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## The Functional State of the Masticatory Muscles and Buccal Epithelium in Children with Various Dental Anomalies.

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### ABSTRACT

A comparative assessment of the bioelectrical activity of the proper masticatory muscles and temporal muscles as well as the cytogenetic stability of the buccal epithelial cells in children with dental anomalies and in children without pathologies was carried out. The parameters of the bioelectric potentials of the temporal and proper masticatory muscles in patients with dental anomalies are found to be higher than in children without pathologies. Analysis of the micronucleus test data for the buccal epithelium of patients with dental anomalies showed an average increase in the incidence of nuclear aberrations of the right and left cheeks compared to healthy children. Correlation analysis showed a relationship between the electromyography indices and the micronucleus test data for the buccal epithelium, which indicates the possibility of integrated application of these techniques. The proposed comprehensive examination can be actively used in modern orthodontics, would improve the quality of treatment and make it possible to predict recovery.

**Keywords:** dental anomalies, bioelectric muscle activity, micronucleous test for buccal epithelium.

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## INTRODUCTION

Orthodontics is currently considered to be one of the most highly-demanded specialty of dentistry. Currently, the number of children with dental anomalies is growing steadily. According to the latest data, every second child in the Russian Federation have one or another anomaly of the dental system [1].

Functional state of the maxillofacial muscles is proved to be closely associated with anomalies of dentition. In the presence of dental anomalies, muscular hyperactivity tends to eliminate occlusive disorders. It can be made, for example, by protruding an “impedient” tooth, which worsens the situation even more. Thus, necessity of monitoring the functional state of the neuromuscular system of the masticatory apparatus during orthodontic correction becomes obvious [2].

This control can be carried out using various investigation methods and their combinations: electromyography, myotonometry, masticography and others. Among diagnostic methods, electromyography holds the key position. It enables assessment of the degree of functional disorders of the nervous tissue and muscles using mathematical analysis of the surface electromyography findings [3].

The number of medical investigations and publications concerning surface electromyography has been steadily increasing over the past 15 years, which indicates an increased interest in it not only from the practical but also from the scientific point of view. According to the PubMed database, the number of publications during 2004 was 1,963 articles, later it gradually increased and reached a maximum in 2014 — 2,654 publications, over the next three years, the figures remained high: 2,631, 2,643 and 2,559 publications, respectively. Such a keen research interest is associated with the search for new methods of diagnosis and treatment of patients [4, 5, 6].

Presently, however, orthodontic correction does not provide for comprehensive diagnostics during all stages of treatment and after its completion. And the result of this is obvious - according to various sources, the number of recurrences exceeds 80% in a few years on the treatment completion [7].

In addition, for modern dentistry, it is not typical to trace the links between various physiological parameters of the dental system activity, while in fact they can be closely related. The revealed dependency may facilitate or accelerate the early diagnosis of anomalies and assess the potential recurrence. We have proposed a comprehensive monitoring of the state of the temporal and proper masticatory muscles using electromyography and monitoring of the incidence rate for cells with nuclear abnormalities in the buccal epithelium [8, 9, 10].

The purpose of this study is to take a comparative assessment of the bioelectrical activity of proper masticatory muscles and temporal muscles as well as the state of the buccal epithelium using a micronucleus test in children with various dental anomalies. To trace the links between the bioelectric activity of muscles and the incidence rate for cells with nuclear abnormalities in the buccal epithelium.

## MATERIALS AND METHODS

The subjects were 65 children with a mixed dentition at the age of 6 - 12 years old, who had been undergoing an orthodontic treatment for no more than 3 months. All patients and their parents were informed about the study design in advance, and their voluntary informed consent was signed [8]. The choice of the age group was due to the active period of development of the dental system, including the muscular apparatuses. That is why, the control of the functional state of the neuromuscular system is especially important. The control group consisted of 20 children without pronounced anomalies of the dental system, who had not undergone a preliminary orthodontic treatment and who had visited the dental clinic for the routine examination.

All examined patients underwent surface electromyography of the temporal muscles and the proper masticatory muscles using a dental four-channel SYNOPSIS electromyograph, and swap samples of dental buccal epithelium on the right and left cheeks were taken.

To assess the state of the muscular apparatuses of the maxillofacial area, a masticatory test was used as a functional research method. With its help, the role of the articular and muscular apparatus in the process of chewing, as well as the intensity and strength of chewing pressure, were evaluated. Masticatory test included chewing four hazelnut kernels for 30 seconds with a simultaneous electromyogram trace. Further, the computer program provided the automatic conversion of an analog signal to a digital one with its subsequent processing.

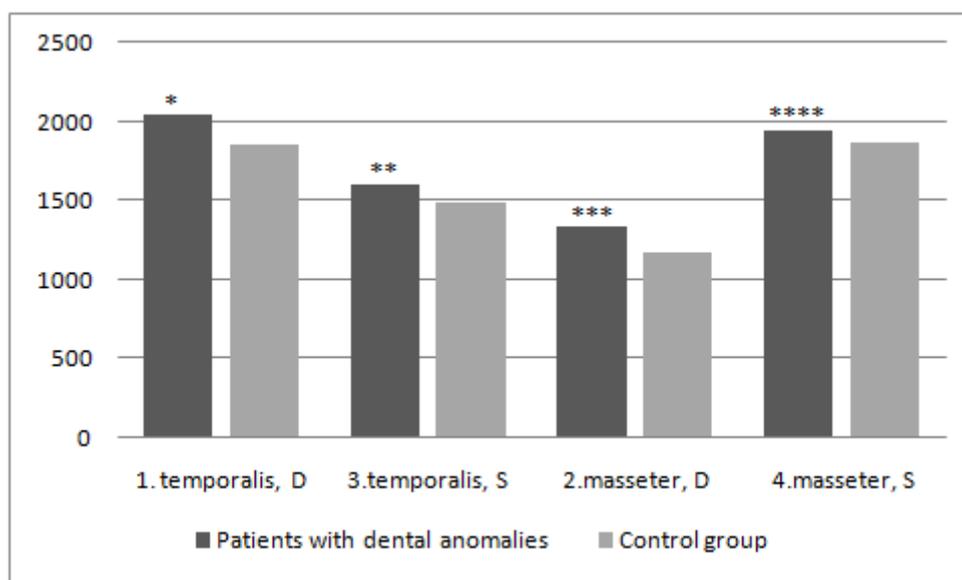
To determine the genetic stability of the buccal epithelium, a micronucleus test was performed. Not less than 1000 cells on each microsample were examined, among which the number of cells with different aberrations of the nucleus was determined (micronucleus, perinuclear vacuole, double nucleus, protrusion, notch, karyorrhexis, karyolysis, karyopicnosis). The examination protocol included the calculation of the incidence rate for cells with each type of disorder as a ratio of the number of cells with one or another aberration to the total number of cells analyzed (%). Also, the frequency of aberrations of all types, as a ratio of total number of cells with disorders to the total number of cells analyzed (%) was calculated.

All data was statistically processed using the SPSS Statistics 20 program. For statistical analysis of the study, the Pearson correlation coefficient was used. Significance was determined by a parametric method with Student's t-distribution. Results were considered to be significant with  $p < 0.05$ .

### RESULTS AND DISCUSSION

Analysis of the electromyography findings within the general chewing test showed that the values of parameters of the bioelectric potentials for the temporal and maxillary-hypoglossal muscles in patients with dental anomalies are significantly higher than in the patients of the control group. Average values of maximum amplitude in patients with dental anomalies are  $2039.2 \pm 20.44 \mu\text{V}$  and  $1609.2 \pm 19.65 \mu\text{V}$  for the right and left temporal muscles, respectively, and  $1334.8 \pm 21.47 \mu\text{V}$  and  $1945.7 \pm 13.81 \mu\text{V}$  for the right and left proper masticatory muscles, respectively. For the control group patients, these figures are considerably lower -  $1860.4 \pm 17.54 \mu\text{V}$  and  $1490.8 \pm 15.67 \mu\text{V}$  for the right and left temporal muscles and  $1180.3 \pm 10.65 \mu\text{V}$  and  $1871.7 \pm 15, 34 \mu\text{V}$  for the right and left proper masticatory muscles, respectively (Table 1; Figure 1).

**Figure 1: Average value of the maximum amplitude ( $\mu\text{V}$ ) for the temporal and proper masticatory muscles in patients with dental anomalies and in the control group**



The average values for a series of experiments are given: differences from the control experimental group ( $p < 0.05$ ); \*differences from the control experimental group ( $p < 0.05$ ); \*\*differences from the control experimental group ( $p < 0.05$ ); \*\*\*differences from the control experimental group ( $p < 0.05$ ); \*\*\*\*differences from the control experimental group ( $p < 0.05$ ).

**Table 1: Average value of the maximum amplitude ( $\mu\text{V}$ ) for the temporal and proper masticatory muscles in patients with dental anomalies and in the control group**

Groups of patients	Average value of the maximum amplitude ( $\mu\text{V}$ )			
	1.temporalis, D	3.temporalis, S	2.masseter, D	4.masseter, S
Patients with dental anomalies	2039.2 $\pm$ 20.44*	1609.2 $\pm$ 19.65**	1334.8 $\pm$ 21.47***	1945.7 $\pm$ 13.81****
Control group	1860.4 $\pm$ 17.54	1490.8 $\pm$ 15.67	1180.3 $\pm$ 10.65	1871.7 $\pm$ 15.34

The average values for a series of experiments are given: differences from the control experimental group ( $p < 0.05$ ); \*differences from the control experimental group ( $p < 0.05$ ); \*\*differences from the control experimental group ( $p < 0.05$ ); \*\*\*differences from the control experimental group ( $p < 0.05$ ); \*\*\*\*differences from the control experimental group ( $p < 0.05$ ). The values are expressed as mean  $\pm$  SD.

The micronucleus test data obtained for the buccal epithelium indicate cytogenetic stability of the buccal epithelial cells. Examination of patients with dental anomalies reveals an increase in the average incidence of nuclear aberrations of  $2.42 \pm 0.24$  and  $3.14 \pm 0.15$  % on the right and left cheeks, respectively. For the control group patients, these indices are considerably lower:  $1.02 \pm 0.27$  and  $1.82 \pm 0.31$  for the right and left cheeks, respectively ( $p < 0.05$ ) (Table 2).

**Table 2: Average incidence of nuclear aberrations in patients with dental anomalies and in the control group**

Groups of patients	Average incidence of nuclear aberrations	
	Right cheek	Left cheek
Patients with dental anomalies	2039.2 $\pm$ 20.44*	1609.2 $\pm$ 19.65**
Control group	1860.4 $\pm$ 17.54	1490.8 $\pm$ 15.67

The average values for a series of experiments are given: differences from the control experimental group ( $p < 0.05$ ); \*differences from the control experimental group ( $p < 0.05$ ); \*\*differences from the control experimental group ( $p < 0.05$ ). The values are expressed as mean  $\pm$  SD.

The Pearson correlation coefficient between electromyography findings and the number of nuclear anomalies for the right and left cheeks was 0.81 and 0.87, respectively. This indicates a direct correlation between the electromyography findings and micronucleus test data for the buccal epithelium.

### CONCLUSION

During this study, it was found that the parameters of the bioelectric potentials of the temporal and proper masticatory muscles in patients with dental anomalies are considerably higher than those in the control group. Analysis of the micronucleus test data for the buccal epithelium of patients with dental anomalies revealed an increase in the average incidence of nuclear aberrations on the right and left cheeks compared to the control group. Correlation analysis showed a relationship between electromyography findings and micronucleus test data for the buccal epithelium, which suggests the possibility of integrated application of these techniques in research activity.

The proposed comprehensive monitoring of chewing efficacy at all stages of orthodontic treatment and after its completion in children aged 6 to 12 years would assess short-term and long-term results of treatment, evaluate the functional alteration of the masticatory muscles, determine the retention period duration, eliminate possible recurrences. All of that can be actively applied to modern orthodontics and improve the quality of treatment.

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