Improving Diagnostic Approaches to Predicting Stroke Complications

E. M. Toshkenov[1], G. S. Rakhimboeva[2*] and U. T. Abdukodirov[1]

[1]*Department of Neurology, Andijan State Medical Institute, Andijan, Uzbekistan.*
[2]*Department of Neurology, Tashkent Medical Academy, Tashkent, Uzbekistan.*

Authors' contributions

This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.

Original Research Article

ABSTRACT

Introduction: This article provides a brief description of the possibility of using reversible cerebral vasoconstriction syndrome as a possible predictor of stroke development. As you know, the main subtypes of ischemic stroke are: atherothrombotic. Cardiogenic embolic, lacunar, hemodynamic, hemorheological. To date, the pathophysiological mechanisms of the development of stroke have not been fully studied, so the search for new diagnostic criteria that expand the clinical diagnosis of acute circulatory disorders remains an urgent issue in clinical neurology.

Materials and Methods: 36 patients aged 30 to 77 years (mean age 53.5 ± 11.4 years) were examined at the Department of Neurology of the ASMI. The diagnosis was made based on anamnestic information, the results of the clinical and neurological examination and MRI data in the T-1, T-2, T2-FLAIR, MPA modes.

Results: According to the results of the study, a mild stroke (NIHSS less than 7 points, Bartel index more than 75 points, mRS less than 2 points) was observed in 36% of subjects, moderate severity (NIHSS 7-14 points, Bartel index 70-60 points, mRS 2-3 points) in 52% of patients with severe severity (NIHSS more than 14 points, Barthel index less than 50 points, mRS - 4 points) in

_____

E-mail: researcher.uz@gmail.com;

12% of patients. In neurological status, in all patients, motor (contralateral hemiparesis or monoparesis and sensory disturbances in combination with impaired innervation of the facial and sublingual nerve were determined to vary degrees. Speech disorders in the form of aphasia and dysarthria, slightly expressed disorders of gnosis and praxis were also detected.

Conclusion: The most significant factors affecting the course and outcome of the disease in patients with stroke can be considered the presence of cerebral angiospasm.

1. INTRODUCTION

Acute cerebrovascular accidents continue to dominate the structure of cerebrovascular diseases [3]. The main subtypes of ischemic stroke in arterial hypertension and atherosclerosis are: atherothrombotic (in 34% of cases), cardiogenic embolic - 22%, lacunar - 20%, hemodynamic - 15%, hemorheological - 9%. The pathophysiological mechanisms underlying the stroke are as follows: a decrease in cerebral blood flow leads to a decrease in ATP synthesis, then there is a dysfunction of the channels of active ion transport, activation of the "glutamate cascade" when excess glutamate is released from the presynaptic ends of ischemic neurons into the intercellular space, calcium is released from the intracellular depot, which causes activation of a number of enzymes - phospholipase, xanthine oxidase, calpain protease, as well as the accumulation of arachidonic acid s, which leads to oxidative stress and the accumulation of free radical compounds, which leads to inflammation and death of neurons [1,5]. Gene expression during neuronal death activates the synthesis of pro-inflammatory cytokines (interleukins-1 of the α and β spectrum, tumour necrosis factor-α, intercellular interaction molecules, cyclooxygenase-2, which triggers inflammation in the field of ischemia, maintaining oxidative stress, impaired microcirculation and blood-brain barrier [4,9].

Reversible cerebral vasoconstriction syndrome can be a predictor of the development of stroke since this syndrome is characterized by a thundering headache and reversible vasoconstriction of the cerebral arteries and can occur either spontaneously or under the influence of an exogenous trigger [6]. Existing assessment of stroke patients is based largely on detailed clinical evaluation that is complemented by neuroimaging methods. However, emerging data point to the potential use of blood-derived biomarkers in aiding clinical decision-making especially in the diagnosis of ischemic stroke, triaging patients for acute reperfusion therapies, and in informing stroke mechanisms and prognosis [11,12].

And with an ischemic stroke, cerebral vessel occlusion occurs, which leads to a decrease in blood circulation or its absence, and the absence of blood circulation for several minutes leads to the death of neurons in the central region of a heart attack [2]. The area surrounding it is called ischemic penumbra (penumbra), which contains functionally damaged brain tissue, which is supplied from collateral vessels [7, 10]. This site can transform into a heart attack due to secondary damage to neurons induced by a whole cascade of hemodynamic, cellular and metabolic reactions, during which brain cells die within a few days [8].

Also, in the pathogenetic mechanism of stroke development, endogenous intoxication plays an important role, which is an important link in the mechanism of development of acute cerebral ischemia, characterized by an imbalance of biologically active substances, in which the accumulation of so-called endogenous toxic substances occurs, i.e. excess products of pathological metabolism.

Therefore, it remains relevant to a search for new diagnostic criteria that affect the development of stroke. To assess the possibility of using reversible cerebral vasoconstriction syndrome as a predictor of stroke.

2. MATERIALS AND METHODS

36 patients aged 46 to 77 years (mean age 57.6 ± 11.4 years) were examined at the Department of Neurology of the ASMI. The diagnosis was made based on anamnestic information, the results of the clinical and neurological examination and MRI data in the T-1, T-2, T2-FLAIR, and MPA modes. MRI was performed on a Toshiba tomograph with a magnetic induction value of 1.5 T. Clinical and neurological examination included determining the level of

wakefulness according to the Glazko scale, according to which the total score of 15 is clear consciousness, 14-12 is stunning, 11-9 is stupor, less than 8 - coma. The severity of neurological disorders was determined by the National Institute of Health (NIHSS, Brott T, Adams H.P.) stroke scale, according to which less than 7 points are a mild degree of neurological disorders, from 7-14 a moderate degree, more than 14 - a severe degree. Also, patients underwent CT angiography. When analyzing angiograms, attention was paid to the caliber, the correct passage and the course of the arteries.

The degree of functional impairment was assessed using the Barthel index and a modified Rankin scale.

Statistical processing was carried out using parametric and nonparametric evaluation criteria (Kruskal-Wallis test, Mann-Winnie test).

3. THE RESULTS OF THE STUDY

The results shown a mild stroke (NIHSS less than 7 points, Bartel index more than 75 points, mRS less than 2 points) was observed in 36% of patients, moderate severity (NIHSS 7-14 points, Bartel index 70-60 points, mRS 2-3 points) in 52% of patients with severe severity (NIHSS more than 14 points, Barthel index less than 50 points, mRS - 4 points) in 12% of patients.

Patients with mild severity noted pyramidal insufficiency, mild motor impairment (hemi and monoparesis), mild paresis of the lower facial muscles and dysarthria, mild speech impairment.

In patients with moderate severity, moderate motor impairment (hemiparesis), hypesthesia, speech impairment, and partial dependence on others were noted.

Patients with severe severity noted hemiplegia, dysarthria, aphasia, agnosia, praxis disorders, complete dependence on others in everyday life.

In neurological status, in all patients, motor (contralateral hemiparesis or monoparesis) and sensory disturbances in combination with impaired innervation of the facial and sublingual nerve were determined to vary degrees. Speech disorders in the form of aphasia and dysarthria, slightly expressed disorders of gnosis and praxis were also detected.

Among all patients with ischemic stroke, patients with atherothrombotic and cardiogenic embolic stroke at admission had the highest severity of neurological disorders. Patients with lacunar stroke at admission had the lowest severity of neurological impairment compared with patients of other groups.

The data obtained indicate a decrease in the severity of neurological symptoms (on the NIHSS scale) and functional impairment on the Barthel scale and Rankin index (Tables 1 and 2) by the end of the acute period of stroke.

Thirty six percent (36%) of stroke patients had thunderous pain. During the Valsalva test (intense physical activity, defecation, sexual activity, cough) was observed in 83% of patients. In 1 patient, a combination of 2 triggers was noted (Valsalva test with exposure to heat or cold - a hot bath, shower, and significant emotional stress).

According to the study, 25% of patients developed focal neurological symptoms, 7% - convulsive syndrome. The incidence of focal neurological deficit depends on the patient sample and study design. In our study, it is 1.5 times more common in men over 55 years old (p <0.05), up to 55 years old women are 1.2 times more likely to suffer from reversible cerebral vasoconstriction syndrome (SSC) (p <0.05) compared to men.

According to the neuroimaging technique (MRI), in the analyzed sample, heart attacks in the occipital lobes were detected in 14 patients (40.30% of the total number of patients), heart attacks in cerebral hemispheres in 11 patients (29.85%), in the brain bridge in 9 patients (25.37%), in the thalamuses in 6 patients (17.91%), in the mediobasal sections of the temporal lobes in 3 patients (10.45%), 2 patients (7.46% each) had heart attacks in the lower medial sections parietal lobes, cerebellar worm, and medulla oblongata, in 1 person in the midbrain (5.97%). At the same time, several patients showed the involvement of two or more brain structures supplied from the vertebrobasilar pool, and 8 patients (20.90%) along with signs of acute ischemia in the vertebrobasilar pool also had neuroimaging signs of acute ischemic changes in the carotid pool.In patients with reversible cerebral vasoconstriction syndrome, a deformity of the main arteries of the head was revealed during a stroke, which was often represented by pyramidal insufficiency: anisoreflexia - 20 (55.56%), increased muscle tone by the pyramidal type - 13 (36.11%), 5

clonuses (13.89%). Horizontal nystagmus was also detected - 16 (44.45%), symptoms of cerebellar ataxia - 2 (5.56%), positive symptoms of oral automatism - 4 (11.12%).

In patients with stroke, localization of the lesion in the carotid basin was observed in 26 (72%), in the vertebro-basilar basin (VBI) - in 4 (11%), in the zone of adjacent blood circulation - in 6 (17%).

In 27 patients (75%), MR-angiography showed hypoplasia of the V4 region of the left vertebral artery. Blood flow asymmetry was noted in sections A1 of the anterior cerebral arteries, which corresponded to an acute violation of cerebral circulation.

Moreover, the main MR-symptoms of reversible cerebral vasoconstriction syndrome are: A symptom of "empty flow", the presence of linear, convoluted structures with no MR signal, intense current in the supply vessels and veins according to magnetic resonance angiography (MRA), the presence of signs previously transferred hemorrhage.

From the development of adverse outcomes, the most significant factors were the assessment of the severity of the condition according to the NIHSS scale, the fact of detecting angiospasm by MRA, the presence of early angiospasm of intracranial arteries according to MRA, and the development of ischemia.

In almost all patients with reversible cerebral vasoconstriction syndrome, anomalies and developmental variants of the vessels of the vertebro-basilar basin were revealed in 83.4% of cases in the form of tortuosity and asymmetry of cerebral vessels.

Table 1. Dynamics of neurological symptoms in patients with various subtypes of stroke on the NIHSS scale

stroke subtype	total points on the NIHSS scale	
	72 hours	**30 days**
Atherothrombotic stroke	6,5 (5-10)	4,3 (2-6)
Cardiogenic embolic stroke	7 (4-12)	5 (2-14)
Lacunar stroke	4 (3-9)	2 (0-4)

Table 2. Dynamics of functional disorders in patients with various subtypes of stroke

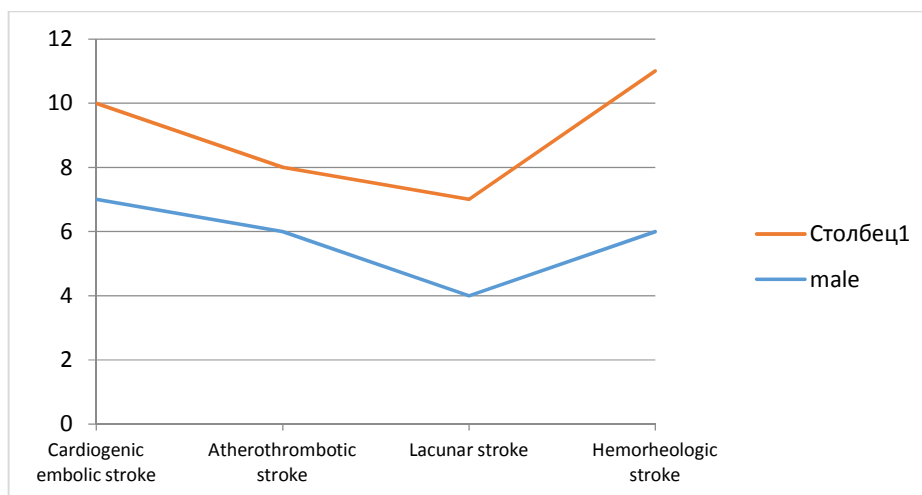| stroke subtype	Sum of points on a scale Bartela	Rankin Index (in points)		
	72 hours	**30 days**	**72 hours**	**30 days**
Atherothrombotic stroke	35 (10-50)	55 (30-75)	4 (3-4)	3 (2-3)
Cardiogenic embolic stroke	40 (23-65)	55 (10-88)	3 (3-4)	2 (2-3)
Lacunar stroke	55 (20-70)	80 (60-100)	3 (3-4)	2 (0-3)

Diagram 1. Distribution of patients by gender and stroke subtype
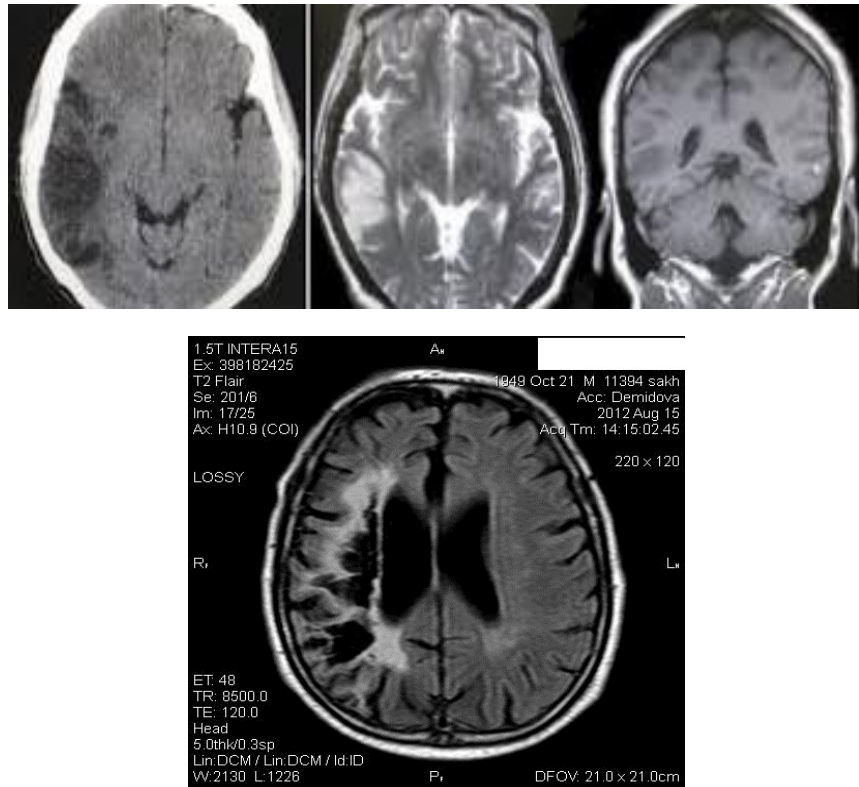
Fig. 1. MRI images of patients with stroke who were at the Department of Neurology of the AGMI
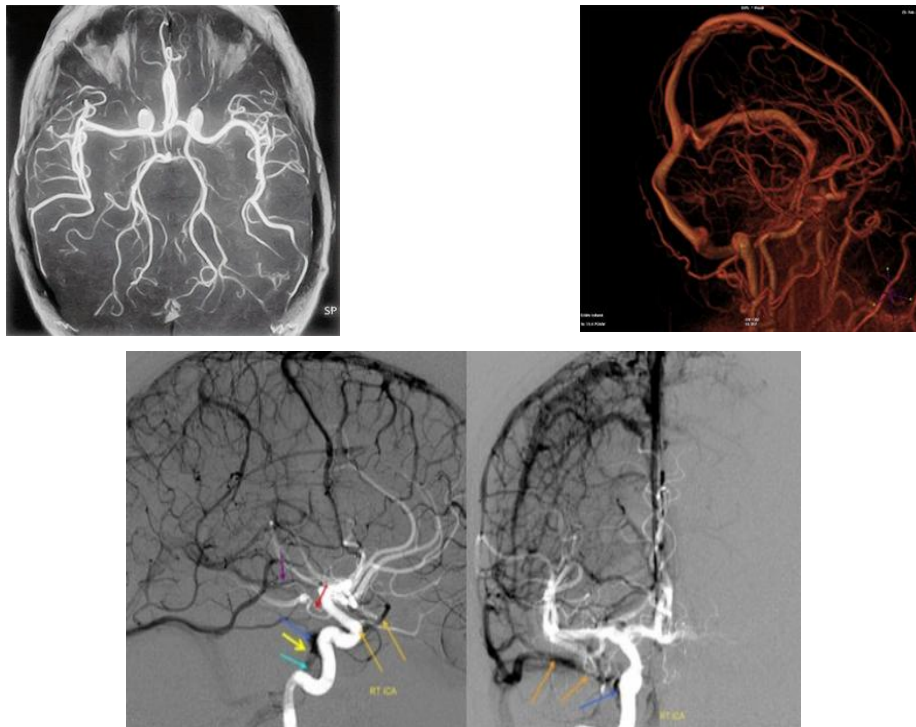

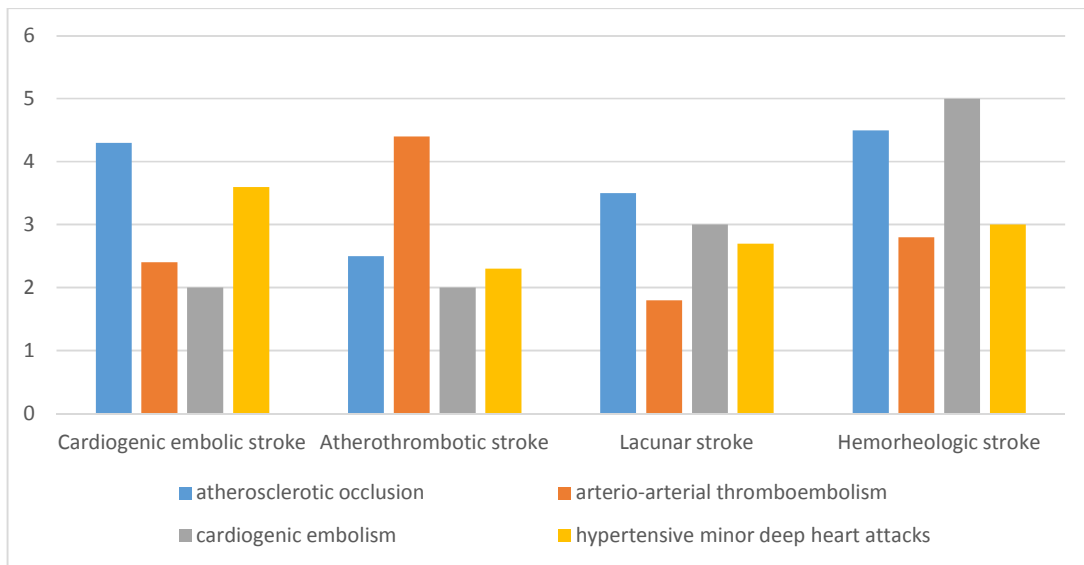**Fig. 2. Magnetic resonance angiography in a patient with reversible cerebral vasoconstriction**

Fig. 3. Characterization of focal changes in the brain in patients with different types of stroke (according to angiographic studies)

Patients with an atherothrombotic type of stroke showed MRA signs of secondary lesions of the intracranial arteries of the brain in the form of narrowing, marginal defects, or the absence of an MRA signal for blood flow. Variants of the formation of arteries of the vertebro-basilar basin are represented by aplasia of one of the peripheral arteries and the tortuosity of its course.

Fig. 3 shows the main characteristic changes in the brain in patients with different types of stroke (according to angiographic studies).

It was also revealed that with the occurrence of early angiographically prone angiospasm, the incidence of reversible cerebral vasoconstriction is 59% - 21 patients, the formation of ischemic heart attacks on brain MRI 41% - 15 patients.

The Mann-Whitney test did not reveal significant differences in the involvement of various brain structures in men and women with stroke, except more frequent cerebellar damage in men ($p = 0.041$). However, one-dimensional analysis of variance did not confirm this difference ($p = 0.24$).

4. CONCLUSION

Summarizing the above, it can be assumed that reversible cerebral vasoconstriction syndrome can be a predictor of the development of stroke, and used as the main method for the diagnosis of acute circulatory disorders. Angiography of cerebral vessels as a diagnostic method has great prognostic value concerning the development of ischemia, and then brain stroke. The most significant factors affecting the course and outcome of the disease in patients with stroke can be considered the presence of cerebral angiospasm.

CONSENT

As per international standard, patient's written consent has been collected and preserved by the author(s).

ETHICAL APPROVAL

As per international standard, ethical approval has been collected and preserved by the author.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

REFERENCES

1. Consoli M. Cuccuini F. Lorenzini, et al. Anatomical variations of the posterior circulation: case reports and a review of literature Ital J Anat Embryol. 2012;117(1): 13-22.
2. Auten RL. Oxygen toxicity and reactive oxygen specils:the devil is in the details /

R.L. Auten, J.M. Dovits // Pediatr. Res. 2009;66(2):121-127.

3. Arterial territories of the human brain / L. Tatu, T. Moulin, F. Vuillier et al. // Front Neurol Neurosci. 2012;30:99-110.

4. Basilar artery occlusion / H.P. Mattle, M. Arnold, P.J. Lindsberg et al. // Lancet Neurol. –2011;10 (11):1002-1014.

5. Bouayed, J. Oxidative stress and anxiety:Relationship and cellurar pathways /J. Bouayed, H. Rammal, R. Soulimani // Oxid. Med. Cell. Longev. 2009;2(2):63-67.

6. Caplan L. Posterior circulation ischemia: Then, now, and tomorrow: The Thomas Willis Lecture-2000 / L. Caplan // Stroke. 2000;31:2011-2023.

7. Caplan L.R. Posterior cerebral artery syndromes. In: Cerebrovascular disease pathophysiology, diagnosis and management / L.R. Caplan, J. Bogousslavsky (M.D. Ginsberg and J. Bogousslavski, eds). Oxford, UK: Blackwell Science. 1998;1028-1045.

8. Detection of intracranial atherosclerotic steno-occlusive disease with 3D timeof-flight magnetic resonance angiography with sensitivity encoding at 3T / C.G. Choi, D.H. Lee, J.H. Lee et al. // Am J Neuroradiol. 2007;28:439-446.

9. Digital map of posterior cerebral artery infarcts associated with posterior cerebral artery trunk and branch occlusion / T. Phan, A. Fong, G. Donnan et al. // Stroke. 2007;38:1805-1811.

10. Thornton, C. Molecular Mechanisms of Neonatal Brain Injury[Electronic resource] / C. Thornton, C.I. Rousset, A. Kichev [et al.] // Neurol. Res. Int. 2012.
Article 506320. – 16 p. – Mode of access: DOI: 10.1155/2012/506320.

11. Harpaz D, Eltzov E, Seet R, Marks RS, Tok AI.Point-of-care-testing in acute stroke management: an unmet need ripe for technological harvest. Biosensors. 2017; 7(3):30.

12. Sinawang PD, Harpaz D, Fajs L, Seet RCS, Tok AIY, Marks RS. Electrochemical impedimetric detection of stroke biomarker nt-probnp using disposable screen-printed gold electrodes. EuroBiotech J. 2017;5: 165–176.
DOI:10.24190/ISSN2564-615X/2017/02. 09.