Association of Radiographically Diagnosed Apical Periodontitis and Cardiovascular Disease: A Hospital Records–based Study

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Abstract

Introduction: Numerous studies have demonstrated an association between oral health status and systemic diseases. However, reports examining apical periodontitis (AP) and cardiovascular disease (CVD) are few. This study investigates whether an association exists between AP and CVD. **Methods:** The present study was a pair-matched, cross-sectional design that used medical and dental chart review. The AP group (n = 182) was defined as subjects with radiographic AP, and the non-AP group (n = 182) was defined as subjects without any radiographic AP. Samples for both groups were pair-matched by age and gender. Diagnosis for CVD, hypercholesterolemia, hypertension, and diabetes were identified by using International Classification of Diseases, Ninth Revision, Clinical Modification and collected from electronic medical records. Documentation of alcohol use, smoking, race, and body mass index within the electronic medical records was also collected. Presence or absence of AP, missing teeth, teeth with root canal treatment, caries experience, and history of periodontal disease were collected from the electronic dental records. Analysis was performed by using Pearson χ^2, the paired t test, and conditional multivariate logistic regression. **Results:** AP was significantly associated with CVD, hypercholesterolemia, race, missing teeth, caries experience, and number of root canal treatments in our bivariate analysis. Our final adjusted conditional logistic regression model showed statistically significant positive associations between AP and CVD (odds ratio, 5.3; 95% confidence interval, 1.5–18.4). **Conclusions:** Subjects with AP were more likely to have CVD than subjects without AP by 5.3-fold. However, further research is needed to elucidate temporality and reinforce association between CVD and AP. *(J Endod 2016;42:916–920)*

Key Words

Apical periodontitis, cardiovascular disease, endodontics, root canal treatment, systemic disease

The link between oral and systemic health has been debated for more than a century. In the early 1900s the focal infection theory gained popularity and evoked fear among its subscribers. The theory suggested that many systemic illnesses were consequences of focal infections originating in the mouth (1, 2). Poor science and lack of evidence-based practice led to harmful consequences to patients. At the peak of its popularity, edentulous therapy became the primary preventive measure (3). The theory was discredited by the mid-1900s; however, interest in the oral and systemic connection persisted. By the beginning of the twenty-first century, publications on the topic had grown exponentially. The first peer-reviewed study investigating oral health and cardiovascular disease (CVD) was published in 1989 (4); by 2010, the rate of publication on the subject matter had increased to more than 160 peer-reviewed articles per year and more than 500 total articles since 1989 (5). Although the periodontal disease and CVD link has received the most attention, a growing number of studies have examined other associations between various oral health factors such as tooth loss, xerostomia, and caries and systemic factors including vascular disease, diabetes, aspiration pneumonia, and preterm birth. Few studies have examined the association between apical periodontitis (AP) and CVD.

AP is an inflammatory process of endodontic origin usually occurring at or near the apex of the tooth root. The biological explanatory model for the AP and CVD relationship resembles the well-established mechanistic evidence that exists for the periodontal disease and CVD relationship (6–9), and both AP and periodontal disease share similar bacterial flora, primarily gram-negative anaerobes, and similar destructive inflammatory reactions (10, 11). Bacteria and inflammation have also been implicated in platelet aggregation, atherosclerosis, and the progression of CVD (7, 9).

The World Health Organization defines CVD as a group of disorders of the heart and blood vessels that include coronary heart disease, cerebrovascular disease, peripheral arterial disease, rheumatic heart disease, congenital heart disease, deep vein thrombosis, and pulmonary embolism (12). The goal of the current study was to investigate an association between CVD and AP. In addition, other known covariates were analyzed for their relationship with AP.

Materials and Methods

The present study used a pair-matched, cross-sectional study design with data ascertained through chart review and examination of dental radiographs. AP was defined radiographically by a periapical radiolucency exceeding twice the width of the normal periodontal ligament space (13–17), and patients with at least 1 tooth exhibiting radiographic evidence of apical pathology were designated as AP cases. All measurements were recorded by 1 observer. Radiographic AP appearance has been

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validated and correlated to histologic findings of periapical inflammation (18). The non-AP group was composed of persons without radiographic evidence of apical pathology; these individuals were pair-matched (1:1) to AP cases on age (±10 years) and gender.

The study was conducted at New York University-Lutheran Medical Center (NYU-LMC), a tertiary care teaching hospital and its associated sites in Brooklyn, NY. Electronic medical and dental records spanning 56 months from July 7, 2008 to February 28, 2013 were reviewed. Patient data were gathered by using Veterans Health Information Systems and Technology Architecture electronic medical records (EMRs) and Dentrix (Henry Schein Practice Solutions, American Fork, UT) Enterprise RT 4.0 electronic dental records (EDRs). The hospital's EMRs and EDRs were integrated and shared patient demographic information.

Patients from EDRs were selected on the basis of random encounter dates within the endodontic and general practice residency practices; dates were randomized by using the Random Calendar Date Generator (19). We included patients who were 30 years of age or older during the review period and had no less than 3 encounters recorded in both the EMRs and EDRs. For study inclusion, EDR charts were required to have a complete patient examination and treatment plan as well as a full mouth set of digital radiographs. Subjects with less than 10 teeth present were excluded. During the period reviewed, all radiographs within the hospital system were taken with Schick by Sirona CDR 2000 sensors. Sirona digital imaging software, CDR Dicom Version 3.5 was bridged to the Dentrix software.

An *a priori* power analysis indicated that a sample of 172 individuals in each group (AP and non-AP) would achieve a power of 80% to detect an odds ratio (OR) of 2.0 or more when the prevalence of exposure among the control group was 20%, assuming an alpha level of 0.05 and using logistic regression.

The independent variables collected from EDRs and EMRs for each patient were age of patient at date of observed radiograph(s), gender, race, alcohol use, smoking history, body mass index (BMI) (obesity measure), history of periodontal disease indicated by treatment or treatment plan, number of teeth with existing root canal treatment (RCT), number of missing teeth (calculated by subtracting number of present teeth from 32), and caries experience indicated by teeth with existing restorations or caries. Among the AP group, the number of teeth with AP was measured.

On the basis of patient-specific EMRs, International Classification of Diseases, Ninth Revision, Clinical Modification (ICD-9-CM) codes were reviewed to identify individuals with CVD-related systemic diseases (12). Table 1 illustrates the range of ICD-9-CM codes used: 414 (coronary artery disease), 427 (arrhythmias), 745-746 (congenital heart defects), 390-398 (rheumatic heart disease), 425 (cardiomyopathy), 413 (angina pectoris), 786.50 (unstable angina), 410 (myocardial infarction), 411 (ischemic heart disease), 415-417 (pulmonary heart disease), 420-429 (other forms of heart disease): 420 and 423 (pericarditis), 422 and 429 (myocarditis), 421 and 424 (endocarditis), 424 (valvular heart disease); 430-438 (cerebrovascular diseases): 435 (transient cerebral ischemia), 434 (ischemic stroke); 440-448 (embolisms and thrombosis that fall under diseases of the arteries, arterioles, capillaries), and 450-459 (diseases of veins). Other diseases found in the literature to be associated with AP and CVD were also recorded: 272 (hypercholesterolemia), 401.9 (hypertension), and 250 (diabetes mellitus II). The observer responsible for recording medical status data was blinded to AP status.

Descriptive analysis was completed by using Pearson χ^2, paired *t* test, and unadjusted conditional logistic regression. AP status was regressed on CVD and selected covariates in a multivariable, conditional logistic model. The most parsimonious model was then computed. IBM SPSS Statistics 20.0 (Chicago, IL) was used for all analyses.

TABLE 1. ICD-9-CM Codes Abstracted from EMRs

Diagnosis	ICD code
*Coronary heart disease**	410-414, 420-429
*Cerebrovascular disease**	430-438
*Peripheral arterial disease**	440-448
*Rheumatic heart disease**	390-398
*Congenital heart disease**	745-746
*Deep vein thrombosis/pulmonary embolism**	451-459
Hypercholesterolemia	272
Hypertension	401.9
Diabetes mellitus II	250

*ICD codes classified for CVD identified in italics.

Results

Data from 364 patients were included in the analysis, 182 AP and an equal number of age-matched, gender-matched non-AP patients.

Characteristics of patients in the AP and non-AP groups are presented in Table 2. Because of the pair-matched design used, the AP and non-AP groups were similar on age (mean, 49 years) and gender (73% female) distribution. Bivariate analysis revealed statistically significant, positive relationships between the presence of AP and each of the following: CVD, hypercholesterolemia, race/ethnicity, missing teeth, number of RCTs, and caries experience.

A subgroup analysis of the AP group ($N = 182$) in Table 3 demonstrated no statistically significant association between CVD and number of teeth with AP. However, among the AP group, a statistically significant association between CVD and number of teeth with existing RCTs was found. When a multivariable model was used, neither findings were statistically significant.

TABLE 2. Characteristics of Persons in AP and Non-AP Groups

Variable	*n* (%) AP	*n* (%) Non-AP	*P* value*
Gender			
Male	49 (26.9)	49 (26.9)	—
Female	133 (73.1)	133 (73.1)	—
Race/ethnicity			
White	34 (18.7)	13 (7.1)	Referent
Hispanic	**113 (62.1)**	**145 (79.7)**	**.001**
Asian	14 (7.7)	3 (1.6)	.707
Black	13 (7.1)	7 (3.8)	.281
Other	**8 (4.4)**	**14 (7.7)**	**.013**
CVD	**58 (31.9)**	**19 (10.4)**	**<.001**
Hypercholesterolemia	**89 (48.9)**	**53 (29.1)**	**<.001**
Hypertension	61 (33.5)	51 (28.0)	.199
Diabetes mellitus II	34 (18.7)	26 (14.3)	.230
Smoking	21 (11.5)	23 (12.6)	.453
Periodontal disease	79 (43.4)	69 (37.9)	.276
	Mean (SD)	Mean (SD)	
Age (y)	49.1 (12.4)	49.0 (12.3)	.896
BMI (kg/m^2)	28.7 (5.8)	28.8 (4.7)	.834
Alcohol use (servings per week)	0.7 (2.4)	0.5 (2.4)	.606
Number of RCTs	**2.7 (2.0)**	**0.6 (1.2)**	**<.001**
Missing teeth	**6.8 (5.0)**	**5.8 (5.0)**	**.020**
Caries experience	**12.1 (4.6)**	**10.4 (5.1)**	**<.001**

AP, apical periodontitis; CVD, cardiovascular disease; RCT, root canal treatment; SD, standard deviation.
Bold font indicates statistical significance ($P < .05$).
*Unadjusted *P* values based on paired *t* tests or unadjusted conditional logistic regression.