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Comparative analysis of different prophylactic methods for roughness of primary tooth enamel

Análise comparativa de diferentes métodos profiláticos sobre a rugosidade do esmalte em dentes decíduos

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ABSTRACT

Objective: The purpose of this study was to comparatively evaluate quantitative effects of three different prophylactic methods of surface polishing treatments for primary teeth compared to a standardized control group. **Material and Methods:** 48 naturally exfoliated primary teeth were selected and randomly assigned into four groups: Control Group – teeth receiving only enamel standardization treatment with polishing disc to reduce natural enamel; Group I – teeth receiving superficial enamel standardization treatment followed by polishing with a mixture of water and pumice; Group II – teeth receiving enamel standardization treatment followed by prophylaxis with paste (Herjos-F, Vigodent S/A Indústria e Comércio, Rio de Janeiro, Brazil); and Group III – teeth receiving enamel standardization treatment followed by sodium bicarbonate spray (Profi II Ceramic, Dabi Atlante Indústrias Médico-Odontológicas Ltda, Ribeirão Preto, Brazil). All the procedures were performed by the same operator and the samples were rinsed and stored in distilled water. Comparative assessment of the enamel surface roughness between experimental groups and control group was performed by using a surface profilometer (Mitutoyo SJ400). **Results:** The results of this study were statistically analysed by using Minitab statistical software (version 17.1.0, 2013). The use of pumice and water led to significantly rougher surfaces than in other groups (i.e. Group I: 1.22 Ra; Group II 0.38 Ra; Group III: 1.01 Ra). **Conclusion:** Based on this study, one can conclude that use of pumice and water resulted in increased enamel surface roughness in comparison to the surface treatment with bicarbonate spray and prophylaxis paste.

KEYWORDS

Dental enamel; Dental prophylaxis; Jet abrasive system; Enamel roughness; Primary teeth.

RESUMO

Objetivos: O objetivo deste estudo foi quantificar e comparar a rugosidade do esmalte dentário após de três diferentes tratamentos profiláticos para polimento de superfície de esmalte em dentes decíduos, em relação a um grupo controle. **Material e Métodos:** 48 dentes decíduos naturalmente esfoliados foram selecionados e alocados aleatoriamente em quatro grupos. Grupo Controle: recebeu apenas padronização do esmalte através do disco de polimento para redução de dentes naturais. O grupo I recebeu padronização superficial do esmalte seguido de polimento por mistura de água e pedra-pomes; o grupo II recebeu padronização do esmalte seguido da pasta de profilaxia Herjos-F (Vigodent S / A Indústria e Comércio, Rio de Janeiro, Brasil); e o grupo III recebeu padronização da superfície do esmalte seguido de spray de bicarbonato de sódio Profi II Ceramic (Dabi Atlante Indústrias Médico Odontológicas Ltda., Ribeirão Preto, Brasil). Todos os tratamentos de superfície foram realizados pelo mesmo operador, por dez segundos e as amostras foram lavadas e armazenadas em água destilada. A avaliação comparativa da rugosidade superficial do esmalte entre os grupos experimentais e controle foi realizada utilizando-se um perfilômetro de superfície Mitutoyo SJ400. **Resultados:** Os resultados deste estudo foram analisados estatisticamente com o software estatístico Minitab (versão 17.1.0, 2013). A pedra-pomes e a água geraram significativamente maior aspereza na superfície de esmalte, em comparação aos outros grupos, quando empregado o teste estatístico de Tukey (Grupo I: 1,22 Ra; Grupo II: 0,38 Ra; Grupo III: 1,01 Ra). **Conclusão:** Com base neste estudo, pode-se concluir que a pedra-pomes e a água resultaram em aumento da rugosidade superficial do esmalte em comparação ao tratamento superficial com spray de bicarbonato e pasta profilática.

PALAVRAS-CHAVE

Esmalte dentário; Profilaxia dentária; Rugosidade do esmalte; Dentes decíduos.

INTRODUCTION

Dental caries in patients with primary or mixed dentition is a challenging, being a highly prevalent chronic disease of childhood [1] that negatively impacts the quality of life [2]. Between 20-50% of the pre-school children have at least one carious lesion in primary dentition [3,4]. Early childhood caries (EEC) is defined as the presence of one or more primary teeth affected by carious lesion in children younger than 6 years old. Several factors can be associated with EEC, such as genetics, socio-economic development, early exposure to sugary foods, familial history, good oral hygiene habits and proper access to pediatric dental care [5,6].

Even though enamel shows clinically a smooth surface, it actually presents several structures on its surface that are detected only microscopically. For instance, perikymata consists of shallow furrows resulting from the extension of the striae of Retzius, that is, from the dentin-enamel junction to the outer enamel surface [6,7]. These furrows run in circumferentially horizontal lines across the face of the crown, especially in the cervical third, giving a wrinkled appearance to the enamel surface where organic debris might accumulate [6,8].

Previous dental prophylaxis procedures were restricted to application of abrasives with the use of rubber cups, brushes or dental tapes, as well as ultrasonic and manual scaling [9-11]. Although considered safe, rubber cups and jet sprays can affect the enamel surface and increase its roughness [12]. Extensive *in vitro* and *in vivo* studies have been performed to compare different dental prophylactic procedures in permanent teeth [9,13-15]. Our earlier studies showed that enamel surface roughness increases when permanent teeth are treated with sodium bicarbonate spray compared to teeth treated with pumice paste [16]. However, the effects of different prophylactic surface treatments on primary teeth have not been extensively studied. Therefore, the purpose of this study is to quantitatively compare *in vitro* three different prophylactic methods of surface polishing treatments for in exfoliated primary teeth.

MATERIAL & METHODS

This study was approved by the local research ethics committee, with 48 healthy human primary teeth, all naturally exfoliated, being selected from the Dentistry School of the São Paulo State University (UNESP). The teeth were included according to the following criteria: 1) morphological and anatomical normal appearance; 2) absence of hypoplastic stain or other enamel developmental defects; 3) preservation of natural color and brightness; and 4) signing of the consent form by parents or caregivers. Teeth with previous restorations or adhesive treatments or those under poor conservation conditions after exfoliation were not included.

Teeth were embedded in acrylic resin and the buccal surfaces left exposed. For each specimen of the experimental and control groups, a region of interest (ROI) was delimited by two longitudinal parallel lines and perpendicular parallel lines at the buccal faces of each tooth (Figure 1).

In accordance with previous studies in the literature, all the specimens received treatment for surface standardization by using polishing disc (Erios - Brazil) to avoid a poor evaluation of the roughness due to natural tooth irregularities [16]. Baseline evaluation of the enamel roughness was performed after surface standardization of the specimens in the four experimental groups and control group.

The selected teeth were equally divided into four groups:

• Control Group: surface treatment by using polishing discs to lightly standardize the enamel surface. This procedure was performed in all selected specimens of the four groups before comparing the polishing procedures.

• Group I: after standardization treatment, the enamel surface received application of a

mixture of 60-g pumice (S.S.White, Juiz de Fora, Brazil) dissolved into 50 ml of distilled water applied with rubber cup (Viking, KG Sorensen, Barueri, Brazil) coupled to a low-speed micromotor handpiece operating at 5000 rpm (Kavo do Brasil Indústria e Comércio Ltda., Joinville, Brazil) [16]. The experimental procedure was performed for ten seconds uninterruptedly, with circular movements over the entire buccal surface at slight pressure.

• Group II: after standardization treatment, enamel surface received application of dental polishing paste (Herjos-F, Vigodent S/A Indústria e Comércio, Rio de Janeiro, Brazil) containing water, lauryl sulphate, calcium carbonate, pumice and artificial flavor. The polishing treatment was performed by using the same type of movement, pressure, speed and duration as in Group I.

• Group III: after standardization treatment, enamel surface was polished with sodium bicarbonate and water by means of air jet (Profi II Ceramic, Dabi Atlante Indústrias Médico Odontológicas Ltda, Ribeirão Preto, Brazil). The tip of the jet was placed at a distance of 5 mm, forming an angle of 90° with the tooth surface, according to the manufacturer's instructions. The procedure was performed uninterruptedly with circular movements over the entire buccal surface for ten seconds.

Next, all the specimens were jet-washed with water for 10 seconds and then air-dried for five seconds.

A single practitioner performed all the procedures in order to minimize the differences in pressure, intensity and movements using the handpiece. The specimens were handled with sterile gloves throughout the experiment phases and after surface treatment they were jet-washed with distilled water for ten seconds and air-dried for five seconds before being individually stored away from light.

Enamel surface roughness was assessed with a profilometer (Mitutoyo SJ400) at the Laboratory of Optic Surface Measurement of the Science and Technology Institute of São Paulo State University (UNESP). Three readings of each specimen (i.e. middle of the buccal surface) were performed perpendicular to the long axis of the tooth with a linear displacement of 1.2 mm, thus resulting in a mean value. The quantification values were determined as the mean roughness (Ra), measured in micrometers (μm), by using the mean of three readings and compared to control group.

Two different approaches were performed to assess the effects of surface polishing treatments compared to controls and to assess enamel roughness between the groups.

For estimation of the power of test and sample calculation in the comparison of three independent samples, we had as reference a previous pilot study. The power of test for roughness (Ra) was performed by using the Minitab statistical software (version 17.1.0, 2013). It was found that, for a sample size equal to 12 and standard deviation of 20 Ra units, the one-way ANOVA (5%) model detects a clinically significant difference of 1.5 Ra units with power above 80%.

RESULTS

The descriptive statistics of the obtained data and graphical representation are presented in Table 1 and Figure 2, respectively.

Table 1 - Descriptive statistics of the roughness values (Ra) after enamel polishing methods.

Group	n	mean	sd	cv(%)	minimum	median	maximum
Control	12	0.18	0.11	57.58	0.09	0.14	0.40
Group I	12	1.22	1.16	95.01	0.11	0.62	3.65
Group II	12	0.38	0.53	140.58	0.07	0.14	1.66
Group III	12	1.01	0.8	96.51	0.07	0.89	2.79

The comparison between control and the three experimental groups was carried out with the aid of the Minitab statistical software (version 17.1.0, 2013). The Dunnett's test (5%) showed that only Group I had statistically significant differences in relation to control

group. This statistical test was employed due to the increased differences in standard deviation between experimental groups and control group. Tukey test (10%) showed that Group I had the highest roughness (1.22 Ra), with significant differences compared to Group II (0.38 Ra). Group III (mean of 1.01 Ra) had intermediate roughness values, without significant differences compared to Groups I and II.

Figure 1 - Delimitation of the area of interest for surface roughness assessment.

The square within the blue lines delimit the area of interest in the buccal face of the deciduous tooth.

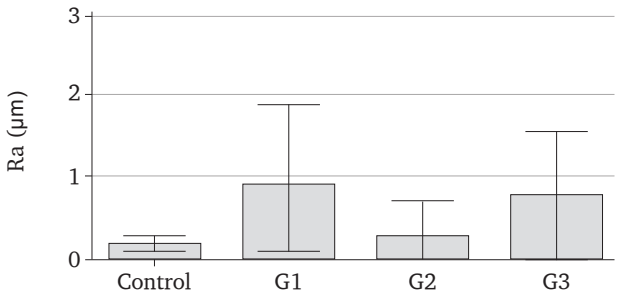

Figure 2 - Column graph (mean ± sd) of roughness values Ra (µm), according to the groups..

Comparative roughness of deciduous tooth enamel.

DISCUSSION

The dental enamel is composed of 96% of mineral substance and 4% of organic material and water. Because enamel has a high mineral content, it is extremely hard [17,18]. This hardness also makes the enamel brittle and therefore an underlying layer of more resistant dentin is needed to maintain its integrity [19]. Microscopic observation of the dental surface reveals a pattern characterized by a number of depressions and protrusions. Striae of Retzius often extends from the amelodentinal junction to the outer surface of the enamel, where they terminate and form shallow grooves known as perikymata, which run in horizontal circumferential lines that cross the surface of the crown. Groove arrangement may reveal a wrinkled surface with presence of undulations that allow accumulation of organic material on the dental surface [20].

Prevention of multifactorial diseases based on etiological agents represents an effective, low-cost public health policy. The mechanical action to inhibit the microbial activity responsible for caries is an effective way to control this disease [21]. Although professional tooth cleaning and polishing is considered an effective and safe way of preventing caries, several studies have shown wear of the tooth enamel surfaces as a result of teeth polishing [9,13].

The present study has comparatively evaluated in vitro the roughness of the dental enamel surface in naturally exfoliated primary teeth by using a profilometer after three commonly prophylactic surface polishing treatments. The surface polishing treatment herein evaluated (10 seconds for each dental face) simulated the clinical daily practice. Also, in order to perform a uniform evaluation of the included specimens as those with stains were excluded.

Our results have revealed alteration of the enamel surface regarding all the prophylactic surface treatment methods studied. The group that received surface treatment by means of prophylactic paste (Group II: Ra = 0.38 μm) had a lower enamel roughness of the dental enamel surface than the group that received prophylaxis using pumice (Group I: Ra = 1.22 μm), with statistically significant differences. The group receiving prophylactic air-jet

treatment with sodium bicarbonate (Group III: Ra = 1.01 μm) showed no statistically significant differences compared to Group I, with Group II showing intermediate behavior. Control group had roughness value of 0.18 μm, which was significant, compared to all groups.

However, these results contradict previous studies on enamel surface roughness in permanent teeth, indicating that sodium bicarbonate, water and air jet resulted in significant increase in the enamel roughness, with pumice and water being the prophylactic method of surface polishing resulting in the smoothest enamel surface [16]. It should be highlighted that previously published data on permanent teeth was evaluated similarly [9,13-15].

The microstructure of dental enamel in deciduous teeth differs from that observed in permanent teeth as the latter have a greater mineral concentration. As a main consequence, there is an increased susceptibility to caries lesion development and dental erosion. Studies have shown that increased enamel roughness predisposes to greater bacterial aggregation and greater adhesion of dental biofilm, which, under favorable conditions, may become acidogenic and lead to a higher risk of dental caries [14]. Dental caries in pediatric patients represents a factor that negatively impacts the child's perception of quality of life [2,22].

Within the limitations of the present work, the primary standardization of the specimen can be pointed as a major concern, although it has already been shown that no significant decrease in enamel roughness can be achieved with this procedure. This method is necessary for accurate profilometer analyses [9,13-15].

Although the conclusions of results obtained from in vitro experiments cannot be completely extrapolated to clinical studies, we can infer that prophylactic methods evaluated are safe and effective for caries control, that is, with no contraindications to their clinical use in pediatric patients [10,23]. However, more studies are needed to provide pediatric patients with prophylactic treatments with less impact on dental structures.

CONCLUSIONS

According to the results of the present study, we can conclude the following:

- Comparison of tooth enamel roughness before and after surface treatments showed statistically significant differences only in the group in which prophylaxis was performed with pumice stone, presenting higher roughness after surface treatment.
- The group that received surface treatment by means of prophylactic paste revealed statistically significant differences compared to the group that received pumice treatment.
- The group that received surface treatment by means of air jet and sodium bicarbonate did not present statistically significant differences compared to the other groups studied.

REFERENCES

1. Nagaoka T. Prevalence of caries in deciduous teeth in early modern Japan: analyses of human skeletons from Hitotsubashi (Tokyo, Japan). Anat Sci Int. 2017:92(3):320-9.
2. Carvalho TS, Abanto J, Pinheiro ECM, Lussi A, Bönecker M. Early childhood caries and psychological perceptions on child's oral health increase the feeling of guilt in parents: an epidemiological survey. Int J Paediatr Dent. 2018 Jan;28(1):23-32. doi: 10.1111/ipd.12306.
3. Bonecker M, Cleaton-Jones P. Trends in dental caries in Latin American and Caribbean 5-6- and 11-13-year-old children: a systematic review. Community Dent Oral Epidemiol 2003:31(2):152-7.
4. Cleaton-Jones P, Fatti P, Bonecker M. Dental caries trends in 5- to 6-year-old and 11- to 13-year-old children in three UNICEF designated regions--Sub Saharan Africa, Middle East and North Africa, Latin America and Caribbean: 1970-2004. Int Dent J. 2006:56(5):294-300.
5. Nascimento Filho E, Mayer MP, Pontes P, Pignatari AC, Weckx LL. Caries prevalence, levels of mutans streptococci, and gingival and plaque indices in 3.0- to 5.0-year-old mouth breathing children. Caries Res. 2004:38(6):572-5.
6. Costa FS, Silveira ER, Pinto GS, Nascimento GG, Thomson WM, Demarco FF. Developmental defects of enamel and dental caries in the primary dentition: A systematic review and meta-analysis. J Dent. 2017 May;60:1-7. doi: 10.1016/j.jdent.2017.03.006.
7. Souza JF, Jeremias F, Costa-Silva CM, Santos-Pinto L, Zuanon AC, Cordeiro RC. Aetiology of molar-incisor hypomineralisation (MIH) in Brazilian children. Eur Arch Paediatr Dent. 2013 Jun 25. [Epub ahead of print].

8. Americano GC, Jacobsen PE, Soviero VM, Haubek D. A systematic review on the association between molar incisor hypomineralization and dental caries. Int J Paediatr Dent. 2017 Jan;27(1):11-21. doi: 10.1111/ipd.12233.

9. Barnes CM, Covey D, Watanabe H, Simetich B, Schulte JR, Chen H. An in vitro comparison of the effects of various air polishing powders on enamel and selected esthetic restorative materials. J Clin Dent. 2014:25(4):76-87.

10. Graumann SJ, Sensat ML, Stoltenberg JL. Air polishing: a review of current literature. J Dent Hyg. 2013:87(4):173-80.

11. Gutmann ME. Air polishing: a comprehensive review of the literature. J Dent Hyg. 1998:72(3):47-56.

12. Garcia-Godoy F, Garcia-Godoy A, Garcia-Godoy C. Effect of a desensitizing paste containing 8% arginine and calcium carbonate on the surface roughness of dental materials and human dental enamel. Am J Dent. 2009:22 Spec No A:21a-24a.

13. Camboni S, Donnet M. Tooth Surface Comparison after Air Polishing and Rubber Cup: A Scanning Electron Microscopy Study. J Clin Dent. 2016:27(1):13-8.

14. Lima FG, Romano AR, Correa MB, et al. Influence of microleakage, surface roughness and biofilm control on secondary caries formation around composite resin restorations: an in situ evaluation. J Appl Oral Sci 2009:17(1):61-65.

15. Salami D, Luz MA. 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.

16. Castanho GM, Arana-Chavez VE, Fava M. Roughness of human enamel surface submitted to different prophylaxis methods. J Clin Pediatr Dent 2008:32(4):299-303.

17. Fincham AG, Moradian-Oldak J, Simmer JP. The structural biology of the developing dental enamel matrix. J Struct Biol. 1999:126(3):270-99.

18. Deutsch D, Catalano-Sherman J, Dafni L, David S, Palmon A. Enamel matrix proteins and ameloblast biology. Connect Tissue Res. 1995:32(1-4):97-107.

19. Jeremias F, de Souza JF, Silva CM, Cordeiro Rde C, Zuanon AC, Santos-Pinto L. Dental caries experience and Molar-Incisor Hypomineralization. Acta Odontol Scand. 2013:71(3-4):870-6. doi: 10.3109/00016357.2012.734412.

20. Kawashima N, Okiji T. Odontoblasts: specialized hard-tissue-forming cells in the dentin-pulp complex. Congenit Anom (Kyoto) 2016:56(4):144-153.

21. Akhter R, Hassan NM, Martin EF, Muhit M, Haque MR, Smithers-Sheedy H, et al. Risk factors for dental caries among children with cerebral palsy in a low-resource setting. Dev Med Child Neurol. 2017:59(5):538-43.

22. Abanto J, Panico C, Bonecker M, Frazão P. Impact of demographic and clinical variables on the oral health-related quality of life among five-year-old children: a population-based study using self-reports. Int J Paediatr Dent. 2018 Jan;28(1):43-51. doi: 10.1111/ipd.12300..

23. Putt MS, Kleber CJ, Davis JA, Schimmele RG, Muhler JC. Physical characteristics of a new cleaning and polishing agent for use in a prophylaxips paste. J Dent Res 1975:54(3):527-34.

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