Emotional disturbances in patients in the remote postoperative period after surgical treatment of cerebral aneurysms

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Aneurysmal subarachnoid haemorrhage is one of the most severe forms of cerebral stroke, associated with a high mortality and disability rate. Development of emotional disorders (anxiety and depression), as well as functional and cognitive deficits, interfere with resocialisation of patients who have undergone surgery for a cerebral aneurysm, and impair quality of life and exacerbate cognitive impairment.

Objective: *to investigate the prevalence of emotional disturbances in the remote postoperative period after surgical treatment of cerebral aneurysms (CA).*

Material and methods. *The prevalence and severity of emotional disturbances in the remote postoperative period after surgical treatment of CA was analysed, mean time after surgery was 3.5 years. Two hundred and one patients underwent surgery for a CA rupture, 110 for a non-ruptured aneurysm. On admission to hospital for surgical treatment, patients underwent a clinical and diagnostic examination to confirm the diagnosis and determine the extent, timing and type of intervention. In the remote postoperative period, the degree of limitation of self-care and functional capacity (using the Barthel Index and the modified Rankin Scale), cognitive functioning (using the MoCA test) and emotional domain (using the HADS scale) were assessed.*

Results. *In the remote postoperative period following surgical treatment of CA, subclinical and clinically significant anxiety was found in 110 (36.3%) patients and depression – in 117 (38.6%). The severity of anxiety and depressive disorders did not decrease over time. The mean score on the HADS anxiety scale during the first year after surgery was 5.9±2.8; after 5 years and more – 6.1±3.4. The mean score on the depression scale in patients tested within 1 year after surgery was 7.3±3.3; after 5 years and more – 6.7±3.5. A correlation was found between the severity of vasospasm and anxiety disorders in the remote postoperative period: anxiety symptoms predominated in patients with normal linear blood flow velocity compared to patients diagnosed with vasospasm ($p=0.03$). The condition of patients at hospital discharge was also associated with the severity of anxiety symptoms in the remote postoperative period: as the Glasgow Outcome Scale (GOS) score increased, so did the severity of anxiety disorders. A statistically significant correlation was found between the groups of patients with a GOS score of 3 and 5 points ($p=0.016$). A significant predominance of anxiety and depressive disturbances was found in female patients in the remote postoperative phase of surgical treatment ($p<0.001$ and $p=0.002$, respectively).*

Conclusion. *Emotional disturbances in patients who underwent surgery for CA persist for a long time, with anxiety disorders predominating in patients without overt neurological disorders during hospitalization. Both anxiety disorders and depressive disorders occur most frequently in female patients. The persistence of emotional disturbances over a long period of time after the exclusion of the aneurysm from the circulation shows the need for their correction in terms of patient's social adaptation.*

Keywords: *cerebral aneurysm; subarachnoid hemorrhage; surgical treatment; emotional disturbances; anxiety; depression.*

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Over the past 2 decades, survival rate for subarachnoid hemorrhage (SAH) has increased significantly [1–5], but only 60% of survivors achieve full functional independence in the remote postoperative period (6 months or more); 34% return to their previous work [6].

The main factors preventing the return of patients with subarachnoid hemorrhage to active life are functional deficits and limited ability of self-care due to motor deficits and cognitive impairment (CI) [7–11].

Usually, researchers do not pay much attention to the prevalence of emotional disorders in the late period of cerebral aneurysm surgery, however, according to the results of a number of studies, one of the independent risk factors for loss of ability to work after SAH is postmorbid emotional disorders (anxiety and depression), the frequency of which ranges from 15% to 50% 4–7 years after SAH [12–14].

According to the research data, a number of unrelated factors predict the development of emotional disorders, including

female gender, premorbid depression, the use of psychoactive substances and drugs associated with CI, presence of focal neurological deficit [13, 15]. However, a significant association between emotional disturbance with the method and timing of surgical treatment of SAH was not found [16].

Regular neuropsychological examination and correction of identified emotional disorders (including the use of medications) could improve the long-term prognosis after aneurysmal SAH surgery: according to international studies, timely detection and treatment of post-stroke depression and CI can prolong the patient's life by 10 years [17].

The aim of this study was to investigate the prevalence of emotional disorders in the remote postoperative period after surgical treatment of CA.

Methods

Study design. The study is based on the results of 311 patientsX examination in the remote postoperative period after surgical treatment of cerebral aneurysms in four neurosurgical clinics of Moscow.

Patient inclusion and data extraction. The average age of patients at the period of surgery was 48.5 years (range 25–82 years; median 49 years). The study included 211 females and 100 males. Surgical treatment after ruptured aneurysm was performed in 201 patients; 110 patients were operated on for unruptured aneurysms. In 242 patients aneurysms were excluded from the blood flow using the microsurgical method; 69 patients underwent endovascular embolization of the CA. Twenty-seven patients in the acute period of aneurysm rupture, along with microsurgical clipping of aneurysms, underwent simultaneous imposition of an extra-intracranial shunt between the branches of the tegmental or cortical segment of the middle cerebral artery and the parietal branch of the superficial temporal artery in order to prevent ischemic complications due to the development of cerebral vasospasm. The microsurgical method was supplemented with fibrinolysis of blood clots in subarachnoid spaces to prevent vasospasm in 16 patients with massive basal SAH.

Aneurysms of the anterior part of the cerebral arterial circle were detected in 293 patients (94.2%): internal carotid artery (ICA) – in 100 (32.1%), middle cerebral artery (MCA) – in 89 (28.6%) patients; aneurysms of the anterior communicating artery (ACA) were detected in 104 (33.4%) patients. Aneurysms of the vertebrobasilar system (VBS) were diagnosed in 17 (5.5%) patients. Multiple aneurysms were detected in 63 (20.3%) patients.

When patients were admitted to the clinic for CA surgery, they underwent clinical and instrumental examination, including:

- computed tomography (CT) of the brain to determine the anatomical form of hemorrhage according to the C.M. Fisher scale (1980);
- CT-angiography of intracranial arteries to visualize the CA, its localization and anatomical features for planning a surgical intervention;
- transcranial duplex scanning of the cerebral arteries upon admission, before surgery and daily after the surgery to assess the degree and prevalence of the MCA vasospasm, as well as determining the Lindegaard index; moderate vasospasm was diagnosed when a linear velocity of blood flow (VBF) was 120 to 240 cm/sec, severe – over 240 cm/sec;
- the patients' condition severity and the risk of surgical mortality in acute period of SAH were assessed in accordance with the Hunt–Hess scale (Hunt W.E., Hess R.M., 1968);
- outcome diagnostics with assessment of consciousness level was performed using the Glasgow Outcome Scale (Jennett B., Bond M., 1975).

In the remote postoperative period after surgical treatment patients were invited to visit the clinic for examination on average 3.5 years (range 1–10 years; median 3.5 years) after surgery. The patient's functional status, the disability degree and independence in the activities of daily living were assessed using the Modified Rankin Scale (mRS; 1988) and the Bathel Index (Barthel Activities of Daily Living Index; 1955). The Montreal Cognitive Assessment Scale was used to assess the cognitive functions and screen for cognitive impairment (MoCA; 1996). The Hospital Anxiety and Depression Scale was used to determine the level of anxiety and depression, as well as to assess the patient's emotional state and well-being (HADS; 1988). We analyzed medical records (outpatient records and discharge summaries), interrogated patients and their relatives to identify risk factors for vascular diseases (arterial hypertension, diabetes mellitus, smoking, alcohol abuse, obesity).

Statistical analysis was performed using STATISTICA for Windows ver. 12.5 (StatSoft Inc., USA) and GraphPad Prism ver. 9.5 (GraphPad Soft, USA). The results were presented as the mean ± standard deviation (M±SD) or median (Me) [25th; 75th percentiles]. Statistical significance of differences between the groups was determined using multivariate parametric analysis of variance (ANOVA). Multiple comparisons were made using Tukey's test. Differences were considered significant at $p<0.05$.

Results. Among 311 surveyed patients, 49 (15.8%) had signs of limited functional capacity (⩾3 points on the mRS); 100 (32.2%) had limitations in activities of daily living (Barthel Index value I95 points); 99 patients (31.9%) had cognitive impairment (I26 points on the MoCA).

The presence of emotional disorders was assessed in 303 patients; another eight (2.5%) could not be tested using the HADS due to pronounced symptoms of cognitive impairment (dementia), as well as aphasia, which prevented their independent completion of HADS questionnaire. Anxiety symptoms were detected in 110 (36.3%) patients, depression – in 117 (38.6%). Subclinical anxiety was diagnosed in 70 (23.1%) patients, clinical anxiety – in 39 (12.9%), subclinical depression – in 64 (21.2%) patients, clinical depression – in 55 (18.1%) patients (Figure 1).

We analyzed dynamics of emotional disorders in the late period of cerebral aneurysm surgery at 6 months, 1–3 years, 3–5 years, and more than 5 years. There were no significant tendencies toward worsening or regression of symptoms; average values remained within normal range (Table 1).

We assessed the effect of the surgical intervention technique on the prevalence of anxiety and depression in the late period of aneurysm exclusion from the blood flow. No significant differences in the severity of anxiety disorders depending on the choice of surgical technique were found (ANOVA $F(1,300) = 2.3696$; $p = 0.12$). The average indicators of anxiety severity in both groups did not exceed the normal values. Symptoms of clinically significant depression were more common in patients who underwent

microsurgical aneurysm clipping (Figure 2). The differences between groups were close to statistical significance (ANOVA F (1,300) = 3.3979; p=0.07).

We analyzed the influence of the severity of patientsX condition on the prevalence of emotional disorders in the late period. Anxiety disorders predominated in patients with mild neurological disorders, as well as in patients without any symptoms (grade I according to the Hunt–Hess scale), while symptoms of depression, on the contrary, predominated in patients who had severe focal and general cerebral symptoms before surgery, corresponding to grade IV according to the Hunt–Hess scale. This trend was not statistically significant (Table 2).

We found a correlation between vasospasm and anxiety severity in the long-term period (ANOVA F(2,191) = 3.5654; p=0.03). In patients with normal linear blood flow velocity anxiety symptoms were more prevalent than in patients with vasospasm (Fig. 3).

Significant association between the prevalence of anxiety symptoms and hospital outcomes according to the GOS was also found (ANOVA F(2,295) = 4.8373; p=0.008). The average scores of HADS anxiety subscale in patients of all groups were within normal values, however, as the GOS score increased, the severity of anxiety disorders also increased. A significant association was found between the groups of patients with 3 and 5 points on the GOS (Tukey test; p=0.016). The severity of depressive disorders in the long-term period did not depend on hospital outcomes according to the GOS (ANOVA F(2,295) = 1.5525; p=0.21) (Figure 4).

The analysis of the prevalence of emotional disorders in patients of different age groups revealed an increase in anxiety and depression severity with increasing age: in patients aged 60 and older depressive disorders predominated in the remote period. The differences in the prevalence of depressive disorders between the patient groups were close to statistical significance (r=-0.104; p=0.07). The average scores on the HADS anxiety and depression subscales in all age groups did not exceed go the normal values (Table 3).

In addition, a significant predominance of anxiety and depressive disorders was established in female patients in the late period of surgical treatment (Mann–Whitney test, p<0.001 and p=0.002, respectively (Table 4).

Discussion. Research data show that depression and paradepressive disorders which, according to some authors, also include anxiety, are the most common mental disorders that develop after cerebral stroke and reduce the quality of life and the effectiveness of rehabilitation measures [18–20]. A sys-

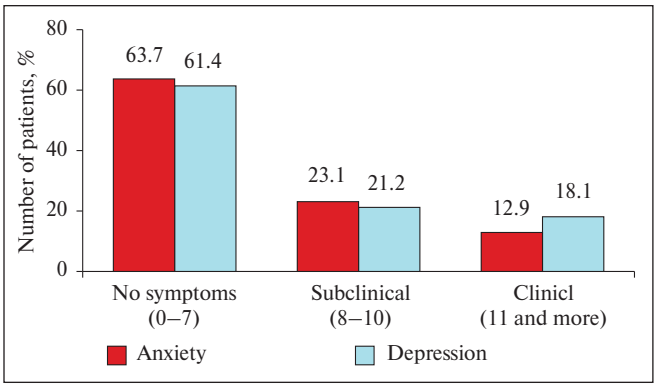

Fig. 1. *Severity of anxiety and depressive disturbances according to HADS scale in the remote postoperative period after surgical treatment of cerebral aneurysms (n=303)*

Table 1. *Outcomes of surgical treatment of cerebral aneurysms in the remote postoperative period at different time of observation (n=303), M±SD*

Long-term study timeframes, years	Average HADS score	
	anxiety	depression
6 months – 1 year (n=27)	5.9+2.8	7.3+3.3
1–3 (n=133)	6.5+3.0	6.0+3.4
3–5 (n=94)	7.0+4.3	7.1+3.7
i5 (n=57)	6.1+3.4	6.7+3.5

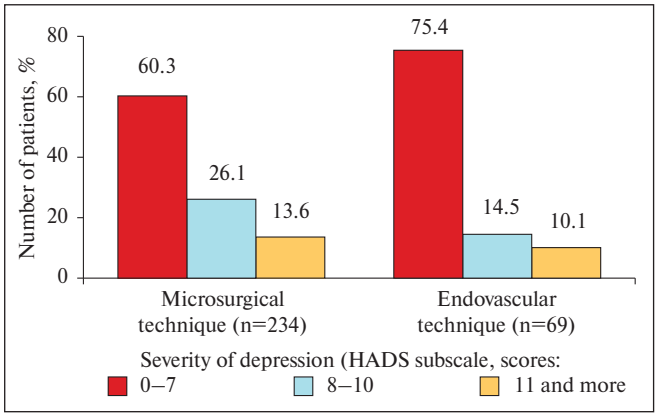

Fig. 2. *Severity of depressive disorders according to HADS scale in patients in the remote postoperative period after surgical treatment of cerebral aneurysms using microsurgical and endovascular techniques (n=303)*

Table 2. *Prevalence of anxiety and depressive disturbances in the remote postoperative period after surgical treatment of cerebral aneurysms in patients with different severity of disease before surgery according to the Hunt-Hess scale (n=195), M±SD*

Severity of patientsX condition before surgery according to the Hunt–Hess scale	Average HADS score	
	anxiety	depression
I (n=123)	6.6+3.2	6.1+3.6
II (n=55)	6.1+2.6	6.8+2.9
III (n=12)	5.3+2.8	6.9+3.8
IV (n=5)	5.4+1.3	7.2+3.6
p value	0.32	0.51

tematic review published by W.K. Tang et al. in 2020, which included the results of 6327 patients' examination from 55 studies [16], reported that the incidence of mild to moderate depression in the late period of SAH was 28.1%. The symptom severity did not depend on the time that elapsed since SAH onset. Long-term persistence of emotional disorders in patients probably indicates that manifestations of depression are ignored by both the patients themselves and the clinicians observing the patients who have had SAH. According to the results of our study, anxiety and depressive disorders are widespread in patients 3.5 years after cerebral aneurysm surgery; their frequency was 36.3% and 38.6%, respectively. A study of the prevalence of symptoms over time also indicates that they persist for 3.5 years or more after surgery. In 2023 a review article was published on the impact of posttraumatic stress disorder (PTSD) on the outcome of SAH [21]. The study results revealed that PTSD symptoms ranged from 1% to 74% (mean 37%) across 17 studies that included data from 1,381 patients. Most often, the development of PTSD was associated with premorbid emotional disorders (long-term depression and neurosis). In contrast to the presented analysis, our study does not allow to assess the degree of influence of premorbid depression on the risk of developing PTSD after aneurysmal SAH, since the work is of a retrospective nature. In addition, $^{2}/_{3}$ of the patients were admitted for surgical treatment after the rupture of CA, due to the fact of hemorrhage. There is no significant evidence in the literature indicating the presence of predictors that determine the risk of developing anxiety and depressive disorders in the long-term period of SAH. P.G. Morris et al. report an increased risk of anxiety in patients with advanced SAH, corresponding to grade IV according to the C.M. Fisher classification (1980) [14]. However, the authors did not find any association of anxiety disorders with other clinical parameters (severity of the condition before surgery, method and timing of surgical intervention, severity of vasospasm). Probably, the fact of the SAH development itself (with acute and sudden onset, loss of consciousness and extremely severe headache) is a kind of trigger that starts the emotional disorders, including anxiety and fear of recurrence. The results of our work, on the contrary, indicate a greater prevalence of anxiety and depression severity in patients with a high degree of functional capacity, which is probably due to preserved critical perception of their own condition and the ability to analyze the severity of the disease. Our data indicate a significant influence of unmodifiable risk factors (gender and age) on the risk of emotional disorders developing in the long term: in elderly patients, the symptoms of depression prevailed compared with young and middle-aged patients; female gender was associated with a higher incidence of anxiety and depression. In contrast, the largest meta-analysis, which included the results of more than 1300 patients' examination in the long-term period of SAH, did not show any association between the frequency of emotional disorders and demographic factors [21].

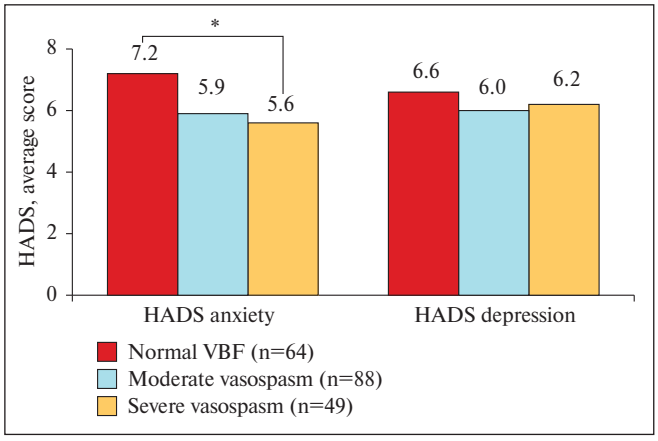

Fig. 3. *Severity of anxiety and depressive disorders according to HADS scale in the remote postoperative period after surgical treatment of cerebral aneurysms in patients with varying degrees of vasospasm (n=195). *p=0,03*

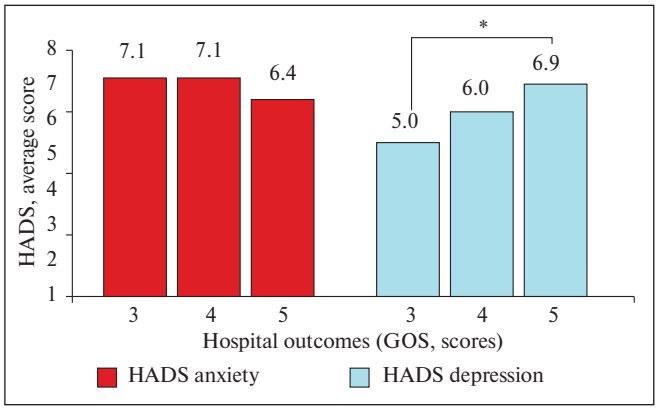

Fig. 4. *Severity of anxiety and depressive disorders according to HADS scale in the remote postoperative period after surgical treatment of cerebral aneurysms in patients with different outcomes according to GOS (n=303). *p=0,016*

Table 3. *Remote outcomes of surgical treatment of cerebral aneurysms in patients of different ages (n=303), M±SD*

Age (years)	Average HADS score	
	anxiety	depression
Up to 44 (n=107)	6.4+3.4	6.1+3.4
45–59 (n=139)	6.7+3.5	6.6+3.6
60 and older (n=65)	6.2+3.7	7.3+3.5
p value	0.47	0.07

Table 4. *Remote results of surgical treatment of cerebral aneurysms in female and male patients (n=303), M±SD*

Sex	Average HADS score	
	anxiety	depression
Female (n=211)	6.9+3.4	7.0+3.5
Male (n=100)	5.6+3.6	5.8+3.3
p value	<0.001	0.002

Conclusion. Emotional status disturbances in patients who have had SAH persist for a long time and are more pronounced than the symptoms of functional disability and limitations of self-care. Apparently, the severity of symptoms of anxiety and depression, diagnosed in more than one third of the patients included in our study, interferes with their effective functioning in a social environment. Regular neuropsychological examination and timely correction of emotional disorders will help patients return to the social environment as soon as possible and prevent the progression of cognitive impairment.

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Conflict of Interest Statement

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