

Association between Chronic Dental Infection and Acute Myocardial Infarction

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Abstract

Introduction: In patients with cardiovascular diseases several risk factors such as high blood pressure, diabetes, smoking and drinking habits, genetic disposition, and chronic inflammation must be considered. The aim of this study was to investigate whether there is a correlation between dental origin infections and the presence of an acute myocardial infarction (AMI). **Methods:** A total of 125 patients who had experienced a myocardial infarction and 125 healthy individuals were included in this study. The oral examination was carried out following the consent of the ethics committee and the National Board for Radiation Protection and included the number of teeth, endodontically treated teeth, periodontal screening index (PSI), clinical attachment level, and radiographic apical lesions (radiograph examination). The medical examination included, among others, blood glucose level, C-reactive protein (CRP) serum levels, and leukocyte number. **Results:** The study demonstrated that patients with AMI exhibited an unfavorable dental state of health. After statistical adjustment for age, gender, and smoking, they exhibited a significantly higher number of missing teeth ($P = .001$), less teeth with root canal fillings ($P = .0015$), a higher number of radiologic apical lesions ($P = .001$), and a higher PSI value ($P = .001$) compared with individuals without myocardial infarction. The medical data showed a nonsignificant correlation between CRP and the number of radiologic apical lesions. **Conclusions:** This study presents evidence that patients who have experienced myocardial infarction also exhibit an unfavorable dental state of health in comparison to healthy patients and suggests an association between chronic oral infections and myocardial infarction. (*J Endod* 2009;35:626–630)

Key Words

Acute myocardial infarction, chronic dental infection, CRP values, radiographic apical lesions

Chronic oral infections and coronary heart disease (CHD) are both chronic diseases that share a common etiology in some points. Both of these inflammatory diseases have a complex genesis with similar risk parameters. Besides the well-established risk factors for CHD such as smoking hypertension, high low density lipoprotein (LDL) serum levels, diabetes, sex, obesity, socioeconomic status, and genetic dispositions, chronic inflammatory processes have been considered as potential predictors for arteriosclerosis (1, 2). CHD is known to be the leading cause of death in industrialized countries, killing more than 7 million people per year (3, 4). In Germany 20% of all deaths are induced by CHD or a myocardial infarction, which can be considered as its long-term manifestation (5).

The conventional risk factors for atherosclerosis have been known since the Framingham Heart Study (6). Other studies described high plasma levels of fibrinogen and a statistically significant correlation between periodontitis and CHD. They support the hypothesis that both diseases share a common etiology (7). Danesh (8) was able to establish a direct link between coronary artery disease with gram-negative bacteria such as *Chlamydia pneumoniae* and *Helicobacter pylori*. Periodontal pathogens such *Porphyromonas gingivalis* and *Aggregatibacter actinomycetemcomitans* have also been detected in human atheromas (9, 10). This significant association between poor oral health, chronic oral inflammations, and CHD has been pointed out in recent studies that also provide evidence of the important role played by inflammatory and hemostatic factors. Dental health status is also discussed as increasing the risk of occurrence for myocardial infarction (11–13). Different studies were able to prove that a baseline periodontal disease is significantly associated with an increased risk of CHD. For more than 10 years numerous authors have discussed a possible correlation between chronic odontogenic foci of infection, putting a special focus on periodontal disease and CHD (14, 15). The inflammatory reaction of the oral connective tissue that is induced by microorganisms leads to a symptomatic vasodilatation, resulting in an increased permeability of the endothelium that allows not only the migration of leukocytes into the perivascular region but also the invasion of bacteria. Several epidemiologic studies have demonstrated an association between chronic periodontal disease and CHD (16), stroke (17), premature birth and/or low weight (18), and cerebrovascular disease (19) as well as between apical lesions and risk of coronary heart disease (20). The severity of the chronic inflammation determines the degree of the acute bacteremia. In less than a minute after an oral intervention has been performed, oral microorganisms are able to reach the heart, lungs, as well as the peripheral capillary system (21). Besides periodontal disease, chronic apical inflammations of periodontal or endodontic origin could be considered as a possible source of bacteremia. Eriksen (22) described apical periodontitis as an acute or chronic inflammatory lesion around the apex of a tooth caused by bacterial infection in the root canal system. Although there are differences between chronic inflammatory disease of periodontal and endodontic origin, there are similarities regarding common existing microbiota (23) and systemic cytokine levels (24). The hypothesis of chronic oral inflammation being a risk factor for heart conditions is further supported by several studies that are concerned with inflammatory markers (25). The aim of the present investigation was to examine whether an association between dental chronic inflammatory diseases and the occurrence of acute myocardial infarction (AMI) could be established to recognize possible risk factors for CHD.

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Material and Methods

Study Population

In the present study 125 patients with AMI between 50 and 82 years of age were enrolled (between September 2007 and June 2008). All subjects included in this examination gave informed consent to participate, and the study was approved by the Institutional Review Board and the Ethics Committee of the University of Mainz and the National Board for Radiation Protection. Informed consent was obtained after informing patients verbally and in writing of the investigational nature. The criterion for inclusion was the presence of AMI verified by characteristic electrocardiogram changes and evaluation of serum enzymes (glutamic oxaloacetic transaminase, creatinine phosphokinase [CPK]). All patients had a recent history of AMI followed by a diagnostic catheterization and interventional treatment of the diseased coronary artery as verified by hospitalization at the Department of Cardiology and Angiology of the University of Mainz.

The oral examination was carried out after 1 month of hospitalization but no longer than 5 months after the cardiovascular disease. Only patients who were deemed clinically stable to visit the dental school and undergo a thorough oral examination were included in the study.

The control patients were a group of matched subjects (gender, age, ethnicity, and smoking habits) from the Dental School of the University of Mainz. These patients were in good general health, without clinical evidence of cardiovascular disease, hypercholesterolemia, and any other severe diseases as confirmed by a cardiologist or an internist at least 6–12 months before the dental examination.

Oral Examination

In this investigation only AMI patients and volunteers with more than 5 teeth were included. The selection of a total of 5 teeth per patient including all quadrants as minimum inclusion criteria was a result after the primary examinations in which most of the AMI patients were edentulous or had a low number of teeth.

The control patients were examined during a regular appointment. All subjects were required to complete a questionnaire and underwent radiologic and oral examinations. The oral examination was performed by 2 calibrated examiners and included all teeth present, number of teeth, endodontically treated teeth, and type of restorations (decayed, missing, and filled teeth values). A panoramic radiograph, periapical radiographs, or in special cases digital volume tomography investigations allowed us to diagnose possible chronic apical lesions either of periodontal (LPO) or endodontic origin (LEO). Teeth were classified as having a chronic apical lesion if they exhibited periapical rarefaction contiguous to the periodontal ligament space, which was more than 2 mm wide and showed absence of an intact lamina dura. Periapical radiolucencies of periodontal and endodontic origin were recorded before and after endodontic treatment as well.

A calibration exercise was performed to obtain acceptable intra-examiner reproducibility for probing depth and recession of the gingival margin. A set of standard periodontal parameters (probing pocket depths [PD], bleeding on probing [BOP], clinical attachment level [CAL], and periodontal screening index [PSI]) were recorded. The PSI serves as a valuable tool to obtain fast information about existing periodontal pathology and treatment needs and helps to distinguish between clinically healthy and inflamed sites. Its screening index ranges from degree 0–4 (0, no bleeding on probing, no pathologic pocket, no calculus; 1, bleeding on probing; 2, calculus and no pathologic pocket; 3, probing depth 3.5–5.5 mm; and 4, probing depth > 5.5 mm). All measurements were recorded at 6 aspects on each of the 6 Ramfjord teeth (mesiobuccal, mid-buccal, distobuccal, mesiolingual, mid-lingual, and distolingual) by using a standard periodontal probe (PCP 15; Hu-Friedy, Chicago, IL).

Medical History

Age, gender, height and weight (body mass index [BMI]) were recorded at the time of enrollment. All subjects were also asked for classic cardiovascular risk factors including family history of coronary artery disease, smoking habits, and diabetes mellitus. Smoking was assessed both categorically (current and former, or never) and continuously as package-years of cigarettes consumed.

The patients had a new diagnosed AMI (ST-elevated myocardial infarction [STEMI] or non-STEMI cardiac events [NSTEMI]). Blood pressure, glucose level, glycosylated hemoglobin (HbA1c), hemoglobin, LDL cholesterol, triglyceride, leukocytes, fibrinogen, CPK, and C-reactive protein (CRP) serum levels were monitored during hospitalization. Glucose and HbA1c values served as an indicator of diabetes mellitus, which is a metabolic syndrome caused by hereditary and environmental causes and resulting in abnormally high blood sugar levels. The patients with diabetes mellitus had both insulin-dependent diabetes (IDDM, type I) as well as non-insulin-dependent diabetes mellitus (NIDDM, type II).

Statistical Analysis

The statistical analysis was performed by means of the SPSS 15.0 for Windows software (Chicago, IL). The description of the clinical data was based on means, medians, and quartiles for continuous parameters and on absolute and relative frequencies for categorical factors obtained from the AMI and control patients. The according graphics of the clinical factors were based on nonparametric box plots. The Fisher exact test was used to establish possible significant differences between the patients with AMI and the healthy controls. Multiple logistic regression analysis was applied to establish possible confounding variables such as age, gender, smoking, and diabetes mellitus. In all test procedures a significance level of $P < .05$ was considered statistically significant.

Results

One hundred twenty-five of 568 AMI patients who were deemed clinically stable and contacted by phone (22% response rate) could be recruited for this study. Reasons for not participating in the study were no teeth, systemic diseases, death, not willing to participate, or a prior dental examination. The AMI patients had a mean age of 61.8 years (standard deviation [SD], 10.4 years) and a distribution of 85% male and 15% female patients; the control patients without CHD had a mean age of 63.4 years (SD, 10.7 years; 82% male, 18% female).

To obtain 125 suitable healthy controls, a total of 352 patients were examined and selected according to the previously described criteria (36% response rate). No statistical difference between the AMI and healthy control groups regarding age and gender was found. The patients with myocardial infarction had a higher overweight and obesity (BMI) as well as diabetes mellitus frequency. The differences between the physical and clinical oral findings are listed after adjustment for age, BMI, smoking, and diabetes mellitus (Table 1). The blood glucose levels of the AMI patients had mean values of 129 mg/mL (SD, 57 mg/mL), and the HbA1c values ranged from 7.4%–5.2% (mean, 6.8%; SD, 0.7%).

In comparison to the control patients, the AMI patients had an unfavorable dental status, a statistically higher number of missing teeth (AMI, 9.4; controls, 3.6), and a higher frequency of chronic dental infection. A significant relationship between increasing severity of periodontitis (PSI) and AMI could be observed. A PSI degree of 4 was found in 42.3% of AMI patients and in only 17.1% in the control patients (Fig. 1). Chronic LEO and LPO were evaluated, and because the impact of chronic dental inflammation on general health conditions is similar,

TABLE 1. Basic Group Characteristics (SD or in Percentage) and *P* values for Differences between 125 Patients with AMI and 125 Healthy Control Patients

Variables	Patients after AMI	Control Patients	<i>P</i> value*
Age (y)	61.8 ± 10.4	63.4 ± 10.7	>.1
Gender (M, F)	106, 19	97, 32	>.1
BMI (kg/m ²)	28.6 ± 4.6	24.6 ± 3.0	.001
Smoker (%)	53	26	.001
Diabetes (%)	16	8.5	.085
No. of missing teeth	9.4 ± 7.8	3.6 ± 3.7	.001
Endodontically treated teeth (n)	1.7 ± 2.0	2.2 ± 2.0	.015
Apical lesions	1.25 ± 1.1	0.7 ± 0.8	.001
Crowns (n)	6.2 ± 5.0	7.8 ± 5.3	.017
PSI (degree: 0–4)	3.3 ± 0.7	2.8 ± 0.7	.001

AMI, acute myocardial infarction; BMI, body mass index; PSI, periodontal screening index. **P* values are based on Fisher exact test. Statistical significance was defined as *P* < .05.

the combination of both was also evaluated together. Digital volume tomography, which provides information concerning the dimension of alveolar bone loss surrounding the root, was made only in selected cases. The distribution of LEOs and LPOs was similar in both groups, and no statistically significant difference between these 2 patient groups was found. AMI patients had LEOs in 48% of the cases, whereas the controls had LEOs in 52% of the cases. Yet it was observed that AMI patients had more LEOs on teeth without endodontic treatment (54.7% versus 45.3% with endodontic treatment), whereas the healthy controls had a greater number of LEOs on teeth with endodontic treatment (26.4% without versus 74.6% with endodontic treatment).

High number of LEOs and LPOs was found in 19.5% of the AMI patients, whereas only 2.3% of the healthy patients had a lower frequency of LEOs and LPOs (Fig. 2). The association of the signs of inflammation measured by means of CRP level (mean, 26 mg/L) showed a weak yet nonsignificant LEO and LPO association number (Fig. 3; *P* = .294). No relationship could be found between the number of LEOs and LPOs and LDL values (mean, 148 mg/dL), CPK value (mean, 204 U/L), blood glucose level (mg/dL), HbA1c values (in %), number of leukocytes (mean, 12.3 n/nL), and fibrinogen value (mean, 759 g/L).

Discussion

In many industrialized countries CHD is the leading morbidity cause. Humphrey et al (4) demonstrated in a systematic review and meta-analysis that periodontal disease including gingivitis, bone loss, and missing teeth is an independent but relatively weak risk factor

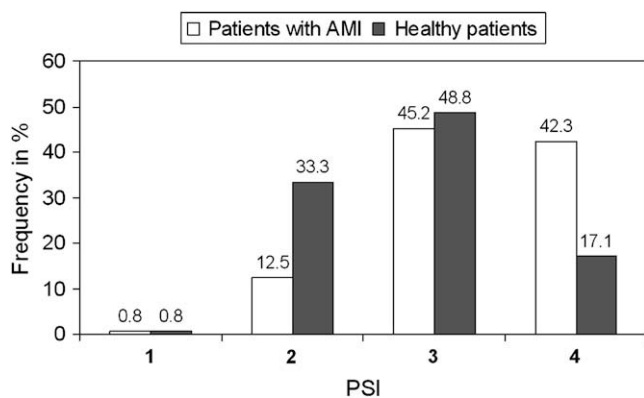


Figure 1. PSI (degree: 0–4) distribution in patients after AMI and healthy controls.

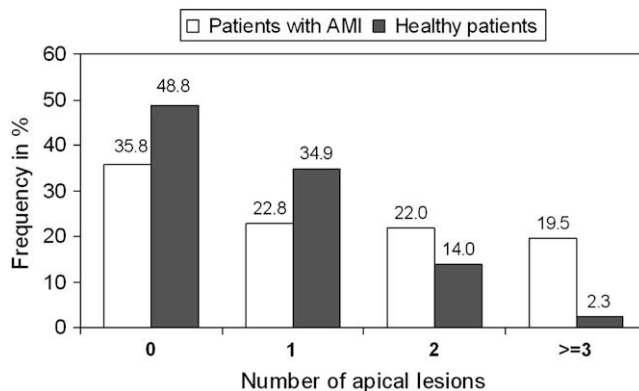


Figure 2. Frequency of apical lesions (LEOs and LPOs) in patients after AMI and healthy control patients.

for CHD. Individuals with periodontal disease have an approximately 24%–35% increase in risk of developing CHD. The assumptions that chronic infections are involved in the pathogenesis of CHD and that chronic infections of dental origin are cumulative in patients with CHD or AMI have been evaluated in different prospective studies (26–28). Mattila (29) demonstrated in a large epidemiologic survey an association between missing teeth and CHD and showed that chronic periodontal diseases are associated with an increased risk of CHD. The author was able to show that elevated levels of CRP, fibrinogen, serum amyloid A, and von Willebrand’s factor are correlated with periodontal disease. Likewise, the number of missing teeth has also been linked with elevated risk levels for CHD. A relationship between oral health and CHD was also demonstrated by De Stefano et al (15). A total of 9760 individuals between 25 and 74 years of age were enrolled in this study and observed for a period of 14 years. Edentulous individuals or patients with periodontal diseases exhibited a higher risk for CHD in 25%, and male patients with periodontal diseases exhibited higher risks for CHD in 70%. In the study of Joshipura et al (26) the question between root canal therapy as a consequence of pulp inflammation and incident of CHD was examined. In the group of male subjects only dentists showed a correlation between root canal therapy and CHD, but this could not be confirmed for nondentist patients. Therefore, the authors

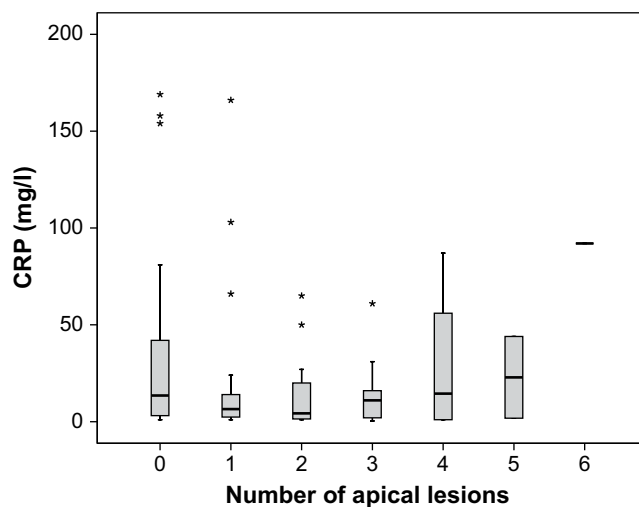


Figure 3. Association between number of apical lesions (LEOs and LPOs) and CRP values (mg/L) in AMI patients. Extreme values are labeled with *.

suggested a possible but modest association between pulpal inflammation and CHD.

In the present study the number of root canal treatments, number of teeth, PSI, and chronic LPOs and LEOs in male and female patients after AMI were examined. The individuals older than 50 years were examined and compared with patients who were age- and gender-matched individuals, with no evidence of CHD, randomly drawn from the same location as the AMI patients. The AMI patients had significantly less number of teeth and a higher total number of LEOs and LPOs. The LEOs that were observed in the AMI patients were mostly in teeth that needed endodontic treatment; consequently, a lower number of root canal treatments and a higher evidence of periodontal disease were observed in this group. These findings are in accordance with other investigations in which the association between CHD, physical health, socioeconomic status, and poor oral health has been demonstrated (13, 14, 16, 17).

A number of different parameters are discussed as risk factors for cardiovascular disease that could explain the relationship between the unfavorable oral health status and the AMI of the patients included in our study. Mattila (30) reported that patients with AMI had a 2-fold dental origin infection than an age- and gender-matched control group. In the present study there was a weak but nonsignificant correlation between the characteristic blood inflammation marker CRP and chronic LEOs and LPOs. Other important factors such as serum glucose, HbA1c, LDL, CPK, or leukocytes showed also no significant association to chronic LEOs and LPOs, root canal treatments, or number of missing teeth. The results of this investigation allow only a moderate association between chronic LEOs and LPOs and AMI.

A possible relationship between evident lesions of endodontic origin and CHD was also evaluated in the study of Caplan et al (20). They found that patients younger than 40 years exhibited a correlation between LEOs and a diagnosis of CHD. However, individuals older than 40 years showed no statistically significant association between chronic periodontal inflammation and the development of heart disease. The results of this study are not in agreement with the ones mentioned earlier and could probably be due to the different ages of the populations investigated.

Spahr et al (31) investigated a possible association between chronic inflammation caused by periodontal disease, periodontal bacteria, and CHD in 263 patients with angiographically confirmed stable CHD. They found a statistically significant association between the periodontal bacteria in periodontal pockets and the presence of CHD. They suggested that periodontal pathogen burden, particularly infection with *A. actinomycetemcomitans*, might be of special importance. A possible influence of socioeconomic risk factors for apical periodontitis was examined by Frisk and Hakeberg (32). In that study 981 women aged 38–84 years participated in a medical and dental survey. They reported that socioeconomic variables and dental examination habits did not appear to have obvious implications for periapical health, whereas root-filled teeth and carious lesions were associated with apical periodontitis. Such factors were not considered in this study, but a relationship between the results obtained in this study and socioeconomic factors is being undertaken. Beck et al (14) compared different risk factors between chronic dental origin inflammation and CHD. Because they found similar risk factors such as age, smoking, gender, consumption of alcohol, socioeconomic status, hypertension, stress factors, and social isolation, analogue causal factors might be possible for both diseases. The hypothesis of chronic dental infection being a risk factor for heart conditions has been underlined by several studies that are concerned with chronic infectious processes (25, 26, 32–35). The results of the present investigation demonstrate that patients who have experienced a myocardial infarction have a higher number of chronic dental

infections. Furthermore, these patients had higher restoration, periodontal, and endodontic treatment needs. When considering inflammatory processes as possible risk factors that could negatively influence the development of CHD, chronic dental infections should also be considered as a weak factor that could influence the patient's health, especially in patients with a history of AMI.

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