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Impact of the Brain Tumor Location on Functional Capacity of the of Patient

Wpływ umiejscowienia guza mózgu na wydolność funkcjonalną chorego

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Abstract

Introduction. The vast majority of lesions of the nervous system are located intra cranially. Their location in each brain structure results in the appearance of different deficits affecting the functional capacity of patients, and ultimately their quality of life.
Aim. The aim of the study is to investigate the effect of tumor location on the functional capacity of patients with such tumors in the preoperative and postoperative periods.
Material and Methods. Material includes 236 patients hospitalized in the Department of Neurosurgery 10th Military Hospital with Policlinic IP HCC Bydgoszcz. The research was approved by the Bioethics Committee at Collegium Medicum in Bydgoszcz (KB 222/2011). The analysis included 5 subgroups of patients taking into account the location of intracranial lesions in these patients. There were defined: a group of patients with tumors located in the temporal lobe (1), frontal lobe (2), parietal lobe (3), cerebral chamber (4), and cerebral lesions (5). The functional capacity was assessed by the KPS Scale (Karnofsky's Performance Scale) (three times: on the day of admission to the Clinic, on the 5th and 30th day after the surgery) and by the GOS Scale (Glasgow's Outcome Scale) (twice: on the 5th and 30th day following the surgery).
Results. On the fifth day of the postoperative period, a statistically significant decrease in the functional capacity was observed in patients with tumors located in the cerebral, the extra cranial tumors, in the frontal and temporal lobes ($p<0.05$). In the postoperative period, significant increase in functioning was observed in patients with ventricular tumors cerebral and extra cranial ($p<0.05$). The final outcome of the treatment was improved on the 30th day in patients with extra cranial tumors ($p<0.05$).
Conclusions. In the early postoperative period the functional capacity of most patients decreases, and the lowest functional capacity decline is observed in patients with parietal lobe tumors. 30 days after the surgery, the functionality of the patients increases, particularly with tumors located in the cerebral cortex as well as with extra cranial tumors.
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Key Words: patient, brain tumor, physical functioning

Streszczenie

Wstęp. Zdecydowana większość zmian rozrostowych układu nerwowego zlokalizowana jest wewnątrzczaszkowo. Umiejscowienie ich w poszczególnych strukturach mózgu skutkuje pojawieniem się różnych deficytów mających wpływ na wydolność funkcjonalną chorych, ostatecznie na ich jakość życia.
Cel. Celem pracy jest zbadanie wpływu umiejscowienia guza na wydolność funkcjonalną chorych z tymi nowotworami w okresie przed i pooperacyjnym.
Materiał i metody. Materiał stanowi 236 pacjentów hospitalizowanych w Klinice Neurochirurgii 10 WSKzP SPZOZ w Bydgoszczy. Na badania uzyskano zgodę Komisji Bioetycznej przy Collegium Medicum w Bydgoszczy (nr KB 222/2011). W analizie uwzględniono 5 podgrup pacjentów biorąc pod uwagę u tych chorych położenie zmiany rozrostowej wewnątrzczaszkowej. Ujęto grupę chorych z guzami położonymi w płacie skroniowym (1), czołowym (2), ciemieniowym (3), w komorach mózgu (4), oraz zmiany położone zewnątrzmózgowo (5). Wydolność funkcjonalną oceniono skalą KPS (Karnofsky's Performance Scale) (trzykrotnie: w dniu przyjęcia do Kliniki, w 5 i 30 dobie po zabiegu) oraz skalą GOS (Glasgow's Outcome Scale) (dwukrotnie: w piątej i 30 dobie po operacji).

Wyniki. W 5 dobie po zabiegu zaobserwowano istotny statystycznie spadek wydolności funkcjonalnej u chorych z guzami położonymi w komorach mózgu, zewnątrzmózgowymi, w płacie czołowym i skroniowym (p<0,05), w 30 dobie po operacji istotny statystycznie wzrost funkcjonalności nastąpił u chorych z guzami komór mózgu i zewnątrzmózgowymi (p<0,05). Wyniki końcowe leczenia uległy poprawie w 30 dobie u chorych z guzami zewnątrzmózgowymi (p<0,05).
Wnioski. We wczesnym okresie pooperacyjnym obniża się wydolność funkcjonalna większości chorych, najniższy spadek wydolności funkcjonalnej zaobserwowano u pacjentów z guzami płata ciemieniowego. 30 dni po operacji wzrasta funkcjonalność chorych, zwłaszcza z guzami położonymi w komorach mózgu i oraz położonymi zewnątrzmózgowo.
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Słowa kluczowe: pacjent, guz mózgu, funkcjonowanie fizyczne

Introduction

Central nervous system tumors occur at a frequency of 6.4/100.000/year. The peak of the disease is between 55 and 64 years of age; moreover, these cancers are more commonly diagnosed in men than in women. The five-year survival index is 33.4% [1]. In Poland, the incidence of brain tumors is similar to the aforementioned data, in 2006 the rate was 6.6/100 thousand/year for women and 7.9/100 thousand/year for men. It grows with age, in people over 55 years it is approximately 20/100 thousand/year [2].

The most commonly diagnosed tumors in the adult population are gliomas, meningitis and metastatic lesions. Glial tumors are the most common central nervous system (CNS) tumors, derived from neurology (from glial tissue, which is a brainstem). 40–90% of these cancers are malignant. However, the most malignant glioblastomas are: multiform glioma and anaplastic glioma [3]. These tumors most often develop in the frontal lobe (40%), then in the temporal lobe (29%), parietal lobe (14%), occipital lobe (3%), and in deep-brain structures (14%) [2].

Meningioma is a tumor derived from the arachnoid covering the brain. They constitute from 30 to 40% of intracranial tumors, 7% of tchem are located in the posterior cranial cavity, 3–12% being tumors of the cerebellar angle. These lesions are more common in women (3:2–2:1). Taking into account their location, hemisphere vaulting meningioma, parassagittal meningioma, Turkish sadle meningioma, cerebellopontine angle meningioma, sphenoid bone wing meningioma and intraventricular meningioma [4] are distinguished.

Metastases to the central nervous system compared to primary tumors occur more frequently, up to 10 times more [5,6]. 85% of metastatic lesions are detected in cerebral hemispheres, 10–15% in cerebellum, 1–3% in brainstem. These tumors most commonly occur in the course of such cancers as: lung cancer, breast cancer, malignant melanoma, kidney cancer, adenocarcinoma of the colon [6].

Brain tumors occur in a manifold manner, and this is related to the location of a particular proliferative lesion. The symptoms include: headache with (or without) increased intracranial pressure, neurological deficits, qualitative and quantitative disorders of consciousness, emotional, cognitive and personality disorders, as well as seizures [7].

Surgical treatment, radiotherapy and chemotherapy are applied in the treatment of patients with brain tumors. The surgical procedure gives the possibility of histopathological diagnosis, reduces tumor mass, and additionally reduces and even relieves neurological symptoms [8]. Surgical treatment of benign tumors such as meningioma, neuroblastoma, or malignant glioblastoma of the first degree may result in healing, provided the tumor has been completely removed [4,9]. In the case of low grade malignant gliomas (I and II degree according to WHO) and malignant gliomas (III and IV degree according to WHO), the success of treatment is less certain as these tumors are characterized by local recurrence, resulting from their aggressive growth, infiltration and by progression to aggravate (in the case of low degree gliomas). Total tumor resection improves the patient's functioning and prolongs the cancer patient's life [10,11].

In 40% of patients suffering from metastatic brain tumors, a single tumor is diagnosed in the imaging examination. Such tumors can be subject to surgical treatment as a part of palliative therapy, which can prolong the life of the patient as well as reduce disability [6].

It should be emphasised that brain tumors despite the use of modern therapeutic methods continue to be a major therapeutic as well as psychological and social problem. They disturb the vital functions of the nervous system, almost always present a potential threat of various degrees of disability. Sometimes a benign brain tumor due to the pressure on important nerve centers is a reason for life threatening [12].

The aim of the study is to investigate the effect of tumor localization on the functional capacity of patients with those tumors in the preoperative and postoperative period.

Material and Methods

The research material consisted of patients with intracranial cancers, planned for surgical treatment in the Department of Neurosurgery of the 10th Military Clinical Hospital with Polyclinic of the National Center for Disease Prevention and Control in Bydgoszcz. The authors of the research have obtained the consent of the Bioethics Committee at the Collegium Medicum in Bydgoszcz (KB 222/2011).

The study group consisted of 236 patients, 124 women (52.5%) and 112 men (47.5%). The most numerous age group included patients whose age ranged from 41 to 60 years — 103 patients (43.6%), a large group included patients from 21 to 40 years of age — 75 (31.8%). Nearly 70% of the patients (164 people) were urban dwellers, 30.5% (72 persons) lived in the rural area. Taking into account the education of respondents, 37.7% (89 patients) had secondary education, 30.5% (72 people) higher education. 74.6% (176) were in permanent relationships, the divorced and the widowed constituted 9.4% (11 patients). 44.5% of the respondents (105 persons) were professionally active, whereas the retired constituted in total the same group (44.5% — 105 patients) (Table 1).

Table 1. Characteristics of the Study Group

Variable	N	%
1	2	3
Gender		
Woman	124	52.5
Man	112	47.5
Overall	236	100.0
Age		
Under 20 years	9	3.8
Between 21 and 40	75	31.8
Between 41 and 60	103	43.6
Over 60	49	20.8
Overall	236	100.0
Place of Residence		
Country	72	30.5
Town below 25 thousand residents	49	20.8
Town from 26–100 thousand residents	36	15.3
City over 100 thousand residents	79	33.5
Overall	236	100.0
Education		
Primary	16	6.8
Vocational	59	25.0
Secondary	89	37.7
Higher	72	30.5
Overall	236	100.0
Family Situation		
Single	38	16.1
In permanent relationship	176	74.6
Divorced	11	4.7
Widowed	11	4.7
Overall	236	100.0
Professional Status		
Student	14	5.9
Career	105	44.5
Retirement/Pension	91	38.6
Retirement/Pension+career	14	5.9
Unemployed	12	5.1
Overall	236	100.0

Five subgroups of patients were considered in the outcome analysis taking into account intracranial lesions in these patients. A group of patients with tumors located in the temporal (1), frontal (2), parietal (3) lobes, in the cerebral chambers (4), and cerebral lesions (5) were included.

The study was conducted three times: on the day of the patient's admission to the Clinic, on the fifth day after the surgery of the brain tumor and 30 days after the surgery. Each patient was evaluated three times by the Karnofsky's Performance Scale (KPS) and twice (on the fifth and thirtieth day after the surgery) by the Glasgow's Outcome Scale (GOS).

For statistical analysis there were applied: the student's T test for dependent samples, the non-parametric Shapiro–Wilka's test was used to verify hypotheses of the normality of the distribution of the features tested, the Wilcoxon's Test. At $p<0.05$ difference or dependence was considered to be statistically significant.

Results

The functional capacity of patients included in the study was assessed by the KPS Scale. Taking into account the general functioning of patients on the fifth day after brain tumor removal surgery, there was observed the decrease in patient's functioning capacity compared to the preoperative period (difference of 6.36, p=0.00001). On the 30th day after the surgery there was observed improvement in patients' functioning (difference of -3.75, p=00002). The physical fitness of patients between

the day of admission to the Neurosurgery Clinic and the 30th day after surgery was also assessed. It turned out to be slightly lower on the 30th day after surgery compared to the preoperative condition of patients (2.63; p=0.004). The final results of the GOS treatment between the fifth and the thirtieth day following the surgery increased slightly (-0.114, p=0015) (Table 2).

Taking into account the location of tumor lesions in the brain, the functional capacity of these patients was also assessed. In the early postoperative period (the fifth day after the procedure), the patients' functioning decreased in all groups of respondents due to the location of the change. The highest reduction occurred in patients with cerebral tumors (on average -12.50), then in patients with extracranial tumors (on average -9.47), followed by patients with frontal lobe tumors (on average -7.27) in those with temporal lobe (on average -4.62), the smallest decrease was observed in patients with temporal lobe tumors (mean -3.89). The parametric Student t-test for dependent groups and the Wilcoxon's nonparametric test in subgroups where the hypothesis of normality of distributions had been rejected, detected significant reduction of the functional capacity in the subgroups except for subgroup 3 (patients with tumors located in the parietal lobe) (Table 3).

On the 30th day after the surgery, the assessment of patients showed an improvement in the functioning of patients in the 4 groups included. The highest improvement was obtained in patients with cerebral tumors (on average 10.00) and in patients with extra cranial tumors (on average 7.87). Statistically significant increase in functionality ($p<0.05$) was obtained in these patients (Table 4).

Evaluating patients with the GOS Scale, there was shown improvement in the final outcomes after tumor resection. The highest score, similar to the assessment made with the KPS Scale, was obtained in patients with cerebral tumors (on average 0.538) and extra cerebral tumors (on average 0.211), whereas no improvement in patients with frontal lobe tumors was observed (on average -0.133). Significant increase in the final results was noted in the subgroup of patients with extra cranial tumors ($p<0.05$), it was non-significant in the remaining subgroups (Table 5).

Table 2. Changes in functioning according to KPS Scale, changes of treatment final results according to GOS

Student t Test for dependent tests	Changes in functioning according to KPS between each period of observation			Final results of treatment according to GOS
	0–5	5–30	0–30	5–30
Difference	6.36	-3.73	2.63	-0.114
Standard deviation difference	14.71	13.26	13.74	0.545
t	6.64	-4.32	2.94	-3.22
df	235	235	235	235
p	0.00001	0.00002	0.004	0.0015

Table 3. Functioning according to the KPS Scale on the 5th day after the surgery and the location of the tumor

	Parameters	The compared groups of different tumor location				
		1	2	3	4	5
Changes of the functional capacity on the KPS Scale between the preoperative period and 5 days after the surgery	N	52	44	18	12	75
	Min	-60	-70	-30	-40	-50
	Max	30	10	10	10	30
	Median	0.0	0.0	0.0	-5.0	0.0
	Mean	-4.62	-7.27	-3.89	-12.50	-9.47
	SD	15.53	16.33	10.92	16.58	17.08
The Shapiro–Wilka's Test of Normality	W	–	0.734	0.894	0.827	–
	W_{kr}	–	0.944	0.897	0.859	–
	normality	–	no	no	no	–
Student t Test for dependent tests	t	2.14	2.95	1.51	2.61	4.80
	p	0.04	0.005	0.15	<0.03	<0.0001
The Wilcoxon's Test	z	–	2.89	1.33	2.31	–
	p	–	0.004	0.18	0.02	–

Table 4. Functioning according to the KPS Scale on the 30th day after the surgery and the location of the tumor

	Parameters	The compared groups of different tumor location				
		1	2	3	4	5
Changes in the functional capacity on the KPS Scale between the 5th and the 30th day after the surgery	N	52	44	18	12	75
	Min	-50	-70	-20	0	-30
	Max	50	40	10	40	50
	Median	0.0	0.0	0.0	10.0	0.0
	Mean	3.46	1.14	-1.67	10.00	7.87
	SD	15.70	16.74	7.86	12.06	14.45
The Shapiro-Wilka's Normality Test	W	–	0.845	0.851	0.752	–
	W_{kr}	–	0.944	0.897	0.859	–
	normality	–	no	no	no	–
Student t Test for dependent tests	t	1.59	0.45	0.90	2.87	4.72
	p	0.12	0.66	0.38	<0.02	<0.0001
The Wilcoxon's Test	z	–	0.73	0.84	2.37	–
	p	–	0.46	0.40	0.02	–

Table 5. Final results according to the GOS Scale on the 30th day after the surgery and the location of the tumor

	Parameters	The compared groups of different tumor location				
		1	2	3	4	5
Changes of treatment results on the GOS Scale between the 5th and the 30th day after the surgery	N	52	45	18	13	76
	Min	-2	-4	-1	-1	-1
	Max	2	1	1	4	4
	Median	0.0	0.0	0.0	0.0	0.0
	Mean	0.135	-0.133	0.167	0.538	0.211
	SD	0.715	0.842	0.618	1.198	0.699
The Shapiro-Wilka's Normality Test	W	–	0.679	0.775	0.725	–
	W_{kr}	–	0.945	0.879	0.866	–
	normality	–	no	no	no	–
Student t Test for dependent tests	t	1.36	1.06	1.15	1.62	2.61
	p	0.18	0.29	0.27	0.14	0.01
The Wilcoxon's Test	z	–	0.45	1.01	1.21	–
	p	–	0.65	0.31	0.22	–

Discussion

The functional capacity is a replacement term for functional fitness. It means performing and satisfying basic living needs, including movement, nutrition, control of physiological needs, maintenance of hygiene. In short, it defines "the ability to be independent of others in fulfilling basic life needs" [13]. Unfortunately, brain tumors have an effect on the dysfunction of the patient's independence and self-determination due to their symptomatology (paralysis, epilepsy, cognitive disorders, or personality disorders) [10]. Surgical treatment of brain tumors on the one hand contributes to the improvement of neurological function and life expectancy in this group of cancer patients, on the other hand however, it may promote neurological deficit which negatively affects the quality of life [14]. A lot of brain tumors, particularly glial-like lesions, are characterized by infiltration of neighboring tissues, and in such cases a complete tumor removal is not possible and the tumor margins cannot be assessed. Therefore, in modern surgery procedures there are applied intraoperative imaging techniques which make it possible to assess the extent of surgery. These include: ultrasonography (USG),

computed tomography (CT) and magnetic resonance (MR). In addition, technologically sophisticated methods such as neuronavigation, intraoperative functional mapping, intraoperative potency monitoring, and even wake-up operations are used. The use of the latter is currently applied in tumor operations near important structures or changes in hardly accessible areas to minimize the risk of significant postoperative damage [2]. In the operations of the patients included in the study, these modern technological solutions were applied, including: intraoperative tomography, neuronavigation, intraoperative monitoring of potentials.

Evaluations of patients' functioning were performed on the KPS and GOS scales. The KPS Scale had been used for a long time to evaluate patients with brain tumors for the purpose of determining the quality of life of these patients. Currently, it has been replaced by other tools for evaluating the quality of life, which take into account, apart from the patient's physical condition and the ability to move, the mental state, social situation and economic conditions, as well as somatic sensation. The KPS Scale is a tool that expresses functional independence in the form of a number from 100 to 0 [15–18]. A score of ≥70 according to the KPS indicates a patient who moves independently and is independent in the performance of everyday activities. In addition, this result is often used as a borderline justifying aggressive treatment [4]. The GOS Scale is a 5-step tool: 5-full independence (return to health), 1-death [15,17].

In our studies, assessing the patients by means of the KPS Scale there has been showed a decrease in the functional capacity in all studied groups, including location of brain tumors [temporal (1), frontal (2), parietal (3) lobes, cerebral cortex (4), and extra cranial lesion (5)]. Reduction of patients' postoperative functioning may result from a number of factors, including the occurrence or aggravation of neurological symptoms, the response of the patient to surgical anesthesia, the postoperative wound, pain (headache, surgical wounds), the anxiety associated with waiting for the definitive diagnosis of the removed lesion [19]. On the thirtieth day after surgery, the capacity of patients in physical functioning is increasing, according to the assessment on the KPS and the GOS Scale. It should be emphasized that this is particularly true in the case of lesions located in the cerebral chambers and in the extra celebral areas. Brain tumors are often benign in the brain and in the extra celebral areas, therefore this element can have a significant impact on the well-being of these patients. In another publication of the same authors, which presented the effect of histopathological diagnosis on the functional capacity of patients, the study showed that in the early postoperative period there was a decrease in the functioning of patients in all included groups due to tumor diagnosis, whereas on the thirtieth day after the surgery there was an increase in the functional capacity, which was the highest in patients with benign tumors [19].

The period between the assessment of patients on the 5th day after surgery and the 30th day after the surgery is the time necessary to regenerate patient's strength in which neurological disorders may subside, as confirmed by Jakola et al. [20].

Salo et al., based on their study of a group of 101 patients with brain tumors in the preoperative period, demonstrated that patients with tumors located to the right or in the front region had worse quality of life compared to patients with brain tumors on the left and towards the back area. On the other hand, functional assessment on the KPS Scale indicated no differences between patients [21].

The study by Ślusarz et al., who used the KPS Scale, have shown that the age and the preoperative condition of patients have a significant effect on patients' functioning on the day of their discharge from hospital [22].

Conclusions

In the early postoperative period the functional capacity of most patients decreases, and the lowest functional decline is observed in patients with parietal lobe tumors. 30 days after the surgery, the functionality of the patients increases, particularly of those with tumors located in the cerebral cortex and in the extra cerebral region.

Implications for Nursing Practice

Assessment of patients on the KPS Scale and GOS Scale may be used in planning nursing care in both preoperative and postoperative period. The level of the functional capacity determines the degree of patient's independence in the performance of everyday activities. Patients with low functional capacity require more involvement of the nursing team in minimizing the self-care deficit.

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