ABRASIVENESS OF DENTIFRICES ON THE BRAZILIAN MARKET

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ABSTRACT: To evaluate, in vitro, the abrasiveness of 42 dentifrices and one dental pumice. Acrylic resin specimens were used for uniformity. The study used three different batches of 42 dentifrices and one dental pumice, with three specimens per product. Tests were performed on an automatic toothbrushing machine, producing 100,000 strokes of oscillating movements for each specimen with soft bristle toothbrushes, corresponding to 4.2 years of toothbrushing. The specimens were ultrasonicated in deionized water and dried. Wear was analyzed by the difference in the weight of specimens before and after toothbrushing and was correlated with type of dentifrice, purpose and abrasive agent by one-way analysis of variance. The dentifrices presented variation in percent weight loss, yet without significant difference according to the main abrasive agent (carbonate/silica), type of dentifrice (paste/gel), and purpose. Greatest weight loss was observed for dental pumice, followed by desensitizing, bicarbonate-containing, whitening, conventional and infant dentifrices and deionized water, though without statistically significant differences. Dentifrices with calcium carbonate and in paste form were more abrasive. The dental pumice was the most abrasive, followed by desensitizing, bicarbonate-containing, whitening, conventional and infant dentifrices.

KEY WORDS: Dentifrice, Tooth Abrasion, Preventive Dentistry.

ABRASIVIDADE DE DENTIFRÍCIOS NO MERCADO BRASILEIRO

RESUMO: Avaliou-se *in vitro* a abrasividade de 42 dentifrícios e de pedra-pome dental. Exemplares de resina acrílica foram usados para conseguir uniformidade. Esse estudo utilizou três lotes de 42 dentifrícios e uma pedra-pome dental, com três exemplares por produto. Os testes foram executados em máquina automática de escovar dentes, produzindo 100.000 movimentos oscilatórios para cada exemplar com cerdos macios, correspondendo a 4,2 anos de escovação dentária. Os exemplares foram ultrasonicados em água deionizada e secos. O gasto foi analisado pela diferença no peso dos exemplares antes e depois da escovação e foi relacionado ao tipo de dentifrício, objetivo e agente abrasivo pela análise de variância. Os dentifrícios variaram em perda percentual de peso, sem nenhuma diferença significante, levando em consideração o agente abrasivo principal (carbonato/sílica), tipo de dentifrício (pasta/gel) e finalidade. A maior perda em peso ocorreu na pedra-pome, seguida por dessensibilização, conteúdo bicarbonato, branqueamento, dentifrícios convencionais e infantis e água deionizada, sem diferenças estatisticamente significantes. Dentifrícios com carbonato de cálcio e em pasta foram mais abrasivos. A pedra-pome foi

a mais abrasiva, seguida por dessensibilização, conteúdo de bicarbonato, branqueamento, dentifrícios convencionais e infantis.

PALAVRAS-CHAVE: Dentifrício; Abrasivos de Dentes; Odontologia Preventiva.

INTRODUCTION

All commercially available dentifrices, either in liquid, powder or paste, contain an abrasive item to aid dental hygiene. The approximate consumption of dentifrice in Brazil is 508 grams of dentifrice per inhabitant per year, with a trend for paste dentifrices. This is very similar to the consumption of dentifrices in the United States (NARVAI, 2000).

Dentifrices contain humectants, water, ligands, detergents, flavors, preservatives and preventive-therapeutic substances. All these agents have a fundamental role in the action or conservation of the dentifrice. The main component of dentifrices are abrasives which have been investigated since 1907 (MILLER, 1907) and are currently raising concern among dental professionals because of their relationship with tooth wear (abrasion) (GUSMÃO et al., 2003). This is especially urgent when the increased life expectancy of the population is taken into account and thus the consequent maintenance of teeth for a longer period (ASHCROFT; JOINER, 2010).

However, abrasives are fundamental to assure dental hygiene and polishing. Concern on the abrasiveness of dentifrices is primarily related to root exposure since dentin is five to six times softer than enamel (CURY, 1987).

High abrasive concentrations may damage the hard and soft tissues and dental restorations. They may cause cervical abrasion, associated to dentin hypersensitivity, which may lead to extreme results, such as loss of tooth structure or pulp and periapical pathologies (ADDY, 2005). Besides the tooth-brushing technique and hardness of toothbrush bristles associated with the dentifrice, the abrasive effect of dentifrices may also be affected by the type and quantity of abrasives and by the size and shape of their particles (GUSMÃO et al., 2003). The ideal degree of abrasion necessary to clean the tooth surface without structure removal has not yet been established although there seems to be no direct relationship between pellicle removal and dentifrices´ abrasiveness (SCHEMEHORN; MOORE; PUTT, 2011).

Knowledge on the abrasiveness of different dentifrices and their indications is highly relevant for the guidance of patients on the most adequate dentifrice for each case (CURY, 1987). Therefore, current in vitro study evaluated the abrasiveness of dentifrices to analyze their possible abrasive effect.

2 METHODS

Current research was approved by the Institutional Review Board of the Hospital for Rehabilitation of Craniofacial Anomalies, University of São Paulo, São Paulo, Brazil. The investigation was conducted on 42 dentifrices commonly available on the Brazilian market and one brand of dental pumice for professional use (Vigodent S.A. Indústria e Comércio, Rio de Janeiro, Brazil). Three tubes of each product were used, from different batches, and one specimen was used per tube, adding up to three specimens per product, following the methodology proposed by Andrade Junior et al. (1998) and Mondelli et al. (2005).

Tests were performed on an automatic tooth-brushing machine (MSEt – Marcelo Nucci ME, São Carlos SP Brazil) with oscillatory movements on ten devices to which the heads of soft bristle toothbrushes were connected (Condor Plus Dupla Ação 35 - Condor SA, São Bento do Sul SC Brazil), with simultaneous tooth-brushing on ten specimens. The machine has a stainless steel base with ten independent standard-shaped orifices, from which impression was taken with condensation silicone (Speedex – Coltene Whaledent Inc., Cuyahoga Falls, USA) for the fabrication of acrylic resin specimens (Jet and Dencôr – Artigos Odontológicos Clássicos Ltda, São Paulo SP Brazil), measuring 4.5 x 4.5 x 5 mm, used for testing (Figure 1). The above material was selected to achieve uniform specimens.

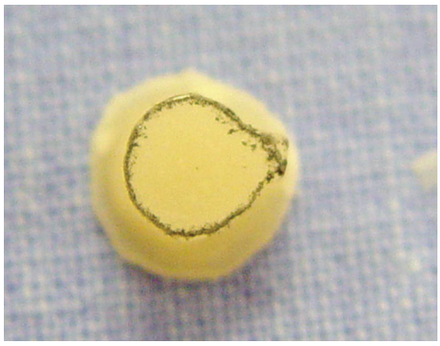

Figure 1. Inferior view of the specimen, highlighting the contour for adaptation to the tooth-brushing machine.

Specimens were kept dry and weighed on a precision scale (A&D Weighing, Tokyo, Japan) for three consecutive weeks, until there was no alteration in their initial weight, ranging between 81.6 mg and 115.4 mg. One specimen was used to test each dentifrice type and batch.

Slurries with 9 grams of dentifrice and 18g of deionized water (1:2) were prepared immediately before use, following ISO specification n. 14569-1 (INTERNATIONAL ORGANIZATION FOR STANDARDIZATION, 1999). The products were weighed on a precision scale (B200 - Micronal, São Paulo SP Brazil) and the slurries were inserted in disposable 20mL plastic syringes (Plascalp Produtos Cirúrgicos Ltda, Feira de Santana BA Brazil).

The syringes were positioned in the tooth-brushing machine, connected to an 8-mm diameter rubber catheter and to angled cannulas n. 4010 (Becton, Dickinson and Company, Franklin Lakes, USA) directed to the toothbrushes. The machine was set to work at 37ºC, performing a complete oscillatory movement at each stroke, at a speed of 374 strokes per minute, amplitude of movement of 3.8cm, with 200g of weight. During tooth-brushing, the machine was set to push the syringe plungers for injection of 0.4mL of slurry at every 2 minutes on each specimen. Overall, 100,000 strokes were performed for each specimen, which corresponded to 4.2 years of tooth-brushing (MONDELLI et al., 2005).

After tooth-brushing, specimens were ultrasonicated (Lavadora Ultrassônica Computadorizada USC 700 - Unique Indústria e Comércio de Produtos Eletrônicos Ltda, São Paulo SP Brazil) in deionized water for 1 minute to remove remnants of dentifrice and then dried with absorbent paper. After tooth-brushing with each dentifrice, the specimens were weighed on the same scale for weight loss (ANDRADE JUNIOR et al., 1998; MONDELLI et al., 2005). A control group of tooth-brushing with deionized water was used for comparison.

Wear was quantitatively evaluated in percentage, according to the difference in the weight of specimens before and after tooth-brushing. Besides the mean and standard deviation of percentage weight loss for each dentifrice, one-way analysis of variance was applied, considering the mean of the three specimens for each dentifrice, to investigate the relationship between weight loss and type of dentifrice (paste or gel); abrasive agent (calcium carbonate or silica); and purpose, as described by the manufacturers on the packages (conventional, infant, whitening, desensitizing or bicarbonate-containing, besides dental pumice).

3 RESULTS

Table 1 shows the characteristics of dentifrices and their respective means of percentage weight loss, in decreasing order.

Table 1. Characteristics of dentifrices analyzed in current study and mean percentage weight loss, in decreasing order.

(continua)

Dentifrice	Number of specimens	Type	Purpose	ppm fluoride	Abrasive agent	Mean percentage weight loss (SD)
Colgate sensitive	3	paste	Desensitizing	1500	silica	1.856 (0.498)
Sorriso nightshade + bicarbonate	3	paste	bicarbonate-containing	1450	calcium carbonate	1.359 (0.400)
Free dent cinnamon and mint	3	paste	conventional	900	calcium carbonate	1.221 (0.396)
'Mais por menos'	3	paste	conventional	1100	calcium carbonate	1.201 (0.254)
Equate gel dental ultra refreshing	3	gel	conventional	1500	silica	1.187 (0.365)

(continua)

Close up triple mint	3	paste	conventional	1500	calcium carbonate	1.136 (0.424)
Sorriso super refrescante	3	paste	conventional	1500	calcium carbonate	1.091 (0.254)
Prophylactic paste	3	paste	professional use	-	-	1.064 (0.560)
Colgate herbal whitening	3	paste	whitening	1500	calcium carbonate	0.981 (0.426)
Sensodyne sodium bicarbonate	3	paste	desensitizing/ bicarbonate-containing	1409	silica	0.957 (0.220)
Alegrinho gel chocolate	3	gel	infant	750	silica	0.934 (0.048)
Equate dental cream total	3	paste	conventional	1200	calcium carbonate	0.923 (0.274)
Kid's gel	3	gel	infant	1100	silica	0.807 (0.173)
Ice fresh	3	paste	conventional	1500	calcium carbonate	0.801 (0.008)
Alegrinho gel Tutti Frutti	3	gel	infant	900	silica	0.799 (0.252)
Close up whitening	3	gel	whitening	1500	silica	0.792 (0.471)
Equate anticarie	3	paste	conventional	1200	calcium carbonate	0.784 (0.043)
Action kids	3	gel	infant	1100	silica	0.765 (0.220)
Gessy crystal	3	paste	conventional	1500	calcium carbonate	0.751 (0.321)
Free dent double mint	3	paste	conventional	900	calcium carbonate	0.746 (0.266)
Sorriso nightshae + propolis	3	paste	conventional	1500	calcium carbonate	0.738 (0.446)
Colgate triple action	3	paste	conventional	1450	calcium carbonate	0.697 (0.323)
Sorriso triple refreshing	3	paste	conventional	1450	calcium carbonate	0.642 (0.270)
Colgate total whitening gel	3	paste	whitening	1450	silica	0.641 (0.337)
Colgate whitening	3	paste	whitening	1500	calcium carbonate	0.629 (0.270)
Sensodyne vitamins + minerals	3	paste	desensitizing	1450	silica	0.568 (0.096)
Tandy	3	gel	infant	1100	silica	0.567 (0.211)
Free dent mint	3	paste	conventional	1000	calcium carbonate	0.539 (0.242)
Colgate sodium bicarbonate	3	paste	bicarbonate-containing	1500	calcium carbonate	0.531 (0.070)
Sorriso whitening brite	3	paste	whitening	1500	calcium carbonate	0.505 (0.099)
Colgate total	3	paste	conventional	1500	silica	0.476 (0.199)
Sensodyne original	3	paste	desensitizing	*	silica	0.470 (0.342)
Colgate maximum caries protection	3	paste	conventional	1500	calcium carbonate	0.467 (0.109)
Free dent herbal	3	paste	conventional	900	calcium carbonate	0.459 (0.204)
Free dent eucalyptus	3	gel	conventional	900	silica	0.435 (0.141)
Sensodyne whitening	3	paste	whitening / desensitizing	1050	silica	0.408 (0.074)
Colgate reliable freshness red gel	3	gel	conventional	1450	silica	0.388 (0.453)
Sorriso herbal natural protection refreshing	3	paste	conventional	1450	calcium carbonate	0.387 (0.161)
Control (deionized water)	3	-	-	*	-	0.380 (0.328)
Sorriso fresh crystal mint	3	gel	conventional	1100	silica	0.380 (0.114)
Colgate junior bob sponge	3	gel	infant	1100	silica	0.313 (0.137)

(conclusão)

Close up Red Fruit	3	gel	conventional	1500	silica	0.284 (0.043)
Colgate Baby Barney	3	paste	infant	500	silica	0.269 (0.046)
Sorriso fluor & calcium	3	paste	conventional	1450	calcium carbonate	0.110 (0.060)

* SD: standard deviation; ppm fluoride: parts per million of fluoride

Mean percent weight loss for paste dentifrices was 0.755 (standard deviation [SD]=0.362), without any statistically significant difference (p=0.09) when compared to gel dentifrices, according to one-way analysis of variance, with mean 0.637 (SD=0.284).

No statistically significant difference was observed between the abrasives, with mean percent weight loss of 0.759 (SD = 0.311) for calcium carbonate and 0.664 (SD = 0.377) for silica.

Table 2 presents the percentage weight loss according to purpose of dentifrices.

Table 2. Percentage weight loss according to purpose of dentifrices.

Purpose	Number of specimens	Mean	Standard deviation	Median	Minimum - Maximum
Dental pumice	3	$1.064^{a.b.c.d}$	0.560	1.064	1.064
Desensitizing	9	0.964^{e}	0.773	0.568	0.470-1.856
Bicarbonate-containing	9	0.945^{f}	0.585	0.945	0.531-1.359
Whitening	18	$0.709^{b.g}$	0.182	0.641	0.505-0.981
Conventional	69	$0.688^{a.h}$	0.320	0.697	0.110-1.221
Infant	21	$0.636^{c.i}$	0.259	0.765	0.269-0.934
Deionized water	3	$0.380^{d.e.f.g.h.i}$	0.328	0.380	0.380-1.000

* means followed by same letters indicate statistically significant difference: (a) p=0.004; (b) p=0.003; (c) p=0.002; (d) p=0.000; (e) p=0.005; (f) p=0.01; (g) o=0.05; (h) p=0.04; (i) p=0.009.

4 DISCUSSION

During recent years, the evolution of dentifrices plus different abrasive substances has been a constant concern among dental professionals. Current analysis did not reveal significant differences in abrasiveness between the dentifrices used.

In the case of clinical implications, the use of dentifrices is fundamental because it increases plaque removal in approximately 70% and reduces new plaque formation in nearly 45% (GUSMÃO et al., 2003). However, dentifrices must be adequately indicated according to individual needs, tooth-brushing pattern and clinical aspects, e.g. in individuals with root exposure, since their abusive use may cause significant dentin wear (ADDY, 2005).

In addition to dentifrice abrasiveness, other factors may influence tooth wear, such as the hardness of toothbrush bristles and the force applied during tooth-brushing. CURY (1987) reported that hard bristles might cause more wear when they are compared to medium or soft bristles. Moreover, as demonstrated by Camargo et al. (2001), abrasiveness is proportionally increased with the size of abrasive particles, and the abrasiveness of materials may also be influenced by particles´ hardness, shape and distribution. Motta et al. (1998) investigated the amount of abrasive in different dentifrices and re-

ported that there seems to be a correlation between the amount of abrasive and the abrasiveness of dentifrices, with lower abrasiveness for gel dentifrices.

In Brazil, dentifrices containing calcium carbonate are the most common because of their easy achievement and low costs. Though not statistically significant, current results suggest that dentifrices with calcium carbonate are more abrasive when compared to dentifrices with silica, in contrast to previous studies in Brazil (ANDRADE JUNIOR et al., 1998; CAMARGO et al. 2001), but corroborating other investigations in Brazil and worldwide (GUSMÃO et al., 2003; MOTTA et al., 1998).

Current analysis also revealed, without any statistically significant difference, a tendency of greater abrasiveness by dental pumice, followed by desensitizing, bicarbonate-containing, whitening, conventional and infant dentifrices. Lack of statistical significance may be related either to sample size or inherent limitations of the study design. Further studies on this subject are required. If future investigations confirm the above findings, desensitizing dentifrices should not be used by people with root exposure because of the possibility of abrasion of the exposed cementum and dentin. Significant differences have been previously reported between different dentifrices, albeit without significant difference for whitening dentifrices (DE MENEZES et al., 2004). However, another study (ANDRADE JUNIOR et al., 1998) reported medium abrasiveness for desensitizing and bicarbonate-containing dentifrices.

Owing to these preliminary findings and to the wide range of commercially available dentifrices, dentifrice characteristics, including the degree of abrasiveness, should be better disclosed by the manufacturers to enhance their proper indication by dental professionals according to the needs of each patient (CURY, 1987).

5 CONCLUSIONS

Within the limitations of current research, the above findings suggested variations in abrasiveness between dentifrices, albeit without any statistically significant difference between different abrasives and types of dentifrice. It seems that there is a trend for greater abrasiveness in dental pumice, with the highest abrasiveness, followed by desensitizing, bicarbonate-containing, conventional and infant dentifrices and deionized water.

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REFERENCES

ADDY, M. Tooth brushing, tooth wear and dentine hypersensitivity—are they associated? **International Dental Journal**, v. 55, n. S4, p. 261-267, 2005.

ANDRADE JUNIOR, A. C. C. et al. Estudo in vitro da abrasividade de dentifrícios; In vitro study of dentifrice abrasivity. **Rev. odontol. Univ. São Paulo**, v. 12, n. 3, p. 231-6, 1998.

ASHCROFT, A. T.; JOINER, A. Tooth cleaning and tooth wear: a review. **Proceedings of the Institution of Mechanical Engineers, Part J: Journal of Engineering Tribology**, v. 224, n. 6, p. 539-549, 2010.

CAMARGO, I. M. C. et al. Abrasiveness evaluation of silica and calcium carbonate used in the production of dentifrices. **Journal of cosmetic science**, v. 52, n. 3, p. 163-167, 2001.

CURY, J. A. Dentifrícios: como escolher e como indicar. **Quintessence**, v. 18, p. 1, 1987.

DE MENEZES, M. et al. Abrasion of eroded root dentine brushed with different toothpastes. **Clinical oral inves-**

tigations, v. 8, n. 3, p. 151-155, 2004.

GUSMÃO, E. S. et al. Aplicabilidade clínica dos dentifrícios. **International Journal of Dentistry**, v. 2, p. 231-5, 2003.

INTERNATIONAL ORGANIZATION FOR STANDARDIZATION. Technical Specification 14569-1. Dental materials - guidance on testing of wear resistance. Part 1: wear by tooth brushing. Switzerland: ISO, 1999.

MILLER, W. D. Experiments and observations on the wasting of tooth tissue variously designated as erosion, abrasion, chemical abrasion, denudation, etc. **Dent Cosmos**, v. 49, p. 1-23, 1907.

MONDELLI, R F. L. et al. Evaluation of weight loss and surface roughness of compomers after simulated toothbrushing abrasion test. **Journal of Applied Oral Science**, v. 13, n. 2, p. 131-135, 2005.

MOTTA, L. G. et al. Análise do conteúdo abrasivo de dentifrícios; Abrasive contend analysis of dentifrices. **Rev. ABO Nac**, v. 6, n. 3, p. 147-8, 1998.

NARVAI, P. C Cárie dentária e flúor: uma relação do século XX. **Ciênc Saúde Coletiva**, v. 5,n. 2,p. 981-92, 2000.

SCHEMEHORN, B. R.; MOORE, M. H.; PUTT, M. S. Abrasion, polishing, and stain removal characteristics of various commercial dentifrices in vitro. **The Journal of clinical dentistry**, v. 22, n. 1, p. 11, 2011.

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