Vertebrogenic Pain Syndrome in Adolescents with Orthopedic Pathology, Aspects of Therapy

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Abstracts: Relevance. Pain in the cervical, thoracic and lumbar spine is relevant not only for adults, but also for children and adolescents. Scoliosis is a predisposing factor for the development of pain syndrome in the back. Osteopathic techniques allow to expand the arsenal of methods in order to increase the effectiveness of treatment of patients with back pain.The aim of the study was to evaluate vertebrogenic pain syndrome in adolescents undergoing outpatient treatment with the diagnosis of dorsalgia. Materials and Methods: An observational study was conducted to analyze 157 case histories of adolescents (95 (60.5%) girls and 62 (39.5%) boys) undergoing outpatient treatment for dorsalgia diagnosed between the ages of 8 and 17 years. The reliability of differences between the studied groups was assessed by frequency analysis, using Pearson's Chi-squared criterion. All obtained differences were considered at a significance level not lower than $p \leq 0.05$. Results. Among the 157 patients studied, orthopedic pathology (scoliosis of the spine, cervical instability, rotational subluxation of C1-C3, wedge deformity of the thoracic spine, L5 antelisthesis, Spina bifida S1) was diagnosed in 76 (48.4%) patients. Thoracic scoliosis of the 2nd degree was significantly more common in girls ($p=0.043$). L5 antelisthesis was significantly more common in boys ($p=0.019$). Lumbar scoliosis of the 2nd degree was significantly more frequent in the group of patients with moderate pain syndrome (VAS 4-6 points) ($p=0,001$). The cause of low back pain syndrome in 61 (38.9%) adolescents was benign musculoskeletal pain without orthopedic pathology. Conclusion: Vertebrogenic pain syndrome is one of the most frequent reasons for seeking outpatient medical care in adolescents. Detection of orthopedic pathology (scoliosis, instability, wedge deformity of vertebrae) against the background of pain syndrome requires examination by a neurologist, orthopedist and osteopath. The basis of therapy and prevention of back pain in adolescents is non-medication therapy, including osteopathic correction. Osteopathic correction is indicated in the detection of somatic dysfunctions.

Keywords: Dorsalgia in Adolescents, Scoliosis, Orthopedic Pathology, Osteopathy.

1. RELEVANCE OF THE STUDY

Pain in the spine region due to lesions of the bone and ligamentous apparatus, muscles, entheses is a significant problem of modern society [1]. Nonspecific pain in the back, in the thoracic and lumbar spine are frequent reasons for seeking medical help, lead to a decrease in work capacity, quality of life [2, 3, 4]. Various epidemiologic studies have revealed that low back pain syndrome is diagnosed with equal frequency in adults, children and adolescents [5, 6, 7, 8, 9, 10]. According to studies conducted in European countries, Canada, it has been revealed that the prevalence of pain syndrome in the spine region among healthy children and adolescents can differ significantly depending on the country of residence. For example, in Finland, the number of healthy children with back pain is 20% [11]; and in Switzerland, 51% [12], Sweden, 29% [13], and Canada, 33% [14]. Probably, the differences in the frequency of pain syndrome are associated not only with ethnic and age heterogeneity of the studied samples, but also with the lack of common diagnostic criteria. For example, in one and the same group of patients at the age of 11 years the frequency of pain syndrome is 11%, and at the age of 15 years it is already 50% [11]. A higher incidence of back pain syndrome has been found in children with reduced mobility of lower limb joints, trunk asymmetry, and tall stature [15, 16]. The most common external factors that provoke the development of back pain syndrome in students are as follows: overloading of the spine by improper carrying of school bags with a load on one shoulder, compliance with the requirements for the selection of school furniture [17], prolonged work at the computer, excessive TV watching [18], heavy physical household loads [19]. Pain syndrome in the spinal region in children and adolescents can be caused in terms of pathogenesis by posttraumatic, inflammatory, tumor, and stress-overload processes arising from or after sports activities associated with injuries, falls, excessive physical exertion, or sudden movements [20].The etiology of the development of back pain syndromes in children against the background of various spinal deformities remains incompletely understood[21].One of the etiologic factors predisposing to the development of back pain syndrome is scoliosis. Scoliosis occurs in 2 to 39% of the pediatric population [22, 23, 24, 25, 26]. The key issue in understanding scoliosis is its etiology and pathogenesis. Despite the diversity of etiologic theories: genetic, hormonal, neurohumoral, central, neuromyogenic, neurodysplastic, today one can see an almost undiscussed paradox: scoliosis is polyetiologic, yet monoform [27, 28, 29, 30, 31, 32, 33].

Idiopathic scoliosis is a compensatory response to the non-adjacent processes of longitudinal growth of the spinal cord and its musculoskeletal "case" [34, 34]. [34, 35, 36]. An indispensable condition for a healthy organism is its stable vertical position in space [37]. If the efficiency of the body's neurohumoral mechanisms is still insufficient, the supporting column of vertebral bodies and intervertebral discs twists around the longitudinal axis coinciding with the projection of the spinal canal [38, 39, 40].

It is important to note that this torsion is the result of sequential rotation of each superior vertebra over the inferior vertebra [41, 38]. Biomechanically, this process is provided by the rotator muscles on the contralateral side. It is also worth noting that this process is reversible, which is of utmost importance because patients have the opportunity to receive appropriate treatment measures in time to prevent scoliosis [36]. It should be emphasized that the horizontal displacement of vertebrae relative to each other comes from the underlying vertebrae (spiral staircase effect). This leads to the inevitable rotational displacement of the entire cranial spinal column and head in this situation. As a result, there is a displacement of the optical axis. It has been found that when this displacement reaches only 4 degrees, there is a reaction from the muscular system in the form of "strong tonic postural asymmetry of paravertebral muscles" [42, 43, 44, 45]. [42, 43, 44, 45]. In other words, on the contralateral (relative to the rotation of the optical axis of the eyes) side of the spinal column, such an activation of the muscles serving the spine occurs and is observed, which returns the optical axis to the normal average (physiological) position. Thus, restoring balance in the vertebral complex only due to primary torsion leads to the need to compensate for its own result.

This manifests itself in the form of the cranial zone of the vertebral column detorsion, which proceeds simultaneously with the aforementioned primary rotation. This results in the formation of two counter-rotations, or the frontal component of the scoliotic deformity [34, 35, 36]. The same paravertebral muscles realize the process of detorsion, but on the contralateral side [46, 47, 48, 49].

Paravertebral muscles are functionally similar to the stretches or cables of a ship's mast, which provide stability of the spinal column [50, 51]. (They work according to special laws: they relax when their attachment points come close together and tense up when their attachment points move away [52]. Violation of body symmetry, the appearance of non-physiological curves of the spine causes asymmetry of load on muscles, which leads to shortening of some muscles and overstretching of others, while shortened muscles, being in constant tension, hypertrophy, and atrophy develops in overstretched muscles, creating a tendency to further disruption of muscle balance and displacement of bone and ligamentous structures of the spine [53]. As a compensatory response to muscle imbalance, there is formation of fascial adhesions, areas of fibrous degeneration in muscles forced to work in static mode. In the thickness of the degenerated muscles there is compression of blood vessels and compression of nerve trunks and endings, local myofascial and pain syndromes are formed.

Osteopathy offers a biomechanical concept of the development of structural (vertebral) pathological changes. In addition, J.P. Barral and P. Mercier introduced the concept of visceral articulation with its sliding surfaces and ligament system.

In recent years, special attention has been paid to the role of connective tissue (fascia) in the development of musculoskeletal pathology. Disturbances in the form of biochemical and mechanical phenomena lead to fascia dysfunction, in turn generating changes in the physiology of a segment or organ [1]. This concept allows the osteopath and chiropractor to consider spondylogenic dorsalgia as a viscero-somatic reaction and to choose a treatment algorithm aimed at eliminating the cause of dysfunction. The so-called visceral articulations with their sliding surfaces and ligament system, as well as scars, adhesions, and adhesions become the point of application in osteopathic correction. A hierarchy of subordination of anatomical structures has been proposed, in which the spine is in the last position and pathological connective tissue in the priority position.

Among the main osteopathic techniques used in orthopedic practice the following can be emphasized [54]:

- Release of the pleura and pleural sinuses using the V-spread technique. Fascial technique for correction of pulmonary-vertebral connections, release of the upper esophagus, fixation of the esophagus to the lungs. It is performed in orthopedic pathology of the cervical and thoracic spine.
- Fascial technique for releasing the interval pleura. It is performed in orthopedic pathology of the thoracic spine.
- Soft tissue technique of diaphragmatic nerve correction. Can be performed before or after correction of orthopedic pathology of any spine.
- Soft tissue technique for correction of the thoracic abdominal diaphragm.

It is used in orthopedic pathology of any spine, but only after the release of the diaphragmatic nerve.

A detailed description of the above techniques can be found in the specialized literature.

2. MATERIALS AND METHODS

The retrospective study included the analysis of 157 case histories of adolescents (95 (60.5%) girls and 62 (39.5%) boys) undergoing outpatient treatment in the neurology department of the clinical diagnostic center of the National Medical Research Center for Pediatric Orthopedics and Traumatology named after G.I. Turner, St. Petersburg with the diagnosis of dorsalgia from 2017 to 2022. The age of the patients was 11.7 ± 4.8 years. Patients underwent conservative physiotherapeutic treatment (PTL), massage and acupuncture (IRT), osteopathic sessions (depending on the diagnosed osteopathic dysfunction), individual LFK sessions with motor control training, non-steroidal anti-inflammatory drugs (NSAIDs) and myorelaxants were used for moderate pain syndrome. Neurological examination was performed according to the generally accepted methods [55, 56], and pain syndrome was assessed using the visual analog pain scale (VAS). Patients underwent digital radiography of the spine on a Simens Healhineers apparatus. The magnitude of arch curvature was measured using the Cobb-Lippman method [57]. MRI of the spine was performed on a Simens Magnetom Espree 1.5 Tesla tomograph using T1, T2, and T2-STIR sequences in three planes with 3 mm spacing without slice spacing.

Statistical analysis of the obtained data was performed on a personal computer using MS EXCEL and IBMSPSS 23 application program packages. Distribution parameters (frequency analysis) were calculated for all studied parameters in each group. The reliability of differences between the studied groups was assessed by frequency analysis, using Pearson's Chi-squared criterion. For convenience of comparative visualization, quantitative indicators in the studied groups are presented graphically. All obtained differences were considered at a significance level not lower than $p \leq 0.05$.

The distribution of patients with spinal pain syndrome is presented in Table 1.

Table 1. Distribution of patients with spinal pain syndrome (n=157) by gender

Patient's gender	Cervical pain (n)	Thoracic pain (n)	Lumbar pain (n)	Total(n)	p-value
Girls	21	18	56	95	0,743
Boys	11	14	37	62	
Total	32	32	93	157	

significance of differences at $p \leq 0.05$

In a comparative analysis between patients with spinal pain syndrome by gender, no significant differences were found.

3. RESULTS OF THE STUDY

The majority of 93 (59.2%) patients experienced low back pain. Pain in the cervical and thoracic spine occurred with equal frequency in 32 (20.4%) patients. Girls were predominant among patients with spinal pain syndrome: 95 (60.5%), of whom 56 (35.7%) experienced lumbar spine pain and 21 (13.4%) experienced cervical spine pain.

Most patients 130 (82.8%) presented with pain syndrome of mild intensity (1-3 points on the visual analog scale (VAS), 27 (17.2%) patients with moderate pain, and no patients with severe pain, as shown in Table 2. The severity of pain syndrome prevailed in the group of girls: 76 (48.4%) patients with mild pain, 19 (12.1%) with moderate pain. Among boys, 54 (34.4%) adolescents had mild pain, 8 (5.1%) adolescents had moderate pain. Patients with mild pain were prescribed non-medication therapy, which included physical therapy, massage, external agents (diclofenac 5% ointment, traumel C ointment), 15 (9.5%) patients with moderate pain were prescribed non-medication therapy: physical therapy, massage, PTL, osteopathic treatment, and 12 (7.6%) patients with moderate pain included a short course of NSAIDs for 7 days.

Table 2. Distribution of patients by severity of pain syndrome (n=157)

Patient's gender	Mild pain 1-3 points (n)	Moderate pain score 4-6 (n)	Severe pain score 7-8 (n)	p-value
girls	76	19	-	0,25
boys	54	8	-	
total	130	27	-	

significance of differences at $p<0.05$

As a result of comparative analysis between patients in terms of pain syndrome severity, no significant differences were obtained.

- In moderate persistent pain syndrome 27 patients were prescribed a short course of NSAIDs and myorelaxants. 11 patients (7 to 12 years old) were prescribed ibuprofen 0.2 mg. 1 tablet 2 times a day for 7 days, tolperisone 0.05 mg. 1 tablet 1 time a day in the evening for 7 days. 16 patients, over 12 years old, took nimesulide 0.1 mg. by 1 sachet 2 times a day for 7 days, diclofenac 0.05 + pyridoxine 0.05 + thiamine 0.05 + cyanocobalamin 0.0025 by 1 caps. 2 times a day for 7 days. In the form of ointment were used: diclofenac 5%, traumel C 2 times a day for 10 days. 9 patients with pain syndrome in the cervical spine underwent soft tissue technique of diaphragmatic nerve correction. 12 patients with pain syndrome in the thoracic spine underwent fascial technique of interval pleura release. 18 patients with pain syndrome in the area of the lumbar spine underwent soft tissue technique of the thoracolumbar diaphragm correction. The result of drug therapy and osteopathic correction was a decrease in the intensity of pain syndrome, which allowed to stop further use of medications. In the future, the patients continued non-medication treatment in the form of physical therapy and massage.

Pain syndrome in 76 (48.4%) adolescents developed against the background of diagnosed orthopedic pathology (cervical instability, scoliosis of the spine of 1, 2 stages, antelisthesis, wedge-shaped deformity of the vertebrae, and S1 vertebral arch malalignment), and no bone-traumatic pathology was found in 81 (51.6%) patients with back pain. The distribution of patients with orthopedic pathology is presented in Table 3.

Table 3. Distribution of patients with orthopedic pathology (n=76) by gender

Patient's gender	girls	boys	p-value
Cervical instability	2	4	0,232
Rotational subluxation of C1-C3	3	1	0,446
Cervical scoliosis.	2	1	0,72
Scoliosis of the thoracic section of the 1st degree.	5	6	0,421
Scoliosis of the thoracic section, stage 2.	5	0	0,043*
1st degree lumbar scoliosis.	15	10	0,674
Grade 2 lumbar scoliosis.	6	1	0,103
AntelisthesisL5	0	4	0,019*
Clinical defect of the thoracic region	4	4	0,692
SpinabifidaS1	1	2	0,408
Total	43	33	0,105

significance of differences at $p<0.05$

As a result of comparative analysis between groups of boys and girls with orthopedic pathology, reliable differences were obtained. Thoracic 2-degree scoliosis was significantly more common in girls (p=0.043). AnthelisthesisL5 was significantly more common in boys (p=0.019).
The correlation of pain syndrome severity and orthopedic pathology is presented in Table 4.

Table 4. Correlation of pain syndrome severity and orthopedic pathology

YOURS	1-3 points	4-6 points	p-value
Cervical instability	6	-	0,27
Rotational subluxation of C1-C3	4	-	0,374
Cervical scoliosis.	3	-	0,445
Scoliosis of the thoracic section of the 1st degree.	10	1	0,511
Scoliosis of the thoracic section, stage 2.	4	1	0,79
1st degree lumbar scoliosis.	21	4	0,972
Lumbar scoliosis, grade 2.	2	5	0,001*
AntelisthesisL5	3	1	0,604
Clinical defect of the thoracic region	8	-	0,196
SpinabifidaS1	3	-	0,445
Total	64	12	0,001*

significance of differences at $p<0.05$

When comparing the groups by pain syndrome, reliable differences were obtained. Lumbar scoliosis of the 2nd degree was significantly more frequent in the group of patients with VAS with 4-6 points. The number of all orthopedic pathologies was significantly more frequent in the group of patients with VAS 1-3 points.

In patients with wedge-shaped deformity of the thoracic spine, antelisthesisL5, spinabifidaS1, the pain syndrome did not exceed 1-3 points on the VAS scale and did not require prescription of NSAIDs, and the use of physical therapy, massage, electroprocedures, and osteopathic correction made it possible to control the pain syndrome.

Conclusions:

Among the 157 adolescents who presented with back pain, 76 (48.4%) were diagnosed with orthopedic pathology: scoliosis of the spine, cervical instability, rotational subluxation of C1-C3, wedge deformity of the thoracic spine, antelisthesisL5, SpinabifidaS1. No significant differences were found between the groups of boys and girls with spinal pain syndrome by sex and intensity of pain syndrome severity. Thoracic scoliosis of the 2nd degree was significantly more common in girls (p=0.043). AntelesthesiaL5 was significantly more common in boys (p=0.019). Lumbar scoliosis of the 2nd degree was significantly more frequent in the group of patients with moderate pain syndrome (VAS 4-6 points) (p=0,001). The cause of low back pain syndrome in 61 (38.9%) adolescents was benign musculoskeletal pain without orthopedic pathology.

The basis of therapy and prevention of musculoskeletal back pain in adolescents is non-medication therapy. Among the methods, individual exercises with training in motor control, preservation of daily activity, and physiotherapeutic treatment are the most effective. Osteopathic correction is indicated when somatic dysfunctions are detected. Moderate pain in the spine (5-6 points on the VAS scale), persisting against the background of non-medication treatment may be an indication for short-term (7 days) administration of NSAIDs.

Conclusion.

Vertebrogenic pain syndrome is one of the most frequent reasons for seeking outpatient medical care in adolescents. Detection of orthopedic pathology (scoliosis, instability, wedge deformity of vertebrae) against the background of pain syndrome requires examination by a neurologist, orthopedist with the involvement of an osteopath. The basis of therapy and prevention of back pain in adolescents is non-medication therapy, including osteopathic correction. Osteopathic correction is indicated in the detection of somatic dysfunctions.

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The group of authors testifies that there is no conflict of interest in preparation for the publication of their article.

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