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Cross-Sectional Study

Periodontitis as a Marker of Systemic Inflammation and Comorbid Pathology: Data from a Multidisciplinary Screening

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ABSTRACT

This single-center cross-sectional study aimed to assess the prevalence and structure of cardiometabolic disorders in patients with chronic periodontitis in real-world clinical practice. A cohort of 212 patients (mean age 51.3±8.7 years) from a dental clinic with a verified diagnosis of moderate or severe periodontitis was included. All participants, in addition to dental examination with determination of CPI, PPD, and CAL indices, underwent comprehensive therapeutic and laboratory examination, including blood pressure measurement, determination of glycated hemoglobin (HbA1c) and high-sensitivity C-reactive protein (hs-CRP) levels. The results revealed extremely high comorbidity. Arterial hypertension was diagnosed in 60.4% of patients, and disorders of carbohydrate metabolism (prediabetes and type 2 diabetes mellitus) in 44.3%. Notably, prediabetes was first identified during this screening in 22.2% of individuals. A clear dose-dependent relationship was established: patients with severe periodontitis (CAL ≥5 mm) suffered from hypertension and dysglycemia significantly more often and had higher levels of systemic inflammatory markers (hs-CRP) compared to the moderate severity group. A strong positive correlation was found between the level of clinical attachment loss (CAL) and hs-CRP concentration ($r=0.48$; $p<0.001$). The obtained data convincingly indicate that severe chronic periodontitis is a significant marker of systemic ill-health and should be considered by general practitioners as an indication for targeted screening for diabetes mellitus, arterial hypertension, and subclinical inflammation. There is a need to develop clinical algorithms for effective interdisciplinary collaboration between dentists and physicians.

Keywords: Chronic periodontitis, Systemic inflammation, Comorbidity, Arterial hypertension, Carbohydrate metabolism disorder, C-reactive protein

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Introduction

The problem of the relationship between dental and general somatic health has been a focus of intense attention in global scientific medicine in recent decades. Traditionally considered a purely local pathology of the tissues surrounding the tooth, periodontal disease is now recognized as one of the key elements in the complex mosaic of systemic inflammation and chronic non-communicable diseases [1, 2]. The modern approach shifts periodontitis from a narrow dental domain into the sphere of interest of physicians, cardiologists, endocrinologists, and rheumatologists, forming a new paradigm of integrative medicine [3, 4]. This work is dedicated to an empirical study of this link in real clinical practice, aiming to quantify the prevalence of cardiometabolic disorders in patients with diagnosed chronic periodontitis.

The relevance of the topic is determined by the unprecedented prevalence of both periodontal diseases and the systemic pathologies with which they are associated. According to the World Health Organization, severe forms of periodontitis, leading to tooth loss, rank sixth among all human diseases in terms of prevalence, affecting up to 20% of the adult global population, equivalent to more than one billion cases [5-7]. In the Russian Federation, the situation remains tense: various forms of inflammatory periodontal diseases are detected in 86-90% of adults, with chronic generalized periodontitis diagnosed in 45-50% of the population, and its severe, destructive forms in 15-20% [8]. These figures transform periodontitis from a private medical problem into a socially significant phenomenon, exerting a colossal impact on the quality of life, work capacity, and psycho-emotional state of millions of people [9, 10].

Simultaneously, the world is experiencing an epidemic of non-communicable diseases, among which cardiovascular pathologies and diabetes mellitus occupy a leading place [11, 12]. In Russia, according to official statistics from the Ministry of Health, over 40% of the adult population suffers from arterial hypertension, and the prevalence of type 2 diabetes mellitus is approaching 6%, with a constant upward trend [13, 14]. Each of these pathologies alone poses a serious threat to the nation's health, forming the main contribution to the structure of mortality and disability. However, it is becoming increasingly evident that these diseases rarely exist in isolation, forming complex comorbid clusters in the pathogenesis of which chronic systemic inflammation plays the role of a universal linking element. It is here that the focus of research shifts towards periodontitis as a potentially powerful and, importantly, modifiable source of such inflammation.

We currently know enough about the pathogenetic pathways that underlie the systemic impact of periodontitis. An broad ulcerated surface is represented by chronically inflammatory periodontal tissue, particularly when deep pockets are present. In severe cases, this area can reach 20–40 square centimeters [15-17]. This area becomes not only a reservoir for highly virulent autochthonous microflora, including such known pathogens as Porphyromonas gingivalis, Tannerella forsythia, and Treponema denticola, but also an active endocrine organ producing pro-inflammatory cytokines [18-20]. Bacterial lipopolysaccharides (endotoxins), live microorganisms (bacteremia), and inflammatory mediators such as interleukin-1β (IL-1β), interleukin-6 (IL-6), and tumor necrosis factor-alpha (TNF-α) continuously enter the bloodstream [21, 22]. Their circulation triggers a cascade of reactions in distant organs and systems: the liver's production of acute-phase proteins (C-reactive protein, fibrinogen) increases, endothelial dysfunction develops, insulin resistance rises, and immune cells in the vascular wall are activated, accelerating the formation of atherosclerotic plaques [23, 24].

Clinical and epidemiological evidence of this link is impressive. A meta-analysis of large cohort studies involving hundreds of thousands of patients demonstrated that the presence of periodontitis is associated with a 20-25% increased risk of developing coronary heart disease and a 50% increased risk of cerebrovascular events (strokes) [25-27]. In type 2 diabetes mellitus, this relationship takes on the character of a vicious circle: periodontitis is recognized as the sixth most significant complication of diabetes, while successful periodontal treatment contributes to a reduction in glycated hemoglobin (HbA1c) levels by an average of 0.4%, comparable to the effect of adding a second glucose-lowering drug [28]. In obstetric practice, the role of periodontitis as a risk factor for miscarriage, preeclampsia, and low birth weight infants has been proven [29-31]. Finally, emerging data point to a potential link between periodontal pathogens and neuroinflammation in Alzheimer's disease [32, 33].

Despite the extensive evidence base formed in international studies, this interconnection often remains underappreciated in Russian clinical practice. Physicians and specialists rarely pay targeted attention to the patient's oral health status, while dentists, in turn, may not have complete information about the patient's somatic status. This dissonance leads to fragmented medical care and missed opportunities for early

diagnosis and prevention. There is an urgent need for specific data obtained in the context of domestic healthcare that would clearly demonstrate the scale of the problem and convincingly argue for the necessity of close interdisciplinary collaboration.

Thus, the present work was initiated to solve a specific clinical task: to quantitatively assess the burden of systemic pathology in patients who initially sought dental care for chronic periodontitis. We hypothesized that this cohort would reveal a disproportionately high prevalence of arterial hypertension, disorders of carbohydrate metabolism, and markers of systemic inflammation, with their frequency and severity correlating with the degree of periodontal tissue destruction. The obtained results are intended not only for academic purposes but also to serve as a practical tool for doctors of various specialties, justifying the importance of a holistic approach to patient diagnosis and management, in which oral health is considered an integral component of the body's overall well-being.

Materials and Methods

Design and organization of the study

This single-center cross-sectional clinical and laboratory study was conducted jointly by the Department of Dentistry and the Department of Medicine of the North Ossetian State University (Vladikavkaz, Republic of North Ossetia-Alania, Russia) from March 2023 to November 2025. The study was performed in accordance with the ethical principles of the Helsinki Declaration (2013) [34]. All participants were preliminarily informed about the aims of the work and provided voluntary written consent for the use of anonymized data.

Clinical sample

The primary sample consisted of 240 consecutive patients from the dental clinic aged 35 to 70 years with a verified diagnosis of "chronic generalized periodontitis" of moderate or severe degree, having at least 12 natural teeth. Patients with acute infectious or severe decompensated somatic diseases at the time of examination, pregnant and lactating women, patients who had received antibiotic therapy or professional oral hygiene within the preceding 3 months, as well as individuals with systemic connective tissue diseases directly affecting the periodontium (rheumatoid arthritis, osteoporosis on bisphosphonate therapy) were excluded from further analysis [35]. As a result of the selection, a final cohort satisfying all criteria was formed for complete interdisciplinary analysis [36-42].

The general scheme of the study is presented in **Figure 1**

After forming the initial cohort and checking the eligibility criteria, the patients' dental records were transferred for interdisciplinary analysis to the Department of Medicine, where the next stage—comprehensive therapeutic examination—was conducted.

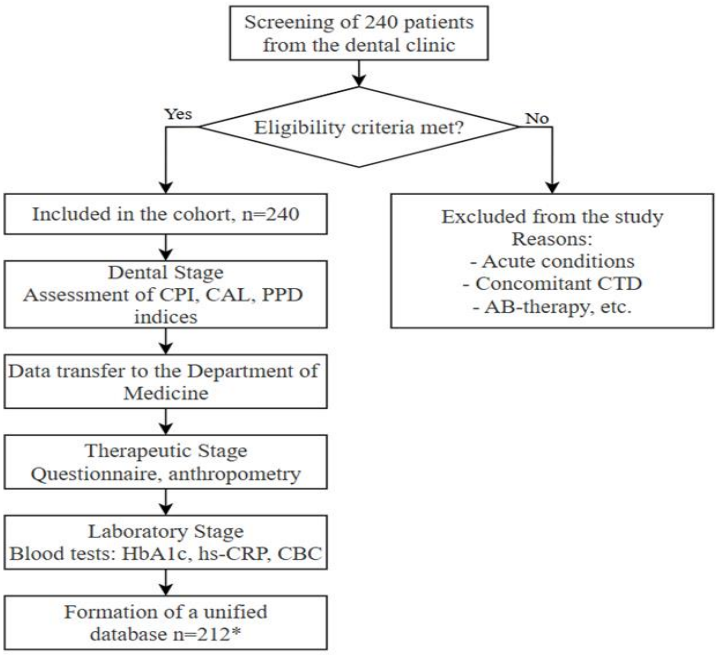

Figure 1. Flowchart of the study design and stages. Note: CTD – connective tissue disease, AB – antibacterial, CPI – Community Periodontal Index, CAL – clinical attachment level, PPD – probing pocket

depth, HbA1c – glycated hemoglobin, hs-CRP – high-sensitivity C-reactive protein, CBC – complete blood count.

Dental diagnostics

At the first stage, a periodontologist performed a complete assessment of the periodontal status. The severity of periodontitis was determined based on measuring the clinical attachment level (CAL) using a graduated periodontal probe according to the WHO classification (2017): moderate degree (CAL 3-4 mm) and severe degree (CAL ≥5 mm) [43]. Additionally, probing pocket depth (PPD), bleeding on probing (BOP), and the oral hygiene index (OHI-S) were recorded. Orthopantomograms were analyzed for objective assessment of bone tissue [44, 45].

Therapeutic and laboratory examination

Within the framework of the interdisciplinary approach, each patient underwent an in-depth examination by a physician. This included the collection of detailed somatic and medication history, questionnaire administration focusing on risk factors (smoking in pack-years), and anthropometry with body mass index calculation. All participants underwent a standard set of tests in a centralized laboratory: a complete blood count with emphasis on leukocyte level and ESR, a biochemical analysis with mandatory determination of glucose and glycated hemoglobin (HbA1c) levels on a D-10 analyzer (Bio-Rad), as well as measurement of high-sensitivity C-reactive protein (hs-CRP) level by an immunoturbidimetric method. Arterial pressure was measured three times on both arms, with the calculation of the average value [46-50].

Database formation and statistical analysis

Data from dental and therapeutic examinations were coded, anonymized, and consolidated into a single electronic database. For statistical processing, the use of applied software packages IBM SPSS Statistics 26.0 and R 4.3.1 is planned. Descriptive statistics for quantitative variables with normal distribution will be presented as M±SD (mean ± standard deviation); in case of deviation from normal distribution, as Me [Q1; Q3] (median [first; third quartile]). Qualitative variables will be described, indicating absolute values and percentages (n, %). For comparison of groups by quantitative variables, the application of Student's t-test or the non-parametric Mann-Whitney U-test is planned, depending on the distribution type. Comparison of frequencies of qualitative variables between groups will be performed using the χ^2 test. To assess relationships between dental and therapeutic parameters, calculation of correlation coefficients (Pearson or Spearman) is planned. Differences will be considered statistically significant at a level of $p < 0.05$.

Results and Discussion

A final cohort was created for thorough interdisciplinary analysis in compliance with the study concept. After applying the exclusion criteria, 212 individuals out of the initial 240 patients were included in the final analysis. The main demographic and dental characteristics of the cohort are presented in **Table 1**.

Table 1. Demographic and dental characteristics of the examined patients (n=212)

Characteristic	Value
Age, years (M±SD)	51.3 ± 8.7
Males / Females, n (%)	98 (46.2%) / 114 (53.8%)
Smoking status (pack-years), Me [Q1; Q3]	15 [5; 30]
Proportion of current/former smokers, n (%)	127 (59.9%)
Oral hygiene index OHI-S, points (M±SD)	2.8 ± 0.9
Prevalence of bleeding (BOP), % (M±SD)	62.5 ± 18.4
Mean pocket depth (PPD), mm (M±SD)	5.1 ± 1.3
Mean attachment loss (CAL), mm (M±SD)	4.8 ± 1.5
Severity of periodontitis:	
- Moderate degree (CAL 3-4 mm), n (%)	89 (42.0%)
- Severe degree (CAL ≥5 mm), n (%)	123 (58.0%)

Analysis of data on concomitant somatic pathology revealed a significant prevalence of systemic disorders **(Table 2)**. More than half of the patients were diagnosed with arterial hypertension (AH), and in almost every fourth patient, blood pressure control was

unsatisfactory (BP ≥ 140/90 mmHg) at the time of examination.

Table 2. Prevalence of concomitant diseases and pathological conditions in the study cohort (n=212)

Disease / Condition	All patients, n (%)	Patients with moderate periodontitis, n=89 (%)	Patients with severe periodontitis, n=123 (%)
Arterial hypertension (established diagnosis)	128 (60.4%)	46 (51.7%)	82 (66.7%)
BP ≥140/90 mmHg at the time of visit	51 (24.1%)	16 (18.0%)	35 (28.5%)
Disorder of carbohydrate metabolism (total)	94 (44.3%)	30 (33.7%)	64 (52.0%)
- Type 2 diabetes mellitus (established)	47 (22.2%)	13 (14.6%)	34 (27.6%)
- Prediabetes (HbA1c 5.7–6.4%)*	47 (22.2%)	17 (19.1%)	30 (24.4%)
Obesity (BMI ≥30 kg/m²)	78 (36.8%)	28 (31.5%)	50 (40.7%)
Elevated hs-CRP level (>3 mg/l)	136 (64.2%)	49 (55.1%)	87 (70.7%)

*Note: HbA1c – glycated hemoglobin. Data in the table demonstrate a clear trend towards greater prevalence of systemic pathologies in the group with severe periodontitis.

Particular attention was paid to disorders of carbohydrate metabolism. In 47 (22.2%) patients, laboratory signs of prediabetes (HbA1c 5.7–6.4%) were first identified within the framework of the present study in the absence of a previously established diagnosis. The summary picture of carbohydrate metabolism disorders depending on periodontitis severity is clearly presented in **Figure 2**.

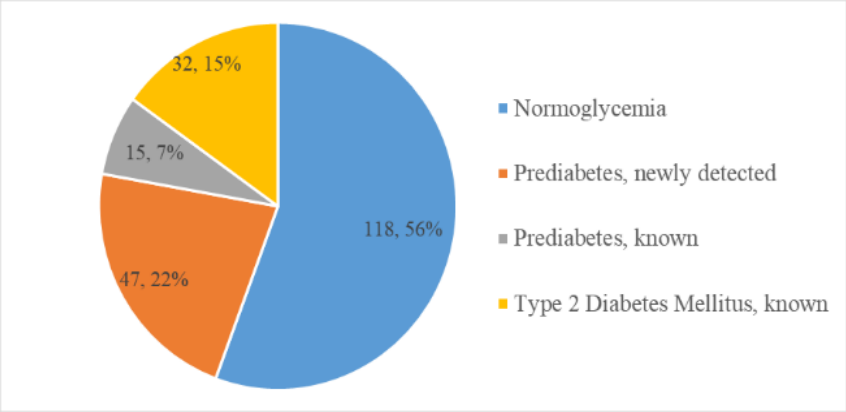

Figure 2. Distribution of carbohydrate metabolism status among patients with periodontitis.

Statistical analysis confirmed the presence of significant correlational links between dental and systemic inflammatory markers. A weak but statistically significant positive correlation was found between mean probing pocket depth (PPD) and glycated hemoglobin level ($r=0.32$; $p<0.001$), as well as between PPD and high-sensitivity C-reactive protein level ($r=0.41$; $p<0.001$). The relationship between clinical attachment loss (CAL) and hs-CRP level was even more pronounced ($r=0.48$; $p<0.001$), as reflected in the scatter plot **(Figure 3)** [51-59].

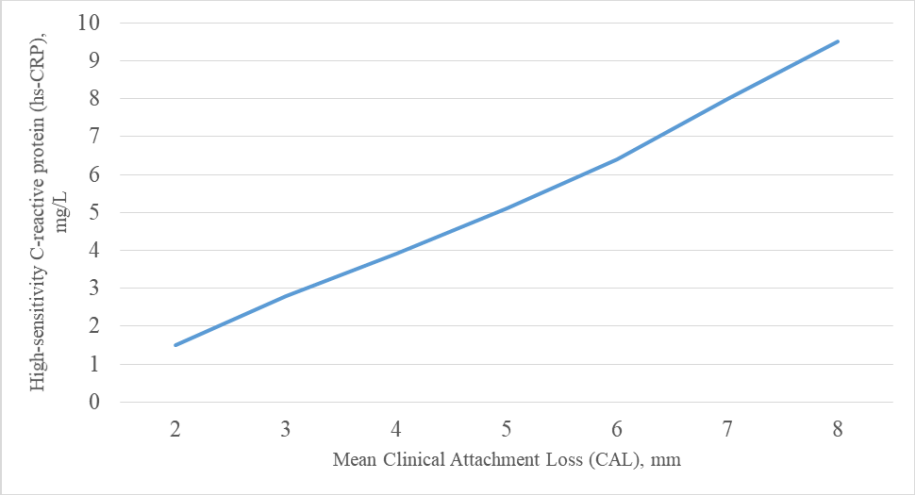

Figure 3. Scatter plot showing the correlation between clinical attachment loss (CAL) and serum hs-CRP level.

A comparative analysis of key laboratory parameters between groups of patients with moderate and severe periodontitis was also conducted **(Table 3)**. In the severe periodontitis group, not only markers of inflammation (hs-CRP, ESR) but also indicators related to metabolic disorders were significantly higher.

Table 3. Comparative analysis of laboratory parameters depending on periodontitis severity

Parameter	Moderate periodontitis (n=89), Me [Q1; Q3]	Severe periodontitis (n=123), Me [Q1; Q3]	p-value
Glycated hemoglobin (HbA1c), %	5.6 [5.3; 6.0]	6.1 [5.6; 7.0]	<0.001
High-sensitivity CRP (hs-CRP), mg/l	2.4 [1.2; 4.1]	4.8 [2.9; 7.5]	<0.001
Erythrocyte sedimentation rate (ESR), mm/h	12 [8; 18]	18 [12; 25]	<0.001
Leukocytes, ×10⁹/l	6.8 [5.9; 7.9]	7.5 [6.4; 8.6]	0.023
Fasting plasma glucose, mmol/l	5.3 [4.9; 5.9]	5.8 [5.2; 7.1]	0.002

Note: Data are presented as median and interquartile range (Me [Q1; Q3]); the Mann-Whitney U test was used for comparison.

Thus, the conducted study revealed a high frequency of comorbid conditions in patients with chronic periodontitis. A clear trend was established: an increase in periodontitis severity is statistically significantly associated with a higher prevalence and degree of severity of systemic disorders, in particular, dysglycemia and chronic systemic inflammation.

Our cross-sectional study clearly demonstrates that chronic periodontitis of moderate and severe degrees is far from an isolated problem of the oral cavity. The obtained data paint a portrait of a patient who, when presenting to a dentist with complaints of gum bleeding and tooth mobility, is highly likely to already have or be at risk of developing serious systemic diseases. The revealed prevalence of arterial hypertension at the level of 60.4% and disorders of carbohydrate metabolism in 44.3% of the examined individuals is several times higher than the average Russian indicators for a comparable age group, which cannot be explained by mere coincidence [60-62]. These figures become logical when considering periodontitis as a chronic, long-standing focus of infection and inflammation.

One important outcome of our research is the discovery of a clear gradient dependence: individuals with severe periodontitis (CAL ≥5 mm) are substantially more likely than those with mild disease to experience cardiometabolic problems. This fact serves as a weighty argument in favor of a cause-and-effect relationship, rather than a simple coincidence [63, 64]. Most indicative in this context is the identified strong positive correlation between the level of clinical attachment loss (CAL) — the main criterion of periodontitis severity — and the concentration of high-sensitivity C-reactive protein (hs-CRP) in the blood serum [65]. This protein, being a universal marker of systemic inflammation, plays a known pathogenetic role in vascular endothelial damage and the development of atherosclerosis [66]. An elevated hs-CRP level in 64.2% of our patients, especially in the severe periodontitis group (70.7%), indicates that the inflammatory process from the periodontal pocket

actively "fuels" the general inflammatory background of the body. These observations are fully consistent with data from large epidemiological studies in which periodontitis was independently associated with elevated levels of systemic inflammatory markers [67-69].

The problem of disorders of carbohydrate metabolism deserves separate attention. The fact that in every fifth patient (22.2%), prediabetes was first identified within the framework of our dental study is an alarming signal for the healthcare system. Our obtained data, demonstrating a statistically significant difference in glycated hemoglobin levels between the moderate and severe periodontitis groups, find confirmation in the contemporary literature [70-72]. A well-studied bidirectional pathogenetic mechanism exists: on the one hand, hyperglycemia creates favorable conditions for the progression of periodontitis by altering the microvascular network and impairing neutrophil function; on the other hand, chronic inflammation in periodontitis contributes to insulin resistance and worsens glycemic control, as reflected in the positions of international consensus documents on diabetes [73]. Thus, periodontitis can be considered not only as a complication of diabetes mellitus but also as a potentially modifiable risk factor for its development and progression.

The high frequency of arterial hypertension in our cohort also fits into the generally accepted pathophysiological model. Chronic bacteremia and periodic entry into the bloodstream of pathogens such as Porphyromonas gingivalis can provoke endothelial dysfunction and enhance oxidative stress, which is one of the triggering mechanisms of hypertensive disease [74, 75]. Notably, in almost a quarter of patients with an established diagnosis of AH, elevated blood pressure readings were recorded at the time of examination, which may indirectly indicate insufficient disease control. This emphasizes the importance of interdisciplinary interaction: stabilization of the periodontal condition can be one of the components of comprehensive non-drug therapy for hypertension.

Limitations of our study include its cross-sectional design, which, while establishing clear associations, does not allow final judgment on cause-and-effect relationships. Furthermore, the sample was formed on the basis of a single dental clinic, which may affect the ability to extrapolate results to the entire population. However, even considering these limitations, the obtained data have high practical significance. They convincingly show that the oral cavity should be considered by physicians and cardiologists not as an isolated system but as an important "window" into the patient's systemic health.

In light of the above, the results of our study allow us to formulate an important clinical conclusion. Severe chronic periodontitis is a significant marker of systemic ill-health and should serve as a signal for the general practitioner for a targeted search for hidden cardiometabolic disorders, primarily prediabetes, type 2 diabetes mellitus, and arterial hypertension. Comprehensive management of such patients, including not only periodontal treatment but also correction of the identified general diseases, can become a more effective strategy for improving both dental and general health prognosis [76-81].

Conclusion

The conducted interdisciplinary study provides convincing clinical evidence of a close relationship between severe chronic periodontitis and systemic metabolic and inflammatory disorders. The obtained data indicate that a patient with an active form of periodontitis is not merely a dental patient but an individual with a high comorbid background. The high prevalence of arterial hypertension (60.4%) and disorders of carbohydrate metabolism (44.3%) in the studied cohort established in the work, as well as the identified dose-dependent effect, a statistically significant increase in the frequency of these pathologies and the level of inflammatory markers (hs-CRP) with increasing severity of periodontitis, translate this relationship from the realm of hypotheses into the area of clinically significant associations. Of particular concern is the fact of primary detection of prediabetes in every fifth patient (22.2%) within a purely dental screening.

The main practical conclusion of this work lies in the need for a radical revision of approaches to the patient with periodontitis. The condition of periodontal tissues should be integrated into the overall clinical picture and considered as a significant diagnostic and prognostic marker. For a physician or general practitioner, signs of severe periodontitis should serve as an unambiguous indication for expanded diagnostic search, including mandatory monitoring of glycated hemoglobin, assessment of systemic inflammation levels, and careful blood pressure monitoring. Conversely, for a dentist, the presence of diagnoses such as diabetes mellitus or cardiovascular diseases in a patient dictates the need for particularly thorough periodontal examination and aggressive prevention.

Thus, further optimization of medical care should be aimed at forming effective algorithms for interdisciplinary interaction between dentists and physicians. Timely diagnosis and comprehensive treatment of chronic periodontitis, extending beyond

local sanitation, are capable of not only preserving teeth but also exerting a substantial positive influence on the control of concomitant systemic diseases, reducing overall cardiometabolic risk, and improving patients' quality of life.

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Conflict of Interest: None

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Ethics Statement: The study was performed in accordance with the ethical principles of the Helsinki Declaration (2013). All participants were preliminarily informed about the aims of the work and provided voluntary written consent for the use of anonymized data.

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