

## Early Verticalization in Brain Stroke in Patients with Heart Disease

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### Abstract

This article discusses the early verticalization in brain stroke in patients with heart disease. We would like to see these methodological recommendations as a practical guide for physicians of neurology departments and other departments and clinics treating patients with cerebral strokes, especially those at risk of developing immobilization syndrome, therefore, it seems relevant to us to explain the rules for preparing and conducting in such patients in the form of generalized provisions and dogmas.

### 1. Relevance

In developed countries, stroke is in third place in terms of incidence and mortality, and also leads in disability (80% of survivors) [6,7].

Modern neurology and medicine in general focuses on this problem in the new millennium, paying special attention to aspects of post-stroke rehabilitation, including through physical activity. However, in these matters, scientists do not agree on the timing of the start of rehabilitation and the required optimal volume, especially in the aspect of the opinion that remains relevant about the need to observe a long purely bed rest [4,10]. The theory that appeared recently about the effectiveness of early verticalization (B) of patients is not supported by all scientists [1,9].

The main idea of verticalization is to increase the gravitational gradient to a maximum ( $> 800$ ), which is achievable by orthostatic training of patients, which determines the normal activity and prevention of

afferentation of receptors of the joints, tendons and muscles, carried out by receiving a load on the spine and joints of the legs, which activates vestibular and postural reflexes, favorably affects on respiration, motility of the gastrointestinal tract (GIT) and urinary system [11,12]

We would like to see these methodological recommendations as a practical guide for physicians of neurology departments and other departments and clinics treating patients with cerebral strokes, especially those at risk of developing immobilization syndrome, therefore, it seems relevant to us to explain the rules for preparing and conducting in such patients in the form of generalized provisions and dogmas.

### 2. Purpose of the Study.

To study the functional reserves of the body in a patient with a cerebral stroke using the early verticalization technique.

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Research material. An assessment of the neurological and vegetative status of patients with hemispheric cerebral stroke was carried out. The studies were carried out on the basis of the neurological department

of the Bukhara branch of the Republican Scientific Center for Emergency Medical Care for the period 2019-2021.

**Table 1.** Characteristics of the groups of examined patients

Group	Number of patients		Qualifying sign
	abc	%	
<b>Main group (OG)</b>	115	63,2%	Patients with IS and CAD, acute and rehabilitation periods
<b>Comparison group (CS)</b>	67	36,8%	Patients with IS without CAD, acute and rehabilitation periods

In total, we studied 182 patients (95 women and 87 men) aged 41 to 79 years in the acute and acute periods of ischemic stroke (IS) in the basin of the middle cerebral artery (MCA) with concomitant cardiac pathology. The main group (MG) consisted of 115 examined (63.2%) patients with hemispheric ischemic stroke IS (ISI) (acute and early rehabilitation periods) and coronary heart disease (CHD). The comparison group (CG) included 67 (36.8%) patients with PIS without CAD. (Table 1).

Table 2 and Figure 1 show the distribution of patients by age and gender. The main group (MG) included 63 women (54.8% of the entire group) and 52 men (45.2%). The average age of men is 65.3±7.6 years, women - 71.3±6.1 years. The comparison group (CG) included 24 (35.8%) women and 43 (64.2%) men, the average age of men and women was 67.1±6.2 years and 69.0±4.3 years, respectively.

**Table 2.** Distribution of patients by age and gender

Groups	Gender		Age WHO, 2022			
			18 - 44 years - young	45 - 59 years - average	60 - 74 years old - elderly	75 - 90 years - senile
<b>MG, n=115</b>	<b>M</b> n=52	abc	8	12	18	14
		%	7,0%	10,4%	15,7%	12,2%
	<b>W</b> n=63	abc	5	15	23	20
		%	1,7%	6,1%	6,1%	7,0%
<b>CG, n=67</b>	<b>M</b> n=24	abc	2	7	7	8
		%	3,0%	10,4%	10,4%	11,9%
	<b>W</b> n=43	abc	5	12	14	12
		%	7,5%	17,9%	20,9%	17,9%

Total	M n=76	abc	10	19	25	22
		%	5,5%	10,4%	13,7%	12,1%
	W n=106	abc	10	27	37	32
		%	5,5%	14,8%	20,3%	17,6%

It can be concluded that patients in the MG were older than those in the CG. In the MG the average age of patients was 69.2±5.1 years, in the CG the average age was 58.4±6.5 years (p<0.05). Moreover, in the MG there were significantly more women of elderly and senile age (37.4% n=43) than men in this group (27.8%, n=32) (p<0.05).

In the CG, women of elderly and senile age also prevailed - 38.8% (26 people) versus men - 22.4% (15 people) (p<0.05). Thus, in both compared groups, females predominated, especially the elderly and senile.

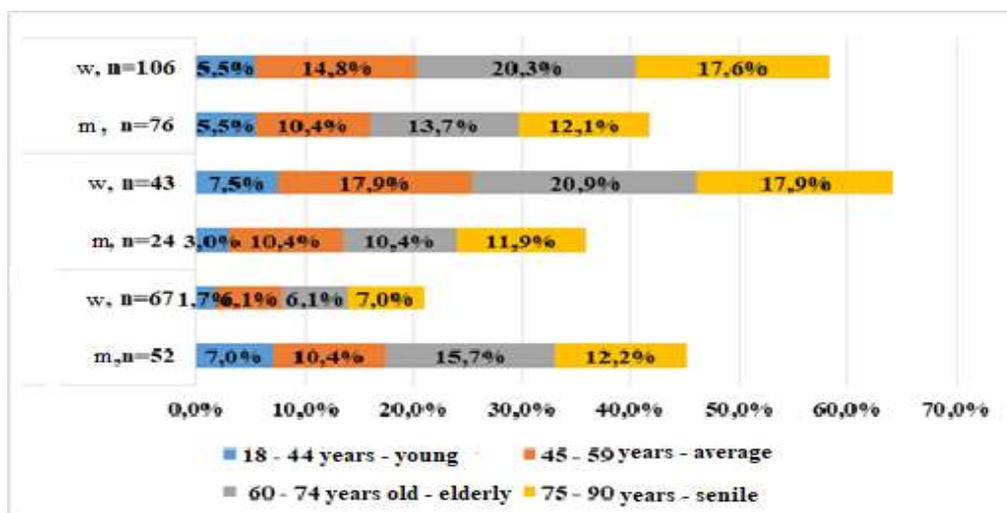


Figure 1. Distribution of patients by sex and sex.

Our study lasted for 1 calendar month, during which patients with OH and HC received the prescribed drug therapy for stroke with drugs of certain groups in accordance with the standard: “antihypertensive drugs (ACE inhibitors, sartans, diuretics, calcium channel blockers), beta-blockers, nitrates, antiplatelet agents (acetylsalicylic acid preparations, clopidogrel), cholesterol-lowering drugs (statins), neuroprotectors” [6].

### 3. Research Methods.

To identify the predominance of the parasympathetic or sympathetic tone of the nervous system, the Kerdo index was used. The degree of activation of the pituitary-adrenal system was judged by the neutrophil-lymphocyte index (LI) and the level of lymphopenia.

Heart rate variability (HRV) was studied by rhythmocardiography (RKG) with recording for the purpose of subsequent analysis of the functional state of the whole organism and violations of regulatory systems [2,5]. HRV parameters were analyzed after statistical processing of the rhythmogram [8]. Method of early verticalization using a verticalizer type 2 (Russia) (1.9).

Verticalization is a preventive and therapeutic method aimed at preventing the development of immobilization syndrome in patients with stroke, used against the background of bed rest for 1 day or more and aimed at obtaining a maximum gravitational gradient (GG) for the patient against the background of any cognitive, psychological and motor status of the patient. By GG

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they understand - the limiting angle B to without the occurrence of orthostatic insufficiency. (12)

PLR (passive leg raising) test - a test of passive raising of the lower extremities to assess the volemic status: in a patient lying on his back in a horizontal position, the researcher raises his outstretched legs to an angle of at least 60°. Hemodynamic parameters are recorded (blood pressure - blood pressure, heart rate - heart rate, central venous pressure - in the presence of a catheter in the central vein) before the start of the ascent and at the top point. The test is positive, i.e. volemic deficit is stated if there is an increase in blood pressure and / or heart rate by 10%, central venous pressure - CVP by 2 mm Hg. from the original level. A positive test indicates the possibility of acute heart failure (AHF) during verticalization, it is necessary to balance the patient's volemic state and repeat the test, verticalization is possible during its passage.

Biheviol pain scale (BPS) or behavioral pain scale is designed to study pain levels by behavioral reflexes in the absence of contact with the patient before and at the beginning of verticalization.

Visual analog scale (VAS) - designed for conscious patients for subjective assessment by conscious patients of pain before and at the beginning of verticalization.

Indications for verticalization:

1. Acute period of any disturbance of cerebral hemodynamics, including acute cerebrovascular accident (ACV) and traumatic brain injury (TBI); 2. The duration of stay in the intensive care unit is more than 2 days; 3. The duration of bed rest is more than 2 days.

Contraindications to Verticalization:

1. Unstable clinical status of the patient 2. Acute myocardial infarction; 3. Subarachnoid hemorrhage with non-clipped aneurysm 4. Shock; 5. An agonal

state (brain death); 6. Pulmonary embolism, progressive thrombosis or the presence of a floating thrombus (in the absence of a cava filter); 7. Unstabilized fracture of the spine, pelvis, lower extremities; 8. Patient refusal.

Processing of the results is carried out by the methods of variational statistics with the determination of the mean and its error values ( $M \pm \sigma$ ), differences in the mean values, the matching criterion ( $\chi^2$ ), and the calculation of the probability (p). The results were accepted as significant at  $p < 0.05$ .

#### 4. Research Results.

A positive index value indicates the predominance of sympathetic tone, and a negative value - parasympathetic tone of the nervous system. The transition from sympathicotonia to the predominance of parasympathetic tone indicates the beginning of the transition of the processes of urgent adaptation to the processes of long-term adaptation. The continuing predominance of the tone of the sympathetic nervous system (a positive value of the Kerdo index) indicates a delay in the transition of the mechanisms of urgent adaptation to long-term adaptation, and the transformation of stress into distress. The norm of the Kerdo index: +5 - +7. The dynamics of changes in the tone of the autonomic nervous system in the acute period of stroke in patients with coronary artery disease is shown in table 3.

On the first day in patients with MG and CG, the predominance of the tone of the parasympathetic nervous system was recorded, which was confirmed by the negative value of the Kerdo index.

By day 5, the examined MG continued to register the predominance of the tone of the sympathetic nervous system (Kerdo index  $7.4 \pm 2.3$  units). These changes indicated a delay in the transition of the mechanisms of urgent adaptation to the stage of long-term adaptation and the transformation of stress into distress.

**Table 3.** Comparative dynamics of the Kerdo index in patients with stroke against the background of coronary artery disease in the acute period of stroke.

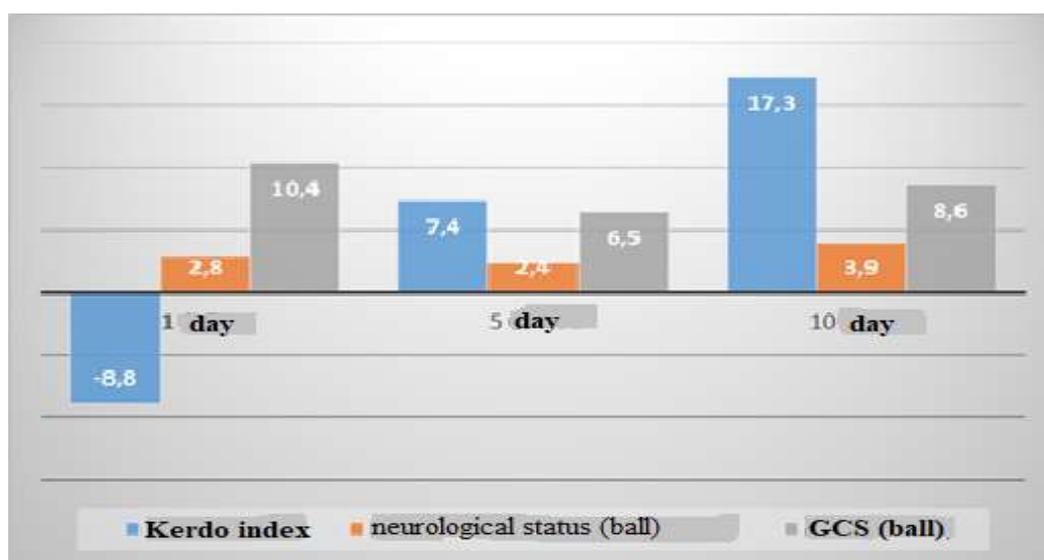
Index	groups	1 day	5 day	10 day
IndexKerdo	MG	(-)8,8±5,2*	7,4±2,3	17,3±6*

	<b>CG</b>	(-)20,2±5,3*	(-)6,7±2,3*	7,1±3,7**
<b>Neurological status (points)</b>	<b>MG</b>	2,8±0,1	2,4±0,1**	2,9±0,1
	<b>CG</b>	3,9±0,1	3,7±0,8**	3,8±0,15
<b>GCS (points)</b>	<b>MG</b>	10,4±0,5	7,5±0,5**	5,6±0,5**
	<b>CG</b>	12±0,4	13,9±0,3**	13,8±0,3

Note: \* - the value is significant compared to the norm ( $p < 0.05$ ), \* - the value is significant compared to the previous day ( $p < 0.05$ ).

On the 10th day in patients with MG, an increase in the tone of the sympathetic nervous system (Kerdo index  $17.3 \pm 6$ ) and a slow transition to the stage of long-term adaptation were recorded (Table 3). Tension of stress-adaptive reactions and persistent activation of the sympathoadrenal system in MG patients were associated with a decrease in the level of consciousness to  $9 \pm 0.5$  b GCS, an increase in neurological deficit up to 2.7 b. By day 5, a progressive decrease in the level of consciousness to 6.5 b on GCS and a significant increase in neurological deficit to 2.4 b (Fig. 2) were noted. Clinical equivalents of increased stress and persistent sympathicotonia by day 10 were the formation of severe further insolvency. 42.6% of patients died in the MG during the most acute period.

In CG patients, by the 3rd day, the predominance of the tone of the parasympathetic nervous system was recorded (the Kerdo index was negative:  $-14.8 \pm 4.9$  c.u.), which indicated the transition of the processes of urgent adaptation to long-term adaptation. On the 5th day in patients of the 2nd group, the continuing predominance of the tone of the parasympathetic nervous system was noted (the Kerdo index is negative:  $-6.7 \pm 2.3$  c.u. and  $7.37 \pm 3.7$  c.u., respectively), but by 10 days in the examined group, the predominance of the sympathetic tone of the autonomic nervous system was again recorded.



**Figure 2.** Dynamics of the Kerdo index and neurological status in patients with MG.

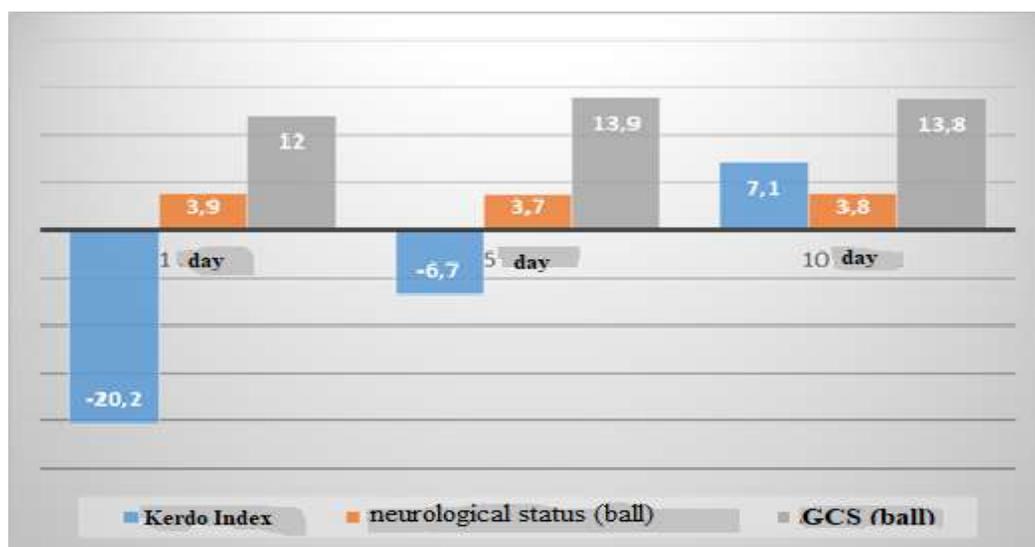
The Kerdo index acquired a positive value of  $7.14 \pm 3.7$  c.u. By day 3, CG patients showed an increase in the

level of consciousness to  $12.5 \pm 0.3$  b on the GCS (initial estimate was  $12 \pm 0.4$  b), a slight decrease in

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neurological deficit on the gradation scale to  $3.43 \pm 0.07$  b ( initial score -  $3.29 \pm 0.09$  b). On the 5th day, in the examined GS, the predominance of vagotonia was recorded, with an increased level of stress, combined with an increase in the level of consciousness to  $13.9 \pm 0.4$  b GCS and a slight improvement in neurological status up to  $3.57 \pm 0.08$  b. By the 10th day

in this group, against the background of the newly appeared predominance of sympathetic tone, the level of consciousness ( $13.8 \pm 0.3$  b on GCS) and neurological deficit ( $3.48 \pm 0.15$  b) did not change significantly compared to the previous day (Fig. 3). All patients in this group survived, but they still had a persistent neurological deficit.



**Figure 3.** Dynamics of the Kerdo index and neurological status in patients of group 2.

In the MG and GS before using B, we found statistically significant differences from the CG - lower RRNN ( $p < 0.05$ ) and SDNN ( $p < 0.01$ ), as well as pNN50% ( $p < 0.05$ ). We did not record a significant difference in the parameters LFnorm, HFnorm and LF/HF between the groups, which indicates the predominance of sympathetic VOD (Table 4).

The coefficients K 30:15 and KR-R stated a statistically significant decrease in parasympathetic VOR and VR in the MG, and slight fluctuations of these indicators were observed in the CG ( $p < 0.05$ ).

Baseline HRV indicators and HRV indicators in dynamics - after the application of the early verticalization technique in patients with IS in the acute period are presented in Table 4.

**Table 4** HRV indicators before and after the end of the application of early verticalization in the acute period of IS,  $M \pm \sigma$ .

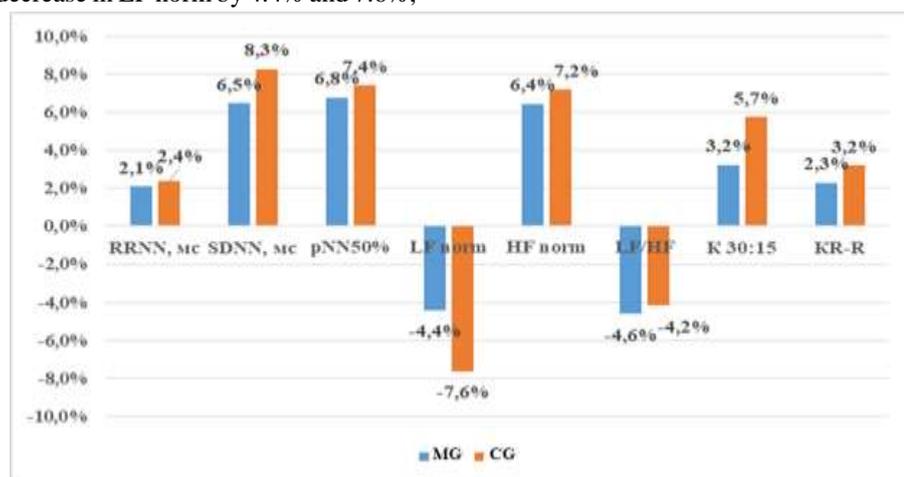
Index	before verticalization		after verticalization		p 1-3	p 2-4
	MG	CG	MG	CG		
	1	2	3	4		
RRNN, mc	$872,31 \pm 47,4$	$891,2 \pm 51,4$	$890,6 \pm 28,4$	$912,3 \pm 42,4$		
SDNN, mc	$32,4 \pm 6,2$	$33,9 \pm 5,3$	$34,5 \pm 5,1$	$36,7 \pm 3,6$	$p < 0,05$	$p < 0,05$
pNN50%	$0,59 \pm 0,44$	$0,81 \pm 0,4$	$0,63 \pm 0,52$	$0,87 \pm 0,5$		

LF norm	49,8±6,3	52,3±3,8	47,6±4,7	48,3±5,1	p<0,05	p<0,005
HF norm	48,1±4,3	47,3±4,5	51,2±3,8	50,7±5,3	p<0,05	p<0,005
LF/HF	1,3±0,1	1,2±0,4	1,24±0,17	1,15±0,3		
K 30:15	0,62±0,07	0,87±0,08	0,64±0,07	0,92±0,07	p<0,05	p<0,05
KR-R	0,87±0,12	0,94±0,04	0,89±0,08	0,97±0,04		

HRV indicators at the end of the acute period of stroke after the end and application of the early verticalization technique are clearly displayed in Figure 4.

In dynamics, in patients with MG and CG, there was a change in the following HRV indicators: an increase in RRNN by 2.1% and 2.4%, respectively, compared with baseline data, a decrease in LF norm by 4.4% and 7.6%,

respectively ( $p < 0.005$ ), an increase in HF norm by 6.4% and 7.2%, respectively ( $p < 0.005$ ), a decrease in LF/HF by 4.6 and 4.2, respectively. The study showed that in the regulation of heart rate in patients with IS there is a tendency to activate the parasympathetic system, in patients MG is stronger, relative to MG and CG.



**Figure 4.** Dynamics of HRV parameters before and after early verticalization of patients in the acute period of IS (%).

Taking into account the results of dynamic monitoring of HRV parameters in the acute period of stroke against the background of the absence or presence of cardiovascular diseases, we concluded that early verticalization of such patients is effective due to a significant improvement in HRV parameters - an increase in HFnorm and a decrease in LFnorm and LF/HF, which allows us to conclude about the presence of shifts towards the normalization of VOD and VR, improvement in K30:15 indicates the normalization of parasympathetic regulation of the CVS.

## 5. Conclusion.

The functional outcome of a stroke depends on the degree of intensity of adaptive reactions and the degree

and timeliness of relief of stress reactions. Excessive persistent tension of the sympathetic-adrenal system (sympathicotonia) in patients with stroke in the acute period leads to death, and the transition from sympathicotonia to the predominance of parasympathetic tone, reflecting the onset of long-term adaptation processes, is a predictor of a favorable outcome.

In dynamics, in patients with OH and HC, there was a change in the following HRV indicators: an increase in RRNN by 2.1% and 2.4%, respectively, compared with baseline data, a decrease in LF norm by 4.4% and 7.6%, respectively ( $p < 0.005$ ), an increase in HF norm by 6.4% and 7.2%, respectively ( $p < 0.005$ ), a decrease in LF/HF by 4.6 and 4.2, respectively.

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In the MG and CG before using B, we found statistically significant differences from the CG - lower RRNN ( $p < 0.05$ ) and SDNN ( $p < 0.01$ ), as well as pNN50% ( $p < 0.05$ ). We did not record a significant difference in the parameters LFnorm, HFnorm and LF/HF between the groups, which indicates the predominance of sympathetic VOD.

Taking into account the results of dynamic monitoring of HRV parameters in the acute period of stroke against the background of the absence or presence of cardiovascular diseases, we concluded that early verticalization of such patients is effective due to a significant improvement in HRV parameters - an increase in HFnorm and a decrease in LFnorm and LF/HF, which allows us to conclude about the presence of shifts towards the normalization of VOD and VR, improvement in K30:15 indicates the normalization of parasympathetic regulation of the CVS.

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