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Assessment of antimicrobial efficacy of APF gel and the combination of chlorhexidine varnish and xylitol containing chewing gum in children

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Abstract

Aim: The aim of the study was to assess the antimicrobial efficacy of APF gel and the combination of Chlorhexidine varnish and Xylitol containing chewing gum on streptococcus mutans levels in 6–10-year-old children.

Materials and methods: The study was conducted on 30 children studying in a government school in Haldia city aged between 6-10 years who were randomly divided into 3 groups.

Group I (xylitol chewing gum) Group II (xylitol gum and chlorhexidine varnish)

Group III (Fluoride gel)

Group I was given xylitol chewing gum twice daily after breakfast and lunch for 45 days. Group II was given xylitol chewing gum twice daily along with application of chlorhexidine varnish at the beginning of the study and on the 30th day. Group III was given Fluoride gel application at the beginning of the study and on the 30th day. Microbiological tests were performed to assess the levels of Streptococcus mutans colony forming units (CFU). CFU scores were categorised as follows: 0 = absence of *S.* mutans, 1 = low level (1-10 CFU), 2 = moderate level (11-100 CFU), 3 = high level (101-250 CFU), 4 = very high level (>250 CFU).

Results: All groups presented a reduction in the Streptococcus mutans levels.

Xylitol and Chlorhexidine varnish together showed the largest reduction throughout the study period, with 58.3% in the first month and 48.2% at the end of the study.

Conclusion: The Xylitol chewing gum and Chlorhexidine varnish combination was efficient and superior to single treatments in suppressing Streptococcus mutans.

Keywords: S. mutans, dental caries, APF gel, Varnish, Xylitol

Introduction

The main pathogen associated with dental caries is Streptococcus mutans. It induces mineral loss due to its strong adhesion to the tooth surface and to the acid production resulting from fermentable carbohydrates, which keeps local pH low[1]. The biofilm produced by this pathogen accounts for adhesion of S. mutans, and is considered to be cariogenic[2]. Chlorhexidine (CHX)[3,4] and xylitol (XYL)[5] have been used as strategies to prevent and reduce carious lesions[6,7]. Chlorhexidine is a bis-biguanide with antibacterial, anticariogenic and remineralising actions and few toxic effects[4,8,9]. Chlorhexidine acts by damaging the cell membrane of prokaryotes and by disrupting the cytoplasmatic constituents. Cell death occurs due to the rapid accumulation of metal ions inside the cells as they become more permeable[10]. Xylitol is also present in human metabolism as a normal metabolic intermediate (in the glucuronate-xylulose cycle). In chemical nomenclature, xylitol is

classified similarly to sorbitol and maltitol (i.e., as a sugar alcohol or a polyol). The theoretical calorie value of xylitol is the same as with other dietary carbohydrates (i.e., about 4 kcal/g)[37]. A significant anti-viral effect on streptococci has been seen with Xylitol/Chlorhexidine combination when compared to pure xylitol or chlorhexidine[27]. Fluoride also has antimicrobial action when used in high concentrations, usually higher than those in fluoride-containing products for clinical purposes[19-21]. The present study assessed the antimicrobial effect of APF gel and combining 1% chlorhexidine varnish with xylitol chewing gum on S. mutans in 6–10-year-old children.

Materials and methods

A randomised experimental study was performed at a Government High School, Haldia, West Bengal, India. Institutional ethical clearance was obtained. All the children of the school were examined out of which only 30 were selected who were within the age group of 6-8 years with early mixed dentition and without any active carious lesions.

The children should not have taken any anti-microbial medication for at least three months before the study and a signed informed consent was obtained from the parents.

Dental examination was performed in the classroom using a mouth mirror and a straight probe.

The children were randomly divided into three groups. In Group I (XYL) (n = 10), xylitol chewing gum was given to the children twice a day, after breakfast and after lunch for a period of 45 days by the in charge care taker. In Group II (CHX + XYL) (n = 10), chlorhexidine varnish at 1% (CERVITEC – Ivoclar) was applied on each child's dentition using an applicator at the beginning of the study and on the 30th day, totalling two applications throughout the study.

These children also used xylitol chewing gum during the study period as except on those days of chlorhexidine varnish application.

In Group III (n = 10), acidulated phosphate fluoride gel, was applied at the beginning of the study and on the 30th day, totalling two applications.

A sterile tongue blade (180 mm × 18 mm) was inserted into the child's oral cavity and then moved around up to ten times, with both sides being then pressed on a plate containing 12 ml of Mitis salivarius agar base containing 0.2 g/ml sorbitol, 0.01 mg/ml potassium tellurite, 1.66 µg/ml bacitracin and 1.275 µg/ml kanamycin sulphate.

The plates were then incubated at 37°C for 72 hours in an anaerobiosis jar with an atmosphere of 80% N2, 10% H2 and 10% CO2.

The period of time lapsed between inoculation and anaerobic incubation did not exceed 4 hours.

Colony forming unit scores (CFU) are counted in the spatula impression area by the same operator using a stereoscopic microscope.

The CFU scores for S. mutans are expressed according to the criteria described by Weber as follows:

0 = absence of S. mutans

1 = low level (1-10 CFU)

2 = moderate level (11-100 CFU)

3 = high level (101-250 CFU)

4 = very high level (>250 CFU)

Data were analysed by using the statistical program SPSS 11.0. Kruskall-Wallis, Mann- Whitney and ANOVA statistical tests were performed with a 5% significance level.

Results

Thirty children were selected for this study. The mean age was 7.27 years old, and the 8-year-old children were mostly (75%) seen in groups G2 (CHX + XYL) and G3 (APF).

All groups had statistically significant reductions in S. mutans levels ($p < 0.001$). Groups G1 and G2 were found to have the largest reductions, on average 1.97. The mean scores (0 to 4) for S. mutans ranged from 3.40 and 3.50 at the baseline (Fig2) to 2.85 and 2.60 after 45 days (Fig 4) for groups G1 (XYL) and G2 (CHX+XYL) respectively. At the baseline, 70% of the children were evaluated as having moderate S. mutans levels (11-100 CFU), whereas 17% had high levels and 12% the highest. After 45 days (last saliva collection), however, the levels of S. mutans had gradually decreased and were found to be lower than those at the baseline: 70% of the children had low levels, 22% had moderate levels of S. mutans.

None of the children had high or very high levels of this micro-organism at the end of the study. S. mutans was gradually suppressed in all groups during the study and all the comparisons were statistically significant ($p < 0.05$). The group G2 (CHX + XYL) showed the highest reduction in S. mutans level of 58.3% in the first month and 48.2% at the end of the study.

Discussion

The first micro-organisms described as being involved in the formation of a pellicle

adhering to dental surfaces were S. mitis, S. oralis, and S. sanguinis. S. mutans is able to

demineralise hydroxyapatite, thus demonstrating its relevance in the development

of caries[1,8,24]. This key role played by S. mutans in the formation of cariogenic biofilm is a hypothesis already accepted in dentistry, since it is the best explanation for caries aetiology[25]. Therefore, reducing the levels of this micro-organism in the oral cavity seems to be crucial for controlling caries in general.

Chlorhexidine (CHX) is known to be an excellent antimicrobial agent, particularly in reducing the levels of S. mutans, which is very sensitive to this substance[4,6,8,11,26]. At low concentrations, chlorhexidine can be considered a bacteriostatic agent[3] because

it affects the metabolic activity of microorganisms by acting on cell membranes, causing intracellular disruption[27]. However, at high concentrations, this product seems to affect the cellular content, thus being bactericidal[8,28].

With regard to S. mutans levels, the largest reduction was observed in group G2 (CHX + XYL) (91.3%) than G1 (XYL) (87%). These results support other previous studies [3,26,28], which showed that individuals using chlorhexidine had the best results regarding biofilm reduction compared to those using either fluoride or only

xylitol (G3 and G1), respectively. Chlorhexidine has the ability to remain inside the oral cavity for a long period of time, mainly as varnish, a finding already proved by other authors[3,4,26,29].

In our study, we observed that in those groups where chlorhexidine was one of the agents (G2), the levels of S. mutans continued to decrease even during the one-month interval between the first and second evaluations. This finding confirms its substantivity.

With regard to the amount of chlorhexidine in the varnish, different concentrations can be used, although 1% chlorhexidine yields better results according to the literature[3,26,29-31]. The varnish vehicle was also justified due to the recommendation of not using gels or mouthwashes for young children.

Xylitol also reduces both biofilm and S. mutans levels when added to a patients' diet as a sweetener, thus preventing early development of caries. The use of chewing gum as a means of administering xylitol was important for achieving co-operation among the children, in addition to remaining for a longer time in the oral cavity, thus prolonging its effect[12,14,17]. Nevertheless, the frequent use of xylitol chewing gum should be controlled to prevent the occurrence of microbial resistance[15-17]. This finding may be related to factors such as formation of acids resulting from glucose and/or polysaccharides resulting from sucrose[33].

The optimum length of time for using xylitol should be further evaluated in order to avoid or minimise the emergence of microbial resistance.

Although the results in group G3 (fluoride) were found to be inferior compared to other groups, this agent has antimicrobial action when used in high concentrations, usually higher than that in fluoride-containing products for clinical purposes.

Conclusion

Based on the results found, we can conclude that combining 1% chlorhexidine with xylitol chewing gum was efficient and superior to single treatments in controlling biofilm and suppressing S. mutans. Further investigation should be carried out in order to confirm the results and develop strategies for using such products to prevent dental caries.

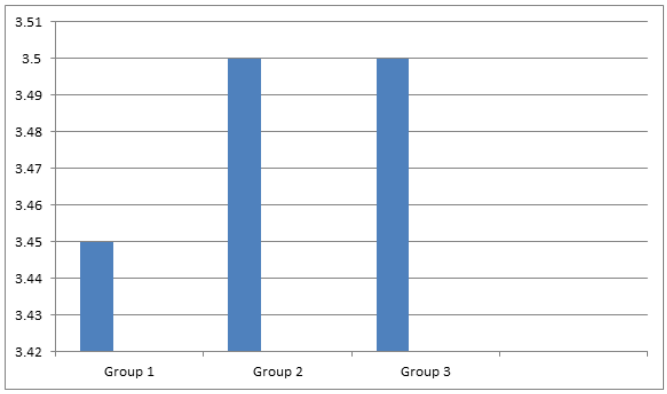

Fig 1: Number of Colony forming units (CFU) of streptococcus mutans in the saliva samples at baseline.

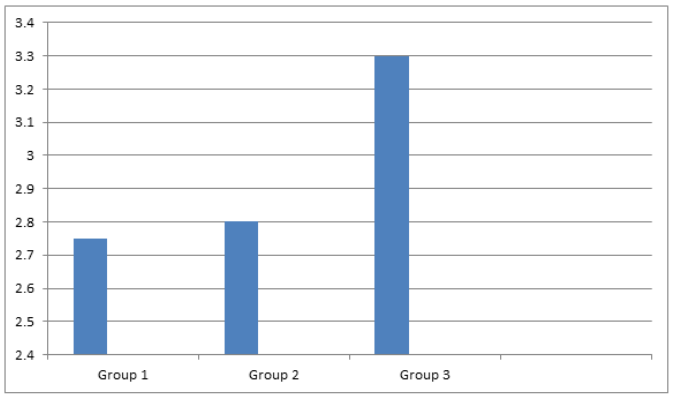

Fig 2: Number of Colony forming units (CFU) of streptococcus mutans in the saliva samples after 30 days.

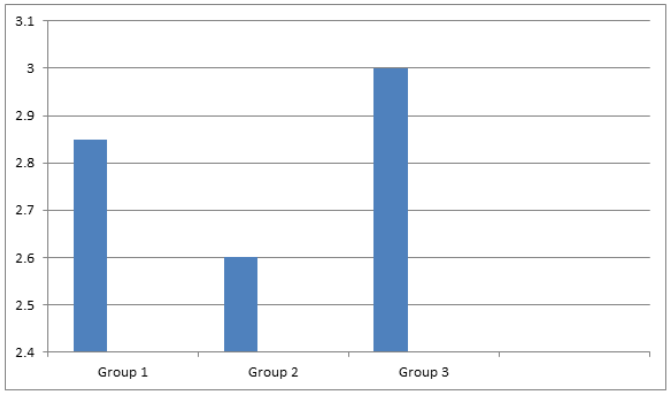

Fig 3: Number of Colony forming units (CFU) of streptococcus mutans in the saliva samples after 45 days

References

1. Banas J A, Miller J D, Fuschino M E et al. Evidence that accumulation of mutants in a biofi lm refl ects natural selection rather than stress-induced adaptive mutation. Appl Environ Microbiol 2007; 73: 357–361.

2. Mattos-Graner R O, Smith D J, King W F, Mayer M P. Water-insoluble glucan synthesis by mutans streptococcal strains correlates with caries incidence in 12- to 30-month-old children. J Dent Res 2000; 79: 1371–1377.

3. Matthijs S, Adriaens P A. Chlorhexidine varnishes: a review. J Clin Periodontol 2002; 29: 1–8.

4. Petti S, Hausen H. Caries-preventive effect of chlorhexidine gel applications among high-risk children. Caries Res 2006; 40: 514–521.

5. Isokangas P, Soderling E, Pienihakkinen K, Alanen A. Occurrence of dental decay in children after maternal consumption of xylitol chewing gum, a follow-up from 0 to 5 years of age. J Dent Res 2000; 79: 1885–1889.

6. Kuramitsu H K, Wang B Y. Virulence properties of cariogenic bacteria. BMC Oral Health 2006; 6(Suppl 1): S11.

7. Napimoga M H, Hofl ing J F, Klein M I, Kamiya R U, Goncalves R B. Transmission, diversity and virulence factors of Streptococcus mutans genotypes. J Oral Sci 2005; 47: 59–64.

8. Glassman P, Anderson M, Jacobsen P et al. Practical protocols for the prevention of dental disease in community settings for people with special needs: the protocols. Spec Care Dentist 2003; 23: 160–164.

9. Rodrigues C R, Marquezan M, Barroso L P et al. Effect of chlorhexidine-thymol varnish on caries lesion development in fi rst permanent molars. J Clin Dent 2008; 19: 18–21.

10. Modesto A, Drake D R. Multiple exposures to chlorhexidine and xylitol: adhesion and biofilm formation by Streptococcus mutans. Curr Microbiol 2006; 52: 418–423.

11. Anderson M. Chlorhexidine and xylitol gum in caries prevention. Spec Care Dentist 2003; 23: 173–176.

12. Burt B A. The use of sorbitol- and xylitol-sweetened chewing gum in caries control. J Am Dent Assoc 2006; 137: 190–196.

13. Holgerson P L, Sjostrom I, Stecksen-Blicks C, Twetman S. Dental plaque formation and salivary mutans streptococci in schoolchildren after use of xylitol-containing chewing gum. Int J Paediatr Dent 2007; 17: 79–85.

14. Thaweboon S, Nakornchai S, Miyake Y et al. Remineralization of enamel subsurface lesions by xylitol chewing gum containing funoran and calcium hydrogenphosphate. Southeast Asian J Trop Med Public Health 2009; 40: 345–353.

15. Miyasawa-Hori H, Aizawa S, Takahashi N. Difference in the xylitol sensitivity of acid production among Streptococcus mutans strains and the biochemical 21: 201–205.

16. Stecksén-Blicks C, Holger son P L, Twetman S. Effect of xylitol and xylitol-fluoride lozenges on approximal caries development in high-caries-risk children. Int J Paediatr Dent 2008; 18: 170–177.

17. Twetman S. Consistent evidence to support the use of= xylitol- and sorbitol-containing chewing gum to prevent dental caries. Evid Based Dent 2009; 10: 10–11.

18. Deng D M, Ten Cate J M, Crielaard W. The adaptive response of Streptococcus mutans towards oral care products: involvement of the ClpP serine protease. Eur J Oral Sci 2007; 115: 363–370.

19. Köhler B, Bratthall D. Practical method to facilitate estimation to Streptococcus mutans levels in saliva. J Clin Microbiol 1979; 9: 584–588.

20. Kimmel L, Tinanoff N. A modifi ed mitis salivarius medium for a caries diagnostic test. Oral Microbiol Immunol 191; 6: 275–279.

21. Weber K A. Comparison of the effectiveness of three education interventions in the prevention of "early childhood caries". Iowa: Iowa University, 2003.Master's Thesis.

22. Ribeiro A, Souza I P. Relação entre biofi lme, atividade de cárie e gengivite em crianças HIV+ Pesqui. Odontol Bras 2002; 16(2): 15–22.

23. Seminario A, Broukal Z, Ivancaková R. Mutans streptococci and the development of dental plaque. Prague Med Rep 2005; 106: 349–358.

24. Matsumoto-Nakano M, Fujita K, Ooshima T. Comparison of glucan-binding proteins in cariogenicity of Streptococcus mutans. Oral Microbiol Immunol 2007; 22: 30–35.

25. Van Houte J. Role of microorganisms in caries aetiology. J Dent Res 1994; 73: 672–681.

26. Law V, Seow W K. A longitudinal study of 0.2% chlorhexidine gel for removal of mutans streptococci infection in preschool children. Aust Dent J 2007; 52: 26–32.

27. Decker E M, Maier G, Axmann D, Brecx M, von Ohle C. Effect of xylitol/chlorhexidine versus xylitol or chlorhexidine as single rinses on initial biofi lmformation of cariogenic streptococci. Quintessence Int 2008; 39: 17–22.

28. Ribeiro L G, Hashizume L N, Maltz M. The effect of different formulations of chlorhexidine in reducing levels of mutans streptococci in the oral cavity: a systematic review of the literature. J Dent 2007; 35: 359–370.

29. Yoshida Y, Palmer R J, Yang J, Kolenbrander P E, Cisar J O. Streptococcal receptor polysaccharides: recognition molecules for oral biofi lm formation. BMC Oral Health 2006; 6(Suppl 1): S12.

30. Timmons S R, Harless J D, Hogan M M et al. Effect of an alcohol-free, 1% chlorhexidine gel as an adjunct to a fluoridated dentifrice using an intraoral crown model. Caries Res 2007; 41: 190–197.

31. Zhang Q, Mulder J, Truin G J, van Palenstein Helderman W H. Effect of 40% chlorhexidine varnish on mutans streptococci counts in pits and fi ssures of permanent fi rst molars. J Dent 2007; 35: 588–592.

32. Haresaku S, Hanioka W, Tsutsui A, Yamamoto M, Chou T, Gunjishima Y. Long-term effect of xylitol gum use on mutans streptococci in adults. Caries Res 2007; 41: 198–203.

33. Massoth D, Massoth G, Massoth I R, Lafl amme L, Shi W, Hu C. The effect of xylitol on Streptococcus mutans in children. J Calif Dent Assoc 2006; 34: 231–234.

34. Assev S, Stig S, Scheie A A. Cariogenic trait in xylitol-resistant and xylitol-sensitive mutans streptococci. Oral Microbiol Immunol 2002; 17: 95–99.

35. Thorild I, Lindau B, Twetman S. Effect of maternal use of chewing gums containing xylitol, chlorhexidine or fl uoride on mutans streptococci colonization in the mothers' infant children. Oral Health Prev Dent 2003; 1: 53–57.

36. Featherstone J D. Delivery challenges for fluoride, chlorhexidine and xylitol. BMC Oral Health 2006; 6(Suppl 1): S8.

37. Janaina Hanson, Linda Campbell. Xylitol and Caries Prevention. Journal of the Massachusetts Dental Society2011;60(2).

Fig 4: Procedures followed in the study