

# Relationship between odontogenic bacteremia and orthodontic stripping

Ahmet Yagci,<sup>a</sup> Tancan Uysal,<sup>b</sup> Kevser Kurt Demirsoy,<sup>c</sup> and Duygu Percin<sup>d</sup>  
Kayseri and Izmir, Turkey, and Riyadh, Saudi Arabia

**Introduction:** The aim of this study was to evaluate the prevalence of bacteremia associated with an orthodontic stripping procedure. **Methods:** The study included 29 orthodontic patients (mean age,  $18.2 \pm 3.4$  years). We used a standardized stripping procedure: a perforated stripping disk with a contra-angle hand piece was used at a low speed ( $<15,000$  rpm; 10 seconds) on the mandibular anterior teeth. Blood samples were collected by inserting a cannula into the left antecubital fossa. A baseline sample was taken before treatment, and a second sample was taken after the stripping procedure. These samples were inoculated into aerobic and anaerobic blood culture bottles and incubated, and the bacterial cultures were identified; the samples collected before and after the stripping procedure were statistically analyzed. **Results:** Transient bacteremia was not detected in any pretreatment blood sample, but it was found in 1 postoperative blood sample; this sample tested positive for *Streptococcus sanguis*. **Conclusions:** The bacterial species in the positive postoperative blood sample was *S sanguis*, which might be associated with infective endocarditis. Clinicians should explain the level of risk to the patient and consult a concerned medical specialist. (Am J Orthod Dentofacial Orthop 2013;144:73-7)

Presence of bacteremia is always considered abnormal, since the blood is typically a sterile environment. Dental treatment is associated with bacterial endocarditis in a small proportion of cases.<sup>1</sup> The relevant dental procedures in question are endodontal therapy,<sup>2</sup> tooth extractions,<sup>3</sup> periodontal surgeries, and orthodontic bandings.<sup>4</sup> The risk of developing infective endocarditis because of bacteremia after dental procedures is not clearly understood because the American Heart Association's guidelines for prevention of infective endocarditis from dental procedures are not based on prospective clinical trials.<sup>5</sup> However, in 2007, the American Heart Association

issued a recommendation on the prevention of bacterial endocarditis, stipulating that antibiotic prophylaxis should be used for patients having any dental procedure that entails bleeding of the gingiva or the oral mucosa and the periapical region.<sup>6,7</sup>

Bacteremia in orthodontics is not well understood. Degling<sup>8</sup> reported no bacteremia after the placement and removal of orthodontic bands. However, findings by Erverdi et al<sup>9</sup> regarding samples from 7.5% of patients after orthodontic banding showed bacteremia, and *Streptococcus sanguis* and *Streptococcus mitis* were isolated. According to Rosa et al,<sup>4</sup> removal of the Haas palatal expander is a traumatic procedure that can result in bacteremia, and orthodontists must act prophylactically if this procedure is used in patients at risk for infective endocarditis. Uysal et al<sup>10</sup> reported that 1 of 40 patients developed bacteremia after insertion of orthodontic mini-implants.

Interproximal enamel reduction, defined as removing part of the dental enamel from an interproximal contact area, offers an appealing alternative to overcome difficulties with premolar extraction and the instability of overexpansion in nonextraction cases. Stripping can be performed for the following reasons: solving Bolton discrepancy problems,<sup>11</sup> treating mild or moderate crowding,<sup>12</sup> improving the gingival relationship and reshaping proximal contacts,<sup>13</sup> and eliminating the need for mandibular retention.<sup>14</sup> This procedure can

<sup>a</sup>Assistant professor, Department of Orthodontics, Faculty of Dentistry, Erciyes University, Kayseri, Turkey.

<sup>b</sup>Professor and chair, Department of Orthodontics, Faculty of Dentistry, Izmir Katip Celebi University, Izmir, Turkey; professor, Department of Pediatric Dentistry and Orthodontics, College of Dentistry, King Saud University, Riyadh, Saudi Arabia.

<sup>c</sup>Research assistant, Erciyes University, Faculty of Dentistry, Department of Orthodontics, Kayseri, Turkey.

<sup>d</sup>Professor, Department of Microbiology, Faculty of Medicine, Erciyes University, Kayseri, Turkey.

All authors have completed and submitted the ICMJE Form for Disclosure of Potential Conflicts of Interest and none were reported.

Reprint requests to: Ahmet Yagci, Erciyes Üniversitesi Diş Hekimliği Fakültesi, Ortodonti A.D. Melikgazi, Kayseri, Turkey; e-mail, dtahmetyagci@hotmail.com.

Submitted, November 2012; revised and accepted, February 2013.

0889-5406/\$36.00

Copyright © 2013 by the American Association of Orthodontists.

<http://dx.doi.org/10.1016/j.ajodo.2013.02.024>

also improve esthetics,<sup>15</sup> significantly reduce treatment time, and allow transverse arch dimensions while maintaining anterior inclinations.<sup>16,17</sup>

Stripping can be used in adolescents and adults, since the interproximal enamel thickness is similar in both groups.<sup>18</sup> Several studies have shown that the stripping site might be more resistant to carious and periodontal disease than unaltered enamel surfaces.<sup>19,20</sup> Some studies have shown that dentogingival manipulative procedures (eg, matrix band, wedge,<sup>21,22</sup> or orthodontic separator<sup>23</sup>) can cause bacteremia. Separation of the teeth with a wedge or other separator can cause transitory bacteremia during the stripping procedure. Moreover, the gum can be destroyed during stripping with rotary instruments. To our knowledge, no authors have investigated the relationship between odontogenic bacteremia and orthodontic stripping. The purpose of this study was to evaluate the prevalence of bacteremia associated with orthodontic stripping.

## MATERIAL AND METHODS

The regional research ethics committee of Erciyes University, Kayseri, Turkey, granted ethical approval for the study. Written informed consent to collect blood samples was obtained from all patients or their parents (if the patients were younger than 18 years). The study included 29 patients (22 female, 7 male) at the Department of Orthodontics, Erciyes University, and their mean age was  $18.2 \pm 3.4$  years (range, 14.7-24.3 years). Sample size was determined in a power analysis conducted using G\*Power (version 3.0.10; Franz Faul, Christian-Albrechts-Universitat, Kiel, Germany).

Criteria for inclusion in the study were patients with a Class I molar relationship with minimal anterior crowding (0-3 mm; according to the index of complexity, outcome, and need, these are patients scoring 0-1)<sup>24</sup> and in the permanent dentition. Poor oral hygiene can cause incorrect evaluation of transient bacteremia; therefore, only patients with adequate oral hygiene were included in this study. With reference to the gingival and plaque index system of Loe,<sup>25</sup> only patients with plaque scores of 0 or 1 were included in the study. The exclusion criteria were based on a study by Erverdi et al<sup>26</sup> and excluded patients with a history of congenital heart disease, rheumatic fever, hypertrophic cardiomyopathy, subacute bacterial endocarditis, aortic or mitral stenosis, prosthetic heart valves, bleeding disorders, or diabetes mellitus; immune suppressed or pregnant patients and patients who had used an antiseptic mouthwash or antibiotics within the last 3 months were also excluded.

To separate the teeth, wedges were placed in the gum before the stripping. For this procedure, a perforated stripping disk set (8934 A.220; Komet, Brasseler, Lemgo,

Germany) with a contra-angle hand piece was used on the mandibular anterior teeth at low speed (< 15,000 rpm) for 10 seconds per tooth. Approximately 0.25 mm of dental tissue was removed from the mesial and distal sides of the tooth. Topical anesthesia (10% lidocaine) was applied to the gingival region before the stripping procedure. The patients were instructed not to eat anything or brush their teeth during the 2 hours preceding the stripping.

All blood samples were collected from the patients under sterile conditions at 2 time points: before and soon after stripping. The vein in the antecubital fossa was used for collection. Before the operation, each patient's left antecubital fossa was disinfected with 70% isopropyl alcohol. A sterile plastic cannula of 20 g (HECOS; Shanghai Medicines & Health Products Import and Export, Shanghai, China) and a sterile syringe were used, and an initial blood sample of 10 cm<sup>3</sup> was collected before treatment. Soon after completing the stripping procedure, the valve of the cannula was reopened, and a second blood sample of 10 cm<sup>3</sup> was taken with a new syringe.

The blood samples were injected into aseptic culture flasks containing 50 cm<sup>3</sup> of brain-heart infusion broth and incubated at 37°C for 5 days. The BACTEC Blood Culture System (Becton Dickinson Diagnostic Instrument Systems, Sparks, Md) used is a fully automated system designed to detect microbial growth in blood specimens. The system measures carbon dioxide produced by organisms as they metabolize the substrate. As carbon dioxide was produced in each bottle, the sensor emitted a fluorescent light that passed through an emission filter to a light-sensitive diode; thus, positive bottles were indicated. The advantages of continuous-monitoring blood culture systems include a decreased laboratory workload, fewer false-positive results, and less pseudobacteremia. Disadvantages include a limited database and a lack of information regarding the initial bacterial load before culturing of the samples. Because the bacteria proliferated until the system detected them, the bacterial load was not the same among the time intervals (at the beginning and at the end of the alarms). Therefore, this value did not provide meaningful information about the extent of bacteremia and was not analyzed.

Cultures from positive bottles were plated onto blood agar supplemented with 0.0005% hemin and 0.00005% menadione (Sigma-Aldrich, St Louis, Mo). The samples from positive culture plates were then subcultured to separate plates containing blood agar (5% sheep blood), chocolate agar, or eosin methylene blue agar, which were then incubated under aerobic conditions. Standard microbiological biochemical testing techniques, colony morphology, gram-staining procedures, and the API kit (API Rapid ID 32 Strep identification strips; BioMerieux, Marcy l'Etoile, France) were used to identify bacterial strains.

The results from the blood samples taken before and a short time after the stripping procedure were analyzed statistically using the McNemar test, with  $P < 0.05$  indicating statistical significance.

## RESULTS

Gingival bleeding occurred in all patients, but this soft-tissue bleeding had stopped normally by the end of the stripping process. There was no statistically significant difference between preoperative and postoperative blood samples with respect to transient bacteremia. Transient bacteremia was not detected in any preoperative blood sample and was found in only 1 postoperative blood sample, with *S sanguis* as the bacterial strain.

## DISCUSSION

In view of recent developments in health care, there is a greater necessity to take precautions to ensure the biosecurity of patients at risk during orthodontic treatment. The aim of our prospective clinical study was to evaluate the prevalence of bacteremia associated with orthodontic stripping. During the stripping procedure, gingival bleeding is usually an unavoidable result, and antibiotic prophylaxis is necessary for dental procedures that entail the manipulation of gingival tissue, according to the American Heart Association's guidelines.<sup>27</sup> Furthermore, in a recent review, it was found that failure to apply antibiotic prophylaxis before dental procedures can result in infective endocarditis, leading to worse sequelae for the patient.<sup>28</sup> Therefore, we aimed to investigate whether bacteremia would occur during the stripping procedure, which would indicate the need for prophylaxis in patients at risk.

Similar to other studies, we used the antecubital vein for sample collection.<sup>29-31</sup> Beeson et al<sup>32</sup> compared the bacterial counts in samples collected from various anatomic sites of patients with bacterial endocarditis. Samples for arterial and venous blood cultures were collected from the antecubital vein, femoral artery and vein, right auricle, hepatic and renal veins, and vena cava. The colony counts of samples collected from the antecubital fossa were similar to (but slightly lower than) those of arterial blood samples. Moreover, the hepatic vein yielded the lowest bacterial count, and the femoral vein was considerably less prone to bacterial invasion.<sup>32</sup>

In this study, a 20-g sterile plastic cannula and a sterile syringe were used for collecting the first and second blood samples; the second blood sample could be taken easily without removing the cannula, via a valve. True postprocedural bacteremia can only be determined by analyzing blood samples collected before and after the procedure.<sup>31</sup>

For optimal detection of bacteremia, the patients were told not to brush their teeth for 2 hours before the

appointment. In 1 study, blood samples taken from 25% of orthodontic patients after brushing showed bacteremia, and these patients had good oral hygiene.<sup>33</sup> According to Pallasch and Slots,<sup>34</sup> toothbrushing can cause transient bacteremia ranging from 0% to 26%. Other researchers have shown that bacteremia was transient in this context and lasted for less than 15 minutes.<sup>35</sup> In our study the nonbrushing period might have been longer than 2 hours for some patients; however, our main aim was to ensure that the patients did not brush their teeth just before the stripping procedure. If we had collected the blood samples less than 20 to 30 minutes after toothbrushing, it might have affected our microbiological results. We standardized our blood samples using this method. The second blood sample was collected 2 minutes after the stripping procedure to optimize the detection of bacteremia; it has been recommended that blood samples should be collected no longer than 2 minutes after trauma to the gingival margin.<sup>36</sup>

The bacterium isolated in this study, *S sanguis*, is a member of the viridans streptococci, which are readily cultivated from dental plaque and saliva. *S sanguis* is known as a precursor colonizer in the formation of dental biofilm.<sup>37</sup> It is also one of the most common bacterial types among the viridans streptococci to cause infective endocarditis.<sup>38,39</sup> This type of streptococci produces dextrans and has the capacity to adhere to the endocardium of the heart, valves, and major vessels.<sup>40</sup> Bacterial dextrans are responsible for the adherence of *S sanguis* to damaged heart valves with preexisting nonbacterial thrombotic endocarditis.<sup>41</sup> The adherence of *S sanguis* is attributable to dextrans of high molecular weight.<sup>39</sup> *S sanguis* can be found on the skin and in the oral flora. In this study, it is possible that *S sanguis* from the skin could have contaminated the sample during collection. However, since the aseptic technique was strictly adhered to, the risk of contamination from the skin was minimal.

All patients experienced gingival bleeding from the use of a wedge or trauma to the gingival margin during the stripping procedure. However, bacteremia was not observed in all patients who had bleeding. Similar to previous studies, our study showed that gingival bleeding does not always cause bacteremia.<sup>29,42</sup> However, there is some controversy regarding bacteremia because of the use of wedges or stripping procedures, and some studies have shown that wedges can cause bacteremia.<sup>21,22</sup> Further studies are needed to elucidate these complexities.

To reduce the risk of bacteremia, the use of mouthwash could be considered an effective method before routine orthodontic procedures including stripping. Tomás et al<sup>43</sup> recommended routine use of 0.2%

chlorhexidine mouthwash before dental extractions to reduce the risk of postextraction bacteremia. However, Erverdi et al<sup>29</sup> found that the prevalence of bacteremia was not significantly affected by prior chlorhexidine application. Similarly, Hirota et al<sup>44</sup> investigated the effect of oral decontamination using clindamycin palmitate on the incidence of bacteremia and found no effect on bacteremia. Therefore, mouthwashes were not used in our study. A recent study reported that xylitol might be useful in patients at risk, since it reduces the pathogenic bacteria (eg, *S sanguis*) in the oral cavity.<sup>45</sup> Further investigations on this topic would be useful to reduce the incidence of dental bacteremia.

In our study, there was no statistical difference in bacterial loads between the first and second blood samples. However, studies have shown different results for different orthodontic procedures. Bacteremia incidence determined after orthodontic banding was approximately 7.5% to 10.0%,<sup>9,42</sup> whereas it was about 6.6% after orthodontic debanding.<sup>26</sup> Percentages in this range are lower than those reported after routine daily activities, such as toothbrushing (25%),<sup>9</sup> use of wooden toothpicks (20%–40%),<sup>7</sup> and chewing food (7%–51%).<sup>7</sup> However, bacteremia incidence was found to be 32% after the removal of bonded maxillary expansion appliances,<sup>30</sup> and it was approximately 50% after use of a Haas palatal expander.<sup>4</sup> Microbiologic evaluation of the samples in our study showed a comparatively low incidence of bacteremia (3.4%) after the stripping procedure.

According to Gaidry et al,<sup>46</sup> any orthodontic procedure that could cause bleeding, such as banding or debanding, should be preceded by antibiotic prophylaxis for 30 minutes to 1 hour before the procedure to control the risk of bacteremia. Based on this opinion, since gingival bleeding is likely to occur during the stripping procedure, the potential need for prophylaxis should not be ignored.

## CONCLUSIONS

To our knowledge, this study is the first to investigate the relationship between bacteremia and an orthodontic stripping procedure. Our findings led us to conclude the following.

1. One of 29 patients developed bacteremia associated with the oral cavity after stripping. The bacterium identified in the postoperative blood sample was *S sanguis*, an organism known to be related to endocarditis in patients with cardiac malformations.
2. Clinicians should evaluate the risk level of each patient and consult the patient's medical specialist before this procedure, which can result in gingival bleeding.

3. If stripping is used in high-risk patients, to avoid the unnecessary use of antibiotics, antibiotic prophylaxis should only be applied after consultation. Preventing trauma to the gingival tissues and using an antiseptic mouthwash before the procedure would also be useful.

## REFERENCES

1. Guntheroth WG. How important are dental procedures as a cause of infective endocarditis? *Am J Cardiol* 1984;54:797-801.
2. Debelian GJ, Olsen I, Tronstad L. Anaerobic bacteremia and fungemia in patients undergoing endodontic therapy: an overview. *Ann Periodontol* 1998;3:281-7.
3. Heimdahl A, Hall G, Hedberg M, Sandberg H, Soder PO, Tuner K, et al. Detection and quantitation by lysis-filtration of bacteremia after different oral surgical procedures. *J Clin Microbiol* 1990; 28:2205-9.
4. Rosa EA, Rached RN, Tanaka O, Fronza F, Fronza F, Assad RA. Preliminary investigation of bacteremia incidence after removal of the Haas palatal expander. *Am J Orthod Dentofacial Orthop* 2004;127:64-6.
5. Dajani AS, Taubert KA, Wilson W, Bolger AF, Bayer A, Ferrieri P, et al. Prevention of bacterial endocarditis: recommendations by the American Heart Association. *J Am Dent Assoc* 1997;128:1142-51.
6. Kwon PH, Laskin DM. Clinician's manual of oral and maxillofacial surgery. 2nd ed. Chicago: Quintessence; 1997.
7. Wilson W, Taubert KA, Gewitz M, Lockhart PB, Baddour LM, Levison M, et al. Prevention of infective endocarditis: guidelines from the American Heart Association: a guideline from the American Heart Association Rheumatic Fever, Endocarditis and Kawasaki Disease Committee, Council on Cardiovascular Disease in the Young, and the Council on Clinical Cardiology, Council on Cardiovascular Surgery and Anesthesia, and the Quality of Care and Outcomes Research Interdisciplinary Working Group. *J Am Dent Assoc* 2007;138:739-45, 747-60.
8. Degling TE. Orthodontics, bacteremia, and the heart damaged patient. *Angle Orthod* 1972;42:399-401.
9. Erverdi N, Kadir T, Özkan H, Acar A. Investigation of bacteremia after orthodontic banding. *Am J Orthod Dentofacial Orthop* 1999;116:687-90.
10. Uysal T, Yagci A, Esel D, Ramoglu Sİ, Kilinc A. Investigation of bacteremia following insertion of orthodontic mini-implants. *World J Orthod* 2010;11:357-61.
11. Peck H, Peck S. An index for assessing tooth shape deviations as applied to the mandibular incisors. *Am J Orthod* 1972;61:384-401.
12. Rossouw PE, Tortorella A. Enamel reduction procedures in orthodontic treatment. *J Can Dent Assoc* 2003;69:378-83.
13. Tuverson DL. Anterior interocclusal relations. Part 1. *Am J Orthod* 1980;78:361-70.
14. Sheridan JJ. Air-rotor stripping. *J Clin Orthod* 1985;19:43-59.
15. JCO/interviews Dr. Björn U. Zachrisson on excellence in finishing. Part 2. *J Clin Orthod* 1986;20:536-56.
16. Pinheiro M. Interproximal enamel reduction. *World J Orthod* 2002; 3:223-32.
17. Zachrisson B, Minster L, Ogaard B, Birkhed D. Dental health assessed after interproximal enamel reduction: caries risk in posterior teeth. *Am J Orthod Dentofacial Orthop* 2011;139:90-8.
18. Chudasama D, Sheridan JJ. Guidelines for contemporary air-rotor stripping. *J Clin Orthod* 2007;41:315-20.
19. El-Mangoury NH, Moussa MM, Mostafa YA, Girgis AS. In-vivo remineralization after air-rotor stripping. *J Clin Orthod* 1991;25:75-8.

20. Jarjoura K, Gagnon G, Nieberg L. Caries risk after interproximal enamel reduction. *Am J Orthod Dentofacial Orthop* 2006;130:26-30.
21. Roberts GJ, Gardner P, Longhurst P, Black AE, Lucas VS. Intensity of bacteremia associated with conservative dental procedures in children. *Br Dent J* 2000;188:95-8.
22. Sonbol H, Spratt D, Roberts GJ, Lucas VS. Prevalence, intensity and identity of bacteraemia following conservative dental procedures in children. *Oral Microbiol Immunol* 2009;24:177-82.
23. Lucas VS, Omar J, Vieira A, Roberts GJ. The relationship between odontogenic bacteremia and orthodontic treatment procedures. *Eur J Orthod* 2002;24:293-301.
24. Daniels C, Richmond S. The development of the index of complexity, outcome and need (ICON). *J Orthod* 2000;27:149-62.
25. Loe H. The gingival index, the plaque index and the retention index systems. *J Periodontol* 1967;38(Suppl):610-6.
26. Erverdi N, Biren S, Kadir T, Acar A. Investigation of bacteremia following orthodontic debanding. *Angle Orthod* 2000;70:11-4.
27. Filippo SD. Prophylaxis of infective endocarditis in patients with congenital heart disease in the context of recent modified guidelines. *Arch Cardiovasc Dis* 2012;105:454-60.
28. Ramu C, Padmanabha TV. Indications of antibiotic prophylaxis in dental practice—review. *Asian Pac J Trop Biomed* 2012;2:749-54.
29. Erverdi N, Acar A, İsgüden B, Kadir T. Investigation of bacteremia after orthodontic banding and debanding following chlorhexidine mouth wash application. *Angle Orthod* 2001;71:190-4.
30. Gürel HG, Basciftci FA, Arslan U. Transient bacteremia after removal of a bonded maxillary expansion appliance. *Am J Orthod Dentofacial Orthop* 2009;135:190-3.
31. Rajasuo A, Nyfors S, Kanervo A, Jousimies-Somer H, Lindqvist C, Suuronen R. Bacteremia after plate removal and tooth extraction. *Int J Oral Maxillofac Surg* 2004;33:356-60.
32. Beeson PB, Brannon ES, Warren JV. Observation on the sites of removal of bacteria from the blood of patients with bacterial endocarditis. *J Exp Med* 1945;81:9-23.
33. Schlein RA, Kudlick EM, Reindorf CA, Gregory J, Royal GC. Toothbrushing and transient bacteremia in patients undergoing orthodontic treatment. *Am J Orthod Dentofacial Orthop* 1991;99:466-72.
34. Pallasch TJ, Slots J. Antibiotic prophylaxis and the medically compromised patient. *Periodontol* 2000;1996(10):107-38.
35. Durack DT. Prevention of infective endocarditis. *N Engl J Med* 1995;332:38-44.
36. Roberts GJ, Radford P, Holt R. Prophylaxis of dental bacteraemia with oral amoxycillin in children. *Br Dent J* 1987;162:179-82.
37. Rosan B, Lamont RJ. Dental plaque formation. *Microbes Infect* 2000;2:1599-607.
38. Mylonakis E, Calderwood SB. Infective endocarditis in adults. *N Engl J Med* 2001;345:1318-30.
39. Ramirez-Ronda CH. Effects of molecular weight of dextran on the adherence of *Streptococcus sanguis* to damaged heart valves. *Infect Immun* 1980;29:1-7.
40. Rowe AHR, Alexander AG. Clinical methods, medicine, pathology and pharmacology. Oxford, United Kingdom: Blackwell Scientific Publications; 1988.
41. Scheld WM, Valone JA, Sande MA. Bacterial adherence in the pathogenesis of endocarditis. Interaction of bacterial dextran, platelets and fibrin. *J Clin Invest* 1978;61:1394-404.
42. McLaughlin JO, Coulter WA, Coffey A, Burden DJ. The incidence of bacteremia after orthodontic banding. *Am J Orthod Dentofacial Orthop* 1996;109:639-44.
43. Tomás I, Alvarez M, Limeres J, Tomás M, Medina J, Otero JL, et al. Effect of a chlorhexidine mouthwash on the risk of postextraction bacteremia. *Infect Control Hosp Epidemiol* 2007;28:577-82.
44. Hirota WK, Wortmann GW, Maydonovitch CL, Chang AS, Medkiff RB, Wong RK, et al. The effect of oral decontamination with clindamycin palmitate on the incidence of bacteremia after esophageal dilation: a prospective trial. *Gastrointest Endosc* 1999;50:475-9.
45. Burgess J. Reducing risks of bacterial endocarditis from dental procedures with oral time-released xylitol. *Dent Today* January 30, 2012; 18:26. Available at: <http://dentistrytoday.com/oral-medicine/6775-reducing-risks-of-bacterial-endocarditis-from-dental-procedures-with-oral-time-released-xylitol->. Accessed January 4, 2013.
46. Gaidry D, Kudlick EM, Hutton JG Jr, Russell DM. A survey to evaluate the management of orthodontic patients with a history of rheumatic fever or congenital heart disease. *Am J Orthod* 1985;87:338-44.