Supragingival Calculus in Children With Gastrostomy Feeding: Significant Reduction With a Caregiver-applied Tartar-control Dentifrice

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Abstract

Purpose: This study assessed the anti-calculus benefit of Crest Dual Action Whitening Toothpaste in gastrostomy (GT) children compared to a control anti-caries dentifrice.

Methods: A double-blind randomized crossover design was used to compare the two dentifrices. A convenience sample of 24 GT subjects, 3-12 years old, was given a consensus baseline Volpe-Manhold Index calculus score by 2 trained examiners, followed by a dental prophylaxis to remove all calculus. Each child was randomly assigned to either study or control dentifrice groups. Caregivers brushed subjects' teeth twice daily with the unlabelled dentifrice for at least 45 seconds. Calculus was scored at 8 weeks (±1 week) by the same investigators. Subjects then had a prophylaxis and received the alternative dentifrice. Subjects returned 8 weeks (±1 week) later for final calculus scoring.

Results: The study dentifrice significantly reduced supragingival calculus from baseline by 58% compared to control dentifrice ($p<0.005$ need exact p-value unless it is <.001; maybe it's reported in the paper). Calculus levels decreased by 68% over the study duration, irrespective of dentifrice. ANOVA found no significant differences in calculus scores based on gender, race, history of reflux, aspiration pneumonia, or oral intake of food. Calculus was significantly related to history of aspiration pneumonia ($p<0.05$ need exact p-value here).

Conclusion: Crest Dual Action Whitening Toothpaste was effective and better than anti-caries control dentifrice in reducing calculus in GT children.

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Children with significant neuromuscular disorders often suffer from gastrointestinal dysfunction, including: (1) oral-motor incoordination; (2) gastroesophageal reflux; (3) delayed gastric emptying; (4) or constipation.[1,2] Instead of by mouth, they are fed by gastric tube (gastrostomy, GT), which reduces the problems of oral feeding and swallowing, and prevents aspiration of food.[3]

Aspiration pneumonia (AP) has an infectious origin resulting from: (1) aspiration of particulate matter; (2) chemical pneumonitis; (3) or inhalation of oropharyngeal secretions containing bacteria.[4] Factors associated with AP include: (1) predisposing medical conditions; (2) reduced functional status or neurologic disease; (3) GT feeding; (4) gastroesophageal reflux; (5) poor nutritional status; (6) oropharyngeal colonization of pathogenic bacteria; and (7) oral/dental disease.[5,6] GT children fit several of these categories and are at risk for AP, despite the absence of oral feeding.

GT feeding is associated with poor oral hygiene and reduced saliva flow, both leading to salivary bacterial overgrowth. Both aerobic and anaerobic bacteria are commonly implicated in AP, including gram-positive cocci, *Bacteroides melaninogenicus*, fusobacteria, alpha-hemolytic streptococci, *Escherichia coli, Klebsiella pneumoniae*, and *Staphylococcus aureus.*[7] These bacteria, when combined with oral debris, may serve as an inoculum, if aspirated, and cause pneumonia. Jawadi et al[8] found GT children more likely to have more of one AP-associated organism in saliva, as well as more calculus and plaque, than mouth-fed children. They established that GT children with a history of AP had significantly more calculus than GT children with no such history, suggesting a relationship between calculus and AP.

GT children do not receive any food by mouth, but exhibit significantly high rates of calculus formation. Klein and Dicks[9] compared calculus formation in GT and mouth-

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Table 1. Responses of Caretakers to Questionnaire

Characteristic	Yes (%)	No (%)	Total (%)
History of gastroesophageal reflux disease	21 (88)	3 (12)	24 (100)
History of aspiration pneumonia (AP)	7 (29)	17 (71)	24 (100)
Oral as well as G-tube food intake	14 (58)	10 (42)	24 (100)

fed mentally and physically disabled children and adults for 90 days and concluded calculus formation was significantly faster in GT individuals, with 71% of calculus forming by 30 days after dental cleaning. Calculus formation in healthy adults reaches a plateau after 8 weeks.[10] In a follow-up study, Dicks and Banning[11] compared GT and mouth-fed individuals for 60 days, providing intensive oral hygiene to both. They found that calculus still accumulated at a significantly higher rate in the GT group, despite superior oral hygiene.

No guidelines currently exist for frequency of dental visits by GT children. Dyment and Casas[12] recommend that GT children have professional cleanings 4 times a year. Each episode of mechanical calculus removal may inoculate lungs with infectious debris, however, creating a dilemma for the dentist. In addition, cleaning may require sedation or general anesthesia. Effective oral hygiene to reduce calculus build-up between visits would be a desirable alternative to frequent cleanings, but most oral hygiene habits do not prevent reformation of supragingival calculus following professional debridement.[13] Previous research also suggests calculus build-up in GT patients, despite superior oral hygiene.[11] Dentifrices also contain foaming agents to aid removal of loosened debris,[14] but foaming action may increase aspiration risk.[8]

One way to improve oral hygiene would be to use a dentifrice targeted at chemical inhibition of calculus—preferably combined with low foaming action. Tartar control dentifrice decreases calculus formation in adults and children,[15-17] and newer tartar-control dentifrices show improved efficacy.[18,19]

The purpose of this study was to determine if regular use of an anticalculus dentifrice with low-foaming action (Crest Dual Action Whitening toothpaste)[18,19] reduces calculus formation in children with gastrostomy compared to Crest Cavity Protection toothpaste.

Methods

Experimental design and sample selection

This study, approved by the Institutional Review Board of Columbus Children's Hospital, Columbus, Ohio, employed a randomized, double-blind crossover design in which enrolled subjects were randomly assigned to 1 of 2 groups. Group 1 began the study using Crest Dual Action Whitening Toothpaste (Procter & Gamble, Cincinnati, Ohio) and group 2 begun using Crest Cavity Protection Toothpaste (Procter & Gamble).

A convenience sample of 27 GT children was drawn from patients followed at Columbus Children's Hospital. Inclusion criteria were: (1) presence of GT for at least 1 year; (2) between 3 and 12 years old; (3) presence of enough erupted teeth for scoring purposes; (4) daily oral hygiene from a caretaker; and (5) no professional dental prophylaxis within 3 months. Exclusion criteria were: (1) allergy to components of study dentifrices; and (2) untreated oral conditions (eg, caries). Guardians or parents provided written informed consent.

Questionnaire

Upon initial examination, caregivers completed a health questionnaire listing the subjects': (1) medical diagnoses; (2) current medications; (3) duration of GT; (4) history of AP; (5) reflux; (6) oral feedings; and (7) current brushing habits. The principal investigator (LB) answered questions that arose during completion and reviewed each questionnaire for completeness prior to dismissal.

Procedures

All subjects were seen by the same 2 trained examiners at all visits. At each subject's first visit, examiners independently assessed supragingival calculus using the Volpe-Manhold Index. They used a periodontal probe to measure calculus in 3 different planes on lingual surfaces of the 6 mandibular anterior teeth[20, 21] and reconciled any discrepancies at that time. The subject then received a dental prophylaxis, which included scaling with hand instruments or ultrasonic scaler to remove existing plaque and calculus and achieve a baseline level of 0 calculus, as agreed upon by visual and tactile methods by the examiners. Caregivers were given a demonstration of proper brushing methods, including: (1) duration of time recommended for brushing; (2) number of times a day to brush; and (3) amount of dentifrice to use. They were instructed to fill out a daily log, including: (1) how often they brushed; (2) whether they brushed for the specified time period; and (3) how much toothpaste they used each time. Caregivers were instructed to brush twice daily with a pea-sized amount of dentifrice in an unlabeled tube known only to a third investigator. Subjects were provided with a new toothbrush to use throughout the length of each study period.

Subjects returned for examination 8 weeks (±1 week SD) following baseline prophylaxis. At this second visit:

1. calculus was again assessed;
2. teeth were cleaned to return to a baseline level of 0 calculus; and
3. the caretakers were given:
   a. the alternative dentifrice for the second 2-month study period;
   b. oral hygiene instructions;
   c. a new brushing log; and
   d. toothbrush.

Subjects returned for final calculus evaluation 8 (±1) weeks following their second visit.

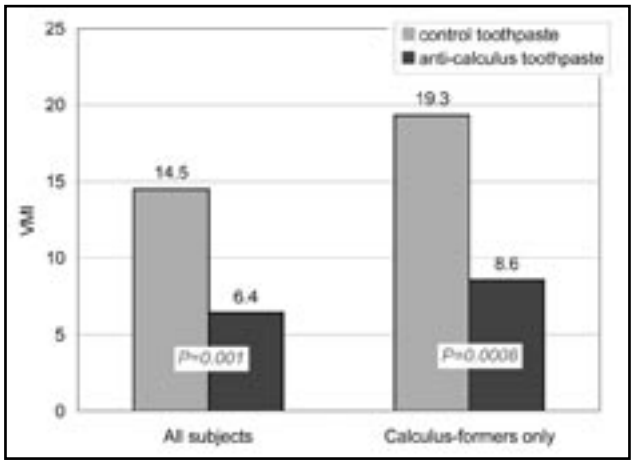

Figure 1. Effectiveness of antitartar dentifrice to control calculus compared to an anticaries control dentifrice, as measured by the Volpe-Manhold Index in all 24 subjects and in 18 calculus-forming subjects (Wilcoxon signed ranks test).

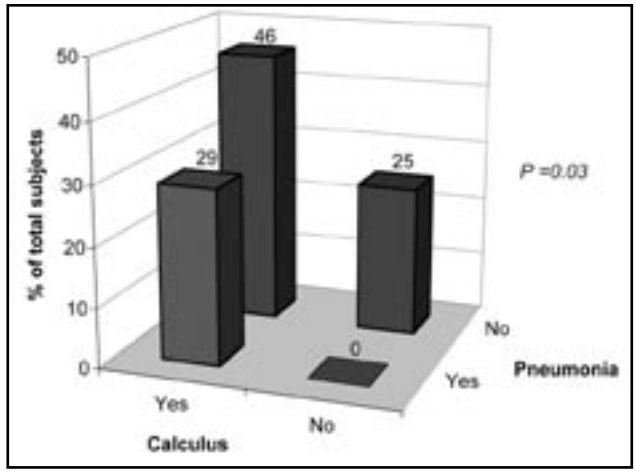

Figure 2. Percentage of 24 subjects with and without aspiration pneumonia history and with or without presence of baseline calculus (likelihood ratio).

Data analysis

Data were entered on computer and analyzed using Jmp software (SAS Corp, Cary, NC) utilizing, when appropriate, (1) Wilcoxon signed rank tests; (2) chi-square, *t* tests; (3) likelihood ratios; and (4) analysis of variance (ANOVA).

Results

Twenty-four subjects (15 males, 7 females) completed the 4-month-long study; 3 dropped out for personal reasons. The mean age was 7.2±2.6 years (range=3-12) for the 7 African American and 17 Caucasian subjects. Baseline characteristics from the questionnaire for these subjects are shown in Table 1. The baseline Volpe-Manhold Index (VMI) score for all 24 subjects for the first study period was 28.2±23.2. When those children with no calculus at baseline were eliminated, a subsample of 18 subjects, deemed calculus formers, had a baseline VMI of 37.6±18.8. The mean VMIs after the 2 months for the comparison dentifrice (group 2, Crest Cavity Protection) and anticalculus dentifrice (group 1, Crest Dual Action Whitening toothpaste) group were 14.5±15.7 and 6.4±10.9, respectively (Figure 1). When excluding subjects who formed no calculus throughout the study, the mean VMI scores were 19.3±15.4 and 8.6±11.9, respectively. The anticalculus dentifrice reduced supragingival calculus deposits by 56% compared to the placebo dentifrice. This reduction in all subjects was significant at the $P<.001$ level, using the Wilcoxon matched-pairs signed-ranks test, and remained significant ($P<.001$) for the subsample of calculus formers.

ANOVA analysis confirmed a significant reduction in calculus from baseline by both dentifrices (placebo=$P<.05$; anticalculus=$P<.001$). The anticalculus dentifrice reduced supragingival calculus deposits by 77% when compared to the baseline VMI score. A significant difference in calculus reduction by the anticalculus dentifrice over the comparison dentifrice ($P<.0001$) confirmed its superiority in this study.

Baseline calculus scores were unrelated to: (1) sex ($P=0.81$ by *t* test); (2) race ($P=.50$ by *t* test); (3) age ($P=.85$, $R^2=0.002$); (4) the number of years the G-tube was in place ($P=.11$, $R^2=0.11$); (5) history of aspiration pneumonia ($P=0.24$ by *t* test); (6) and oral intake of foods ($P=.51$ by *t* test). Lower baseline calculus scores were correlated with a greater number of tooth-brushings per day, as reported by parents/guardians at baseline ($P=.001$, $R^2=0.47$).

A significant relationship between the history of aspiration pneumonia and presence of calculus was detected using a likelihood ratio ($P\leq.03$) and is depicted in Figure 2. No subject with a baseline VMI of 0 had a history of aspiration pneumonia. The amount of calculus in subjects with calculus (N=18) was, however, not significantly related ($P=.86$) to a history of pneumonia by *t* test (mean baseline VMI for subjects with a positive history of pneumonia 36.6±18.7; mean VMI for a negative history 38.3±19.8). When all 24 subjects were considered, mean baseline VMI for subjects with a positive history of pneumonia was 36.6±18.7 and the mean VMI for a negative history was 24.8±24.5 ($P=.27$).

Table 2. Calculus Reduction (VMI Score) Over 3 Visits

Total subjects in study (n=24)			
Visit	**Mean VMI (+/-SD)**	**Percent reduction vs baseline**	**Percent reduction vs visit no. 2**
Baseline	28.2 (+/-23.2)	---	---
Visit no. 2 (2 mos)	12.0 (+/-14.7)	58*	---
Visit no. 3 (4 mos)	8.9 (+/-13.4)	68†	26‡

*P=.002 (student t test).
†P=.001 (student t test).
‡Not significant (student t test).

No correlation between frequency of daily brushing and reduction in calculus levels for subjects using the anticalculus dentifrice was found. VMI levels and amount of time elapsed between follow-up visits were not related.

When subjects were evaluated by follow-up visits instead of by dentifrice type, mean VMI scores for the second and third follow-up visits were 12.0±14.7 and 8.9±13.4, respectively (Table 2). In comparing VMI at the second visit to baseline, a 58% reduction in calculus was evident. Calculus levels decreased by 68% from baseline to the third visit, but only by 26% between the second and third visits. Using student *t* tests, the decrease between the baseline and third visit VMI measurements was significant ($P<.001$) as was the decrease in VMI from baseline to second visit ($P<.005$). The reduction in VMI scores from the second to third visit was not significant (Table 2).

Discussion

This study addressed whether an extra-strength anticalculus dentifrice[18,19] would be effective in reducing calculus in GT children. Calculus formation is a considerable problem in the GT population as noted by numerous authors.[8,9,11,12] We found that the anticalculus dentifrice (Crest Dual Action Whitening toothpaste) produced a 56% reduction in calculus when compared to the control dentifrice (Crest Cavity Protection toothpaste) and an overall 77% reduction when compared to the baseline VMI score. There was a reduction in calculus levels for both dentifrices used, however, and caregivers demonstrated improved oral hygiene—resulting in a decrease in calculus by 68% over the study.

Previous investigators noted that calculus accumulated at a significantly higher rate in GT subjects, despite superior oral hygiene levels,[11] but this was not this study's finding and methodologies differed in these 2 studies. It appears that conscientious regular oral hygiene can contribute to a reduction in calculus in these patients. The authors did note that the decrease diminished from the second to third visit, and 2 subjects had worse VMI scores at the study's end, so the benefits of both improved hygiene and the anticalculus dentifrice can be variable.

Providing oral hygiene or professional calculus removal in GT patients can be extremely challenging because of: (1) retained gag and biting reflexes; (2) poor motor control; (3) aversion to perioral contact; (4) behavior problems due to intellectual delays; and (5) difficulty handling oral fluids. Several subjects in this study had to be immobilized or treated under sedation, and caretakers reported difficulty complying with oral hygiene care required in this study, often using immobilization on a regular basis at home.

Dentists who treat these patients face a conundrum. Do they restrain and clean visible calculus and possibly contribute to aspiration pneumonia risk by doing so, or do they leave calculus, perhaps with the same potential outcome? This study's findings offer some hope to clinicians who can now add the option of an anticalculus, low-foaming dentifrice with some evidence to support its use and parents' efforts to provide home hygiene. The authors' clinical recommendation based on the study's outcome is that the best approach for the GT patient may still be periodic professional cleaning combined with regular home use of an anticalculus dentifrice such as Crest Dual Action Whitening toothpaste.

The relationship between AP history and presence of calculus in the present study supports what has been reported by Jawadi et al.[8] In addition, all subjects with a prior incidence of AP presented with calculus at baseline. No subjects who presented without calculus had a history of AP. Calculus accumulation may play a role in the initiation of aspiration pneumonia in these children, and clinicians should weigh this when deciding whether or not to remove calculus.

The study design and implementation may have held biases. Although this study used a randomized, double-blind design, bias may have been present in that:

1. both dentifrices, while in unlabelled tubes, had different shapes; and
2. the anticalculus dentifrice emerged as a bicolored ribbon rather than a single shade.

This may have influenced caregivers to prefer this dentifrice to the other one and to brush better. ANOVA comparing the VMI scores for the anticalculus dentifrice with the number of brushings per day, however, revealed no effect of number of brushings per day on the VMI scores ($P=.2461$) during the study. Neither caretaker nor evaluator, however, knew which dentifrice was anticaries and which was anticalculus. Caretakers informally reported a preference for the anticalculus dentifrice and none reported any negative side effects such as foaming or choking, although these were not quantified in the study.

Conclusions

Based on this study's results, the following conclusions can be made:

1. Crest Dual Action Whitening toothpaste was significantly better than Crest Cavity Protection toothpaste at reducing calculus in gastrostomy patients.
2. Both dentifrices provided significant calculus reduction from baseline measurement in this study.

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Abstract of the Scientific Literature

Childhood Obesity and Type 2 Diabetes Mellitus

Until recently, the majority of cases of diabetes mellitus among children and adolescents were immune-mediated type 1a diabetes. Being obese or overweight is the most important risk factor for the development of type 2 diabetes (T2DM) among children and adolescents. The number of children diagnosed as being overweight has increased by more than 100% over the past 30 years. Children and adolescents with T2DM may experience the microvascular and macrovascular complications of this disease (including atherosclerotic cardiovascular disease, stroke, myocardial infarction and sudden death, renal insufficiency and chronic renal failure, limb-threatening neuropathy and vasculopathy, and retinopathy leading to blindness) at younger ages than individuals who develop diabetes in adulthood.

Comments: Dental practitioners often see older children and adolescents more frequently than physicians. Children and adolescents who are overweight or obese and, therefore, at increased risk of development of T2DM and/or "metabolic syndrome" (a constellation of metabolic abnormalities including insulin resistance, glucose intolerance, hypertension, and dyslipidemia, which promote long-term cardiovascular complications) should be identified and referred for appropriate medical intervention including exercise programs, reduction of sedentary activities, healthier diets (incorporating more fruits and vegetables and less highly processed, high-fat, or sweetened foods), and possibly medication. **GEM**

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