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THE EFFECT OF COMORBIDITIES ON PERIODONTAL, HYGIENE INDICES AND ORAL FLUID MINERAL COMPOSITION

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ABSTRACT: Relevance. In patients with comorbidities, the barrier resistance of periodontal tissues decreases due to oral homeostasis damage, which increases the severity of inflammatory periodontal diseases and needs the interaction of dentists and internists to develop common approaches to such patients' treatment and management. Aim. The study aimed to study the periodontal and oral hygiene indices and the oral fluid mineral composition in dental patients with comorbidity.

Materials and methods. The study examined 63 dental patients with comorbidities: coronary artery disease, chronic gastritis, chronic nephritis, and chronic sinusitis. The Green-Vermillion oral hygiene index (OHI-S) detected the oral hygiene status, and the CPITN index of the WHO and the PMA index revealed the periodontal status. Electrothermal atomic absorption spectroscopy using QUANTUM.Z1 graphite furnace atomic absorption spectrometer determined the amount of calcium, magnesium, zinc and copper in the oral fluid.
Results. Patients with coronary artery disease and chronic nephritis demonstrated a statistically significant decrease in oral hygiene associated with severe periodontal inflammation. Analysis of the oral fluid mineral composition showed that patients with coronary artery disease had decreased calcium, magnesium and zinc levels. The chronic nephritis patients had a copper and zinc decrease in the oral fluid. In patients with chronic gastritis, there was a lack of magnesium and copper in the oral fluid. The patients with chronic sinusitis showed a decrease in copper.
Conclusions. Dental professionals should consider patient systemic diseases and oral fluid mineral composition at a dental appointment, during treatment and during preventive measures prescription.
Key words: inflammatory periodontal diseases, macronutrients, micronutrients, oral cavity, systemic diseases.

RELEVANCE

According to WHO recommendations, oral health should be considered an integral part of overall health and well-being. Preventive dentistry relies on adequate and comprehensive oral hygiene and should be considered in the context of preventing somatic diseases as well.

Patients with coexisting somatic pathology, due to impaired oral homeostasis, experience decreased barrier resistance of periodontal and hard tissues, leading to an increased severity of dental diseases [1, 2]. Oral diseases may be linked to cardiovascular, gastrointestinal, urinary, ENT, and other diseases [1-3]. The mechanisms of this connection include

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bacteremia and its systemic inflammatory consequences – increased C-reactive protein levels and oxidative stress [3], necessitating the use of prophylactic toothpastes with anti-inflammatory effects [4].

Pathological processes in the digestive system lead to alterations in salivary secretion rate, viscosity, and the free radical balance of oral fluid [5]. Recent research confirms the link between inflammatory periodontal diseases and heart diseases [3, 6-8]. Several observations suggest that maintaining oral hygiene practices (toothbrushing) reduces the frequency of cardiovascular diseases [9]. Patients with chronic kidney failure exhibit an increase not only in dental hard tissue lesions but also in the prevalence of oral mucosal pathology and inflammatory periodontal diseases, necessitating sanitation measures, including professional oral hygiene and remineralization therapy, which should be performed twice a year, along with personal hygiene practices using prophylactic toothpastes with remineralizing and anti-inflammatory effects [10, 11].

Oral fluid normally possesses certain properties and a constant composition. It is hypothesized that alterations in the composition of oral fluid during a number of somatic diseases may serve as an indirect indicator of disrupted metabolic processes in the body. Thus, the development of interdisciplinary collaboration between dentists and internists, aimed at establishing unified approaches to the treatment and management of patients with somatic and dental diseases, becomes an urgent issue in contemporary medicine [12].

As a diagnostic fluid, saliva has advantages over serum and can be used for both oral and systemic disease diagnosis. Recently, researchers have focused on analyzing the mineral composition of oral fluid in various periodontal diseases, considering that deficiency or excess of macro- and microelements can be associated with both inflammation and oxidative damage, leading to destruction of periodontal tissues [13, 14].

According to a systematic analysis by G. Baima and colleagues, elevated sodium and potassium levels are most commonly associated with periodontitis. Conflicting results have been found for all elements, although calcium, copper, and manganese concentrations have generally increased in periodontitis [15].

Copper and zinc are essential for the functioning of antioxidant enzymes, their decline leads to the accumulation of pro-oxidants and oxidative stress, which is one of the indicators of inflammation and destruction of periodontal tissues. Copper's protective function also lies in preventing tissue destruction by bacterial enzymes and toxins [16]. Reduced zinc in oral fluid is one of the factors in the pathogenesis of inflammatory periodontal diseases, as zinc is involved in preventing collagen degradation [17]. Magnesium ions affect the migration and adhesion of fibroblasts and contribute to the growth of soft tissues in the oral cavity [18]. Magnesium at alkaline pH inhibits both Gram-negative and Gram-positive bacteria [19]. Thus, the decrease in calcium, magnesium, zinc, and copper levels in inflammatory periodontal diseases is logical and related to their function in the oral cavity.

Dietary preferences, ethnic characteristics, circadian and seasonal fluctuations are of paramount importance when interpreting the results of analyzing metabolites and ions in oral fluid [15]. It should also be considered that changes in the levels of macro- and microelements in biological fluids can indicate systemic diseases [15].

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Objective: To study periodontal and oral hygiene indices, as well as the mineral composition of oral fluid in dental patients with coexisting somatic pathology.

MATERIALS AND METHODS.

The clinical part of the study was conducted in the therapeudental department of Samarkand state medical university from April 2021 to April 2022 and from December 2022 to December 2023. The study was carried out in accordance with the provisions of the Helsinki Declaration on the observance of ethical principles; all subjects voluntarily signed informed consent to participate in the experiment.

The study included 63 dental patients aged 36 to 60 years (average age 44.80 ± 1.24 years). The age periodization adopted in 1965 at the International Symposium on Age Periodization in Moscow was taken into account (https://studfile.net/preview/3052965/page:13/). All patients corresponded to the second period of middle age - 36-60 years for men and 36-55 years for women.

Inclusion criteria: presence of informed consent to participate in the study, inflammatory periodontal diseases, chronic somatic diseases, absence of medical contraindications.

Exclusion criteria: drug or toxic dependence, allergic reactions, refusal to participate in the study.

Dental patients with inflammatory periodontal diseases (IPD) were divided into groups according to existing somatic diseases.

Group 1: Coronary heart disease (CHD) - 11 patients (7 women, 4 men) aged 36 to 60 years (average age 45.50 ± 2.18 years);

Group 2: Chronic gastritis (CG) - 14 patients (8 women, 6 men) aged 36 to 59 years (average age 46.00 ± 2.07 years);

Group 3: Chronic sinusitis (CS) - 13 patients (7 women, 6 men) aged 36 to 57 years (average age 42.3 ± 1.9 years);

Group 4: Chronic nephritis (CN) - 11 patients (6 women, 5 men) aged 39 to 60 years (average age 46.2 ± 2.0 years).

The control group consisted of dental patients with IPD without somatic diseases - 14 people (8 women, 6 men) aged 36 to 55 years (average age 42.6 ± 1.9 years).

The formed patient groups were comparable in age ($p > 0.05$) and the ratio of men to women.

The oral hygiene status of all patients was determined using the simplified Green-Vermillion hygiene index (OHI-S). The surface area of the tooth covered with plaque and calculus was assessed without the use of special dyes. The buccal surface of 16 and 26, the labial surface of 11 and 31, the lingual surface of 36 and 46 were examined, moving the tip

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of the probe from the cutting edge towards the gum. The results were assessed as follows: 0-0.6 - low, good hygiene; 0.7-1.6 - medium, satisfactory hygiene; 1.7-2.5 - high, unsatisfactory hygiene; more than 2.6 - very high, poor hygiene.

The extent and severity of gingivitis were determined using the papillary-marginal-alveolar index (PMA) in absolute numbers. Inflammation in different zones of the gum was taken into account: interdental papillae (P), in the marginal (M) and attached gum (A). No inflammation - 0 points; inflammation of the papilla - 1 point; inflammation of the papilla and gum margin - 2 points; inflammation of the marginal and alveolar gums - 3 points. PMA = sum of indicators: (number of teeth × 3).

To determine the WHO periodontal index CPITN, a periodontal probe with a 0.5 mm diameter ball at the end and a black stripe 3.5 mm from the tip of the probe was used. The periodontium was examined in the area of six tooth groups (17/16, 11, 26/27, 37/36, 31, 46/47) on the lower and upper jaws. If there are no index teeth in the named sextant, then all remaining teeth are examined in this sextant. The results of the study were recorded according to the following codes: 0 - healthy gums, no signs of pathology; 1 - bleeding of the gums is observed after probing; 2 - subgingival calculus is determined by the probe; the black stripe of the probe does not sink into the gingival pocket; 3 - a pocket of 4-5 mm is determined; the black stripe of the probe partially sinks into the gingival pocket; 4 - a pocket of more than 6 mm is determined; the black stripe of the probe is completely submerged in the gingival pocket.

The content of calcium, magnesium, zinc, and copper in oral fluid in patients with concomitant somatic diseases was determined by electrothermal atomic absorption spectrometry using a spectrometer with a graphite furnace "KVANT.Z1". Samples of oral fluid, collected in a test tube in the morning on an empty stomach, were brought by patients to the dental appointment.

The results and graphical representation of the obtained data were processed using generally accepted statistical methods using the standard block of statistical programs Microsoft Excel (2007) and SPSS Statistics 23. The research materials, in accordance with the results of checking the comparable populations for normality of distribution (Shapiro-Wilk test), were subjected to statistical processing using parametric analysis methods. All results were expressed as mean (M) and standard error (m). Intragroup analysis was carried out using the paired Student's t-test. The difference between the compared values was considered statistically significant at a significance level of $p < 0.05$.

Table 1. Dental indices in groups of patients with systemic diseases

Patient group	Dental indices		
	OHI-S	PMA	CPITN
Control (n=14)	0.58 ± 0.17	0.58 ± 0.17	0.58 ± 0.17
Coronary artery disease (n = 11)	1.17 ± 0.21*	1.17 ± 0.21*	1.17 ± 0.21*
Chronic gastritis (n = 14)	0.81 ± 0.16	0.81 ± 0.16	0.81 ± 0.16

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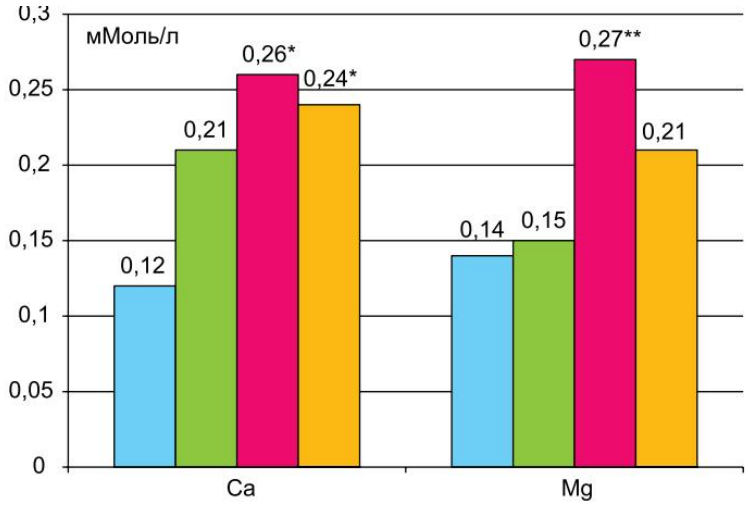
Chronic sinusitis (n = 13)	Chronic sinusitis (n = 13)	Chronic sinusitis (n = 13)	Chronic sinusitis (n = 13)
Chronic nephritis (n = 11)	Chronic nephritis (n = 11)	Chronic nephritis (n = 11)	Chronic nephritis (n = 11)

**p ≤ 0.05, **p ≤ 0.01 – differences are statistically significant at compared to the control group*



A.Coronary artery disease

B.Chronic gastitis

C. Chronic sinusitis

D. Chronic nephritis

Fig. 1. The oral fluid calcium and magnesium levels in patients with inflammatory periodontal diseases associated with systemic diseases.

Differences are statistically significant compared to patients with coronary artery disease *at p ≤ 0.05; ** at p ≤ 0.01

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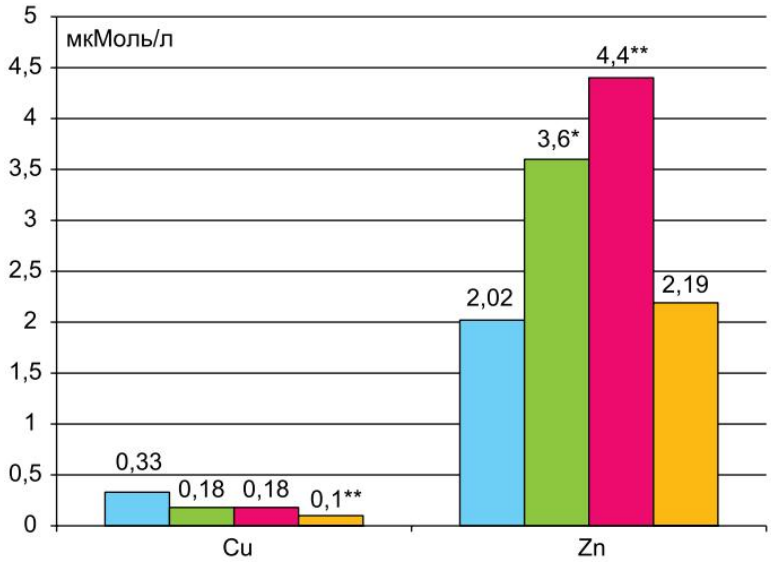

A.Coronary artery disease B.Chronic gastitis

C. Chronic sinusitis D. Chronic nephritis

Fig. 2. The oral fluid copper and zinc levels in patients

with inflammatory periodontal diseases on the background of somatic diseases.

Differences are statistically significant compared to patients with coronary artery disease

*at $p \leq 0.05$; ** at $p \leq 0.01$.

RESULTS.

The characteristics of oral hygiene and periodontal status in dental patients with IPD against the background of somatic diseases are presented in Table 1.

The most pronounced decrease in oral hygiene was found in patients with CHD (Group 1) and CN (Group 4), OHI-S was 1.17 ± 0.21 and 1.07 ± 0.14, respectively, compared to 0.58 ± 0.17 in the control group (at $p \leq 0.05$). In these same groups, the most pronounced inflammation of the periodontium was found, both in terms of PMA (4.94 ± 1.15 and 2.69 ± 0.46, respectively, compared to 1.06 ± 0.3; $p \leq 0.05$-0.01), and in terms of CPITN (0.9 ± 0.1 and 0.96 ± 0.09, respectively, compared to 0.57 ± 0.09; $p \leq 0.05$-0.01).

In the group of patients with CG, the level of oral hygiene did not differ statistically significantly from the control group, however, periodontal inflammation was more pronounced - 2.74 ± 0.59 compared to 1.06 ± 0.3 ($p \leq 0.05$).

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In patients with CS, there was only a trend towards a deterioration in oral hygiene and the severity of inflammation ($p > 0.05$).

The characteristics of the mineral composition of oral fluid in patients with IPD against the background of somatic diseases are presented in Figures 1 and 2.

Analysis of the mineral composition of oral fluid showed that in patients with coronary heart disease (Group 1), there is a low level of calcium (0.12 ± 0.05 mmol/L), magnesium (0.14 ± 0.03 mmol/L), and zinc (2.02 ± 0.35 µmol/L). In patients with CG, a decrease in magnesium (0.15 ± 0.03 mmol/L) and copper (0.18 ± 0.05 µmol/L) levels was found in oral fluid, and in patients with CS, a decrease in copper (0.18 ± 0.025 µmol/L). With CN, a decrease in copper (0.10 ± 0.03 µmol/L) and zinc (2.19 ± 0.50 µmol/L) was shown in oral fluid.

DISCUSSION.

A statistically significant decrease in oral hygiene (according to the OHI-S index) relative to the control group was found in dental patients with coronary heart disease and CN. They also have the most pronounced inflammatory changes in periodontal tissues. Our results are consistent with data on the link between cardiovascular diseases and CKD with periodontal diseases [3, 6-8].

The severity of macro- and microelement deficiency in oral fluid in dental patients was found to be associated with somatic pathology. In patients with CHD, we found the most pronounced deficiency of calcium, magnesium, and zinc. Magnesium and zinc deficiency increases the risk of cardiovascular diseases [20, 21], which explains its low level in this group of patients.

In patients with CN, we found a deficiency of copper and zinc. Zinc deficiency increases the risk of urinary system diseases [22, 23].

In patients with CG, a decrease in magnesium and copper was noted, which may be associated with the use of medications, in particular proton pump inhibitors, prescribed for acid-dependent diseases of the stomach, duodenum, and esophagus. According to J. Joel, most of these patients have hypomagnesemia and hypocalcemia [24].

As noted above, copper and zinc are essential for the functioning of antioxidant enzymes, reducing oxidative stress - one of the factors of inflammation and destruction of periodontal tissues. Magnesium ions at alkaline pH have an inhibitory effect on Gram-negative and Gram-positive bacteria. Thus, a decrease in the level of copper, zinc, and magnesium in oral fluid in patients with somatic diseases exacerbates the course of periodontal diseases and should be taken into account by the dentist when treating and prescribing preventive measures in this group of patients.

CONCLUSIONS

1. In dental patients with ischemic heart disease and chronic nephritis, a decrease in oral hygiene and more pronounced inflammatory phenomena in the periodontium were found.

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2. In the oral fluid of dental patients, a statistically significant deficiency of calcium, magnesium, zinc, and copper of varying degrees was found, depending on the type of somatic pathology:

- Ischemic heart disease - deficiency of calcium, magnesium, and zinc;

- Gastritis - decreased magnesium and copper;

- Chronic nephritis - deficiency of copper and zinc;

- Chronic sinusitis - copper deficiency.

3. During dental appointments, when conducting treatment and prescribing preventive measures, it is necessary to take into account the presence of somatic diseases in patients and the mineral composition of their oral fluid.

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