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ОСОБЛИВОСТІ ДІАГНОСТИКИ СПАСТИЧНИХ М'ЯЗІВ У ДІТЕЙ РАННЬОГО ВІКУ З ЦЕНТРАЛЬНИМИ ПАРЕЗАМИ

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У статті розглянуто основні методи діагностування наявності спастики в м'язах тулуба і кінцівок, а також ступеня її вираженості в тій чи іншій м'язовій групі. Спочатку було проаналізовано основні сучасні медичні методи визначення ступеня спастичного

стану м'язів від достатньо суб'єктивних (за шкалою Ешворта) (Modified Ashworth Scale for Grading Spasticity), коли діагност сам має відчутти ступінь м'язового опору при виконанні рухів пацієнтом (що може варіювати оцінку в достатньо широкому діапазоні особистих відчуттів) до інструментальних, апаратурних, заснованих на використанні технічних пристроїв. Перш за все це стосується способу м'язової тонометрії, яка за принципом дії тонометра підрозділяється на два види: статичну та динамічну. Розглянуто також можливості відносно складної з технічної точки зору м'язової електроміографії за допомогою спеціального міографа «Міакома». Показана трансформація методів діагностування м'язової спастичності від суто медичних, недоступних для більшості педагогів методів, до більш прийнятних в масовій практиці дошкільних педагогічних і реабілітаційних установ. Мається на увазі методика мануального м'язового тестування за методом пальпації. За її допомогою робиться оцінка спроможності м'язу реагувати збільшенням збудження на розтягування її брюшка, що також потребує спеціальних професійних медичних навичок. До того ж по відношенню до дітей раннього віку зі спастичними формами парезів всі ці медичні техніки підходять лише частково при організації відповідних особливих умов. Більш привабливими виглядають описові ігрові методики, з якими зможе працювати не тільки підготовлений фахівець-медик, а й педагогічний працівник, а також батьки дітей. Насамперед це відноситься до авторських педагогічних тестів М. Єфименка, що призначені для виявлення особливостей тону м'язів як у верхніх, так і в нижніх кінцівках малюків за допомогою доступних рухово-ігрових завдань, до яких діти ставляться позитивно. Представлена удосконалена методика тонічної діагностики м'язів, що пройшла апробацію в практиці корекційного фізичного виховання дошкільнят з порушеннями опорно-рухового апарату.

У статті була зроблена спроба пошуку оптимальних варіантів діагностування патологічного гіпертону м'язів у дітей раннього віку із спастичними формами парезів як за допомогою медичних інструментальних методів, так і використовуючи потенціал педагогічної методики ігрового тестування дітей.

Ключові слова: спастичність, гіпертонус, діагностика, центральні парези, діти раннього віку, ігрові тести.

ОСОБЕННОСТИ ДИАГНОСТИКИ СПАСТИЧНОСТИ МЫШЦ У ДЕТЕЙ РАННЕГО ВОЗРАСТА С ЦЕНТРАЛЬНЫМИ ПАРЕЗАМИ

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В статье рассмотрены основные методы диагностирования наличия спастичности в мышцах туловища и конечностей, а также степени ее выраженности в той или иной мышечной группе. Сначала были проанализированы основные современные медицинские методы определения степени спастического состояния мышц от достаточно субъективных (по шкале Эшворт) (Modified Ashworth Scale for Grading Spasticity), когда диагност сам должен почувствовать степень мышечного сопротивления при выполнении движений пациентом (что может варьировать оценку в достаточно широком диапазоне личных ощущений в инструментальных, аппаратурных, основанных на использовании технических устройств. Прежде всего это касается способа мышечной тонометрии, которая по принципу действия тонометра подразделяется на два вида: статическую и динамическую. Рассмотрены также возможности относительно сложной по технической с точки зрения мышечной электромиографии с помощью специального миографа «Миакома». Показана трансформация методов диагностики мышечной спастичности от чисто медицинских, недоступных для большинства педагогов методов, к более приемлемых в массовой практике дошкольных педагогических и реабилитационных учреждений. Имеется в виду методика мануального мышечного тестирования по методу пальпации. С ее помощью производится оценка способности мышцы реагировать увеличением возбуждения на растяжение ее брюшка, что также требует специальных

профессиональных медицинских навыков. К тому же по отношению к детям раннего возраста со спастическими формами парезов все эти медицинские техники подходят только частично при организации соответствующих особых условий. Более привлекательными выглядят описанию игровые методики, с которыми сможет работать не только подготовленный специалист-медик, но и педагогический работник, а также родители детей. Прежде всего, это относится к авторским педагогическим тестам Н. Н. Ефименко, предназначенные для выявления особенностей тонуса мышц как в верхних, так и в нижних конечностях малышей с помощью доступных двигательных игровых задач, к которым дети относятся положительно. Представлена усовершенствованная методика тонической диагностики мышц, которая прошла апробацию в практике коррекционного физического воспитания дошкольников с нарушениями опорно-двигательного аппарата.

В статье была сделана попытка поиска оптимальных вариантов диагностирования патологического гипертонуса мышц у детей раннего возраста со спастическими формами парезов как с помощью медицинских инструментальных методов, так и используя потенциал педагогической методики игрового тестирования детей.

Ключевые слова: спастичность, гипертонус, диагностика, тонометрия, центральные парезы, дети раннего возраста, игровое тестирование.

PECULIARITIES OF DIAGNOSTICS OF MUSCLE SPASTICITY IN CHILDREN OF EARLY AGE WITH CENTRAL PARES

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The article describes the main methods of diagnosing the presence of spasticity in the muscles of the trunk and limbs, as well as the degree of its severity in a particular muscle group. First, the main modern medical methods for determining the degree of spasticity of

muscles from fairly subjective (on the Ashworth scale) (Modified Ashworth Scale for Grading Spasticity) were analyzed, when the diagnostician himself should feel the degree of muscular resistance when the patient performs the movements (which can vary in a fairly wide range). personal sensations) in instrumental, instrumental, based on the use of technical devices. First of all, it concerns the method of muscle tonometry, which, according to the principle of action of the tonometer, is divided into two types: static and dynamic. The possibilities of muscular electromyography, which is relatively difficult from a technical point of view, were also considered using the special “Miakoma” myograph. The transformation of methods for diagnosing muscle spasticity from purely medical methods that are inaccessible to most teachers to more acceptable in mass practice pre-school pedagogical and rehabilitation institutions is shown. This refers to the method of manual muscle testing by the method of palpation. It is used to evaluate the ability of a muscle to respond by increasing excitation to stretching its abdomen, which also requires special medical professional skills. In addition, in relation to young children with spastic forms of paresis, all these medical techniques are only partially suitable for organizing the relevant special conditions. The description of game techniques looks more attractive, with which not only a trained medical specialist can work, but also a pedagogical worker, as well as parents of children. First of all, this refers to the author's pedagogical tests of N. N. Efimenko, designed to identify the features of muscle tone in both the upper and lower extremities of children with the help of available motor-game tasks, to which children are positive. An improved method of tonic muscle diagnostics is presented, tested in the practice of remedial physical education of preschoolers with disorders of the musculoskeletal system.

In the article, an attempt was made to search for optimal options for diagnosing pathological muscle hypertonia in young children with spastic forms of paresis, both using medical instrumental methods and using the potential of pedagogical methods of game testing of children

Key words: spasticity, hypertonus, diagnostics, tonometry, central paresis, children of early age, game testing.

The article describes the main methods of diagnosing the presence of spasticity in torso muscles and limbs, as well as the degree of its severity in a particular muscle group. First, the main modern medical methods were analyzed for determining the muscles spasticity degree from enough subjective (Modified Ashworth Scale for Grading Spasticity), when the diagnostician himself should feel the degree of muscular resistance when the patient performs the movements (which can vary the evaluation in a fairly wide range of personal sensations) till instrumental, based on the use of technical devices. First of all, it concerns the method of muscle tonometry, which, according to the principle of tonometer functioning, is divided into two types: static and dynamic. The possibilities of muscular electromyography, which is relatively difficult from a technical point of view, were also considered using the special “Miakoma” myograph. The methods transformation for diagnosing muscle spasticity from purely medical methods that are inaccessible to most teachers to more acceptable in mass practice pre-school pedagogical and rehabilitation institutions is shown. This refers to the method of manual muscle testing by the palpation method. It is used to evaluate the ability of a muscle to respond by increasing excitation to stretching its abdomen, which also requires special medical professional skills. In addition, in relation to early age children with spastic forms of paresis, all these medical techniques are only partially suitable for organizing the relevant special conditions. The description game techniques looks more attractive, with which not only a trained medical specialist can work, but also a pedagogical worker, as well as parents of children. First of all, this refers to the author's pedagogical tests of N. N. Efimenko, designed to identify the features of muscle tone in both the upper and lower limbs of children with the help of available motor-game tasks, to which children are positive. An improved method of tonic muscle diagnostics is presented, tested in the practice of remedial physical education of preschoolers with disorders of the musculoskeletal system.

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Key words: spasticity, hypertonus, diagnostics, tonometry, central paresis, early age children, game testing.

The classical definition of spasticity was given by J. Lance [8] in 1980: "Spasticity is a motor impairment that is the part of the syndrome of upper motor neuron failure, characterized by a rate-dependent increase in muscle tone and accompanied by an increase in tendon reflexes as a result of hyperexcitability of stretch receptors."

To assess the level of spasticity, there is a number of medical and pedagogical techniques: from relatively complicated-to-perform classical instrumental electromyography and tonometry (in various modifications) to the use of simpler and more accessible subjective methods of diagnosis in the form of all sorts of scales or visual-palpatory methods.

Since we are interested in the possibilities of corrective physical education of young children with spastic forms of motor impairments, the aim of this article is to search for optimal options for diagnosing the degree of spasticity of various muscle groups in this group of children for more objective planning and subsequent estimation of effectiveness of corrective measures being implemented.

Among the special scales used, the most common is **the modified Ashworth Spasticity Scale** (Modified Ashworth Scale for Grading Spasticity) [5]:

0 – muscle tone is normal;

1 – muscle tone is slightly increased and manifests itself on initial stages of tension with rapid relief;

1-a – a slight increase in muscle tone, which is manifested in a smaller part of the total number of passive movements;

2 – tone is increased moderately throughout the entire passive movement, at this, it is carried out without difficulty;

3 – tone increased significantly, there are difficulties in the process of passive movements;

4 – part of the limb affected by paresis, neither fully bend, nor unbend.

There is a significant moment of subjectivity in definition in the proposed version of determining the degree of spasticity of muscles. We agree with the position of a number of specialists that "...subjective estimation of muscle tone, as well as MFG, is a cumulative impression obtained on the basis of a number of factors that are difficult to take into account: condition of the skin, subcutaneous tissue, muscle elasticity, its reaction to palpation, the ability of the patient to relax, etc. Naturally, the experience of the researcher of this process is a significant factor. The listed features of kinesthetic tonometry, being valuable in certain conditions, create considerable difficulties in comparative estimation of the studied parameter, allowing for broad possibilities for different interpretations.

The existing objective methods of *tonometry* (highlighted by me – N. D.) can be divided into two groups: static and dynamic ones. All devices for these purposes allow deforming the muscle and measuring the deformation index. Static tonometers cause a muscle to flex under own weight, and spring ones – with the help of force of the spring.

Electromyography (highlighted by me – N. D.) reflects the essence of the phenomenon studied more accurately than tonometry by the named methods, but it is technically and methodically more complicated.

Myotonometry with devices of various designs and comparison with the data of kinesthetic tonometry are impossible for one significant reason: The instrumental method allows one single indicator to be recorded – deformation of the muscle. Even the registration of this indicator at short intervals (myotonography) can not be considered adequate to the goal set" [6, p. 12].

Very common today is **the method of manual muscle testing** [1, 2, 3]. It is well known that impairments of the nervous system, as well as functioning of the supporting-motor apparatus, can be *functional* (reversible) and/or *organic*. The functional nature of impairments of the nervous system manifests itself in its inadequate response to following five tasks, and manifests itself during following development stages of functional tension or functional insufficiency:

1. Adequate perception of signals from ecteroceptors, proprioceptors and intraceptors.
2. Transfer of impulse to the spinal cord.
3. Sorting information.
4. Quick response through efferent fibers in case of acute need: mechanical (muscle contraction), chemical (delivery of nutrients) and energy (the amount of ATP required), inclusion of the meridian system.
5. Delivery of information to the upper nervous system.
6. Receiving signals from the overlaying departments and ensuring the implementation of a specific movement.

To solve each of the tasks posed, it is necessary to have certain conditions:

1. Adequate perception of signals from ecteroceptors, proprioceptors and intraceptors:
 - 1.1. Absence of additional irritations in surrounding tissues (trigger zones in the venter of the muscle, its tendons, presence of a scar on the skin).
 - 1.2. The presence of viscerospasm on internal organs.
2. Transfer of impulse to the brain.
3. Quick response through efferent fibers in case of acute need: mechanical (muscle contraction), chemical (delivery of nutrients) and energy (the amount of ATP required), engagement of the meridian system.
 - 3.1. The ability of a particular muscle to respond an incoming signal.
 - 3.1.1. Muscle excitability when polarization changes.
 - 3.1.2. Increased muscle excitability in response to stretching of its venter, a decrease in its excitability in response to stretching of the muscle tendon.
 - 3.2.1. Coordination of muscle contraction between muscles-antagonists.
 - 3.2.2. Increased muscle excitability in response to stretching of muscle-antagonist, a decrease in its excitability in response to stretching of the venter of the muscle-antagonist.
4. Receiving signals from the overlaying departments and ensuring the reply via implementation of a specific movement.

If all these conditions are met, then the muscle is normotonic. If the muscle does not reduce its excitability in response to inhibitory stimulation, then it is considered hypertonic.

From these positions, *the change in muscle tone* is an indicator of functional disorders of a body at different levels of formation of neurological disorganization and a *provoker* of painful muscle syndromes in different regions of the spine and limbs due to their compensatory biomechanical overload...

Muscle testing is an assessment of ability of muscles to respond by increasing excitation by stretching its venter, i. e. analysis of functional state of the tone and strength of the muscle being studied (highlighted by me – N. D.).

For this, it is important:

1. "To create conditions, under which power and tone increase in muscle: it is important to make an isometric contraction of the muscle being studied and perform a movement in which the studied muscle is an agonist.

In addition, it is necessary to exclude the influence of other muscles. For this, it is important to perform the initial position correctly, in which muscle fibers are located along the line of contraction, which makes it possible to complete it with little effort (excluding the engagement of synergists).

2. Correctly assess the strength and tone of the muscle in the form of an increase in strength in 2 to 3 seconds after the onset of isometric muscle contraction due to engage of myotactic reflex "[3, p. 4 - 5].

It is clear that the full implementation of manual muscle testing of early age children will be significantly hampered by a rather complicated procedure that requires a high specialized medical qualification of the diagnostician, due to early age children inability to perform the adult's instructions to the necessary extent. It is necessary to somewhat simplify the diagnostic procedure without losing the informative value of tests.

Interesting in this regard are the ***author's neuro-pedagogical tests*** for revealing features of muscle tone performed in the form of gaming tasks in the passive-static position [4] – here

a child does not need to do anything functionally, and if the movement itself is provided, then it shall be passive, with the help of an adult.

Test "Aircraft Inspection": the subject is asked to reproduce the airplane standing at an airfield while being inspected by a mechanic. From the initial normal standing position, hands should be spread to the sides horizontally, stretched and turned palms up. The angle in the elbow joint is estimated. If it is less than 180° degrees, this indicates the presence of flexural tension in the elbow joint, most likely caused by increased tone of flexor muscles of the forearm.

Test "Flower": from the initial position, sitting on the growth chair (when the thigh and the shin form a right angle between each other), the subject should put his hand on the elbow placing the forearm strictly vertically, the wrist should be as relaxed as possible. Thus, the hand imitates the form of a flower. If the wrist does not reach the level of the horizon in the free passive position, but is slightly or noticeably raised above the horizontal line resembling the "pioneer salute", one can speak of the presence of unnatural hypertone of extensor muscles of the hand, i.e. about spasticity.

Test "Seagull over the boat." From the initial position, sitting on the growth chair or standing, the subject alternately takes each of his hands to the side horizontally, maximally straightening out, straining wrists and pinched fingers. Normally, a wrist should resemble a boat in shape. The wrist shape is estimated in a tensed state: if it does not have a moderate natural concavity (cavus) – presence of hypertension of muscles and ligaments of wrists should be assumed.

Test "Thumb up!" being in a convenient starting position, bend a hand in front of you and show the traditional "thumb up" sign with your thumb, when four small fingers are compressed into a fist, and the big one is pulled vertically upwards in a tensioned state. The shape of the thumb and its location regarding the vertical are evaluated. If there is no natural cavus in the thumb and it is tilted forward along the arm from the vertical line, there is a high probability of tension in its joints caused by the hypertone of corresponding muscles.

Test "Clock": from the initial position of the subject, lying the back in a relaxed state, the diagnostician fixes one of his straightened legs with his hips, and the other one tries to take aside to the maximum possible position gradually, slightly shaking. This is reminiscent of movement of pointers on the clock face. The angle of the leg taken aside is estimated. If taking aside is difficult and does not exceed 50° , and also causes the subject to feel painfully, this is an indicator of abduction limitation of the thigh due to hypertone of the corresponding muscle group.

Test "Froglet": from the initial position of the subject, lying on the back, legs are bent in knees and hip joints, the diagnostician tries cautiously, slightly shaking, to stretch them aside as much as possible until appearance of persistent pain. To fix legs in a stable bent position, you can support feet of the subject child with your knees. Stretching rate of legs is estimated. If thighs are spread with difficulty at a common angle not exceeding 90° and the subject feels pain, this indicates limitation of this function due to hypertone of the corresponding muscle group.

Test "Sentry": the subject is invited to stand on the dais for example, on a wooden cube at "attention" and strain the whole body and legs (like a sentry's honor guard). Pay attention to the shape of legs in knee joints. If legs are slightly bent (i.e., do not straighten at knees completely), this is a sign of flexion tension in legs due to hypertone of corresponding muscle groups.

Test "Pennon": in the initial position of the subject lying on his stomach, alternately bend a leg in knee to a vertical position of the shin, then passively carry out the maximum possible back folding of the foot (with the help of hands of a diagnostician). The leg in this pose resembles a pennon. The angle formed by foot and shank is estimated: if it is more than 60° – it should be a question of stiffness in this ankle joint due to hypertone muscles that perform plantar flexion of the foot.

Certainly, the recommended author's neuro-pedagogical tests are quite suitable for diagnosing the degree of spasticity in young children with central paresis, but they do not

carry any gradation of the degree of spasticity, more precisely, it (this gradation) is subjective enough and depends on sensory features of a diagnostician.

In connection to this, a modified *method for assessing muscle tone in children*, which is deserves attention in the mainstream of our study, is presented [7]: "A way of assessing muscle tone in preschool children. In the method for assessing muscle tone in children by examining and visual-palpatory estimation, according to a useful model, the estimation of muscle tone of body parts is performed based on determination of the amplitude of passive movements using a goniometer, the degree of tensile strength and also elasticity of muscles at rest; after determining these characteristics, a corresponding score from "-3" to "3" is assigned for each part of the body to be evaluated for subsequent estimation of muscle tone on the profile.

The essence of the method is that the estimation of muscle tone in children is carried out by examining estimation of the amplitude of passive movements, the degree of tensile strength, and also the elasticity of muscles in a relaxed state for muscles of anterior and posterior surfaces of right and left halves of the trunk and extremities. The received estimations are recorded in the appropriate minutes, in which the muscle tone in each of studied muscle groups is estimated in accordance with the developed scale:

- the norm is normal muscle tone (normotone);
- minor violations of muscle tone (by hyper- and hypotype);
- moderate violations of muscle tone (by hyper- and hypotype);
- pronounced violations of muscle tone (by hyper- and hypotype).

All included protocol estimates constitute the profile of muscle tone and give a comprehensive picture of its distribution, which is the basis for further remedial and rehabilitation measures.

The method is performed as follows. The study of muscle tone of a child is carried out from the top down, according to the principle of "from head to toes". The muscle tone is examined alternately as follows: neck, upper limbs, chest, stomach, back and lower limbs. The basis of criteria for evaluating the muscle tone, is comprised via several characteristics taking

into account the amplitude of passive movements, which is investigated using a goniometer, the degree of tensile strength and also the elasticity of muscles in a relaxed state. Results of the study are recorded in the appropriate protocol, in which muscle tone in each of the studied muscle groups is evaluated in accordance with the scale of muscular tone estimations developed by us (Table 1).

Table 1.

Estimation scale	Features of muscle tone
"-3"	pronounced muscular hypotension
"-2"	moderate pronounced muscular hypotension
"-1"	insignificantly pronounced muscular hypotension
"0"	normal muscle tone
"+1"	insignificantly pronounced muscular hypertension
"+2"	moderately pronounced muscular hypertension
"+3"	pronounced muscular hypertension

An attractive aspect of this technique is its relative simplicity and accessibility, which allows teachers and physicians to diagnose the tone state of muscles at preschool educational institutions and specialized rehabilitation centers for subsequent planning of necessary corrective measures.

In the method of assessing muscle tone in children in practical diagnostics mentioned above, we found a significant drawback – the impossibility of a finer differentiation of the degree of spasticity from one or another side of the child's body in regard to symmetry-asymmetry. For example, there is a moderately pronounced muscular hypertone in both upper limbs. But even visually it is noticeable that it is expressed more significantly in the right hand. According to the described method, the same value of "+2" should be entered into the minutes for diagnosing the tone of flexor muscles of the forearm on the left and the right hand as well. In our opinion, this technique can be improved by applying even finer differentiation

within each of the proposed gradations by using additional "-" (in case of muscle hypotension) and "+" (in case of muscle hypertension). We can traditionally introduce three more gradations of asymmetry: +2+, +2++, +2+++, which will correspond to insignificant, moderate and severe asymmetry of muscular hypertension within the framework of description of features of muscle tone presented in the original table.

Concluding a brief analysis of main methods of studying muscle tone (spasticity), we should formulate preliminary **conclusions**:

1. Today there are various methods for studying features of muscle tone in children and adults, ranging from simple visual-palpatory tests to complex medical hardware studies. All of them give a fairly accurate picture of the tone state of muscles, including spasticity. But, first of them are based to a large extent on subjective perception of the degree of elasticity (tension) of muscles and can depend on many aspects of the study, which somewhat reduce their accuracy and objectivity. Hardware techniques (myography) are very accurate and objective, but are relatively expensive and unavailable for diagnosing muscle tone in pre-school educational institutions.

2. A compromise between availability of muscle tone research and their objectivity can be found in integration (unification) of elements of visual-palpatory diagnostic methods with fairly simple and accessible hardware techniques. So, for example, carrying out the author's neuro-pedagogical, pedagogical tests will allow a child to relocate the survey procedure quite comfortably as it is performed on a positive emotional-playing background in the form of imaginative tasks-exercises. The degree of spasticity can be determined on the Ashworth scale. But the objective change in spastic muscles due to use of means of correctional physical education can be estimated fairly simple, but at the same time exact method of hardware tonometry based on the use of a mechanical or electronic-mechanical tonometer.

Prospects for research in this area are in the field of practical connection of these three components in a real diagnostic process and development of an appropriate integrated methodology with the required form of documentation.

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