosity of the region's dentin and cementum[2].

Thus, the effects of the prophylactic techniques employed in this study did not modify the superficial roughness of the dental surface, allowing their application without collateral effects. The application of the prophylactic techniques on the experimental restorative materials did not produce rougher surfaces than the polished ones (controls). This fact also makes the use of these techniques safe when restorations are present. We must emphasize, however, that on composite resin, the PP produced a rougher surface than did the WP. This probably means that the PP eroded the organic component more than the exposed inorganic particles which are harder and, consequently, more resistant to erosion[8].

The statistical results were confirmed by the scanning electron micrographs as the specimens submitted to the SEM analysis did not receive any treatment to remove the smear layer. The smear layer presented different characteristics depending on which prophylactic treatment was applied and depending on the treated substrate[12]. The smear layer was maintained because its removal would have altered the surface characteristics revealed when the rugosimetric readings were carried out. The SEM images showed only slight superficial alterations of the surface roughness of the treated specimens when compared with the natural tissues or with the polished materials studied.

## CONCLUSIONS

Based on the methodology used in this study we could conclude that:

- the prophylactic techniques studied did not increase the superficial roughness of the studied surfaces, and the pumice paste was able to smooth out the enamel surface;
- comparing the techniques' effects, the pumice paste produced a rougher surface than did other treatments on dental tissues; on composite resin it produced a rougher surface than did the whiting paste. On compomer, the treatments applied did not produce statistically different effects on surface roughness.

## ACKNOWLEDGEMENTS

FAPESP – Process number: 00/09239-6.

Salami D, Luz MAA de C. Effect of prophylactic treatments on the superficial roughness of dental tissues and of two esthetic restorative materials. Pesqui Odontol Bras 2003;17(1):63-8.

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Recebido para publicação em 04/03/02
Enviado para reformulação em 23/08/02
Aceito para publicação em 28/11/02