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Dynamic assessment of the enzyme immunoassay composition of the oral fluid in children with physiological occlusion and anomalies of the dentition

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Abstract

Background. Understanding the dynamics of changes in the immunoenzyme composition of the oral fluid at various stages of treatment will allow the doctor to correctly draw up a treatment plan, predict its timing, and prevent the development of complications.

Aim. Dynamic assessment of the enzyme immunoassay composition of the oral fluid in children with physiological occlusion and anomalies of the dentoalveolar system.

Material and methods. The study groups consisted of 125 children aged 6–12 years with anomalies of the dentoalveolar system receiving treatment with plate and mouth guard orthodontic appliances, and 42 children with physiological occlusion of the dentition. Quantitative determination of total immunoglobulins G, A, M and secretory immunoglobulin A of the oral fluid was carried out before the start of treatment, after 3 and 6 months. Statistical analysis was carried out using IBM SPSS Statistics 20, StatTech v. 1.2.0. Shapiro–Wilk, Kolmogorov–Smirnov, Kruskal–Wallis, Dunn with Holm correction, Friedman, Wilcoxon with Holm correction were used.

Results. In patients with anomalies of the dentoalveolar system, a pronounced increase in the content of secretory immunoglobulin A, total immunoglobulin A in the oral fluid during treatment with a kappa apparatus and a pronounced increase in the content of total immunoglobulin M during therapy with a plate apparatus were found. In children with physiological occlusion, there is a dynamic decrease in the content of secretory immunoglobulin A 6 months after the start of observation. These changes indicate the development of a protective mechanism of a specific immune response of the oral cavity when using orthodontic appliances.

Conclusion. As a result of a dynamic assessment of the enzyme immunoassay composition of the oral fluid in children with physiological occlusion, there was a decrease in the content of secretory immunoglobulin A; in children with anomalies of the dentition, a change in the content of secretory immunoglobulin A, total immunoglobulins A and M was found.

Keywords: enzyme immunoassay composition of the oral fluid, anomalies of the dentoalveolar system, physiological occlusion.

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Background

The mucous membrane immune system is one of the most important factors in the protective reaction of the oral cavity. Immunoglobulins are specific local immune response factors, and they are mainly represented in the oral fluid by secretory immunoglobulin A (sIgA), whereas other classes of general immunoglobulins G, A, and M (IgG, IgA, and IgM, respectively) are much less common.

The period of mixed dentition is a stage of active restructuring of the functional parameters of the maxillofacial region, which may affect the changes in the immune system of the oral mucosa; however, such dynamic studies are currently insufficient [1].

Changes in the levels of immunoglobulins in the oral fluid of children with dentition abnormalities during the period of orthodontic correction are interesting. In most cases, the use of removable and non-removable appliance eliminates the occlusal disorders. Orthodontic construction is perceived by the immune system of the oral cavity as foreign, which leads to a change in the enzyme-linked composition of the oral fluid [2, 3]. Understanding

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Table 1. Analysis of the dynamics of changes in the levels of sIgA, IgA, IgM, and IgG in the oral fluids of children with dentition abnormalities and physiological occlusion (Me, Q_1–Q_3).

Parameter	Group	Follow-up stages		
		Before treatment	After 3 months	After 6 months
sIgA, μg/mL	Control	14.3 [13.1–26.6]	11.4 [10.2–16]	10.2 [10–24]*#
	1	15.7 [13.6–22.2]	25.3 [21.6–26.5]*^	18.5 [12.2–18.9]#^
	2	19.7 [18.1–27.8]	71.8 [70.3–72.8]*^&	33.9 [32.8–37.1]*#&
IgA, μg/mL	Control	65.7 [60–144.9]	73.4 [97–245.6]	76 [65–78]
	1	64.8 [63.6–104.7]	151 [65.4–161]*^	70.8 [70.6–70.9]#^
	2	69.3 [62.1–99.1]	298.5 [293.3–299.8]*^&	117.3 [111.1–127.2]*#^&
IgM, μg/mL	Control	12.9 [7.9–35.9]	10.4 [8.6–19.2]	18.3 [15–20]
	1	10.7 [7.3–14.1]	13.8 [9.6–18.1]*^	29.3 [28.1–31.4]*#^
	2	9.9 [9.1–12.9]	21.5 [20.3–22.6]*&	14.4 [11.4–15.9]*#^&
IgG, μg/mL	Control	10.1 [9–16.8]	13 [11.3–16.4]	11.1 [10.1–19.3]
	1	13.4 [12.5–24.9]	13.5 [11.7–16.8]^	12.1 [9.1–17.2]^
	2	13.5 [12.6–13.9]	31.7 [29.2–34.5]*^&	43.1 [31.6–44.8]*#&

Note: *$p < 0.05$, compared with the values before treatment; #$p < 0.05$, compared with the indicators after 3 months; ^$p < 0.05$, compared with the control group; &$p < 0.05$, compared with the indicators of group 1; Ig, immunoglobulin; sIg, secretory Ig.

the dynamics of changes in the immunoenzymatic composition of the oral fluid at various stages of treatment enables the doctor to make a correct treatment plan, predict its timing, and prevent timely the development of complications. However, there are very few such studies [4, 5].

Aim

The study aimed to perform a dynamic assessment of the enzyme immunoassay composition of the oral fluids in children with physiological occlusion and abnormalities of the dentoalveolar system.

Materials and methods of research

The study groups consisted of 125 patients from the Children's Dental Outpatient Clinic No. 2 in Voronezh, aged 6–12 years, with abnormalities of the dentoalveolar system, and receiving treatment with plate (group 1) and splint (group 2) orthodontic appliances. The control group consisted of 42 children with physiological occlusion of the dentition. A cohort longitudinal prospective study was conducted in 2018–2020.

The research program was approved by the ethical committee of the N.N. Burdenko Voronezh State Medical University (Minute No. 2 dated October 30, 2018).

At the preparatory stage, patients and their parents were informed about the purpose and detailed description of the study procedure. The case follow-up of the patients was performed every 3 months (before the start of treatment, after 3 months, and after 6 months). At all stages, with an empty stomach in the morning, the oral fluid was collected in disposable test tubes. Quantification of levels of IgG, IgA, IgM, and sIgA in oral fluids was performed using the "sandwich" variant of the enzyme-linked immunosorbent assay on a Multiskan Go analyzer (Thermo Fisher Scientific, Finland).

Statistical analysis was performed using IBM SPSS Statistics 20, StatTech v. 1.2.0 (Stattech, Russia). Quantitative indicators were assessed for compliance with the normal distribution using the Shapiro–Wilk test (participants < 50) or the Kolmogorov–Smirnov test (participants > 50). The required number of participants was determined by Lehr's formula for relative values (study power of 80%). In the absence of a normal distribution, quantitative data were described using the median (Me) and lower and upper quartiles (Q_1–Q_3). The comparison of ≥3 groups according to a quantitative indicator, with non-normal distribution, was performed using the Kruskal–Wallis test, and post hoc comparisons were performed using the Holm–adjusted Dunn test. When comparing ≥3 dependent populations, with non-normal distribution, the nonparametric Friedman test was used with post hoc comparisons using the Holm–adjusted Wilcoxon test.

Results and discussion

The dynamics of the changes in the levels of sIgA, IgA, IgM, and IgG in the oral fluids of children with dentition abnormalities and physiological occlusion during the mixed dentition stage was analyzed (Table 1).

When assessing the dynamics of changes in the sIgA level in patients with dentition abnormalities, after 3 months, a significant increase in the sIgA level was noted in groups 1 and 2 ($p = 0.023$ and $p = 0.008$, respectively) with the development of a compensatory reaction after 6 months and a significant ($p = 0.009$ and $p = 0.011$) decrease in the sIgA level in both groups.

Such dynamics may be associated with the main functions of sIgA; i.e., when the hygienic state of the oral cavity deteriorates, it penetrates into the dental plaque and pellicle, decreases the fixation of microorganisms, and accelerates their phagocytosis by neutrophils [6–8]. With the use of orthodontic structures, the hygienic state of the oral cavity worsens, and the local immune response of the oral cavity is activated. Development of adaptive mechanisms and hygienic skills in oral care under new conditions take time. They are formed after 6 months of treatment.

In the control group, a significant ($p = 0.017$) decrease in the sIgA level was detected after 6 months, which may be associated with an increase in mucosal inflammation due to a change in occlusion [9] and required monitoring by parents and a doctor.

The quantitative content of sIgA with initially comparable indicators after 3 months in groups 1 and 2 was significantly higher ($p = 0.027$; $p = 0.016$) than that in the control group; it was significantly higher after 6 months in group 1 ($p = 0.006$) than in the control group. This indicates deterioration in the hygienic state of the oral cavity during the period of using orthodontic appliances and activation of the local immunity of the oral cavity.

The analysis of the dynamics of changes in the level of IgA among patients with dentition abnormalities revealed a significant ($p = 0.018$) increase in the levels of IgA in groups 1 and 2 after 3 months, as well a significant ($p = 0.031$) decrease after 6 months.

According to the literature, IgA enters the oral fluid from the blood serum as a result of extravasation through the inflamed or damaged mucous membrane [10]. We assumed that the cause of the detected dynamics was the high degree of traumatization of the mucous membrane with elements of orthodontic appliances, which was partially eliminated following prosthesis correction during control visits to the dentist. Significantly ($p = 0.019$) higher IgA levels after 3 months in group 2 than in group 1 was associated with a higher protective reaction of the oral cavity and aspects of adaptation of the oral mucosa to the splint. In the control group, we did not detect significant changes ($p = 0.131$) in the total IgA level, which may be due to the absence of systematic damage to the oral mucosa.

When assessing the dynamics of the changes in the level of IgM in patients with dentition abnormalities, a significant ($p = 0.016$; $p = 0.023$) increase was noted in the levels of IgM in the oral fluid after 3 and 6 months in group 1, and a significant ($p = 0.031$) increase after 3 months and then a significant ($p = 0.036$) decrease in IgM levels were noted after 6 months in group 2.

IgM is known to be least capable of penetrating the oral fluid, but can enter the oral cavity through the bloodstream [10]. We also associated the dynamics detected with the traumatization of the oral mucosa and ingress of IgM into the oral cavity through the blood. In the control group, no significant changes ($p = 0.233$) were noted in the dynamics of the level of total IgM, which may be due to the absence of systematic damage to the oral mucosa.

When assessing changes in the level of total IgG, a significant ($p = 0.015$) increase in its levels in the oral fluid was detected in group 2. According to the literature, the detection of IgG in the oral fluid is associated with the entry of polymorphonuclear leukocytes into the oral cavity. Their main source is the crevicular fluid, and a study reported that their number increases sharply with periodontal inflammation, which is typical for the pathogenesis of periodontitis [11]. The dynamics detected may be associated with the effect of the splint apparatus and onset of periodontopathy, which requires the dentist's special attention. In the control group, when assessing the level of total IgM, no significant changes were detected ($p = 0.122$).

Our findings are consistent with those of Godovantes et al., where they revealed an increase in the level of sIgA in patients with dentition abnormalities and explained this as a protective-compensatory mechanism of the specific immune response of the oral cavity [12].

In addition, our results partially agree with those of Kiseleva, who found a decrease in sIgA level in unstimulated mixed saliva in patients with periodontal inflammation and an increase in the levels of total IgA and IgG, which the author attributed to a compensatory immunological response [13].

Thus, the need to monitor the dynamics of changes in the levels of sIgA, IgA, IgM, and IgG in the oral fluid of children with dentition abnormalities and physiological occlusion is beyond doubt. The comparison of the changes in the levels of the enzyme immunoassay composition of the oral fluid in pediatric patients with dentoalveolar abnormalities during treatment using various orthodontic appliances is novel.

A promising direction for further research consists in determining the immunological response of the oral cavity at later stages of orthodontic correction and to other types of medical structures, which enables the doctor to make a correct treatment plan and predict its duration. An impairment of the local immune system in the oral cavity can adversely affect the results and timing of orthodontic treatment.

Conclusions

1. The dynamic assessment of the enzyme immunoassay composition of the oral fluid in children with physiological occlusion revealed a decrease in the level of sIgA.

2. In pediatric patients with dentition abnormalities, a change in the levels of sIgA, as well as total IgA and IgM, was detected.

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Conflict of interest. The authors declare no conflict of interest.

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