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Nd:YAG-Assisted Periodontal Curettage to Prevent Bacteremia Before Cardiovascular Surgery

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Bacterial endocarditis is a relatively rare yet serious heart infection caused by any microorganism that enters the bloodstream,[1] whereas subacute bacterial endocarditis (SBE) is very rare and diagnosed in about one case per 100,000 each year in the general population.[2] Ten percent or less of all SBE cases are related to dental or medical procedures.[3,4] Surgical and dental procedures and instruments involving mucosal or contaminated tissues commonly cause transient bacteremia that rarely persists for more than 15 minutes. Bloodborne bacteria may lodge on damaged or abnormal heart valves, the endocardium, or the endothelium near congenital anatomic defects. The result typically is bacterial endocarditis.

Although bacteremia is common following many invasive procedures, only a limited number of bacterial species commonly cause endocarditis. Bacteria of oral origin, mainly those of the periodontal sulcus, result in the highest incidence for SBE.[5,6] The remaining causes of SBE are a result of poor oral health and hygiene, leading to bleeding gums, and random bacteremias, toothbrushing, toothpicking, and mastication of foods. Defecating, ulcerations in the gastrointestinal tract, and intravenous drug usage can also produce SBE.

Good oral health, not antibiotic prophylaxis for dental procedures, is universally accepted as the best preventative for SBE of oral origin.[7] Prior to the antibiotic era, SBE was 100% fatal. Today's mortality for SBE is less than 10%.[8,9,10] The American Heart Association (AHA) has issued guidelines for the prevention of SBE in dental patients, but has cautioned these guidelines as the standard of care.[11,12]

Subacute bacterial endocarditis may occur in spite of appropriate antibiotic prophylaxis. No adequate, controlled clinical trials of antibiotic regimens for the prevention of bacterial endocarditis in humans have been performed. Recommendations regarding antibiotic use are based on in vitro studies, clinical experience, data from experimental animal models, and assessment of bacteria most likely to produce bacteremia from a given site and those most likely to cause endocarditis.[10]

Because there has never been a placebo-controlled prospective study on antibiotic prophylaxis to prevent endocarditis, the exact incidence of an unmedicated, at-risk patient developing endocarditis after a dental procedure is unknown. Although it is unlikely these patients will contract endocarditis after a dental procedure, it is possible that a medicated patient will develop endocarditis as a result of prophylactic failure from the bacterial insensitivity of many antibiotics.[13]

Transient bacteremias are associated with the extraction of teeth and various forms of periodontal treatment.[14] Positive postextraction blood cultures average about 52%, which is considerably higher than the 10% to 15% average of positive cultures reported for suspected bacteremias not related to surgery.[15]

There is a standard prophylactic regimen and dental procedures for dental and oral procedures for patients at risk of bacterial endocarditis. Poor dental hygiene and periodontal or

periapical infections may produce bacteremia even in the absence of dental procedures. Individuals who are at risk of developing bacterial endocarditis should establish and maintain the best oral health to reduce the potential for bacterial seeding. Dentists should make every attempt to reduce gingival inflammation in patients who are at risk through brushing, flossing, fluoride rinses, chlorhexidine gluconate mouth rinses, and a professional cleaning before proceeding with routine dental procedures. Chlorhexidine painted on isolated and dried gingiva 3 to 5 minutes prior to tooth extraction has been shown to reduce postextraction bacteremias by approximately 10%.[10]

Antibiotic prophylaxis is recommended with all dental procedures likely to cause gingival bleeding, including routine professional cleanings. If a series of dental procedures is required, it may be prudent to observe a 7-day interval prior to cardiovascular surgical procedure to reduce the emergence of resistant strains of organisms.[10]

The recommended standard prophylactic regimen for all dental and oral procedures is amoxicillin. Amoxicillin, ampicillin, and penicillin V are equally effective in vitro against alpha-hemolytic streptococci. However, amoxicillin is now recommended because it is better absorbed from the gastrointestinal tract and provides higher and more sustained serum levels.[10] Individuals who are allergic to penicillin-based antibiotics should be treated with alternative oral regimens. Erythromycin ethylsuccinate and erythromycin stearate are recommended because of their rapid absorption. For individuals that cannot tolerate penicillins or erythromycins, clindamycin hydrochloride is the recommended alternative.[10]

The standard of oral or periodontal surgery involves the use of all the already mentioned protocol. The incidence of bacteremia is still prevalent because of the resistant strains of oral bacteria that may cause bacterial endocarditis.[10]

There is standard protocol for patients who are to undergo aortic or mitral valve replacement and open heart surgery. Patients who have cardiac conditions that predispose them to endocarditis are at risk of developing bacterial endocarditis when undergoing open heart surgery. Similarly, patients who undergo surgery for placement of prosthetic heart valves, using prosthetic intravascular or intracardiac materials are also at risk of developing bacterial endocarditis. Endocarditis associated with open heart surgery is most often caused by *Staphylococcus aureus*, coagulase-negative staphylococci, or diptheroids. Streptococci, gram-negative bacteria, and fungi are less common. No single antibiotic regimen is effective against all these organisms, and prolonged use of broad spectrum antibiotics may cause a superinfection with unusual or resistant microorganisms.[10]

Prophylaxis at the time of cardiac surgery is usually directed primarily against staphylococci and for a short duration. The high prevalence of infection by methicillin-resistant, *S aureus* in particular, institutions is usually treated with vancomycin for perioperative prophylaxis.[10] A comprehensive preoperative dental evaluation is the standard established procedure, so required treatment of dental infections can be completed before cardiac surgery whenever possible. Such measures may decrease the incidence of late postoperative endocarditis, although the use of all these above protocols is not 100% effective.[16]

The current methods used in the treatment of dental and periodontal disease prior to cardiac surgery encompasses the use of antibiotics and conventional surgical techniques. However, although these procedures do reduce the risk of bacterial endocarditis, they also are not 100% effective in preventing bacteremias induced from oral pathogens. A more effective approach must be researched and developed to prevent oral bacteria from entering the bloodstream after dental surgery.

ND:YAG-ASSISTED GINGIVAL CURETTAGE BEFORE DENTAL SURGERY

The Nd:YAG laser has been applied to many soft tissue surgical procedures. Nd:YAG lasers have been used in gastroenterology, urology, and gynecology. Dermatologists have used the Nd:YAG laser to remove gross cavernous hemangiomas. It has been used to control hemorrhage during neurovascular procedures where it is an effective coagulator.[17] Nd:YAG assisted laser treatment significantly reduces postoperative bleeding compared to the scalpel procedure.[18] A recent study has shown the ability of the Nd:YAG laser to kill bacteria as well as ablate cells and cell nuclei. The study shows that the Nd:YAG was totally effective against several strains of bacteria, including *S aureus*, and streptococcal varieties at 5W and 60 seconds of laser exposure.[19]

The use of dental lasers has been explored for 20 years by dental researchers. Research specific to Nd:YAG laser usage has shown the soft tissues encountered in dental surgery can be cut or excised using a laser with the fiber optic contact delivery system. The interaction of laser wavelength and energy density with tissue at the tip of the fiber optic contact delivery system allows simultaneous cutting and coagulation of tissue and reduction of periodontal pathogens in the gingival sulcus.

MATERIALS, METHODS

The total number of patients studied in this clinical protocol was 92, ranging in age from 42 to 91. All these patients were to undergo open heart surgery for either aortic or mitral valve replacement surgery or heart transplantation, so they were all at risk for bacterial endocarditis.

The patients were evaluated via a comprehensive oral medicine and dental evaluation consisting of complete radiographic examination, periodontal examination taking six-

point gingival readings, a comprehensive medical history, a social history, and routine dental examinations. Preoperative blood cultures were obtained prior to dental therapy and cardiac surgery. All patients were placed on AHA prophylactic protocol before dental surgery, including chlorhexidine gluconate rinses if it was feasible. Patients were treated for various dental infections ranging from chronic periodontitis to acute periodontal abscesses.

The protocol used in surgery was initiated by irrigation with chlorhexidine gluconate and 3% hydrogen peroxide. All teeth were debrided of bacterial plaque and calculus by an ultrasonic cavitron (Dentsply 2001). The cavitron was used primarily for periodontal root planing and scaling. The teeth were again irrigated with chlorhexidine and hydrogen peroxide. Gingival curettage was performed with an Nd:YAG laser (Biolase Laser-35) on all teeth whether they were to be removed or retained. The laser was used to cut, coagulate, ablate, and contour intraoral soft tissues at the marginal and interdental gingiva. The laser was set at 5 to 15W, water pressure was set at 2 psi and air pressure was set at 18 psi. Laser energy was delivered through a 600-µm fiber that was cleaved at 10 mm from the end. Irradiation began with the fiber in contact with the gingival sulcus at the gingival height of the tooth and circumferential lasing around each tooth for 60 to 120 seconds. Extreme care was taken not to contact hard tissue surfaces. The fiber was used in a cutting mode removing the gingival epithelium within the gingival sulcus.

All teeth present were treated similarly beginning with gingival irrigation using chlorhexidine and hydrogen peroxide after the laser curettage. Patients scheduled to have dental extractions were also treated with this method in addition to surgical incision of the overlying mucosa with the laser, flap elevation, and elevation of the teeth or root fragments and removal. Nd:YAG coagulation of the gingival mucosa and mucosal flaps was accomplished prior to suture placement. Postoperative blood cultures were drawn within 15 to 30 minutes after dental surgery. The patient was placed on chlorhexidine rinses q.i.d. for 5 days postoperatively.

The control group used in this clinical observation included 20 patients treated under conventional dental therapy.[14] The ages of these patients ranged between 42 and 83 years. The protocol was AHA premedication regimen followed by oral surgery. Three of the control group patients developed bacteremias.

RESULTS

The 92 patients treated with the periodontal precardiac surgery protocol™ (PPSP™) were evaluated for bacteremia presurgically and postsurgically by isolated bacterial blood cultures drawn every 5 minutes for three samples. Although most of these patients suffered from acute periodontitis, bacteria was detected in only one patient (epidermal contamination) in the presurgical samples. The results of all 92 patients were 0% growth at 1, 2, and 3 days postoperatively.

DISCUSSION

The Nd:YAG laser was used as an adjunct surgical instrument in addition to the established standard protocol for treating dental infections. The Nd:YAG laser is very beneficial in the prevention of bacteremias, which could lead to bacterial endocarditis. Since the studies demonstrate antibiotic prophylaxis is not 100% effective against all strains of oral bacteria before dental surgery, another methodology must present itself in the successful treatment of bacteremias from an oral origin. The PPSP™ demonstrates the excellent results derived from Nd:YAG laser usage.

The majority of postoperative dental surgeries are evaluated for 7 days on an antibiotic regimen before proceeding with open heart surgery to reduce the potential for bacterial endocarditis. Postoperative dental surgeries that have positive blood cultures generally are treated with intravenous antibiotics for several weeks and often months before the open heart procedure can be accomplished. These clinical observations showed many patients were in urgent need of open heart surgery. Waiting for 7 days or more can complicate the cardiovascular health of many individuals not to mention a possible increase in mortality.

The use of PPSP™ has been effective in the treatment of dental infections. More importantly, PPSP™ expedites recovery by the significant reduction of bacteremia so these patients may undergo cardiac surgery in a timely fashion. This protocol can improve the success of patients waiting for open heart surgery by substantially reducing the dental postoperative and cardiac operative time. Periodontal precardiac surgery protocol™ may also demonstrate a substantial reduction in in-patient hospitalization expenses vs hospitalization following the conventional approach.✦

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