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Diagnostic Characteristics of Vertebrogenic Pain Syndromes in Children

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Annotation: Diagnosing vertebrogenic pain syndromes in children presents significant difficulties related to the peculiarities of clinical manifestations in pediatric practice, the subjectivity of pain sensations, and the limited possibilities of applying a number of instrumental research methods. The clinical manifestations of vertebrogenic pathology in children often have an atypical course, may be disguised as other diseases, or may be asymptomatic for a long time.

Keywords: vertebrogenic pain syndromes, children, clinical manifestations, instrumental diagnostics, spine, pediatrics, pediatric neurology, pain syndrome, functional disorders.

Introduction. Modern instrumental diagnostic methods, including radiography, computed tomography, magnetic resonance imaging, and functional studies of the spine, allow for the detection of structural changes and functional disorders in the musculoskeletal system. However, the interpretation of the obtained data in childhood requires a special approach, taking into account the age-related anatomical and physiological characteristics of the growing organism [1,5]. Despite significant achievements in the field of diagnostics and treatment of vertebrogenic pathology, many issues related to the features of clinical manifestations, diagnostic criteria, and optimal examination algorithms for children with vertebrogenic pain syndromes remain insufficiently studied [2,6]. The lack of unified approaches to diagnosing and assessing the severity of the condition leads to late detection of the pathology, inadequate treatment, and the development of complications [3,7].

In connection with the above, the comprehensive study of the clinical and instrumental features of vertebrogenic pain syndromes in children is a pressing task, the solution of which will contribute to improving the quality of diagnostics, optimizing treatment and preventive measures, and preventing the progression of pathological processes in the spine [4,8].

Purpose of the study: to study the clinical and instrumental features of vertebrogenic pain syndromes in children to optimize diagnostic approaches and improve the quality of medical care.

The study involved 74 adolescents (13-18 years old, students of schools in the city of Samarkand) who had applied to the pediatric neurology department and the consultative polyclinic of the Multidisciplinary Clinic of the Samarkand State Medical University with complaints of spinal pain syndromes. All patients formed the main observation group. The gender distribution included 41 boys (55.4%) and 33 girls (44.6%). Part of the children (n=46; 62.2%) had not previously received specialized treatment and had visited for the first time, while 28 patients (37.8%) had episodes of therapy, predominantly symptomatic, with temporary improvement. Inclusion criteria were the presence of clinically confirmed vertebrogenic pain syndrome, absence of acute infectious diseases, systemic rheumatological pathologies, and spinal injuries in the anamnesis. To clarify the syndromic structure of pain manifestations, patients were divided into subgroups depending on the clinical level

of spinal damage: the cervical level of impairment (cervicalgia, cervicocranialgia) was noted in 21 patients (28.4%); the level of thoracic damage (thoracalgia) in 14 patients (18.9%); the lumbar-sacral level was (lumbalgia, lumboischialgia) in 39 patients (52.7%). Risk factors potentially influencing the formation of pain syndrome were assessed separately, taking into account a thorough analysis of the anamnesis. Thus, among the examined, the following were identified: regular moderate and high-intensity sports loads in 27 children (36.5%); interesting were the peculiarities of the relationship with musical instruments (violin, piano, wind instruments) with pronounced posture asymmetry in 11 patients (14.9%); posture disorders associated with gadget use activity (bentness, hyperlordosis, kyphoscoliosis) in 48 children (64.8%); and idiopathic changes in the form of clinical signs of connective tissue dysplasia (hypermobility, muscle-ligamentous weakness) in 29 children (39.2%). In accordance with the goal of determining the syndromic structure of vertebrogenic pain syndromes, patients of the main group were divided into three subgroups according to the clinical level of spinal damage, which is the most pathogenetically justified approach: I subgroup - cervical level of damage (cervicalgia, cervicocranialgia) 21 patients (28.4%); II subgroup - chest level of lesions (thoracalgia) - 14 patients (18.9%); Subgroup III - lumbar-sacral level of lesion (lumbalgia, lumboischialgia) 39 patients (52.7%). The control group consisted of 40 practically healthy adolescent children, comparable to the main group in age and gender (22 boys and 18 girls), who did not complain of back pain and had no history of chronic diseases of the musculoskeletal system and nervous system. The control group was used to compare clinical, instrumental, and postural indicators.

Research methods included a complex of clinical-neurological, orthopedic, instrumental, and functional assessments. A detailed assessment of pain syndrome was conducted using a visual analogue scale (VAS) and a pain intensity scale (NRS), analyzing the localization, irradiation, and duration of the pain episode. Neurological status was assessed using standard protocols, including the study of muscle tone, reflexes, sensitivity, and assessment of tension symptoms (Laseg, Neri). Orthopedic examination was conducted according to the methodology for determining postural disorders using standard tests (shoulder and pelvic balance, gait lines, Schober test). A separate emphasis is placed on the following diagnostic features: ultrasound examination of paravertebral muscles to assess their thickness, symmetry, and the presence of myofascial consolidations; identification of changes, superficial electromyography (EMG) to determine the functional activity of the musculoskeletal system and to identify muscle-tonic imbalance, are important for differentiation; in some cases, the method of spinal radiography in straight and lateral projections was used to identify scoliotic and kyphotic deformities, flatfoot, spondyloliasis/spondylolisthesis; similarly, clinical and photosturological analysis (computer posturography) was conducted in some adolescents to assess the dynamic and static parameters of posture; according to the standard for examining patients with vertebrogenic functional disorders, questionnaires and functional activity scales (ODI for adolescents, Pediatric Functional Disability Inventory) were used.

To analyze the relationship between pain manifestations and posture disorders, connective tissue dysplasia, and physical exertion, a comparison of the frequency and severity of vertebrogenic syndromes was conducted between the identified subgroups. Additionally, age, gender, body mass index, duration of sports or playing a musical instrument, as well as the presence of concomitant orthopedic pathologies were taken into account.

Statistical data processing was performed using SPSS 26.0. Descriptive statistical methods, $\chi 2$-criterion for the analysis of categorical variables, Student's t-criterion and Mann-Whitney U-criterion for the comparison of quantitative indicators, Pearson/Spearman correlation coefficients for assessing the relationship between clinical, orthopedic, and instrumental parameters were used. The level of statistical significance was taken at $p < 0.05$.

Research results. Analysis of the clinical symptoms in adolescents with vertebrogenic pain syndromes revealed a pronounced heterogeneity of clinical manifestations depending on the level of spinal damage, the nature of physical activity, and the presence of postural disorders. In the main group (n=74), the pain syndrome was predominantly chronic or recurrent in nature, with pain duration

ranging from several weeks to 6 months or more, compared to the control group (n=40), where there were no complaints of back pain.

In the structure of vertebrogenic pain syndromes, lumbosacral pain prevailed, which were detected in 39 patients (52.7%). Neck pain syndrome was diagnosed in 21 children (28.4%), chest pain in 14 patients (18.9%). That is, the greatest clinical load was on the lumbar spine, which is most likely related to its biomechanical vulnerability during periods of intensive growth and increased physical activity. Thus, patients with cervical involvement predominantly complained of local pain in the cervical-occipital region, a feeling of tension, fatigue, tension headaches, and limited neck mobility. Objectively, an increase in paravertebral muscle tone, palpation pain, moderate muscle tone asymmetry were noted, without gross sensory and tendon reflex disorders. At the same time, in patients with impairment at the chest level, complaints of localization between the shoulder blades, a feeling of chest "tension" were noted, which intensified with static exertion and prolonged sitting. Clinically, posture disorders were identified as a type of increased chest kyphosis, local muscle-tonic reaction, and decreased chest excursion.

As a rule, there was no neurological deficit. In the lumbar-sacral subgroup, the clinical picture was most pronounced. The pain was intense, often accompanied by irradiation to the lower extremities, intensification with physical exertion and prolonged standing. Pronounced muscle hypertonia, decreased paravertebral muscle trophism, positive tension symptoms (Laseg), and moderate decrease in tendon reflexes were observed in some patients. It was in this subgroup that repeated appeals and a prolonged course of pain syndrome were more frequently recorded. The intensity and assessment of pain syndrome were conducted on a visual analog scale (VAS), where significant differences were noted between the subgroups. The average level of pain was 4.1±0.9 points in the cervical subgroup and 4.8±1.1 points in the subgroup. An important aspect of the study is determining the relationship between pain syndrome and posture disorders and physical exertion. The examination results of patients in the main group revealed posture disorders in 64.8% of cases and were significantly more common in the lumbar-sacral subgroup (where the significance is $p<0.05$). Connective tissue dysplasia was associated with earlier onset of pain syndrome and its longer duration. Regular high-intensity physical activity, as well as engaging in musical instruments with an asymmetrical posture, significantly correlated with the severity of pain manifestations ($r=0.62$; $p<0.01$). In children who did not have regular loads, the pain syndrome was less intense. Comparative analysis also showed that in patients of the main group, muscle-tonic disorders, tone asymmetry, decreased spinal mobility, and signs of functional postural disorders were significantly more frequently detected compared to the control group ($p<0.001$). Correlation analysis revealed a close relationship between the level of spinal damage and the intensity of pain ($r=0.68$; $p<0.001$), while compared to the severity of postural disorders and the frequency of recurrence of pain syndrome ($r=0.59$; $p<0.01$). The clinical severity of vertebrogenic pain syndromes increases from the cervical to the lumbosacral level of the lesion. The lumbar subgroup is characterized by the highest intensity of pain, high frequency of muscle-tonic disorders, posture disorders, and repeated appeals. In the control group, clinically significant pain and postural disorders were detected extremely rarely. Consequently, vertebrogenic pain syndromes in adolescents have a distinct syndromic structure, depending on the level of spinal damage. The most severe clinical manifestations are characteristic of the lumbosacral region and are associated with posture disorders, high physical activity, and connective tissue dysplasia. Comparison with the control group confirms the significance of the identified clinical and functional changes and justifies the need for early comprehensive diagnosis.

The next stage of the study, no less important and necessary, is the study of instrumental control in adolescent patients suffering from chronic pain syndrome. Instrumental examination was performed on all patients of the main and control groups using ultrasound examination of the paravertebral muscles, surface electromyography, and computer postural analysis. The use of a complex of methods made it possible to objectify functional and structural disorders of the spine and musculoskeletal system and to compare them with clinical and neurological manifestations of pain syndrome.

Ultrasound examination of the paravertebral muscles in patients of the main group revealed changes characteristic of myofascial pain syndrome: heterogeneity of muscle echostructure, decrease in their thickness, asymmetry, and presence of local hypoechogenic zones. The most pronounced changes were noted in the lumbar-sacral subgroup, where muscle thickness asymmetry exceeded 15-20%, and signs of muscle hypotrophy were registered in 61.5% of patients. In the cervical subgroup, functional changes without pronounced trophic insufficiency predominated, while in the thoracic subgroup, the changes were moderate in nature and more often combined with postural disorders. In the control group, the structure of the paravertebral muscles was homogeneous, the asymmetry did not exceed 5%.

The results of the analysis of the study of surface electromyography indicators revealed pronounced muscle-tonic imbalance in most patients of the main group during the study. At the same time, in the cervical subgroup, elevated bioelectric activity of the trapezius and scalene muscles was recorded, which correlated with complaints of local pain and tension headaches. Meanwhile, in the subgroup with chest pathology, asymmetry of paravertebral muscle activity was noted against the background of postural disorders. The most significant EMG changes were identified in patients with lumbar-sacral pain syndrome: decreased bioelectrical activity amplitude, impaired muscle contraction coordination, and signs of chronic overstrain, which were accompanied by higher pain intensity and positive tension symptoms. The correlation analysis conducted between the subgroups of the main contingent of patients and the control group showed a significant correlation between the intensity of pain on VAS and the degree of muscle imbalance according to EMG data had data $r=0.67$; $p<0.001$, in addition, between the decrease in bioelectrical activity and the duration of pain syndrome was $r=-0.59$; $p<0.01$.

Posturological analysis or computer analysis of posture revealed pronounced static-dynamic disorders in adolescents of the main group. At the same time, in the cervical subgroup, displacement of the center of gravity and shoulder girdle asymmetry prevailed, in the thoracic subgroup, increased thoracic kyphosis and rotational components of the spine were noted, and in the lumbar-sacral subgroup, pronounced inclination of the pelvis, asymmetry of the lower extremities, and compensatory curvatures were revealed. Postural balance disorders were significantly more frequently detected in patients with connective tissue dysplasia and high physical activity ($p<0.01$). In the control group, postural analysis indicators corresponded to age norms, without clinically significant deviations. Comparative analysis by subgroups, age, and gender did not reveal significant and significant differences ($p>0.05$). However, in boys, pronounced changes according to EMG and posturology data were registered significantly more often, which is most likely associated with higher physical activity. In girls, signs of connective tissue dysplasia and posture disorders were more frequently detected, especially in the breast subgroup. Compared to the control group, patients in the main group had significantly more pronounced changes in all instrumental parameters ($p<0.001$), which emphasizes the pathological nature of the identified disorders. The most severe changes were identified in patients with lumbosacral pain syndrome, which is manifested by a high frequency of muscle hypotrophy, pronounced EMG imbalance, and gross postural control disorders. In the control group, the indicators corresponded to the physiological norm. Consequently, instrumental analysis results confirm that vertebrogenic pain syndromes in children are accompanied by pronounced functional and structural disorders of the musculoskeletal system and postural control. The degree of instrumental changes is directly related to the level of spinal damage and the intensity of pain syndrome, as well as the presence of risk factors such as high physical activity and connective tissue dysplasia.

Conclusions: The research results confirm the multifactorial nature of vertebrogenic pain syndromes in school and adolescent children and emphasize the leading role of functional and postural disorders in their formation. It has been established that the clinical severity of pain syndrome and the nature of instrumental changes depend on the level of spinal damage, the intensity of physical activity, and the presence of postural disorders. The most pronounced clinical and instrumental changes were identified in patients with lumbar-sacral pain syndrome, which is apparently related to the biomechanical vulnerability of this part of the spine during active growth. Muscle-tonic imbalance, paravertebral muscle asymmetry, and postural control disorders detected through ultrasound, EMG, and postural analysis reliably correlated with pain intensity and disease duration, confirming the significance of

objective instrumental markers in assessing vertebrogenic pain in children. The obtained data also indicate a significant influence of risk factors, such as increased physical activity, exercise, and the presence of connective tissue dysplasia, on the formation and chronicity of pain syndrome. The absence of significant differences in age and gender between subgroups emphasizes the universality of the identified pathogenetic mechanisms, while comparison with the control group made it possible to clearly differentiate pathological and physiological postural changes. Overall, a comprehensive clinical and instrumental assessment provides a deeper understanding of the mechanisms for the formation of vertebrogenic pain syndromes in adolescents and substantiates the need for early identification of risk factors.

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