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Association of chlorhexidine and fluoride for plaque control and white spot lesion remineralization in primary dentition

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Background. Plaque control and caries arrest still remain a challenge for dentists.

Objective. This study was conducted to assess the effect of the combined use of chlorhexidine varnish and fluoride varnish on the visible plaque index (VPI) and white spot lesion (WS) remineralization in primary dentition.

Methods. A total of 80 caries-active preschool children (3–5 years) were randomly divided into four groups. Group 1 received a chlorhexidine varnish application every week during 4 weeks. Group 2 received a fluoride varnish application every week during 4 weeks. Group 3 received alternated applications of chlorhexidine and fluoride varnish during 4 weeks. Group 4 served as control (without any type of cariostatic agent).

Results. There was no statistically significant difference in the VPI and WS remineralization among the groups after 1 month. However, 3 months follow-up demonstrated that group 3 (chlorhexidine + fluoride) showed significantly better results for both VPI and WS remineralization.

Conclusion. The combined application of chlorhexidine and fluoride varnishes is more effective on plaque and remineralization of incipient caries after 3 months than the same agents applied separately.

Introduction

Active white spot lesion (WS) is the first clinical sign of caries, although it cannot be considered the onset of the disease, once partial dissolution of hydroxyapatite crystals attains a depth of 20–100 μm from the external surface of enamel before there is any macroscopic visualization[1].

For white spot formation, the enamel must be exposed to unaltered cariogenic plaque for about 14 days, sufficient time for significant mineral loss to occur[2].

Plaque accumulation for long periods is facilitated in primary dentition because preschool children lack motor coordination to perform satisfactory oral hygiene[3], or because parents find it difficult to perform their children's toothbrushing[4]. A widely used clinical parameter for measuring mechanical plaque removal in very young children is the visible plaque index (VPI)[5].

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Caries progression control, especially in its initial clinical stages, may be favoured by the use of fluorides. Fluoride varnish enhances remineralization of active WSs[6], because the quantities of calcium and phosphate lost by dental structure can be replaced by the enamel in the form of fluorapatite[7].

The isolated use of fluoride proved to be insufficient to prevent progressive mineral loss and consequent lesion formation[8,9] in children at high risk for caries development. To control plaque formation and reduce its acidogenicity, increasing the possibility of remineralizing the WSs, some authors recommend the concomitant use of chlorhexidine[10,11].

The aim of this study was to assess whether the combination of fluoride and chlorhexidine varnishes has a positive effect on the presence of plaque and on WS mineralization, and whether there is any relation between mineralization and the VPI in preschool children.

Materials and methods

Eighty caries-active children (37 boys and 43 girls) aged between 3 years and 5 years (mean

age 3.4), resident in a rural area not provided with fluoridated water (representative of low social–economical population), were selected. The children presented complete primary dentition and good general health. After the children's guardians had signed the free informed term of consent, the sample was submitted to an initial clinical exam (T1) by a single examiner. The exam was performed in a dental office, with optimal light conditions. The dft caries index was assessed clinically by vision inspection (mean value was 2.2; SD ± 1.6), and the following data were collected:

1 VPI: Analysis of the presence of plaque was performed by visual exam only, without using plaque-revealing substances[5]. For recording VPI, the vestibular surfaces of all primary teeth were examined, receiving scores of 0 or 1, in accordance with the absence or presence of plaque, respectively. After summing all the values, the VPI was transformed into percentages.

2 The number of surfaces with active WSs: After prophylaxis with pumice stone (S.S. White, Rio de Janeiro, Brazil) and drying the teeth, all primary teeth surfaces were examined, and these lesions were diagnosed with the aid of a no. 4 buccal mirror and no. 5 exploratory probe, active lesions being considered those with a dull, rough, opaque surface[1]. WS value was calculated considering the number of affected surfaces per person. To assure the reliability of the examiner's diagnosis, a further exam was performed (the same examiner) a week after the first one to obtain the kappa index (10% of the sample was re-examined).

After the initial clinical exam (T1), in which standard guidance on diet (decrease on sugar intake) and oral hygiene were given, the children with cavitated lesions received restorative treatment. The material of choice for anterior teeth was light polymerizable resin composite, and for the posterior teeth, silver amalgam. After that, the 80 children were randomly divided into four groups.

1 Group 1 (G1 – $n = 20$): The children received a weekly application of varnish with chlorhexidine[12] (Cervitec, Ivoclar-Vivadent, São Paulo, Brazil), during 4 weeks. The application was made after prophylaxis with pumice stone, with the aid of a brush and under relative insulation, emphasizing that the varnish was applied on all the surfaces of every tooth[13].

2 Group 2 (G2 – $n = 20$): The children received a weekly application of varnish with fluoride (Fluorniz, S.S. White) during 4 weeks. The application method was similar to that described in GI.

3 Group 3 (G3 – $n = 20$): The concomitant therapy of varnish with fluoride (Fluorniz) and varnish with chlorhexidine (Cervitec), applied alternately once a week during 4 weeks, was tested. The application followed the same protocol used in G1 and G2.

4 Group 4 (G4 – $n = 20$): Control group. No treatment was performed, except restorative treatment when necessary.

The test groups received the recommendation not to ingest food or drinks for 1 hour after varnish applications and not to brush their teeth on the day of application[13] to prevent chemical interactions among the dentifrice components and the substances in the varnish formulations[14].

The children in the test groups returned for follow-up after 1 month (T2), and 3 months (T3) after the last varnish application. In G4, the returns (T2 and T3) were scheduled from the last restorative treatment session. On these follow-up visits, the VPI and WS were again assessed and compared.

This study was approved by the Ethics Committee of the Health Science Faculty of the University of Brazilian under registration no. 09/04.

The descriptive statistical techniques (calculation of means, standard deviation, and relative and absolute frequencies) and the non-parametric Kruskall–Wallis and Spearman correlation tests were used for statistical analysis. The level of significance adopted was $P < 0.05$.

Results

The four groups presented very similar mean VPI and WS values (not statistically significant) at the initial clinical exam (T1), as shown in Table 1.

The degree of intra-examiner agreement (kappa) was 0.964 (T1).

Table 1. Visible plaque index (VPI) and white spot lesion (WS) means at time T1 for all groups.

	Group	*N*	Mean	Standard deviation
VPI (%)	1	20	37.50	20.68
	2	20	38.50	15.82
	3	20	36.75	19.49
	4	20	35.25	17.28
WS	1	20	3.15	2.23
	2	20	3.45	2.31
	3	20	3.10	2.59
	4	20	3.25	2.00

Sample loss was around 5%, because of the 80 children in the initial sample, 78 were examined at time T2, and 76 at time T3.

Table 2 shows the reduction in VPI in all the groups for the intervals T1 and T2. There was a trend towards greater reduction in the groups in which the varnish with chlorhexidine was used (isolated or in combination with fluoride varnish), although this difference was not statistically significant when the groups were compared ($P = 0.105$). Between the times T1 and T3, there was a reduction in VPI in the three test groups, whereas in the control group (G4), an increase in this variable was found. The differences in VPI variation among the four groups in this time interval were statistically significant ($P = 0.005$), and the groups that presented the greatest reduction were, respectively, G3 (chlorhexidine and fluoride), G1 (chlorhexidine), and G2 (fluoride).

With regard to WS, no significant reduction was found among the groups when they were examined at the time interval T1–T2 (Table 3). Between times T1–T3 and T2–T3, however, the reduction in WS was statistically significant among groups. The best results were presented by groups G3 (chlorhexidine and fluoride), G2 (fluoride), and G1 (chlorhexidine), respectively. The combination of the varnishes (G3) demonstrated a mean value of 0.85 WS remineralization in the time interval T2–T3, whereas in the interval T1–T3, the mean remineralization was even higher: 1.40 lesions. On the other hand, the control group presented an increase in WS in these periods (Table 3).

No strong correlation was found between the variables VPI and WS in the times T1–T3 when the groups were compared. The Pearson coefficient of correlation was not significant for the groups G2, G3, and G4, but for G1 – 0.474 (Table 4).

Table 2. Visible plaque index (VPI) mean variation × time intervals.

	Group 1		Group 2		Group 3		Group 4		
	Mean (%)	SD	Mean (%)	SD	Mean (%)	SD	Mean (%)	SD	*P*
VPI T1–T2	–11.25	13.36	–5.79	12.05	–11.50	12.57	–4.74	6.12	0.105
VPI T2–T3	3.88	6.98	4.21	9.75	2.75	5.95	6.31	7.04	0.575
VPI T1–T3	–8.05	12.50	–1.58	9.58	–8.75	10.87	1.58	8.67	0.005†

Kruskal–Wallis test.
SD, standard deviation.
– Sign means reduction; † – statistical significance among all groups.

Table 3. White spot lesion (WS) mean variation × time intervals.

	Group 1		Group 2		Group 3		Group 4		
	Mean	SD	Mean	SD	Mean	SD	Mean	SD	*P*
WS T1–T2	–0.35	0.74	–0.47	0.77	–0.55	0.99	–0.21	0.63	0.691
WS T2–T3	–0.61	1.14	–0.58	1.17	–0.85	1.46	0.58	0.77	< 0.001†
WS T1–T3	–0.89	1.45	–1.05	1.54	–1.40	2.21	0.37	1.01	0.004†

Kruskal–Wallis test.
SD, standard deviation.
– Sign means reduction; † – statistical significance among all groups.

Table 4. Correlation between visible plaque index (VPI) and white spot lesion (WS) in the interval of time T1–T3 for all groups.

	WS (T1–T3) × VPI (T1–T3)		
Group	***N***	**Pearson's correlation**	***P***
1	18	0.47	0.047*
2	19	0.28	0.253
3	20	0.36	0.117
4	19	0.18	0.452

*$P \leq 0.05$.

Discussion

The sample was composed of children resident in a region of non-fluoridated water, presenting comparable VPI and WS indexes. Although there was loss of sample (5%), this can be considered low and acceptable. No relevant technical problem was observed during the experimental periods. All children allowed dental examination and treatment according to conditioning techniques described in paediatric dentistry literature.

The kappa value indicates excellent agreement, an important factor for data comparison.

As regards the variable VPI, a reduction of this index was expected in the groups that made use of chlorhexidine, because it is an antimicrobial agent with proven antiplaque action[15]. However, no significant reduction in VPI was observed in the T1–T2 interval among the test and control groups. This could be attributed to the oral hygiene guidance that motivated the children, and the restorative treatment, which removed the bacterial retention niches, facilitating mechanical plaque control, also in the control group.

With an increase in the time interval between the follow-up visits, the positive effect of the restorative treatment and the oral hygiene guidance on plaque seemed to be minimized, with only the residual effect of the antimicrobial agent remaining. This can be verified when observing the small increase in VPI in all the groups between the times T2 and T3. These data confirm the importance of constantly reinforcing oral hygiene guidance at the follow-up visits in patients that have difficulty with mechanical plaque control[16].

The cariostatic agents used in the study, even 3 months after their application, exercised a positive influence on plaque accumulation. The results obtained with the combination of chlorhexidine and fluoride corroborated the findings of Joyston-Bechal *et al.*[17], in which irradiated patients made concomitant use of these substances in gel and collutory form, and also evidenced significant reduction in the plaque index after 6 months and 12 months.

However, Luoma *et al.*[18], comparing chlorhexidine-based mouthwashes with fluoride and chlorhexidine-based products, after 4 consecutive days of use, found no significant differences in the stained plaque index. In addition, the authors demonstrated a trend towards higher plaque levels after associating chlorhexidine with fluoride than after the isolated use of chlorhexidine. It is relatively difficult to make a comparison between the results obtained in this study and those shown by Luoma *et al.*[18]. In the latter, the observation time was restricted to only 4 days, and the sample completely suspended mechanical plaque control during the research. As previously discussed, the oral hygiene guidance given to the children in the present research exerted an influence on the results obtained and could have acted synergically with the varnishes, amplifying their effect on the VPI.

The results showed that the combination of chlorhexidine and fluoride in the longer time interval of 3 months was more effective in remineralizing the white spots than the fluoride alone. Previous studies[10,17] also found similar results in irradiated patients, considered at high risk for caries. All children presented an initial decrease in WS values in interval T1–T2; however, G4 was the only one that presented an increase for T1–T3 and T2–T3. It must be emphasized that G4 children did not receive any sort of cariostatic agent, and the initial WS decreased observed might be explained by the restorative treatment offered, oral hygiene, and diet instructions.

The concomitant use of varnish with fluoride and varnish with chlorhexidine seems to create a favourable environment for remineralizing incipient lesions. Chlorhexidine, with its antiplaque effect and its specific action on *Streptococcus*

mutans, would be responsible for the lower production of acid close to the active WSs[19]. With a smaller drop in pH in plaque and the availability of fluoride ions released by the fluoridated varnish, there would be mineral replacement in the enamel in the form of fluorapatite[7].

This synergic action has been related in the literature. The combination of two cariostatic agents was shown, *in vitro*, to promote less pH reduction than the same substances individually[20,21]. In addition, another *in vivo* research found that the combination resulted in less mineral loss from the enamel after 4 weeks of unaltered plaque accumulation, than the isolated use of fluoride or chlorhexidine[9].

Another possibility of cariostatic agent to be combined with fluoride or with both fluoride and chlorhexidine varnishes is xylitol. Although the sample had not received specific recommendation to use any kind of chewing gum, concomitant use of a xylitol-containing one could be a good option to an even higher decrease in VPI. A previous study[22] showed that xylitol-sweetened gum was effective against the build-up of dental plaque and eliminated microbes found in saliva, particularly mutans streptococci. The combination of these three cariostatic agents should be tested to confirm the hypothesis of best results.

As regards the correlation between plaque accumulation and active WSs, the data indicate weak relation between dental caries and the amount of bacterial plaque on the teeth. Similar results were described by Bellini *et al*.[23].

Caries is a multifactorial disease, what makes difficult to consider the VPI as the only predictor of risk for caries. Although the VPI represents a static (momentary) situation, mineralization is a dynamic process, which makes correlation between the two difficult.

It must, however, be pointed out that the observation period in this study was only 3 months, considered short for assessing caries progression. Longitudinal studies with longer observation times are necessary in order to confirm the lack of correlation between VPI and active white spot remineralization in primary dentition.

Conclusion

The combination of varnishes with chlorhexidine and fluoride was shown to be more effective in reducing the plaque index and in active white spot remineralization after 3 months of observation, than the isolated use of varnishes, and could be a useful resource for controlling caries in primary dentition in children with high caries activity.

What this paper adds

- Information about the combination of fluoride and chlorhexidine varnishes for the control of WSs and dental plaque in primary dentition.

Why this paper is important to paediatric dentists

- The combination between the two varnishes, fluoride and chlorhexidine, can be a good alternative for the control of dental plaque and WSs remineralization in children.
- The tested protocol can be used in both private practice and/or public oral health programmes.

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