International Journal of Medical Toxicology & Legal Medicine Volume 27, No. 2, 2024
e-ISSN: 0974-4614
p-ISSN: 0972-0448

Clinical and Diagnostic Indices of Cerebral Blood Flow in Patients with Cervical Spine Diseases

Aziza Jurabekova[1], Shohsanam Eshimova[2], Janna Nazarova[3], Nigora Alikulova[4], Nargiza Abdullaeva[5]

[1,2,5]Samarkand State Medical University, Samarkand, Uzbekistan.
[3,4]Center for Professional Development of Medical Workers, Tashkent, Uzbekistan.

Received: 10.08.2024 Revised: 08.09.2024 Accepted: 03.10.2024

ABSTRACT
In 88 patients, ultrasound duplex and magnetic resonance angiography of the arterial and venous sections of the vascular bed of the head and neck were performed, and it was shown that in degenerative diseases of the cervical spine (CS), along with changes in the arterial blood flow, changes in the regulation of venous circulation are also indicative.
Aim: Study of cerebral venous blood flow in cervical spinal injuries.
Materials and methods: A total of 88 patients with degenerative changes in the cervical spine were examined, who were treated in the neurological department of the clinic of the Samarkand Medical University from 2022 to 2024. Comprehensive diagnostics using modern methods such as magnetic resonance angiography (MRA), rheoencephalography (REG), and Doppler ultrasonography of the cerebral vessels were performed for each patient.
Results and discussions: It has been found that various disorders in the cervical spine cause changes in arterial blood flow and regulation of venous outflow from the skull.
Conclusion: Thus, various disorders in the cervical spine cause changes in arterial blood flow and regulation of venous outflow (VO). Expansion of the IJV and a decrease in blood flow intensity are often associated with degenerative changes in the cervical spine.

Keywords: Degenerative Diseases of the Cervical Spine, Venous Hemodynamics, Duplex Scanning.

1. INTRODUCTION

Degenerative changes in the cervical spine (CS) affect the blood circulation of the brain, including not only the vertebrobasilar system, but also other parts of it [1]. Neurology pays special attention to the development of advanced methods for the diagnosis and treatment of these diseases [3]. These studies expand our understanding of how disorders in the cervical spine affect the blood supply to various brain structures [2] [4]. They also help to introduce new treatment methods. Recently, some authors have rethought traditional concepts of degenerative-dystrophic lesions of the spine and question the role of spondylogenic factors in the development of cerebral circulatory insufficiency [5].
Modern medical knowledge increasingly clearly indicates the need for in-depth research aimed at identifying the connection between pathological changes in the cerebral vessels and disorders of the biomechanics of the cerebral spinal column, since the results of these scientific studies play a key role in understanding the causes and mechanisms underlying cerebral circulatory insufficiency associated with degenerative processes in the cerebral spinal column [9].
The main motivation for conducting this study is the lack of unambiguous systematized data in the scientific literature on the use of magnetic resonance angiography (MRA) to assess the arterial and venous circulation of the brain in various pathologies of the cerebral cortex [8]. This creates a significant gap in understanding the impact of these diseases on the blood supply to the brain [7]. Due to the importance of correct diagnosis and selection of the most appropriate treatment strategy for such patients, it is necessary to conduct additional research on the results of MRA in the context of a comprehensive assessment of the state of the cerebral vascular system, especially in the presence of disorders in the cervical spine [6].

2. Aim Of The Study

To study the characteristics of cerebral venous blood flow in young patients with degenerative lesions and injuries of the cervical spine.

3. MATERIALS AND METHODS

This study included 88 young patients who were treated in the neurological department of the clinic of the Samarkand Medical Institute from 2022 to 2024. Comprehensive diagnostics using modern methods such as magnetic resonance angiography (MRA), rheoencephalography (REG), Doppler ultrasonography of the cerebral vessels were performed for each patient.

The inclusion criteria for the study included the following parameters: patients with degenerative diseases of the cervical spine who had persistent symptoms associated with dysfunction of the spine; patients who suffered injuries to the cervical spine due to whiplash injury, accompanied by various neurological disorders. The age category of patients ranged from 20 to 45 years, which allowed us to focus on a young contingent and take into account the characteristics of the course of diseases in this age group.

The patients were divided into 2 groups: Group 1 included 46 patients with cervical spine osteochondrosis, including 22 (47.8%) men and 24 (52.2%) women, with an average age of 31.3±8.7 years, and a gender index m/f of 0.9; Group 2 included 42 patients with cervical spine injuries due to whiplash, including 26 (54.8%) men and 19 (45.2%) women, with an average age of 30.6±9.5 years, and a gender index m/f of 1.2. The control group included 40 people who were selected from among relatively healthy individuals. This group was equally divided between men and women: 20 men (50.0%) and 20 women (50.0%), which corresponds to a gender index m/f of 1.0. The average age of the participants was 31.6±4.8 years, which ensures a fairly homogeneous age composition for comparative analysis (Table 1).

Table 1: Distribution of Patients into Groups

Indicators	Group I, n=46		Group II, n=35		Control group, n=40	
	abs	%	abs	%	abs	%
men	24	52,2%	22	62,9%	20	50,0%
female	22	47,8%	13	37,1%	20	50,0%
gender index m/f	1,1		1,7		1,0	
average age, years	26,3+9,7		31,6+7,5		27,6+4,8	

Each patient underwent a comprehensive neurological examination, including both standard methods for assessing the state of the nervous system and specialized diagnostic procedures. As part of the diagnostics, MRI of the brain with angiografia (MRA) was performed. This method allowed for a detailed study of the venous outflow through the brachiocephalic veins and venous sinuses, which made it possible to identify possible disorders and anomalies in the venous system of the brain. At the same time, duplex scanning (DS) was performed for an accurate analysis of blood flow in the vessels both inside and outside the skull.The method involved the use of pulsed and color Doppler imaging, which allowed not only the visualization of blood flow but also the measurement of its parameters, such as speed and direction, in real time.

For MRA, high-field Siemens Magnetom Verio 3T and MagnetomAvanto 1.5 T devices were used. They provided high image quality and diagnostic accuracy, and special programs T1-TR (450 ms), T2-TR (6000 ms) and tirm TR (600 ms, TI 110 ms) were used to achieve maximum detail. These programs allowed scanning with a slice thickness of 4 mm in axial, sagittal and coronal projections.

To improve the quality of visualization and provide better contrast of vascular and tissue structures, the contrast agent Magnevist was used in a volume of 10 to 20 ml. The introduction of the contrast agent significantly improved the visualization of small vessels, allowing more clearly to determine pathological changes, such as vascular malformations or the presence of tumors.

MRA was performed using the two-dimensional time-of-flight angiography (2DTOF) method, which offers extremely accurate visualization of the cerebral vasculature. This method allows for detailed images of the vessels, which is important for diagnosing various vascular diseases. Fast T2-weighted programs were used to evaluate the CSF dynamics of the Sylvian aqueduct. This process involved comparing the signal intensity of the CSF pulsation in the Sylvian aqueduct with the signal in the lateral ventricles at the same level to detect differences in CSF dynamics. These data allow for more accurate diagnosis of various neurological diseases associated with impaired CSF circulation, such as hydrocephalus, intracranial hypertension, and others.

To ensure the accuracy and reliability of the research results, a thorough statistical analysis used both parametric and nonparametric methods. Microsoft Office Excel 2016 spreadsheets were used to collect, process, systematizes and display the obtained data. For a more in-depth statistical analysis, IBM SPSS Statistics version 26 software developed by IBM Corporation was used. This software allowed for complex statistical calculations and guaranteed high accuracy of data processing.

4. RESULTS

All patients reported dull, pressing headaches, which were especially intense in the morning and spread throughout the head, but were most often localized in the back of the head. Many also complained of pain and discomfort in the neck. In 63 (71.6%) patients, moderate noise in the head accompanied headaches. These

additional symptoms not only complicated the clinical picture, but also required more thorough diagnostics and an individual approach to treatment.

Table 2: Main Complaints and Results of Neurological Examination of Patients with Cervical Spine Diseases

Complaints	n	%
Headache	87	69,3
Dizziness	67	76,1
Sleep disturbance	61	69,3
Memory disorder	73	83,0
General weakness	59	67,0
Noise in the head	32	36,4
Dysphagia	6	6,8
Diplopia	7	8,0
Ataxia	22	25,0
Dysarthria	19	21,6

82 of 88 patients, or 93.2% of the study participants, had cervical spine pain, which highlights the high prevalence of this symptom among the subjects. Patients often described the pain as chronic, with periodic exacerbations, which significantly worsened their quality of life, reduced their activity level, and affected their daily tasks and work capacity. Some patients (less often than a combination of neck pain and headache) reported episodes of dizziness, which they associated with neck pain.

The patients had stenosis and tortuosity of the vessels, indicating occlusive processes, as shown by the results of DS and MRA. Tortuosity of the carotid arteries was found in 31.4% of patients in Group I and in 38.2% of patients in Group II, indicating that it was common in both groups. No statistically significant differences were found between the left and right sides ($p>0.5$).

Twenty-seven percent of patients had evidence of atherosclerosis, including vessel wall thickening, plaque formation, and intimal loosening and thickening. The intima-media thickness ranged from 0.6 to 2.7 mm, with an average of 1.4±0.4 mm. No complete occlusion of the common carotid artery (CCA) was observed.

In patients of group I, the linear blood flow velocity (LBFV) in the left CCA was slightly lower than in the control group. In the control group, the average velocity was 26.5±3.14 cm/s, and the average velocity in patients of group I was 30.9±3.44 cm/s ($p < 0.05$).

Table 3: Data on the Volumetric Blood Flow Rate (Q, ml/min) of Extracranial Arteries Depending on the Nature of the Cervical Spine Pathology

Q	Group I (n = 46)	II group (n = 35)	KG (n=40)
CCA	468 ± 91*	495 ± 96	523 ± 89
ICA	213 ± 48* ^	246 ± 39^	292 ± 68
VA	54 ± 24*	81 ± 29	96 ± 35
Qsumm	578 ± 78*^	634 ± 106^	798 ± 84

Note: * - significance of differences between groups and control ($p < 0.05$), ^ - significance of differences between groups ($p < 0.05$).

In the second group of patients, a gradual decrease in LBFV in the left CCA was observed. The average LBFV in Group II was 25.2 cm/s (standard deviation 4.43), in the control group - 30.9 cm/s, $\sigma = 3.44$. In the control group, the maximum LBFV was 84.0 cm/s ($\sigma = 15.1$) compared to 105.1 cm/s ($\sigma = 13.8$) in patients of Group II. In the control group, the minimum LBFV was 26.0 cm/s ($\sigma = 4.4$) compared to 32.2 cm/s ($\sigma = 5.2$) in patients of Group II. All these changes were statistically significant ($p < 0.01$). In the right CCA, such changes were less significant.

For a more detailed analysis of hemodynamic changes, a study of the volumetric blood flow rate (Q) in the carotid (CA) and vertebral (VA) arteries was conducted. Particular attention was paid not only to individual indicators for each artery, but also to the overall total volumetric blood flow rate (Qsumm). The results of these measurements are presented in Table 3 and make it possible to assess how much the volumetric blood flow indicators change depending on the presence of pathology and its severity.

In Group I patients, significant changes in cerebral blood flow were detected; this was demonstrated by a statistically significant decrease in blood flow volume in the common (CCA), internal (ICA) carotid arteries and VA. A significant decrease in Qsumm was found.

In contrast to patients in Group I, patients in Group II showed a slight decrease in TSBF, especially in the

arteries supplying the posterior parts of the brain. In Group I, a significant decrease in blood flow indices was observed. Both LBFV and BCV decreased significantly, especially in the ICA.
Since the jugular veins are the main route of venous outflow from the skull, a study of blood flow in them was conducted in patients of this sample. The results of the study showed that, except for significant obstructions to blood flow, the lumen of the internal jugular vein (IJV) remained patent in all patients. In each patient, a valve was visualized at the orifice of the IJV; in most cases, this was a bicuspid valve, which is normal.
Respiratory load was used to assess the function of the IJV valves. During deep inspiration, the valve cusps contract which reduces blood flow. In contrast to the control group, 59 (67.0%) patients showed a reversal of blood flow, indicating valve insufficiency.
All patients in the control group and most patients in the study group showed a three- or four-phase IJV blood flow pattern synchronized with breathing; these patterns are considered physiologically normal. The IJV diameter in the study patients was larger than in the control group, as shown in Table 4.
A decrease in the intensity of venous blood flow in combination with a phasic disorder was most common in patients with a long history of cervical spine diseases (Fig. 1). It is known that in a horizontal position of the body, the main load falls on other venous collectors, so the outflow of blood through the vertebral vein (PV) is usually practically absent [1,2]. However, in patients with cervical spine pathology, changes in the activation of outflow through the PV were observed even in a horizontal position.

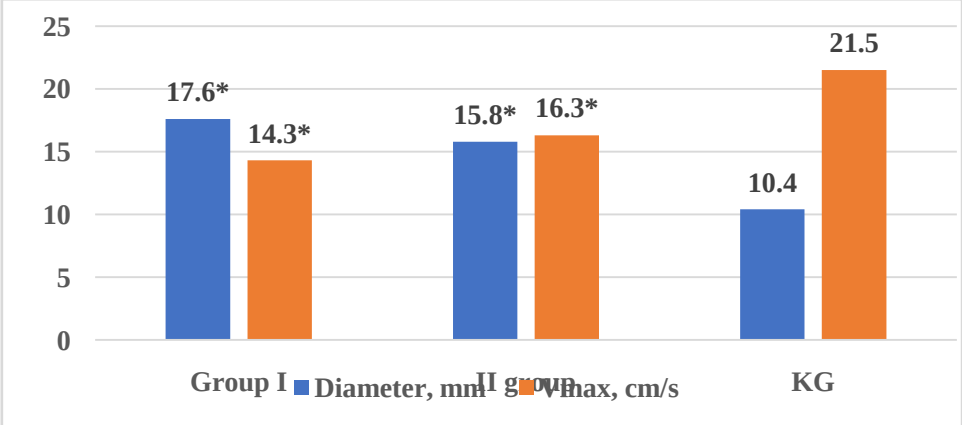

Figure 1: Diameter and Flow Velocity in the Internal Jugular Vein According to the Nature of the Pathology Cervical Spine
Note: * - reliability of differences between observation and control groups ($p<0.05$)

The patients were placed in the supine position for PV flow examination. In the first group, 51.1% of PV flow cases were detected, while in the second group, this figure was 43.1%. All patients in both groups had vertebral vein flow when the body position was changed to vertical (orthostasis). Problems with visualization of the vertebral veins were related to technical limitations of the equipment and the overall quality of visualization. However, the data showed that patients in the first group had a higher rate of PV leakage, which was statistically significant ($p<0.05$).
All patients in the control group (CG) had normal stable monophasic blood flow in the basal vein of Rosenthal on both sides and the straight sinus (Table 4).
In patients of the first group, the parameters of the LBFV in the basal veins of Rosenthal and the straight sinus did not show any noticeable differences from the parameters of patients of the second group. However, it was found that the pulsatility index (PI) decreased gradually. Despite the absence of obvious differences in LBFV, this indicates that gradual changes in hemodynamics are observed in this group of patients.
Magnetic resonance angiography (MRA) results showed asymmetry of the main venous collectors in most patients. In 53% of the examined patients, the expansion of the jugular veins and cerebral sinuses was predominantly on the right side, while in 27% of patients it was on the left side.

Table 4: Blood Flow Parameters in Intracranial Veins Depending on the Nature of the Cervical Spine Pathology

Groups	Parameters	Rosenthal's Vienna	Direct sine
Group I	Vmax, cm/s	23,4 ± 7,2*	31,2 ± 6,2*
	PI	0,21 ± 0,07*	0,24 ± 0,08*
Group II	Vmax, cm/s	21,8 ± 7,2	29,6 ± 7,8
	PI	0,28 ± 0,08	0,32 ± 0,07

CG	Vmax, cm/s	12,8 ± 5,4	20,1 ± 6,2
	PI	0,41 ± 0,08	0,48 ± 0,07

Abnormalities in the cerebral drainage system were found in 58% of patients. Of these patients, 14% had aplasia of the transverse sinus and 36% had hypoplasia of the transverse sinus (12% on the left, 6% on the right). Of the 6 patients who had sigmoid sinuses, 4 had hypoplasia of the right sinus and 2 had hypoplasia of the left sinus.

5. DISCUSSION

According to some authors, pathology of venous outflow in the vertebrobasilar basin may be caused by degenerative-dystrophic changes at the level of the cervical spine [1,2].

This is primarily due to the anatomical features of the location of the extracranial part of the cervical vertebrae and vertebral veins, passing in a narrow mobile bone canal, in the openings of the transverse processes of the cervical vertebrae and having a common vegetative innervation. At the same time, even minor growths of the uncinate processes can injure the vascular-nerve bundle, directly squeezing or irritating the sympathetic plexus and disrupting not only the arterial inflow, but also the venous outflow [7]. With degenerative changes in the cervical spine, the most common causes of pathological effects on the cervical vertebrae and veins are uncovertebral arthrosis and pathological mobility in the vertebral segments [10]. Increasing venous congestion leads to disturbances in cerebral metabolism, the development of hypoxia and hypercapnia, and an increase in venous and intracranial pressure [1].

Many researchers consider venous dyscirculation, which occurs as a result of compression of the venous vertebral plexuses by herniated discs, osteophytes, hypertrophied ligaments, etc., as one of the universal factors in the development of congestive hypoxic encephalopathy, leading to vascular disorders of the brain along with other factors [1,2,10].

Thus, various disorders in the cervical spine cause changes in arterial blood flow and regulation of venous outflow (VO). Expansion of the IJV and decreased blood flow intensity are often associated with degenerative changes in the cervical spine. This indicates disorders of VO, which can be compensatory mechanisms for patients with venous insufficiency. The data obtained emphasize the importance of using a comprehensive approach to the diagnosis and treatment of cerebral spine pathologies, taking into account both arterial and venous components of cerebral circulation.

REFERENCES

1. Vasiliev I.A., Stupak V.V., Chernykh V.A., Polovnikov E.V., Chernykh E.R., ShevelaE.Ya., Dergilev A.P. Pathogenetic aspects of cerebral venous circulation disorders. International Journal of Applied and Fundamental Research. 2014; 23-26.
2. Chatterjee, P., Siddiqui, S., Granata, G., Dey, P., & Abdul Kareem, R. S. (2024). Performance Analysis of Five U-Nets on Cervical Cancer Datasets. Indian Journal of Information Sources and Services, 14(1), 17–28.
3. Ezhova O.B., Tulupov A.A. Potential of magnetic resonance imaging in assessing cerebrospinal fluid dynamics and venous outflow from the brain // Scientific conference “Medical genomics and proteomics”. - Novosibirsk. - 2009. - P. 172.
4. Lelyuk V. G., Lelyuk S. E. Cerebral circulation and arterial pressure. // M.: “Real Time”, - 2004. 304 p.
5. Matkhalikov, A. F. Neurological syndromes of cervical osteochondrosis. Methodical manual / A. F. Matkhalikov. - Tashkent, 2003. - 256 p.
6. Muzaffarova N.Sh., Khakimova S.Z., Akhmadeeva L.R., Baikov D.E., Gizatullin R.R., Bulyakova G.A. Additional methods of functional and visualization diagnostics of the brain for planning personalized care for a neurological patient // Effective pharmacotherapy. 2023. Vol. 19. No. 45. P. 14-22.
7. Savelyeva L.A., Tulupov A.A. Features of venous outflow from the brain according to magnetic resonance angiography // Bulletin of NSU. - 2009. - Vol. 7. - Issue 1. - P. 36-40.
8. Yakhno, H. N. Comparison of clinical and MRI data in cerebrovascular insufficiency. / H. N. Yakhno, O. S. Levin, I. V. Damulin // Neurological journal. 2001. - Vol. 6, No. 3. - P. 10-19.
9. Diagnostics of cerebral venous ischemia / S.E. Semenov, M.V. Shumilina, E.A. Zhuchkova, et al. // Clinical physiology of blood circulation. - 2015. - No. 2. - P. 5-16.