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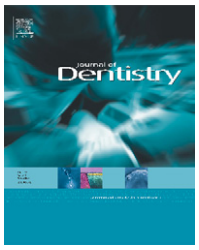

Review

The effect of different formulations of chlorhexidine in reducing levels of mutans streptococci in the oral cavity: A systematic review of the literature

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ABSTRACT

Objectives: The current study undertakes a systematic review of the literature in order to assess how long different formulations (solutions, gels and varnishes) of chlorhexidine (CHX) reduce the level of mutans streptococci (MS) in the oral cavity.

Sources: A search of the PUBMED and LILACS databases was conducted through October 2005.

Study selection: Clinical studies evaluating the effects of CHX solutions, gels, or varnishes on MS levels were targeted ($n = 52$).

Conclusions: The studies varied greatly in quantity of mouthwash solution used in rinsing, length of rinsing, and treatment frequency and period. CHX mouthwash solution had short-term effect on salivary MS. Most of studies evaluating CHX gel and varnish used a concentration of 1%. The 1% CHX gel showed a significant reduction through intensive treatment (3–4 daily applications over 2 days) or through daily application for 10 and 14 days. It cannot be asserted that 1% CHX varnish provides better results when applied intensively as compared to applications conducted at intervals of 1 or more months. Treatment using 1% CHX varnish displays large variations in the level and length of decreased MS levels. Despite variability in results, 40% CHX varnish has a greater effect on the period of decreased MS levels than does 1% CHX varnish. Studies did not show a statistically significant difference between the gel and the varnish. The effects of CHX treatment must be monitored, given sharp individual variability in response to this treatment.

1. Introduction

Of all microorganisms, mutans streptococci (MS) are most closely associated with the development of dental caries disease.[1,2] They may cause mineral loss due to their characteristic capacities to adhere to the dental surface, to rapidly transport fermentable carbohydrates and convert them into acid, to produce extra- and intracellular polysaccharides, and to maintain carbohydrate metabolism in a low pH (acid-tolerant) medium.[3–5] The presence of MS in dental biofilm has been used as an indicator of cariogenic biofilm.[6] One way of controlling cariogenic activity would be to reduce

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the number of such microorganisms in dental biofilm through the use of antimicrobrial agents that can alter its composition. This ecological modification of the biofilm may balance the process of demineralization and remineralization between the dental surface and the adjacent plaque.[7]

Of the antimicrobial agents available for dental use, chlorhexidine (CHX) is the most thoroughly researched in terms of ability to control cariogenic activity.[8–10] CHX reduces the proportions of some microorganisms, especially MS, which are particularly sensitive to this substance.[11–13]

Chlorhexidine affects the metabolic activity of bacteria because, in low concentrations, it is bacteriostatic and prompts both changes to the functioning of the cellular membrane as well as leakage of intracellular constituents,[14,15] while in high concentrations it acts as a bactericide, prompting irreversible precipitation of the cellular content. It likewise inhibits the action of the glycosyltransferase enzyme, responsible for accumulation of bacteria on the dental surface, and has effects on sugar transport and acid production in oral bacteria.[13,16–18]

Chlorhexidine comes in the form of dentifrices (0.4%), solutions (0.12% and 0.2%), gels (1%), and varnishes (1%, 10%, 20%, and 35%). A number of studies have been designed to evaluate how different formulations of chlorhexidine decrease MS in the oral cavity. The current study undertakes a systematic review of the literature in order to assess the effect of CHX solutions, gels, and varnishes in reducing levels of mutans streptococci in the oral cavity.

2. Materials and methods

A search of the PUBMED and LILACS databases was conducted through October 2005, using as keywords ''chlorhexidine + S-*treptococcus mutans*,'' ''chlorhexidine + mutans streptococci,'' and ''clorexidina + *Streptococcus mutans*.'' Clinical studies evaluating the effects of CHX solutions, gels, or varnishes on MS levels were targeted, while unpublished studies and papers defined as theses or dissertations were not included. Of the 317 references found on PUBMED and 14 on LILACS, 89 and 2 papers were selected, respectively, based on their abstracts. After a full reading of these 91 papers, 39 studies were excluded, following these criteria: (i) studies that included other preventive methods, such as the use of some kind of fluoride, dental hygiene guidance, dietary counseling, intensive professional prophylaxis, or polyurethane varnish over the chlorhexidine varnish (total of 22 papers); (ii) studies involving no prior restorative treatment (2 papers); (iii) studies where the same results were published in different scientific articles (2 papers); (iv) studies lacking data on reductions in MS levels during differing evaluation periods (13 papers). Our review thus encompassed 52 studies, 11 focused on CHX solutions, 14 on CHX gels, 23 on CHX varnishes, and 4 comparing CHX gels and varnishes.

3. Results and discussion

3.1. *Chlorhexidine solution*

The selected studies on chlorhexidine solutions evaluated their effect only on decreased salivary MS levels and not on dental biofilm MS. CHX concentrations of 0.12% and 0.2% were tested, with one paper comparing concentrations of 0.025%, 0.05%, and 0.12%.[19] The studies varied greatly in quantity of mouthwash solution used in rinsing, length of rinsing, and treatment frequency and period (Table 1).

In the studies evaluating 0.12% CHX solutions, mouthwash quantity ranged from 10 ml to 15 ml, with one study using 4 ml. Rinsing occurred daily, twice daily, or weekly and lasted for 30 s or 1 min, with treatment periods varying from a single rinsing to 6 weeks. In studies involving a 0.2% CHX concentration, the amount of mouthwash used in each rinsing ranged from 5 ml to 10 ml, with rinsing occurring once, twice, or four times daily and lasting for 1 min, with treatment periods of 1–4 weeks.

Most of the reviewed papers evaluated the effect of rinsing with 0.12% and 0.2% CHX solutions shortly after treatment.[19–24] In all cases, a significant decrease in MS was observed up to 24 h after rinsing, except for the study by Dahlen.[20]

Of the studies that evaluated the long-term effects of treatment using chlorhexidine solutions, only one (0.12% CHX) had a lasting effect in reducing salivary MS levels (i.e., 6 weeks)[25]; the treatment period in this case was prolonged, that is, 6 weeks as well. Treatments using 0.12% CHX solutions for 1 or 2 weeks, with 1 or 2 rinsings daily, did not produce any significant long-term reduction in salivary MS.[26–28] Increasing the CHX concentration to 0.2% and the treatment period to 4 weeks produced results similar to studies using a lower concentration or shorter treatment period.[29]

Of the 11 papers on chlorhexidine solutions, only 5 referred to randomized, controlled studies. Of these, 2 evaluated effects up to 24 h after rinsing; 1 detected a significant decrease in MS levels[21] while the other did not.[20] The long-term effects of CHX solutions were assessed in 3[27–29]; of these, 2 showed no significant decrease for any of the evaluation periods and 1 demonstrated a decrease only during treatment itself (third and sixth days after rinsing began). The randomized and controlled studies showed that rinsing with a CHX mouthwash solution had no long-term effect on salivary MS.

3.2. *Chlorhexidine gel*

Of the studies under review, most of those evaluating the effect of CHX gel on MS levels in the saliva and/or dental biofilm used a concentration of 1% (Table 2). Some, however, researched other concentrations, such as 0.2%,[30] 0.5%,[31] and 5%.[32,33]

CHX gel at 0.2%, 0.5%, and 1% is applied with a toothbrush,[30,31,34] while 1% and 5% gels are applied through professional prophylaxis[35] and with the aid of individual trays.[36–39]

Toothbrush application of 0.2% and 0.5% CHX gel did not cause any significant decrease in MS levels as compared to a placebo gel.[30,31] Both studies showed a decrease in these microorganisms in both test and control group. Toothbrush application of 1% CHX gel twice daily for 2 weeks reduced MS levels for up to 4 weeks following treatment. However, this study did not use a control group.[34]

CHX gel at a concentration of 1% was applied using individual trays either in the office or at home. The studies under review involved intensive treatments for 1 or 2