Scientific Article

Primary Tooth Enamel Loss After Manual and Mechanical Microabrasion

Ângela Cristina Cilense Zuanon, DDS, MS, PhD[1] • Lourdes Santos-Pinto, DDS, MS, PhD[2] • Elcilaine Rizzato Azevedo, DDS[3] • Luciana Monti Lima, DDS, MS[4]

Abstract: ***Purpose:*** *This study's purpose was to assess the amount of dental enamel loss on primary incisors after manual or mechanical microabrasion with a phosphoric acid/pumice paste.* ***Methods:*** *Ten exfoliated primary maxillary incisors were bisected faciolingually and the resulting 20 halves were randomly assigned to 2 groups: group 1 (N=10)—manual technique (plastic spatula); and group 2 (N=10)—mechanical technique (rubber cup attached to a low-speed handpiece). Microabrasion was performed on the buccal surface using an abrasive paste prepared with 37% phosphoric acid and pumice. Ten 20-second applications alternated with 20-second risings were performed in each group. Enamel thickness measurements made under stereomi-croscopy before and after microabrasion were analyzed statistically by analysis of variance and pairwise t test.* ***Results:*** *There was a statistically significant difference (P=.003) between the manual and mechanical techniques. The mechanical technique produced a mean enamel loss of 274.16 µm (66% of total enamel thickness), while the mean enamel loss with the manual technique was 152.59 µm (39% of total enamel thickness).* ***Conclusion:*** *Manual microabrasion using a plastic spatula removed less enamel, but was sufficient to eliminate most superficial stains and defects, and may be a viable option for the microabrasive technique on primary teeth.* *(Pediatr Dent 2008;30:420-3) Received March 15, 2007 / Last Revision September 19, 2007 / Revision Accepted October 19, 2007*

KEYWORDS: MICROABRASION, DENTAL ENAMEL, PRIMARY TEETH

Enamel microabrasion is a conservative, nonrestorative technique for elimination of superficial stains or defects of dental enamel. It makes use of the wear provided by the mechanical action of abrasive agents, such as pumice, associated with the chemical action of phosphoric acid or hydrochloric acid on the enamel's organic portion.[1,2] This technique has been widely used because it provides immediate and permanent esthetic outcomes with the removal of small amounts of dental enamel, thus re-establishing esthetics without the need for cavity preparation and restoration.[3-5]

The microabrasion technique was originally developed for removal of enamel fluorotic stains.[6,7] It is further indicated for the removal of white stains resulting from hypocalcification, inactive caries lesions, and other superficial enamel structural defects.[7-9] Special care should be taken, however, to distinguish these stains from white spot lesions caused by active caries. In these cases, there is a very high risk of cavity formation during the microabrasive procedure due to the possibility of exposing the subsurface (the lesion corpus), which is more porous and friable than the enamel surface.[10]

Among the microabrasion materials used, a paste of 37% phosphoric acid and pumice is the easiest to obtain, requires a short application time, and is a low-cost option.[7] The use of this paste also is safe because the phosphoric acid is not excessively corrosive. These materials are also generally available in dental offices, as they are employed in adhesive restorative procedures and bonding of orthodontic brackets.[3]

The esthetic outcome of microabrasion depends directly on the severity, location, and depth of the stain because the thickness of the enamel layer varies with the tooth's region and surface.[11,12] The mean thickness of primary incisor enamel at the region located 0.125 mm from the cementoenamel junction (CEJ) is 0.277 mm. At a distance of 0.25 mm from the CEJ, however, the mean enamel thickness increases to 0.385 mm. The maximum enamel thickness on the buccal surface is 0.505 mm.[13]

In spite of the excellent results obtained with the microabrasive technique for removal of intrinsic stains on permanent teeth enamel,[2] little information is available regarding the amount of enamel removed by microabrasion of primary teeth.

This study's purpose was to assess enamel loss on exfoliated primary maxillary incisors after microabrasion was performed either manually or mechanically using a paste prepared with 37% phosphoric acid and pumice.

[1]Dr.Zuanon and [2]Dr. Santos-Pinto are associate professors, both in the Department of Pediatric Dentistry, [3]Dr. Azevedo is postgraduate student, Master's degree program in Dental Sciences, and [4]Dr. Lima is postgraduate student, PhD program in Dental Sciences, all in the School of Dentistry of Araraquara, São Paulo State University (UNESP), São Paulo, Brazil. Correspond with Dr. Zuanon at aczuanon@foar.unesp.br

Methods

After study design approval by the Institutional Ethics in Research Committee of the School of Dentistry of Araraquara, São Paulo, 10 exfoliated primary maxillary incisors were obtained from the tooth bank of the School of Dentistry of Araraquara, São Paulo State University, São Paulo, Brazil, and stored in 0.1% thymol solution for no more than 6 months before use.

The teeth were bisected faciolingually with a water-cooled diamond saw in a sectioning machine (Isomet-Buehler, Lake Bluff, Ill) at low speed, thus providing 20 halves that were fixed on wooden blocks with low-fusion impression compound. The tooth sections were randomly assigned to 2 groups, as follows: group 1 (N=10), to which the acid/pumice paste was applied manually with a plastic mixing spatula (Master-Dent, Dentonics, Inc, Monroe, NC); and group 2 (N=10), to which acid/pumice paste was applied with a rubber cup attached to a low-speed handpiece.

Prior to microabrasion, the specimens were submitted to rubber cup prophylaxis with a pumice/water slurry, rinsed thoroughly, and dried. The enamel thickness was measured using a stereomicroscope at X50 magnification at 3 different sites within an area delimited with a pencil. The average of the measurements was calculated (Figure 1). Microabrasion was performed on the buccal surface using an abrasive paste prepared with 37% phosphoric acid and pumice. In each group, ten 20-second applications were performed under a 20 kg force (kgf) load controlled by means of an absolute Dial Depth Gage (series no. 7200, Mitutoyo, São Paulo, Brazil) adapted to an apparatus with articulated arms, to which the low-speed handpiece and the spatula were attached. After each application, the teeth were rinsed with an air/water spray from a 3-way syringe for 20 seconds and dried. The average enamel thickness was obtained in the same way as aforementioned.

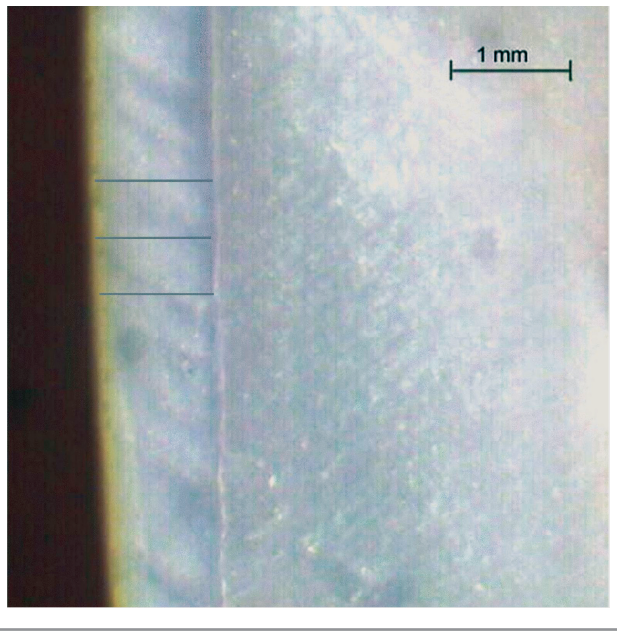

Figure 1. Demarcated areas for measurement of the initial enamel thickness (µm)

All measurements were performed twice by 2 examiners, with a 2-week interval between evaluations. The statistical methods used for data analysis were Pearson's correlations, analysis of variance (ANOVA) and pairwise *t* test. A .05 level of significance was established for the tests.

Results

The correlation between the first and second measurements obtained at different dates was excellent (r=0.93). Interexaminer agreement also was excellent (r=0.82). The averages of the measurements were used for statistical analysis.

The results are given in Table 1. The mechanical technique (rubber cup) produced a mean enamel loss of 274.16 µm (66% of the total enamel thickness). With the manual technique (plastic spatula), the mean enamel loss was 152.59 µm (39% of the total enamel thickness). The difference in enamel removed by the manual and mechanical techniques was statistically significant (ANOVA; P=.003).

The pairwise *t* test showed that the specimens (halves) from the same tooth did not present statistically significant differences in the initial enamel thickness (P=.38). There was a statistically significant difference (P=.001), however, comparing the enamel loss values in both groups.

Discussion

In clinical practice, it is often difficult to precisely determine the actual depth of enamel intrinsic stains. In these cases, enamel microabrasion has been suggested as the first treatment option, as it is a more conservative procedure and it also provides esthetic improvement.[2] Although the enamel loss may not be clinically perceptible, this technique should be performed with caution, especially in primary teeth, which have different characteristics from those of permanent teeth. These differences include a thinner enamel layer, greater amount of organic content, and lesser prismatic mineral content.[14]

In this study, the amount of enamel removed by the mechanical technique (rubber cup and low-speed handpiece) was greater than that removed by the manual technique (plastic spatula). The mean enamel loss was 27.41 µm per application with the mechanical technique and 15.26 µm with the manual technique, both employing a 37% phosphoric acid/pumice paste. Chan et al,[15] however, using a Prema microabrasion compound (Premier Dental Products Co, Plymouth Meeting, Pa), reported that the manual and mechanical techniques provided similar amounts of enamel removal (15 µm per application, on average). According to these authors, the hydrochloric acid's chemical erosive action was the main factor in enamel removal, rather than the method of application.

An optical microscopic study evaluated the amount of enamel loss after mechanical microabrasion with different formulations.[16] The authors reported that the 18% hydrochloric

Table 1. INITIAL AND FINAL ENAMEL THICKNESS (µM) AND PERCENTAGE OF ENAMEL LOSS AFTER MICROABRASION

Group 1 (manual application—plastic spatula)					Group 2 (mechanical—rubber cup)			
Specimen no.	Initial enamel thickness (µm)	Final enamel thickness (µm)	Difference	% loss	Initial enamel thickness (µm)	Final enamel thickness (µm)	Difference	% loss
1	301.01	211.11	89.90	30	348.48	255.55	92.93	27
2	419.19	289.90	129.29	31	333.30	95.96	237.37	72
3	325.25	85.86	239.39	74	452.52	215.15	237.37	52
4	294.95	255.55	39.40	13	422.22	150.50	271.72	64
5	421.21	164.65	256.56	61	435.35	123.23	312.12	72
6	512.12	348.48	163.64	32	496.97	133.33	363.64	73
7	431.31	206.06	225.25	52	377.99	77.78	300.21	79
8	409.09	279.80	129.29	32	422.22	137.37	284.85	67
9	406.06	304.37	101.69	25	426.26	158.59	267.67	63
10	403.03	251.51	151.52	38	405.05	31.36	373.69	92
Mean±(SD)	**392.32±66.94**	**239.73±75.85**	**152.59±70.05***	**39**	**380.67±113.80**	**132.24±63.92**	**255.60±96.76***	**65**

* Statistiscally different at the 5% level; ANOVA test (*P*=.003).

acid plus pumice provided the largest amount of enamel loss, followed by 18% hydrochloric acid alone, 37% phosphoric acid plus pumice, 37% phosphoric acid alone, and Prema Compound. The mean enamel loss per application with phosphoric acid/pumice and Prema Compound was 17.5 µm and 7.31 µm, respectively.

Silva et al[7] evaluated the application of 37% phosphoric acid/pumice and Prema Compound to enamel surfaces using either a manual applicator or disposable rubber cup. They concluded that both products are effective for removal of superficial enamel fluorotic stains. The difference is the number of required applications—that is, the 37% phosphoric acid/pumice paste is able to remove enamel twice as fast as Prema Compound, which contains 10% hydrochloric acid.

The acid-abrasive mixture of phosphoric acid and pumice has a thick consistency, which facilitates its application with a rotary rubber cup. Its efficacy is between that of the 18% hydrochloric acid/pumice paste, which is corrosive and aggressive to the soft tissues, and that of Prema Compound, which is innocuous and weaker. Additionally, phosphoric acid is readily available in dental offices and has been shown to provide satisfactory results.[11]

The buccal enamel in permanent incisors is approximately 1 mm thick. It has been shown that 10 applications of hydrochloric acid can remove nearly 25% of the enamel in this area.[17] The thickness of the enamel of primary maxillary incisors has been reported as being 505 µm (±91 µm).[13] In the present study, the thickness of buccal enamel was 402.18 µm (ranging from 294.95-512.12 µm) and microabrasion removed from 39% to 66% of the enamel.

The removal of an amount of enamel as small a 100 µm is sufficient to eliminate most superficial stains without causing any damage or any change in tooth shape.[16] Therefore, the use of 37% phosphoric acid associated with pumice should be limited to 6 applications.[11] Based on this recommendation and according to the results of the present study, it is advisable to use 4 applications of 37% phosphoric acid/pumice with the mechanical technique and up to 7 applications with the manual technique. In the present study, manual and mechanical microabrasion was performed with a specific force controlled by means of a dynamometer in order to standardize the microabrasive protocol and allow reliable comparisons of enamel removal under the tested conditions. Nevertheless, a major concern regarding the use of these techniques in clinical practice refers to the force applied during microabrasion, which is very difficult to standardize and differs from one operator to another.

Conclusion

Manual microabrasion using a plastic spatula should be considered as a viable option when the microabrasive technique is indicated in primary teeth.

References

1. Croll TP. Enamel microabrasion: Observations after 10 years. J Am Dent Assoc 1997;128(suppl):45S-50S.
2. Sundfeld RH, Croll TP, Briso ALF, De Alexandre RS, Sundfeld ND. Considerations about enamel microabrasion after 18 years. Am J Dent 2007;20:67-72.

3. Croll TP, Cavanaugh RR. Enamel color modification by controlled hydrochloric acid-pumice abrasion. I. Technique and examples. Quintessence Int 1986;17:81-7.
4. Croll TP, Cavanaugh RR. Enamel color modification by controlled hydrochloric acid-pumice abrasion. II. Further examples. Quintessence Int 1986;17:157-64.
5. Croll TP. Enamel microabrasion for removal of superficial demineralization and decalcification defects. J Am Dent Assoc 1990;120:411-5.
6. Wray A, Welbury R. UK National clinical guidelines in pediatric dentistry: Treatment of intrinsic discoloration in permanent anterior teeth in children and adolescents. Int J Paediatr Dent 2001;11:309-15.
7. da Silva SM, de Oliveira FS, Lanza CR, Machado MA. Esthetic improvement following enamel microabrasion on fluorotic teeth: A case report. Quintessence Int 2002; 33:366-9.
8. Croll TP. Enamel microabrasion followed by dental bleaching: Case reports. Quintessence Int 1992;23:317-21.
9. Croll TP, Segura A, Donly KJ. Enamel microabrasion: New considerations in 1993. Pract Periodontics Aesthet Dent 1993;5:19-28.
10. Erdogan G. The effectiveness of a modified hydrochloric acid-quartz-pumice abrasion technique on fluorosis stains: A case report. Quintessence Int 1998;29:119-22.
11. Dalzell DP, Howes RI, Hubler PM. Microabrasion: Effect of time, number of applications, and pressure on enamel loss. Pediatr Dent 1995;17:207-11.
12. Pourghadiri M, Longhurst P, Watson TF. A new technique for the controlled removal of mottled enamel: Measurement of enamel loss. Br Dent J 1998;184:239-41.
13. Seow WK, Young WG, Tsang AK, Daley T. A study of primary dental enamel from preterm and full-term children using light and scanning electron microscopy. Pediatr Dent 2005;27:374-9.
14. Silness J, Hegdahl T, Gustavsen F. Area of the organic-inorganic interface of dental enamel. Acta Odontol Scand 1973;31:123-9.
15. Chan DCN, Howell ML, Carraway KB, Garcia-Godoy F. Polarized and transmitted light microscopy study of enamel after microabrasion. Quintessence Int 1995;26: 57-61.
16. Mendes RF, Mondelli J, Freitas CA. Wear after microabrasion of human enamel with different formulations and number of applications. J Appl Oral Sci 1999;7:35-40.
17. Waggoner WF, Johnston WM, Schumann S, Schikowski E. Microabrasion of human enamel in vitro using hydrochloric acid and pumice. Pediatr Dent 1989;11:319-23.

Abstract of the Scientific Literature

Evaluation of enamel matrix derivative (EMD) for pulpotomy treatment in primary teeth

The aim of this study was to contrast clinical and radiographic success between biologically active odontogenic protein enamel matrix derivative (EMD) and formocresol. This was a randomized, single-blinded study utilizing a split-mouth design. This study involved 15 children with a mean age of 5.0 ±0.7 years who had deep caries lesions on both primary mandibular right and left molars. Radiographs were used to exclude teeth with noticeable pulpal changes and periapical and furcal radiolucencies. Thirty teeth were randomized into either the EMD or formocresol group. Primary mandibular molar amputated pulp stumps in the formocresol group were treated with Buckley's formocresol (1:5 dilution) while pulp stumps on the contralateral side were treated with Emdogain gel. Teeth were then restored with stainless steel crowns. Assessments were made at 1 week, 2, 4, and 6 months post-treatment by 2 examiners who were blinded to the treatment agent. No significant differences in clinical success rates between the EMD and formocresol control groups were noted at 6 months (93% vs. 67%) but did exist radiographically (60% vs. 13%, p=.04). This study offers initial evidence of the potential effectiveness of EMD as a pulpotomy agent for primary teeth.

Comments: *This study points to the future potential use of EMD gel as it may produce similar success rates as proven methods. Until more data on the long term success and safety of this procedure via larger randomized controlled trials are known, defined techniques are established, and ease of use are improved, practitioners should continue with the traditional 1:5 formocresol pulpotomy technique.* ***RJS***

Address correspondence to Dr. Jumana Sabbarini, Ministry of Health, Irbid Health Department, Irbid, Jordan; e-mail: jumanadm@yahoo.com

Sabbarini J, Mohamed A, Wahba N, El-Meligy O, Dean J. Comparison of enamel matrix derivative versus formocresol as pulpotomy agents in the primary dentition. J Endod 2008;34:284-7.

22 references