IJCNP, Volume 2, Issue 6, 2024 ISSN: 2995-536X
https://medicaljournals.eu/index.php/IJCNP

INTERNATIONAL JOURNAL OF COGNITIVE NEUROSCIENCE AND PSYCHOLOGY

RESULTS OF ULTRASOUND EXTRACRANIAL DOPPLER ULTRASONOGRAPHY IN PATIENTS WITH CERVICAL VERTEBRAL PATHOLOGY

Nargiza Shukhratovna Muzaffarova
Department of Neurology, Faculty of Postgraduate Education

Sokhiba Ziyadulloevna HAKIMOVA
Department of Neurology, Faculty of Postgraduate Education, Doctor of Medical Sciences, Associate Professor, Samarkand State Medical University

Abstract: Ultrasound is able to assess the condition of the vessels of the neck that supply blood to the brain. Brachiocephalic ultrasound is a more effective method of diagnosing pathology of vertebral, carotid arteries. Brachiocephalic vascular ultrasound is the study of the extracranial areas of the brachiocephalic arteries. In this type of study, the condition of and brachiocephalic trunk, vertebral arteries, carotid arteries, subclavian arteries is assessed. This method is a highly effective diagnostic method that allows to detect the full range of structural pathology of these vessels: stenoses (narrowings), atherosclerotic lesions, anomalies of vessel development, pathology of vessel course (in particular, associated with spinal osteochondrosis) and others.

Key words: pathology of the cervical vertebrae, extracranial Doppler ultrasound, vertebrobasilar syndrome.

Introduction. Complaints of dizziness are one of the most common reasons for a patient to consult a neurologist [6]. The traditional division is into systemic and non-systemic vertigo [1]. Systemic vertigo is often characterized by an acute onset and extremely pronounced clinical manifestations, which forces the patient to seek emergency and emergency medical care [4]. Determining the cause of systemic dizziness is often a clinical dilemma for the doctor of the emergency department and is accompanied by errors [2, 8]. These errors are due to both objective reasons (for example, heterogeneity of the phenomenon of dizziness, low degree of informativeness of instrumental and laboratory research methods, the possibility of combining several forms of dizziness) and subjective reasons (low informativeness of doctors about the causes of dizziness, insufficient objective examination, non-use of specific vestibular diagnostic tests) [3, 10]. It is extremely important to exclude potentially life-threatening diseases with damage to the central nervous system, such as stroke, abnormalities of the craniovertebral junction, bulky formations, infectious and toxic lesions [5]. Nevertheless, according to the literature, acute cerebrovascular accident (ONMC) may not be mistakenly diagnosed in 35% of patients at the admission department stage [1].

The purpose of the study: to study the parameters of ultrasound extracranial dopplerography in patients with cervical vertebral pathology

Materials and methods of research. For the study, 80 patients with complaints of dizziness who are undergoing inpatient treatment at the neurological department of the Samarkand City Medical Association were selected. The research methods were: general clinical, clinical neurological, transcranial Doppler and radiographic examination methods.

The results of the study. Depending on the state of blood flow through the vertebral artery, three variants of ultrasound results were identified:

1. LSC values in the vertebral artery are within the normal range,

2. asymmetry of the LSC along one of the vertebral arteries,

3. bilateral decrease in blood flow through the vertebral artery

The first variant was noted in 10 patients - blood flow is within normal limits, 7 patients (70%) of them have clinical symptoms due to local manifestations of cervical osteochondrosis, and 3 (30%) have symptoms due to hemodynamic disorders in VBB.

The second variant - asymmetry of blood flow along one of the vertebral arteries from 20-80% was detected in 25 patients with osteochondrosis of the cervical vertebrae. At the same time, 20-50% were registered in 18 (72.0%) patients. In 90%, clinical symptoms were revealed due to hemodynamic disorders in VBB, and in 10% - only local manifestations of cervical osteochondrosis.

The third option - a deficiency of blood flow in both vertebral arteries from 20-40% was diagnosed in 15 patients with osteochondrosis of the cervical vertebrae. At the same time, 20-30% were registered in 10 (66.6%) patients. In 93.4% (14 cases) there were clinical symptoms due to hemodynamic disorders in VBB, and in 6.6% - local manifestations of cervical osteochondrosis. The conducted study allows us to conclude that the severity of clinical manifestations caused by cervical osteochondrosis of the spine and hemodynamic disorders in VBB are largely associated with impaired blood flow in the vertebral arteries.

Intervertebral fissure protrusion CV-CVI was found in two patients. In these cases, brain blood flow disorders were limited to changes in blood flow along the left vertebral artery.

In a patient with CVI-CVII disc protrusion, a 23% decrease in blood flow in the left vertebral artery was detected in the arterial phase. The linear velocity along the middle and posterior cerebral arteries was reduced by about 20%.

It should be noted that changes in the blood flow of the brain in osteochondrosis of the cervical vertebrae in combination with protrusions of the intervertebral discs were noted in all examined patients. All this indicates the etiopathogenetic interdependence of cerebral circulatory disorders and intervertebral disc protrusion [1].

As we have already emphasized, it is usually believed that the pathology of the extracranial parts of the central vessels of the head is a factor of changes in the blood flow of the brain of more than 50%, in addition, at least 25% of all examined in the cranio-vertebral vascular basin of a dyscirculatory nature [8]. This is a direct effect of damage to the vertebral arteries. At the same time, the violation of the biomechanics of the cervical vertebrae and the impact of the affected structures of the spinal column are studied both in isolation - as the main mechanism for external damage to the vertebral arteries, and in the form of aggravating factors in the detection of atherosclerosis of the arteries of the brain. At the same time, scientific publications speak of doubts about the importance of spondylogenic factors for the development of blood flow insufficiency in the cranio-vertebral vascular system [9].

It is known for certain that the optimal functioning of the central nervous system is ensured by adequate blood flow through the brachiocephalic vessels. Constant maintenance of brain blood flow in the range of 50-55 ml per 100 g of brain tissue parenchyma per 1 minute in the hemispheric region and 33 ml per 100 g of brain tissue per 1 minute in the cerebellum area is necessary for the physiological course of brain tissue metabolism [3].

To clarify the cause of neurological complaints in the examined patients and to establish the interdependence with osteochondrosis, we conducted an ultrasound examination of the vessels of the cervical spine.

The parameters of blood flow velocity in the suboccipital area of the PA were evaluated using color duplex scanning. Visualization of the vertebral arteries was performed on the ESoate Mylab class C device (Italy) with a sector sensor 2 - 8 MHz.

To assess the normal parameters of the vessels, VBS were studied and analyzed in 20 volunteers without pathology and any complaints.

Ultrasound of the PA took into account the level of its entry into the bone canal of the transverse processes of the vertebrae, the presence of tortuosity, hypoplasia, the type of departure from the subclavian arteries, and the diameter in the area of the Atlanta loop. The PA are located behind the carotid arteries, in most cases their diameter in the control group ranged from 2.5–4.0 mm, in some cases reaching 5-6 mm, which is consistent with the opinions of some authors. According to other authors, the diameter of the vertebral artery in different parts ranges from 2.3 to 4.5 mm on the left side and from 3.83 to 7.4 mm on the right.

As for the PA, we know that it is divided into four divisions: division I — from the mouth to the entrance to the bone canal of the transverse processes C6; II — the department in the canal of the transverse processes from C6 to C2; division III — from the exit from the canal of the transverse process C2 to the entrance to the skull through the large occipital foramen; after after exiting the transverse process C2, the vertebral artery bends posteriorly and outwards, passes to the transverse process C1, passes through it and makes an arcuate bend, called loop C1. Rotation of the head relative to the cervical vertebrae is performed by loop C1. The distance from the entrance of the vertebral artery through the large occipital foramen to the confluence with another vertebral artery into the unpaired, basilar artery forms the intracranial vertebral artery, i.e. the IV department.

As is known, the mapping of the III department of the vertebral artery, C1, is a necessary link in clarifying violations of brain blood flow in the cranio-vertebral region due to high vulnerability due to frequently noted skeletal abnormalities, subluxations, arthrosis, in addition to the vessels themselves. The examination of the III department was performed using a linear sensor with a frequency of 5-7.5 MHz, and the IV department was performed with a sector sensor with a frequency of 2-5 MHz. The study was provided from transoccipital access. The patient's position is sitting or horizontally on his stomach with his neck bent forward as much as possible.

The Atlantean segment of the PA has some nuances of the trajectory in different sections, that is, four bends, which create certain difficulties in removing this department along its entire length in one plane of ultrasound examination. During the study, two departments were distinguished: the proximal, or vertical, located in the interval between the transverse processes C1 and C2; the distal, or horizontal, located between the transverse process C1 and the large occipital foramen.

To visualize the V3 and V4 segments of the PA during the examination, the patient is positioned horizontally lying on his stomach with an emphasis on the forehead. The sensor of the device is projected between the contour of the sternocleidomastoid muscle from behind and the spinous processes C1-C2 so that the scan section is perpendicular to the longitudinal axis of the spine. The sensor is tilted so that the scan section is projected through the atlantooccipital joint and the outer part of the large occipital foramen. Thus, the final section V3 of the vertebral artery segment is better visualized from the transverse process C1 to the entrance to the cranial cavity, which wraps around the outer mass C1 on its way, passing in the recess of the same name. This segment of the artery looks like a horseshoe on the screen. Further, during a longitudinal scan of the neck, the sensor is rotated 90 degrees and positioned parallel to the posterior contour of the sternocleidomastoid muscle directly under the occipital bone of the head so that the section is projected parallel to the longitudinal axis of the spine. In this form, the initial section V3 of the segment of the vertebral artery between the transverse processes C1–C2 of the cervical vertebrae is visualized. On the monitor screen, this section of the vessel looks S–shaped (Fig.1).

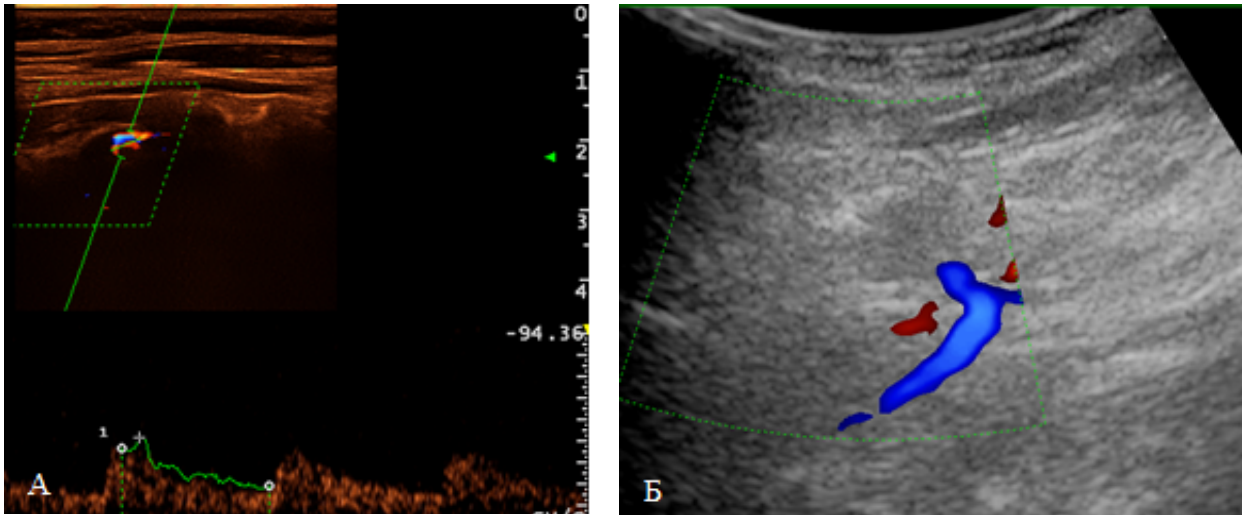

Figure 1. Dopplerography of the vertebral arteries. Craniovertebral department. A – visualization using a linear sensor, B –visualization using a cavity sensor.

Ultrasound duplex scanning with color mapping of blood flow objectively reflects vascular anatomy and allows us to identify various structural variants of the extracranial sections of the vertebral and internal carotid arteries. At the same time, when performing ultrasound Dopplerography of the V3 segment of the vertebral arteries, based on the experience of scientists, we faced a number of difficulties: short neck, large thickness of soft tissues, difficult stroke. As a result, only 2 out of 50 patients received visualization of the V3 segment (Fig.2), which did not provide diagnostically significant information.

At the next stage, we examined the main arteries of the brain of patients with AK by ultrasound transcranial dopplerography (TCDG) with the location of extra- and intracranial vessels (Fig.3). Transcranial Dopplerography was performed using the EDAN instruments version 1.2 system using a phased frequency range sensor 2 - 8 MHz.

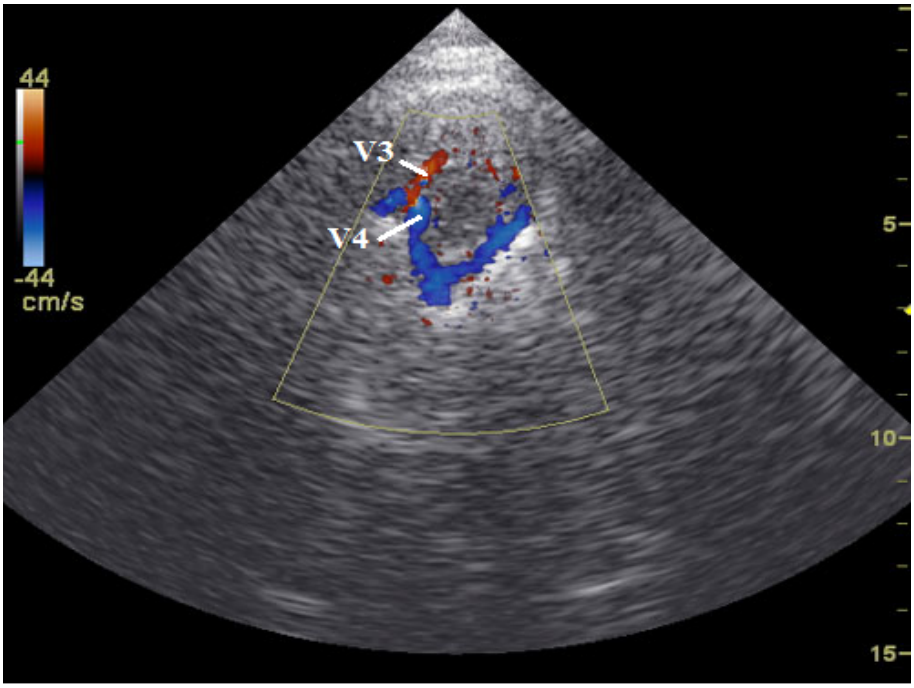

Figure 3. Scan of the vertebral artery in V3 and V4 segments of the PA in the CDK mode.

The purpose of evaluating the TKDG signal was solved by us in two stages. At the initial stage, the envelopes of the spectral characteristics of the signal were evaluated. At the second stage, based on the evaluation of envelopes, different criteria of blood flow were calculated. The Doppler spectrogram of

blood flow in the vertebral artery was monophasic in nature. A slow decrease in blood flow velocity from the maximum in systole to the minimum at the end of diastole was clearly visualized.

The main feature of the Doppler examination is that the amplitude of the detected signal is not always a reliable criterion, since it depends on many parameters that are not related to the blood flow rate. But the pronounced modification of the amplitude of the received signal, especially in the study of symmetrical arteries, is generally informative for diagnosis. That is why, when evaluating the Doppler signal, criteria related to shape and amplitude were used (Fig. 4).

The general state of blood circulation during Dopplerography was assessed by both qualitative and quantitative parameters.

The qualitative assessment includes: the nature of the sound Doppler signal; the shape of the Dopplerogram; the frequency distribution in the Dopplerogram. The type of the TKDG Dopplerogram makes it possible to study the role of blood circulation especially accurately, since with changes in blood circulation, the type of spectrogram undergoes pronounced changes. Among the qualitative indicators, we analyzed: the initial maximum rise of the curve, which corresponded to the peak systolic velocity (Vmax, cm/s); the point of the curve, which preceded the subsequent cycle and corresponded to the final diastolic velocity (Vmin, cm/s). The clipping, the backflow at the early diastole and the absence of blood flow in the final diastole are qualitative indicators of the Doppler spectrogram.

The quantitative assessment consisted in determining the maximum (Vmax, cm/s), average (Vmean, cm/s) and minimum (end-diastolic – Vmin, cm/s) blood flow rates. The final diastolic velocity (Vmin) was determined by peripheral vascular resistance. But you need to know that the criteria being evaluated are interdependent on the angle of inclination of the sensor relative to the trajectory of blood flow. During the study, the tilt of the sensor is set so as to have a pronounced saturation of the spectrogram display, achieved at an angle of approximately 45 °. Next, this angle value was used to calculate the above parameters.

In order to calculate the quantitative criteria of blood flow, which are independent of the angle of inclination of the sensor, specific indices were used:

- circulatory resistance index RI = (Vmax- Vmin) / Vmax (Pourcelot index - Pourcelot index);

ripple index PI = (Vmax- Vmin) / Vmean (Goesling index - Goesling index).

Indicators of the dynamics of blood circulation in the vertebral arteries were studied in the horizontal position of the patient lying on his stomach, first with the head facing down, then with a maximum turn to the right and then with a maximum turn to the left. The assessment of changes in blood flow parameters during the samples was carried out by calculating the reactivity coefficient (KR, %) according to the formula: (PRP/DP–1) x 100, where PRP and DP are the indicator data after the rotational sample and when the head is face down (before the sample).

All neurological manifestations of changes in blood flow in the vertebral artery, which are caused by both physiological changes and organic disorders, are determined by the vertebral artery syndrome. This syndrome combines a complex of head and vegetative syndromes that occur due to damage to the sympathetic plexus of the vertebral artery, changes in its shape, wall, and lumen.

In the scientific literature, in elderly people with degenerative diseases of the cervical vertebrae, symptomatic irritable vertebral artery syndrome was most often noted with relapses of fainting and dizziness. The classic test for detection is the rotational movement of the head with mixed torsion horizontal nystagmus towards the compressed artery and dizziness.

The data of the TCDG of the vertebral arteries of the V4 segment at rest and during a rotational sample of representatives of the control group are given in table 1.

The data of descriptive statistics of the general sample of patients with AK in TCDH are presented in Table 2, from which it can be seen that for all the studied parameters, the parameter $p \leq 0.05$, which corresponds to the reliability criterion ≥95%.

Initially, in all groups, the indicators of the dynamics of blood flow rates in the vertebral arteries on the right and on the left were compared and, due to the absence of significant differences between them, were subsequently evaluated in total. When the head was face down, the blood flow registration data in the suboccipital segment of the vertebral arteries almost did not differ between the groups.

It follows from the data obtained that Vmax both on the right and on the left in the examined patients with osteochondrosis undergoes a decrease in velocity parameters in the systolic phase (35.41±1.63 and 30.74±1.26 cm/sec), and at the same time there is a bilateral decrease in diastolic blood flow parameters (Vmin) in V3 and V4 segments of the PA (18.29±0.97 and 15.97±0.77 cm/sec, respectively). As a result, there is a large difference in the amplitude of blood flow velocities, which was not observed in individuals from the control group. In the presence of vasoconstriction, a slight increase in maximum velocity and a change in the waveform of blood flow were observed on the dopplerogram of the contralateral side. This was regarded by us as the result of a strong reaction of both vertebral arteries with a pronounced level of compensatory, as well as various adaptive capabilities.

As we can see, a comparative analysis of the results of blood flow in the examined groups of patients with pathology and those from the control group showed, although unexpressed, but a distinct tendency to decrease in speed indicators in all comparable blood flow groups.

Comparing the maximum linear blood flow rates, there was a tendency to a bilateral decrease in parameters with an indistinct predominance in the female group of the examined (Fig. 21, 22), which also reinforces the nature of the above changes.

Vmean-velocity indicators also tended to depression in a larger number of subjects with a predominance on the left (Fig. 23, 24). The lowest speeds were again observed in the female part, but then with an increase in speed indicators, these data were leveled, confirmed by the analysis of RI and PI indicators (Fig. 29-30).

Generalization of the results of our studies of the V3 and V4 segments of the vertebral arteries of patients with AC on TCDH (tab.3) showed us changes in blood flow: both in the right and left PA, a slowdown in blood flow was mainly noted (64.5% and 90.9%, respectively). In none of our observations was there any acceleration of blood flow on the pathological side.

Based on the normative indicators of blood flow in the vertebral arteries according to Zwiebel and the data of the control group, a decrease in blood flow velocity was determined in the examined patients with varying degrees of severity (Table 4). In patients with initial manifestations of osteochondrosis, hemodynamically significant changes in blood flow velocity were not noted: in the V4 segment of the vertebral artery, the average blood flow velocity was 37.65±3.07 cm/s on the right and 34.55±2.94 cm/s on the left. In contrast to these data, in patients with diagnosed osteochondrosis and deforming spondylosis, we found a decrease in blood flow within the lower edge of the regulatory criteria: the average blood flow rate in the V4 segment of the vertebral artery was 29.70±3.15 cm/s on the right and 34.10±3.37 cm/s on the left.

The examined patients in all age groups showed hemodynamically significant changes in blood flow on this side, although it did not always lead to neurological symptoms. With unexpressed osteochondrosis, the Vmean was 37.0±1.19 cm/s on the right and 30.39±1.08 cm/s on the left, which was probably compensated by the opposite vertebral artery, where blood flow rates were within the normal range. Pronounced degenerative-dystrophic changes led to a slowdown in blood flow (on the right 15.34±0.62 cm/s and on the left 15.56±0.62 cm/s) (Table 4).

At the next stage of the study, a rotational test was performed in all groups of examined patients, the data of which were recorded by the TKDG method. The data of descriptive statistics of the general sample of patients after a rotational test for TCD are presented in Table 5, from which it can be seen that for all the studied parameters the value of $p < 0.05$, which corresponds to the reliability criterion of ≥95%.

TKDG is a study of blood flow dynamics in V3, V4 segments of vertebral arteries with spondylogenic vertebrobasilar insufficiency due to osteochondrosis (Table.5) revealed a decrease in the linear velocity of blood flow, identical with ipsilateral lateral rotation of the head, especially in patients with pronounced degenerative-dystrophic changes.

The velocity parameters of blood circulation in the vertebral arteries during contralateral rotation did not significantly differ from those corresponding with ipsilateral head rotation, as a result of which they were also analyzed in total in all groups of subjects.

The data of hemodynamic parameters in V3 and V4 departments of PA at rest corresponded to the works of other authors. Intergroup differences were recorded by the value of the average linear blood flow velocity, but at the same time, the dynamics of Vmean on head rotation in the compared groups tended to decrease. When analyzing the data obtained after conducting a rotational sample and compiling visual histograms (Fig.7, Fig.8), an increase in the index was noted and have a direct dependence.

The lumen of the vertebral artery usually does not change during atlantoaxial rotation, and narrowing is usually induced by extravasal exposure or inflection of the vessel.

The results of our studies show that significant hemodynamic parameters during head rotation in healthy people in the control group were not recorded, however, in patients with IBD with osteochondrosis, the data obtained indicated significant extravasal effects in V3 and V4 segments of the PA during head rotation in the subjects of these groups, depending on the variant of the bone bridge. The values of the maximum peak velocity at the neutral position of the head and during turns did not differ in healthy people, but the degree of decrease in Vmax during head turns in patients with osteochondrosis was significantly greater. In addition, the groups differed in the number of cases of a decrease in Vmax of more than 20% ($p < 0.05$).

Thus, we analyzed the dynamics of the average linear velocity of blood flow when comparing these functional samples. Vmax of blood flow, which characterized the patency of the segments of the vascular bed studied by us, significantly changed its parameters during extravasal compression. The results obtained serve as a convincing criterion of hemodynamic significance. Considering the above, it seems possible for us to evaluate the results of a rotary sample based on the dynamics of Vmax blood flow.

A diagnostically significant criterion for a positive rotational test is a decrease in the peak blood flow rate of ≥ 20% compared with the blood flow before rotation, while the probability of a positive test, relative to the control group, and the occurrence of these changes is 7.5 times greater in patients with vertebrobasilar insufficiency.

In addition, according to the TCDG, in 72 (65.5%) of the total number of patients with vertebral artery syndrome, we found pathological changes in blood flow through the vertebral arteries in the form of asymmetry of more than 30% (comparing LSCs on the right and left), noted according to some data up to 95.5% of cases with compression-irritative effect of vertebral syndrome PA.

When evaluating the results available for TCDD of the vertebral arteries in all patients with spondylogenic cranio-vertebral insufficiency, it was emphasized that the average values of the blood flow criterion in V3, V4 segments as a whole did not differ significantly from the reference criteria at rest within the groups and remained on the atlas side without a vaulted opening, which is probably due to a compensatory mechanism.

As can be seen, the revealed significant changes in blood flow through the vertebral arteries were manifested, first of all, in the form of a decrease in LSC mainly in one of the vertebral arteries.

In the control group, the value of the peak blood flow velocity during the rotary test decreased slightly (within 2%), mainly in the left vertebral artery. In patients with Kimmerle's anomaly, the peak blood flow rate decreased significantly on the side with the presence of a bone bridge, regardless of the

direction of rotation. The diagnostic threshold for detecting extravasal effects on the vertebral artery is a 20 percent decrease in peak blood flow rate when turning the head.

The severity of the detected changes often depended on the duration of the disease, in which there was a decrease in hemodynamic parameters, which, in our opinion, indicated the depletion of compensatory mechanisms for regulating hemodynamics in the vertebral-basilar system as the disease progressed, noted in the work of some authors.

In summary, the results of our study showed that the passage of the PA through an arch or through a vaulted opening is potentially the cause of periodic disturbances in arterial blood flow, as well as exerts pressure on the periarterial sympathetic plexus, especially during head rotation. The result of this is the induction of transient phenomena of VDNH.

Conclusions: As you can see, the literature review and our research show the highest possibilities of the ultrasound method of examination, in particular TKDG in the diagnosis of hemodynamic disorders of the difficult-to-access craniovertebral articulation. Modern ultrasound technology makes it possible to differentiate all departments of the PA very qualitatively, identify pathological changes in its lumen, evaluate hemodynamic parameters of blood flow, and conduct various tests to assess the physiological state of the cerebral blood flow system.

List of literature

1. Abramov, A. S. "The possibilities of X-ray diagnostic methods in assessing the instability of the vertebral-motor segments of the cervical vertebrae." Modern problems of science and education 3 (2019): 184-184.
2. Aliyev K. T. et al. On the issue of the clinic of spondylogenic circulatory disorders in the vertebral-basilar basin //Scientific notes of St. Petersburg State Medical University named after IP Pavlov. – 2012. – vol. 19. – No. 1.
3. Andreev V. V. et al. Assessment of the size of the bone canal on the posterior arch in Kimmerle anomaly in the pathogenesis of dyscirculatory disorders in the vertebral-basilar basin //Topical issues of neurovascular rehabilitation: Materials of the All-Russian Scientific and practical conference with international participation. St. Petersburg. – 2007. – pp. 30-31.
4. Bayevsky P.M. Prognosis of critical conditions on the verge of norm and pathology.-M.: Medicine, 2019.- 295 p
5. Beletsky A.V. Radiometry of the spine / A.V. Beletsky, V.T. Pustovoitenko, A.F. Smeyanovich. – Minsk, 2018. – 297 s
6. Brandt T. Vertigo / T. Brandt, M. Dieterich, M. Stropp; [Translated from eng. ed. Zamergrad M. V.]. – Moscow : Praktika, 2009. – 200 p.
7. Verulashvili, Ivane, M. Beraya, and M. Kortushvili. "Features of cerebral venous hemodynamics in chronic disorders of cerebral circulation." Effective pharmacotherapy 24 (2018): 88-92.
8. Voznesenskaya T.G. Pain syndromes in neurological practice / Edited by V.L. Golubev. – M., 2010. – 330 p.
9. Gamanovich, A. I. "Analysis of the economic efficiency of the method of diagnosis of viscero-vertebral pain syndrome in lumbar osteochondrosis." (2017).
10. Gamanovich, A. I., A. S. Girinovich, and E. A. Kovalchuk. "Diagnosis of reflected viscero-vertebral pain syndrome." (2020).
11. Gilveg A. S., Parfenov V. A., Evzikov G. Yu. Issues of diagnosis and treatment of carpal tunnel syndrome //Neurology, neuropsychiatry, psychosomatics. – 2019. – vol. 11. – No. S1.
12. Dzhalkhi A.M. Spondylogenic circulatory disorders in the vertebral-basilar basin (clinical options, complex treatment) : dis. – St. Petersburg State Medical University. Univ., 2015.

13. Druzhinin D. S. The state of cerebral circulation in patients with hypoplasia of the vertebral artery (clinical Dopplerography): dis. – NC of Neurology of the Russian Academy of Medical Sciences, 2010.
14. Yelenskaya S.V. Possibilities of radiation diagnostics in the expert assessment of vertebro-neurological pathology / S.V. Yelenskaya, I.I. Sergeeva: Topical issues of radiation diagnostics (the first level of visualization) // Collection of scientific papers dedicated to the 65th anniversary of the Department of radiation diagnostics of BelMAPO and the 80th anniversary of academician A.N. Mikhailov. – Minsk, 2016. – pp.56-59.
15. Zamergrad M. V. Vestibular vertigo / M. V. Zamergrad // Neurology, neuropsychiatry, psychosomatics. – 2009. – № 2
16. Zozulya I. S. et al. On the issue of craniovertebral dysfunction and the features of its diagnosis: a scientific review and personal observations //International Journal of Neurology. – 2012. – №. 2 (48).
17. Ivanichev G.A. Cervical ataxia (cervical vertigo) / G.A. Ivanichev, N.G. Staroseltseva, V.G. Ivanichev - Kazan, 2010. — 244 p.
18. Ippolitova E. G. et al. Marker indicators of electroneuromyography in the diagnosis of spinal osteochondrosis //Siberian Medical Journal (Irkutsk). – 2018. – vol. 152. – No. 1.
19. Ippolitova E. G. et al. Functional diagnostics and acupuncture in patients with osteochondrosis of the cervical vertebrae //Acta Biomedica Scientifica. – 2016. – Vol. 1. – №. 4 (110). – Pp. 40-45.
20. Kiriyenko A. N., Sorokovikov V. A., Pozdeeva N. A. Degenerative-dystrophic lesions of the cervical vertebrae. Siberian Medical Journal 2015; 138 (7): 21-26. Kirienko A. N., Sorokovikov V. A., Pozdeeva N. A. Degenerative-dystrophic cervical spine disorders (literature review). Sibirskij medicinskij zhurnal 2015; 138 (7): 21-26.
21. Kolyagin, Yu. I., Eremushkin, M. A., & Polyaev, B. B. (2018). New approaches in the diagnosis of myoadaptive postural syndromes in osteochondrosis of the spine. Therapeutic physical education and sports medicine, (4), 20-27.
22. Kutashov V. A., Ulyanova O. V., Khabarova T. Yu. Osteochondrosis. Modern methods of diagnosis and treatment. Drug blockades. – 2016.
23. Losev R. Z. et al. Diagnosis and treatment of patients with circulatory insufficiency in the vertebral-basilar basin //Saratov Journal of Medical Science. – 2009. – vol. 5. – No. 4.