

# **Plaque Reduction in School Children Using a Disposable Brush Pre-Pasted with Xylitol Toothpaste**

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## Introduction

A current review of the available epidemiological data from many countries clearly indicates a marked increase in the prevalence of dental caries. This global increase in dental caries affects children as well as adults, primary as well as permanent teeth, and coronal as well as root surfaces.<sup>1-4</sup>

For over eight years, the first investigator (BH) directed a School Based Dental Prevention Program in Sullivan County Tennessee schools that have a fifty percent free and reduced school lunch program. During this period, it became clear that children's oral health was suffering from a lack of oral hygiene. The extensive amount of caries, missing teeth, and number of restorations observed seemed to indicate that an improvement in oral hygiene would result in reduced plaque and therefore a decrease in dental disease, thus sparing children the potential for health complications resulting from dental diseases. The fact that dental caries in children is on the increase worldwide<sup>1</sup> suggests that preventive measures should have a positive outcome in reducing the prevalence of dental caries with the added benefit of being a cost effective way to improve children's overall health.

Further observation identified the child's school as a prime source for the majority of his/her development. The educational environment plays an integral role in the child's growth and evolution as a person. The proposition that oral health be part of the child's socialization process was stated many years ago by Garcia-Godoy<sup>7</sup>. Proper oral care as part of the educational curriculum can be established and reinforced in the school setting if a child is given the opportunity, instruction, and instrumentation<sup>5,6</sup>.

Xylitol is a sugar alcohol or polyol commonly used as a sugar substitute. Xylitol has been approved by the FDA as a food additive since the 1960s and is safe for use with children.<sup>8,9</sup> It is most commonly used as a sweetener in foods in the United States. The European Union has also approved a health claim regarding xylitol as a “tooth friendly” component in chewing gums.<sup>10</sup>

Xylitol and other sugar alcohols are non-cariogenic so their consumption does not produce dental caries.<sup>11</sup> Furthermore, xylitol has a protective effect against dental caries because it can reduce the levels of *Streptococcus mutans*, a gram-positive bacterium commonly found in saliva and plaque which is a significant contributor to tooth decay.

The xylitol toothpaste evaluated in this study was developed without fluoride to avoid the need to expectorate the fluoride component of regular toothpastes and for ease of use in a primary school setting.

The purpose of this study was to evaluate (1) the feasibility and acceptance of a new school tooth brushing program, and (2) the effectiveness of using a disposable brush pre-pasted with a safe to swallow xylitol toothpaste in controlling dental plaque in school children. The hypothesis to be tested was that school children can be properly instructed to brush their teeth after eating their noon meal, accept it as a routine course of action, and be effective in brushing to remove plaque.

## **Materials and Methods**

A school of 300 children, grades kindergarten through eighth grade, was offered the opportunity to participate in a 30 day study. The study involved providing the students with disposable toothbrushes with pre-applied xylitol toothpaste made with food grade products that can be swallowed harmlessly and did not require the need to spit (Zylocare, Bristol, TN, USA). The brush that was provided was an ADA approved 27 tuft brushes with a 13.5 centimeter handle on which .5 gms of paste was applied. The paste was composed of 48-49% by weight of xylitol, 48-49% by weight of glycerin, 2-2.5% by weight of baking soda and 1-1.5% by weight of flavoring.

The brushing was to be performed in the classroom immediately after lunch. The Rural Vale School at Tellico Plains, TN, Monroe County, was invited to participate in the study, and the plan was approved by school's principal. The project was also approved by the Institutional Review Board (IRB) of the University of Tennessee Health Science Center in Memphis, Tennessee (# 12-01790-XP) as a feasibility study to evaluate the logistics and acceptance of the program.

Information was provided to the student population consisting of about 300 children. The informational material provided was approved by the IRB committee of the University of Tennessee Health Science Center in Memphis. Two hundred children volunteered to participate in the 30 day study. Of the 200 children agreeing to participate in the plaque study to evaluate the feasibility, acceptance, and effectiveness of the program, 54 were selected by the school staff. This group of 54 children represented six children from each of the nine grade levels. The

children's selection was strictly based on the agreement to participate and the Principal's assessment of the level of cooperation from the subject to participate in the study.

Figure 1-B depicts a volunteer demonstrating the 10 x 10 brushing technique to the children. Prior to initiating the program, a simple DVD was created featuring children brushing their teeth using the 10 x 10 brushing technique, Figure 1-A, conceived by the investigator. Final production of the DVD occurred at the midpoint of the 30 day study. Copies of this DVD were given to the teachers to present on a "smartboard" so that students could visualize a brushing procedure that could achieve maximum results (Figure 2). The DVD was watched by the students in the classroom after lunch as they performed the 10x10 brushing technique during each of the last 15 days of the study. The approach used was the "Tell, Show and Do" strategy which consists of explaining and demonstrating a skill as it is being performed.<sup>14</sup>

On the first day of the study (10-1-2012), before eating lunch, groups of six children were escorted into a classroom that was provided for the exclusive use of the study. Groups of six children were seated in straight back chairs, and the disclosing solution was placed on the facial of the six maxillary anterior teeth, and the results noted on the IRB approved tracking form. Confirming photographs were taken to demonstrate plaque levels. Fifteen school days later (10-22-2012), the participating students' teeth were again stained before eating lunch and photographs taken. The results were noted on the IRB tracking forms. Fifteen school days later (11-15-2012), the third evaluation was performed, this time immediately after lunch. The children were then allowed to brush in the presence of the investigator (BH), and the facials of the six maxillary anterior teeth were immediately stained, photographed, and the results noted

on the IRB approved tracking forms. As seen on the graph, the vertical axis represents the plaque scores and the horizontal axis represents the length of time of the study (Fig. 4).

0 = no visible disclosed plaque

1 = visible disclosed plaque on 1/3 of the tooth surface

2 = visible disclosed plaque on 2/3 of the tooth surface

3 = visible disclosed plaque on MORE than 2/3 of the tooth surface

9 = missing

This plaque assessment was considered the baseline plaque index for the selected children. No incentive was offered for participation. Since the data was not normally distributed, a nonparametric statistical analysis (Wilcoxon matched pairs) was used.

## **Results**

Figure 3 visually demonstrates the results of the 30-day study. Fifty-four children were initially enrolled in the study. One child was reported as moved and was not seen for the 2<sup>nd</sup> and 3<sup>rd</sup> evaluations. One child withdrew from the study as the taste did not appeal to her and therefore was not seen for the 2<sup>nd</sup> and 3<sup>rd</sup> evaluations. Forty-eight children were present for the 2<sup>nd</sup> evaluation. Fifty-one children were present for the final evaluation. Forty children were present for all three evaluations.

There were no adverse events reported by the study participants related to either the toothbrush or toothpaste used.

Figure 4 is the Wilcoxon test and shows a highly statistically significant difference ( $P < 0.001$ ) between plaque scores after lunch with and without the brushing program.

## **Discussion**

A successful after lunch school tooth brushing program can be achieved with the cooperation of the children, faculty and ancillary staff. A simple and concise brushing technique, demonstrated with the use of audiovisual equipment, can implement and enhance the children's ability to perform brushing in the classroom or the lunch room.

A recent unpublished study by Garcia-Godoy & Babu<sup>15</sup> in which the xylitol-containing toothpaste used in this study was tested proved that its effectiveness against *Streptococcus mutans*, *Streptococcus sobrinus*, *Streptococcus aureus*, and *Actinomyces viscosus* was greater than that produced by sodium fluoride dentifrices. Another study by Garcia-Godoy et al<sup>16</sup> also demonstrated that a non-fluoride xylitol-containing dentifrice had some effect in preventing enamel demineralization.

Use of the xylitol-containing toothbrush-toothpaste as described in this study has the potential to prevent dental caries by controlling dental plaque formation along with the growth of *Streptococcus mutans*. The inclusion of this program following school lunches would be a deterrent to plaque formation in the population of school children due to the protection it

would provide for their enamel surfaces over the lengthy period of time before the child brushes at night with a fluoridated toothpaste.

The role of xylitol in caries prevention seems to be as a non-fermentative sugar substitute because there is no lactate production from xylitol. Also, xylitol has no effect on the metabolome profile.<sup>17</sup> One study<sup>18</sup> showed that xylitol did not reduce mutans streptococci in plaque; however, xylitol inhibited the glycolysis and growth of *Streptococcus mutans* to different degrees among bacterial strains and with different xylitol concentrations.<sup>19</sup>

From a logistical standpoint, the use of a fluoridated toothpaste in a school program would require additional space (washroom facilities), time, organization, and close monitoring since fluoridated toothpaste should not be ingested. The xylitol-containing toothpaste tested in this study, however, can be swallowed and the toothbrush simply discarded. Therefore, the students can brush their teeth anywhere avoiding the necessity of finding a place where they could expectorate a fluoridated toothpaste.

The study demonstrated that the lunchtime tooth brushing program for school children utilizing the xylitol pre-pasted toothbrush was feasible, well-accepted, and effective in controlling plaque. Further studies should be conducted to evaluate the long term effect on caries, plaque, and gingivitis.



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## **10 TIMES 10 BRUSHING PROGRAM (10 x 10)**

**Purpose:** Instill in children at an early age a systematic method of brushing that will result in consistent results for improved oral hygiene for life time.

**Method:** Children will be instructed to brush in following manner:

Upper right:	Cheek side Front to back Back to front 10 times
Upper right:	Inside the upper back teeth 10 times
Upper left:	Cheek side Back to front Front to back 10 Times
Upper left:	Inside the upper back teeth 10 times
Bottom left:	Cheek side Back to Front Front to Back 10 Times
Bottom left:	Inside bottom teeth next to tongue 10 times
Bottom right:	Cheek side Back to front Front to back 10 times
Bottom right:	Inside next to tongue 10 times
Upper Front Teeth Inside:	Brush Handle down Brush back of upper front teeth 10 times
Lower Front Teeth Inside:	Brush Handle up Brush back of lower teeth 10 times

(Fig 1-A) 10 Times 10 Brushing Technique



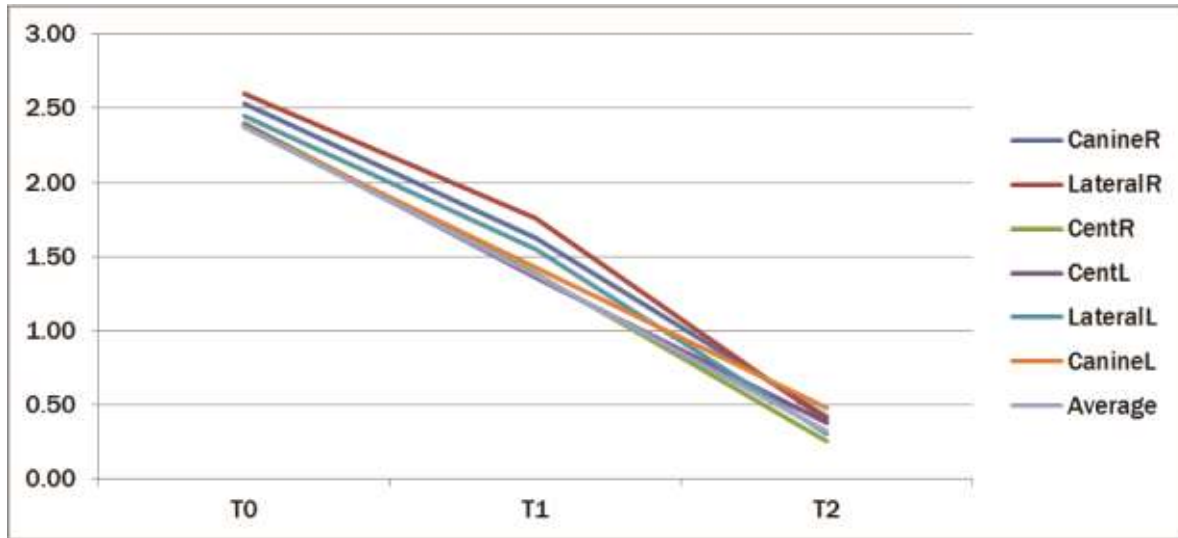
(Fig. 1-B) Volunteer instructing the students on the tooth brushing technique.



(Fig. 2) Classroom PowerPoint presentation.



(Fig. 3) Top photo baseline (before lunch, no brushing program), middle photo, 15 days after the initial brushing and also taken before lunch. The last image was taken after 30 days and after lunch tooth brushing. A clear reduction of the plaque levels can be seen after the lunch meal tooth brushing using the pre-pasted toothbrush with the xylitol-containing toothpaste.



(Fig. 4) After the 30 day study, a clear reduction in plaque levels was shown when children brushed after lunch in a school environment. All time data were statistically significantly different from the baseline plaque score (T0) (Wilcoxon matched pairs). Vertical axis shows plaque score. Horizontal axis shows the observation time T0 – Baseline; T1 = 15 days after the brushing program; T2 = 30 days after the brushing program).