

**СОСТОЯНИЕ ТРОМБОЦИТАРНОГО ЗВЕНА СИСТЕМЫ ГЕМОСТАЗА
В ПАТОГЕНЕЗЕ ПРОГРЕССИРОВАНИЯ ХРОНИЧЕСКОГО ПАРОДОНТИТА**

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Цель. Оценить структурно-функциональное состояние тромбоцитов как клеточного компонента системы гемостаза при хроническом генерализованном пародонтите (ХГП) различной степени тяжести и установить его роль в прогрессировании заболевания. **Материалы и методы.** В исследование включено 83 пациента (47 мужчин и 36 женщин) с ХГП, разделенных на три сопоставимые по возрастно-половому составу группы: в первую группу (n=21) включили пациентов с ХГП легкой степени тяжести, во вторую (n=36) – средней степени тяжести, в третью (n=26) – тяжелой степени. Методы исследования включали оценку структурно-функциональных характеристик тканей пародонта, общего гигиенического состояния полости рта, выраженности воспалительного процесса по индексным показателям; исследование микроциркуляции тканей пародонта, определение выраженности оксидативных процессов в слюне, плазме крови, тромбоцитах, изучение липидного состава тромбоцитов. **Результаты.** При ХГП отмечаются патологические изменения липидного состава мембран тромбоцитов (увеличение процента лизофосфолипидов и свободных жирных кислот), связанные с системной активизацией оксидативных процессов и фосфолипазных ферментных систем, что сопровождается повышением их агрегационной активности. Степень повышения активности тромбоцитов сопряжена с выраженностью нарушений микроциркуляции в тканях пародонта. Состояние клеточного компонента системы гемостаза коррелирует со степенью тяжести патологического процесса в пародонте. При тяжелой степени ХГП структурно-функциональные изменения тромбоцитов максимальны. **Заключение.** При ХГП системная активация оксидативных процессов приводит к модификации липидного состава мембран тромбоцитов, что способствует повышению их агрегационной активности, играя важную роль в формировании гиперкоагуляции, нарушении микроциркуляции и прогрессировании воспаления в тканях пародонта.

Ключевые слова: пародонтит; нарушения микроциркуляции; гемостаз; тромбоциты.

**CONDITION OF PLATELET FACTOR OF HEMOSTASIS SYSTEM
IN PATHOGENESIS OF CHRONIC PERIODONTITIS PROGRESSION**

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Aim. To evaluate the structural and functional condition of platelets as a cellular component of the hemostasis system in chronic generalized periodontitis of different severity, and to establish its role in the progression of the disease. **Materials and Methods.** Clinical studies included 83 pa-



tients (47 men and 36 women) with chronic generalized periodontitis, comparable in age and sex, divided into three groups according to the severity of the disease: the first group (n=21) – periodontitis of mild severity; the second group (n=36) – moderate degree of severity; the third group (n=26) – severe periodontitis. Methods of the study included evaluation of the structural and functional characteristics of periodontal tissues, general hygienic condition of the oral cavity, the severity of the inflammatory process according to index parameters; study of microcirculation of periodontal tissues, determination of the evidence of oxidative processes in saliva, blood plasma, platelets, study of lipid composition of platelets. **Results.** In chronic generalized periodontitis, pathological changes in the lipid composition of platelet membranes (an increase in the percentage of lysophospholipids and free fatty acids) were associated with systemic activation of oxidative processes and of phospholipase enzyme systems, which was accompanied by an increase in their aggregation activity. The degree of increase in the activity of platelets was associated with the severity of microcirculatory disturbances in the periodontal tissues. The condition of the cellular component of the hemostasis system correlated with the severity of the pathological process in the periodontium. In severe degree of chronic periodontitis, structural and functional changes in platelets were maximal. **Conclusion.** In chronic periodontitis, the systemic activation of oxidative processes leads to a modification of the lipid composition of platelet membranes, which contributes to increase in their aggregation activity playing an important role in the induction of hypercoagulation, microcirculation disturbances and progression of inflammation in the periodontal tissues.

Keywords: *periodontitis; microcirculation disorders; hemostasis; platelets.*

The importance of the problem of chronic periodontitis is associated with its rapid progression, high degree of recurrences and low effectiveness of therapy [1-3]. Modern views of the pathogenetic mechanisms of chronic periodontitis assign the important role not only to pathological changes in the microcirculation [4], but also to systemic disorders [5,6]. Some authors state an increase in the level and activity of platelets in chronic periodontitis [7-9], but the mechanism of such changes in the system of hemostasis is not completely studied [10,11]. Besides, the role of hypercoagulation in progression of chronic periodontitis also remains unclear.

The *aim* of study – to evaluate the functional condition and lipid composition of platelets in chronic generalized periodontitis (CGP) with different extent of severity and to determine its role in the progression of the disease.

Materials and Methods

The study included 83 patients (47 men and 36 women) with CGP of different severity who referred to the Dental Clinic of N.P. Ogaryev National Research State University

of Mordovia. The average age of patients was 43.4 ± 8.2 years, the duration of the disease was 2.4 ± 0.6 years.

All patients were divided into three groups comparable in age and gender: the first group (n=21) – patients with a mild degree of CGP, the second group (n=36) – with a moderate degree, and the third group (n=26) – with severe CGP. As the control group (norm) the average parameters of 25 healthy volunteers of the same gender and age as in the groups of study, were taken.

The study was approved at a meeting of Local ethical committee of N.P. Ogaryev NRSUM №34 of 2017 February 15. All procedures were conducted after signing of the written informed consent by the patients.

Patients with CGP were subjected to a complex clinic-laboratory and X-ray examinations, and according to their results were diagnosed and divided into groups. Additional examinations included evaluation of structural and functional characteristics of periodontal tissue by papillary-marginal-alveolar (PMA) index (Parma, 1960), indicating the evidence of gingivitis, by sulcus bleeding in-

dex, SBI (Muhleman, 1971), by hygiene of approximal surfaces of teeth API (Lange, 1997) showing the dynamics of formation of tooth plaque, by resistance of gingival capillaries (method of dosing vacuum by V.I. Kulazhenko), by simplified oral hygiene index OHI-s (Green, Vermillion, 1969), by Schiller-Pisarev test, by calculation of plaque index, by examination of microcirculation in periodontal tissues using laser doppler flow metry on LAKK-02 analyzer (OOO NPP Lasma, Russia) equipped with specialized software, by determination of evidence of oxidative processes in saliva, blood plasma, platelets, by the content of secondary products of peroxide oxidation of lipids (D.Yu. Egorov, A.V. Kozlov, 1987), by examination of lipid composition of platelets (after isolation on chromatograms by dencitometric method on dencitometer Model GS-670 (BIO-RAD, USA) with the corresponding software (Phosphor Analyst / PS Software)).

Statistical analysis of the data was carried out using application program package Statistica 7.0 (Stat Soft Inc., USA). The type of distribution for each studied parameter was evaluated taking into account the obtained results. The following statistical methods were chosen: calculation of Student-t test, Pearson correlation coefficient, χ^2 criterion for evaluation of significance of the age and gender factors. The differences were considered statistically significant at $p < 0.05$.

Results and Discussion

The conducted studies showed that at the moment of visiting a dentist, in patients with CGP significant deviations of calculated and measured characteristics of the condition of the periodontium from norm were found, with the evidence corresponding to severity of the disease.

Simplified hygienic index (OHI-s) increased the norm by 72.4% ($p < 0.001$), 120.95% ($p < 0.001$) and 161.2% ($p < 0.001$) in patients of the first, second and third group, respectively. To note, the parameter OHI-s was more than 1, which is assumed to indi-

cate a poor hygienic condition of the mouth cavity.

Plaque index (PI) in patents of the first and second groups was 0.83 ± 0.21 which 9.2 times exceeded the norm. This parameter in the second group was 3.89 ± 0.23 , which corresponded to a moderately severe pathology of periodontium indicating the existence of gingivitis with formation of a clinical pocket with a fixed tooth with no disorder in function. The most evident change in PI were found in patients of the third group, where it was 4.64 ± 0.25 .

Determination of numeric equivalent of Schiller-Pisarev test showed a reliable increase in the given parameter in patients of the second group by 184.12% (4.83 ± 0.23) which corresponded to staining of alveolar papillae and of the gingival margin and was characterized as the existence of a moderate inflammation process of periodontal tissues. In patients of the third group the score according to the results of this test exceeded normal parameters by 354.62% ($p < 0.05$) that was characterized as the existence of a severe inflammation of periodontal tissues.

Evaluation of papillary-marginal-alveolar index at the moment of visiting the clinic showed increase in the parameter in patients of the first, second and third groups by 12.1 ($p < 0.001$), 23.2 ($p < 0.001$) and 38.7 times ($p < 0.001$, respectively, indicating the existence of an active inflammatory process in the periodontal tissues.

Sulcus bleeding index of patients in the studied groups was 5.4 times ($p < 0.001$), 16 times ($p < 0.001$) and 21.2 times ($p < 0.001$) the norm, respectively. Index of hygiene of approximal surfaces of teeth in the given groups also exceeded the normal values 4.5 times ($p < 0.001$), 16.7 times ($p < 0.001$) and 18.3 times ($p < 0.001$) which indicated unsatisfactory condition of the hygiene of the oral cavity and intense formation of dental deposit and dental plaque. Evaluation of Kulazhenko test revealed reduction of the time of hematoma formation by 51.2% ($p < 0.001$), 75.0%

($p < 0.001$) and 82.4% ($p < 0.001$), respectively, which evidenced a disorder in the functional condition of the vessels of periodontium and increased fragility of capillaries.

It was also found that structural and functional alterations in periodontal tissues in CGP were accompanied by disorders in microcirculation and by the phenomena of oxidative stress not only at the local, but also at the systemic level. Thus, examination of a microcirculatory status of periodontal tissues using LDF showed that at the moment of visiting a doctor, a patient with evident clinical signs of exacerbation of CGP had significant deviations of LDF from the norm. The study showed that in patients of the first group, the microcirculation index (MI) in the periodontium was insignificantly decreased. The index of effectiveness of microcirculation (IEM) and the parameters of the regulatory components of periodontium were comparable with normal ones. A statistically significant increase in the shunting index (SI) was recorded – by 30.1% ($p < 0.05$) against the norm.

In evaluation of microcirculation in patients of the second group a considerable increase in MI was found (41.6%, $p < 0.05$), with simultaneous increase in SI by 107.1% ($p < 0.05$). The ratio of the maximal amplitudes of cardiac and low frequencies increased 20.0% ($p < 0.05$). The parameter of neurogenic tone increased 17.3% ($p < 0.05$), and that of myogenic tone decreased by 26.8% ($p < 0.05$) relative to normal values. Effective microcirculation index decreased by 19.2% ($p < 0.05$). The obtained data evidence disorder in the microcirculation in periodontal tissues in the form of reduction of effectiveness of microcirculation in the periodontium and of shunt of blood through shunting vessels with involvement of cardiac mechanisms of compensation, with suppression of humoral myogenic regulation with activation of sympathetic influences.

In severe CGP in patients of the third group, MI in periodontium reduced by 75.2% ($p < 0.05$) with increase in SI by 210.1% ($p < 0.05$) against the norm which was probably due to

irreversible sclerotic alteration of periodontal tissue. Evaluation of mechanisms of regulation of vessel tone on the basis of the amplitude-frequency analysis revealed changes in microcirculation corresponding to the third degree of severity [12]. Depletion of compensatory cardiac and respiratory mechanisms and disorders of neurogenic and humoral regulation of microhemodynamics were found.

It is known that disorders in microcirculation with the underlying disorders in the vessel wall and pathological alterations of cell membrane lead to frustration of transport and utilization of oxygen by tissues and to mixed hypoxia [13]. Circulatory and tissue hypoxia was characterized by derangement of metabolism and by shift of dynamic equilibrium between the evidence of the activity of antioxidant system and the rate of POL processes toward the latter [14].

Besides, at the moment of visiting the clinic, considerable deviation of markers of oxidative stress in saliva of the studied individuals were recorded. The content of substances reacting with thiobarbituric acid (TBA) 141.2% ($p < 0.05$) exceeded the norm in patients of the first group, 233.3% ($p < 0.05$) in patients of the second group, and 604.3% ($p < 0.05$) in patients of the third group. Activity of superoxide dismutase in the first and second groups showed a compensatory increase by 22.0 and 49.3% ($p < 0.05$), respectively, and in a severe form of the disease decreased by 42.2% ($p < 0.05$) which probably evidenced breakage of compensatory mechanisms of antioxidant enzymatic systems.

Activation of oxidative processes was as well noted at the systemic level as a component of acute phase response. The level of malondialdehyde in blood plasma exceeded the norm by 21.2% ($p < 0.05$) in the first group of patients, 63.4% ($p < 0.05$) in the second group and 92.8% ($p < 0.05$) in the third group.

Increase in phospholipase activity of plasma was recorded corresponding to the severity of the pathological process, the studied parameter was above the norm by 49.1%

($p < 0.05$), 113.4% ($p < 0.05$) and 236.1% ($p < 0.05$) in the first, second and third groups, respectively. This fact also plays an important role in the pathogenesis of progression of the disease taking into consideration not only membrane-destabilizing activity of this enzyme [15], but also its role in formation of

arachidonic acid with triggering of its metabolic cascade as an important source of mediators of inflammation [16].

Analyzing the obtained data, it should be noted that the evidence of systemic pathological alterations in CGH correlated with severity of the disease ($r = 0.89$, Figure 1).

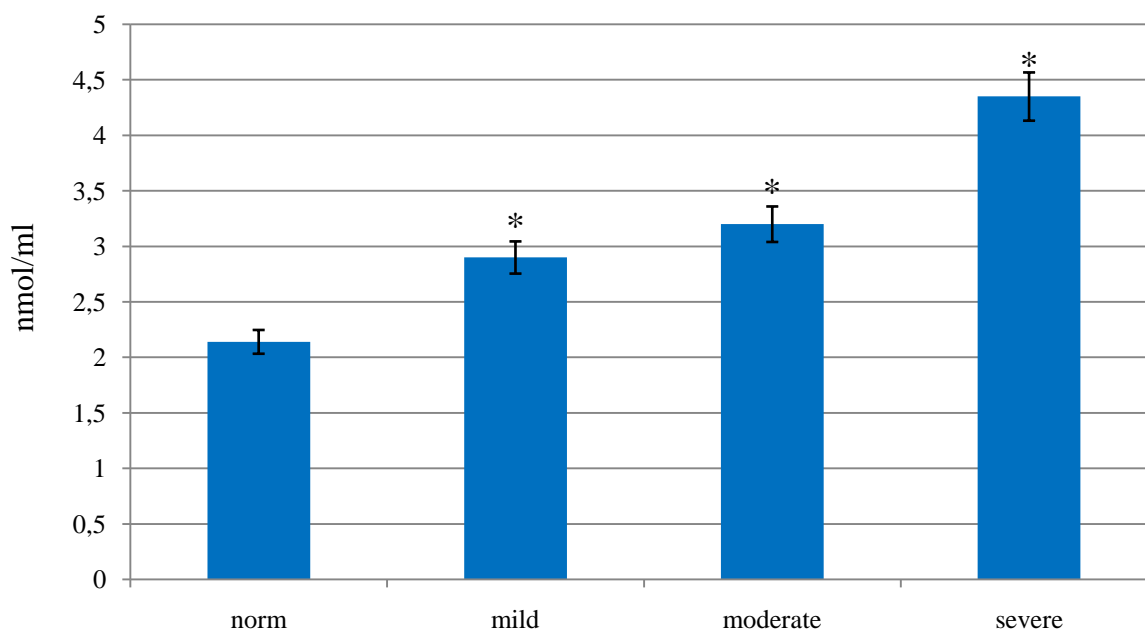


Fig. 1. Content of malondialdehyde in blood plasma of patients with different degree of severity

Note: * – statistical significance of changes relative to norm ($p < 0.05$)

Surely, activation of the main factors of alteration of cell membranes in blood plasma cannot but told upon the structural-functional conditions of the formed elements of blood and of endothelial cells as the first ‘targets’ of self-destruction. Of a special interest is a study of structural-functional characteristics of platelets, activation of thrombogenic properties of which may promote microthrombosis and worsening of microcirculation in tissues leading to progression of the pathological process. It was shown by some studies that evidence of hemostatic disorders correlated with the degree of severity of CGP [17].

A study of the activity of oxidative processes in platelets showed increase in the

content of secondary products of POL by 56.4% ($p < 0.05$) in a mild degree of CGP, by 86.9% ($p < 0.05$) in moderate degree and by 129.3% ($p < 0.05$) in a severe form. Activity of phospholipase A_2 of platelets increased 30.2%, 85.4% and 143.2% ($p < 0.05$), respectively (Figure 2).

Increase in the activity of lipid-modifying factors of cell membranes was accompanied by changes in lipid composition of platelets, with the highest changes in fractions of free fatty acids and lysophospholipids. Other parameters of lipid composition of platelets also showed reliable changes relative to norm, especially in severe CGP.

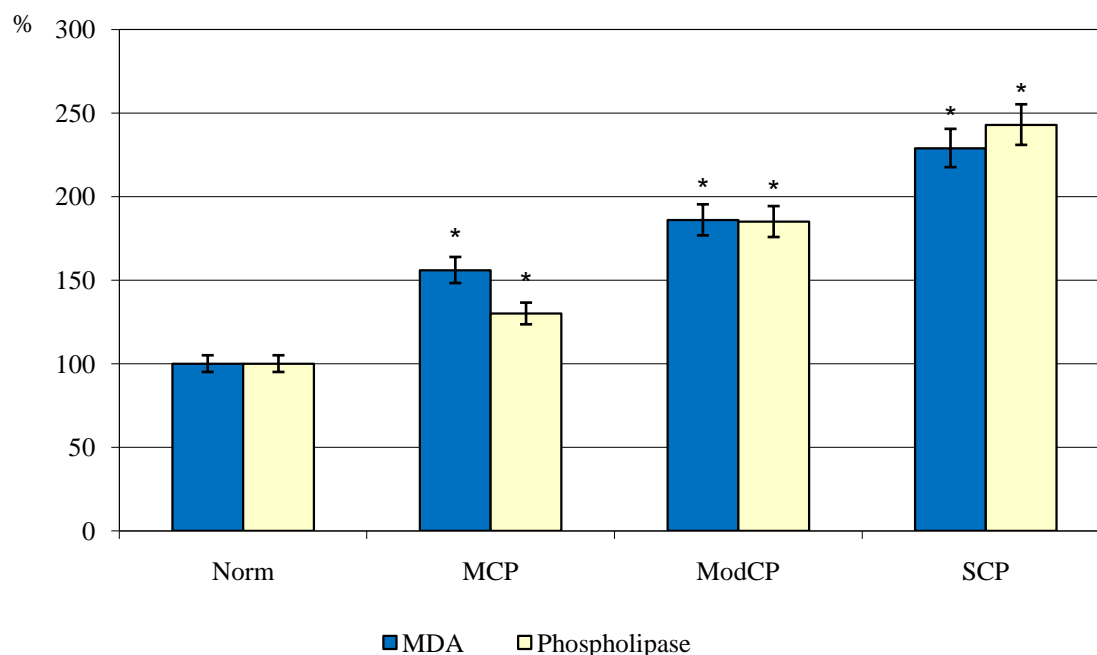


Fig. 2. Parameters of activity of POL and activity of phospholipase A₂ of platelets of in blood of patients with CGP with different degree of severity

Note: * – statistical significance of changes relative to norm (p<0.05)

Table 1

Lipid Spectrum of Platelets in Chronic Generalized Periodontitis

Parameter	Norm	Degree of Severity of CGP		
		Mild	Moderate	Severe
Cholesterol esters, %	6.71±0.46	6.56±0.58	5.17±0.39	8.28±0.67*
Cholesterol, %	25.05±1.58	24.67±1.26	35.14±1.07*	42.34±2.00*
Free fatty acids, %	4.42±0.28	6.12±0.39*	6.99±0.31*	7.52±0.48*
Triglycerides, %	5.32±0.37	5.76±0.33	5.73±0.50	7.42±0.29*
Total phospholipids, %	55.82±3.74	53.83±2.80	42.74±1.29*	38.60±2.16*
Fractions of Total Phospholipids				
Lysophosphatidylcholine	1.15±0.06	1.86±0.15*	4.02±0.28	4.86±0.11*
Sphingomyelin	23.13±2.29	22.36±1.19	17.89±0.88*	10.80±1.19*
Phosphatidylinositol	7.44±0.41	7.27±0.29	10.89±0.34*	10.86±0.30*
Phosphatidylcholine	35.96±1.13	32.51±1.43	27.26±1.67*	25.33±1.45*
Phosphatidylethanolamine	24.82±1.28	25.23±1.36	32.02±1.29*	34.23±1.44*
Phosphatidylserine	9.64±0.40	10.90±0.32	16.17±0.39*	18.62±0.34*

Note: * – statistical significance of changes relative to norm (p<0.05)

Table 2

Functional Activity of Platelets in Chronic Generalized Periodontitis

Parameter	Norm	Degree of Severity of CGP		
		Mild	Moderate	Severe
Degree of platelet aggregation, %	57.46±2.99	71.34±4.71*	76.02±3.88*	86.23±5.78*
Rate of platelet aggregation, conv.u	2.05±0.14	2.87±0.19*	3.41±0.18*	3.88±0.25*
Time of platelet aggregation, sec	195.75±10.57	171.65±10.13	136.46±9.01*	109.64±6.36*

Note: * – statistical significance of changes relative to norm ($p < 0.05$)

Besides, increase in the aggregation capacity of platelets was found that was most significant in a severe form of the disease when the extent and rate of aggregation exceeded the norm by 50.0 and 89.3% ($p < 0.05$), respectively, with shortening of aggregation time by 56.0% ($p < 0.05$) against the norm (Table 2).

Alteration of molecular structure of lipid composition of platelet membranes correlated with disorders in their functional activity ($r = 0.79-0.86$).

The given modifications of structural-functional activity of platelets may be one of factors triggering the intravascular way of activation of a cascade of hemostatic reactions leading to hypercoagulation condition and to microthrombosis with impairment of microcirculation of tissues [18]. This fact is confirmed by a strong correlation dependence of parameters of structural-functional condition of platelets and parameters of condition of periodontal tissues and the data of laser dopplerflowmetry of microcirculation of the gingival tissue ($r = 0.86-0.91$).

In discussion of the obtained results it should be noted that studies of N.A. Georgiadi et al. [19] and of M.S. Alieva et al. [20] also showed that derangement of microcirculation in periodontal tissues correlated with the expression of inflammation in CGP. Phenomena of systemic oxidative

stress in exacerbation of CGP in the form of increase of POL products in blood plasma revealed by us, confirm the literature data [21]. Results of increase in the aggregation activity of platelets in CGP with a tendency to increment with progression of the pathology do not contradict the results of studies of V.N. Kitaeva, et al. [22] and of E.V. Pounukalina, et al. [23].

Conclusion

In chronic generalized periodontitis, pathological alterations in lipid composition of platelet membranes were noted associated with systemic activation of oxidative processes and of phospholipase enzymatic systems with increase in their aggregation activity. The given alterations correlate with the evidence of disorders in microcirculation in tissues of periodontium. The condition of platelet hemostasis corresponds to the degree of severity of the pathological process in periodontium. In a severe chronic generalized periodontitis, the structural-functional alterations in platelets were maximal.

Thus, in chronic periodontitis, systemic activation of oxidative processes was associated with modification of lipid composition of platelet membranes and with increase in their aggregation activity which correlated with disorders in microcirculation and expression of the inflammation in tissues of periodontium.

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