

PERSONALITY CHANGES FOLLOWING BRAIN ARTERY ANEURYSM SURGERY

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SUMMARY – Neuropsychological testing of patients in the course of their recovery from brain injuries enables analysis of cognitive deficiencies and/or emotional changes. The principle study objective was to define organic and/or reactive personality changes and the course of these changes in the function of the time span following brain artery aneurysm surgery in both female and male patients. The study was carried out at the Clinical Department of Neurosurgery, Zagreb University Hospital Center in Zagreb. The data refer to the period from 1989 to 2012 collected in two time intervals, i.e. 11 months and 12-48 months following brain artery aneurysm surgery. Of 72 patients included in the study, there were 28 male and 44 female patients. Neuropsychological testing consisted of clinical interview, clinical assessment of frontal lobe syndrome, Cornell personality questionnaire and Emotional Profile Index. Study results showed evidence of frontal lobe syndrome in 32% of patients on first testing and significant recovery on retesting, when only 17% of patients presented with frontal lobe syndrome. The reactive personality changes found in both testing intervals indicated increased neuroticism. In the first testing period, asthenic syndrome occurred most often, followed by conversion and aggressive-antisocial syndromes, while in the second testing interval asthenic syndrome was most pronounced and conversion and antisocial syndromes showed the same level of expression. The results also showed higher depressive and disorganizing states, which were even more pronounced in the second testing interval. As regards sex differences, the inclination toward cardiovascular somatization and destructiveness was more expressed in females than in males, showing a tendency of aggravation with increasing the time span following surgery. It may be concluded that the study has contributed to better understanding of organic and/or reactive personality changes in patients undergoing brain artery aneurysm surgery.

Key words: *Subarachnoid hemorrhage – surgery; Cerebral aneurysm – surgery; Personality disorders; Postoperative complications; Neuropsychological tests*

Introduction

Neuropsychological testing is important in terms of helping in the diagnosis of existence or non-existence of mental function damages following brain injuries of different etiology, in defining whether they are caused by organic or psychogenic factors, and also

in the follow up of patient recovery in the course of different stages of neuropsychological rehabilitation^{1,2}. Every neuropsychological testing includes testing of cognitive and conative functions, i.e. definition of organic and/or reactive personality changes in situations of function loss and mental deterioration^{2,3}. Since different types of brain injuries are highly stressful events for the patients, they often react very emotionally regardless of the extent and/or anatomical position of the lesion³. Frontal lobe syndrome or dysexecutive syndrome, which occurs as a result of frontal lobe injury, presents as a specific entity including the symptoms

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Received December 23, 2014, accepted March 10, 2015

such as disorders in executive function, abstract thinking, speech production and personality, and emotional changes (e.g., reduced self-control and self-direction, lack of criticism, emotional instability, apathy, irritability, excitability, disinhibition in expressing emotions, socially improper behavior and ignoring of social rules, and changes in sexual behavior)¹. The most common reactive personality changes produced as a result of realizing the existing situation in terms of sudden and deep changes in lifestyle and constant frustration because of the disease usually present as anxiety and depression⁴.

Subarachnoid hemorrhage (SAH) is clinically manifested as headache, loss of consciousness, meningeal signs and neurological defects⁵. The most common cause of SAH is rupture of intracranial aneurysm, which may occur both in restful periods and in periods of activities that cause increased intracranial pressure⁶. Treatment of intracranial aneurysms can include micro-neurosurgical procedure or radiological interventional endovascular embolization^{5,7}. As SAH, i.e. rupture of an aneurysm, more often affects younger patients, its psychosocial consequences can interfere with regular everyday functioning for years⁸. A large number of patients with brain injuries show increased anxiety many years after SAH event, resulting in distraction, difficulties in concentration, depression, and lack of interest⁹.

Wermer *et al.*⁸ found that 59% of patients noticed their personality changes many years following SAH, particularly in terms of increased agitability, apathy and emotional instability accompanied by higher levels of depression and anxiety than that observed in the control group.

Rinkela and Algra¹⁰ report that more than 50% of their patients also exhibited greater levels of anxiety and depression symptoms even two years after SAH, whereas post-traumatic stress disorder (PTSD) and sleep difficulties were found in every third patient. The principal reason for life dissatisfaction included inability to return to previous job, while 7% of patients described SAH as the main cause of divorce. In patients with previous emotional and anxiety disorders, the risk of depression and PTSD increases as a consequence of SAH¹¹. Hedlund *et al.*¹² found that one-third of patients developed depression as a consequence of SAH, which contributed to the development of unfavorable and pessimistic perception of recovery and thus may

have negatively affected long term recovery outcomes. Voglesang *et al.*¹³ found that even 10 years following SAH, the patients experienced problems manifesting as pain and discomfort during everyday activities and mobility, and also higher levels of anxiety and depression. The results reported by Voglesang *et al.*¹⁴ also show that anxiety and depression occurred more often in patients having suffered rupture of aneurysm in the posterior part of brain circulation. Powell *et al.*¹⁵ report that 9 months following SAH the patients showed up to three times greater level of anxiety and depression when compared with healthy controls; 25% of them reported intrusive thoughts about the disease and hospitalization and 17% exhibited a certain type of evasive behavior, similar to that seen in PTSD. More than 35% of patients showed very low level of independence, while 18 months after SAH 22% of patients continued to have intrusive thoughts and 13% showed evasive behavior. They also had a higher level of depression and anxiety.

Many studies show that SAH experience can be so traumatic that about 35% of patients are prone to developing PTSD, and more than 30% are extremely afraid of repeatedly experiencing SAH. Those with PTSD are more pessimistic about their future than those with SAH experience but no PTSD¹¹. Study results reported by Otawara *et al.*¹⁶ show that the level of anxiety as a condition increases after surgery, while the level of anxiety as a personality trait remains unchanged. High preoperative anxiety ranks as the most important factor in anxiety increase after surgery. This study also showed that anxiety as a condition increased after surgery for non-ruptured aneurysm in elderly patients. Haug *et al.*¹⁷ and Kubo *et al.*¹⁸ confirm that the quality of life deteriorates in patients submitted to either ruptured or non-ruptured aneurysm surgery, which is probably due to the psychological consequences of having to cope with a life-threatening condition. Fear from disease was expressed to the greatest extent in patients with non-ruptured aneurysm who had suffered preoperatively from a high level of anxiety and depression. However, these findings normalized in 3 months after surgery. The patients with aneurysm smaller than 7 mm consented to surgery because of strong fear from hemorrhage and were more relaxed when given the opportunity to surgically treat their aneurysm and decline the possibility of rupture and SAH. Their quality of life at 3 and 12 months of sur-

gery was similar to that seen in patients with either non-ruptured or ruptured aneurysm.

Vuletić *et al.*¹⁹ report that 45% of patients with stroke feel tired and tiredness was found to significantly correlate with the symptoms of anxiety and depression. Some other studies also showed that negative psychological reactions such as fear from relapse and decreased self-confidence could slow down their recovery and make it more difficult¹².

Patients often suffer from depression after SAH^{12,15}. Psychological process of adjustment affects the individual's ability to cope with stressful situations. Even though in most stressful situations people use to cope both with the problem and their emotions, many studies have shown that certain coping strategies prove more efficient than the others. Depressive patients tend to use the coping strategy aimed at behavior, which usually negatively affects their participation in recovery process. Mood disorders, neuroticism and passive coping are usually related to low quality of life²⁰.

The principal study objective was to find out whether the patients undergoing brain artery aneurysm surgery experience organic (frontal lobe syndrome or dysexecutive syndrome) and reactive personality changes, and to define the course of these changes with regard to the time span from surgery. Furthermore, the idea was to define sex differences in reactive personality changes, also as related to the time elapsed from surgery.

Patients and Methods

Study sample

There were 72 patients included in the study, 28 (38.95%) male and 44 (61.1%) female patients. The patients with premorbid conditions related to the central nervous system, lesions of the central nervous system, or psychiatric illnesses were not taken into consideration for the study. All our study patients had subarachnoid hemorrhage. The age of our patients ranged from 27 to 76 years ($M=46$, $SD=9.184$); 69 of them were right-handed and three were predominantly left-handed. Their average educational level was high school (10 patients had 8 years of school, 45 had 9 to 12 years of school, and 17 had 13 and more years of school). Location of aneurysms and sex distribution in study patients are presented in Table 1.

Table 1. Location of aneurysm according to cerebral artery and sex

Location of aneurysm – cerebral artery	n	Male	Female
Anterior communicating artery (ACoA)	27	10	17
Anterior cerebral artery (ACA)	1	1	0
Medial cerebral artery (ACM)	19	10	9
Interior carotid artery (ACI)	9	3	6
Basilar artery (AB)	1	0	1
Other arteries	6	2	4

As regards the number of aneurysms, six (87.5%) patients had only one aneurysm and there were nine (12.5%) patients with multiple aneurysms. Most of the patients ($n=66$; 91.7%) were submitted to one surgical procedure, four (5.5%) patients had two surgeries, and two (2.8%) patients had more than two surgeries. Most patients had aneurysm in either right ($n=33$; 46.5%) or left ($n=27$; 38%) brain hemisphere, while there were 22 (15.5%) patients with aneurysms in both hemispheres.

Instruments

The 4-degree scale was used for clinical assessment of organic personality changes, or frontal lobe syndrome: 0 denoting no symptoms of frontal lobe syndrome, 1 for mild, 2 for moderate, and 3 for severe frontal lobe syndrome.

Personality traits were tested by the Cornell personality questionnaire²¹ and Emotions Profile Index (EPI)²². The Cornell N-4 index contains 110 statements. It is meant for individuals above 16 years of age; it can be used individually and in group and takes about 20 minutes. The questionnaire measures 12 different groups of symptoms or behavior tendencies: anxiety, phobia, hypersensitivity, depression, obsessive-compulsive tendency, cardiovascular somatization, inhibitory and gastrointestinal conversion, hypochondria, impulsive, destruction and paranoid tendencies. Factor analysis provided 12 primary factors corresponding to previous behavioral tendencies and being inter-related at relatively high correlations. Three secondary factors were also obtained: asthenic syndrome factor (anxiety reactions – the sum of anxiety, phobias, hypersensitivity, depression and obsessive-compulsive

tendencies); conversion syndrome factor (conversion reactions – the sum of cardiovascular, inhibitory, gastrointestinal and hypochondriac tendencies); and the factor of asthenic or aggressive-antisocial syndrome (aggressive reactions – the sum of impulsive, paranoid and aggressive tendencies). General factor of the third line is defined as tertiary factor of general neuroticism with norms defined so that the score 0-19 is considered normal, 20-38 score is considered moderate neuroticism, and the result ranging from 39 to 110 score represents pronounced neuroticism. The Cornell index is referred to as a reliable and valuable tool for the measurement of general neuroticism and definition of single diagnostic categories within neurotic behavior²¹.

The EPI²² is used for the measurement of emotional status as defined by Plutchik multidimensional model of emotions, which assumes the existence of eight basic dimensions of emotions: joy, trust, surprise, fear, sadness, disgust, anticipation and anger. Each emotion has its function and produces certain types of behavior. Emotions and behavior present in terms of three general characteristics: intensity, similarity and polarity. On defining study instruments and based on preliminary investigation, 12 personality traits were selected. They were grouped in pairs in all possible combinations and as such included as test items. A group of experienced clinical psychologists defined the degree of personality traits and emotions in single diagnostic frames. Inter-correlations and factor analysis were made and the results obtained showed that the relations between personality traits and emotions could be circularly presented and the concept of polarity was confirmed (for example, *Reproduction vs. Deprivation*). The analysis also showed that the frequency of conflict answers increased as a function of patient maladjustment, i.e. that those who were less adjusted had more difficulty in expressing their emotions. Bias assessment was also included in the test in order to obtain the inclinations of study participants in presenting themselves in socially (un)desirable sense. The EPI assesses relative importance of these eight emotions in the individual's life, i.e. the strength and importance of basic personality traits and conflicts. It contains 62 items in terms of pairs that represent personality traits (12 in total). The study participant should choose which of the two words in pair describes him/her better. The individual profiles obtained can be interpreted in two ways: in the sense of high and low

scores in single dimensions, and in the sense of explaining certain combinations of results for single emotions.

Procedure

The study participants were patients tested from 1989 to 2012 at the Clinical Department of Neurosurgery, Zagreb University Hospital Center in Zagreb. Neuropsychological assessment was carried out in two time intervals: first during 11 months following surgery, and second from 12 to 48 months following surgery. Only data related to personality trait assessment were taken into consideration for our study purposes.

Descriptive statistics was generally used, whereas t-test for dependent samples was used to determine the significance of difference in the expression of frontal lobe syndrome in time function and significance of difference in the results obtained by the Cornell personality questionnaire scales and EPI profile of emotions; univariate analysis of variance was used to test the significance of sex differences. Kolmogorov-Smirnov test was used to define normal distributions. The Windows Statistics 10 software was used and the level of significance was set at 0.05.

Results

The first question was whether patients submitted to brain artery aneurysm surgery experienced organic personality changes, especially in terms of frontal lobe syndrome, and what was the course of these changes with regard to the time elapsed from surgery.

Study results showed that most of the patients ($n=49$; 68.1%) had no symptoms of frontal lobe syndrome in the first testing period, ten (13.9%) patients had mild disorders, eight (11.1%) showed moderate disorders, and only five (6.9%) patients showed severe frontal lobe syndrome. Improvement was noticed in the second testing period, when 60 (83.3%) patients showed no signs of frontal lobe syndrome, nine (12.5%) had mild symptoms and three (4.2%) patients had moderate disorders in terms of frontal lobe syndrome. In the second testing period, none of the patients had severe frontal lobe syndrome.

As the number of study subjects was rather small *per* each single category of syndrome, the variable was recorded and two groups were obtained. The first group

Table 2. Descriptive statistics of personality traits tested by Cornell personality questionnaire in two time periods following brain artery aneurysm surgery

Cornell personality questionnaire		M	N	SD	t	df	p
Anxiety	T ₁	5.56	63	3.031	-2.557	62	0.013*
	T ₂	6.27	63	3.194			
Phobia	T ₁	2.56	63	2.169	-1.724	62	0.090
	T ₂	2.90	63	2.414			
Hypersensitivity	T ₁	3.90	63	2.656	-2.188	62	0.032*
	T ₂	4.44	63	3.015			
Depression	T ₁	1.92	63	2.127	-2.417	62	0.019*
	T ₂	2.65	63	2.628			
Compulsive tendencies	T ₁	1.43	63	1.467	-1.655	62	0.103
	T ₂	1.68	63	1.615			
Asthenic syndrome	T ₁	15.38	63	9.651	-2.876	62	0.006*
	T ₂	17.83	63	10.825			
Cardiovascular conversion	T ₁	1.79	63	1.894	.0242	62	0.809
	T ₂	1.75	63	1.951			
Inhibitory conversion	T ₁	1.48	63	1.654	-1.199	62	0.235
	T ₂	1.63	63	1.781			
Gastrointestinal conversion	T ₁	1.56	63	2.401	-1.850	62	0.069
	T ₂	2.00	63	2.946			
Hypochondriac tendencies	T ₁	5.32	63	3.719	-1.436	62	0.156
	T ₂	5.84	63	4.224			
Conversion syndrome	T ₁	10.14	63	8.232	-1.603	62	0.114
	T ₂	11.19	63	9.593			
Impulsiveness	T ₁	1.22	63	1.142	-0.910	62	0.366
	T ₂	1.33	63	1.191			
Paranoid tendencies	T ₁	1.60	63	1.238	-2.210	62	0.031*
	T ₂	1.97	63	1.596			
Aggressive tendencies	T ₁	1.86	63	1.664	-2.574	62	0.012*
	T ₂	2.40	63	1.922			
Aggressive-antisocial syndrome	T ₁	4.65	63	3.173	-2.918	62	0.005*
	T ₂	5.73	63	4.069			
Total	T ₁	30.19	63	19.734	-2.867	62	0.006*
	T ₂	34.73	63	22.840			

T₁ = first testing (11 months following surgery); T₂ = second testing (12 to 48 months following surgery); *p<0.05

comprised of subjects without frontal lobe syndrome and the second of those with disorders pertaining to frontal lobe syndrome; this group included patients with mild, moderate and severe frontal lobe syndrome. T-test was then performed, yielding a statistically significant difference between the two testing periods ($t(71)=4.267$; $p<0.05$), meaning that significant recov-

ery occurred in terms of diminishing the signs of frontal lobe syndrome, although a smaller number of patients had not recovered completely and continued exhibiting disorders but to a lesser extent ($M_1=0.57$; $M_2=0.21$).

Another objective was to define which reactive personality changes occurred in patients undergoing brain

Table 3. Descriptive statistics of personality trait expression based on EPI for two time intervals following surgery

EPI		M	N	SD	t	df	p
Reproduction	T ₁	60.60	55	31.082	2.167	54	0.035*
	T ₂	51.91	55	37.352			
Incorporation	T ₁	62.82	55	32.493	2.250	54	0.029*
	T ₂	54.15	55	37.567			
Orientation	T ₁	23.91	55	24.713	-0.067	54	0.947
	T ₂	24.13	55	24.139			
Protection	T ₁	59.78	55	24.687	0.416	54	0.679
	T ₂	58.33	55	25.757			
Deprivation	T ₁	67.82	55	31.575	0.028	54	0.978
	T ₂	67.69	55	30.131			
Rejection	T ₁	35.51	55	29.444	-1.475	54	0.146
	T ₂	42.00	55	29.629			
Exploration	T ₁	31.91	55	24.460	0.510	54	0.612
	T ₂	30.29	55	22.972			
Destruction	T ₁	58.05	55	26.470	-1.122	54	0.267
	T ₂	61.98	55	27.015			
Bias	T ₁	41.09	55	29.383	0.692	54	0.492
	T ₂	38.56	55	32.783			

EPI = Emotions Profile Index; T₁ = first testing (11 months following surgery); T₂ = second testing (12 to 48 months following surgery); *p<0.05

artery aneurysm surgery; the Cornell personality questionnaire and EPI were used for this purpose. It was also interesting to observe the course of changes in the function of the time elapsed from surgery.

Table 2 shows data on the number of subjects (N), mean values (M) and standard deviations (SD). Also, the t-test for dependent samples was employed to define the level of significance of difference in the expression of the respective personality traits.

As shown in Table 2, the Cornell personality questionnaire was used in 63 patients. On the first testing of personality assessment, i.e. 11 months following surgery, the results obtained for any scale or primary factor did not exceed 50% of symptom expression. Hence, none of the behavioral tendencies can be specifically emphasized. The analysis of secondary factors showed the asthenic syndrome to be most expressed in the first testing period, followed by conversion syndrome, while aggressive-antisocial syndrome was the least expressed one. Tertiary factor indicated moderate neuroticism.

On second testing performed in the period from 12 to 48 months following surgery, an increased value was

only found for the results on anxiety (M₂=6.27), i.e. it actually declined from normal because the study subjects gave answers to more than 50% of scale items. The results for other scales and syndromes showed no decline, although in some cases they were close to the borderline. The analysis of secondary factors showed that the symptoms of asthenic syndrome were the most expressed ones, while the symptoms of conversion and aggressive-antisocial syndromes ranged at the same level. Here also the tertiary factor indicated moderate neuroticism.

The results obtained on both the first and second testing showed the presence of moderate neurosis. However, a statistically significant difference was found between the two testing results, specifically in terms of a significant increase in the total number of neurotic symptoms ($t(62)=-2.867$; $p<0.05$).

Analysis of the results *per* individual syndromes revealed the number of symptoms of asthenic ($t(62)=-2.876$; $p<0.05$) and aggressive-antisocial syndromes ($t(62)=-2.918$; $p<0.05$) to have significantly increased with time. The results for each single behavioral tendency showed a statistically significant increase in

Table 4. Descriptive statistics of personality trait expression according to Cornell personality questionnaire according to sex and two time intervals following surgery

Cornell personality questionnaire		Men			Women			F	p
		M	N	SD	M	N	SD		
Anxiety	T ₁	5.09	22	3.038	5.80	41	3.035	1.312	0.256
	T ₂	5.59	22	3.528	6.63	41	2.981		
Phobia	T ₁	2.05	22	2.126	2.83	41	2.167	3.829	0.055
	T ₂	2.00	22	2.160	3.39	41	2.428		
Hypersensitivity	T ₁	3.55	22	1.993	4.10	41	2.956	0.855	0.359
	T ₂	3.95	22	3.244	4.71	41	2.892		
Depression	T ₁	1.64	22	2.172	2.07	41	2.114	1.265	0.265
	T ₂	2.14	22	2.731	2.93	41	2.563		
Obsessive-compulsive tendencies	T ₁	1.36	22	1.432	1.46	41	1.502	0.102	0.751
	T ₂	1.59	22	1.919	1.73	41	1.450		
Asthenic syndrome	T ₁	13.68	22	9.063	16.29	41	9.940	1.610	0.209
	T ₂	15.32	22	12.029	19.17	41	10.017		
Cardiovascular somatisation	T ₁	1.00	22	1.414	2.22	41	1.994	8.637	0.005*
	T ₂	0.86	22	1.583	2.22	41	1.981		
Inhibitory conversion	T ₁	1.50	22	1.921	1.46	41	1.518	0.001	0.972
	T ₂	1.59	22	2.153	1.66	41	1.575		
Gastrointestinal conversion	T ₁	0.91	22	1.444	1.90	41	2.737	1.930	0.170
	T ₂	1.45	22	2.874	2.29	41	2.977		
Hypochondriac tendencies	T ₁	5.05	22	3.592	5.46	41	3.822	0.890	0.349
	T ₂	4.91	22	4.151	6.34	41	4.229		
Conversion syndrome	T ₁	8.45	22	7.443	11.05	41	8.576	1.933	0.169
	T ₂	8.82	22	9.485	12.46	41	9.521		
Impulsiveness	T ₁	1.14	22	1.125	1.27	41	1.162	0.596	0.443
	T ₂	1.14	22	1.082	1.44	41	1.246		
Paranoid tendencies	T ₁	1.55	22	1.471	1.63	41	1.113	0.071	0.791
	T ₂	1.91	22	1.659	2.00	41	1.581		
Aggressive tendencies	T ₁	1.95	22	1.397	1.80	41	1.806	0.143	0.707
	T ₂	2.09	22	1.770	2.56	41	2.001		
Aggressive-antisocial syndrome	T ₁	4.64	22	3.001	4.66	41	3.299	0.200	0.656
	T ₂	5.23	22	3.891	6.00	41	4.183		
Total	T ₁	26.77	22	18.302	32.02	41	20.442	1.599	0.211
	T ₂	29.32	22	24.155	37.63	41	21.853		

T₁ = first testing (11 months following surgery); T₂ = second testing (12 to 48 months following surgery); *p<0.05

anxiety ($t(62)=-2.557$; $p<0.05$), hypersensitivity ($t(62)=-2.188$; $p<0.05$), depression ($t(62)=-2.417$; $p<0.05$), paranoid ($t(62)=-2.210$; $p<0.05$) and aggressive tendencies ($t(62)=-2.574$; $p<0.05$).

Table 3 shows descriptive statistics data and comparison of results for 55 patients obtained in the two

testing periods for personality traits as assessed by EPI questionnaire. The results of the first testing showed diminished dimension of Orientation ($M_1=23.91$) and Exploration ($M_1=31.91$), which may be interpreted as avoiding new experiences and social contacts and the lack of organization and self-control. Lower results

were obtained for the dimension of Rejection ($M_1=35.51$), indicating a higher degree of indecisiveness and dependence. Similar results were obtained for the categories of Reproduction and Incorporation, namely, they were lower than expected, which was due to withdrawal from social contact and distrust in social relations. Slightly higher results were obtained for the dimension of Deprivation, which accounts for depressive mood, sadness and apprehension.

Similar results were obtained on second testing, where the score was slightly lower than on the first testing in the majority of dimensions (Reproduction, Incorporation, Protection and Exploration). It indicated even greater withdrawal from social contact, avoiding new experiences, disorganization, dependence and mistrust in social relations. The results concerning Orientation and Deprivation remained practically equal, whereas the dimension of Destruction was slightly elevated.

The results that can be pointed out as elevated were those concerning the dimension of Deprivation in both testing intervals ($M_1=67.82$; $M_2=67.69$), while lower results were obtained for the dimension of Orientation ($M_1=23.91$; $M_2=24.13$), which is indicative of a certain degree of behavioral rigidity.

When comparing the results in the two time periods, a statistically significant difference was only obtained for the dimensions of Reproduction ($t(54)=2.167$; $p<0.05$) and Incorporation ($t(54)=2.250$; $p<0.05$). In both cases, the results were lower on second testing, which, with regard to Reproduction, showed a greater tendency toward withdrawal from social contacts ($M_1=60.60$; $M_2=51.91$), and with regard to the dimension of Incorporation it meant greater mistrust in social relations ($M_1=62.82$; $M_2=54.15$).

The third objective was to determine whether there were sex differences in reactive personality changes in individuals undergoing brain artery aneurysm surgery using the Cornell personality traits questionnaire and EPI.

As shown in Table 4, there were 22 men and 41 women tested by the Cornell personality traits questionnaire. The first testing results showed that women scored higher than men in all items. The analysis of secondary factors showed the asthenic syndrome to predominate in both sexes, followed by disorders of aggressive-antisocial syndrome, whereas the conversion syndrome appeared to exhibit the smallest num-

ber of symptoms. Also, in secondary factors, women scored higher than men, i.e. they showed a greater number of symptoms. The difference was also observed in tertiary factor, where men showed low levels of neuroticism, while the results for women indicated moderate neurosis.

In the second testing, increased values were recorded for almost all dimensions in both sexes, although women continued to score higher than men in all dimensions. The analysis of secondary factors showed that, similar to the first testing results, asthenic syndrome predominated in both sexes, although women had practically the same score for the symptoms of conversion and aggressive-antisocial syndrome, whereas men had higher scores for the aggressive-antisocial syndrome than for conversion syndrome. As for the tertiary factor, unlike the results obtained in the first testing, the score for both sexes indicated moderate neurosis, yet higher in women than men.

In order to determine whether there were statistically significant differences between men and women for particular dimensions in personality traits during the two time intervals, the analysis of variance was performed and a statistically significant difference obtained for one dimension only, namely, for cardiovascular somatization ($F(1.61)=8.637$; $p<0.05$), indicating that women expressed symptoms of psychosomatic disorders of the cardiovascular system to a greater extent than men. When analyzing the results for particular personality traits and syndromes, it can be noticed that women showed greater inclination toward neuroticism. Considering the elevated score in women, only the results obtained on the anxiety scale in the second testing could be assessed as such ($M=6.63$).

As shown in Table 5, results of the first testing showed that both sexes scored low in the dimensions of Reproduction, Incorporation, Orientation and Exploration; still, the results for men were slightly higher than those for women. Both men and women had low results for the dimension of Exploration, although men showed more symptoms than women, particularly in terms of disorganization. Self-protection scored similarly for both sexes and was closer to high scores, which is indicative of greater caution and anxiety.

In the second testing, the results were still lower for both sexes in the dimensions of Reproduction, Incorporation and Exploration; women, however, had even lower scores, which means that they exhibited more

Table 5. Descriptive statistics of personality trait expression obtained by EPI personality questionnaire for men and women in two time intervals following surgery

EPI		Men			Women			F	p
		M	N	SD	M	N	SD		
Reproduction	T ₁	62.25	24	25.420	59.32	31	35.209	0.451	0.505
	T ₂	56.67	24	35.864	48.23	31	38.641		
Incorporation	T ₁	68.08	24	27.342	58.74	31	35.88	1.656	0.204
	T ₂	61.46	24	34.094	48.48	31	39.664		
Orientation	T ₁	28.54	24	24.324	20.32	31	24.805	3.402	0.071
	T ₂	31.25	24	26.530	18.61	31	20.909		
Protection	T ₁	59.33	24	26.777	60.13	31	23.388	0.036	0.851
	T ₂	60.04	24	23.427	57.00	31	27.736		
Deprivation	T ₁	63.00	24	29.725	71.55	31	32.927	1.093	0.300
	T ₂	64.25	24	26.111	70.35	31	33.085		
Rejection	T ₁	32.54	24	25.657	37.81	31	32.301	1.106	0.298
	T ₂	37.04	24	25.080	45.84	31	32.604		
Exploration	T ₁	33.92	24	27.549	30.35	31	22.120	0.269	0.606
	T ₂	31.58	24	23.380	29.29	31	22.987		
Destruction	T ₁	52.38	24	26.654	64.18	31	25.589	4.209	0.045*
	T ₂	53.38	24	28.990	68.65	31	1.878		
Bias	T ₁	43.42	24	28.798	39.29	31	30.176	1.061	0.308
	T ₂	45.08	24	32.536	33.52	31	32.597		

EPI = Emotions Profile Index; T₁ = first testing (11 months following surgery); T₂ = second testing (12 to 48 months following surgery); *p<0.05

social withdrawal and had less confidence in others. The score for women in the dimension of Destructiveness increased, while in men it remained the same as in the first testing. The results for other personality trait dimensions did not differ from those obtained in the first testing for both sexes.

A higher score was also obtained for the dimension of Deprivation in both male (M₁=63.00; M₂=64.25) and female (M₁=71.55; M₂=70.35) patients, although without statistically significant difference. A higher score was obtained for the dimension of Destructiveness in women (M₁=64.18; M₂=68.65). Although statistically nonsignificant, it is seen that Orientation decreased in women and increased in men, which could mean that women aimed at stability and safety and avoided new experiences. The results for Orientation were low in both men (M₁=28.54; M₂=31.25) and women (M₁=20.32; M₂=18.61). A lower score was found in the dimension of Exploration in both men (M₁=33.92; M₂=31.58) and women (M₁=30.35; M₂=29.29), and tended to decrease with time. The

analysis of variance confirmed a statistically significant sex difference only for the dimension of Destruction (F(1.53)=4.209; p<0.05); it is also seen that women tended toward greater aggressiveness than men.

Discussion

Frontal lobe syndrome includes difficulties in thinking and executive function, inability to control one's socially inappropriate emotional reactions, such as aggressive outbursts in frustrating situations and the lack of specific anxiety and depressive reactions. Usually, the self-awareness of one's cognitive and emotional difficulties is impaired²³. The study results showed positive changes in the expression of frontal lobe syndrome with the passage of time, which is in accordance with previous studies.

Clinchot *et al.*²⁴ report that in patients with ruptured anterior communicating artery (ACoA) aneurysm, organic personality changes occur and signifi-

cantly affect the patient social recovery. In their quality of life study, they report on significant personality changes in the domain of interest, initiative and energy in patients after rupture of ACoA aneurysm. Hackett and Anderson²⁵ report that 50% of their patients complained of memory difficulties and mood changes. The patients who did not completely recover from SAH complained of significant quality of life deterioration.

Apathy relates to the individual's behavioral, emotional and motivational characteristics including diminished interest and participation in normal meaningful behavior, occurring upon damage to frontal lobes of the brain. Brown²⁶ found apathy to occur after traumatic brain injury in 46% and after hypoxic damage in 79% of patients, while even higher percentages have been reported for the right cerebral hemisphere injuries. Apathy following stroke (cerebrovascular insult) prevails in 20%-25% of patients and is accompanied by chronic and progressive decline of functional capacity²⁷.

Our study results confirmed the occurrence of reactive personality changes. The results obtained by the Cornell personality questionnaire for tertiary factor in the first testing interval showed moderate neuroticism. The results for any scale or primary factor did not exceed 50% of symptom expression, so it is difficult to emphasize the expression of a specific behavioral tendency; however, the analysis of secondary factors showed the asthenic factor to be the most expressed one, followed by conversion syndrome, while the aggressive-antisocial syndrome showed lowest expression.

In the second testing, only the result obtained for the dimension of anxiety was considered increased. The results for other scales and syndromes showed no deviation, although some of them were close to the limit. The analysis of secondary factors showed that the symptoms of asthenic syndrome were most expressed, while the symptoms of conversion and aggressive-antisocial syndromes were at the same level, yet slightly more for conversion syndrome. Tertiary factor indicated moderate neuroticism.

Comparison with the results obtained by the Cornell personality questionnaire showed that a greater number of neurotic symptoms occurred with the passage of time, although in both testing intervals the results were categorized as moderate neurosis. An increased number of symptoms were noticed for asthenic syndrome and aggressive-antisocial syndrome.

Analysis of the results for individual behavior tendencies showed significant changes with the passage of time in the dimensions of anxiety, hypersensitivity, depression, paranoid and destructive tendencies. These findings comply with our initial hypothesis.

Depression is the most commonly identified problem in patients with brain disorders²⁶. The prevalence of its occurrence in patients following SAH varies from 5% to 50%. Unlike many other cognitive functions that recover with time, depression is a rather unique one and persists even 18 months after SAH. Constant prevailing of depression following SAH can be attributed to frightening experience and fear of re-experiencing it. It has been confirmed that mood, anxiety, sleep, tiredness and the method of neurosurgical treatment affect cognitive and functional outcomes²⁷. Al-Khindi *et al.*²⁸ report that depression is associated with poor performance in verbal test and in the test of spatial working memory, but not in visual memory test. Wright *et al.*²⁹ analyzed a case of a 53-year-old man who had ruptured anterior cerebral artery aneurysm. Four weeks following the aneurysm rupture, the patient had memory and depression problems, and his wife reported that he was more impulsive and impatient than before, but was not socially embarrassing or violent.

Anxiety is another frequent sequel of SAH and it affects 27%-54% of patients²⁶. Similar to depression, the level of anxiety does not decrease even 18 months following SAH. One explanation is that the patients consider their condition as a chronic one. Al-Khindi *et al.*²⁸ state that the patients' belief that their condition is chronic diminishes with time, although their belief in personal control and the possibility of medical treatment for their condition also diminishes. These factors can contribute to mood disorders, including a higher level of depression and anxiety. The two most common symptoms associated with depression comprise intrusive thoughts related to SAH and avoiding everything that reminds of SAH. In the majority of patients, these symptoms were reduced 18 months after surgery, although in a smaller number of them they remained at the same intensity level. However, the prevalence of anxiety in patients following SAH is three times greater than in the general population²⁸. A study carried out in patients 4 to 7 years following SAH showed that 48.3% of patients reported to have noticed that their personality traits were changed. The majority of

patients described changes in terms of greater irritability and violence, anxiety, hypersensitivity to noise, lowered self-confidence, more intensive emotional reactions and aggression, slower thinking and changes of mood. Only four of 123 patients suffered from depression³⁰.

Brain injuries can be associated with acute stress disorder and later on with PTSD²⁶. Among most interesting study results is the one reporting on the increasing number of PTSD patients following SAH, estimated at 18% to 37%. The prevalence of PTSD significantly increases from 5 to 14 weeks after hospitalization and remains unchanged to between 3 and 13 months. PTSD is a significant predictor of poor physical and mental quality of life, sleep disorders and increased tiredness²⁸. Goldstein and Mc Neil²⁷ state that the PTSD symptoms frequently accompany stroke and can be one of the principal predictors of the quality of life.

The first testing results for EPI showed lower Orientation and Exploration, which is related to avoiding new experiences and social contacts, disorganization and the lack of self-control. A lower score was found for the dimension of Rejection, which is also interpreted as indecisiveness and dependence. The results on the Reproduction and Incorporation dimensions were lower than in the general population and are indicative of withdrawal from social contacts, i.e. mistrust in social relations. Slightly elevated results were obtained for the dimension of Deprivation, which indicates depressive mood, sadness and apprehension.

Similar results were obtained in the second testing, in which the results for most dimensions were slightly lower than in the first testing (e.g., for Reproduction, Incorporation, Protection and Exploration), being the signs of even more intense social withdrawal, avoiding new experiences, disorganization, dependence and mistrust in social relations. The results for the Deprivation and Orientation dimensions remained practically unchanged, while slight elevation was noticed for the dimension of Destruction. As the time passed, changes in the EPI could be observed for the dimensions of Reproduction and Incorporation in terms of lower results in the second testing interval. As regards Reproduction, it showed even greater tendency toward social withdrawal and greater mistrust in social relations for the dimension of Incorporation. Elevated score was observed for the Deprivation dimension in

both testing intervals, which is interpreted as depressive mood, sadness and apprehension. Lower results were obtained for the dimension of Orientation in both testing intervals, and these refer to a desire for greater stability and safety, and avoidance of new experiences. The results obtained by EPI questionnaire were in accordance with our expectations (reduced Reproduction and Incorporation and increased Deprivation and Destruction).

When discussing sex differences examined by the Cornell personality questionnaire, it can be seen that in the first testing women scored higher than men. The analysis of secondary factors showed that asthenic syndrome predominated in both sexes, followed by aggressive-antisocial syndrome, while the smallest number of symptoms was shown for conversion syndrome. Also in secondary factors, women scored higher, i.e. they had a greater number of symptoms. The difference was also found in tertiary factor where men showed a low level of neuroticism and women showed a tendency toward moderate neurosis.

In the second testing interval, the scores were higher for almost all dimensions in both sexes, although women continued to have higher results than men in all dimensions. The analysis of secondary factors showed that, similar to the first testing, asthenic syndrome predominated in both sexes; however, women had almost the same number of symptoms for conversion and aggressive-antisocial syndromes, while men showed more symptoms of aggressive-antisocial than conversion syndrome. Unlike the first testing, the results for tertiary factor showed a tendency toward moderate neurosis, although women scored slightly higher. A statistically significant sex difference was only found for the dimension of cardiovascular somatization; women showed symptoms of psychosomatic disorders of the cardiovascular system to a higher extent than men. As stated above, women expressed more symptoms in almost all dimensions and showed greater tendency toward neuroticism. Only the results showing more than 50% increase in positive answers on the anxiety scale for women in second testing were considered increased.

Comparison between men and women for EPI in the first testing showed that they both had low scores for the dimensions of Reproduction, Incorporation, Orientation and Exploration, although men showed slightly elevated results than women in these dimen-

sions. This could mean that women tended more to withdraw from social contacts, showed mistrust in social relations, were more indecisive and dependent, showed less self-control and avoided new experiences more than men. The results for Deprivation were higher for both sexes, but women had more symptoms, i.e. a higher level of sadness and depression. They also scored higher for the dimension of Destruction, which means tendency toward quarrelling and disputing. Both men and women had low scores for Exploration, but men showed more symptoms, i.e. greater disorganization. Protection was equally expressed in both sexes and was closer to higher results, indicating greater caution and anxiety.

In the second testing interval, the results for both sexes were even lower for the dimensions of Reproduction, Incorporation and Exploration, although women scored lower than men. In women, the results for the dimension of Destruction increased, while in men it was equal as in the first testing. The results for other dimensions were similar to those obtained in the first testing interval for both sexes.

The results obtained by EPI questionnaire showed that there were no statistically significant sex differences in either personality dimension in the first testing, whereas a statistically significant difference was found in the second testing interval for the dimension of Destruction, where women seemed to be more inclined toward quarrelling, disputing and open expression of anger. The number of symptoms of Destruction increased with time in men too, but significantly more in women. Although an increased score for the dimension of Deprivation was obtained for both sexes, higher for women than men, there was no statistically significant difference. Higher score was also found for the dimension of Destruction in women. The dimension of Orientation was decreased in both sexes, which can be interpreted as tendency toward stability and safety and avoiding new experiences. Similar results were obtained for the dimension of Exploration, which is interpreted as disorganization and the lack of self-control.

An objectionable feature of our study was a relatively small number of study subjects and unequal number of male and female subjects. Having in mind the fact that it was a longitudinal study, since the study subjects were tested in two time intervals, it would be interesting to carry out testing in one more interval to

see if and what other changes may occur over a longer period of time. Rinkel and Algra¹⁰ report their study results which showed the quality of life to be much better 5 years after SAH and to continue improving from 5 to 12.5 years following SAH despite efficiency decline due to age.

It is also possible for emotional condition of patients after surgery to be affected by other factors that were not taken into consideration in our study, e.g., family support, support of friends, compliance with medical advice, etc.

Brown²⁶ has discussed some cases of psychoses occurring as a consequence of stroke, but points out how rare these are. The aim of a case study was to indicate the possible connection between the psychotic paranoid disorder and non-ruptured intracranial aneurysms. At the beginning of diagnostic procedure, suspicion of the possibility of organic cause and/or relation was based exclusively on psychiatric and psychological assessment. Neurologic status of the patient was within the normal limits, apart from tremor in hands. In this case, the way in which non-ruptured intracranial aneurysm and psychotic paranoid disorder were related was not clearly defined³¹.

Conclusion

On the basis of our study results, it can be concluded that organic and reactive personality changes occur as a consequence of surgical treatment of brain artery aneurysm. Frontal lobe syndrome occurred in about 32% of patients, which gradually spontaneously subsided to a significant degree. With regard to reactive personality changes tested in the first time interval, moderate neuroticism was found; analysis of secondary factors showed that asthenic syndrome was the most expressed one, followed by conversion, while the aggressive-antisocial syndrome was the least expressed one. In the second testing interval, tertiary factor continued to show moderate neuroticism and the analysis of secondary factors revealed that the symptoms of asthenic syndrome remained most expressed ones; the symptoms of conversion and aggressive-antisocial syndromes were at equal level of expression, although conversion was slightly more pronounced. Based on the Cornell personality questionnaire, the number of neurotic symptoms increased with time, i.e. the number of symptoms was greater for asthenic and aggres-

sive-antisocial syndromes. The results for particular behavioral tendencies showed significant changes as the time passed, specifically in the dimensions of anxiety, hypersensitivity, depression, paranoid and destructive tendencies.

The profiles obtained in the first testing by EPI questionnaire showed the individuals to be more often depressive, rather disorganized, but with the need of self-control; they had certain difficulties in social relations, were withdrawing from social contacts, showed mistrust and were inclined toward aggressive reactions. In the second testing interval, these symptoms were even more expressed. Changes also occurred with time in the dimensions of Reproduction and Incorporation, with the results that were statistically significantly lower in the second testing, which indicated even greater tendency to social withdrawal and greater mistrust in social relations.

Comparison of personality changes according to sex showed a statistically significant difference in the dimension of cardiovascular somatization and destruction. Namely, women showed the symptoms of cardiovascular system disorders to a greater degree than men and, as revealed by the EPI questionnaire, greater destructiveness, i.e. inclination toward quarrelling, disputing, and open expression of anger, which increased with the time elapsed from surgery.

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Sažetak

PROMJENE LIČNOSTI NAKON OPERACIJE ANEURIZME MOŽDANIH ARTERIJA

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Neuropsihologijsko testiranje tijekom praćenja oporavka bolesnika s moždanim oštećenjima omogućuje uvid u postojeće kognitivnih deficita i/ili emocionalnih promjena. Cilj istraživanja bio je utvrditi postojanje organskih i/ili reaktivnih promjena ličnosti te tijek tih promjena u funkciji vremena proteklog od operacije aneurizme moždanih arterija u bolesnika oba spola. Istraživanje je provedeno u Klinici za neurokirurgiju Kliničkog bolničkog centra Zagreb. Podaci su prikupljeni u razdoblju od 1989. do 2012. godine u dva vremenska intervala, 11 mjeseci i 12-48 mjeseci nakon operacije aneurizme moždane arterije. U istraživanje su bila uključena 72 bolesnika, od toga 28 muškog i 44 ženskog spola. Neuropsihologijsko testiranje sastojalo se od kliničkog intervjua, kliničke procjene frontalnog sindroma te primjene Cornellova upitnika ličnosti i Profila indeksa emocija. Rezultati istraživanja upućuju na postojanje frontalnog sindroma kod 32% bolesnika u prvom testiranju te na značajan oporavak pri ponovnom testiranju, kada je samo 17% bolesnika imalo frontalni sindrom. Utvrđeno je i postojanje reaktivnih promjena ličnosti koje u oba vremenska intervala upućuju na povišeni neuroticizam. U prvom testiranju je najizraženiji bio astenički sindrom, slijedi konverzivni, a zatim agresivno-asocijalni sindrom, dok je u drugom testiranju najizraženiji bio astenički sindrom, a konverzivni i agresivno-asocijalni sindrom su bili podjednako izraženi. Rezultati ukazuju i na povišenu depresivnost i dezorganiziranost, što je u drugom testiranju bilo još naglašenije. Vezano uz spol, rezultati upućuju na promjene vezane uz sklonost kardiovaskularnoj somatizaciji i agresivnosti koje su izraženije kod osoba ženskog spola te se pogoršavaju s protokom vremena od operacije. Zaključno, provedeno istraživanje je doprinijelo boljem razumijevanju organskih i/ili reaktivnih promjena ličnosti u bolesnika nakon operacije aneurizme moždanih arterija.

Ključne riječi: *Subarahnoidno krvarenje – kirurgija; Cerebralna aneurizma – kirurgija; Ličnost, poremećaji; Poslijeoperacijske komplikacije; Neuropsihološki testovi*