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Clinical-functional and immune-microbiological features of the oral cavity in children and adolescents with chronic forms of gingivitis

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Abstract: It is known that inflammatory periodontal diseases (IPD) rank second among dental diseases and are widespread across all population categories regardless of age, place of residence, or gender. It is also known that the transition from gingivitis to periodontitis begins with the appearance of a specific group of oral cavity pathogens, among which P. gingivalis, Actinobacillus actinomycetemcomitans, Treponema denticola, and others play a significant role. Local causes of IPD include poor oral hygiene, improper techniques and use of basic and additional oral care products, frequent consumption of soft foods, and an excess of easily fermentable carbohydrates. Currently, the prevalence of IPD has sharply increased and continues to rise, with a growing trend among younger individuals. Based on the above, this study examines the clinical-functional and immunomicrobiological state of the oral cavity, including the gingival sulcus, in children and adolescents suffering from catarrhal and hypertrophic gingivitis. A total of 425 children and adolescents were selected for the study, including those with chronic catarrhal gingivitis (n=195, CCG) and chronic hypertrophic gingivitis (n=165, CHG), as well as practically healthy children (n=65, control group – CG). Based on the established diagnosis, the clinical-functional and immunomicrobiological state of the oral cavity, including the gingival sulcus, was examined in children and adolescents with various forms of gingivitis. It was found that children and adolescents with CCG and CHG exhibited poor oral hygiene, which worsened with age. Severe inflammatory processes in the gums were observed in all children and adolescents with chronic gingivitis, particularly catarrhal gingivitis. Additionally, local circulatory disorders in the gums were noted, accompanied by increased vascular tone, decreased peripheral resistance to blood flow, reduced vascular elasticity, and impaired blood rheology. Furthermore, β-hemolytic streptococci of group A were identified as the predominant microorganisms in the gingival sulcus and oral cavity, along with a significant increase in the proportion of Candida spp., particularly Candida albicans. Immune status disorders were also detected, characterized by increased IgG, IgA, and IgM concentrations in the blood. A correlation was observed between the quantitative indicators of microorganisms in oral fluid and gingival sulcus contents in patients with CCG and CHG. Based on the OHI-S and PLI indices, as well as caries indicators of primary and permanent teeth in patients with CCG, poor oral hygiene was evident (p

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<0.0001). The results of various functional and clinical assessments suggest that patients with CCG and CHG exhibit local circulatory disorders in chronic disease progression. These disorders are accompanied by increased vascular tone, while β-hemolytic streptococci of group A and Candida albicans frequently dominate in the gingival sulcus and oral cavity. Additionally, a correlation was found between local immune status, particularly among children aged 10–13 years.

Keywords: *Chronic catarrhal gingivitis, Chronic hypertrophic gingivitis, Dentistry, immunology, Functional research methods of the oral cavity, Inflammatory periodontal diseases, Oral hygiene, Oral microbiology.*

1. Introduction

Relevance. It is known that inflammatory periodontal tissue diseases (IPTD) rank second among dental diseases and are widespread across all population categories, regardless of age, place of residence, or gender [1-3]. It is also established that the primary microbial composition of purulent-inflammatory processes in the maxillofacial region consists of both facultative anaerobic microorganisms and obligate aerobes [4-6]. More recent studies demonstrate that the transition from gingivitis to periodontitis begins with the emergence of a specific group of oral pathogens (OP), among which P. gingivalis, *Actinobacillus actinomycetemcomitans*, *Treponema denticola*, and others play a significant role [7-9].

Studies have proven that local causes of inflammatory periodontal tissue diseases (IPTD) include: poor oral hygiene, improper technique and use of primary and additional oral care products; frequent consumption of soft foods, and a predominance of easily fermentable carbohydrates, among others [10-13]. It has also been established that systemic causes are based on morphological, immunological, and biochemical changes in the human body as a whole, including in the oral cavity [14-16]. In children and adolescents, contributing factors include general somatic pathology, such as endocrinopathies, diseases of the gastrointestinal tract, cardiovascular system, systemic diseases, and others [17-19]. Currently, the prevalence of IPTD has sharply increased and continues to rise, with a notable trend toward higher incidence among younger individuals. One of the most pressing issues in modern dentistry remains the selection of effective diagnostic and treatment methods for IPTD [20-22].

Research Objective. To study the clinical, functional, and immunomicrobiological characteristics of the mucous membrane of periodontal tissues in children and adolescents with chronic gingivitis.

Materials and Methods. This study was conducted at the Department of "Dentistry, Pediatric Dentistry, and Orthodontics" of the Center for Professional Qualification Development of Medical Workers under the Ministry of Health of the Republic of Uzbekistan.

A total of 425 children and adolescents were examined between 2022 and 2025. Among them:

- n = 195 (45.9%) with chronic catarrhal gingivitis (CCG) (Main Group 1 – MG-1),
- n = 165 (38.9%) with chronic hypertrophic gingivitis (CHG) (Main Group 2 – MG-2),
- n = 65 (15.3%) practically healthy individuals (Control Group – CG-1).

Patients were further classified based on age and gender (Table 1).

Table 1.
Examined Groups by Age and Gender (M± in %).

Diagnosis	**CCG (1-гр.)**				**CHG (2-гр.)**				**CG**			
Age group	195/45.9	Among them			165/38.9	Among them			65/15.3	Among them		
Total		6-9 age	10-13 age	14-18 age		6-9 age	10-13 age	14-18 age		6-9 age	10-13 age	14-18 age
425/100%		44/22.6	88/45.1	63/32.3		33/20.0	67/40.6	65/39.4		15/23.1	25/38.5	25/38.5
Boys-	85/50.1	Including			59/35.1	Including			24/14.3	Including		
168/39.5		18/21.2	34/40.0	33/38.8		14/23.7	23/39.0	22/37.3		8/33.3	8/33.3	8/33.3
Girls-257/60.5	110/42.8	Including			106/41.2	Including			41/16.0	Including		
		26/23.6	54/49.1	30/27.3		19/17.9	44/41.5	43/40.6		13/31.7	13/31.7	15/36.6

Note: CCG - Chronic Catarrhal Gingivitis; CHG - Chronic Hypertrophic Gingivitis; CG - Control Group (without TP pathology).

The examination was conducted using standard dental clinical methods:

- Complaints specific to patients with CCG and CHG were studied.
- The intensity of dental caries was determined using the DMF+DM and DMF indices.
- The degree and intensity of gingival sulcus bleeding (IKD) were assessed according to Mühlemann [23] and Cowell [24].
- The color and moisture of the oral mucosa (OM) were evaluated.
- The nature of frenulum attachment, the presence and severity of mucosal bands, and the depth of the oral vestibule were determined.
- Oral hygiene was assessed using the simplified hygiene index (OHI-S) by Green and Vermillion [25].
- The periodontal index (PI) was determined according to Russell [26].
- The need for periodontal disease treatment was evaluated using the CPITN index, following WHO methodology recommendations.

To study the clinical and functional condition of the oral mucosa (OM) in patients, a total of n=105 patients were selected, including 90 patients from OG-1 and OG-2 (15 from each age group) and 15 subjects from the control group (CG). Special research methods were conducted to assess the degree of gingival inflammation:

- Temperature (t_0) of the oral tissues was measured using TEP-1 in the mucosal area of the gingiva near the incisors and premolars of the upper (UJ) and lower jaw (LJ), both on the right and left sides.
- Microcirculation in the gingival tissues was assessed using rheoparodontography (RPG) (with RPG-2-02). The obtained data were used to calculate the rheographic index (RI), vascular tone index (VTI), peripheral resistance index (PRI), and elasticity index (EI).
- Capillary blood flow was evaluated using laser Doppler flowmetry (LDF) studies (LAKK-01).

To study the microbiota of the oral mucosa, a total of:

- 60 patients from OG-1a (a subgroup of OG-1) diagnosed with CCG,
- 52 patients from OG-2a (a subgroup of OG-2) diagnosed with CHG,
- 26 patients from CG-1a (a control subgroup) with healthy periodontal tissues

were selected for analysis. Biological samples were collected from the gingival sulcus (GS) and soft tissues of the periodontium, and a comparative characteristic was conducted.

Microbiological examination of biological samples included:

- Primary cultures for aerobic and facultative anaerobic microorganisms using selective and enriched culture media.
- Bacteriological analysis was performed using the Vitek 2 Compact system.
- Mass spectrometry was conducted using MALDI-TOF MS for microbial identification.

To assess the local immunological (Ig) status of blood and oral fluid (OF), the following methods were used:

- Radial immunodiffusion [27] to determine immunoglobulin levels.
- Lysozyme activity in saliva was measured using the method developed by Aliyev [28].
- Immunological status of the gingival papilla and subpopulation markers were also analyzed.

The obtained results were processed using standard statistical methods:

- Raw quantitative data were organized into tables using MS Excel version 7.0.
- Statistical analysis was conducted using the "Descriptive Statistics" module in STATISTICA 6.1 under the Windows system.

Results and Discussion

The primary complaint among patients with CCG (MG-1) was gingival bleeding (63.6%). Additionally, 34.9% of patients reported bad breath and noticed traces of blood on their pillow.

In patients with CHG (MG-2):

- 67.9% exhibited severe inflammatory processes in the gums.

- 33.3% had significant thickening and enlargement of the gingival tissue, indicating noticeable hyperplasia.
- 80.1% complained of pain and bleeding during toothbrushing.
- Dental calculus (DC) was detected in 35.4% of CCG patients and 23.03% of CHG patients.

The study revealed malocclusions in:

- 58.9% of patients with CCG and 51.5% of patients with CHG.
- Specific types of malocclusions were found in 42% of CCG patients and 32.1% of CHG patients.
- In the control group (CG-1), 32.3% had malocclusions, and 23% exhibited tooth crowding.

Additionally, anatomical anomalies were identified:

- Frenulum attachment anomalies and a shallow oral vestibule in 28.7% of CCG patients and 35.1% of CHG patients.
- Among CCG patients:
- 16.9% had a short upper lip frenulum.
- 22.5% had a short lingual frenulum.
- 11.3% had a shallow oral vestibule.
- Among CHG patients:
- 8.5% had a short upper lip frenulum.
- 10.9% had a short lingual frenulum.
- 9.7% had a shallow oral vestibule.

The obtained results for OHI-S, PLI indices, and caries indicators in primary and permanent teeth among the studied patients showed:

- OHI-S values:
- CCG patients: above 2.8±0.3 units.
- CHG patients: 1.4±0.40 units.
- This clearly indicates poor oral hygiene in children with CCG ($p < 0.0001$).
- The most significant poor oral hygiene was observed in 10-13-year-old patients with both forms of gingivitis:
- CCG: 3.0±0.1
- CHG: 1.42±0.01
- Quantitative assessment of dental plaque in the cervical area (PLI index):
- CCG patients: 2.86±0.52 units.
- CHG patients: 1.57±0.47 units.

The prevalence of dental caries among patients was:

- 62.4±1.22% in CCG patients.
- 58.8±1.64% in CHG patients ($p > 0.05$).
- The ratio of carious (C), filled (F), and extracted (M) teeth showed no significant differences between the groups.

Among children and adolescents with chronic gingivitis (CFG), the following dental abnormalities were observed:

- Hypoplasia – 12.2%
- Delayed tooth eruption – 6.9%
- Primary adentia – 24.4%
- Tooth number anomalies – 13.3%
- Endemic dental fluorosis – 5%
- Tooth wear – 5.3%
- Dental trauma – 8.9%
- Enamel necrosis – 10.8%
- Enamel erosion – 3.3%

In children and adolescents with chronic gingivitis, the unstimulated oral fluid (UOF) level showed a variable correlation with the OHI-S, PMA, and GI indices.

- Age-related trends were clearly observed:
- Up to 10 years old: Index values remained below 3 points, indicating satisfactory oral hygiene.
- From 10 years old and above: Index values exceeded 3 points, reflecting poor oral hygiene.

The results showed a decrease in gingival temperature (t_0) in different areas among children and adolescents with chronic gingivitis (CFG), ranging from 36.40°C to 33.60°C.

- In CCG patients, gingival temperature decreased from 33.80°C to 32.60°C.
- In CHG patients, it ranged from 35.40°C to 33.40°C.
- In both groups, a progressive decrease in gingival temperature was observed with increasing age.

Rheoparodontography (RPG) findings showed:

- A gradual ascending phase,
- A rounded peak, and
- A smoother dicrotic notch, often located in the upper third of the catacrotic phase.

Quantitative RPG indicators:

- Rheographic index (RI): 0.03±0.01 Ω
- Elasticity index (EI): 54.6±2.22%
- Vascular tone index (VTI): 12.2±1.48%
- Peripheral resistance index (PRI): 96.4±2.89%

These values indicate impaired local blood circulation in the gingiva.

According to laser Doppler flowmetry (LDF):

- Microcirculation index (MI): 11.1±0.41 PE
- Blood flow oscillations: 1.8±0.44 PE
- Variation coefficient (VC) (reflecting vasomotor activity): 11.9±0.44% (Table 2).

Rheoparodontography (RPG) findings were characterized by:

- A gradual ascending phase,
- A rounded peak, and
- A smoother dicrotic notch, often observed in the upper third of the catacrotic phase.

Gingival Temperature (t_0) Trends

- Significant tendency to decrease by 0.2–0.8°C in different gingival zones.
- Most of these fluctuations were statistically significant.

Quantitative RPG Indicators

In CCG patients:

- Rheographic index (RI): 0.04±0.06
- Elasticity index (EI): 59.2±1.98
- Vascular tone index (VTI): 11.6±1.2
- Peripheral resistance index (PRI): 98.9±3.2

In CHG patients:

- RI: 0.05±0.01
- EI: 57.2±2.04
- VTI: 12.4±1.18
- PRI: 99.4±3.2

Conclusions

- In both groups, these values indicate impaired local blood circulation in the gingiva.
- A worsening trend or deviation from average values was observed, correlating with increasing age in children and adolescents.

Table 2.
Indicators of Gingival Temperature (t0), Rheoparodontography (RPG), Laser Doppler Flowmetry (LDF), and Blood Flow Regulation Dynamics in the Examined Groups (M± in %).

diagnosis		CCG				CHG			
Age / gr. / indicators		average n=45	6-9 age n=15	10-13 age n=15	14-18 age n=15	average n=45	6-9 age n=15	10-13 age n=15	14-18 age n=15
t^0 u/j	right	33.8±0.48	35.2±0.54	34.1±0.46	32.1±0.44	35.4±0.48	36.5±0.54	35.3±0.46	34.4±0.44
	center	33.4±0.44	34.4±0.51	33.6±0.43	32.2±0.38	33.8±0.14	35.1±0.19	33.9±0.15	32.4±0.08
	left	32.6±0.28	33.9±0.35	32.5±0.29	31.4±0.20	33.4±0.31	34.7±0.39	33.3±0.32	32.2±0.22
t^0 l/j	right	33.6±0.18	35.1±0.28	33.3±0.19	32.4±0.07	33.8±0.14	35.2±0.21	33.5±0.13	32.7±0.08
	center	32.8±0.24	34.3±0.31	32.9±0.23	31.2±0.18	33.8±0.12	35.1±0.18	33.7±0.11	32.6±0.07
	left	33.1±0.44	34.9±0.51	33.3±0.43	31.1±0.38	33.8±0.14	35.1±0.19	33.6±0.13	32.7±0.10
PI (Om)		0.04±0.006	0.06±0.08	0.05±0.06	0.01±0.04	0.05±0.01	0.07±0.01	0.04±0.01	0.04±0.01
IE (%)		59.2±1.98	67.1±2.29	60.6±1.87	50.2±1.78	57.2±2.04	66.7±2.76	56.4±2.13	48.5±1.23
PT (%)		11.6±1.24	14.3±1.98	11.7±1.19	8.8±0.55	12.4±1.18	15.8±1.54	12.1±1.11	9.3±0.89
PRI (%)		98.9±3.22	110.1±3.86	97.3±3.15	89.3±2.65	99.4±3.24	112.3±3.86	98.7±3.28	87.2±2.58
LDF	PM(pe)	10.2±0.22	13.1±0.27	10.3±0.21	7.2±0.18	12.8±0.44	14.9±0.64	12.6±0.43	10.9±0.25
	Q(pe)	1.3±0.02	1.9±0.03	1.1±0.02	0.9±0.01	1.6±0.07	2.2±0.09	1.5±0.06	1.1±0.06
	KV (%)	11.8±0.34	13.9±0.51	11.6±0.33	9.9±0.18	11.4±0.81	14.2±0.98	10.9±0.74	9.1±0.71
AMF	Vasomotion	113.4±3.1	120.7±4.9	112.3±3.2	107.2±1.2	111.0±3.1	119.7±4.3	110.5±2.9	102.8±2.1
	Vascular tone	86.8±0.7	96.7±0.9	85.6±0.6	78.1±0.6	89.9±0.2	94.7±0.3	88.6±0.2	86.4±0.1
PMF	HFF	54.2±0.6	61.1±0.8	53.7±0.6	47.8±0.4	52.4±0.2	58.3±0.3	51.7±0.2	47.2±0.1
	PF	44.3±0.4	49.7±0.5	43.2±0.4	40.0±0.3	48.4±0.4	52.6±0.5	47.5±0.4	45.1±0.3
FI		1.06±0.4	1.28±0.5	1.12±0.4	0.78±0.3	0.92±0.4	1.13±0.5	0.91±0.4	0.72±0.3
IVR		3.38±0.26	4.08±0.39	3.27±0.25	2.79±0.14	3.88±0.22	4.27±0.37	3.91±0.21	3.46±0.08

Note: CCG – Chronic Catarrhal Gingivitis, CHG – Chronic Hypertrophic Gingivitis, RI – Rheographic Index, VTI – Vascular Tone Index, PRI– Peripheral Resistance Index, EI– Elasticity Index, LDF– Laser Doppler Flowmetry, AMF– Active Fluxmotion Mechanism, PMF – Passive Fluxmotion Mechanism, HFF – High-Frequency Fluctuations, PF – Pulse Fluctuations, FI – Fluxmotion Index, IVR – Intravascular Resistance * $p<0.05$ compared to the average values of age groups.

Based on the results of various functional and clinical characteristics, it can be concluded that in patients with chronic catarrhal gingivitis (CCG) and chronic hypertrophic gingivitis (CHG), local circulatory disorders in the gums can be detected in 98.6% of cases. These disorders are accompanied by increased vascular tone, decreased peripheral resistance to blood flow, impaired vascular elasticity, and altered blood rheology.

The results obtained from samples of the oral mucosa of the dentoalveolar complex were analyzed using comprehensive microbiological studies, incorporating both classical and modern methods. Enriched and selective culture media were used, revealing that the biological samples contained not only representatives of the normal microbiota, such as:

- Streptococcaceae family (including the Viridans streptococcus group: *Streptococcus mitis*, *S. mutans*, *S. oralis*, *S. sanguinis*, *S. sobrinus*, *S. anginosus group*),
- Staphylococcaceae,
- Neisseriaceae,
- Corynebacteriaceae,
- Haemophilus spp.

but also opportunistic and pathogenic microorganisms, including:

- Gram-negative bacteria from the *Enterobacteriaceae* family, such as *Klebsiella spp.*
- Non-fermenting Gram-negative bacteria, including *Pseudomonas aeruginosa*
- Fungi, such as *Candida spp.* (Table 3).

Table 3.
Frequency of Facultative Anaerobic Microorganisms Isolated from the Gingival Sulcus in Examined Children and Adolescents.

No.	Family\genus	Species of Microorganisms	Frequency (abs.%)		
			MG-1a. n=60	MG-2a. n=52	CG-1a. n=15
1	Staphylococcaceae\ Staphylococcus	Coagulase-positive staphylococci. including *Staphylococcus aureus* (*S. aureus*)	35 (31.3)	15(28.8%)	8 (20.0)
		Coagulase-negative staphylococci (CoNS)	14 (12.5%)	8(15.4%)	15(37.5%)
2	Streptococcaceae\ Streptococcus	Alpha-hemolytic streptococci (Viridans group streptococci - VGS)	108 (96.4%)	51(98.1%)	40 (100%)
		Beta-hemolytic streptococci. including *Streptococcus pyogenes* (*S. pyogenes*)	32 (28.6%)	13(25.0%)	2 (5.0%)
3	Neisseriaceae \ Neisseriae	N. meningitidis	0	0	0
		Non-pathogenic Neisseria	95 (84.8%)	46(88.5%)	38(95.0%)
4	Pasteurellaceae Haemophilus	Haemophilus influenzae	0	0	0
		Non-pathogenic Haemophilus	35 (31.3%)	18(34.6%)	38(95.0%)
5	Corynebacteriaceae\ Corynebacterium	C. diphtheriae	0	0	0
		Non-pathogenic C. diphtheriae	92 (82.1%)	44(84.6%)	35 (87.5%)
6	Enterobacteriaceae	Enterobacteriaceae spp and Klebsiella spp	2 (1.8%)	1(1.9%)	0
7	Bifidobacterium	Bifidobacterium spp	42 (37.5%)	22(42.3%)	34 (85.0%)
8	Lactobacillaceae\ Lactobacillus	Lactobacillus spp	33 (29.5%)	18(34.6%)	33 (82.5%)
9	NGOB	Pseudomonas aeruginosa	1 (0.9%)	1(1.9%)	0
10	Candida spp.	Candida spp.	38 (33.9%)	16(30.7%)	5(12.5%)

In most samples, representatives of the *Streptococcus* genus predominated. In the microbiota of young patients with intact periodontium, the proportion of *Streptococcus* was significantly higher compared to the other two groups, with this difference being statistically significant. It was also found that the dominant majority of coagulase-positive staphylococci belonged to *Staphylococcus aureus* (*S. aureus*).

In patients with chronic catarrhal gingivitis (CCG), the main detected microorganisms included *Streptococcus*, *Staphylococcus*, *Micrococcus*, *Neisseria*, *Corynebacterium species*, *Enterobacter species*, *Pseudomonas species*, and *Candida albicans*. Notably, in oral fluid (OF), beta-hemolytic streptococci, *Neisseria*, and *Candida albicans* were most frequently observed in MG-1a (up to 31%) and MG-2a (up to 24%).

Compared to the control group (CG), the content of the gingival sulcus in MG-1a showed:

- Beta-hemolytic *Streptococcus* colonies were found 3 times more frequently, and in MG-2a, 2.5 times more frequently.
- *Neisseria* was detected 2.5 times more often in MG-1a and 1.9 times more often in MG-2a.
- *Candida albicans* appeared 1.8 times more frequently in MG-1a and 1.4 times more frequently in MG-2a (Table 4).

Table 4.
The Average Number of Colonies of β-Hemolytic *Streptococcus*, *Neisseria*, and *Candida albicans* in Oral Fluid (OF) and Gingival Crevice Content in Examined Patients.

Indicators group		Oral Fluid (OF)			Gingival Crevice		
		Str.ß	Neisseria	Candida	Str.ß	Neisseria	Candida
MG-1a. CCG	6-9 age	96.2±0.3*	67.2±0.8*	51.3±0.6*	156.7±0.27*	8.9±0.21*	5.3±0.5*
	10-13 age	103.1±0.5*	71.5±0.9*	55.7±0.7*	161.4±0.31*	13.8±0.25*	8.9±0.6*
	14-18 age	95.3±0.2*	66.5±0.7*	50.2±0.5*	155.3±0.26*	7.6±0.20*	5.0±0.4*
	Total	98.2±0.4*	68.4±0.8*	52.4±0.6*	157.8±0.28*	10.1±0.22*	6.4±0.5*
MG-2a. CHG	6-9 age	93.1±0.4*	53.2±0.2*	44.2±0.3*	143.4±0.67*	8.1±0.21*	3.9±0.1*
	10-13 age	98.7±0.5*	59.1±0.3*	49.1±0.4*	148.3±0.71*	10.1±0.25*	7.1±0.4*
	14-18 age	92.0±0.3*	52.1±0.1*	42.9±0.2*	142.1±0.66*	6.7±0.20*	2.8±0.1*
	Total	94.6±0.4*	54.8±0.2*	45.4±0.3*	144.6±0.68*	8.3±0.22*	4.6±0.3*
CG-1a	6-9 age	37.2±0.2*	37.1±0.8*	37.2±0.6*	47.2±0.2*	3.9±0.7*	2.9±0.2*
	10-13 age	42.1±0.3*	41.8±0.9*	41.6±0.7*	51.7±0.3*	6.1±0.9*	5.1±0.3*
	14-18 age	35.9±0.1*	36.3±0.7*	36.4±0.5*	46.3±0.1*	3.2±0.7*	2.8±0.1*
	Total	38.4±0.2*	38.4±0.8*	38.4±0.6*	48.4±0.2*	4.4±0.8*	3.6±0.2*

Note: CCG – Chronic Catarrhal Gingivitis; CHG – Chronic Hypertrophic Gingivitis; CG – Control Group (without periodontal pathology); *p<0.05 – statistically significant compared to CG; **p<0.05 – statistically significant compared to age groups.

It was also established that the primary microorganisms in the gingival crevice and oral fluid were β-hemolytic streptococci of group A. Additionally, there was an increase in the number of Neisseria spp., such as *Neisseria mucosa*, *Neisseria sicca*, and *Neisseria flavescens*, ranging from 10^5–10^6 to 10^{12}–10^{13} CFU/mL, indicating their dominant presence. A significant increase in the proportion of Candida spp. was also observed, with *Candida albicans* being detected 1.8 and 1.4 times more frequently, respectively.

The analysis of IgA, IgG, and IgM levels in the blood serum of children and adolescents in MG-1a and MG-2a showed that patients with chronic forms of gingivitis had deviations from the control group (CG), with increased immunoglobulin levels in plasma. The highest Ig levels were observed in MG-1a. In the CG, these indicators were nearly identical to the generally accepted norms for healthy children and adolescents. Particularly noteworthy are the results for the 10–13 age group, where IgA, IgG, and IgM levels showed the most significant deviations compared to other age groups, including those in the control group (CG) (Table 5).

Table 5.
Study of Immunoglobulins (IgA, IgG, IgM) in the Blood Serum of Examined Children

Indicators Group		IgA mkmol/l	IgG mkmol/l	IgM mkmol/l
MG-1a. CCG	6-9 age	24.9 (24.3;25.5)*	135.6 (135.1;136.1)*	21.9 (21.2;22.6)*
	10-13 age	32.4 (31.8;32.9)*	143.3 (142.8;143.8)*	25.9 (25.1;26.7)*
	14-18 age	23.1 (23.0;23.2)	137.2 (136.8;137.8)*	20.6 (20.0;21.2)*
	Total	26.8 (26.2;27.5)*	138.7 (138.1;139.3)*	22.8 (22.1;23.5)*
MG-2a. CHG	6-9 age	23.7 (23.1;24.3)*	133.2 (132.7;133.7)*	21.0 (19.1;22.1)*
	10-13 age	31.2 (30.8;31.8)*	140.1 (139.5;140.7)*	24.7 (23.1;26.1)*
	14-18 age	22.5 (22.1;22.9)*	131.4 (131.0;131.8)*	19.1 (18.8;21.8)*
	Total	25.8 (24.8;26.8)*	134.9 (134.2;135.6)*	21.6 (20.8;23.4)*
CG-1a	6-9 age	14.2 (13.6;14.8)	106.1 (105.6;106.7)	11.1 (10.4;11.8)
	10-13 age	18.1 (17.5;18.2)	113.2 (112.6;114.0)	14.9 (13.4;16.2)
	14-18 age	13.9 (13.4;14.4)	105.9 (105.3;106.5)	10.6 (10.0;11.2)
	Total	15.4 (14.4;16.4)	108.4 (107.6;109.2)	12.2 (11.4;13.1)

Note: CCG – Chronic Catarrhal Gingivitis; CHG – Chronic Hypertrophic Gingivitis; CG – Control Group (without periodontal pathology); *Me (median, interquartile range).

One of the key factors in the development and progression of inflammatory periodontal diseases (IPD), especially chronic catarrhal gingivitis (CCG), is the disruption of the local and systemic immune

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status of the body. Additionally, a correlation has been observed between the quantitative levels of microorganisms in saliva and the contents of the gingival sulcus in patients with CCG and chronic hypertrophic gingivitis (CHG).

2. Conclusions

The obtained results for the OHI-S, PLI indices and the indicators of caries in primary and permanent teeth among patients with chronic catarrhal gingivitis (CCG) clearly demonstrate poor oral hygiene ($p < 0.0001$) in children and adolescents with CCG. The presence of carious lesions and gingivitis mutually exacerbate the course of the disease. Bleeding and gum pain during exacerbations hinder effective tooth brushing, which in turn accelerates the caries process. These correlations once again confirm that the initial condition of children and adolescents diagnosed with CCG and chronic hypertrophic gingivitis (CHG) occurs against the background of poor oral hygiene, which worsens with age.

Thus, based on a number of functional and clinical characteristics, it can be concluded that patients with chronic catarrhal gingivitis (CCG) and chronic hypertrophic gingivitis (CHG) exhibit local circulatory disorders in the gums during the chronic course of the disease. These disorders are accompanied by increased vascular tone, decreased peripheral resistance to blood flow, impaired vascular elasticity, and altered blood rheology. Rheographic pulse graph (RPG) was visually characterized by a gently rising section, a rounded peak, and a smoother dicrotic notch, often located in the upper third. The temperature (t_0) of the gums in different areas showed a significant downward trend, decreasing by 0.2–0.8°C. In most cases, these fluctuations were statistically significant. Additionally, a worsening of these indicators or deviations from the average values were observed in correlation with increasing age in children and adolescents.

Studies have shown that the primary microorganisms found in the gingival sulcus (GS) and oral fluid (OF) were β-hemolytic streptococci of group A. Additionally, there was a significant increase in the presence of Neisseria spp., indicating their dominant role. A notable rise in the proportion of Candida spp. was also observed, with Candida albicans being the most frequently detected species. These findings highlight a correlation between local immunological status and microbial composition, with particular attention to the 10–13 age group, where IgA, IgG, and IgM levels showed more pronounced deviations compared to other age groups, including the control group. The observed changes in children and adolescents suffering from chronic forms of gingivitis indicate a weakening of natural defense mechanisms. Neglecting such conditions in dental practice may lead to various complications. Moreover, this issue is a growing concern in clinical dentistry. Several scientific publications have emphasized that, alongside key periodontopathogenic obligate anaerobic pathogens, such cases can contribute to moderate to severe periodontal diseases.

Transparency:

The authors confirm that the manuscript is an honest, accurate, and transparent account of the study; that no vital features of the study have been omitted; and that any discrepancies from the study as planned have been explained. This study followed all ethical practices during writing.

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