

Local oral immunity and psycho-emotional state in military personnel with chronic gingivitis

Yurii Bandrivsky¹, Vasyl Bilan¹, Orysia Bandrivska², Nataliia Malko³, Vasyl Krupei¹

¹Department of Pediatric Dentistry, I. Horbachevsky Ternopil National Medical University, Ternopil, Ukraine

²Department of Orthopedic Dentistry, I. Horbachevsky Ternopil National Medical University, Ternopil, Ukraine

³Department of Pediatric Dentistry, Danylo Halytsky Lviv National Medical University, Lviv, Ukraine

ABSTRACT

Purpose. To analyse the changes in local immunity in the oral fluid of servicemen of the Armed Forces of Ukraine with chronic catarrhal gingivitis depending on their psycho-emotional state.

Material and methods. The study of local oral immunity in oral fluid was conducted in 22 military patients of the Armed Forces of Ukraine with chronic catarrhal gingivitis (main group), in 11 patients of civilian specialties with chronic catarrhal gingivitis (comparison group), and in 16 dentally healthy individuals (control group). Additionally, military patients in the main group were divided into 4 subgroups depending on their psychoemotional state. The determination of sIgA in the oral fluid was performed by the method of Mancini et al. The photoelectrocolorimetric method was used to measure lysozyme activity in the oral fluids of patients. The content of cortisol in the oral fluid of patients in the study groups was determined by a competitive enzyme-linked immunosorbent assay.

Results. As a result of the laboratory studies, it was found that in patients with chronic catarrhal gingivitis, military personnel of the Armed Forces of Ukraine had a 1.2-fold decrease in the content of sIgA in the oral fluid ($p < 0.01$) and lysozyme activity ($p < 0.05$), against the background of an increase in cortisol levels by 61.18 % ($p < 0.01$) compared to the data in the comparison group.

Conclusion. Thus, summing up the data of laboratory studies, it can be stated that patients of the main group (military personnel of the Armed Forces of Ukraine) with chronic catarrhal gingivitis have a more pronounced weakening of local oral immunity, which is manifested by a decrease in sIgA levels and lysozyme activity, compared with similar data in the comparison group (patients of civilian professions) with chronic catarrhal gingivitis. At the same time, the imbalance of immunological parameters deepened with the deterioration of the psychoemotional state of patients in the main group, which was confirmed by an increase in the level of cortisol in the oral fluid.

Keywords: chronic catarrhal gingivitis, military personnel, psycho-emotional state, local oral immunity, oral fluid

INTRODUCTION

In today's challenging circumstances, namely during wartime, the formation of combat units of the Armed Forces of Ukraine is taking place against a backdrop of a high prevalence of somatic diseases, in particular the dentition. The state of health of servicemen, including the state of their oral cavity and periodontal tissues, is the foundation of the combat readiness and combat capability of the Armed Forces of Ukraine. Chronic catarrhal gingivitis is one of

the most prevalent periodontal diseases, characterised by prolonged inflammation of the gums without deep tissue involvement [1,2]. It could lead to a decline in overall health. Systemic factors, including hormonal changes, stress, smoking, and general health, play a significant role in the pathogenesis of chronic catarrhal gingivitis [3,4]. Those in the military, who frequently encounter elevated levels of stress and psycho-emotional strain, are at an increased risk of developing this disease [5,6].

Corresponding author:

Yurii Bandrivsky

E-mail: bandrivsky@tdmu.edu.ua

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It is established that stress can have a deleterious impact on the immune system, thereby reducing its capacity to safeguard the body from infection [7]. One of the primary defence mechanisms within the oral cavity is local immunity, which is provided by secretory immunoglobulin A (sIgA) and other components, including lysozyme [8,9]. A reduction in secretory immunoglobulin A (sIgA) and lysozyme activity may indicate a decline in local immunity, thereby increasing the susceptibility to pathogens [10,11]. The investigation of local immunity in military personnel with chronic catarrhal gingivitis, contingent on their psycho-emotional state, enables the establishment of a correlation between stress and the emergence of inflammatory conditions affecting the oral cavity.

The relationship between local oral immunity and the psycho-emotional state of military personnel is multifaceted, involving both physiological and psychological factors [12-14]. In states of stress, military personnel experience constant activation of the sympathetic nervous system and an increase in cortisol (a stress hormone). The suppressive effect of cortisol on the immune system, particularly on local immunity in the oral cavity [15], can result in a reduction in the protective properties of the oral mucosa. This, in turn, can contribute to the development of infections and inflammatory processes, such as gingivitis or caries [16,17].

Constant stress and emotional strain have been demonstrated to have a detrimental effect on oral health, with the development of detrimental habits such as smoking, poor hygiene, and an unhealthy diet being possible consequences. These factors, in turn, have been demonstrated to weaken the local immunity, thereby contributing to the development of infections, inflammatory diseases, and in some cases even autoimmune reactions [18, 19, 20].

A considerable body of research has identified that persistent psycho-emotional stress exerts a detrimental effect on the nervous system, thereby interacting with the immune system [21-23]. This phenomenon can be observed through the activation of the autonomic nervous system (especially the parasympathetic nervous system), which is responsible for the regulation of numerous physiological processes, including healing and immune defence [24].

The provision of emotional comfort, the absence of anxiety and depression, and psychological support have been demonstrated to be efficacious in the normalisation of immune function and the prevention of the development of oral diseases [25]. For instance, the provision of psychological support to military personnel in conjunction with appropriate pharmacotherapy has been demonstrated to reduce stress hormones and restore normal immune status [26].

The present study is of particular pertinence insofar as it explores the relationship between the psycho-emotional state and local immunity in the oral cavity of military personnel. This exploration is of crucial importance, as it will facilitate the determination of the mechanisms of stress on the occurrence of inflammatory diseases. Furthermore, it will enable the development of effective approaches to the prevention and treatment of chronic catarrhal gingivitis.

MATERIALS AND METHODS

The study was based on the results of laboratory examinations of local oral immunity in 22 military personnel of the Armed Forces of Ukraine with chronic catarrhal gingivitis (the main group), 11 civilian patients with chronic catarrhal gingivitis (the comparison group), and 16 dentally healthy individuals (the control group). In consideration of the findings from our preceding studies [27,28] (in which the psycho-emotional state of servicemen in the Armed Forces of Ukraine was ascertained, encompassing the assessment of reactive and personal anxiety according to the Spielberger-Hanin scale [29] and the determination of stress resistance, Holmes TH, Rahe RH, [30], patients in the primary group were categorized into four subgroups based on their psycho-emotional state: Group I – demonstrated exceptional stress resilience with minimal reactive anxiety; Group II – showed a high level of stress resilience accompanied by low reactive anxiety; Group III – had a borderline level of stress resilience with moderate reactive anxiety; Group IV – presented a low level of stress resilience with elevated reactive anxiety.

The secretory immunoglobulin A (sIgA) levels in oral fluid was detected by the method of Mancini et al. [31]. This method is based on the fractionation of the proteins of the substrate under study with organic solvents and buffer solutions. The formation of protein-buffer complexes alters the photoelectric density of the medium, enabling the photoelectrocolorimeter to display indicators that characterise the Ig content.

Determination of lysozyme activity in oral fluid. Oral fluid was obtained from patients on an empty stomach, 10 minutes after rinsing the mouth with 5ml of saline solution. The samples were centrifuged at 3000 rpm for 15 minutes, and then the supernatant was collected. To ascertain the activity of lysozyme in the oral fluid, a wash of the daily agar culture of *Micrococcus lysodeikticus* (1/15 with phosphate buffer at pH 6.2) was prepared. The resulting micrococcal suspension was standardised using a CFC-2 photoelectrocolorimeter with a green light filter, resulting in an optical density of 0.66. For the purposes of the study, 0.1 ml of diluted oral fluid, 0.4

ml of 1/15 phosphate buffer at pH 6.2, and 2.0 ml of the standardised micrococcal suspension were added to the test tubes. Three control tubes were filled with 0.5 ml of 1/15 M phosphate buffer at pH 6.2 and 2.0 ml of micrococcal suspension. The tubes were incubated in a thermostat at 37°C for 30 minutes, after which the optical density of the contents of the control and test tubes was measured using a CFC-2 photoelectrocolorimeter with a green light filter at a wavelength of 520 nm. In accordance with the calibration tables, taking into account the degree of preliminary dilution of the oral fluid samples, the concentration of lysozyme was determined in mg/ml [32].

Determination of cortisol content in oral fluid. The concentration of cortisol in the oral fluid of patients enrolled in the study was determined by competitive enzyme-linked immunosorbent assay (ELISA) [33] using an ELISA kit from Diametra (Italy).

The studies were conducted in accordance with the provisions and principles set forth in the Declaration of Helsinki for Research Involving Human Subjects, with particular attention paid to the protection of patient confidentiality and the acquisition of informed consent.

Data analysis was performed on a personal computer utilizing licensed software, including Microsoft Excel 2021 and Statistica.

RESULTS

In order to investigate the state of local immunity and local immune response, the levels of sIgA and lysozyme activity in the patients of the study groups were examined. According to the data shown in Figure 1, the level of sIgA in the oral fluid of the control

group was 290.0 ± 11.30 mg/ml. At the same time, in patients with chronic catarrhal gingivitis of both study groups (main and comparison), the level of sIgA was significantly lower than in the control group: by 28.10% in the comparison group and by 37.73% in patients-military personnel of the main group, $p < 0.01$, $p_1 < 0.05$.

The activity of lysozyme in the oral fluid of healthy subjects in the control group was 7.0 ± 0.18 ng/ml and was higher than in patients with chronic catarrhal gingivitis: 24.29 % in the control group and 30.19% in the main group, $p < 0.01$, $p_1 > 0.05$.

The study of sIgA content and lysozyme activity in the oral fluid of patients in the main group according to their psychoemotional state showed (Table 1) that in patients with chronic catarrhal gingivitis with very high and high resistance to stress and low level of reactive anxiety (subgroup I-II), the content of sIgA ranged from 196.25 ± 9.20 mg/ml to 184.13 ± 9.15 mg/ml, $p_1 > 0.05$, and did not differ significantly from the values in the control group (208.50 ± 9.26 mg/ml). At the same time, in patients-military personnel with chronic catarrhal gingivitis at threshold and low resistance to stress with high level of reactive anxiety (subgroups III-IV), the content of sIgA in oral fluid was significantly higher than in the control group: by 17.51 % in subgroup III, $p < 0.05$, and by 18.47% in subgroup IV, $p < 0.01$.

The dynamics of lysozyme levels in the oral fluid of military personnel with chronic catarrhal gingivitis was characterised by a decrease in the data of the studied parameter with the deterioration of their psychoemotional state: from 5.10 ± 0.16 ng/ml in patients of the first subgroup to 4.92 ± 0.15 ng/ml in the second subgroup, which did not differ statistically from the data of patients of the comparison group

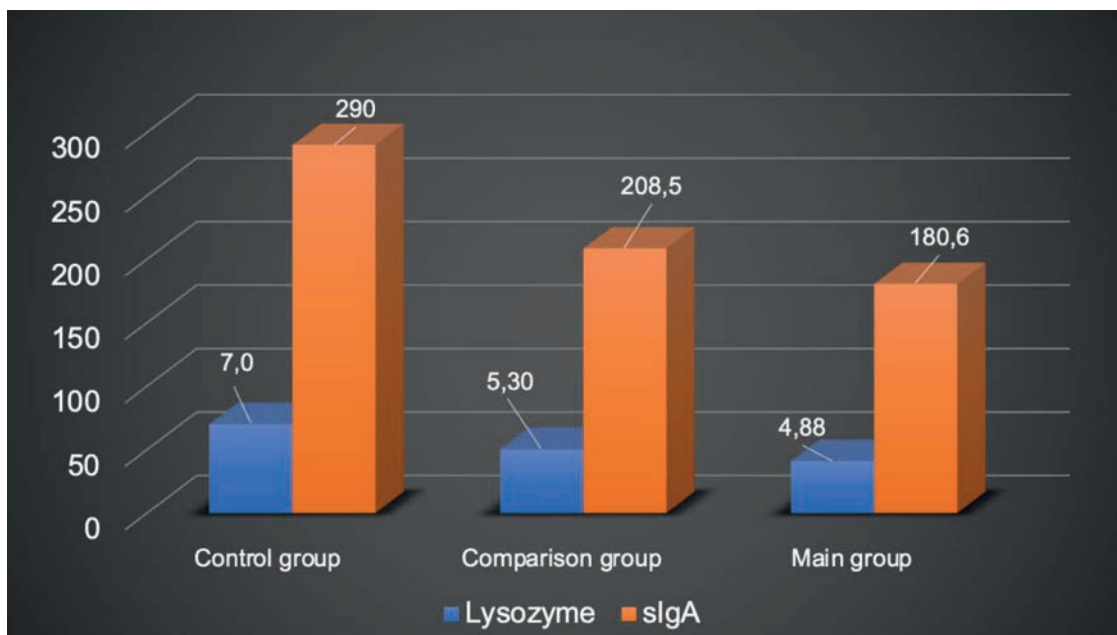


FIGURE 1. The levels of sIgA and lysozyme activity in the oral fluid of the study groups

TABLE 1. Values of sIgA content and lysozyme activity in oral fluid of patients with chronic catarrhal gingivitis of the main group according to their psychoemotional state

Research groups	Indicators	
	sIgA, mg/ml	Lysozyme, ng/ml
Comparison group, (n=11)	208,50±9,26	5,30±0,16
I subgroup, (n=3)	196,25±9,20	5,10±0,16
II subgroup, (n=3)	184,13±9,15	4,92±0,15
III subgroup, (n=9)	172,0±9,00**	4,83±0,14**
IV subgroup, (n=7)	170,0±8,80*	4,70±0,13**

Note:

*p<0,01; **p<0,05 – significant difference in values in relation to the data of comparison group

(5.30±0.16 ng/ml), p>0.05. At the same time, in patients of subgroups III and IV, the data of the studied parameter were 8.87% and 11.33 % lower than in the comparison group, p <0.05.

The study found that military personnel with chronic catarrhal gingivitis had significantly elevated levels of the stress hormone cortisol in their oral fluid (Figure 2).

Thus, it was found that in somatically and dentally healthy persons of the control group the content of cortisol in the oral fluid was 10.28±1.23 nmol/l, which was lower than in the data: by 20.0 % in civilian subjects with chronic catarrhal gingivitis (comparison group), p <0.05, and by 93.48 % in patients-military personnel of the Armed Forces of Ukraine (main group) with chronic catarrhal gingivitis, p <0.01. At the same time, the level of cortisol in oral fluid in patients of the main group with chronic catarrhal gingivitis exceeded the same values in patients of the control group by 61.18 %, p1 <0.01.

Analysis of the values of oral fluid cortisol in patients in the main group according to their psych-

oemotional state showed (Table 2) that only in patients with very high stress resistance and low reactive anxiety the content of oral fluid cortisol did not differ significantly from the values in the comparison group (13.28±2.87 nmol/l vs. 12.34±1.56 nmol/l, p2>0.05).

TABLE 2. Cortisol content in oral fluid of patients-military personnel of the Armed Forces of Ukraine (main group) with chronic catarrhal gingivitis in relation to their psycho-emotional state

Research groups	Indicator
	Cortisol, nmol/l
Comparison group, (n=11)	12,34±1,56
I subgroup, (n=3)	13,28±2,87
II subgroup, (n=3)	15,50±2,92 ††
III subgroup, (n=9)	22,05±3,08 ••, †
IV subgroup, (n=7)	28,71±3,24 •, *, †

Notes:

•p<0,01; ••p<0,05 – significant difference in values in relation to the data of subgroup I

*p1<0,01 – significant difference in values in relation to the data of subgroup II

†p2<0,01; ††p<0,05 – significant difference in values in relation to the data of comparison group

In patients of the main group with high stress resistance and low reactive anxiety (subgroup II), the content of cortisol in oral fluid exceeded the data by 25.60%, p, p2 <0.05, and increased significantly in patients of the third and fourth subgroups: by 78.68 %, p2 <0.01, p1 <0.05, and by 132.66%, p, p1, p2 <0.01, respectively.

DISCUSSION

A study of local oral immunity in military personnel with chronic catarrhal gingivitis revealed

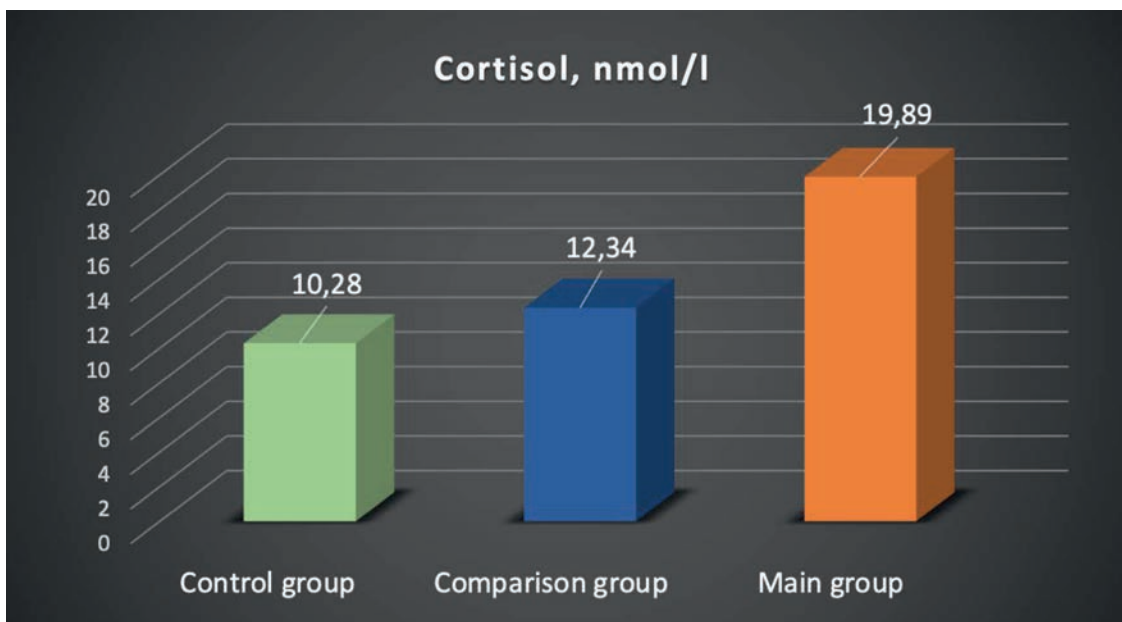


FIGURE 2. Values of the content of cortisol in the oral fluid of the patients in the study groups

significant associations between oral fluid immune parameters and the psychoemotional state of the study participants. Specifically, elevated cortisol levels, a widely recognised biomarker of stress [34], were observed to correlate with diminished levels of secretory immunoglobulin A (sIgA) and lysozyme activity. This observation underscores the deleterious impact of stress on local oral immunity and its role in the progression of gingival inflammation.

Stress-induced suppression of local immunity is a critical factor in the pathogenesis of chronic catarrhal gingivitis [35]. Secretory immunoglobulin A (sIgA) is the primary defence mechanism in the oral cavity, preventing pathogen adhesion and neutralising microbial antigens. A decrease in sIgA concentration increases the vulnerability of the oral mucosa to pathogenic colonisation, potentially exacerbating gum inflammation [36]. Concurrently, a decline in the activity of lysozyme, a key enzyme that facilitates the degradation of the bacterial cell wall, further undermines local immune defence, thereby creating a conducive environment for disease progression [37].

The findings of this study are consistent with those of previous studies that have similarly reported a correlation between psychoemotional stress and immunological dysregulation in the oral cavity. For instance, research has demonstrated that heightened cortisol levels can compromise mucosal immunity, thereby augmenting vulnerability to inflammatory conditions such as gingivitis [15, 38]. Converging findings have been reported by Silva et al. [39], who underscored the pivotal role of stress in modulating the immune system's responses in periodontal disease. Furthermore, Kapila [40] emphasised the intricate relationship between oral health and systemic stress responses, thereby further corroborating the findings of this study.

Further stratification of the military cohort based on stress tolerance and reactive anxiety revealed a gradient of immunological disorders. Subgroups demonstrating lower stress tolerance and higher levels of reactive anxiety exhibited a more pronounced decrease in sIgA and lysozyme levels, as well as significantly increased cortisol concentrations. This finding underscores the interplay between psychological factors and immune function, thereby highlighting the potential for psychological influences to shape dental health outcomes.

In view of these findings, there is an imperative for the integration of psycho-emotional support and stress management strategies into periodontal care protocols for military personnel. Such measures have the potential to mitigate stress-related immunosuppression, thereby enhancing the effectiveness

of conventional therapeutic interventions. Future research should focus on the efficacy of targeted anti-stress interventions and their potential to normalize immune parameters in the oral fluid, thereby reducing the incidence and severity of chronic catarrhal gingivitis. Approaches analogous to this have been advocated by Lee et al. [33] and Takeuchi et al. [9], who explored the impact of anti-stress interventions on immune markers.

In conclusion, the present study underlines the pivotal impact of psycho-emotional stress on local oral immunity and its ramifications for periodontal health. The findings support the adoption of a multidisciplinary approach to oral healthcare, encompassing both clinical and psychological dimensions, to ensure optimal treatment outcomes for military personnel confronted with elevated stress levels.

CONCLUSION

Thus, summing up the data of laboratory studies, it can be stated that patients of the main group (military personnel of the Armed Forces of Ukraine) with chronic catarrhal gingivitis have a more pronounced weakening of local oral immunity, which is manifested by a decrease in sIgA levels and lysozyme activity, compared with similar data in the comparison group (patients of civilian professions) with chronic catarrhal gingivitis. At the same time, the imbalance of immunological parameters deepened with the deterioration of the psychoemotional state of patients in the main group, which was confirmed by an increase in the level of cortisol in the oral fluid.

The findings of this study unequivocally underscore the necessity for a holistic approach to the management of chronic catarrhal gingivitis in military personnel. This comprehensive strategy should encompass not only pharmaceutical interventions but also the remediation of patients' psycho-emotional state. This, in turn, has the potential to enhance the efficacy of dental interventions and restore local immunity. In future, these findings can be used to develop personalised therapeutic programmes that take into account the specifics of the psycho-emotional stress of the military, as well as to develop preventive measures aimed at strengthening local immunity and preventing the development of periodontal tissue diseases under conditions of constant stress and intense physical activity.

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