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Research Article

CHARACTERISTICS OF CEREBRAL HEMODYNAMICS IN PATIENTS WITH POST-COVID SYNDROME

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ABSTRACT

This article discusses the characteristics of cerebral hemodynamics in patients with post-COVID syndrome. In a comprehensive clinical examination of patients, the generally accepted clinical examination of the somatic status, laboratory research methods, and instrumental research methods (USDG of the arteries and veins of the head and neck) were used.

KEYWORDS

Characteristics of cerebral hemodynamics, post-COVID syndrome, clinical examination, somatic status, laboratory research methods, instrumental research.

INTRODUCTION

Studies have shown that individuals after respiratory distress syndrome experience deficits in memory, attention, fluency, information processing speed and control functions, while 30 to 80% of patients continue to show cognitive impairment a year after atypical acute respiratory distress syndrome (2,4,8).

To be sure, a large number of severe cases of COVID 19 are associated with pre-existing conditions that are also associated with neuropsychological deficits,

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including hypertension, diabetes, cardiovascular disease, cancer, and chronic respiratory disease (3, 6,7). Because of this, it is necessary to study the complex factors and medical complications faced by patients after COVID 19, as the exact nature and extent of the neuro-psychological deficit experienced by COVID 19 survivors has not yet been established, the results are likely to vary widely in depending on a number of clinical factors and individual differences.

Purpose of the study. To evaluate the features of Doppler characteristics of cerebral hemodynamics in patients with post-COVID syndrome.

Material and research methods. The study included 87 young patients aged 18 to 44 years (mean age 31.9±12.1 years) with post-covid syndrome (PCS) (Fig. 1). The patients were divided into two groups: group I consisted of 36 women (41.4%), group II - 51 men (58.6%), gender index was 1.4:1.0.

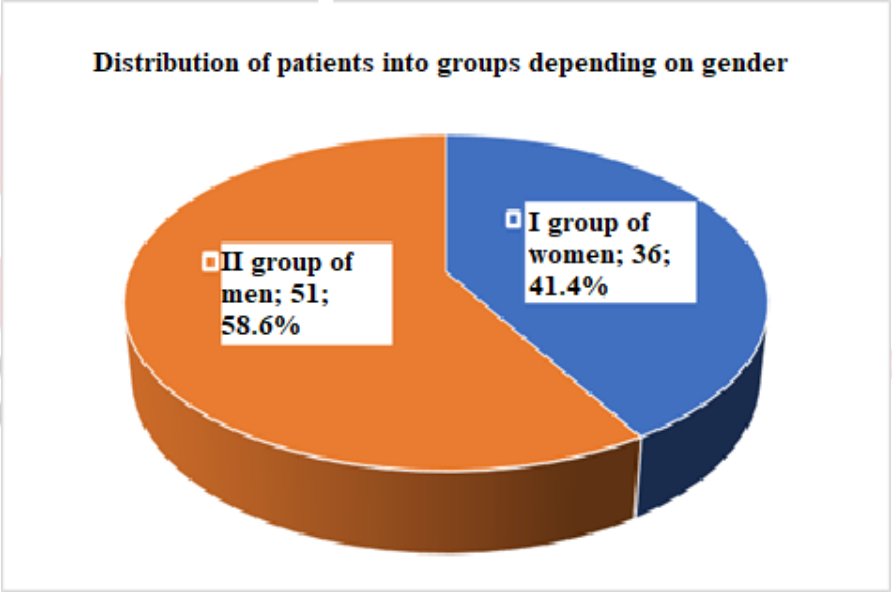

Figure 1. Distribution of patients by sex.

The control group (CG) included healthy individuals comparable with those of the main group in terms of sex and age characteristics (n=20; mean age 32.4±7.3 years; gender index 1,0:1,2).

The diagnosis of post-COVID syndrome was included in the International Classification of Diseases (ICD-10), heading code U09.9 "Post-COVID-19 condition, unspecified", which also includes post-COVID state (5). Patients were observed in the conditions of the neurological and therapeutic departments in the regional hospital of the city of Andijan.

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In a comprehensive clinical examination of patients, the generally accepted clinical examination of the somatic status, laboratory research methods, and instrumental research methods (USDG of the arteries and veins of the head and neck) were used.

Statistical significance of the results was assessed using Student's test of significance (t) for parametric distribution and Fisher's test (F) for nonparametric data distribution. Differences were considered significant at 95% confidence interval (P≤0.05).

Research results. In the study of Doppler ultrasound of patients with PCS, it was found that in women the percentage of patients with vasodilation and a combination of vasodilation with venous congestion is significantly higher than in male patients (Fig. 2).

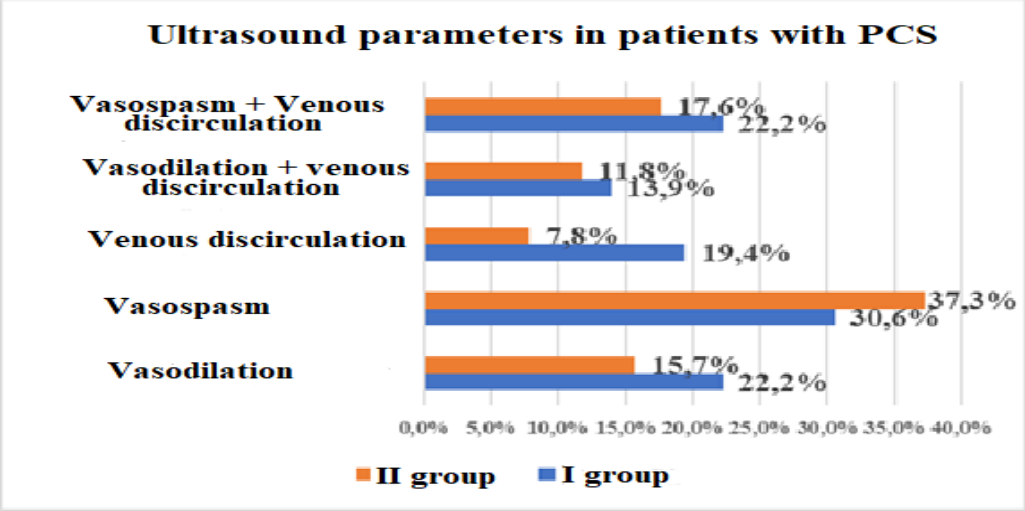

Figure 2. Ultrasound parameters in patients with PCS

So these figures were 22.2% and 13.9% versus 15.7% and 17.6% respectively. Vasospasm was significantly more common in the group of male patients - 37.3% versus 30.6% of female patients. Vasospasm reserves were found to be reduced in 57% of patients with PCS.

Structural features of the cerebrovascular system in young patients with PCS and the state of extra- and intracranial cerebral arteries in patients with PCS were assessed by non-invasive methods, such as DS, TCD. The course of the carotid arteries in patients of both groups was physiological, which did not distinguish them from patients in the control group.

Table 1

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Features of the course of the vertebral arteries in patients with PCS

Sign	I group women, n=36		II group, men, n=51		Control n=20	
	abc	%	abc	%	abc	%
Bending in V1 pPa	5	13,9%	7	13,7%	2	10,0%
Bending in V1 lPa	1	2,8%	3	5,9%	1	5,0%
Total in V1	5	13,9%	8	15,7%	3	15,0%
Bending in V2 pPa	2	5,6%	3	5,9%	1	5,0%
Bending in V2 lPa	0	0,0%	0	0,0%	0	0,0%
Total in V1 and V2	6	16,7%	9	17,6%	3	15,0%
High entry of pPA	2	5,6%	3	5,9%	1	5,0%
High LPA entry	2	5,6%	3	5,9%	1	5,0%
Non-rectilinear course of PA	7	19,4%	11	21,6%	3	15,0%

Note: * - significant differences.

The internal diameters of the ICA in patients with PCS were smaller ($p<0.001$) than in CG patients. The course of PA was more variable (tpb. 1). Patients with PCS were significantly more likely to have non-straight VA course, asymmetry of their internal diameters, and hypoplasia of one of the vertebral arteries. Structural changes were observed more often in males (Table 2).

Table 2

Hypoplasia of the PA and asymmetry of the internal diameters of the PA in patients with PCS

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Sign	I group women, n=36		II group, men, n=51		Control n=20	
	abc	%	abc	%	abc	%
Hypoplasia pPA	4	11,1%	8	15,7%	2	10,0%
LPA hypoplasia	7	19,4%	11	21,6%	1	5,0%
Total	11	30,6%	19	37,3%	3	15,0%
Asymmetry of internal diameters of PA	9	25,0%	16	31,4%	3	15,0%

Note: * - significant differences.

Analysis of SCR in CCA in PCS showed a slight decrease in the left OSA (26.5 cm/s;) compared with the control group (30.9 cm/s; $p<0.05$). Here and below, the data are presented as the arithmetic mean (M) and standard deviation (a) (Fig. 3).

Assessing the linear velocity of blood flow, it can be stated that as the disease progresses, a decrease in SCR occurs. Attention is drawn to the fact that a significant decrease in SCR is more typical for men.

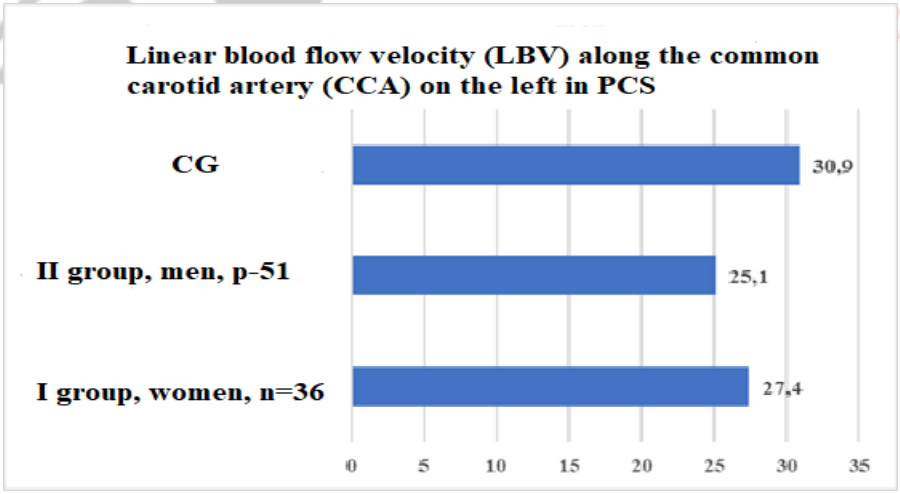

Figure 3. SCR on the left CCA in PCS.

In order to assess hemodynamic changes in PCS, the volumetric blood flow rate Q (in ml/min) in the CA and VA was studied, as well as the total volumetric velocity Qsumm (Table 3).

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Table 3

Volumetric blood flow data (Q, ml/min) intracranial arteries in PCS

Q	I group, women, n=36	II group, men, n=51	CA
CCA	545,2 ± 71,5	495,8 ± 96,1 *	523,6 ± 89,3
ICA	274,1 ± 48,4	246,2 ± 39,4 *	292,6 ± 68,5
PA	92,5 ± 26,1	81,6 ± 29,3	96,3 ± 35,5
Qsumm	754,7 ± 15,1	634,4 ± 106,1 *	798,4 ± 84,7

The main method for assessing the functional characteristics of the cerebrovascular system in patients with PCS was TCDG with the determination of cerebrovascular reactivity (CVR).

Hemodynamics in the carotid system in patients with PCS was characterized by significantly higher linear blood flow velocity (BFV) ($p<0.001$) and increased circulatory indices RI and PI ($p<0.001$). In combination with a significantly smaller diameter of the ICA in patients with PCS, this is a compensatory reaction that occurs under the influence of the system of autoregulation of cerebral circulation and is aimed at maintaining adequate blood flow in the carotid artery system.

When comparing hemodynamic parameters in the carotid pools in patients identified in accordance with the type of initial autonomic tone of the subgroups, only significantly significant differences were obtained in the parameters of each of the subgroups with the control group, and not between the subgroups.

The most pronounced differences with the control group were noted in patients of subgroups 1 and 2 (sympathicotonic and mixed variant of autonomic dysfunction), where the highest values of systolic and mean SCR and PI were recorded, which can be explained by the predominant influence of the sympathetic nervous system. However, both in vagotonics and even in patients with eutonia, higher SCR values were revealed than in the control group. This is evidence that the identified changes are certainly associated with concomitant CTD autonomic dysfunction, but they can probably be interpreted in terms of pronounced dysplastic-dependent structural and functional changes in the resistive vessels of the cerebral circulatory system in the structure of the PCS vascular syndrome. Thus, the intense work of the autoregulatory system in patients with PCS is even

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more complicated in the presence of concomitant SVD, especially its sympathicotonic variant.

Hemodynamic parameters in the vertebrobasilar system also differed significantly in patients with PCS and in the control group. However, such a significant increase in systolic SCR was not observed here, as in the carotid basins, with the exception of the left VA, in which Vs was significantly higher. The increase in Vs in the left VA may be compensatory and is due to the fact that in this study, in patients with PCS, hypoplasia of the left VA occurred 2 times more often than the right one. When evaluating hemodynamic parameters in patients with PCS, it should be noted that there were no significant differences in SCR and PI between groups.

CVR is the most significant parameter for the functional assessment of cerebral blood flow. The vasomotor reactivity index (VMI) in patients with PCS is significantly higher ($p<0.001$), the values of the coefficient of reactivity to hypercapnic load are also higher ($p<0.001$) than in the control group, while the values of the coefficient of reactivity to hypocapnic load are lower than in the control group ($p<0.05$). Autoregulation threshold shift index (ATSI) in patients with PCS is significantly lower ($p<0.01$) than in the control group.

All complaints presented by patients were associated with PCS. In the case of complaints of discomfort in the region of the heart, a moderate positive correlation ($r=0.45$; $p<0.001$), with complaints of palpitations, a positive weak correlation ($r=0.26$; $p=0.003$), with complaints of interruptions in the region of the heart - a moderate positive relationship ($r=0.34$; $p<0.001$).

In patients with PCS, a correlation was found between complaints of headache and the values of the diameters of the ICA (moderate negative; $r=-0.43$), IVMR (moderate positive; $r=0.63$) and the value of the coefficient of reactivity to hypercapnic load Vm Kp+ (moderate positive; $r=0.38$). Thus, headache in young patients with PCS is a pain of a vascular nature, for which there is anatomical and functional preconditioning.

Complaints of dizziness are associated with the non-rectilinear course of the vertebral arteries (moderate positive correlation; $r=0.69$), asymmetry of the internal diameters of the vertebral arteries (moderate positive correlation; $r=0.38$), high entry of the vertebral arteries into the canal of the transverse processes of the cervical vertebrae (weak positive relationship; $r=0.30$) and hypoplasia of the vertebral arteries (weak positive relationship; $r=0.19$). That is, dizziness in young patients with PCS is also vascular in nature.

The study revealed that the internal diameters of the ICA in patients with PCS are smaller. The dependence of the ICA diameters on the diameters of the common carotid arteries (CCA) is determined. The relationship is

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positive of medium strength (r=0.62). Significance level is high: p<0.001. Regression analysis yielded the following equation: y=0.16+0.49*x, where x is the diameter of the common carotid arteries and y is the diameter of the internal carotid arteries.

IVMR in patients with PCS is significantly higher than in patients of the control group. A correlation is revealed between the value of IMRI and the values of the diameters of the CCA and ICA. In the case of OSA, this relationship is negative and moderate (r=-0.36), with a significance level of <0.001; with ICA - negative strong relationship (r=-0.78), at a significance level of <0.001.

CONCLUSION

In young patients with post-covid syndrome, the ability to vasoconstriction is reduced, because. under the influence of the autoregulation system, the vessel is initially narrowed, which, in turn, increases the ability to vasodilate. The existing shift in autoregulation indicates that the reserve has already been activated, the remaining reserve possibilities for compensating for anatomical and functional changes are limited. Significantly significant differences in the above indicators of reactivity between male and female patients were not obtained.

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