REVIEW ARTICLES

Dental Considerations for Cardiac Surgery

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ABSTRACT **Many patients requiring cardiac surgery possess poor oral health. The presence of decayed teeth, untreated dental abscesses, and periodontitis can all represent potentially potent causes of an odontogenic infection. Ultimately, such an infection can have catastrophic consequences if it occurs during or soon after certain cardiac procedures. Since an association exists between poor oral hygiene and various systemic diseases, many patients scheduled for cardiac procedures inherently possess poor oral hygiene and untreated dental infections. Inadequate patient education, financial constraints, and dental phobia all serve as barriers for patients receiving routine intraoral care. Consequently, patients may unknowingly present for cardiac surgery with undetected oral infections that can magnify the likelihood of an adverse outcome, leading to increased costs, morbidity, and possibly mortality. It is recommended to view oral health in the perspective of systemic health, specifically, recognizing the deleterious impact that an untreated odontogenic infection can have upon cardiac surgery. Therefore, considering scheduling constraints and the urgency of the operation, if time and resources permit, then it is suggested that patients who undergo elective cardiac surgery should be screened preoperatively to ensure that any oral infection is diagnosed and definitively treated. Such an investment can yield significant improvements in surgical outcome and overall patient health.** doi: 10.1111/j.1540-8191.2008.00708.x *(J Card Surg 2009;24:64-68)*

DENTAL CONSIDERATIONS FOR CARDIAC SURGERY

Many patients requiring cardiac surgery possess poor oral health. The presence of decayed teeth, untreated dental abscesses, and periodontitis all represent potentially potent causes of an odontogenic infection. Ultimately, such an infection can have catastrophic consequences if it occurs during or soon after certain cardiac procedures. Presurgical dental treatment to remove such foci of infection is a prudent course of action for this problem. This paper will elaborate on the association between oral health and cardiovascular disease (CVD) and present evidence highlighting the importance of obtaining a dental evaluation and definitive treatment prior to elective cardiac surgery.

Dental diseases are the most common infectious diseases in the world.[1] Moreover, the relationship between a patient's dentition and overall systemic health has increasingly been gaining both scientific and media attention. In May 2000, the United States Surgeon General published the first ever report on oral health in America.[2] It highlighted the association between oral and systemic health. The report stated, "The mouth reflects general health and well-being. The mouth is a readily accessible and visible part of the body and provides health care providers and individuals with a window on their general health status." Stated simply by former Surgeon General C. Everett Koop, "You are not healthy without good oral health."

The link between oral bacteria and undesirable systemic effects has been the focus of researchers for many years.[3,4] A number of epidemiological studies have examined the relationship between oral health and cardiovascular disease.[5,6] Current information regarding the pathogenesis and treatment of CVD suggests that oral health can be an important factor in the exacerbation of preexisting coronary disease.[7,8] Oral microbes congregate as dental plaque, coating the surfaces of teeth. Dental plaque provides a microhabitat for organisms that can translocate and colonize in other parts of the body, damaging vital organs.

Chronic infections such as periodontal disease may play a role in the initiation and development of CVD. Periodontitis is a local inflammatory process involving a bacterial infection of the supporting structures of the teeth. This disease process is also characterized by systemic inflammatory host responses that may contribute to the reported elevated risk of CVD among patients with periodontal disease.[9] Several periodontal organisms including *P. gingivalis*, *T. denticola*, *S.*

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sanguinis, and *A. actinomycetemcomitans* have been detected directly within the atherosclerotic plaque lesion of the vessel wall.[10]

The role of oral health in the etiology of heart disease has been well documented and debated.[11,12] Most experts on this subject agree that poor oral hygiene can be a risk factor for infective endocarditis (IE) in vulnerable populations. Poor oral health, especially if it involves a compromised periodontal status, is an important associated risk factor for infective endocarditis and associated sequelae. Gingival inflammation correlates positively with the prevalence and severity of a bacteremia. Although infective endocarditis is a rare condition in the general population it continues to be a serious complication, mainly in patients who possess susceptible cardiac conditions. Endocarditis usually develops in individuals with underlying structural cardiac defects who develop a bacteremia.[13] Blood-borne bacteria may lodge on damaged or abnormal heart valves, the endocardium, or the endothelium near anatomic defects, resulting in this specific type of inflammation. Consequently, in the surgical environment, preventive pharmacological measures have become routine.

For decades, a patient who presented to the dental office with a known cardiac condition (i.e., mitral valve prolapse with regurgitation) for a procedure likely to cause bleeding, such as periodontal treatment or extractions of teeth, was routinely treated preoperatively with antibiotics. However, the most recent research behind this common practice has led to a significantly altered perspective. The American Heart Association released updated guidelines for the prevention of infective endocarditis, with major changes and clarifications regarding who should receive antibiotic prophylaxis.[14] The new guidelines are based upon the current available evidence and deviate greatly from the previous ones. The updated recommendations include the following: (1) Only an extremely small number of cases of IE might be prevented by antibiotic prophylaxis for dental procedures even if such prophylactic therapy were 100 percent effective; (2) IE prophylaxis for dental procedures should be recommended only for patients with underlying cardiac conditions associated with the highest risk of adverse outcome from IE (Table 1); (3) For patients with these underlying cardiac conditions, prophylaxis is recommended for all dental procedures that involve manipulation of gingival tissue or the periapical region of teeth or perforation of the oral mucosa; and (4) Prophylaxis is not recommended based solely upon an increased lifetime risk of acquisition of IE.

Optimizing a patient's dentition and periodontal health has been shown to lower the risk of cardiovascular disease.[15] Also, optimizing one's oral health is usually dependent on the individual receiving regular professional dental care.[16] For many patients, however, obtaining routine intraoral care may be limited by several barriers. Financial constraints, inaccessibility to dental professionals, a lack of patient education, and dental phobia may all contribute to irregularly scheduled or even no visits to the dentist.[17] As a result, such patients may experience a greater incidence of poor oral hygiene, tooth decay, periodontal disease, and oral infections. Moreover, if a patient presents for a major cardiac procedure and has not had a dental examination for many years (possibly decades), the potential for an undetected oral infection is magnified even further. Thus, patients who have not received appropriate preoperative dental treatment are set up for a potentially adverse outcome to their cardiac procedure—even before it commences.

TABLE 1
Cardiac Conditions Associated with the Highest Risk of Adverse Outcome from Endocarditis for which Prophylaxis with Dental Procedures is Reasonable[14]

- Prosthetic cardiac valve or prosthetic material used for cardiac valve repair
- Previous infective endocarditis
- Congenital heart disease (CHD)*
- Unrepaired cyanotic CHD, including palliative shunts and conduits
- Completely repaired congenital heart defect with prosthetic material or device, whether placed by surgery or by catheter intervention, during the first six months after the procedure†
- Repaired CHD with residual defects at the site or adjunct to the site of a prosthetic patch or prosthetic device (which inhibit endothelialization)
- Cardiac transplantation recipients who develop cardiac valvulopathy

*Except for the conditions listed above, antibiotic prophylaxis is no longer recommended for any other form of CHD.
†Prophylaxis is reasonable because endothelialization of prosthetic material occurs within six months after the procedure.

Patients scheduled for cardiac surgery who unknowingly possess an intraoral infection may also lack proper education regarding its potential impact on the procedure. Studies have been conducted to assess patients' awareness of the association between oral health and heart disease. Lowry et al.[18] designed a qualitative focus group-based study on patients three months post cardiac surgery. They discovered that patients did not accept the link between their oral health status and their general health. Additionally, the patients revealed that oral health was not included on the agenda of the surgical team, and suggested that the surgeon defined what was important to the patient and what was not. The inclusion of the oral health professional in the presurgical stage has the potential to enhance the importance of oral health in overall systemic health, especially if their role is endorsed by the surgeon.

Not only do patients demonstrate a lack of awareness of the link between oral health and cardiac disease, but parents of pediatric cardiac patients are not being properly educated regarding this association. Balmer et al.[19] administered questionnaires to the families of 38 pediatric cardiology patients and conducted brief dental examinations. They found that only 64% of parents were aware of the link between the oral health of their children and infective endocarditis. Despite being vulnerable congenital heart disease patients, few children with or without known dental

disease received basic education regarding oral health. Moreover, Da Silva et al.[20] conducted structured interviews with guardians, and oral examinations were performed on 104 children. The authors determined that only 10 of the guardians were aware of the term "heart infection." The guardians displayed unsatisfactory knowledge with respect to the importance of maintenance of good oral health for the prevention of infective endocarditis.

In addition to the poor education of patients regarding this link, the incidence of dental caries in children undergoing such critical procedures is significant. Hayes et al.[21] conducted dental screenings on 209 pediatric patients six months and older whom were scheduled for cardiac surgery. Dental disease was diagnosed in 175 (84%) of the 209 patients: 164 (78%) gingivitis; 60 (29%) caries; six (7%) dental abscess; three (1%) periodontal abscess; and five (2%) pericoronitis. Twenty-four (12%) cardiac surgeries were postponed. The authors concluded that all cardiac surgical patients should have a dental screening prior to cardiac surgery.

Currently though, a dental screening is not a universal occurrence within the hospital cardiac services. There are several possible reasons for this omission. First, patient education regarding this association may be lacking.[22] Second, surgeons may overlook the importance of eradicating this potential source of infection prior to cardiac surgery and therefore do not impress it upon their patients preoperatively. Third, patients may not have adequate insurance coverage to address their required dental treatment.[23] As a result, too many patients are now entering the operating room harboring a potentially dangerous intraoral infection that could have been detected with a thorough preoperative dental examination.

A preoperative dental examination[24] may include palpation of extraoral tissues (i.e., in the submandibular region) in order to detect any abnormal swelling. Intraoral tissues such as the palate, tongue, floor of month, and buccal mucosa are also examined for any lesions or evidence of infection. Exploration of the patient's individual teeth and each existing dental restoration (i.e., silver amalgams, composite resins, crowns, bridges) for new or recurrent decay is also performed. An overall assessment of oral hygiene may also include probing of periodontal pocket depths. The space between a tooth and the surrounding gums (i.e. gingiva) widens and deepens as periodontal disease progresses. Pocket depths $\geq$4 mm and/or bleeding upon probing are usually indicative of periodontal disease. A series of intraoral radiographs is taken to supplement the clinical examination, and may illustrate evidence of tooth decay or an infection occurring at surrounding structures. Bone levels visualized on such films can further support evidence of mild, moderate, or severe periodontal disease. Thus, the palpation and inspection of intraoral tissues, teeth, and their surrounding structures during a clinical examination, combined with radiographic evidence provides a thorough assessment of a patient's intraoral health.

Including a dental examination in the preoperative phase prior to a major operation has been utilized effectively. Many patients awaiting transplants for failing organs such as the heart, liver, and kidney possess a concomitantly poor dentition and oral hygiene. Patients awaiting a liver transplant, for example, may be on such a list due to alcohol-related cirrhosis of the liver. Such systemic damage is often paralleled by intraoral neglect, which manifests as excessive tooth decay and/or moderate to severe periodontal disease. Similarly, patients currently awaiting various cardiac procedures may also possess an oral health condition that is suboptimal, and a potential hazard to the surgery's success.

At some medical centers,[25] prior to a cardiac transplant or another transplantation procedure, it is mandatory for a patient to undergo a complete physical examination by a series of specialists in order to rule out any potential source of infection. Included in this systemic checklist is the requirement of a thorough evaluation by a dentist. A clinical examination, intraoral radiographs, and any other indicated treatment is essential prior to the patient being "cleared" for surgery from an oral health standpoint. This protocol has yet to become a standard practice employed by cardiac teams throughout the country. Although this action is currently often overlooked by the patient, primary physician, and cardiac team, its routine implementation should be strongly considered.

Currently, physicians such as internists and cardiologists do not provide routine, thorough dental examinations of their patients. However, steps are being taken at medical schools to augment the oral health component within the medical curriculum. Areas of focus include dental caries, periodontal disease, oral cancer, and oral-systemic interactions.[26] In the future, with the surgeon's acceptance of the link between oral health and cardiac disease, the dentist may eventually become a more regularly involved member in the presurgical phase.

When poor dentition has been identified prior to cardiac surgery, the benefit of treating the condition prior to the planned surgery must be evaluated with a proper perspective. Often, a patient presents with a chronic condition such as moderate periodontitis that has been asymptomatic for many years (Fig. 1). Multiple teeth may be loose, yet there are no signs of an acute infection and the patient reports no signs of pain or distress.

Figure 1. *Adult periodontitis.*

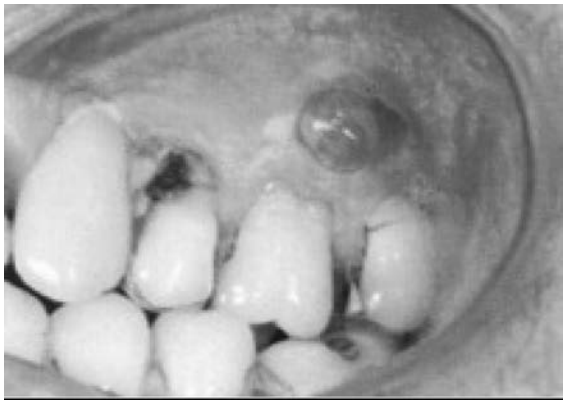

Figure 2. *Dental abscess.*

Treatment of this undesirable condition would be ideal, but it is not often practical given the immediacy of a major cardiac procedure. Comprehensive treatment of such a long-standing periodontal condition usually requires multiple and meticulous dental sessions, whose duration may span several months. Such a diseased state is not cured overnight. Therefore, the benefit of properly treating such a chronic condition at the expense of delaying the cardiac procedure, which most likely poses a more urgent and ominous threat to the patient, is not usually a practical form of action. In fact, the consequences of postponing a case may include the depressing effect of cancellation on patients and their families due to the high level of emotional stress and anxiety that is associated with surgery,[27,28] such as working days lost and disruption to daily life. There is also the potential for revenue losses incurred by the hospital.[29,30]

However, it is the acute, symptomatic infection, one that presents as an abscess, for example (Fig. 2), that should be more aggressively treated prior to the operation. If the tooth is deemed to be nonrestorable, its removal (i.e., extraction) may be necessary. Whether an extraction, periodontal treatment, or endodontic (root canal) therapy is indicated, healing of surrounding structures (i.e., bone, gingiva) is recommended. Dental procedures should be performed at a minimum of one week before the scheduled operation to ensure adequate healing time and promote proper resolution of the disease process. Ideally, a prolonged asymptomatic period of one month is even more beneficial in order to minimize the potential for recurrence of the infection and adverse effects on the cardiac procedure. It is widely recognized that the time-line associated with allowing sufficient intraoral healing from such a dental procedure, with a patient's subsequently planned elective cardiac surgery is often compromised due to scheduling constraints and/or urgency of the cardiac operation. In these situations, an appropriate risk versus benefit analysis is warranted.

Cardiac surgery already consumes more healthcare resources than any other single therapy[31] and is estimated to cost $27 billion annually in the United States.[32] Infection in the setting of a cardiac operation increases morbidity, mortality, and cost.[33,34] Patients undergoing cardiac surgery appear to be at an increased risk for the development of infections, particularly nosocomial, due to the prevalence of multiple surgical wounds, frequent postoperative utilization of invasive devices (i.e., intraaortic balloon counterpulsation, pulmonary artery catheter), and the customary use of prophylactic or empiric antibiotics in the perioperative period.[35] If not treated preoperatively, any source of infection, known or not, dental or not, can compromise the outcome of the surgery. Postoperative infections may result in an increased morbidity rate, delay wound healing, and extend hospital stays beyond the expectations of the patient and the surgeon.[36] In addition to the prolonged duration of recovery, the unfortunate development of a postoperative infection ultimately culminates in higher costs for those involved.[37] Thus, the value of a thorough dental examination, and/or the detection of an oral infection prior to an elective cardiac procedure cannot be underestimated.

We encourage the cardiac community to view oral health in the perspective of systemic health. Since an association exists between poor oral hygiene and various systemic diseases, many patients scheduled for cardiac procedures inherently possess poor oral hygiene and untreated odontogenic infections. A patient who is unaware of the presence of an intraoral infection, and/or is uneducated with respect to its significance on his/her upcoming surgery, is even more susceptible to a poor outcome. Therefore, it is suggested that patients who are to undergo elective cardiac surgery should be screened preoperatively to ensure that any oral infection is diagnosed and definitively treated. Obviously, a detailed inspection of each tooth, all intraoral tissues, and taking dental radiographs by members of the cardiac community is not realistic. However, a consultation with a dentist should be considered prior to proceeding with the elective cardiac procedure. Where time permits, it is also suggested that the surgery not proceed until a detected dental abscess is thoroughly addressed preoperatively. Initially, this preemptive action may postpone the procedure. In the long run, however, a thorough preoperative dental examination and indicated treatment may save invaluable time and money. Most importantly, this small investment during the preoperative phase may yield significant improvements in surgical outcome and overall patient health.

REFERENCES

1. Dajani AS, Taubert KA, Wilson W, et al: Prevention of bacterial endocarditis. Recommendations by the American Heart Association. J Am Med Assoc 1997;277(22):1794-1801.
2. Department of Health and Human Services: Oral Health in America: A report of the Surgeon General—Executive Summary. Rockville, MD: U.S. Department of Health and Human Services, National Institute of Dental and Craniofacial Research, National Institutes of Health, Bethesda, MD, 2000.

3. Dorn BR, Dunn WA Jr, Progulske-Fox: Invasion of human coronary artery cells by periodontal pathogens. Infect Immun 1999;67:5792-5798.
4. Stelzel M, Conrads G, Pankuweit S, et al: Detection of Porphyromonas gingivalis DNA in aortic tissue by PCR. J Periodontol 2002;73:868-870.
5. Beck J, Garcia R, Heiss G, et al: Periodontal disease and cardiovascular disease. J Periodontol 1996;67:1123-1137.
6. Beck JD, Pankow J, Tyroler HA, et al: Dental infections and atherosclerosis. Am Heart J 1999;138:S528-S533.
7. Jansson L, Lavstedt S, Frithiof L, et al: Relationship between oral health and mortality in cardiovascular diseases. J Clin Periodontol 2001;28:762-768.
8. Buhlin K, Gustafsson A, Hakansson J, et al: Oral health and cardiovascular disease in Sweden. J Clin Periodontol 2002;29:254-259.
9. Geerts SO, Legrand V, Charpentier J: Further evidence of the association between periodontal conditions and coronary artery disease. J Periodonol 2004;75:1274-1280.
10. Beck J, Eke P, Heiss G, et al: Periodontal disease and coronary heart disease: A reappraisal of the exposure. Circulation 2005;112:19-24.
11. Seymour R, Preshaw P, Steele J: Oral health and heart disease. Prim Dent Care 2002;9:125-131.
12. Seymour R, Lowry R, Whitworth J, et al: Infective endocarditis, dentistry and antibiotic prophylaxis; time for a rethink? Br Dent J 2000;189:610-616.
13. Gordon SC, Barasch A, Foong WC: Does dental disease hurt your heart? J Can Dent Assoc 2005;71:93-95.
14. Wilson W, Taubert KA, Gewitz M, et al: Prevention of infective endocarditis: Guidelines from the American Heart Association. JADA 2007;138(6):739-760.
15. Amar S, Han Xiaozhe: The impact of periodontal infection on systemic diseases. Med Sci Monit 2003;9(12):RA291-RA299.
16. Johnson NW, Glick M, Mbuguye TN: Oral health and general health. Adv Dent 2006;19(1):118-121.
17. Riley JL, Gilbert GH, Heft MW: Dental attitudes: Proximal basis for oral health disparities in adults. Comm Dent Oral Epidemiol 2006;34(4):289-298.
18. Lowry RJ, Maunder P, Steele JG: Hearts and mouths: Perceptions of oral hygiene by at-risk heart surgery patients. Br Dent J 2005;199:449-451.
19. Balmer R, Bu'Lock FA: The experiences with oral health and dental prevention of children with congenital heart disease. Cardiol 2003;13:439-443.
20. Da Silva DB, Souza IPR, Cunha MCSA: Knowledge, attitudes and status of oral health in children at risk for infective endocarditis. Int J Paediatr Dent 2002;12:124-131.
21. Riley JL 3rd, Gilbert GH: Childhood dental history and adult dental attitudes and beliefs. Int Dent J 2005; 55(3):142-150.
22. Edelstein BL: Disparities in oral health and access to care: Findings of national surveys. Ambul Pediatr 2002;2(2 Suppl):141-147.
23. Seymour R, Preshaw P, Steele J: Oral health and heart disease. Prim Dent Care 2002;9:125-131.
24. Hayes PA, Fasules J: Dental screening of pediatric cardiac surgical patients. ASDC J Dent Child 2001;68:255-258; 228-229.
25. Turcotte J, Magee J, Bromberg J, et al: Update of the adult and pediatric liver transplant program at the University of Michigan. Clin Transp 1996;203-216.
26. Mouradian W, Reeves A, Kim S, et al: An oral health curriculum for medical students at the University of Washington. Acad Med 2005;80(5):434-442.
27. Tait AR, Voepel-Lewis T, Munro HM: Cancellation of pediatric outpatient surgery: Economic and emotional implications for patients and their families. J Clin Anaesth 1997;9:213-219.
28. Ivarsson B, Kimblad PO, Sjöberg T: Patient reactions to cancelled or postponed heart operations. J Nurs Manag 2002;10:75-81.
29. Dexter F, Marcon E, Epstein RH: Validation of statistical methods to compare cancellation rates on the day of surgery. Anesth Analg 2005;101:465-473.
30. Strum DP, Vargas LG, May JH: Surgical subspecialty block utilization and capacity planning: A minimal cost analysis model. Anesthesiology 1999;90:1176-1185.
31. Riddle MM, Dunstan JL, Castanis JL: A rapid recovery program for cardiac surgery patients. Am J Crit Care 1996;5:152-159.
32. Engoren M, Luther G, Fenn-Buderer N: A comparison of fentanyl, sufentanil, and remifentanil for fast-track cardiac anesthesia. Anesth Analg 2001;93:859-864.
33. Keon WJ, Sherrard H: Early release following cardiac surgery. Curr Opin Cardiol 1996;11(6):599-602.
34. Fowler VG, O'Brien SM, Muhlbaier LH: Clinical predictors of major infections after cardiac surgery. Circulation 2005;112:I-358-I-365.
35. Kollef MH, Sharpless L, Vlasnik J: The impact of nosocomial infections on patient outcomes following cardiac surgery. Chest 1997;112:666-675.
36. Ferschl M, Tung A, Sweitzer BJ, et al: Preoperative clinic visits reduce operating room cancellations and delays. Anesthesiology 2005;103(4):855-859.
37. Dexter F, Abouleish AE, Epstein RH, et al: Use of operating room information system data to predict the impact of reducing turnover times on staffing costs. Anesth Analg 2003;97:1119-1126.