

Transient bacteremia induced by toothbrushing: a comparison of the Sonicare toothbrush with a conventional toothbrush

Shamsi Bhanji, DDS, MSD Bryan Williams, DDS, MSD, MEd
Barbara Sheller, DDS, MSD Thomas Elwood, MD Lloyd Mancl, PhD

Dr. Bhanji is in private practice, Seattle, Wash; Dr. Williams is director of dental medicine; Dr. Sheller is director of education and resident training, Dental Medicine, Children's Hospital, Seattle, Wash; Dr. Elwood is assistant professor, University of Calgary and Department of Anesthesia, Alberta Children's Hospital, Alberta, Canada; Dr. Mancl is research assistant professor, Dental Public Health Sciences, University of Washington, Seattle, Wash. Correspond with Dr. Bhanji at shamib@hotmail.com

Abstract

Purpose: Several investigations have demonstrated toothbrush-induced bacteremias. Transient bacteremias are well tolerated by healthy individuals but may increase endocarditis risk in patients with cardiac conditions. This study assessed bacteremia levels after brushing with either the Sonicare electric toothbrush or a manual toothbrush.

Methods: Fifty healthy children receiving dental treatment under general anesthesia with oral intubation were randomly assigned to a manual or Sonicare group. Plaque levels and gingival health were scored and a blood sample collected. Teeth were brushed for 1 minute and a postbrushing blood sample was drawn. Samples were analyzed for aerobic and anaerobic bacterial growth.

Results: Gingival health and plaque scores did not differ between groups. No correlation was detected between plaque and gingival scores and occurrence of bacteremia. The frequency of bacteremia was 46% with manual brushing: 18% aerobic, 9% anaerobic and 73% both. This differed significantly ($P=.022$) with 78% bacteremias in the Sonicare group: 22% aerobic, 22% anaerobic and 56% both.

Conclusions: The Sonicare induced significantly more bacteremias than manual toothbrushing. These results show that vigorous brushing increased bacteremia from one brushing but does not answer whether bacteremia incidence would decrease with a program of vigorous daily brushing; this should be clarified before recommending brushing methods for patients with compromised cardiac conditions. (*Pediatr Dent.* 2002;24: 295-299)

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Transient bacteremias may occur after certain medical and dental procedures.¹⁻³ In healthy individuals, this bacteremia is usually of short duration and well tolerated.^{4,5} In patients with certain cardiac conditions, transient bacteremias can increase the risk of infective endocarditis.⁶ Individuals with structural cardiac defects are at higher risk for developing bacterial endocarditis when exposed to bacteremia.

Although relatively uncommon, bacterial endocarditis has a high morbidity and mortality rate.^{4,6,7} In the United States, the prevalence of infective endocarditis has been estimated to range from 1.7 to 4.9 cases per 100,000 person-years.⁸

The American Heart Association provides guidelines for antibiotic prophylaxis of individuals at risk for contracting bacterial endocarditis following certain medical and dental procedures.⁶ Although there is no conclusive evidence linking infective endocarditis with poor oral health, dental and medical professionals have stressed the importance of excellent oral care in patients at risk for endocarditis. Paradoxically, tooth brushing and flossing may cause bacteremia, which therefore poses a risk for endocarditis. Although emphasis has been placed on minimizing bacteremia during dental extraction, everyday toothbrushing may actually present a more significant risk.² Toothbrushing

alone was found to cause a bacteremia 39% of the time in a study by Roberts and coauthors.²

Recently there have been several innovations in oral care devices. The Sonicare electric toothbrush (Phillips Oral Healthcare Corporation) works by high frequency brushing (31,000 brush strokes per minute) and sonic waves to dislodge plaque bacteria beyond the reach of the bristles and is especially recommended for patients with high oral disease activity. In a study of patients with fixed orthodontic appliances, the Sonicare has been demonstrated to be more effective at plaque removal than manual toothbrushing.⁹ This increase in brushing vigor and efficacy could generate a bacteremia that may be of concern for patients at risk for endocarditis.

This study was a randomized clinical trial designed to compare the incidence of bacteremia resulting from use of the Sonicare brush and manual brushing.

Methods

Subjects

After IRB approval, parental consent (and patient assent where appropriate), 50 children receiving dental care under general anesthesia at Children's Hospital & Regional Medical Center were enrolled. The examiner was not blinded to the patient's treatment group. A sample size of 25 children per group was determined to have statistical power greater than 80% to detect a two-fold increase in bacteremia with use of the Sonicare brush given a 40% rate of bacteremia with manual brushing using a two-sided chi-square test at 0.05 significance level. Eligible patients:

- Were between the ages of 2 to 6 years;
- Had no medical conditions requiring antibiotic prophylaxis for dental treatment;
- Had not received antibiotic therapy within the past 30 days;
- Had no sinus tracts associated with dental abscesses;
- Had no conditions altering alveolar ridge or gingival anatomy (eg, cleft alveolus).

Procedures

Patients were randomly assigned to either the Sonicare or manual toothbrushing group. After an inhalational induction, orotracheal intubation was performed by the attending anesthesiologist to avoid bacteremia from nasotracheal intubation.¹⁰ The skin around the antecubital fossa of either arm or the area around the saphenous vein on either leg was

prepared with Betadine. Blood samples were collected from the venipuncture site rather than the patient's IV line. The first blood sample (# 1) of 10 ml was collected and divided: 3 ml was placed into an aerobic vial and 7 ml into an anaerobic vial. Saline was flushed through the venipuncture site to avoid clotting and to facilitate drawing a second blood sample from the same site after toothbrushing.

The gingival health was evaluated using a score modified from Loe and Silness¹¹ where: 0=normal gingiva; 1=mild inflammation: slight change in color, slight edema; 2=moderate inflammation: redness, edema and glazing; and 3=severe inflammation: marked redness and edema, tendency to spontaneously bleed and ulceration.

Plaque scores were assigned to the labial and lingual surfaces of 6 teeth after application of disclosing solution. Teeth included were the most posterior tooth in each quadrant (4 teeth total), one maxillary incisor and one mandibular incisor. The amount of plaque was scored as follows: 0=no plaque; 1=thin line of plaque at the gingival margin; 2=plaque covering up to one-third of the tooth; 3=plaque covering up to two-thirds of the tooth; and 4=plaque covering greater than two-thirds of the tooth. A maximum score of 48 was possible (labial score + lingual score for each of 6 teeth).

The teeth were brushed for a timed one-minute interval either manually or with the Sonicare electric toothbrush. All toothbrushing, gingival score and plaque index assessments were performed by one of the authors (SB). Thirty seconds after toothbrushing, saline and 1 ml of blood were drawn and discarded.¹² A second sample (#2) was collected and distributed to culture vials.

The culture vials were incubated for 5 days using the BacTec 9240 blood culture system (Becton and Dickinson). Positive vials were gram stained, isolated on agar media and analyzed using standardized clinical laboratory protocol.

Statistical analysis

The proportion of subjects with positive cultures after toothbrushing (sample # 2) in the two groups was compared using both the chi-square test and logistic regression, which controlled for plaque index and gingival scores. Mean plaque scores were compared between groups using a two sample *t* test, and gingival scores were compared between groups using a chi-square test. A chi-square test and logistic regression were used to assess the association between plaque scores and gingival scores with the blood culture results.

Results

Three patients had positive blood cultures before toothbrushing (sample # 1) and were excluded from further analysis. Toothbrushing resulted in positive blood cultures for 46% of manual (11 of 24) and 78% of Sonicare patients (18 of 23; *P*=.022, chi-square; Table 1). Positive cultures in the manual toothbrushing group were 18% aerobic (2 of 11), 9% anaerobic (1 of 11) and 73% both (8 of 11). In the Sonicare group, positive cultures were 22% aerobic (4 of 18),

Table 1. Positive Blood Cultures After Brushing

Group	n	%*	95% CI†
Manual (n=24)	11	46%	26%, 66%
Sonicare (n=23)	18	78%	62%, 95%

*Rates are significantly different; *P*=.022.

†CI, confidence interval

22% anaerobic (4 of 18) and 56% both (10 of 18). Gram stain results of the positive cultures were primarily gram positive cocci in chains (Table 2).

No patient scored higher than 1 for gingival score (mild inflammation). There was no difference in gingival health between the 2 groups. The manual group had 17% of subjects with mild inflammation and the Sonicare group had 17% ($P=.95$, chi-square). Plaque scores were also similar in the manual group (mean=22.1, SD=5.5) vs Sonicare group (mean=19.7, SD=5.1, Table 3; $P=.12$, t test). Analysis using logistic regression to compare the manual toothbrushing and Sonicare groups, while controlling for plaque and gingival scores, also indicated that bacteremia levels were higher in the Sonicare group (odds ratio=6.6, $P=.013$).

There was no difference in the rate of bacteremia between subjects with normal gingiva (61.5%) and subjects with mild inflammation (63%; $P=.96$, chi-square test). There was no relationship between plaque scores and bacteremia (odds ratio=1.05, $P=.44$, logistic regression).

Discussion

As hypothesized, the Sonicare induced more bacteremia than the manual toothbrush. The frequency of bacteremia was 46% with manual brushing compared to 78% with the Sonicare toothbrush. In comparison, a study by Roberts and coauthors² found manual toothbrushing alone caused a bacteremia 39% of the time. Although much concern has been expressed over bacteremia risk from dental extractions, one could speculate that frequent transient bacteremias may pose a greater cumulative risk for bacterial endocarditis than the occasional dental procedure.¹³ A monthly total of bacteremic exposure from oral hygiene activities and chewing has been estimated to add up to 5,376 minutes while an uncomplicated dental extraction entails just 6 minutes of bacteremic exposure.¹⁴

The issue of whether poor oral hygiene and/or poor periodontal health predispose patients to bacteremia is controversial. Cobe¹⁵ showed that there was no significant difference in the incidence of bacteremias between healthy mouths vs periodontally diseased mouths. Silver¹⁶ reported more positive cultures in patients with increased severity of gingival inflammation. Elliot and Dunbar¹⁷ have shown that 36% of children without gingivitis had bacteremia while undergoing dental extractions.

More recently, there have been case-control and epidemiologic studies that strongly associate poor oral health with both cardiovascular disease and preterm low birth weight infants.¹⁸ In this study, gingival health and plaque scores were not predictive of bacteremia using either technique. Despite the characteristics of the child population that presents for dental treatment under general anesthesia, we found low scores for inflammation and fairly healthy gingiva. This may be due to limitations of the method related to time constraints in the operating room and the investigator's inability to detect subtle changes in gingival color.

Levels of serum C-reactive protein and fibrinogen have been found to be a reliable indicator of gingival health in

adults.¹⁹ These proteins are generally elevated in patients with inflammation or infection. In future research, serum levels of these proteins may be a more objective and reliable predictor of baseline gingival health than the visual assessment technique in this study.

Of interest were the three study patients who had positive blood cultures before toothbrushing. All patients had fasted and had no oral care for 8 to 10 hours before surgery. The positive prebrushing blood samples may be attributed to skin contamination, intubation,¹⁰ undetected infection or other unknown patient behavior. Orotracheal intubation was used because bacteremia rates ranging from 10% to 16% have been demonstrated after nasotracheal intubation.^{2,10} Berry et al¹⁰ speculated that bacteremia associated with nasotracheal intubation is probably due to seeding of nasopharyngeal organisms into the circulation while passing the tube through the area.

The organism most implicated in bacterial endocarditis is the viridans group of streptococci.^{3,5} Although oral streptococci can be isolated under aerobic conditions, it was chosen to use both aerobic and anaerobic blood culture vials to maximize the chances of isolating all bacteria from the blood samples. There have been reports of isolating anaerobic gram-positive rods (diphtheroids) and anaerobic gram-negative rods.²⁰ Six of the 29 positive cultures grew only aerobically and 5 of the cultures were positive only in the anaerobic vials. Although most of the isolates detected in the positive blood cultures were streptococci, using only aerobic or anaerobic vials would have reduced the number of positive cultures isolated. No strict anaerobes were isolated after toothbrushing, which is similar to the findings by Sconyers et al.²¹

This study did not quantify the number of bacteria present in the positive blood cultures. Additionally, research to date has not identified a concentration of bacteria in the blood that is clinically significant. Previous studies of tooth extractions have found no direct correlation between the intensity (colony forming units per milliliter of blood) of bacteria following an extraction and the incidence of bacterial endocarditis.²² A recent study of tooth-cleaning

Table 2. Gram Stain Results of Isolates

Gram stain result	# of isolates
Gram positive cocci in chains	23
Gram negative cocci	5
Gram positive rods	3
Gram negative rods	1

Table 3. Mean (SD) Plaque Scores and Percent (n) of Mild Inflammation in the Manual and Sonicare Groups

Group	Plaque*	Inflammation†
	Mean (SD)	% (n)
Manual (n=24)	22.1 (5.5)	17% (4)
Sonicare (n=23)	19.7 (5.1)	17% (4)

*Difference is not significant; $P=.12$.

†Difference is not significant; $P=.95$.

procedures in children demonstrated a bacterial intensity range from 0 to 1,666 colony-forming units per ml of blood.²² A more significant risk factor than the intensity of bacteremia may be the ability of a bacterium to adhere to damaged heart valves and induce bacterial endocarditis.²³ Therefore, quantifying the magnitude of bacteremia may not provide the clinician with information on the risk of developing bacterial endocarditis.

Risk factors of the patient and virulence properties of the individual bacteria isolated must also be considered in identifying patients at more risk. It is unclear whether patients with HIV disease or immune compromise are at risk of contracting bacterial endocarditis. Certainly, they have increased risk for contracting bacterial infections; however bacterial endocarditis requires a number of predisposing factors such as a damaged or prosthetic heart valve or congenital heart disease.

Bacteremia resulting from toothbrushing on an anesthetized patient may differ from the incidence of bacteremia from self-brushing. Factors such as the challenge of maneuvering around the orotracheal tube may alter the dynamics of brushing and brushing without toothpaste and water may affect the rate of bacteremia. We evaluated bacteremia after the patients' first exposure to the Sonicare brush. This study showed that vigorous brushing increased bacteremia during one brushing but does not answer whether bacteremia levels would decrease with vigorous daily brushing. Would optimizing the gingival health reduce the incidence of bacteremia over the long term? The Sonicare has been clinically proven to reverse gingivitis and decrease gingival bleeding by effective removal of plaque.⁹ Over time with repeated Sonicare brushing, improved gingival health may lower the incidence of bacteremia.

Based on the findings in this project, future research directions could include investigating the primary mechanisms of how bacteria enter the bloodstream via the oral cavity. Bacteremia can occur in patients with healthy gingiva²⁴ as well as in edentulous patients.²⁵ Therefore, gingival trauma and inflammation may be only a few of the many factors contributing to the occurrence of bacteremia.

Conclusions

1. Manual toothbrushing resulted in positive blood cultures in 46% of the study patients while use of the Sonicare brush resulted in positive blood cultures in 78% of the study patients.
2. Further studies are needed to assess the correlation between progressive improvements in oral hygiene and frequency of bacteremias. Cellular mechanisms of the process of bacterial infiltration into blood via the oral cavity need to be investigated further as the process may be multifactorial.

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ABSTRACT OF THE SCIENTIFIC LITERATURE



ADOLESCENT REPORTS OF PHYSICIAN COUNSELING FOR SMOKING

Approximately 4 million children under the age of 18 in the United States smoke cigarettes, and each day, nearly 6,000 more youths start smoking. Cigarette smoking by young people has been associated with reduced lung growth and lung function, early signs of risk factors for heart disease, and increased risk for chronic obstructive pulmonary disease. Physicians clearly are in a position to lower adolescent smoking rates for several reasons. First, most children see a physician nearly 20 times before their 21st birthday. Second, adolescents view physicians as credible sources of medical information and attend to their advice more often than their parents or other adults do. Finally, adolescents report their physician's advice is influential in their health practices and would motivate them to try to stop smoking. The appropriate delivery of smoking prevention and cessation messages depends on adequate screening of adolescents, identification of smokers, and adolescents' willingness to disclose their smoking behaviors. Current clinical practice recommendations from the Agency for Health Care Policy and Research and the American Academy of Pediatrics stress the essential role of health care providers as agents in smoking prevention and cessation and outline a 5-step approach for reducing smoking among patients (the 5 As: ask, assess, advise, assist and arrange).

A survey on smoking and health of 5,016 adolescents between the ages of 16 and 19 revealed the prevalence of physician screening, counseling, and adolescents' willingness to disclose their smoking. Overall, 43.4% of the sample reported physician screening, 42.1% reported receiving counseling, and only 28.8% of adolescents reported both. Furthermore, 79.3% of smokers reported they would admit their smoking if asked. Screening, counseling, and disclosure rates differed by gender, neighborhood income level, smoking status, and asthma status.

The outcome indicated the need for more intensive provider-delivered intervention. Efforts should focus on helping providers identify smoking correctly and communicate appropriate prevention or cessation messages. Persistence and sensitivity with boys, experimental smokers, and youths with chronic health conditions should be a focus of provider training. The less willing these youths are to disclose their smoking behaviors, the more that identification and intervention will be a barrier.

Comments: Pediatric dentists should take on the responsibility of understanding the issue of experimental smoking and contribute toward its prevention or cessation. **SZ**

Address correspondence to Dr. Susan M. Zbikowski, Group Health Cooperative, Center for Health Promotion, 12401 East Marginal Way S, Tukwila, WA 98168. zbikowski.s@ghc.org

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