

Alteration of the bristles of a toothbrush after brushing of the acrylic resin using different dentifrices

Alteração das cerdas de uma escova dental após escovação da resina acrílica com diferentes dentífricos

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ABSTRACT

Objective

This study evaluated the change in toothbrush bristles after brushing with water and four dentifrices, one for natural teeth (Sorriso, Colgate-Palmolive Ind e Com. Ltda., Osasco, Brazil) and three for dentures: Corega (GSK - GlaxoSmithKline, Brasil Ltda., Rio de Janeiro, Brazil), Experimental 1 (Zonil) Experimental 2 (Chloramine T).

Methods

Soft brushes were used with 26 clumps of bristles with 0.25 mm in diameter and 10 mm high. Brushing was performed on a Pepsodent machine where the toothbrushes and associated dentifrices brushed acrylic specimens (Plex-glass). The brushing time was 50 minutes (one year/17,800 cycles). Ten toothbrush bristles per group were removed. A group of ten unused bristles represented the control group. The bristles were placed on a Plex-glass dish so that they were all in the same plane. The diameter measurement was performed using a profilometer with a precision of tenths of millimeters (0.01 mm) to within 0.02 mm of the tip of the bristle. Ten values were obtained for each combination (toothbrush and toothpaste) tested.

Results

Data analysis was performed using Anova Test ($P < 0.05$). The results indicated that only the Sorriso group (Colgate-Palmolive Ind e Com. Ltda., Osasco, Brazil) (0.15 ± 0.02) compared with the control group (0.2 ± 0.02) was statistically significant ($P = 0.0117$), while the values of the other groups (Water: 0.18 ± 0.02 ; Corega (GSK - GlaxoSmithKline, Brasil Ltda., Rio de Janeiro, Brazil): 0.17 ± 0.2 ; Experimental 1: 0.16 ± 0.02 ; Experimental 2: 0.16 ± 0.02) showed no significant change.

Conclusion

The Sorriso toothpaste (Colgate-Palmolive Ind e Com. Ltda., Osasco, Brazil), suitable for natural teeth, caused the biggest change on the tips of toothbrush bristles.

Indexing terms: Complete denture. Dentifrices. Toothbrushing.

RESUMO

Objetivo

Avaliar a alteração nas cerdas de escovas dentais após escovação com água e quatro dentífricos, sendo um para dentes naturais (Sorriso, Colgate-Palmolive Ind e Com. Ltda., Osasco, Brasil) e três para próteses totais: Corega (GSK - GlaxoSmithKline, Brasil Ltda., Rio de Janeiro, Brasil), Experimental 1 (Zonil), Experimental 2 (Cloramina T).

Métodos

Foram utilizadas escovas macias com 26 tufo de cerdas de 0,25mm de diâmetro e 10 mm de altura. A escovação foi realizada em máquina do tipo Pepsodent, na qual as escovas associadas às suspensões dos dentífricos escovaram corpos-de-prova de resina acrílica (Plex-glass) por um período de 50 minutos, simulando um ano (17800 ciclos). Foram removidas dez cerdas das escovas por grupo. Um grupo com dez cerdas não utilizadas representou o controle. As cerdas foram posicionadas em uma placa de Plex-glass de forma que ficassem todas em um mesmo plano. A aferição do diâmetro foi realizada em perfilômetro com precisão de décimos de milímetros (0,01 mm) a 0,02 mm da ponta da cerda. Foram obtidos dez valores para cada combinação (escova e dentífrico) testada.

Resultados

A análise dos dados foi realizada por meio dos Testes ANOVA ($p < 0,05$). Os resultados indicaram que apenas o grupo Sorriso (Colgate-Palmolive Ind e Com. Ltda., Osasco, Brasil) ($0,15 \pm 0,02$) quando comparado com o grupo controle ($0,2 \pm 0,02$) apresentou significância estatística ($p = 0,0117$), enquanto os outros grupos (água: $0,18 \pm 0,02$; Corega (GSK - GlaxoSmithKline, Brasil Ltda., Rio de Janeiro, Brasil): $0,17 \pm 0,2$; Experimental 1: $0,16 \pm 0,02$; Experimental 2: $0,16 \pm 0,02$) não apresentaram valores de alteração significantes.

Conclusão

O dentífrico Sorriso (Colgate-Palmolive Ind e Com. Ltda., Osasco, Brasil), indicado para dentes naturais, foi o que causou a maior alteração nas pontas das cerdas das escovas.

Termos de indexação: Prótese total. Dentífricos. Escovação dentária.

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INTRODUCTION

The hygiene of complete dentures is essential to their longevity and the health of the patient. According to the Council on Dental Materials, Instruments and Equipment (CDMIE)¹, inadequate cleaning of the complete dentures leads to the growth of bacteria and fungi which originate from the buildup of mucin, food remains and pigments such as those in tobacco.

The biofilm of the complete denture is defined as a dense microbial mass formed by microorganisms and their metabolic products, made up of over 10^{11} microorganisms per gram dry weight², constituting a significant etiological factor in Chronic Atrophic Candidiasis (Denture Stomatitis)³.

Two methods are proposed to perform the hygiene, divided into chemical and mechanical². Brushing with a toothbrush and paste or soap is the most widely-used method and is a common practice in oral hygiene⁴. It has the advantage of being a simple, low-cost and effective method of removing stains and organic deposits⁵. On the other hand it has the disadvantage of being difficult to use, mainly for patients with motor coordination problems⁶ and it may wear the acrylic resin and damage the surfaces of rebuilding materials through improper use⁴.

The abrasion occasioned by brushing depends of a numerous factors such as abrasiveness of the dentrifice, characteristics of the, bristles brush technique and frequency of brushing, force applied to the brush and the hardness of the substrate⁷.

Certain precautions should be taken when using brushes on the complete denture surfaces. If the auxiliary agents are not used carefully they can modify the surface of the acrylic resin, leaving it rough and as a result more likely to retain biofilm and food remains⁸. Thereby, the recommended auxiliary agents should be low abrasion. It is possible to find studies in the literature that have evaluated the abrasiveness of various dentrifices, using a standard model of brush⁸, and other studies that have analyzed abrasiveness by varying the brushes, in this case maintaining as standard the use of just one dentrifice⁹. However, it is not known how much the abrasiveness of dentrifices acts by altering the anatomy of the toothbrush bristles, modifying their shape and thereby turning them into potentially abrasive instruments. Additionally, patients should be instructed not to use brushes with hard bristles; in this context, a soft brush limits the force that can be applied to the brush/abrasion system¹⁰. In the literature, there have been few studies concerning the

influence of the shape of toothbrush bristles in producing abrasiveness on the acrylic resin. Few studies report on the degree of softness of bristles with abrasion. As for the importance of keeping the surface of the acrylic resin smooth for adequate control over the biofilm formation, it is important that all the elements related to the mechanical method for cleaning prostheses are well studied.

The aim of this study, was to evaluate the alteration in the diameter of the bristle tips of a toothbrush after brushing the acrylic resin, with 4 different dentrifices, 1 conventional (for natural teeth) and 3 specific for complete denture.

METHODS

Soft toothbrushes were used (Colgate Professional, Colgate-Palmolive Ind. e Com. Ltda., São Paulo, Brazil) with 26 clumps of bristles 0.25mm in diameter and 10 mm high, combined a conventional toothpaste and three other dentrifices used specifically for complete denture (Chart 1). Acrylic dishes of plex-glass (Plex Glass, polymethyl methacrylate, Day Brasil S.A., Ribeirão Preto, Brazil) 90 mm long by 30 mm wide by 4 mm thick, were used as specimens. This material is regarded as being internationally acceptable for the analysis of dentrifices¹¹⁻¹²

With the aim of provoking deformation at the tip of the toothbrush bristles, the test was conducted with the aid of a Pepsodent type machine (MAVTEC - Com. Peças, Acess. e Serv. Ltda. ME, Ribeirão Preto, Brazil), equipment which promotes artificial or in vitro brushing. A total of 6 plex-glass test specimens were used and 6 brushes for each group: control, water, Corega (GSK - GlaxoSmithKline, Brasil Ltda., Rio de Janeiro, Brazil), Sorriso (Colgate-Palmolive Ind e Com. Ltda., Osasco, Brazil), dentrifice 1 and dentrifice 2.

The brushes had their handles cut off with the aim of permitting them to be adapted to the shoes of the brushing machine.

The brushing machine permitted the testing of six samples simultaneously at a speed of 356 rotations per minute and a stroke covered by the brush corresponding to 3.8 cm. The weight of the shoe, with the brush connected, was 200 grams¹³⁻¹⁵. The brush was affixed by means of screws placed at the sides and the top of the shoe. The correct adjustment of these screws permitted the proper leveling of the brush.

For the suspensions a sufficient volume of each dentrifice (10 mg) was used, diluted in distilled water (proportion of 1:1) and the solution was poured into the tubs of the apparatus on to the test specimens. A brushing test was carried out using only brush and distilled water at room temperature. As a control group, the diameter of the bristles of new brushes was measured.

The period of 50 minutes (17,800 cycles) of brushing employed, simulated one year of prosthesis use for a healthy individual. After brushing, the toothbrushes were removed, rinsed in running water and dried with sheets of absorbent paper so that the bristles could be analyzed.

The diameters of the toothbrush bristles were examined, by the same operator. The measuring of the diameter was performed using a profilometer (Nikon, Nippon Kogaku K.K., Japan) to an accuracy of tenths of millimeters (0.01 mm).

To analyze the diameter, bristles were cut off the base, with an approximate length of 10 mm, thus preserving the architecture. They were affixed by way of double-sided adhesive tape to plex-glass dishes, leaving the extremity of the active tip of the bristle over the edge of the dish so as to facilitate the reading of the diameters using the profilometer. Ten bristles per group (control, water, Corega, GSK - GlaxoSmithKline, Brasil Ltda., Rio de Janeiro, Brazil; Sorriso, Colgate-Palmolive Ind e Com. Ltda., Osasco, Brazil), dentrifice 1 and dentrifice 2) were placed on each dish thus obtaining 10 values for each group.

Each measurement was taken individually by positioning the tip of each bristle in the center of the profilometer screen. From the tip, the base of the profilometer was moved 200 micrometers in the direction of the cut of the bristle and the first measurement (M1) was noted. Then, the base of the apparatus was moved once again (by 200 micrometers) in the same direction and measurement number two (M2) was noted (Figure 1). Thus were obtained two measurements and the difference between them was calculated to determine the diameter. These data were used in the statistical analysis.

Data analysis was performed to evaluate the change in the diameter borne by the toothbrush bristles after brushing with the various dentrifices based on a factor of variation, i.e. the dentrifices. After checking the normal and homogeneous distributions of the data, they were submitted for a variance analysis (One-way ANOVA), with a level of significance of 5%.

RESULTS

The measurements of the brush bristles were taken at M1 and M2 and the variation of the diameters of the bristles is shown in Table 1.

The ANOVA test ($p \leq 0.05$) (Table 2) showed a difference between the groups: Sorriso dentrifice. (Colgate-Palmolive Ind e Com. Ltda., Osasco, Brazil) presented a significant difference when compared to the control group. The other groups did not present differences between each other. All the dentrifices promoted an alteration of the tip of the bristles, however the Sorriso dentrifice (Colgate-Palmolive Ind e Com. Ltda., Osasco, Brazil) was the one that caused the biggest change, leaving them with a smaller diameter (Figure 2). The comparison of the means and standard deviations is shown in Table 3.

Chart 1. Dentrifices used.

Commercial name	Composition	Manufacturer
Sorriso Super Refrescante	1500 ppm fluorine, sorbitol, calcium carbonate, carboxymethyl cellulose, sodium lauryl sulfate, sodium saccharin, tetrasodium pyrophosphate, sodium silicate, aromatic composition, formaldehyde, methyl-paraben, propyl-paraben, water. Contains sodium monofluorophosphate	Colgate-Palmolive Ind e Com. Ltda., Osasco, São Paulo, Brazil
Experimental 1	Hydroxyacetylcellulose, Glycerin, Benzoic acid, Methylparaben, EDTA, Fluorosurfactant (Zonyl), Silica (Sident 8), Silica (Sident 22S), Titanium Dioxide, menthol and eucalyptol, distilled water.	Ribeirão Preto Faculty of Dentistry, University of São Paulo, Ribeirão Preto, SP, Brazil
Experimental 2	Hydroxyacetylcellulose, Glycerin, Benzoic acid, Methyl-paraben, EDTA, Chloramine-T, Silica (Sident 8), Silica (Sident 22S), Titanium Dioxide, menthol and eucalyptol, distilled water.	Ribeirão Preto Faculty of Dentistry, University of São Paulo, Ribeirão Preto, SP, Brazil
Corega Brite	Tetrapotassium, Cocamidopropyl Betaine, Peppermint, Sodium Saccharin, Titanium Dioxide, Ammonia, Menthol, Anethole and Eucalyptol	GSK - GlaxoSmithKline, Brasil Ltda., Rio de Janeiro, Brazil

Table 1. Measurements of the variations in bristle diameter for each group studied.

n	Control	Water	Sorriso	Corega	Dentifrice 1	Dentifrice 2
1	0.185	0.15	0.148	0.184	0.132	0.183
2	0.176	0.145	0.144	0.172	0.159	0.135
3	0.187	0.179	0.137	0.160	0.161	0.171
4	0.175	0.180	0.148	0.180	0.157	0.184
5	0.137	0.169	0.139	0.175	0.133	0.162
6	0.213	0.170	0.164	0.121	0.176	0.159
7	0.183	0.188	0.113	0.159	0.167	0.157
8	0.187	0.234	0.164	0.176	0.204	0.155
9	0.188	0.174	0.162	0.183	0.133	0.158
10	0.185	0.180	0.189	0.179	0.154	0.183

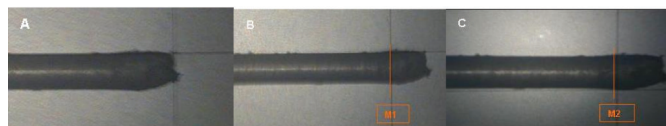
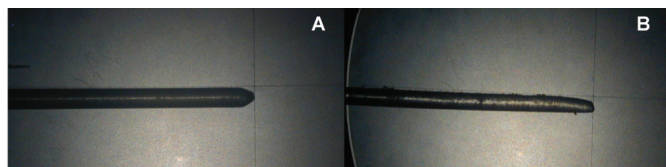
Table 2. Variance analysis.

Variation factors	Sum of the squares	df	Squared means	(F)	Prob. (H0)
Between columns	0.0067	5	0.0013	3.28	1.176%
Residual	0.0221	54	0.0004		
Total variance	0.0288	59			

Table 3. Comparison of means (SD) between measurements of toothbrush bristles for each group.

	Control	Water	Sorriso	Corega	Dentifrice 1	Dentifrice 2
Mean	0.182	0.177	0.151	0.169	0.158	0.165
SD	0.019	0.023	0.020	0.019	0.022	0.016

NB Same symbols indicate statistical equality.

**Figure 1.** a) bristle positioned in the center of the profilometer; b) bristle positioned at 200 µm off-center to obtain M1; c) Bristle positioned at 200 µm from M1 to obtain second measurement M2.**Figure 2.** a) bristle that was not subjected to brushing; b) bristle subjected to brushing with Sorriso (Colgate-Palmolive Ind e Com. Ltda., Osasco, Brazil).

DISCUSSION

It is known that dentrifices have abrasive particles of different sizes and shapes that can interfere with their abrasive potential. The abrasion generated on acrylic resin is an important phenomenon and undesirable aesthetic and biologically. It makes the resin surface rougher and susceptible to pigmentation and biofilm accumulation and can also interfere with their adaptation⁷. Sexson & Phillips¹⁶ stated that in two years of manual brushing, it is expected to see a loss of a third of a millimeter of the surface of the prosthetic base.

Many factors may affect the degree of abrasiveness caused by the brushing of a substrate. Among these are the hardness of the acrylic resin, the type of abrasive

agent, the size and shape of the abrasive particle, the degree of dilution of the dentrifice, the type of brush used and the force applied to it¹⁷⁻¹⁸. Moreover, according to Heath & Wilson¹⁹, the characteristics of the specimens, such as polymer/monomer proportion, presence of cross-linking agents, uniformity of the mixture, temperature and thickness of the surface, can make comparisons of the results obtained difficult or Thus, a degree of caution was observed when carrying out the study.

The use of machines for in vitro brushing in the abrasiveness tests is questionable since the brushing is very vigorous, and may produce some difficulty when comparing the results with the brushing pattern of a patient¹⁶. However, studies indicate a relationship between the clinical and laboratory studies²⁰⁻²¹. Artificial brushing using machines is considered to be a simple method by ISO/DTS 145692, being suitable for quantifying abrasiveness of brushing on acrylic resin⁵. In vivo studies to evaluate the abrasiveness of dentrifices have their disadvantages, including the time required and the inability to interpret the results generated by wear in the presence of many variables²².

This study used Sorriso (Colgate-Palmolive Ind e Com. Ltda., Osasco, Brazil), a dentrifice widely used in Brazil to brush natural teeth and also complete denture, although this is not a correct recommendation; Corega Brite (GSK - GlaxoSmithKline, Brasil Ltda., Rio de Janeiro, Brazil), a dentrifice specific to prostheses; and finally two new dentrifices that had been previously characterized with regard to density, pH, consistency and rheological characteristics²³. Employed as samples for brushing were plex-glass dishes, a polymethyl methacrylate produced with a standardized criterion industrially and internationally accepted for the testing of abrasiveness generated by dentrifices¹¹⁻¹².

Taking into consideration the abrasiveness of dentrifices on prostheses, this study evaluated the action of these dentrifices on the tips of toothbrush bristles. According to Wiegand et al.²⁴, different diameters of toothbrush bristles, when combined with different dentrifices, are responsible for generating differences in the abrasiveness of dental enamel.

The analysis of each bristle/dentrifice combination showed a great similarity in the values of wear and tear suffered by the bristles of the groups brushing with water, dentrifice 1, dentrifice 2 and Corega (GSK - GlaxoSmithKline, Brasil Ltda., Rio de Janeiro, Brazil), when compared to the control group, knowing that dentrifices 1 and 2 and Corega (GSK - GlaxoSmithKline, Brasil Ltda.,

Rio de Janeiro, Brazil) are specific for complete dentures. Freitas-Pontes et al.⁹ stated that the use of specific dentrifices for complete dentures causes less damage to the acrylic resin surface. Given the results of the results of the present study, it is believed that the abrasive potential of these substances is not statistically significant to infer that the bristles undergo wear and tear that is sufficient to increase their abrasiveness and consequently increase the abrasive potential of the bristle/dentrifice combination.

Although the wear of the bristles may be very low, it can be seen that the group of bristles brushed using the toothpaste Sorriso (Colgate-Palmolive Ind e Com. Ltda., Osasco, Brazil) underwent a greater change, which could be confirmed after the statistical analysis, where the values obtained were statistically significant when compared to the control group ($P=0.0117$). The abrasiveness of the formulation is commonly described in terms of Relative Enamel Abrasion (REA) and Relative Dentin Abrasion (RDA)²⁵. Despite being a very important piece of information, these specific values were not located for the commercial dentrifices used. As well as the composition, the manufacturers should be obliged to furnish RDA values. However, according to ISO 8627²⁶, by means of an analysis of abrasiveness using the gravimetric method after tests of mechanical brushing for 100 minutes and with a 200 g load, a dentrifice may be considered to be of low abrasion when it promotes a weight loss of less than 21 mg, medium abrasion when the weight loss is between 21 and 40 mg, and high abrasion when the weight loss exceeds 41 mg. Based on these guidelines, Pisani et al.¹⁵ considered the dentrifices Sorriso (Colgate-Palmolive Ind e Com. Ltda., Osasco, Brazil) and Corega Brite (GSK - GlaxoSmithKline, Brasil Ltda., Rio de Janeiro, Brazil) as being of medium abrasion.

The time used for brushing, or one year, may be considered a limitation since dentists recommendation is that the brushes are changed every three months of use. It is known, however, that this guideline is not always observed by the population. Moreover, the period for replacement of prostheses is 5 years, it being necessary to conduct studies with a prolonged period of brushing^{9,23}. As a result of these facts, added to the characteristics of the studies conducted in the literature^{9,15,23}, which employ the same methodology as the present study, which favors comparison of results, a brushing time of 50 minutes was adopted thereby simulating one year of brushing.

The results of this study match those of the findings of Panzeri et al.²³, where the plex-glass specimens brushed with the toothpaste Sorriso

(Colgate-Palmolive Ind e Com. Ltda., Osasco, Brazil) showed evidence of abrasion on account of the presence of grooves in the acrylic surface and a reduction in brilliance, which could be detected visibly. This could have happened due to the abrasiveness of the sodium bicarbonate particles^{12,23} which, in addition to affecting the resin surface, can alter the toothbrush bristles. Panzeri et al.²³ also found that the Chloramine T, Zonil and Corega (GSK - GlaxoSmithKline, Brasil Ltda., Rio de Janeiro, Brazil) based dentrifices showed less roughness and lower results in terms of weight loss when compared to Sorriso (Colgate-Palmolive Ind e Com. Ltda., Osasco, Brazil). According to the authors, the factor responsible for the differences in the reduction of abrasiveness of the different dentrifices may have been the shape of the abrasive particles. The thinking is that the results of the alteration in the toothbrush bristles in the present study can be similarly explained by this line of logic.

CONCLUSION

The groups Water, Dentrifice 1, Dentrifice 2 and Corega (GSK - GlaxoSmithKline, Brasil Ltda., Rio de Janeiro, Brazil) did not present statistically significant values concerning wear and tear of bristles when compared to the Control group. The Sorriso dentrifice (Colgate-Palmolive Ind e Com. Ltda., Osasco, Brazil) caused the greatest alteration in the format of the toothbrush bristles leaving them smaller in diameter.

The results of this study suggest that the greater abrasiveness of a dentrifice could be damaging to the toothbrush bristles, increasing their power of abrasiveness on surfaces like that of acrylic resin.

Collaborators

MX Pisani contributed with the composition of the article. EE PEREIRA contributed with the laboratory development of this research study, and the composition of the article. CHL Silva contributed with guidance in the performance of the laboratory work and the composition of the article. HFO PARANHOS contributed with guidance in the performance of the laboratory work and the composition of the article.

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