

DIAGNOSTIC ALGORITHM OF THE MASTICATORY MUSCLE HYPERTONIA IN DENTAL PATIENTS

Makedonova Y. A.^{1,2}, Vorobev A. A.^{1,2}, Kurkina O. N.¹, Kabytova M. V.¹,
Dyachenko D. Yu.¹, Osyko A. N.¹, Yavuz I³

1. Volgograd State Medical University of the Ministry of Health of the Russian Federation, Department of Dentistry INMFO, Volgograd, Russia
2. GBU Volgograd Medical Research Center laboratory of innovative methods of rehabilitation and habilitation, Volgograd, Russia
3. Harran University, Faculty of Dentistry, Department of Pediatric Dentistry, Sanliurfa, Turkey

*Corresponding author: Volgograd State Medical University of the Ministry of Health of the Russian Federation, Department of Dentistry INMFO, Volgograd, Russia
E-mail : mihal-m@yandex.ru

Abstract

It is extremely difficult to diagnose muscle hypertonia due to the variety of clinical manifestations and patients' complaints, and since the disease is often chronic and prolonged, and pain can radiate to any part of the head and neck. Our study is aimed to propose the unique diagnostic algorithm of the masticatory muscles hypertonia as there is not any. We involved and examined 189 patients with the developed diagnostic algorithm. The patients' examination included the survey, taking the life history and anamnesis, the psychoemotional status assessment. The clinical examination was carried out in two stages. At the first stage, the dental status was determined, masticatory muscles were palpated to find out the involuntary muscle contractions. At the second stage, the functional status of the muscles was assessed using additional research methods (electromyographic, ultrasound and laser Doppler flowmetric study). Results. To apply the main and additional methods while patients' examinations at a dental appointment will allow to identify the masticatory muscle hypertonia at an early stage, as well as to determine the etiopathogenetic and physiological aspects of this pathology development. Conclusion. The presented diagnostic algorithm of the masticatory muscle hypertonia contributes to a critical understanding of the provisional diagnosis or to accidentally muscle hypertonia detection.

Clinical Research (HRU IJDOR 2021; 1(2): 39-44)

Key words - diagnostics, algorithm, examination, muscle hypertonia, masticatory muscle.

Introduction

Muscle tone is defined as a residual muscle tension during resting state, or resistance to passive stretch during the voluntary muscle resting (1,2). In other words, this minimum muscle tension is maintained during resting state. Increased muscle tone is one of the main neurological syndromes and nervous system disorders (3). Brain signals are incorrectly transmitted along nerve fibers, misinterpreted, or do not reach their destination, which cause the incorrect, slow response of the muscles. The hypertonia is caused by many factors that provoke excessive tension in any muscle groups, which persists at the resting state. This condition is associated with

psychological stress, anxiety, depression. Therefore, at a dental appointment, it is necessary to assess the psychosocial status in order to identify the cause of this pathology (4).

A dentist makes a provisional diagnosis based on patient's life history, his anamnesis of the disease development and an objective examination data, which subsequently deny or confirms with the help of additional examination methods (5). The final diagnosis is made based on survey data, the results of main and additional examination methods, taking into account the awareness and experience of the doctor. The traditional diagnostic algorithm is presented schematically (Fig. 1).

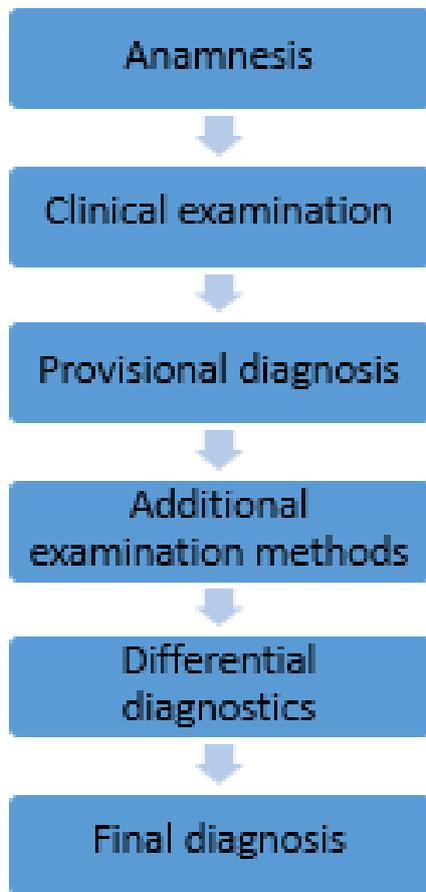


Figure 1. Standard diagnostic algorithm.

However, nowadays, there is no diagnostic algorithm of masticatory muscles hypertonia (6). Developed RDC (research diagnostic criteria) - a special examination protocol to diagnose the TMJ pathology (temporomandibular joint) (7). The table shows diagnoses and mandatory criteria (tab. 1).

Table 1. Research diagnostic criteria, group I

MPS	Mandatory criteria
Myofascial pain	1. Complaints for muscle pain 2. Pain on palpation (three or more muscles) 3. One muscle tension on the side of complaints
Myofascial pain with limited jaw opening	1. Myofascial pain 2. Self-mouth opening without pain less than 40 mm 3. The maximum mouth opening with the doctor's help is 5 mm or more than self-mouth opening.

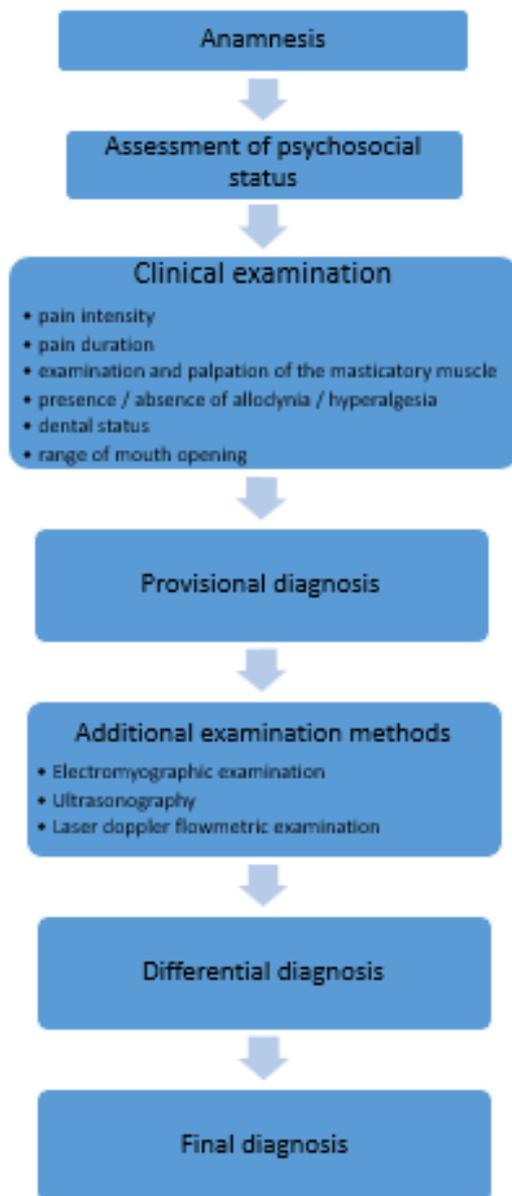
The table shows only group I, since group II characterizes with the TMJ pathology with displacement of the disc, and group III reveals such pathology as arthralgia, osteoarthritis, osteoarthritis. Not every patient with masticatory muscles hypertonia has pain in the temporomandibular joint, not all patients with joint pathology suffer from bruxism, so it is difficult to establish a cause-and-effect relationship. The developed RDC can only be applied in case of suspicion of TMJ pathology; it is inappropriate to use them to diagnose the hypertension. There are many methods to diagnose «muscle hypertonia» (ICD code - 10 - M 24.8.0; F45.8 - other somatoform disorders (bruxism, teeth «grinding»)), however, there is no clear algorithm to diagnose and examine dental patients. This fact caused the purpose of this study. The study is aimed to develop the diagnostic algorithm of the masticatory muscles hypertonia in dental patients.

Material and Methods

To achieve the purpose, 189 patients were examined, they made a dental appointment with caries and its complications, or for a preventive examination. Among patients were 112 (59.2%) women and 77 (40.8%) men. The average age of the patients was 31.8 ± 1.7 years. The examination was carried out according to the developed diagnostic algorithm of masticatory muscles hypertonia (MMH), presented in the diagram.

1. Taking the thorough anamnesis.

Dentists during taking patients history with the masticatory muscles hypertonia pay attention to the presence / absence of the underlying and coexisting diseases, the disease exacerbation (seasonality, intake of irritating food, neuropsychic stress, prosthetics, implantation, change of toothpastes and other hygiene products). We found out the presence of coexisting systemic diseases, such as diabetes mellitus, hypertensive disease, cardiovascular system diseases, gastrointestinal tract, liver and biliary tract, and thyroid gland. If any coexisting disease was detected, the patient was referred to endocrinologist, neurologist, cardiologist, gastroenterologist or others. While taking the anamnesis, we clarified if the patients took any drugs, which could also provoke the disease, and an allergic history was carefully completed. The patients were revealed to have morning chewing muscles pain.



2. Assess the psychoemotional state using the scale of psychological stress PSM-25 (Lemur - Tesier - Fillion).

All patients were asked to fill out a questionnaire. The stress level was determined according to the following gradation by calculating the sum of points for all questions: less than 99 points - low stress level; 100-125 points - average stress level; more than 125 points - a high level of stress.

3. Assess the work of the masticatory muscles using the developed questionnaire.
 4. Perform a visual analysis of gait and movement
 5. Objective diagnostic methods
- a. Conduct an external examination (angle of youth detection).

b. The chewing muscles examination

- to palpate the masticatory muscles and determine the pain in 3 points out of 20 palpation points (one of the pain points must be located on the side of the pain).
 - to assess pain: - on a scale from 0 to 3x (VAS): 0 points - no tension and no pain; 1 point - slight muscle tension, no pain on palpation; 2 points - moderate muscle tension and pain on palpation (discomfort); 3 points - pronounced muscle tension and sharp pain on palpation, the presence of painful muscle induration and / or trigger points).
 - to assess the pain intensity according to the developed scale.
 - to determine the pain duration according to the developed scale
 - to reveal the disability of the lower jaw due to pain according to the developed scale.
 - to determine the masticatory muscle induration
 - to reveal the presence / absence of allodynia, hyperalgesia
 - to assess muscle tone on the MAS scale.
 - to identify involuntary contractions of individual muscular fascicles or muscles
 - to assess the dental status (gum recession, caries and non-carious lesions, pathological changes in the oral mucosa (trauma), pathological abrasion, trismus)
 - to palpate the lymph nodes (to exclude inflammation).
 - to determine the degree of restriction of mouth opening using the developed gnathic device (8).
 - to analyze the pressure changes using the developed gnathic device (9).
6. Additional diagnostic methods.
- to evaluate the work of the masticatory muscles according to the electromyographic study data (10). The masticatory muscle electromyographic study was performed in patients in a sitting position using a four-channel «Synopsis» apparatus and determined the amplitude in mkV at specified loads and at rest.
 - to perform the masticatory muscles ultrasound examination at rest and during exercise.

The masticatory muscles ultrasound examination was performed using an ultrasound device - Voluson E8 Expert; Ultrasonic sensor: linear multifrequency. Volumetric scanning was performed in the area of masticatory and temporal muscles, special attention was paid to trigger points. The masticatory muscle thickness at rest and tension was assessed, and the masticatory muscle cross-sectional area at rest / under load was measured. Focal changes in the structure, induction, ultrasound signs of pathology (the infiltration zone) were revealed.

• to perform the laser Doppler flowmetric study to analyze the state of capillary blood flow in the masticatory muscles.

OPTG, CT if TMJ pathology is suspected. Temporomandibular joint dysfunction is a criterion for exclusion from the study (11).

Results

The presence of coexisted pathology was detected in 5.8% of cases (11 people) among 189 patients; they were referred to a therapist, gastroenterologist and endocrinologist for the treatment of the main pathology. Six (3.2%) people took sedatives, which is a criterion for exclusion from the study, since it is impossible to assess the psychoemotional state of the patient against the background of this pharmacotherapy. Analysis of the PSM-25 psychological stress scale revealed a high level of stress in 135 patients - 160.87 ± 3.08 points. It confirms the fact of the influence of psychoemotional stress on the development of muscle hypertonia. The presence of morning pain after sleep in the area of the masticatory muscles was noted in 104 people (55%).

The following questionnaires were developed to assess the masticatory muscles work, which were given to patients for filling (a certificate of registration of the database was obtained «Screening diagnostics of masticatory muscles hypertonia in adults») (12).

Questionnaire 1. Chewing ability analysis, points

0 - without difficulties

1 - without difficulties, however, the chewing cause certain discomfort

2 - chewing is difficult, but possible due to techniques that reduce spasticity

3 - chewing is difficult and may require necessary techniques to reduce spasticity, worsening mouth opening

4 - chewing food is difficult, some food cannot be chewed due to masticatory muscles hypertension, "blocking" the lower jaw

5 chewing food is impossible, only liquid forms.

Questionnaire 2. Speech analysis, points

0 - without difficulties, loud, fast speech

1 - can speak, but with some discomfort

2 - can speak, but uses certain tricks

3 - can speak, but some effort is required (unclear speech)

4 - speaks hard

6 - unable to pronounce several sentences, does not move lips

Questionnaire 3. Swallowing assessment, points

0 - without difficulties

1 - swallows, but with some discomfort

2 - swallows, but uses certain tricks

3 - swallows, but some effort is required

4 - extremely difficult to swallow

5 - constantly chokes, swallowed

Questionnaire 4. Emotions expression analysis

0 - without difficulties, a conscious increase in emotional manifestations

1 - expresses emotions, but with some discomfort

2 - expresses emotions, but uses certain tricks

3 - expresses emotions with certain difficulties

4 - expresses emotions with difficulties, can not laugh

5 - can not express emotions, does not move lips

The number of points in the analysis of chewing ability was 2.46 ± 0.3 , which indicates that patients have difficulties in chewing food. 17% of the surveyed performed a set of myogymnastic exercises previously prescribed by a dentist, therefore, 2 points were given at this point.

Pronunciation in patients with masticatory muscles hypertonia caused slight difficulties - 1.2 ± 0.8 points. Swallowing and emotions expression on a point scale was 1.3 ± 0.8 points and 1.6 ± 0.1 points. In general, it should be noted that patients are accustomed to constant chronic pain in the area of the masticatory muscles, and they simply did not pay attention to it in everyday life.

Visual analysis of gait revealed deviations in four patients, which was the reason to refer them to a vertebrologist to examine the spine.

External examination showed that there is a loss of the angle of youth in the form of its smoothing in 38% cases. The masticatory muscles spasm contributes to the sagging jowls on the neck (17 people). The effect of sunken eyes (a visually spasmodic masticatory muscle crawled over the lower border of the eye like a roller) was observed in 23% patients.

On palpation of the masticatory muscles, pain was noted on average in 9 out of 20 points, while pronounced muscle tension and pain on the VAS scale were 2.4 ± 0.3 points.

The pain intensity was assessed according to the developed 10-point scale. Patients were asked to assess the pain intensity in the masticatory muscles in the week preceding the survey, from 0 to 10 (0 - no pain, 10 - extremely excruciating pain). The result calculation - the lowest pain intensity + the highest pain intensity + (2 x usual pain intensity) / 4. The average pain intensity was 6.5 ± 1.2 points.

The pain duration was determined according to the developed scale, presented below. (tab. 2)

Table 2. Pain duration scale.

	0	1	2	3	4	5
0 – no pain	38					
1 – less than 10% of the time		6				
2 – 10-25% of the time			117			
3 – 26-50% of the time				16		
4 – 51-75% of the time					8	
5 - >75% of the time						4

The pain duration scale revealed the following results. So, the pain observed in 83% of cases from 10-25% of the time. It should be noted that in 17% of cases, pain was noted almost 50% of the time of the day. The developed lower jaw disability scale is presented below (tab. 3).

Table 3. Scale of assessment of disability of the lower jaw.

	0	1	2	3	4	5
0-no pain	38					
1-pain worries, but does not dysfunction the LJ		8				
2-pain prevents to make some activities, but does not cause the disability			24			
3-disability is partly due to pain				114		
4-pain is one of the reason to prevent performing many activities					4	
5-pain is the main cause of disability						1

In 81% of the surveyed, pain worries in the masticatory muscles, while it is a noticeable cause of the lower jaw disability. Patients are often accustomed to constant chronic pain and only noticed the pain when the doctor paid their attention to it. The pain prevented to make some actions in the rest of the patients, but was not a noticeable cause of the lower jaw disability.

Painful muscle induration was found in 19.6% (37 subjects); it was the reason to refer patients to make the masticatory muscle ultrasound examination, which confirmed a change in the structure of masticatory muscle, its hypertrophy. Allodynia was recorded in 93%, hyperalgesia - 15.6% of cases.

Muscle tone assessment according to the MAS scale confirmed a significant increase in the masticatory muscles hypertonia- 2.4 ± 0.2 points. In 34% of cases, patients complained of headaches, 13 people developed migraines that lasted for weeks.

In 18 people (9.5%), involuntary contractions of individual muscle fiber bundles were revealed. Pathological abrasion was observed in 147 people

(77.8%), while gingival recession (ICD code -10 K.06.0) Miller class I was 65.6%. It should be noted 181 patients (95.8%) had the non-carious lesions in the form of a wedge-shaped defect of varying severity. The mouth opening width was 31 ± 1.3 mm. To determine the degree of mouth opening restriction using the pneumosimulator-mouth expander showed an increase in pressure of more than 0.42 ± 0.14 bar. This numerical value also indicates a limitation of the mouth opening. Crunching, crepitus and clicking of the joint were noted in 7% of cases, which constituted the criteria for exclusion from this study. Thus, using the diagnostic algorithm, the masticatory muscles hypertonia of varying severity was revealed in 80% of cases, the TMJ pathology was revealed in 13 people (7%).

Lymphatic submandibular, submental, cervical and occipital nodes were not palpated; it indicates the absence of inflammation.

Electromyographic study was performed in patients in a sitting position. The sensors were fixed according to the instructions. The data obtained are shown in Table 4 (the case of 30 patients).

Table 4. The EMG test results for "bruxism" detection the case of 30 patients

Parameters	Max. amp. (mkV)	Average amp. (mkV)	Total (mkV*ms)
1.Temporalis D. (M±m)	5359±101	655±49	1816±131
2.Masseter D. (M±m)	4522±128	447±94	1093±187
3.Temporalis S. (M±m)	6018±348	506±85	1445±124
4.Masseter S. (M±m)	4303±146	506±63	1120±158

According to the electromyography data, the total potential of the bruxism test was 10200 ± 1300 mkV. The rather high figures of the maximum amplitude showed the temporal and masticatory muscles tension on the right and on the left, which corresponds to muscle spasticity.

During the masticatory muscles ultrasound examination, a mainly hypoechoic structure was visualized, which was divided by hyperechoic septa.

Induration were found in 43 people; it should be noted that trigger points were identified only in 37 patients on palpation. The masticatory muscle cross-section thickness, which is in hypertonicity, was averaged 11.5 ± 0.3 mm. After chewing load, the cross-sectional thickness significantly increased by 13% and amounted to 13.2 ± 0.2 mm ($p < 0.05$). The obtained data show parafunctional muscle activity, and the masticatory muscles ultrasound examination helps to confirm the disease.

LDF - a metric study showed the microcirculation disturbance in the masticatory muscles. M - the arithmetic mean of the microcirculation index was 27.85 ± 1.2 pf. units, δ - the average deviation (RMS) of the amplitude of blood flow fluctuations from the arithmetic mean (M) was 1.18 ± 0.5 pf. units, Kv - the integral indicator of variation, the calculated parameters which allow to perform a general assessment of the state of hemomicrocirculation - $4.2 \pm 0.8\%$. The obtained data show a lack of blood supply to the masticatory muscles, probably due to damage to muscle cells against the background of a high load.

Discussion

Currently, to make the masticatory muscles hypertonia diagnosis and manage this disease is extremely urgent. Severe hypertonia forms significantly complicate the full mouth debridement. We considered our developed diagnostic algorithm of masticatory muscles hypertonia to be a real solution to this problem. Nowadays, there are researches aimed to improve the quality of dental treatment. Along with the variety of developed treatment methods and treatment prevention protocols, the problem of providing dental care is still unresolved. Knowledge and implementation of the basic and additional methods of examining patients at a dental appointment will allow us to identify masticatory muscles hypertonia at an early stage, to determine the etiopathogenetic and physiological aspects of this pathology. Muscle pain lead to the chronicity; the effect on this pain factor allows you to start the reverse the functional changes in the masticatory muscles hypertonia, which, in turn, will prevent the development of a number of dental complications. An important work for doctors is to increase the effectiveness of dental treatment aimed at improving the dental status of the population.

Conclusion

During disease diagnostic, the dentist makes a provisional diagnosis, the final diagnosis is the result of a deductive analysis of the anamnesis data, complaints. The presented diagnostic method of the masticatory muscles hypertonia contributes to a critical understanding of the provisional diagnosis or to accidentally detect muscle hypertonia. The data of an additional examination method (electromyography, ultrasound) allow you to get more accurate reliable results, to confirm or deny the diagnosis. The presented work describes the diagnostic criteria aimed at identifying and / or interpreting the main masticatory muscles hypertonia symptoms. The proven

techniques contribute to both early diagnosis and random detection of the masticatory muscles' parafunctional activity, even in the absence of complaints, and the final diagnosis of the masticatory muscles' hypertonia.

Author contributions:

MYA. and VAA; conceived the ideas
KMV, DDY, OAN; collected and analyzed the data
KON, AOY; led the writing
IY; design of the manuscript; work with graphic material; editing and processing of the manuscript

Acknowledgements:

The authors thank the local authorities (Volgograd State Medical University) for their support and contributes in this study.

Conflicts of Interest

The authors report no conflicts of interest pertaining to any of the products or companies discussed in this article.

References

1. Beddis H, Pemberton M, Davies S. Sleep bruxism: an overview for clinicians. - Br Dent J. - 2018; 225(6):497-501. PMID: 30237554
2. Ella B, Ghorayeb I, Burbaud P, Guehl D. Bruxism in Movement Disorders: A Comprehensive Review. - J Prosthodont. - 2017;26(7):599-05. PMID: 27077925.
3. Kuhn M, Türp JC. Risk factors for bruxism. - Swiss Dent J. - 2018;128(2):118-24. PMID: 29533049.
4. Guo H, Wang T, Niu X, Wang H, Yang W, Qiu J, Yang L. The risk factors related to bruxism in children: A systematic review and meta-analysis. - Arch Oral Biol. - 2018;86:18-4. PMID: 29149621.
5. Gouw S, de Wijer A, Creugers NH, Kalaykova SI. Bruxism: Is There an Indication for Muscle-Stretching Exercises? - Int J Prosthodont. - 2017;30(2):123-32. PMID: 28267818.
6. Vavrina J, Vavrina J. Bruxismus: Einteilung, Diagnostik und Behandlung [Bruxism: Classification, Diagnostics and Treatment]. - Praxis (Bern 1994). - 2020;109(12):973-8. PMID: 32933386.
7. Cavallo P, Carpinelli L, Savarese G. Perceived stress and bruxism in university students. - BMC Res Notes. - 2016;9(1):514. PMID: PMC5178076.
8. Vorobev A.A., Makedonova Yu. A., Aleksandrov A. V., Sosulya E. Yu. Gnatic device / Patent No.RU 2744236 effective from 04.03.2021 (In Russ.).
9. Makedonova Yu. A. Vorobyov A. A. Osyko A. N., Alexandrov A.V., Pavlova-Adamovich A. G., Stavskaya S. V. Justification of the use of a pneumotanager-rotorasshirator in patients with hypertonus of the masticatory muscles.- Medical Alphabet.- 2021;12: 72-8. (In Russ).
10. Makedonova Yu. A., Vorobyev A. A., Alexandrov A.V., Osyko A. N., Pavlova-Adamovich A. G. Electromyographic indicators of masticatory muscles in children with cerebral palsy / Certificate of state registration of the database No. 2021621050 dated 21.05.2021.
11. Butova A.V., Itskovich I.E., Silin A.V., Sinitina T.M., Maletskiy E. Yu., Kakheli M.A. MRI possibilities of the masticatory muscles alteration diagnostics at musculoarticular temporomandibular joint dysfunction herald of north-western state medical university named after I.I. Mechnikov. - 2016; 8(3): 13-18.(In Russ.)) eLIBRARY ID: 27470076
12. Makedonova Yu. A., Vorobyev A. A., Alexandrov A.V., Dyachenko D. Yu. Screening-diagnostics of masticatory muscle hypertonus in adults // Certificate of registration of the database No. 2021621703 of 11.08.2021, application No. 2021621557 of 29.07.2021 (In Russ.)