

Correlation between the state of periodontal tissues and selected risk factors for periodontitis and myocardial infarction

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Abstract

Background. The current level of knowledge indicates a relationship between periodontitis and diabetes and/or cardiovascular diseases (CVD). Periodontitis can be not only a risk factor for these diseases, but also a condition modifying other primary risk factors associated with the occurrence of cardiovascular complications (lipid disorders, arterial hypertension, etc.) or diabetes.

Objectives. The aim of the study was an analysis of the correlation between the state of periodontal tissues and selected risk factors for myocardial infarction (MI) in patients after recent myocardial infarction.

Material and methods. The study included 417 patients (92 women, 325 men) hospitalized due to recent MI. The inclusion criteria were MI history and age below 70 years. The state of periodontal tissues (plaque index, bleeding on probing, pocket depth and clinical attachment loss, CPI index) and selected risk factors for periodontitis and CVD were recorded.

Results. An analysis of the results showed no statistically significant correlation between the depth, the number, percentage of periodontal pockets and the average clinical attachment level on one hand and BMI on the other hand. Whereas a statistically significant correlation was observed between tobacco smoking and the degree of severity of periodontal diseases measured by the average pocket depth, the number and percentage of pockets above 4 mm and the average clinical attachment loss, as well as between hypertension and the state of oral hygiene and between diabetes and the number of preserved teeth and the number of pockets above 4 mm.

Conclusions. The degree of severity of periodontal disease can impact hypertension and diabetes, which could potentially influence the occurrence and course of CVD.

Key words: risk factors, periodontitis, cardiovascular diseases

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Introduction

The current level of knowledge indicates a relationship between periodontal disease and systemic diseases, including diabetes, cardiovascular diseases, stroke, premature birth and low birth weight, as well as Parkinson's disease, Alzheimer's disease and pancreatic cancer. Periodontitis can constitute not only a risk factor for these diseases, but also a condition modifying other primary risk factors associated with the occurrence of cardiovascular complications (lipid disorders, arterial hypertension, etc.) or diabetes.^{1,2}

Cardiovascular diseases are the main cause of premature death in most European countries. This situation is closely associated with lifestyle and the influence of risk factors on the occurrence and course of cardiovascular diseases.

Risk factors beyond our control include age, gender, genetic load. Those on which we have an influence include cigarette smoking, arterial hypertension, lipid disorders, diabetes and obesity, bad eating habits, stress.

The results of studies in recent years also suggest that in the future periodontal disease may be considered one of the many risk factors for cardiovascular diseases.³

Research has shown that the same risk factors as well as the same pathophysiological processes are the underlying cause for the destabilization of atherosclerotic plaques and the destruction of periodontal tissues. Particular attention should be paid to the interactions that could potentially occur between periodontal diseases and other risk factors, i.e. the concentration of lipoproteins LDL and HDL, or arterial hypertension, due to their joint participation in the induction of oxidative stress in the circulatory system.^{2,4}

Oxidative stress, generally coexisting with pathogens associated with periodontal disease, which are often detected in atherosclerotic plaque, accelerates apoptosis, and increases inflammation. This process can initiate the erosion of atherosclerotic plaque and raise its vulnerability to rupture, which is a high risk of thrombosis and acute coronary events.^{5,6}

The prevalence of periodontal disease in our civilization and the positive results of periodontal therapy necessitate a deeper examination of the pathogenetic mechanisms linking periodontitis with atherosclerosis and consequently with the resulting cardiovascular diseases.^{7,8}

Therefore, the objective of this study was to assess the state of periodontal tissues and to analyze the correlation between the state of periodontal tissues and selected risk factors for myocardial infarction in patients after acute myocardial infarction.

Material and methods

The study was conducted in the Department of Periodontology and in the Clinic and Department of Cardiology of five medical universities in Poland (Warszawa, Szczecin, Wrocław, Lublin, Białystok) in 2010–2014.

The study included 417 patients hospitalized with recent acute myocardial infarction (MI). The inclusion criteria were MI history and age below 70 years. The patients agreed to participate in the study by signing a declaration approved by the Bioethics Committee in Medical University of Warszawa (opinion: KB-145/2011). Patients diagnosed with cancer, rheumatic disease, autoimmune disease, chronic liver disease, chronic renal disease stages 4 and 5, stroke history and individuals receiving periodontal treatment or systemic antibiotic therapy in the preceding 6 months were excluded from the study.

The study group included 417 patients (92 females, 325 males) aged 25 to 69 years.

Social enquiry and general medical history

All participants of the study were interviewed, which included a collection of the following data:

- General patient data: first name, family name, gender, date of birth, phone number, place of residence;
- Education, defined as primary, secondary and higher education;
- Socio-economic status, determined on the basis of income per family member per month: < 800 PLN, 800–1500 PLN, > 1500 PLN;
- Cigarette smoking, defined as: current (smoking of 10 or more cigarettes a day continuously for at least 5 years), smoking in the past and never;
- Identification of risk factors for cardiovascular disease: arterial hypertension, diabetes, as well as BMI and WHR.

Physical examination

Physical measurements were performed in accordance with applicable guidelines. All the study participants were evaluated for:

- Weight [kg], height [cm], waist circumference [cm] and hip circumference [cm], which allowed for the calculation of each patient's body mass index (BMI was calculated by dividing the body weight [kg] by the square of the body height [m²]) and WHR (WHR was calculated by dividing the waist circumference by the hip circumference). BMI 25–29.9 kg/m² was defined as overweight, and BMI ≥ 30 kg/m² was defined as obesity. Abdominal obesity was diagnosed when waist circumference (WC) was ≥ 80 cm in women and ≥ 94 cm in men.
- Blood pressure, which was measured in a sitting position after several minutes' rest, using a sphygmomanometer. Arterial hypertension was defined as systolic blood pressure ≥ 140 mm Hg or diastolic blood pressure ≥ 90 mm Hg or use of antihypertensive drugs.

Dental and periodontal examination

The dental examination took place within 6 weeks after the myocardial infarction. This examination was carried out in an artificial light, using a dental mirror and a peri-

odontal probe (Hu-Friedy PCPUNC 15). The number of teeth, the number of roots with pulp necrosis present in the mouth and edentulousness rate were determined. The examination did not include third molars. The periodontal examination covered:

- Dichotomous Plaque Index (PI) by O’Leary⁹ on 4 surfaces of the tooth (mesial, distal, lingual and buccal); the presence or absence of plaque was determined;
- Bleeding on Probing (BoP) index by Ainamo and Bay¹⁰ where the examination was conducted at 4 sites around the tooth: mesial buccal (MB), buccal (B), distal buccal (DB) and lingual (L), only the presence or absence of bleeding from gingiva while probing the pocket was determined;
- Pocket depth (PD) at 4 sites around the tooth: MB, B, DB, L, which was defined as the distance from the gingival margin to the bottom of the pocket determined by the probe;
- The number of active (bleeding) pockets above 4 mm in depth;
- Clinical attachment loss (CAL) at 4 sites around the tooth: MB, B, DB, L, which is defined as the distance between the bottom of the pocket determined by the probe and the cemento-enamel junction.

The periodontal status of each patient was determined on the basis of the CPI index definition¹¹, with the following categories:

- CPI-0 – no inflammatory symptoms,
- CPI-1 – presence of bleeding on probing,
- CPI-2 – presence of supra- and/or subgingival calculus or filling overhangs,
- CPI-3 – presence of pathological periodontal pockets from 3.5 to 5.5 mm deep,
- CPI-4 – the presence of pathological periodontal pockets 5.5 mm and deeper.

Statistical analysis

Statistical analysis was performed using PQStat v. 1.4.4 software. The Mann-Whitney and Kruskal-Wallis tests were used to assess the significance of differences between 2 and more groups. The χ^2 test was used to search significant differences between the frequencies of the analyzed data. Correlation between variables were measured by the Spearman rank correlation. P-value lower than 0.05 was decided as significant differences.

Results

Characteristics of the study group

The age of patients ranged from 25 to 69 years, with the median at 57 years, and with significantly more men than women (77.9% vs 22.1%).

Most of the patients came from large cities (223 individuals, 56.9%), the least - 69 patients (17.6%) - lived in the country outside urban areas.

Within the study group the largest subgroup were individuals with a secondary education 53.9%, the least numerous - with incomplete university education or full university education (15.7%).

Analyzing the income per family member it was observed that more than half had an income ranging from 800 to 1500 PLN per family member (Table 1).

The results of the periodontal examination showed an average of 12 preserved teeth in women and 18 in men (total median: 16 preserved teeth). Mean values of plaque index (PI) were high in both females and males (76.9% and 78.2% respectively). Also the BOP index was high, regardless of gender (44.6%). The number of pockets > 4 mm was significantly higher in men (Table 2).

Characteristic of risk factors and correlations between variables

Analyzing risk factors for heart diseases, overweight (BMI 25-30 kg/m²) or obesity (BMI \geq 30 kg/m²) were observed in almost 80% of patients. Most of the patients were current or past smokers of tobacco (almost 80%), arterial hypertension was present in 90.1% of individuals in the study group, diabetes in almost 25%, dyslipidemia in more than half of the patients with myocardial infarction (Table 3).

Table 1. Characteristics of the study group

Patients' overall profiles		Total
Number of patients		417
Percentage of the study group		100.0%
Age	median	57
	Q1-Q3 range	52-61.25 25-69
Number and percentage of females		92 22.1%
Place of residence	city	223 56.9%
	town	100 25.5%
	village	69 17.6%
Education	primary	122 30.4%
	secondary	216 53.9%
	licentiate	10 2.5%
	Master's degree	53 13.2%
Income per month	< 800 PLN per person	101 25.5%
	[800; 1500] PLN per person	212 53.5%
	> 1500 PLN per person	83 21.0%

Table 2. Full-mouth dental and periodontal status

Periodontal parameters		Females (n = 92)	Males (n = 325)	Comparison (Mann-Whitney test)	Total
Number of teeth (median; Q1–Q3)		12 (4–18)	18 (9–23)	p = 0.0007	16 (8–22)
Number of lost teeth (median; Q1–Q3)		16 (10–24)	10 (5–19)	p = 0.0007	12 (6–20)
Number and percentage of edentulous patients		15 (16.3%)	30 (9.2%)	p = 0.0007	45 10.8%
Applies only to patients with preserved own teeth (n = 372)	PI (mean (SD))	76.9% (25.4)	78.2% (21.4)	p = 0.8178	77.9% (22.3)
	BOP (mean (SD))	45.0% (30.8)	44.5% (28.6)	p = 0.8917	44.6% (29.0)
	PD (mean (SD))	2.8 (1.3)	2.8 (1.0)	p = 0.6169	2.8 (1.1)
	number and percentage of patients with pockets ≥ 4 mm*	67 (87.0%)	270 (92.8%)	p = 0.1050	337 (91.6%)
	PD ≥ 4 mm – number (median; Q1–Q3)	6 (2–15)	11 (5–21.75)	p = 0.0041	10 (4–20)
	PD ≥ 4 mm – percentage (mean (SD))	24.8% (25.1)	27.4% (24.6)	p = 0.2508	26.8% (24.7)
	CAL (mean (SD))	3.9 (2.0)	3.9 (2.2)	p = 0.8814	3.9 (2.1)
CPI (median; Q1–Q3)		3 (3–4)	4 (3–4)	p = 0.0511	4 (3–4)

* χ^2 test

Table 3. Values medical risk factors for periodontitis

Risc factors	Subgroups	Values
BMI	mean (SD)	28.7 (4.9)
	underweight and emaciation (BMI < 18.5)	4 (1.0%)
	optimal weight	83 (20.1%)
	overweight (25 ≤ BMI < 30 kg/m ²)	179 (43.3%)
	obesity (BMI ≥ 30 kg/m ²)	147 (35.6%)
WHR (mean (SD))		0.98 (0.10)
Tobacco smoking	presently	204 (49.3%)
	in the past	115 (27.8%)
	never	95 (22.9%)
Arterial hypertension		309 (90.1%)
Diabetes		100 (24.2%)

An analysis of the relationship between periodontal status and sociological parameters demonstrated a statistically significant correlation between the number of lost teeth, and age, gender, education and income, a similar association was observed between CPI median and education and income of patients.

An inverse correlation between BOP and PI on one hand and education and income on the other hand was also observed (Table 4).

The conducted study showed a correlation between age, place of residence, education and income on one hand and average pocket depth, number and percentage of pockets above 4 mm and mean CAL on the other one (Table 5).

No correlation was observed between BMI and activity and severity of periodontitis or the state of oral hygiene and CPI median.

The number of lost teeth, BOP and CPI correlated with smoking. The number of lost teeth and the plaque index showed a statistically significant positive correlation with the cumulative effects of tobacco and its combustion products in the form of the number of pack-years (Table 6).

An analysis of the results showed no relationship between the depth, number and percentage of periodontal pockets and the clinical attachment level on one hand and BMI on the other hand, whereas a certain correlation was observed between tobacco smoking on one hand and the average depth of pockets, the number and percentage pockets > 4 mm and the average clinical attachment loss on the other hand.

Own research also shows that a great majority, 97% of individuals with heart attack history, are past or present cigarette smokers. Actually smokers had significantly deeper periodontal pockets and clinical attachment loss. There was significant correlation between CAL and body weight measured only by WHR (Table 7).

The number of teeth in patients with diabetes was significantly lower than among non-diabetic group (Table 8).

Table 4. Relations between sociodemographic variables and periodontal status (number of teeth, PI, BoP and CPI indices)

Median (Q1; Q3) Mean ± SD		Number of teeth	PI	BoP	CPI median
Age (Spearman's rank correlation test)		r = 0.37 p < 0.0001	r = 0.07 p = 0.1763	r = 0.02 p = 0.6986	r = 0.07 p = 0.1707
Gender	females	16 (10; 24)	76.9% ± 25.4 p.p.	45.0% ± 30.8 p.p.	3 (2; 3)
	males	10 (5; 19)	77.6% ± 22.2 p.p.	44.2% ± 28.6 p.p.	3 (2; 4)
Mann-Whitney U test		p = 0.0007	p = 0.7310	p = 0.9595	p = 0.5283
Place of residence	city	11 (5; 20)	78.3% ± 21.6 p.p.	43.7% ± 29.1 p.p.	3 (2; 4)
	town	15 (8; 23)	77.5% ± 22.4 p.p.	49.4% ± 28.9 p.p.	3 (2; 4)
	village	11 (6; 17)	83.0% ± 18.8 p.p.	49.1% ± 28.5 p.p.	3 (3; 3)
Spearman's rank correlation test		r = 0.04 p = 0.4125	r = 0.06 p = 0.2705	r = 0.10 p = 0.0677	r = 0.05 p = 0.3254
Education	primary	16 (9; 23)	86.8% ± 17.8 p.p.	57.1% ± 29.5 p.p.	3 (3; 4)
	secondary	12 (6; 20)	77.6% ± 21.0 p.p.	42.7% ± 27.4 p.p.	3 (2; 4)
	BA	10 (8; 12)	41.1% ± 28.1 p.p.	26.0% ± 22.8 p.p.	2 (1; 3)
	MA	6 (3; 14)	70.2% ± 21.6 p.p.	36.3% ± 27.7 p.p.	2.5 (2; 3)
Spearman's rank correlation test		r = -0.26 p < 0.0001	r = -0.31 p < 0.0001	r = -0.28 p < 0.0001	r = -0.26 p < 0.0001
Income per month	< 800 PLN per person	15 (9; 23)	87.4% ± 17.5 p.p.	56.2% ± 29.1 p.p.	3 (3; 4)
	[800; 1500] PLN per person	12 (8; 21)	77.9% ± 21.1 p.p.	44.6% ± 28.2 p.p.	3 (2; 4)
	> 1500 PLN per person	6 (3; 12)	71.2% ± 22.9 p.p.	37.4% ± 27.4 p.p.	3 (2; 3)
Spearman's rank correlation test		r = -0.30 p < 0.0001	r = -0.27 p < 0.0001	r = -0.24 p < 0.0001	r = -0.22 p < 0.0001

Discussion

Age and gender are an important, non-modifiable risk factor for both periodontal disease and cardiovascular disease. Numerous epidemiological studies confirm a higher incidence of periodontitis in the elderly.^{12,13} Studies conducted by Persson et al.¹⁴ showed that both of these diseases may occur simultaneously, particularly in individuals over 60 years of age. The occurrence of periodontal disease was observed in about 50% of those aged over 60 years, and 55% were overweight or with an episode of stroke or acute coronary syndrome.¹⁴

Our study also showed a higher incidence of myocardial infarction, as well as periodontal disease in men. Male predilection for the occurrence of periodontal disease and cardiovascular disease was also observed by other authors.^{13,15,16}

An analysis of modifiable factors, which depend on us, included, among other things, education and the degree

of wealth. Our study showed a lower number of individuals with higher education and higher income among patients after myocardial infarction. Zhang et al.¹⁷ demonstrated that education lasting at least 6 years significantly affects the decreased incidence of advanced periodontal disease and impacts the course of treatment and survival of patients after ACS.

Individuals with higher education usually have a permanent job, which is associated with a regular income and frequent access to dental care. They also have higher health awareness.

Our results are also confirmed by other authors, indicating that the level of wealth is an important modifiable risk factor for periodontal disease.¹³ These results can also indicate that individuals with a low income lose their own teeth earlier, due to the limited possibility of receiving treatment. These results also showed a high proportion of toothlessness, which occurred earlier in individuals with a lower income after myocardial infarction.^{12,18}

Table 5. Relations between sociodemographic variables and periodontal status (PD, CAL)

Median (Q1; Q3) Mean \pm SD		Mean PD	PD \geq 4 mm – number	PD \geq 4 mm – percentage	Mean CAL
Age (Spearman's rank correlation test)		r = 0.10 p = 0.0677	r = -0.03 p = 0.5966	r = 0.11 p = 0.0283	r = 0.18 p = 0.0007
Gender	females	2.8 \pm 1.3	6 (2; 15)	24.8% \pm 25.1 p.p.	3.9 \pm 2.0
	males	2.8 \pm 1.0	11 (5; 22)	27.3% \pm 24.6 p.p.	3.9 \pm 2.2
Mann-Whitney U test		p = 0.6146	p = 0.0039	p = 0.2599	p = 0.8270
Place of residence	city	2.7 \pm 0.9	9 (3; 21)	25.2% \pm 23.5 p.p.	3.8 \pm 2.1
	town	3.1 \pm 1.1	9 (5; 16)	31.3% \pm 28.8 p.p.	4.6 \pm 2.1
	village	3.1 \pm 1.4	11 (6; 22)	28.4% \pm 24.1 p.p.	4.0 \pm 2.0
Spearman's rank correlation test		r = 0.13 p = 0.0184	r = 0.07 p = 0.2099	r = 0.09 p = 0.0937	r = 0.09 p = 0.0859
Education	primary	3.1 \pm 1.0	11 (6; 24)	33.6% \pm 26.3 p.p.	4.6 \pm 2.2
	secondary	2.9 \pm 1.1	10 (4; 20)	26.5% \pm 23.9 p.p.	3.9 \pm 2.0
	BA	2.2 \pm 0.6	3.5 (1; 9.5)	8.8% \pm 9.7 p.p.	1.6 \pm 1.4
	MA	2.5 \pm 0.9	6 (2; 16)	19.2% \pm 23.9 p.p.	3.3 \pm 1.8
Spearman's rank correlation test		r = -0.23 p < 0.0001	r = -0.16 p = 0.0031	r = -0.24 p < 0.0001	r = -0.26 p < 0.0001
Income per month	< 800 PLN per person	3.1 \pm 1.1	10.5 (5; 23)	33.0% \pm 26.4 p.p.	4.5 \pm 2.2
	[800; 1500] PLN per person	2.9 \pm 1.2	10 (5; 19)	28.4% \pm 25.6 p.p.	4.2 \pm 2.1
	> 1500 PLN per person	2.4 \pm 0.7	8 (2; 18.5)	18.0% \pm 19.0 p.p.	2.9 \pm 1.7
Spearman's rank correlation test		r = -0.22 p < 0.0001	r = -0.07 p = 0.1661	r = -0.21 p = 0.0001	r = -0.24 p < 0.0001

Studies by Bertoldi et al.¹⁵ indicated that a higher income correlated with a lower number of lost teeth, but also with a better condition of periodontal tissues. People with a lower socio-economic status had fewer teeth, most likely due to the fact that tooth extractions are less expensive and less time consuming, and persons with higher status had more teeth, perhaps because they more often opted for conservative treatment.

Analyzing the group of patients after myocardial infarction, it clear that the number of preserved teeth and the condition of periodontal tissues is much worse compared to epidemiological studies on randomly selected Poles of the same age group.¹³ Indeed, the average number of preserved teeth in the group after myocardial infarction was 12 in women and 18 in men (mean 16).

Studies by Górski et al.¹⁹ showed an average of 24 teeth in the control group of the same age. In the group of patients after myocardial infarction also the percentage of

edentulous individuals was high at 16.3% in women and 9.2% in men (mean 10.8%), in the control group examined by the above-mentioned author the number of edentulous patients was 2.5%.

A research by Desvarieux et al.²⁰ on the relation between the number of teeth and progression of atherosclerosis and risk of myocardial infarction showed plaque in carotid arteries in 46% of individuals who had lost from 0 to 9 teeth and in 60% of individuals who had lost more than 10 teeth. Also studies by Schillinger et al.²¹ indicated that toothless patients had more advanced atherosclerotic lesions in carotid arteries.

Holmlund et al.²² reported that individuals with more than 10 teeth demonstrated a 7-fold increase in the risk of mortality from heart attacks compared to persons with more than 25 teeth, as well as more advanced atherosclerotic lesions in carotid arteries in individuals with fewer teeth.

Table 6. Relations between general health parameters and periodontal status (number of teeth, PI, BoP and CPI indices)

Median (Q1; Q3) Mean ± SD		Number of teeth	PI	BOP	CPI median
BMI	underweight and emaciation (BMI < 18.5)	11 (3; 18)	72.0% ± 33.1 p.p.	37.7% ± 33.0 p.p.	3 (2; 4)
	optimal weight	14 (8; 21)	78.4% ± 24.0 p.p.	46.9% ± 32.3 p.p.	3 (2; 3)
	overweight (25 ≤ BMI < 30 kg/m ²)	10 (5; 19)	75.6% ± 23.7 p.p.	41.8% ± 28.7 p.p.	3 (2; 4)
	obesity (BMI ≥ 30 kg/m ²)	11 (7; 20)	79.1% ± 21.0 p.p.	46.5% ± 27.6 p.p.	3 (3; 4)
Spearman's rank correlation test		r = -0.03 p = 0.6007	r = 0.02 p = 0.7601	r = 0.06 p = 0.2171	r = 0.07 p = 0.1961
WHR (Spearman's rank correlation test)		r = 0.05 p = 0.3231	r = -0.01 p = 0.8888	r = 0.02 p = 0.7217	r = 0.10 p = 0.0827
Tobacco smoking	presently	14 (7; 21)	80.4% ± 20.5 p.p.	48.0% ± 28.7 p.p.	3 (3; 4)
	in the past	11 (5; 20)	74.1% ± 23.4 p.p.	41.1% ± 29.1 p.p.	3 (2; 3)
	never	10 (5; 17)	75.1% ± 26.0 p.p.	40.6% ± 28.6 p.p.	3 (2; 4)
Kruskal-Wallis ANOVA		p = 0.0138	p = 0.0583	p = 0.0350	p < 0.0001
Number of pack-years (Spearman's rank correlation test)		r = 0.29 p < 0.0001	r = 0.18 p = 0.0196	r = 0.02 p = 0.7817	r = 0.13 p = 0.0972

The state of periodontal tissues evaluated by the number and percentage of patients with pockets above 4 mm and the average CAL was higher compared to the control group in the study by Górski et al.¹⁹, respectively 14.3 vs 8.5 and 4.2 vs 2.5.

Our study showed no correlation between BMI and the average pocket depth, the number and percentage of pockets above 4 mm, or the average clinical attachment loss. However, a statistically significant correlation was observed between WHR and the number of pockets above 4 mm and the average CAL. The BMI data is not a confirmed association between obesity and periodontitis by other authors.^{23,24} Al-Zahrani et al.²⁵ showed that there is an association between high BMI and WHR on the one hand and an increase of typical periodontal disease indicators: CAL, PD and BOP. Similar observations were made by Dalla Vecchia et al.⁶, who evaluated the association between overweight, obesity and periodontitis. The meta-analysis of Chaffee and Weston²⁶ demonstrated a stronger obesity- periodontitis association in younger persons, women and non-smokers than in the general population.

In our study we observed a correlation between smoking and average pocket depth, the number and percentage pockets above 4 mm and an average loss of clinical attachment loss. The study also shows that most people who experienced a heart attack were past or present cigarette smokers. Hyman et al.²⁷ demonstrated that smokers

with concomitant advanced periodontitis were at 8-fold higher risk of myocardial infarction. Tobacco smoking is undoubtedly the most important risk factor for both cardiovascular²⁸ and periodontitis. Studies have shown that in the case of death of a smoker before 50 years of age due to CVD, there is a 80% probability that this death was caused by the addiction.²⁹ Results obtained by other authors^{16,30} confirm our data.

Another modifiable risk factor for both diseases is diabetes. Our own study shows that 25% of patients after myocardial infarction also suffered from coexisting diabetes. Wożakowska-Kapłon et al.³¹ observed diabetes in 34% of MI patients younger than 60 years old. The risk of periodontitis progression in patients with poorly controlled diabetes is 11 times higher than in healthy control.³² Studies by Kannel et al.³³ and McGee et al.³⁴ showed that diabetes increases the risk of fatal cardiovascular complications by 1.7 times in men and 2.1 times in women. The INTERHEART study showed that diabetes increases the risk of myocardial infarction by 3.08 times³⁵ and of mortality in patients with acute coronary syndrome.³⁶ On the other hand, studies by Gerstein et al.³⁷ indicated that the risk of MI rises with values of HbA1C > 5.4%, and any growth in hemoglobin concentration by one percentage point independently increases the risk of MI by additional 19%.

In our study group, more than 90% of patients with myocardial infarction had arterial hypertension, which is

a very important risk factor for cardiovascular disease, and recent studies increasingly indicate a relationship between the state of marginal periodontal tissues and blood pressure values.³⁸ This correlation appears to result from the outflow of bacteria associated with periodontitis,

which may be responsible for the increase in both systolic and diastolic blood pressure through an immune reaction by activating T lymphocytes. The immune reaction may cause increased sensitivity of the body to the action of angiotensin II.³⁹

Table 7. Relations between general health parameters and periodontal status (PD, CAL)

Median (Q1; Q3) Mean ± SD		Mean PD	PD ≥ 4 mm – number	PD ≥ 4 mm – percentage	Mean CAL
BMI	underweight and emaciation (BMI < 18.5)	3.1 ± 1.5	10 (5; 18)	34.2% ± 37.9 p.p.	4.0 ± 3.3
	optimal weight	2.9 ± 1.0	9 (4; 18)	27.9% ± 23.8 p.p.	3.9 ± 2.2
	overweight (25 ≤ BMI < 30 kg/m ²)	2.8 ± 1.0	10 (3; 22)	26.4% ± 25.3 p.p.	3.8 ± 2.2
	obesity (BMI ≥ 30 kg/m ²)	2.9 ± 1.1	10 (5; 20)	26.6% ± 24.4 p.p.	4.0 ± 2.0
Spearman's rank correlation test		r = 0.02 p = 0.6621	r = 0.06 p = 0.2542	r = 0.02 p = 0.7447	r = 0.06 p = 0.2764
WHR (Spearman's rank correlation test)		r = 0.07 p = 0.2040	r = 0.11 p = 0.0544	r = 0.09 p = 0.1015	r = 0.13 p = 0.0235
Tobacco smoking	presently	3.1 ± 1.2	12 (6; 22)	32.8% ± 27.0 p.p.	4.5 ± 2.0
	in the past	2.6 ± 0.9	7 (2; 17)	22.0% ± 22.5 p.p.	3.2 ± 2.2
	never	2.6 ± 0.7	9 (3; 18)	20.1% ± 19.1 p.p.	3.3 ± 1.9
Kruskal-Wallis ANOVA		p < 0.0001	p = 0.0039	p = 0.0001	p < 0.0001
Number of pack-years (Spearman's rank correlation test)		r = 0.07 p = 0.3625	r = 0.12 p = 0.1382	r = 0.13 p = 0.0934	r = 0.13 p = 0.0964
Arterial hypertension	yes	3.0 ± 1.1	10 (5; 20)	29.3% ± 25.4 p.p.	4.2 ± 2.0
	no	2.8 ± 0.9	8 (3; 21)	23.4% ± 21.9 p.p.	4.1 ± 1.8
Mann-Whitney U test		p = 0.3546	p = 0.488	p = 0.1985	p = 0.5376
Diabetes	yes	2.8 ± 0.9	7 (2; 14)	25.2% ± 23.7 p.p.	4.3 ± 2.0
	no	2.9 ± 1.1	11 (4; 22)	27.4% ± 25.1 p.p.	3.8 ± 2.2
Mann-Whitney U test		p = 0.8718	p = 0.0121	p = 0.4631	p = 0.0904

Table 8. Differences between periodontal status (number of teeth, PI, BoP and CPI indices) in patients with arterial hypertension and diabetes

Median (Q1; Q3) Mean ± SD		Number of teeth	PI	BoP	CPI median
Arterial hypertension	yes	12 (7; 20)	78.5% ± 22.4 p.p.	46.1% ± 28.8 p.p.	3 (2; 4)
	no	12 (6; 17)	86.0% ± 17.9 p.p.	50.5% ± 30.5 p.p.	3 (2; 4)
Mann-Whitney U test		p = 0.1527	p = 0.0618	p = 0.3864	p = 0.6304
Diabetes	yes	16 (7; 22)	79.7% ± 20.5 p.p.	46.3% ± 31.6 p.p.	3 (2; 4)
	no	11 (6; 20)	76.5% ± 23.6 p.p.	43.3% ± 27.9 p.p.	3 (2; 4)
Mann-Whitney U test		p = 0.0132	p = 0.3665	p = 0.5923	p = 0.844

Conclusions

Summing up, it must be said that in the light of modern research the role of risk factors for the occurrence and course of periodontal diseases and cardiovascular diseases is unquestionable, but whether the list of known risk factors for CVD will be supplemented by periodontitis is a matter of time and research.

Our own studies have confirmed that periodontitis and the degree of its severity have an impact on hypertension and diabetes, WHR, which potentially could influence the occurrence of cardiovascular diseases, which could lead to myocardial infarction.

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