Periodontal disease in relation to selected parameters of the cardiovascular system in a group of patients with stable angina pectoris

MONIKA WŁOSOWICZ1, BEATA WOŻAKOWSKA-KAPŁON1,2, RENATA GÓRSKA3

1Faculty of Health Sciences, The Jan Kochanowski University, Kielce, Poland
21st Clinical Department of Cardiology, Swietokrzyskie Cardiology Center, Kielce, Poland
3Department of Periodontology, Institute of Dentistry, Medical University of Warsaw, Poland

Abstract

Introduction: Periodontal diseases (PD), which are the cause of chronic inflammatory processes, can develop increased susceptibility to vascular diseases through atherosclerosis. Due to the raised inflammatory and thrombotic risk, PD can have a significant influence on the course and results of stable angina pectoris (SAP).

Objectives. The aim of the study is to evaluate the influence of chosen PD parameters on selected cardiovascular system parameters, and the correlation between chosen parameters of periodontitis and cardiovascular system parameters.

Material and methods: the case group included 67 patients with SAP, ≤ 60 years of age. The occurrence of well-known cardiovascular disease risk factors was evaluated on the basis of the clinical interview, clinical examination and laboratory tests. The occurrence of known risk factors for cardiovascular diseases (CVD) was established on the basis of the interview, clinical research and laboratory tests. Periodontal examination included API (approximal plaque index), CAL (clinical attachment level), PD (pocket depth), and BI (bleeding index). IMT (intima-media thickness) and the size of atherosclerotic plaque in carotid arteries were assessed by ultrasound examination. Segmental contractility abnormalities were assessed on the basis of echocardiography examination, presence of the single-vessel vascular and multi-vessel vascular disease on the basis of angiographic examination.

Results: In the study group of patients, numerous risk factors and a higher level of API, CAL, PD and BI were observed. A higher prevalence of multi-vessel disease (75%) than single-vessel disease (25%) was noted on the basis of angiographic examination. Patients with contractility abnormalities demonstrated also poor oral cavity health. In addition, a higher concentration of CRP (3.2 mg/dl), fibrinogen (3.3 g/l) and the progression of atherosclerosis, e.g. increased IMT (2.1 mm) and formation of atherosclerotic plaques were noted. Results of multivariate logistic regression demonstrated that API and PD had a significant influence on IMT. In patients with BMI ≥ 30 kg/m², the risk of increased IMT (OR = 4.67) was fourfold higher.

Summary: Periodontitis may influence the occurrence and course of the atherosclerotic process in persons with stable angina.

Key words: periodontal diseases, atherosclerosis, cardiovascular diseases.

Cardiovascular diseases, including coronary disease, are at present the main cause of death in middle-aged and old-aged adults [1]. The most frequent form of the disease is stable angina pectoris (SAP). The frequency of occurrence of the disease increases with age for both sexes [2]. Initiation of atherosclerotic plaques is preceded by the dysfunction of endothelium caused by its local damage [3]. The classical factors causing damage of endothelium are oxidized low-density lipoproteins (oxy-LDL), tobacco smoking, arterial hypertension and diabetes. Apart from the factors mentioned above, there is scientific evidence supporting the assertion that inflammatory processes also facilitate development of atherosclerotic plaques. An indicator of chronic inflammation, typical of atherogenesis, is an increase in concentration of C-reactive protein (CRP), which in stable angina is an independent predictor of heart failure incidents for both men and women [4]. During two-year observation of 2121 patients with SAP it was found...
that in patients with CRP > 3.6 mg/dl, the risk of cardiac arrest or sudden cardiac death was doubled in comparison to patients with a normal CRP level.

The mediators of atherosclerotic plaque development are cytokines such as tumor necrosis factor α (TNF-α), interleukins, interferon-γ (IFN-γ); growth factors including insulin-like growth factor 1 (IGF-1), platelet-derived growth factor (PDGF), transforming growth factor β (TGF-β) and vascular endothelial growth factor (VEGF) [5].

Within the last decade, it has been frequently pointed out that periodontal diseases (PD) constitute an independent risk factor for cardiovascular diseases. It has been demonstrated that common risk factors and similar elements of the inflammatory process lie at the basis of periodontal diseases and atherosclerosis, both in patients with SAP and acute coronary syndromes (ACS).

Periodontal diseases, similarly to atherosclerosis, have chronic, long-term, asymptomatic course, which results in irreversible changes in periodontium. Numerous epidemiological research projects showed that a poor condition of the oral cavity, chronic periodontitis or numerous missing teeth correlate with atherosclerosis in arterial vessels and advanced coronary disease [6,7]. It is noted that in the course of periodontal diseases, a high concentration of mediators and pro-inflammatory cytokines is observed, such as TNF-α, prostaglandin E2 (PGE-2), interleukin 1β (IL-1β), IL-6, proteolytic enzymes, metalloproteinase (MMP), whose presence may not only have a destructive effect on periodontium, but also can induce destabilization of atherosclerotic plaques. Cytokines stimulate liver to produce acute-phase proteins, including C-reactive protein (CRP) and fibrinogen, that is markers of the systemic inflammatory response and thrombotic risk. What is more, the markers can stimulate stratification of ACS risks [8].

The aim of the study is to evaluate the influence of chosen PD parameters on the selected cardiovascular system parameters, and a correlation between chosen parameters of periodontitis and cardiovascular system parameters.

### Material and methods

Sixty-seven hospitalized patients, aged ≤ 60, with SAP were included in the research. The occurrence of cardiovascular diseases risk factors was evaluated on the basis of the clinical interview, clinical examination and laboratory tests. Elements such as male sex, tobacco smoking, obesity (BMI > 30 kg/m²), arterial hypertension and diabetes, CRP concentration > 5 mg/l and fibrinogen concentration > 4 g/l were regarded as risk factors.

Periodontal examination included approximal plaque index (API), clinical attachment loss (CAL), probing depth (PD), bleeding index (BI) and the number of remaining teeth. Intima-media thickness (IMT) and the amount of atherosclerotic plaques in carotid arteries were evaluated on the basis of an ultrasound scan. 16 patients were recommended to undergo coronary angiography, which was performed in order to assess the degree of atherosclerotic changes in coronary vessels. Segmental disorder of myocardial contractility disturbances was evaluated on the basis of echocardiography.

The research project was approved by the Commission of Bioethics of the Swietokrzyskie Region Chamber of Physicians and Dentists (approval number 4/2008).

The present study is a part of a wider project, in which relations between the state of periodontium and advancement of inflammatory processes were examined in patients with stable angina and patients with myocardial infarction.

In statistical analysis for individual quantitative parameters, average values and standard deviation were determined. Spearman’s rank correlation coefficient, simple regression analysis with hazard ratio were used. The level of statistical significance was established at $p < 0.05$.

### Results

Male patients prevailed in the study group, and the dominant risk factor was tobacco smoking. In a considerable number of cases (Table 1), arterial hypertension,
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Table 2. Comparison of oral health status parameters and chosen cardiovascular parameters

| Parameter | BMI | BNP | IMT | sBP | Hyperlipidemia | CRP | Fibrinogen |
|-----------|-----|-----|-----|-----|----------------|-----|------------|
| r         | 0.511 | 0.245 | 0.368 | 0.581 | 0.0024 | 0.127 | 0.261 |
| p         | < 0.000 | NS   | < 0.05 | < 0.0001 | NS   | < 0.05 | < 0.01 |

Table 3. Results of imaging examinations (ultrasound, angiography, echocardiography examination) in patients with SAP

| IMT (mm) mean ± STD | Quantity of atherosclerotic plaque in carotid arteries (n) | One-vascular disease (n) | Multi vascular disease (n) | Segmental contractility abnormalities (n) |
|---------------------|----------------------------------------------------------|-------------------------|--------------------------|---------------------------------------|
| 2.1 ±0.8            | 17 (11%)                                                 | 4/16 (25%)              | 12/16 (75%)              | 16/29 (55%)                           |

Results of multiple logistic regression demonstrated that API and PD had a significant influence on increasing IMT, which is recognized as the indicator of subclinical atherosclerosis. It was also proven that the risk of higher IMT increases with the patients‘ age and with coexisting tobacco smoking. Obese patients (BMI ≥ 30) had a fourfold higher risk of increasing IMT (OR = 4.67) in comparison with normal body mass index patients; in patients with a hypertension risk, IMT increase was two-fold in comparison with patients with a normal range of blood pressure (OR = 2.06). The risk of increasing IMT appeared also in patients with hyperlipidemia (OR = 1.75) (Table 6).

Table 4. Comparison of oral health status parameters in the group of patients with (16 pts) and without (13 pts) segmental contractibility abnormalities

| Parameter | Segmental contractility abnormalities (n = 16) | No segmental contractility abnormalities (n = 13) | p |
|-----------|---------------------------------------------|---------------------------------------------|---|
| API (%)   | 42.0 ±20.4                                  | 34.4 ±14.4                                  | 0.3440 |
| CAL (mm)  | 2.6 ±2.2                                    | 2.0 ±2.0                                    | 0.6352 |
| PD (mm)   | 2.9 ±0.9                                    | 2.4 ±0.9                                    | 0.2463 |
| BI (%)    | 31.5 ±17.8                                  | 23.5 ±16.9                                  | 0.1852 |
| Edentulousness (n (%) | 17 (58.6%) | 12 (41.4%) | 0.6670 |

API – approximal plaque index; CAL – clinical attachment level; PD – pocket depth; BI – bleeding index

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arterial hypertension, diseases such as diabetes, vascular diseases [12]. Also Fujita risk factor for periodontal diseases, can also occur in cardio-
ceence of dental plaque (biofilm), which is known as the basic 
research conducted by other authors showed that the pres-
ary incidents [11]. In the study group, poor dental hygiene 
CRP concentration correlates with the occurrence of coro-
tial pressure, increased fasting glucose concentration), are 
 arterial hypertension, hyperlipidemia and diabetes. The 
siderable degree as male sex, tobacco smoking, obesity,

**Table 5.** Associations between inflammatory markers (CRP, fibrinogen), oral status parameters (API, CAL, PD, BI) and IMT

| IMT | CRP | Fibrinogen | API | CAL | PD | BI |
|-----|-----|------------|-----|-----|----|----|
|     |     |            |     |     |    |    |
|     | r   |            |     |     |    |    |
|     | p   | 0.0480     | 0.0113 | 0.0539 | 0.1887 | 0.2303 | 0.0146 |

**Table 6.** Influence of oral health status parameters and independent variables on intima-media thickness (IMT) – multiple logistic regression analysis results. Odds ratio (OR) over one indicates an increased probability of IMT ≥ 0.9 mm

| Independent variables | OR (95% CI) | p   |
|-----------------------|------------|-----|
| API (%)               | 1.0277     | 0.0048 |
| CAL (mm)              | 0.1905     | 0.0643 |
| PD (mm)               | 1.1448     | 0.0200 |
| BI (%)                | 0.9948     | 0.6080 |
| age                   | 1.0779     | 0.0262 |
| smoking               | 2.3700     | 0.0826 |
| diabetes              | 0.4637     | 0.7539 |
| obesity               | 4.6745     | 0.0135 |
| arterial hypertension | 2.0625     | 0.0023 |
| hyperlipidemia        | 1.7566     | 0.7152 |

**Discussion**

In the discussed group of patients, such classical cardio-
avascular disease risk factors were observed to a con-
siderable degree as male sex, tobacco smoking, obesity, 
arterial hypertension, hyperlipidemia and diabetes. The factors are common for both periodontal diseases and heart diseases [9, 10].

Numerous research projects showed that patients who possess at least 3 out of 5 features of the metabolic syndrome (abdominal obesity, high concentration of triglycerides, lowered concentration of fraction HDL-cholesterol, elevated arterial pressure, increased fasting glucose concentration), are at a greater risk of cardiovascular complications. Elevated CRP concentration correlates with the occurrence of coronary incidents [11]. In the study group, poor dental hygiene (API) and presence of periodontitis were demonstrated. The research conducted by other authors showed that the presence of dental plaque (biofilm), which is known as the basic risk factor for periodontal diseases, can also occur in cardiovascular diseases [12]. Also Fujita et al. [13] showed that in patients with poor dental hygiene, diseases such as diabetes, arterial hypertension, a high concentration of triglycerides and a low concentration of HDL-cholesterol appear more often. Frequently, in patients with SAP, periodontal disease (which can lead to chronic inflammation) could influence occurrence and course of vascular disease. Moreover, other authors showed that in patients with periodontal disease and presence of dental plaque, myocardial infarction appeared more often than stable angina [14]. In the discussed group of patients, mild periodontitis dominated. This fact can be indicated by higher values of CAL, PD, BI, and moderately increased CRP and fibrinogen concentrations. In the present study, the strongest correlation appeared between CAL, which is an indicator of periodontitis advancement, and CRP concentration and also between API, which indicates the level of dental hygiene, and concentration of fibrinogen. A correlation between API and fibrinogen concentrations confirms participation of dental plaque in occurrence of periodontitis [15]. Moreover, a correlation between cardiovascular parameters such as BNP, BMI, IMT, hypertension and API, CAL, PD was demonstrated. The results may suggest multiple correlations between oral cavity health and cardiovascular diseases. The hypothesis seems to be confirmed by the results of recent research, which suggests a correlation between obesity and periodontitis. In Fukuo-
ka promotion program, in a group of 643 persons aged 19-79, the risk of periodontitis was increased over fourfold in a group of persons with the highest WHR index – BMI ≥ 30 kg/m² [16].

Edentulousness appeared in 10% of the examined pa-
tients. It is believed that the number of teeth reflects, to a considerable degree, occurrence and course of periodon-
titis. Holmlund et al. [17] demonstrated that the risk of death caused by MI among patients with less than 10 teeth is 7-fold higher. Numerous studies proved that the more advanced periodontitis the more intense inflammatory and atherosclerotic processes become [18]. A correlation be-
tween CRP concentration and development in atherosclero-
sis in coronary vessels was statistically confirmed [19, 20].

A raised concentration of fibrinogen associated with an increased aggregation of erythrocytes, increased viscosity and microcirculatory resistance in patients with arterial hypertension, stable and unstable angina and myocardial infarction were observed [21]. According to the present study, an increased CRP concentration relates to coexistence of periodontal disease and coronary disease. Numerous studies showed that proper periodontal therapy can significantly improve the condition of periodontium and reduce inflamma-
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Summary

Periodontitis with numerous risk factors can initiate and influence the course of the atherosclerotic process in patients with stable angina pectoris.

The authors declare no conflict of interest.

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