ЗДОРОВ'Я СУСПІЛЬСТВА
ЗДОРОВЬЕ ОБЩЕСТВА HEALTH OF SOCIETY

UDC 616-71,616-009.861(616.831-005.4) *DOI: 10.22141/2306-2436.6.4.2017.123508*

A.O. Volosovets
Shupik National Medical Academy of Postgraduate Education, Kyiv, Ukraine

Dopplerographic features of patients with onset of acute cerebral stroke in different periods of the day

Abstract. ***Background.*** *The question of a connection of pathological changes in the hemodynamic parameters of cerebral circulation with a time of a stroke onset in the literature is not considered well, that determines the relevance of the study of this problem. The purpose of our study was to evaluate the state of cerebral hemodynamics and the nature of hemodynamic disorders in patients depending on the period of an ischemic cerebral stroke onset.* ***Materials and methods****. For achieving our goals we have performed clinical and magnetic resonance tomography examination for 300 patients who suffered from an acute ischemic stroke (men — 196, women — 104) aged 42 to 84 years (average age 65.2 ± 8.7 years). To optimize the analysis of the obtained data, all patients were divided into 4 groups according to the period of the day when an ischemic stroke occurred: group 1 — patients suffering from cerebral ischemia in the afternoon (8.00–14.59); group 2 — patients with stroke occured in the evening (15.00–21.59); group 3 — patients which had an ischemic stroke at night (22.00–7.59).* ***Results.*** *Indicators of cerebral hemodynamics in patients after a «daytime» cerebral stroke had a higher incidence of pronounced vascular stenosis (18.4 %). However, after the «evening stroke», patients had a higher incidence of all hemodynamically significant stenosis in general (90.7 %) and a more pronounced pathological pattern than among patients in the group of «nocturnal stroke» (29.7 %), that may be explained by the prevalence among the patients in the second groups of such risk factors as obesity, hypercholesterolemia and decreased physical activity, that contributed to the increased systemic narrowing of vascular lumen due to chronic progressive atherosclerosis and, as a consequence, the formation of chronic cerebral ischemia.* ***Conclusions****. The study of cerebral hemodynamic disorders in patients with different time of stroke onset has revealed that parameters of cerebral hemodynamics in patients after a «daytime» and «night» stroke had a less pathological character than among the patients after an «evening stroke».*

Keywords: *stroke; hemodynamic disorders; time of onset*

Introduction

The intensive study of cerebral hemodynamics with ischemic lesions [1–4] by means of ultrasound dopplerography reveals new pathogenetic features of regional blood circulation in severe cerebral vascular catastrophes. The advantages of ultrasound are its low cost and low invasiveness, which makes this method accessible to mass research and continuous monitoring [5].

In connection with such autonomy of regulation of cerebral circulation, the definition of regional tone of the vessels of the brain becomes a practical value [6, 7], which leads to a constant search for new informative, preferably non-invasive methods of research. This is confirmed by the commonality of ontogenesis, the identity of vasomotor influences and conditions of staying both of them and others in the semi-rigid medium [8].

Violations of hemodynamics play an important role in the pathogenesisand development of complications in acute cerebrovascular diseases [9, 10]. However, the question of the connection of pathological changes in the hemodynamic parameters of cerebral circulation with the time of onset of the stroke in a literature is not presented well, which determines the relevance of the study of this problem.

The purpose of our study was to evaluate the state of cerebral hemodynamics and the nature of hemodynamic disorders in patients depending on the period of ischemic cerebral stroke onset.

Materials and methods

For achieving our goals we have performed clinical and magnetic resonance tomography examination of 300 patients who suffered from an acute ischemic stroke

Для кореспонденції: Волосовець Антон Олександрович, Національна медична академія післядипломної освіти імені П.Л. Шупика, вул. Дорогожицька, 9, м. Київ, 04112, Україна; e-mail: healermaster@gmail.com
For correspondence: Anton Volosovets, Shupyk National Medical Academy of Postgraduate Education, Dorohozhytska st., 9, Kyiv, 04112, Ukraine; e-mail: healermaster@gmail.com

(men — 196, women — 104) aged 42 to 84 years (average age — 65.2 ± 8.7 years). The criteria for inclusion in this study were: the age of patients from 40 to 85 years; ischemic character of the stroke verified on the MRI; consent of the patient or his legal representative.

To optimize the analysis of the obtained data, all patients were divided into 4 groups according to the period of the day when an ischemic stroke occurred:

— group 1, patients suffering from cerebral ischemia during the day (8:00–14:59);

— group 2, patients whose stroke was observed in the evening (15:00–21:59);

— group 3, patients had an ischemic stroke at night (22:00–7:59).

The main cause of cerebrovascular accident was arterial hypertension, which was detected in all patients, in 218 (72.6 %) of which it was combined with atherosclerosis of blood vessels, in 70 (23.3 %) — with diabetes. In the case of 246 (82.0 %) patients with onset, there were various manifestations of coronary heart disease: flashing arrhythmia — 68 (27.4 %), conduction failure on the electrocardiogram — 45 (18.6 %), signs of circulatory insufficiency — in 61 (24.7 %) of the surveyed. In myocardial infarction, 26 (10.6 %) patients have undergone a history of myocardial infarction.

To determine the influence of hemodynamic disorders at the time of an ischemic stroke acute period onset, we have performed a study of cerebral hemodynamics by the method of transcranial and extracranial duplex dopplerography (UDS). A blood circulation research was performed in the first 6–24 hours after a stroke onset.

Results and discussion

Medium parameters of extracranial cerebral hemodynamics data in a general carotid artery (GenCA), internal carotid artery (ICA) and vertebral artery (VA) in all groups are presented in table 1.

According to the data of the UDS of patients with a day stroke, the hemodynamic picture was characterized by the development of gross stenotic changes that localized in the baseline of the internal carotid artery or in the vertebral arteries and predominated from one side or the other, accompanied by a moderate bilateral angiospasm. Hemodynamic significant stenoses (> 70 %) occurred in 50 % (n = 73) of this group, which in 27 (18.4 %) cases reached a critical degree (≥ 90 %) of the lining of extracranial carotid arteries. In the 2nd group, the carotid artery stenosis group had a relatively higher frequency (n = 62, 57.9 %) compared to the 1st group, but they reached a critical level less often (n = 15, 14.01 %). For patients in the 3rd group hemodynamic significant stenoses of extracranial carotid arteries occurred in 10 cases (21.2 %), of which 4 (8.5 %) — reached a critical degree.

In the vertebral arteries, signs of stenosis > 70 % with a decrease in MBS were observed in 5 patients in group 1 with stroke in vertebrobasilar localization (VBL), of which a significant degree of stenosis (≥ 90 %) was detected in 2 cases. The worst situation was among the patients in group 2, where the incidence of VBL was higher, and signs of stenosis > 70 % with a decrease in MBS were observed in 17 patients, a significant degree of stenosis (≥ 90 %) — at 8. Somewhat better situation was in patients of the group 3 — 9 patients with signs of stenosis > 70 % in the vertebral arteries, in 3 — size stenosis (≥ 90 %).

In 80.1 % of patients in group 1 (n = 117) was a decrease in the linear velocity of blood flow by more than 30 % of normal. The vascular reactivity in this group of patients was reduced in 95.8 % of cases (n = 142). In the 20.5 % of cases (n = 30), retrograde blood flow was recorded on the supraclavicular artery, and in 60.2 % (n = 88), the antegrade blood flow in response to the compression test varied retrograde with a hemodynamically significant decrease in blood flow velocity in the supraclavicular artery and moderate increase in the level of a vascular tone.

Hemodynamic disorders among patients in the group 2 were accompanied by diffuse bilateral atherosclerotic changes in the velocity of blood flow in the arterial thromboembolism with a significant decrease in the level of MBS, increased rigidity of the vascular wall. In 70.1 % (n = 75) of patients we have seen decreased

Table 1. Parameters of extracranial cerebral hemodynamics in patients with acute cerebral stroke (M ± SD)

Groups	Vessels	Parameters		
		MBS, cm/sec	PI	RI
1st (n = 146)	GenCA	55.4 ± 5.4	2.53 ± 0.43	1.28 ± 0.25
	ICA	46.6 ± 5.7	2.18 ± 0.27	1.30 ± 0.25
	VA	27.6 ± 4.1	1.69 ± 0.35	1.17 ± 0.21
2nd (n = 107)	GenCA	56.6 ± 4.2	2.49 ± 0.40	1.23 ± 0.26
	ICA	48.8 ± 3.9	2.14 ± 0.30	1.22 ± 0.22
	VA	25.8 ± 4.8	1.71 ± 0.32	1.05 ± 0.19
3rd (n = 47)	GenCA	54.5 ± 4.1	2.43 ± 0.41	1.25 ± 0.22
	ICA	47.8 ± 3.5	2.16 ± 0.33	1.26 ± 0.27
	VA	23.8 ± 4.3	1.62 ± 0.32	1.15 ± 0.12

Table 2. Parameters of intracranial cerebral hemodynamics of patients after acute cerebral stroke (M ± SD)

Groups	Vessels	Parameters		
		MBS, cm/sec	PI	RI
1st (n = 146)	MCA	54.1 ± 8.2	2.21 ± 0.48	1.08 ± 0.25
	ACA	39.0 ± 4.5	1.75 ± 0.32	0.95 ± 0.22
	PCA	26.6 ± 4.6	1.57 ± 0.28	0.90 ± 0.19
2nd (n = 107)	MCA	50.6 ± 6.5	2.08 ± 0.22	1.09 ± 0.20
	ACA	41.4 ± 6.9	1.67 ± 0.16	0.99 ± 0.16
	PCA	22.8 ± 7.5	1.45 ± 0.18	0.97 ± 0.21
3rd (n = 47)	MCA	56.3 ± 7.4	2.11 ± 0.58	1.05 ± 0.23
	ACA	38.5 ± 7.3	1.65 ± 0.42	0.92 ± 0.24
	PCA	25.6 ± 5.2	1.53 ± 0.27	0.94 ± 0.15

vascular reactivity in response to a compression test. A decrease in the linear velocity of blood flow by more than 30% was detected in 70.1 % of patients (n = 75). In 10.1 % of patients (n = 11) the blood flow to the supraclavicular artery was retrograde, and in 35.5 % of patients (n = 38), in response to a compression test, the antegrade blood flow changed to retrograde.

The group 3 was characterized by atherosclerotic changes in blood flow velocity in an arterial artery bypass graft and VA, a decrease in the linear velocity of blood flow by more than 30 % in 59.5 % of patients (n = 28). In 57.4 % of patients (n = 27) in response on compression test antegrade blood flow has changed to retrograde. In all surveyed groups an increase in the Poursel and Gosling index, indicating an increase in blood flow resistance, an increase in peripheral resistance, and rigidity of the vascular wall were resided.

The detailed picture of cerebral blood flow and hemodynamic parameters in the intracranial vessels: middle cerebral artery (MCA), anterior cerebral artery (ACA) and posterior cerebral artery (PCA) of the patients with different time of stroke onset, is presented in table 2.

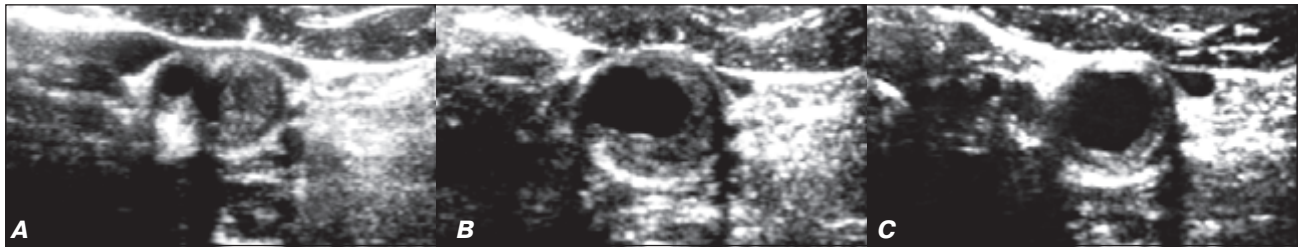
The data of patients in group 1 showed prevalence of signs of asymmetry of blood flow with hypoperfusion in the affected vessel. A local decrease in blood flow velocity ≥ 30 % with signs of turbulence was observed in 40.4 % (n = 56) patients. Stenosis of the vessel lumen > 70 % was detected only in the medial cerebral artery (MCA) and was observed in 38 patients. Stenosis > 90 % have had 9 of them.

The study of intracranial hemodynamics of patients in the group 2 showed that the patients dominated by signs of reduction of perfusion on MCA with an increase in the rigidity of the vascular wall. The presence of asymmetric type of main flow and signs of difficult perfusion was detected in 85.1 % (n = 91) of patients in the 2nd group. The stenosis of a vascular lumen > 70 % was observed only in the AMA, it was detected in 69 (64.4 %) cases, 16 (14.9 %) patients of which had a vessel stenosis over > 90 %.

The data of intracranial hemodynamics in patients of group 3 have indicated that among the patients also the signs of reduction of perfusion on the MCA with an associated increase in rigidity of the vascular wall were dominated. Signs of a difficult perfusion were found in 78.7 % (n = 37) of patients in the group 3. The stenosis of a vascular lumen > 70 % was observed only in the MCA (in 19 cases), the overlapping lumen > 90 % — in 2 patients.

Graphic comparison between all three groups is presented on pict. 1.

It should be noted that the location of the lesion focus depended on the violation of hemodynamics according to the UDS. The stroke emergence of a neural cells in the subcortical sections of the brain with the involvement of structures such as subcortical nodes, the setival center, thalamus and the internal capsule in the pathological process, was accompanied by a decrease in the median blood flow velocity in the MCA and the intracranially — in AVA. A localization of the stroke center in the area of the pons or cerebellum was characterized by a decrease in the average rate of blood flow in one or both of the VA. The brain infarctions of the cortical-subcortical localization were mostly accompanied by a significant decrease in the linear velocity of the blood flow in the ipsilateral MCA.



Picture 1. Doppler differentiation of patients at the time of stroke

Conclusions

The study of cerebral hemodynamic disorders in patients with different time of stroke onset has revealed that the parameters of cerebral hemodynamics in patients after a daytime and night stroke had a less pathological character than among patients after evening stroke. In group 1, hemodynamically significant stenoses were found predominantly in ACA and VA, whereas in patients of the group 2, such a degree of lining of the vessel was observed predominantly in the MCA, and in the group 3 — in the MCA, PMA and VA.

Such a picture may be explained by the fact, that among patients in the second group such risk factors as obesity, hypercholesterolemia and decreased physical activity prevailed were widely presented, that contributed to the increased systemic narrowing of vascular lumen due to chronic progressive atherosclerosis and, as a consequence, the formation of a chronic cerebral ischemia.

Conflicts of interests. Author declares the absence of any conflicts of interests that might be construed to influence the results or interpretation of their manuscript.

References

1. Mishchenko T.S. Epidemiology of cerebrovascular disease in Ukraine // Vascular diseases of the brain. — 2006. — № 1. — P. 3-7.

2. Spence J.D. Transcranial Doppler monitoring for microemboli: a marker of a high-risk carotid plaque // Semin. Vasc. Surg. — 2017 Mar. — 30(1). — P. 62-66.

3. Cires-Drouet R.S. Imaging of high-risk carotid plaques: ultrasound / Cires-Drouet R.S., Mozafarian M., Ali A., Sikdar S., Lal B.K. // Semin. Vasc. Surg. — 2017 Mar. — 30(1). — P. 44-53.

4. Vranic H. Critical Carotid Artery Stenosis in Coronary and Non-Coronary Patients — Frequency of Risk Factors / Vranic H., Hadzimehmedagic A., Haxibeqiri-Karabdic I., Mujacic E., Djedovic M. // Med. Arch. — 2017 Apr. — 71(2). — P. 110-114.

5. Lal B.K. Asymptomatic carotid stenosis is associated with cognitive impairment / Lal B.K., Dux M.C., Sikdar S., Goldstein C., Khan A.A., Yokemick J., Zhao L. // J. Vasc. Surg. — 2017 Oct. — 66(4). — P. 1083-1092.

6. Rafailidis V. Contrast-enhanced ultrasound of the carotid system: a review of the current literature / Rafailidis V., Charitanti A., Tegos T., Destanis E., Chryssogonidis I. // J. Ultrasound. — 2017 Feb. — 9. — 20(2). — P. 97-109.

7. Age-Wise Association of Carotid Intima Media Thickness in Ischemic Stroke / Saxena Y., Saxena V., Mittal M., Srivastava M., Raghuvanshi S. // Ann. Neurosci. — 2017 May. — 24(1). — P. 5-11.

8. Noh M. Impact of diabetes duration and degree of carotid artery stenosis on major adverse cardiovascular events: a single-center, retrospective, observational cohort study / Noh M., Kwon H., Jung C.H., Kwon S.U., Kim M.S., Lee W.J., Park J.Y., Han Y., Kim H., Kwon T.W., Cho Y.P. // Cardiovasc. Diabetol. — 2017, Jun 6. — 16(1). — P. 74.

9. Haq S. Colour Doppler Evaluation of Extracranial Carotid Artery in Patients Presenting with Acute Ischemic Stroke and Correlation with Various Risk Factors / Haq S., Mathur M., Singh J., Kaur N., Sibia R.S., Badhan R. // J. Clin. Diagn. Res. — 2017 Mar. — 11(3). — TC01-TC05.

10. Chi N.F. Dynamic Cerebral Autoregulation Assessment Using Extracranial Internal Carotid Artery Doppler Ultrasonography / Chi N.F., Ku H.L., Wang C.Y., Liu Y., Chan L., Lin Y.C., Peng C.K., Novak V., Hu H.H., Hu C.J. // Ultrasound. Med. Biol. — 2017 Jul. — 43(7). — P. 1307-1313.

Received 04.11.2017

Волосовець А.О.

Національна медична академія післядипломної освіти імені П.Л. Шупика, м. Київ, Україна

Особливості показників допплерографії в пацієнтів із мозковим інсультом залежно від періоду його появи

Резюме. ***Актуальність.*** Питання про зв'язок патологічних змін у гемодинамічних параметрах мозкового кровообігу з часом настання інсульту в літературі не представлене добре, що визначає актуальність дослідження цієї проблеми. ***Мета*** дослідження полягала в оцінці стану церебральної гемодинаміки та характеру гемодинамічних розладів у пацієнтів залежно від періоду настання ішемічного мозкового інсульту. ***Матеріали та методи.*** Для досягнення поставлених цілей нами проведено клінічне дослідження та магнітно-резонансну томографію 300 пацієнтів, які перенесли гострий ішемічний інсульт (чоловіків — 196, жінок — 104), віком від 42 до 84 років (середній вік — 65,2 ± 8,7 року). Для оптимізації аналізу отриманих даних усі пацієнти були розподілені на 3 групи за періодом дня, коли стався ішемічний інсульт: 1-ша — пацієнти з ішемією головного мозку протягом дня (8:00–14:59), 2-га — пацієнти, у яких інсульт спостерігався ввечері (15:00–21:59), 3-тя — пацієнти, які мали ішемічний інсульт вночі (22:00–7:59). ***Результати.*** Показники церебральної гемодинаміки в пацієнтів 1-ї групи характеризувались більш вираженим стенозом судин (18,4 %). Проте пацієнти 2-ї групи мали вищу частку всіх гемодинамічно значущих стенозів загалом (90,7 %) та більш виражену патологічну картину, ніж пацієнти 3-ї групи (29,7 %), що можна пояснити поширеністю серед пацієнтів 2-ї групи таких факторів ризику, як ожиріння, гіперхолестеринемія та зниження фізичної активності, що сприяло підвищенню системного звуження судинного просвіту внаслідок хронічного прогресуючого атеросклерозу та, як наслідок, формуванню хронічної ішемії головного мозку. ***Висновки.*** Вивчення церебральних гемодинамічних розладів у пацієнтів із різним періодом початку інсульту показало, що параметри церебральної гемодинаміки в пацієнтів після денного та нічного інсульту мають менш патологічний характер, ніж у пацієнтів після вечірнього інсульту.

Ключові слова: інсульт; гемодинамічні розлади; час початку

Волосовец А.А.
Национальная медицинская академия последипломного образования имени П.Л. Шупика, г. Киев, Украина

Особенности показателей допплерографии у пациентов с мозговым инсультом в зависимости от периода его появления

Резюме. ***Актуальность.*** Вопрос о связи патологических изменений в гемодинамических параметрах мозгового кровообращения со временем наступления инсульта в литературе не представлен хорошо, что определяет актуальность исследования этой проблемы. ***Цель*** исследования заключалась в оценке состояния церебральной гемодинамики и характера гемодинамических расстройств у пациентов в зависимости от периода наступления ишемического мозгового инсульта. ***Материалы и методы.*** Для достижения поставленных целей мы провели клиническое обследование и магнитно-резонансную томографию 300 пациентов, перенесших острый ишемический инсульт (мужчин — 196, женщин — 104), в возрасте от 42 до 84 лет (средний возраст — 65,2 ± 8,7 года). Для оптимизации анализа полученных данных все пациенты были разделены на 3 группы по периоду дня, когда произошел ишемический инсульт: 1-я — пациенты с ишемией головного мозга в течение дня (8:00–14:59), 2-я — пациенты, у которых инсульт наблюдался вечером (15:00–21:59), 3-я — пациенты, которые имели ишемический инсульт ночью (22:00–7:59). ***Результаты.*** Показатели церебральной гемодинамики у пациентов 1-й группы характеризовались более выраженным стенозом сосудов (18,4 %). Однако пациенты 2-й группы имели более высокую долю всех гемодинамически значимых стенозов в целом (90,7 %) и более выраженную патологическую картину, чем пациенты 3-й группы (29,7 %), что можно объяснить распространенностью среди пациентов 2-й группы таких факторов риска, как ожирение, гиперхолестеринемия и снижение физической активности, которые способствуют повышению системного сужения сосудистого просвета вследствие хронического прогрессирующего атеросклероза и, как следствие, формированию хронической ишемии головного мозга. ***Выводы.*** Изучение церебральных гемодинамических расстройств у пациентов с различным периодом начала инсульта показало, что параметры церебральной гемодинамики у пациентов после дневного и ночного инсульта имеют менее патологический характер, чем у пациентов после вечернего инсульта.

Ключевые слова: инсульт; гемодинамические расстройства; время начала