COMPLEX APPROACH IN THE TREATMENT OF ANGLE CLASS III MALOCLUSION

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Abstract

Introduction Class III Angle malocclusion is a sagittal plane dento-maxillary anomaly characterized by mesial molar relationship and reverse frontal offset. Clinical manifestations in childhood class III Angle malocclusion are frequently associated with various disturbances of muscle and neurophysiological activity. There are many published studies in the literature on the alteration of the muscles of the stomatognathic system in orthodontic pathologies. ***Aim of the study*** To determine the functional adaptive activity of the muscles of the stomatognathic system in children associated with Angle class III malocclusion under the influence of orthodontic treatment. ***Material and methods*** The study included 58 children, who were divided into 2 groups, statistically equivalent according to age, gender, facial development, balanced psycho-emotional state. Patients in both groups were investigated by clinical and paraclinical examination methodology which was completed by neuro-physiological examination. The study was based on clinical and paraclinical examination data, methods of diagnosis and orthodontic treatment of Angle class III malocclusion, treated in the orthodontic department and in the dental clinic S.C " Orto-Dental". Electro-neurophysiological investigations were conducted in the Neuronova University Clinic, Republic of Moldova. These technologies have been applied with the investigation of surface electromyography in healthy children and children with Angle class III malocclusion, in conditions of application of different samples (chewing, forced biting, swallowing). ***Results***. Our results demonstrated that the degree of functional maladaptation in the masticatory muscles can be assessed according to 3 criteria: 1) the intensity of functional and adaptive process disturbances; 2) the degree of asymmetry of the functional interaction processes of the muscles; 3) integral indices of functional-adaptive correlation.

Key words: dento-maxial anomaly, neuro-physiological examination, complex approach.

INTRODUCTION

Over the last few years neurophysiological methods have become more widespread in the diagnosis and monitoring of children with Angle class III malocclusion. It has been shown that many of the clinical manifestations in this pathology are associated with the activity of the trigeminal system, but currently the peculiarities of changes in the activity of this system depending on the severity of the disease, the therapeutic methods applied, etc. are not known. In recent years, research has been carried out on the study of trigeminal reflexes with the aim of individualizing orthodontic treatment (11). This aspect of the problem is of great interest, since the clinical manifestations in children with Angle class III malocclusion (orthodontic pain, maladaptive functional disorders in muscle activity, etc.) are associated with the activity of the trigeminal system. It is important to develop comprehensive (clinico-neurophysiological) diagnostic methods, considering that effective treatment of Angle class III malocclusion based on clinical manifestations exclusively is not possible (6;8;9).

There are many publications available referring to the modification of the muscles

of the stomatognathic system in orthodontic pathologies (2). A clear correlation has been established between different variants of occlusion and the EMG pattern of muscles in the head and neck region. In patients with Angle class III, a higher activity of masseter and temporalis muscles has been detected compared to patients with class I and II. It has been established that craniofacial morphological indices essentially influence the activity of the stomatognathic system muscles (3;12).

In patients with occlusal disturbances EMG is applied for predictive purposes for screening, differential diagnosis and monitoring. The authors consider that EMG is not informative enough compared to standard methods of diagnosis of occlusal disorders (7). Therefore, it can be concluded that new technologies and methods of EMG application need to be developed and interdisciplinary investigations need to be carried out to reveal the real diagnostic potential of EMG (e.g.: study of correlations with the trigeminal system, etc.). These studies will also lead to the development of new orthodontic treatment programmes (1;4;10).

The operating hypothesis

A complex diagnosis by combining orthodontic and neurophysiological methods in children with Angle class III malocclusion may lead to increased rehabilitation efficiency by individualizing the healing action on the stomatognathic system.

MATERIAL AND METHODS

The study was based on clinical and paraclinical examination data, diagnostic methods and orthodontic treatment of patients with Angle class III malocclusion, treated in the Orthodontics Department of the Nicolae Testemitanu USMF and the dental clinic D.C. "Orto-Dental", Moldova.

Electroneurophysiological investigations were carried out in the Neuronova University Clinic, Chisinau, R.Moldova. Modern specialized software with Neuro-MVP (Neurosoft) neurophysiological device was applied. The research included clinical-statistical study method with meta-analysis. According to the inclusion criteria: age and gender, psycho-somatic disorders, facial asymmetry, presence of Angle class III malocclusion in association with laterodeviation or mandibular laterognathia, dento-alveolar or skeletal shape, changes in facial aesthetics. As principles of exclusion are Class I and II Angle malocclusions. Anamnesis (daily aesthetic impact), clinical and paraclinical examinations were collected from these patients and results were obtained from them, which will be presented later. The study includes patients who underwent orthodontic treatment with the aim of harmonizing and balancing the functional and static occlusion through a correctly individualized intermaxillary ratio in all three planes: sagittal, transversal, vertical.

During the photostatic, extraoral examination, all the conclusive landmarks of a clear diagnosis are measured (in profile, semi-profile and frontal), which allow trajectories to be defined to assess the morphological parameters.(5,6)

In the frontal aspect, the facial levels, lip-mentum ratios, facial symmetry and smile line are studied. Laterally, the ratio of the lower facial floor to the others, the labial step, the shape of the chin, the labio-mental, nazo-labial and mandibular angles are detected. Performing an accurate photographic analysis is based on parallelism between the actual horizontal plane and the Frankfurt

horizontal, noting actual functional or skeletal disorders.

Regarding the endo-oral analysis, dynamic and static occlusion is established, in accordance with the tonicity of the muscles involved and the functionality of the TMJ, communicating information about the three-dimensional development of the dental arches. As a result, the study models engaged in the articulator were also investigated with a specific supplement in achieving maximum possible aesthetics.

The paraclinical examination started with the panoramic x-ray, which outlines a complex of landmarks through the prism of panoramic radiology. Diagnosis has become more relevant following contemporary methods such as CT, which includes 3D imaging.

The orthodontic treatment option is supported by cephalometric analysis, which according to Tweed's indexes forms a triangle of three planes: the mandibular plane (Gonion- Menton), the Frankfurt plane (Porion-Orbitale), the axis of the frontal teeth of the lower jaw with pros and cons regarding the planning of orthodontic tactics.(5) Under the FMA angle, the skeletal typology in the vertical plane is assessed with values greater than 28º, thus it includes a hyperdivergent development specific to class III Angle malocclusion, which can also assess deviations from the given statement, where its value is in the norm or lower. The IMPA index value asserts a resonance greater than 90º, thus contouring the proclination of the lower incisors to the base of the skull. When presenting the FMIA angle, values of less than 64º are determined, which assess the inclination of the buccal lower incisive axis in relation to the facial skeleton.

An addition to what has been reported is Steiner's analysis which evaluates the SNA, SNB and ANB angles detected as those values which subsequently require treatment tactics either orthodontic, surgical or involving both areas.So ANB angle with values lower and negative than 2º determines a favorable index in treatment planning only orthodontically with a delimitation up to -4º. According to the Witts analysis we can specify skeletal occlusion of class III Angle that up to -2º follows effective and successful results following orthodontic treatment, while on reaching figures beyond the limit we estimate the involvement of the surgical treatment. According to the Witts analysis we can specify skeletal occlusion class III Angle that up to -2º follows effective and successful results following orthodontic treatment, while on reaching figures beyond the limit we estimate the involvement of the surgical treatment. Another important indicator in the detection of malocclusion is the analysis of the Sella turcica angle (Ar-Se-N) according to Jarabak, which informs about the rotation of the lower jaw and facial development, as well as the trajectory and the mandibular growth potential reaching values lower than 120º. The values obtained were adapted and reported using Microsoft Office - Excel software according to the data identified in the medical records.

RESULTS

This study demonstrates another aspect of the complex approach to Class III malocclusion that is less studied - the adaptive peculiarities of the muscles of the stomatognathic system. In recent years in the literature there have been published studies in which the assessment of muscle activity is performed by determination of adaptive possibilities of muscles: EMG-Cp - the coefficient of functional adaptation (plasticity) [Avakyan, Groppa, 2012]. In our studies, we applied these technologies with the investigation of

superficial electromyography in healthy children and children with Angle class III malocclusion, in conditions of application of different samples (chewing, forced biting, swallowing).

In (tab.I) the data regarding EMG-Cp in healthy children are shown - it can be observed that different muscles have a rather high variability of this index.

Tab.I. Indices of functional adaptation of the stomatognathic system muscles (EMG-Cp) in healthy children

Muscles	Functional tests, EMG-Cp index		
	Mastication	AFD	Deglutition
Temporalis anterior (n = 18)	72,5 ± 3,6 (65 – 100)	78,2 ± 4,6 (70 – 100)	38,9 ± 3,2 (30 – 100)
Masseter (n = 18)	76,8 ± 3,4 (70 – 100)	79,7 ± 4,8 (75 – 100)	54,8 ± 4,2 (50 – 100)
Digastricus (n = 18)	96,6 ± 3,8 (85 – 100)	48,9 ± 5,2 (40 – 100)	91,1 ± 3,6 (90 – 100)

NB: the EMG-Cp change range is indicated in brackets

At the first stage, we studied the frequency of cases with EMG-Cp disturbances in children with Angle class III malocclusion before and after treatment in different muscles - m. masseter (Table II), m. temporalis anterior (Table III) and m. digastricus (Table IV).

In order to highlight the particularities of the functional adaptation of the muscles, we performed a series of functional tests (mastication, forced tooth-angle, swallowing), each for 15 seconds, with EMG recording and determination of the adaptation coefficient (EMG-Cp) before and during the test. To be noted, the adaptation coefficient in each muscle is determined in all mentioned functional tests.

Tab.II Frequency of decreased m. masseter functional adaptation indices in children with Angle class III malocclusion under the influence of treatment

Investigation period	Functional tests, EMG-Cp		
	Mastication	AFD	Deglutition
Before treatment	$\frac{34}{58,6\%}$	$\frac{38}{65,5\%}$	$\frac{15}{25,9\%}$
3 years post-treatment	$\frac{4}{6,9\%}$*	$\frac{6}{10,3\%}$*	$\frac{5}{8,6\%}$

NB: * - statistically significant differences ($p < 0.05$) pre-treatment vs. post-treatment.

Tab.III. Frequency of decreased functional adaptation indices of the m. temporalis anterior in children with Angle class III malocclusion under the influence of treatment

Investigation period	Functional tests, EMG-Cp		
	Mastication	AFD	Deglutition
Before treatment	38 / 65,5%	37 / 63,8%	16 / 27,6%
3 years post-treatment	8 / 13,8%*	7 / 12,1%*	4 / 6,9%

NB: * - statistically significant differences ($p < 0.05$) pre-treatment vs. post-treatment.

Tab. IV. Frequency of decreased functional adaptation indices of m. digastricus in children with Angle class III malocclusion under the influence of treatment

Investigation period	Functional tests, EMG-Cp		
	Mastication	AFD	Deglutition
Before treatment	33 / 56,9%	25 / 43,1%	36 / 62,1%
3 years post-treatment	5 / 8,6%*	10 / 17,2%	7 / 12,1%*

NB: * - statistically significant differences ($p < 0.05$) pre-treatment vs. post-treatment.

The obtained results show that in children with Angle class III malocclusion, functional adaptation processes are diminished in the m. temporalis anterior, m. masseter, m. digastricus venter anterior with worsening dysfunctions in the process of mastication, forced tooth angulation and swallowing (functional-dysadaptive disorders).

In (tab. II-IV) EMG-Cp data of muscles studied in different conditions of investigation in children with Angle class III malocclusion under the influence of treatment with appreciation of lateralized (left-right) changes are reported.

Surprisingly, the adaptive capacities of the studied muscles do not have essential (statistically significant) differences of asymmetry indices (left-right), while from literature it is known that classical EMG indices (muscle tone) have significant asymmetry in occlusal pathologies [Кузнецова, Якупов, 2011]. This phenomenon, possibly, can be explained by the inclusion of voluntary (cortico-cerebral) mechanisms in the performance of the mentioned functional tests, which compensate for the functional adaptation disturbances related to the activity of brainstem structures.

Tab. V. Indices of anterior temporal muscle functional adaptation (EMG-Cp) in children with Angle class III malocclusion (n = 58) under the influence of treatment

Functional test	Investigation period	Laterality, EMG-Cp	
		Left	Right
Mastication	Before treatment	52,3 ± 4,3**	59,7 ± 4,2
	3 years post-treatment	58,4 ± 3,2*	58,9 ± 3,9
AFD	Before treatment	53,7 ± 4,0**	60,9 ± 4,3*
	3 years post-treatment	61,2 ± 3,7*	62,3 ± 5,2
Deglutition	Before treatment	24,2 ± 3,1**	28,9 ± 3,8
	3 years post-treatment	27,5 ± 2,7*	29,6 ± 3,6

NB: statistically significant differences in indices in children with Angle class III malocclusion vs. healthy children: * - $p < 0.05$, ** - $p < 0.01$; pre-treatment vs. post-treatment: $p > 0.05$.

Tab. VI. Indices of masseter muscle functional adaptation (EMG-Cp) in children with Angle class III malocclusion (n = 58) under the influence of treatment

Functional test	Investigation period	Laterality, EMG-C_p	
		Left	Right
Mastication	Before treatment	72,3 ± 3,1	71,5 ± 3,7
	3 years post-treatment	74,8 ± 4,2	73,9 ± 3,5
AFD	Înainte de tratament	66,9 ±3,4*	63,8 ± 3,5*
	3 years post-treatment	73,2 ± 4,1	75,4 ± 3,8
Deglutition	Before treatment	41,9 ± 4,8	43,7 ± 3,9
	3 years post-treatment	48,6 ± 5,2	50,8 ± 3,5

NB: statistically significant differences in indices in children with Angle class III malocclusion vs. healthy children: * - $p < 0.05$; pre-treatment vs. post-treatment: $p > 0.05$.

Tab.VII. Indices of digastric functional adaptation (EMG-Cp) in children with Angle class III malocclusion (n = 58) under the influence of treatment

Functional test	Investigation period	Laterality, EMG-C_p	
		Left	Right
Mastication	Before treatment	86,3 ± 1,6**	88,6 ± 0,8**
	3 years post-treatment	89,4 ± 2,9	90,5 ± 1,7
AFD	Before treatment	35,5 ± 4,7	35,3 ± 5,0
	3 years post-treatment	40,3 ± 3,8	39,6 ± 4,4
Deglutition	Before treatment	77,1 ± 3,0**	83,8 ±1,6*
	3 years post-treatment	$85,3 \pm 2,8^x$	$89,5 \pm 2,4^x$

NB: statistically significant differences in indices in children with Angle class III malocclusion vs. healthy children: * - $p < 0.05$, ** - $p < 0.01$; pre-treatment vs. post-treatment: x - $p < 0.05$.

Two more important features are highlighted. The first - the functional adaptive capacity of the anterior m. temporalis, although tending to improve, still differs statistically significantly ($p < 0.05$) from the indices in healthy children. From the literature it is known that the activity of the m. temporalis anterior increases with increasing severity of malocclusion and establishment of Angle class III interocclusal relationships. It should be noted, that also according to Nuno-Licona [Nuno-Licona, 1993], after finishing treatment in patients with Angle class III malocclusion, the activity of the m. temporalis did not change significantly. We can see that in the period after treatment, despite the improvement in the functional adaptation of the muscles studied, there is insufficient compensation of the mandible elevation function (m. temporalis component), which leads to the preservation of deficiencies in masticatory function in these children.

In our studies, we detected low EMG-Cp values in the m. digastricus, especially in the forced tooth-gear test, which is consistent with data published in the literature .

According to recent publications, as in our results, after finishing treatment, in children with Angle class III malocclusion, the m. digastricus activity increases the most compared to the indices before treatment.

In conclusion, it can be seen that the assessment of the effectiveness of rehabilitation of muscle activity in the stomatognathic system in children with Angle class III malocclusion can be made

according to the degree of establishment of indices of functional adaptation of the m. temporalis anterior in the process of mastication, forced angulation of teeth, swallowing and m. digastricus venter anterior in the process of swallowing.

As we determined, under the influence of orthodontic treatment, the re-establishment of the adaptive potential (functional plasticity) of the muscles of the stomatognathic system in children with Angle class III malocclusion occurs in the order of growth: m. masseter - m. temporalis anterior - m. digastricus venter anterior.

Of interest is the interaction of muscles in the aspect of functional adaptation processes (tab. V-VII).

In our studies we applied several functional tests (mastication, forced bite swallowing). The most obvious statistically significant changes were obtained in the EMG-Cp analysis in the teeth forced bite sample.

In children with Angle Class III malocclusion there is a very large difference in the coordination of the adaptive processes of the muscles of the stomatognathic system. Practically, in all the muscles studied the application of correlative analysis revealed a pronounced adaptive failure. Only the adaptive coordination of the masseter-masseter and temporalis-temporalis muscle pair in children with Angle class III malocclusion preserves the character of physiological reactions, even though these correlations are much weaker compared to healthy children. The presence of a maladaptive muscle syndrome, which is typical for children with Angle class III malocclusion, can be observed.

These data are of importance primarily in orthodontic diagnosis - they allow objective assessment of muscle activity in the stomatognathic system and the degree of adaptive dysfunction in coordination of muscle activity.

On the other hand, knowledge of these features creates new possibilities for monitoring the orthodontic treatment process and evaluating the effectiveness of the treatment.

On the basis of the experience gained and the investigations carried out, we can see the importance and necessity of studying and implementing methods of diagnosing the functional state of the trigeminal system and trigeminal reflexes in children with Angle class III malocclusion. The arguments derive from the clinico-neurophysiological peculiarities highlighted in our study and data from the literature.

CONCLUSIONS

1. In patients with orthodontic pathologies occur muscular dysfunctions of neurogenic, inflammatory, traumatic etiology, etc. In many cases, these dysfunctions have asymmetric character, creating an afference of different modality and intensity in the truncal structures with the appearance of the phenomenon of neuromuscular dysregulation.

2. In children with Angle class III malocclusion, adaptive-functional processes are diminished in the m. temporalis anterior, m. masseter, m. digastricus venter anterior with worsening of dysfunctions in the process of mastication, forced tooth angulation and swallowing (functional-dysadaptive disorders).

3. Reestablishment of functional adaptive potential under the influence of orthodontic treatment occurs in order of growth: m. masseter - m. temporalis anterior - m. digastricus venter anterior.

4. In children with Angle class III malocclusion, a complex diagnosis combining traditional orthodontic and modern neurophysiological methods leads to an increase in the effectiveness of rehabilitation by individualizing treatment with a sanogenic action on the stomatognathic system, brainstem structures, trigeminal reflexes and processes of functional adaptation of the muscles of the stomatognathic system.

PRACTICAL RECOMMENDATIONS

1. To optimise the diagnosis and treatment of children with Angle class III malocclusion, it is recommended to assess the functional adaptation of the muscles of the stomatognathic system (EMG-Cp), especially the m. temporalis anterior and m. digastricus venter anterior.

2. Determination of the effectiveness of rehabilitation of occlusal functions in children with Angle class III malocclusion is recommended to be carried out by the combined approach of traditional orthodontic methods and occlusal reflex determination.

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