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## Regarding the question of hyperdiagnosis of vertebrogenic syndromes

I. F. Fedotova<sup>1</sup>, N. Yu. Prytula<sup>1</sup>, O. V. Kovernyk<sup>2</sup>

<sup>1</sup> Sytenko Institute of Spine and Joint Pathology National Academy of Medical Sciences of Ukraine, Kharkiv

<sup>2</sup> PE «Kharkiv Regional Clinical Hospital». Ukraine

*The spine occupies a special place in the complex anatomical structure of the human body and is, on the one hand, the center of statics and movement, and on the other, a protective frame for the nerve roots and spinal cord. Wide connections between the structures of the spinal canal and other organs determine their participation in the formation of many different syndromes. It can be confidently stated that the aphorism «all diseases are caused by the nerves» gave way to the thesis «all diseases are caused by the spine». However, it is important to clearly differentiate vertebrogenically caused syndromes from somato-neurological manifestations of various diseases. Objective. To draw the attention of the general medical community to the problem of overdiagnosis of vertebrogenic syndromes. Methods. Relevant literature in specialized sources for the last 10 years and own 25-year experience at the Sytenko Institute of Spine and Joint Pathology National Academy of Medical Sciences of Ukraine. Results. Own experience and published information indicate the polymorphism of complaints with which patients turn to a vertebrologist. Syndromes associated with changes in the cervical, thoracic and lumbar regions of the spine are considered. The attention is focused on their anatomical features. The necessary studies are indicated for the differential diagnosis of the vertebrogenic origin of clinical manifestations from other diseases depending on the level of the spine. Conclusions. The diagnosis of vertebrogenic disorders should not be confused with diseases that are not directly related to the spine or to the locomotor system in general. This attitude can deprive the doctor of the opportunity to diagnose the existing «non-vertebrogenic disease». Only a complex and thorough analysis of clinical and paraclinical data, coordinated work of doctors of all specialties make it possible to establish an accurate diagnosis, which will provide pathogenetically conditioned treatment.*

*Хребет посідає особливе місце в складній анатомічній конструкції людського організму та є, з одного боку, центром статички та руху, із іншого — захисним каркасом для нервових корінців і спинного мозку. Широкі зв'язки структур хребтового каналу з іншими органами обумовлюють їхню участь у формуванні безлічі різних синдромів. Можна впевнено констатувати, що афоризм «усі хвороби — від нервів» поступився першістю тези «всі хвороби — від хребта». Проте важливо чітко диференціювати вертеброгенно обумовлені синдроми від сомато-неврологічних проявів різноманітних захворювань. Мета. Звернути увагу широкого лікарського загалу на проблему гіпердіагностики вертеброгенно обумовлених синдромів. Методи. Проаналізовано релевантну літературу в спеціалізованих джерелах за останні 10 років і власний 25-річний досвід у ДУ «ІПХС ім. проф. М. І. Ситенка НАМН України». Результати. Власний досвід та опублікована інформація вказують на поліморфізм скарг, з якими пацієнти звертаються до вертебролога. Розглянуто синдроми, асоційовані зі змінами у шийному, грудному та поперековому відділах хребта. Акцентовано увагу на їхніх анатомічних особливостях. Указано на необхідні дослідження для диференційної діагностики вертеброгенного походження клінічних проявів від інших захворювань залежно від рівня хребта. Висновки. Не слід плутати діагноз вертеброгенні порушення та захворювання, які не мають прямого відношення ані до хребта, ані взагалі до опорно-рухової системи. Таке ставлення може позбавити лікаря можливості діагностувати наявне «невертеброгенне захворювання». Лише комплексний і ретельний аналіз клінічних і параклінічних даних, злагоджена й узгоджена робота лікарів усіх спеціальностей дають змогу встановити точний діагноз, який забезпечить патогенетично обумовлене лікування. Ключові слова. Вертеброгенні синдроми, гіпердіагностика, диференційна діагностика, патологія хребта.*

**Key words.** Vertebrogenic syndromes, overdiagnosis, differential diagnosis, spine pathology

## Introduction

The spine occupies a special place in the complex anatomical structure of the human body and is, on the one hand, the center of statics and movement, and on the other, a protective frame for the nerve roots and spinal cord. Wide connections between the structures of the spinal canal and other organs determine their participation in the formation of many different syndromes. It can be confidently stated that the aphorism «all diseases are caused by the nerves» gave way to the thesis «all diseases are caused by the spine».

The basis for overdiagnosis of vertebrogenic syndromes is the number and variety of their clinical manifestations in the form of root, vascular and spinal compression disorders in combination with changes in the emotional sphere. The main pathogenic factors of their formation are: compressive mechanisms and reflex effects, accompanied by an aseptic inflammatory process, microcirculatory disorders and their combination. Therefore, it is important to clearly differentiate vertebrogenically caused syndromes from somato-neurological manifestations of various diseases [1–3].

The *purpose* of our informative message is to draw the attention of the general medical community to the problem of overdiagnosis of vertebrogenic syndromes.

## Material and methods

The study involved assessment of the relevant literature in specialized sources for the last 10 years and own experience at the State Institution «Professor M. I. Sytenko Institute of Spine and Joint Pathology of the National Academy of Sciences of Ukraine».

## Results and their discussion

Our observational experience and published information indicate the polymorphism of presentation in patients seeking a vertebrologist's advice. Syndromes associated with changes in the cervical spine include hypertension, psychoemotional, cochleo-vestibular disorders, impairments of the maxillofacial system, and ophthalmological diseases [4–6].

Clinical analysis of vertebrogenic cervical syndromes requires attention to some important anatomical features of this part of the spine. Most of the extracranial part of the vertebral artery, accompanied by its vegetative plexus and spinal veins, passes in a mobile narrow bone channel formed by holes in the transverse processes of the cervical vertebrae. In this channel, the vascular-nerve bundle is closely adjacent to the vertebral bodies. The passage of the vertebral artery and its plexus through the holes in

the transverse processes of the six upper cervical vertebrae creates conditions for compression and irritation of the neurovascular formation. Even minor growths of unvertebral junctions can injure the vascular-nerve bundle, directly compressing or irritating the sympathetic plexus [7–10].

The specified features of the cervical spine and the tendency of the sympathetic nervous system to wide irradiation and generalization of excitement, hypothetically, can explain the development of dysfunction of the centers that regulate blood pressure. However, it was not possible to experimentally confirm this hypothesis [11].

In the occipital region, when the vertebral arteries leave the spine, their loops are formed, providing head turns without arterial steal syndrome, but this feature creates vulnerability to external pressure on the vessels [12].

We emphasize that in the modern specialized literature there is no convincing data on the cause-and-effect relationship between arterial hypertension and diseases of the cervical spine, therefore, any increase in blood pressure should not be equated with changes in the neck. The European Society of Cardiology recommends the following basic research methods as a diagnostic algorithm in case of increased blood pressure: general clinical blood and urine tests, determination of glucose content in blood plasma, creatinine, uric acid and potassium, lipidography, electrocardiography (ECG), fundus examination, echocardiography (EchoCG). X-ray of chest organs, ultrasound examination of kidneys, adrenal glands and brachiocephalic arteries are used as additional methods. But there is no recommendation for examining the cervical spine, which once again emphasizes the lack of a relationship between blood pressure elevations and neck disorders [13].

Vegetative, asthenic, cochleo-vestibular, cerebellar symptoms, lesions of cranial nerves are not at all characteristic of degenerative changes of the cervical spine. In order to connect these signs with the vertebrogenic effect on the spinal artery, it is necessary to conduct an angiographic study of the vessels of the neck, which is done quite rarely in routine practice. Even if a number of X-ray signs indicate a possible vertebrogenic origin of clinical manifestations, it is always relevant to conduct a differential diagnosis with impaired blood circulation in the inner ear system, benign systemic vertigo syndrome, cerebellar tumors, diseases of the autonomic nervous system, etc.

Another of the common reflex syndromes with which patients come to see a vertebrologist is a headache.

Taking into account the pronounced polymorphism of the clinical presentation, the possibility of «masking» other types of headache (for example, migraine) in diagnosis, the main attention should be paid to the following clinical data: localization of pain in the neck and occipital region; irradiation in the frontal-orbital zone, temple, ear; increase during head movements or prolonged stay in one position. Diagnostic value is attributed to limitation of range of motion in the cervical spine, soreness of neck muscles, changes in muscle tone or reaction to passive or active stretching. Magnetic resonance imaging (MRI) objectification of the state of brain structures in such a case is, in our opinion, absolutely justified in order to rule out the primary cerebral cause of headache [14, 15].

Among modern concepts of vertebrogenic vertigo, the most common hypothesis is that this condition is the result of incoherence of vestibular, visual, and cervical afferent activity. This imbalance is especially evident during neck movements. The reasons for the development of vertebrogenic dizziness are changes in the state of proprioceptors in the spasmed neck muscles, irritation of the sympathetic spinal plexus and spinal artery. Neck proprioceptors are involved in the coordination of eye movements, head and body position, i. e. in spatial orientation. M. Hulse [16] notes that 50 % of all proprioceptors and mechanoreceptors of the neck are located in the articular capsules from vertebrae C<sub>1</sub> to C<sub>III</sub>. Therefore, these anatomical bases may explain why dysfunction of the upper neck can cause vertigo. However, this level of damage is observed in 5–15 % of patients, and most often degenerative changes occur at the level of V–VII cervical segments.

In 1926, J. A. Barre described the so-called posterior cervical sympathetic syndrome, which included headache, dizziness, tinnitus, and vasomotor symptoms. The cause of the syndrome was called degenerative changes in the cervical spine, accompanied by a decrease in the height of the intervertebral discs, marginal bone growths, development of unvertebral arthrosis, resulting in chronic irritation of the sympathetic plexus of the spinal artery. It has been suggested that the sympathetic plexus surrounding the vertebral arteries may be compressed by degenerative changes in the neck, and this may contribute to reflex vasoconstriction in the vertebrobasilar system [17].

Decades later, Foster and Jabbour experimentally discredited Barre-Lieuw syndrome for two reasons. First, its symptoms are not unique and typical for many vestibular disorders. Second, experimental denervation of the sympathetic plexus has no apparent

effects in normotensive individuals and stimulation of the plexus also causes vasoconstriction. No sympathetic or vascular changes due to denervation were found. Thus, vestibular presentations due to cervical spine disorders are greatly overestimated in routine practice [18].

In the development of degenerative changes, bone-cartilaginous growths narrow the intervertebral opening, therefore, at the cervical level, the roots are more often compressed not through a herniated disc in the epidural space, as it happens in the lumbar spine, but in the intervertebral opening itself. During movements in the cervical spine, uncovertebral growths injure the root and its membranes, and the edema that develops in them turns the relative narrowness of the intervertebral opening into an absolute one. Crushed root undergo swelling, resulting in the development of reactive aseptic inflammatory signs. C<sub>VI</sub> and C<sub>VII</sub> roots are most often affected, C<sub>III</sub>–C<sub>V</sub> less often [19, 20].

Another problem that makes patients seek vertebrologist's advice is transient paresthesia in the hands and feet, a feeling of weakness in certain muscle groups. Demyelinating diseases also make their debut in such cases, which are often disguised as radicular deficiency (Fig. 1). In addition, it should be remembered that tumor or inflammatory processes, malignant neoplasms of the apex of the lungs, etc., often manifest as root symptoms at the neck level [21–24].

A thorough neurologic examination, history, and use of brain and spinal cord imaging should be used in the differential diagnosis.

At the cervical level, not only the roots and their arteries can be compressed, but also the spinal cord.

The tendency to damage spinal vessels is due to their location on the front surface of the spinal cord (in the area of typical localization of compressive formations) and the absence of a network of anastomoses. The combination of a vertebrogenic abnormal effect on the spinal cord (disc ruptures, marginal bony growths, reactive scarring, post-traumatic deformations of the spinal canal, instability) with a premorbid deficiency of its vessels (atherosclerosis, vasculitis, vascular malformations, etc.) reduces the compensatory possibilities of spinal blood circulation.

One of the specified factors becomes a trigger in the development of spinal cord ischemia, and subsequently an integrative effect is formed, which, taking into account the high sensitivity of brain tissue to hypoxia, results in irreversible morphological changes. It should be noted that the motor structures of the spinal cord are the most sensitive to hypoxia due to the specificity of their vascular organization,

physico-chemical features, high functional activity and huge energy demand. Therefore, in presentation of vertebrogenic myelopathy, movement disorders are considered the most important.

Our observations and literature analysis show several variants of vertebrogenic cervical myelopathy. These are the syndromes of amyotrophic lateral sclerosis, pyramidal insufficiency, syringomyelic, poliomyelitic, Brown-Sécar, posterior trunk syndromes. Pain syndrome in cervical myelopathy is a rare sign. In the case of such symptom complexes it is always important, first of all, to exclude the primary spinal process [25–28].

It should be noted here that the formation of a vertebrogenic compression effect can cause the development of ischemic foci in the spinal cord. However, sometimes, under an obvious vertebrogenic compressive effect, cells in the spinal cord can have a different character (for example, demyelinating).

Without dwelling on the details, we would like to emphasize once again that «vertebrogenic» alopecia, prosopalgia, toothache, feeling of a lump in the throat, panic attacks are casuistic. Therefore, one should never neglect the presentation, history and neurological examination data.

Vertebrogenic thoracic visceral syndromes are rather diagnoses of exclusion, despite the wide radiological manifestations, and are associated with its functional and anatomical specificity. The thoracic region is the longest and at the same time the least mobile part of the spine. In addition, the spinal ganglion and spinal nerve, which are given the main role in the formation of syndromes, in the foraminal part of the root canal are fixed by fibrous connections to the bone walls of the canal, which limits their vulnerability and the ability to move [29, 30].

Girdle pain, dyspepsia, impaired evacuatory function of the intestine, pain in the heart — this is a small set of symptoms that make patients seek help from a vertebrologist.

The correlation between the severity of X-ray changes of the spine and clinical symptoms is deter-

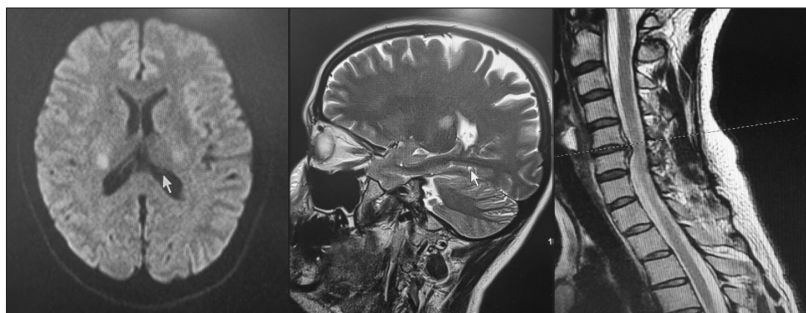
mined only in isolation. Therefore, radiographic signs of osteochondrosis cannot always be an explanation of the cause of the development of neurological syndromes exclusively by vertebrogenic factors.

The main symptom of vertebrogenic disorders at the chest level is dorsalgia. At the same time, the pain is deep, excruciating, aching and burning. Vertebrogenic irritation of the receptors of the affected motor segment (receptors of the fibrous ring of the intervertebral disc, posterior longitudinal ligament, joint capsule) triggers local chest pains and muscle-tonic disorders [31].

The interrelationship of visceral and vertebral reflex disorders at the thoracic level confirms the fact that objectively, in dorsalgia syndrome, changes in sensitivity are detected in the form of hypalgesia — the Zakharyin-Hed zone, where vegetative-trophic disturbances are most severe. These zones are also formed in people with visceral diseases. Therefore, in pain reflex syndromes, subtle differential diagnosis of vertebral and visceral symptoms using modern diagnostic methods (CT, ultrasound) is always necessary.

Presumably, in some cases, attacks of pain in the heart, for example, secondary to atherosclerotic lesions of coronary arteries in patients with degenerative diseases of the spine, also occur reflexively. But the unconditional recognition of this possibility of the reflex development of cardiac pain syndrome, in turn, shifts the «center of gravity» to the disorders of the spine, reducing the importance of independent damage to the coronary arteries. In recent years, we have been dealing with a simplified approach to the interpretation of chest pain in the elderly with proven radiological degenerative changes of the spine. The irrevocable opinion that such pain is «spondylogenic» can lead to failure to recognize cardiac diseases (Fig. 2).

Various abdominal syndromes are extremely rarely caused by vertebrogenic irritation of the vertebral structures. Similar symptoms also occur in patients with compression of the abdominal nerves, various



**Fig. 1.** A 41-year-old patient E. MRI. Presented with abrupt dizziness and numbness of the hands after sports



neoplasms of the gastrointestinal tract. Therefore, confirmation of the vertebrogenic nature of the disorder can be legitimate only after a detailed examination and exclusion of abdominal diseases.

There is no organic damage to the nervous system in the development of reflex neurological syndromes at the lumbar level, and the clinical manifestations are caused by nociceptive impulses of the endings of the recurrent spinal nerves (synuvertebral Luschka nerve) as a result of the action of a mechanical compression factor (disc herniation, hypertrophy of the yellow ligament), weakening of the fixation properties of the spinal motor segment, dyschemic or aseptic-inflammatory disorders in the structures of the spine. Nociceptive afferentation entering various departments of the central nervous system triggers a complex of integrative reactions in response, evolutionarily aimed at functional immobilization of the affected departments. This is muscle-tonic tension of the paravertebral muscles [32–35].

Reflex syndromes in diseases of the lumbar spine include lumbago, in the acute development of the disease; lumbago, in subacute or chronic course; coccygodynia; piriformis muscle syndrome; pelvic floor syndromes, etc. In the differential diagnostic sense, in the presence of a pain syndrome in the lumbar region of the spine, it is also necessary to take into account pelvic bone tumors, kidney disorders, intestinal diseases, etc.

Compression syndromes in lumbar osteochondrosis are also diverse: radicular, caudal, discogenic myelopathy.

Root compression syndromes more often develop due to disc herniation at the level of  $L_{IV}$ – $L_V$  and  $L_V$ – $S_I$ . When evaluating paresthesia and pain in the legs, obliterating endarteritis, «restless legs syndrome», Lerisch's syndrome should also be taken into account. In order to avoid errors in diagnosis, it is necessary to consider peculiarities of presentation,

spondylography, electromyography and ultrasound findings.

An unfavorable variant of lumbar vertebrogenic compression syndromes is cauda equina compression, the so-called caudal syndrome. Most often, it occurs in the case of large median disc herniations, neoplasms, when all the roots at this level are compressed. In severe cases and rapid development of the syndrome, it is accompanied by sphincter disorders. Caudal lumbar myelopathy occurs as a result of occlusion of the lower accessory radiculomedullary artery (more often at the root of the  $L_V$ , Desproges-Gotteron artery) and is manifested by weakness of the peroneal, tibial and gluteal muscle groups, sometimes with segmental sensitivity disorders. Often, ischemia is determined simultaneously in the epiconus ( $L_V$ – $S_I$ ) and cone ( $S_{II}$ – $S_V$ ) segments of the spinal cord. In such cases, it is accompanied by pelvic disorders. Given the polymorphism of clinical symptoms, differential diagnosis with demyelinating process, degenerative neuromuscular diseases, amyotrophic lateral sclerosis, syringomyelia, spinal cord tumors, and acute disorders of spinal blood circulation is absolutely justified.

Another frequent symptom is swelling of the lower extremities, which is mistaken for a sign of lumbar spinal stenosis.

This assumption is associated with the venous wall, which is poor in muscle fibers, and the fact that in the intervertebral foramen one third is the root and artery, and two thirds is the venous plexus. The root and artery are denser, so the veins are easier to squeeze. However, it is impossible not to take into account the presence of six longitudinal venous tracts, anastomoses with transverse veins, which provide venous outflow regardless of the state of bone-cartilaginous structures. In addition, the variation in the pressure of the cerebrospinal fluid, which is manifested by the pulsation of the dura mater, affects



**Fig. 2.** A 62-year-old patient T. MRI. Presented with pressing pain behind the sternum, radiating to the left arm, nausea secondary to increased blood pressure. Diagnosis: hypertensive disease, stage II. Hypertension, degree 3. Dyslipidemia. LVH. Obesity, degree 2. Impairment of glucose tolerance. Risk 4 (very high). Two months after the start of antihypertensive therapy, there was a pronounced regression of symptoms

the epidural veins, promoting venous blood flow and preventing stasis. It is quite important that the brain and membranes do not contain lymphatic capillaries and vessels, so lymph outflow is carried out through lymphatic fissures [36].

## Conclusions

It stands to mention that the diagnosis of a vertebral disorder should not be confused with diseases that are not directly related to the spine or to the locomotor system in general. Such an attitude can deprive the doctor of the possibility to diagnose the existing «non-vertebrogenic disease». Only a comprehensive and thorough analysis of clinical and paraclinical indicators, coordinated and coordinated work of doctors of all specialties make it possible to establish an accurate diagnosis, which will provide pathogenetically determined treatment.

**Conflict of interest.** The authors declare no conflict of interest.

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## REGARDING THE QUESTION OF HYPERDIAGNOSIS OF VERTEBROGENIC SYNDROMES

I. F. Fedotova <sup>1</sup>, N. Yu. Prytula <sup>1</sup>, O. V. Kovernyk <sup>2</sup>

<sup>1</sup> Sytenko Institute of Spine and Joint Pathology National Academy of Medical Sciences of Ukraine, Kharkiv

<sup>2</sup> PE «Kharkiv Regional Clinical Hospital». Ukraine

✉ Inga Fedotova, DMSci: ibolokadze@ukr.net

✉ Nataliya Prytula, MD: natpryt@ukr.net

✉ Oleksii Kovernyk: kovernik136@gmail.com