



## Cognitive Functioning, Anxiety, and Depression in Patients with Intracranial Tumors with and Without Aphasia

*Original research article*

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### Abstract

*Introduction: Cognitive impairment is the most common neurological disorder associated with brain tumors, which leads to linguistic communication damage. Anxiety and depression are among the most prevalent psychiatric comorbidities in this population. Objectives: To determine the level of cognitive functioning, anxiety, and depression in patients with intracranial tumors with and without aphasia. Subjects and methods: A prospective study was conducted on 91 patients with verified brain tumors which were hospitalized at the Clinic for Neurosurgery for one year period. The patients were assessed with Mini Mental State Examination, Beck's depression inventory, and Beck's anxiety inventory. The type and severity of aphasia were determined by the Boston Aphasia Test. Results: The highest number of patients, a total of 31 (37.3%), had moderate anxiety disorder. 30 patients (36.1%) had shown symptoms of moderate depression, and 33 (39.7%) had shown mild and moderate cognitive dysfunction. Conclusion: Anxiety, depression, and cognitive dysfunction were significantly more pronounced in subjects with aphasia.*

**Keywords:** *intracerebral tumors, aphasia, cognition, depression, anxiety*

Intracranial tumors, whether primary or metastatic, often lead to a wide spectrum of neurocognitive and psychological disturbances. Cognitive impairments particularly in memory, attention, executive function, and processing speed are frequently observed and may arise from the tumor itself, peritumoral edema, treatment effects, or increased intracranial pressure (Taphoorn & Klein, 2004). These cognitive deficits can significantly affect daily functioning, treatment adherence, and overall quality of life. Dysfunction of cognitive processes leads to linguistic communication damage. American association for speech, language, hearing and cognition (ASLHA) gives a following overview of aspects of cognition that affect the language as a communication tool: damages to attention, perception and memory, impulsivity, inflexibility or disorganized thinking, inefficiency of information processing, difficulties in processing abstract information, difficulties with learning new information, rules, procedures, inefficiency in evoking old or earlier stored information, inadequate social setting, damage to executive functions, ineffective problem solving and judgment. Cognitive impairment is the most common neurological disorder associated with brain tumors, and is present in many patients with brain tumors from the time of diagnosis. (Fox et al., 2006).

In addition to cognitive symptoms, patients with brain tumors are at high risk for affective disorders. Anxiety and depression are among the most prevalent psychiatric comorbidities in this population, with reported prevalence rates ranging from 20% to 50%, depending on tumor type, location, disease stage, and the tools used for assessment (Rooney et al., 2013; Huang et al., 2017). Depression and anxiety not only diminish health-related quality of life but may also be associated with poorer survival outcomes (Litofsky et al., 2004). The mechanisms underlying anxiety and depression in this population are multifactorial. Tumor location may directly disrupt neural circuits involved in mood regulation; treatment modalities, including corticosteroids, surgery, and radiotherapy, contribute both acutely and chronically to brain physiology and psychological stress. In parallel, psychosocial stressors - including diagnostic uncertainty, cognitive decline,

role loss, and fear of progression - aggravate psychological distress (Otto-Meyer et al., 2019; Fehrenbach et al., 2021).

Despite the high prevalence and clinical importance of these symptoms, emotional and cognitive difficulties in brain tumor patients are frequently underrecognized and undertreated in routine clinical practice (Piil et al., 2015). Screening tools are inconsistently used, and randomized controlled trials of psychological or pharmacologic interventions specific to intracranial tumor populations are limited (Rooney et al., 2013). There is a pressing need to map the prevalence and severity of cognitive dysfunction, anxiety, and depression in well-characterized patient cohorts to inform screening protocols and therapeutic strategies. Early identification and management of these symptoms are essential for optimizing patient care and improving psychosocial outcomes. In this study, we aim to evaluate the prevalence and severity of cognitive impairment, anxiety, and depression in patients with intracranial tumors. The sample includes patients both with and without aphasia, allowing for a more comprehensive assessment of neuropsychological functioning across varying language capacities. Aims: To establish the levels of cognitive functioning, anxiety, and depression in patients with intracranial tumors with and without aphasia.

## Methods

In this prospective study, we evaluated a consecutive cohort of patients hospitalized at the Department of Neurosurgery, University Clinical Center Tuzla, over 1 year, diagnosed with an intracranial tumor verified by CT or MRI of the neurocranium, to: (1) assess the prevalence and severity of anxiety, depressive symptoms, and cognitive dysfunction. Patients who had aphasia for any reason before the onset of the brain tumor, as well as those in whom the ability to read and write had not been acquired, were excluded from the study. The testing was carried out before patients underwent any surgical procedures, and all were assessed with Mini Mental Test (Folstein et al., 1975), Beck's anxiety inventory, and Beck's depression inventory. The type and severity

of aphasia were determined by the Boston Aphasia Test.

### Statistical Analysis

The Arcus QuickStart statistical program for the Microsoft Windows operating system was used for data processing. Patients were classified according to the degree and type of aphasia assessed by BDAE, the degree of cognitive dysfunction assessed by MMS, anxiety assessed by BAI, and depression by BDI, then the median and 25-75 percentile values were determined for the given parameters. Differences in medians for the degree of aphasia, cognitive functioning, anxiety, and depression were determined by the non-parametric Mann-Whitney U-test. The significance of the difference was considered at the  $p < 0.05$  level.

### Results

During this study, a total of 91 patients were analyzed with verified brain tumors by methods of neuroimaging (i.e., CT or MRI scanning of neurocranium), who were hospitalized at the Clinic for Neurosurgery, University Clinical Centre (UKC) Tuzla, in a period from 08.05.2012 to 08.05.2013. The average age of this group ranged from 10 to 81 years, with an average of  $55.7 \pm 14.1$  years. Duration of the symptoms ranged from 2,4-10 months

$\pm 2.19$  months. All patients were literate. 73 of patients had work experience. 10 of the patients spoke a foreign language. All of them were right-handed. 26 (28.5%) of patients had left-handedness in their immediate family. In the analyzed group, 7 (7.6%) patients with right-sided and 9 (9.8%) with left-sided hemiparesis or paralysis were observed. In this study, 25 (27.5%) patients were diagnosed with a speech-language disorder defined as aphasia. The highest number, 10 or (40%) had anomic aphasia, followed by Broca's aphasia and agraphia with 3 (12%) patients each. The results showed that the entire sample of 90 patients, 9 of which had difficulties with repeating sentences, 26 had impaired voice quality, and 12 had auditory comprehension problems. Patients who were not diagnosed with aphasia (65 in total) also had certain speech difficulties. Thus, 8 patients had hypophonic speech, 10 had speech tempo disorders, 28 had articulation disorders, and 39 patients had limited phrase length. Furthermore, 18 patients had problems with grammar forms, 27 patients had a disorder of melodic line, and 9 patients had word-finding disorders in relation to fluency.

In the group of patients with intracranial tumors without verified aphasia, the highest number had localized tumors in the frontal lobe (9 patients), with predominance on the left side.

**Table 1.**

*Distribution of Patients With Intracranial Tumors with and Without Aphasia According to Tumor Location*

Region	Side	Without Aphasia	With Aphasia
L. temporalis	Left	4	4
	Right	5	3
L. frontalis	Left	9	2
	Right	8	0
	Bilateral	2	0
L. parietalis	Left	3	3
	Right	2	1
L. occipitalis	Right	1	1
	Bilateral	1	0
LL. parieto-occipitalis	Left	1	1
LL. temporo-frontalis	Left	1	0
	Right	2	0
LL. fronto-parietalis	Left	1	1
	Right	2	0
LL. fronto-temporo-parietalis	Right	2	0

**Table 1 (continued).**

*Distribution of Patients With Intracranial Tumors with and Without Aphasia According to Tumor Location*

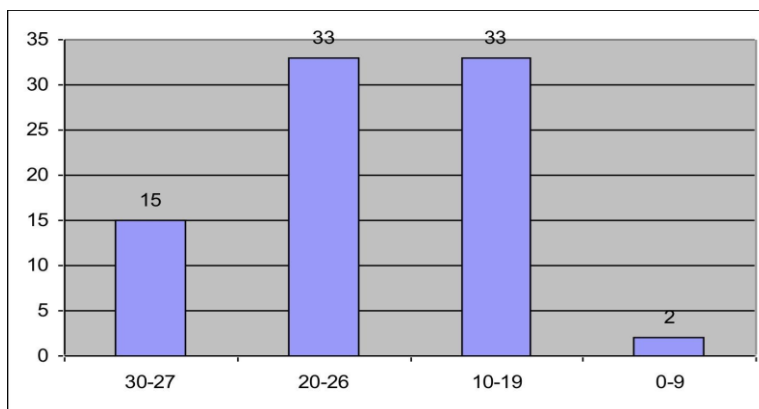
Cerebellum	Left	4	0
	Right	2	0
	Midline	2	1
PCU (pontocerebellar angle)	Left	2	0
	Right	1	0
Pons	Midline	2	1
Thalamus	Midline	1	0
Sella turcica / parasellar region	Midline	4	0
Corpus callosum	Midline	1	1
Superior sagittal sinus	Midline	2	0
Parasagittal	Left	0	1
Mediosagittal	Left	0	1
Intraventricular	Left	0	1
<b>Total</b>		<b>65</b>	<b>26</b>

The average value of cognitive functioning measured with MMSE was  $20 \pm 5.5$  (2-30), and 33 (39.7%) of participants

had moderate and mild cognitive dysfunction (Figure 1).

**Figure 1.**

*Cognitive Functioning of Patients with Intracranial Tumors*



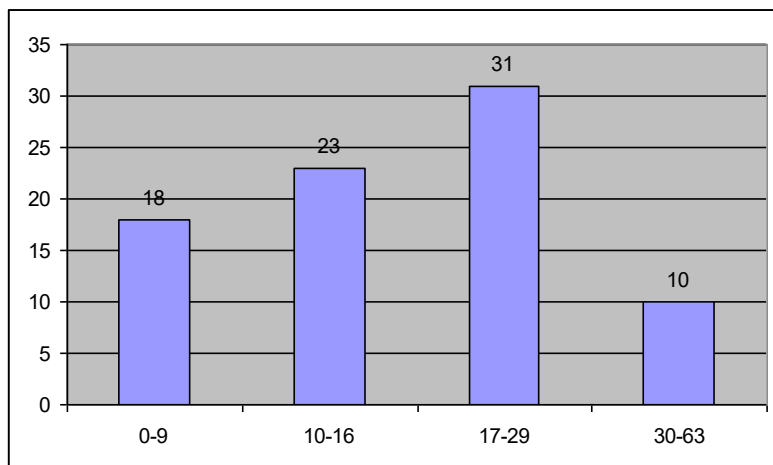
*27-30 normal cognition, 20-26 mild dysfunction, 10-19 moderate dysfunction, 0-9 severe dysfunction*

In a sample of 83 subjects, levels of anxiety were determined using the Beck Anxiety Inventory (BAI), depression was measured using the Beck Depression Inventory (BDI), and cognitive levels were

measured using the Mini Mental State Examination (MMSE) instrument. The average anxiety level was  $17.8 \pm 9.5$  (0-45). The largest number of subjects, a total of 31 (37.3%) were moderately anxious (Figure

**Figure 2.**

*Distribution of Patients with Intracranial Tumors in Relation to Anxiety Level*



*0-9 minimal anxiety, 10-16 mild anxiety, 17-29 moderate anxiety, 30-63 severe anxiety*

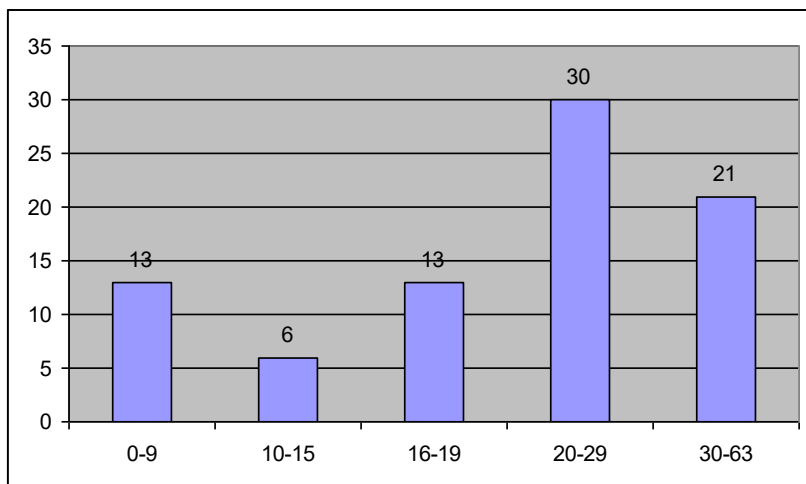
The average value of the depression level was  $22.5 \pm 11.3$  (0-47).

Out of a total of 83 tested subjects,

30 (36.1%) showed symptoms of moderate depression (Figure 3).

**Figure 3.**

*Distribution of Patients with Intracranial Tumors in Relation to the Degree of Depression*



*0-9 These ups and downs are considered normal, 10-15 Mild mood disturbance, 16-19*

*Borderline clinical depression, 20-29*

*Moderate depression, 30-63 Severe depression.*

A significantly lower level of cognitive functioning was observed in the

group of patients with aphasia, while the levels of anxiety and depression in these two groups of subjects did not differ significantly (Table 2).

**Table 2.**

*Levels of Anxiety, Depression, and Cognitive Status in Patients with Intracranial Tumors with and Without Aphasia*

Measure	Group	Median	Percentile (25–75)	Min.	Max.	p-value
BAI	Without aphasia	11.7	10 – 26	0	45	p = 0.7822
	With aphasia	15.5	12 – 25.5	8	34	
BDI	Without aphasia	22	16 – 30	0	47	p = 0.6987
	With aphasia	21	17.25 – 25.75	6	44	
MMSE	Without aphasia	21	18 – 25	2	30	p = 0.001*
	With aphasia	17.5	16 – 19	7	26	

*Note: BAI = Beck Anxiety Inventory; BDI = Beck Depression Inventory; MMSE = Mini-Mental State Examination.*

Higher scores on BAI and BDI indicate greater levels of anxiety and depression, respectively, while higher MMSE scores reflect better cognitive functioning.

### Discussion

In this one-year study, a total of 91 patients with brain tumors verified by methods of neuroimaging were analyzed. The average age of the tested group ranged from 10 to 81 years, with an average of  $55.7 \pm 14.1$  years. In the analyzed group, 7 (7.6%) patients with right-sided and 9 (9.8%) with left-sided hemiparesis or paralysis were observed.

Patients with intracranial tumors often complain of problems in spontaneous speech; they also state that testing communication skills is of great importance in diagnosis (Satoer et al., 2014).

Slow-growing tumors tend not to produce serious communication problems, while high-grade tumors, especially within the left hemisphere, cause severe semantic deficits (Campanella et al., 2009).

In this study, the highest number of patients with verified aphasia had tumors located in the temporal lobe (7 patients), with a predominance on the left, followed by the parietal region (left 3, right 1) and the left temporoparietal region (3 patients). Brain tumors can lead to neuropsychiatric symptoms such as headache, mental status disorder, and hemiparesis. All these symptoms depend on the location of the

tumor and usually have a subacute and progressive course. Other authors observed a patient with anomic aphasia whose tumor was localized in the left temporal lobe (Remley & Butala, 2021).

In one study, it was reported that lesions in the frontal lobe of the dominant hemisphere are associated with the occurrence of aphasia (Bizzi et al., 2012). The aim of their prospective study was to investigate the association between language deficits and lesion location in patients with intracranial tumors. Testing was performed on 19 patients. All had speech difficulties. Tumors localized in the left parietal region are more likely to cause aphasia.

The average value of cognitive functioning measured by MMSE in this study was  $20 \pm 5.5$  (2-30) and of the total sample, 33 (39.7%) subjects had mild to moderate cognitive impairment. In patients with aphasia, all had a reduction in cognitive functions, and the highest number, 13 or 72.2%, had moderate cognitive impairment.

Cognitive assessment in conjunction with speech testing is a necessary step in the evaluation of patients with brain tumors, both before and after surgery (Santini et al., 2012). Also, cognitive assessment in patients with brain tumors is essential for prognosis and quality of life (Ramirez et al., 2013; Kehayov et al., 2012). This has led to the introduction into clinical use of neuropsychological test batteries for patients with brain tumors. This way, authors constitute an important clinical measure for assessing the effectiveness of

various treatment modalities, such as surgery, radiation, and chemotherapy. The impact of cognitive deficits on the quality of life of patients is very important. These are some of the most common neurological symptoms associated with brain tumors.

Patients with brain tumors may have problems with cognitive functioning, including impaired working memory, which significantly affects their quality of life. The study investigated cognition and working memory in patients with localized brain tumors in the left frontal lobe.

Reports are stating that cognitive function in patients with intracranial tumors is very important in the treatment of patients (Scotland et al., 2012). The sample of their study consisted of 118 patients with intracranial tumors. All patients had reduced levels of cognitive functioning. Cognitive dysfunction can be present in early stages of the disease, and early identification of patients at risk is very important (Ek et al., 2010). A study conducted by Tucha aimed to examine the frequency of cognitive disorders in patients with brain tumors in the frontal or temporal lobe. The sample consisted of 139 patients. The results of their study showed that more than 90% of patients had difficulty in at least one area of cognition. Executive function difficulties were noted in 78% of patients, and memory and attention difficulties were noted in 60% of patients. These results show that most patients with brain tumors in the frontal or temporal lobes show impaired cognitive functions (Tucha et al., 2000).

All this leads us to the conclusion that cognitive changes are very common in patients with intracranial tumors. The results of our study showed that 39.7 % of patients have mild or moderate cognitive impairment.

### Conclusions

In this study, we found that 27.5% of subjects with a brain tumor had a language disorder of the aphasia type. The most common was anomic aphasia (40%), with the most frequent localization in the temporal lobe of the brain. The largest number of respondents showed a moderate level of anxiety (37.3%) and a moderate level of depression (36.1%). The largest number of subjects had mild or moderate cognitive dysfunction (39.7%), which was significantly

more pronounced in subjects with aphasia.

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