



Evaluation of the psychological burden during the early disease trajectory in patients with intracranial tumors by the ultra-brief Patient Health Questionnaire for Depression and Anxiety (PHQ-4)

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Abstract

Purpose Depressive symptoms of patients with intracranial tumors need to be assessed adequately. The Patient Health Questionnaire for Depression and Anxiety (PHQ-4) is an ultra-short screening tool consisting of four items, a cutoff of six indicates depressive symptoms. The aim was to assess patients' psychological burden by the PHQ-4 compared with the results of well-established screening instruments.

Methods Patients were screened three times after primary diagnosis postoperatively (t1), after 3 (t2) and 6 (t3) months using the PHQ-4, the Hornheide Screening Instrument (HSI), the NCCN Distress Thermometer (DT), and the European Organization for Research and Treatment of Cancer Quality of Life Core Questionnaire with its brain module (EORTC QLQ-C30 + BN20). Demographic, tumor-related data, and Karnofsky Performance Scale (KPS) were analyzed. A cutoff value for PHQ-4 indicating a need for support or increased distress was determined by applying receiver operating characteristic (ROC).

Results The proportion of patients reaching a total score ≥ 6 was $n = 32$ out of 139 (23%) at t1; at t2, $n = 12$ out of 117 (10%) scored ≥ 6 . At t3, $n = 8$ out of 96 (8%) scored ≥ 6 . At t1, PHQ-4 scores did not differ significantly between gender, age groups, and tumor laterality. A cutoff value of 2.5 was identified to moderately discriminate between patients in or not in distress (sensitivity 76.8%) and between patients wishing further, specific support or not (sensitivity 82.5%).

Conclusion The PHQ4 can be applied in this patient cohort to detect those with relevant psychological comorbidities. The cutoff value should be re-evaluated in a larger cohort as we observed that a cutoff of 6, as recommended previously, may be too high in order to detect affected patients adequately.

Keywords Cancer · Oncology · Brain tumor · Distress · Intracranial tumor · Psychosocial burden · Quality of life · Screening

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Introduction

Regardless of the tumor entity, approximately 20% of patients with intracranial tumors endorse a high level of depressive symptoms and depression [1–5]. Adequately addressing these symptoms may not only improve patients' quality of life, but may even increase survival rates by improving treatment adherence and health behavior [6]. In order to identify patients in need of support, validated self-reporting questionnaires or screening instruments are widely used, given the advantages of standardized scoring and direct assessment of the patients' perspective [7]. However, assessment in patients with intracranial tumors remains challenging for several reasons; patients are not willing or able to fill in questionnaires due to cognitive or focal neurological deficits or questionnaires are too demanding. Another reason may be staff refusal to implement the assessment in clinical routine, be it because of time constraints, be it because they fear to not be able to adequately address all those patients scoring above a certain threshold [8–10].

Therefore, ultra-short screening tools, that have been developed for cancer patients in general, might also be suitable for brain tumor patients, which often present with specific needs regarding cognitive functioning. These questionnaires are typically defined as measures with 1–4 items, requiring less than 4 min to complete [11, 12]. However, these ultra-short screeners have rarely been applied in cohorts of neurological patients [11, 13, 14].

In this prospective observational study, we evaluated the psychosocial burden during the early disease trajectory of patients with intracranial tumors 6 months following the first diagnosis by self-reporting questionnaires and screening instruments. We included the Patient Health Questionnaire for Depression and Anxiety (PHQ-4) within a larger questionnaire set assessing health-related quality of life (HRQoL) and psychosocial issues. The brief instrument screens for core symptoms of depression and anxiety disorders and is comprised of only four items [15]. Our previous report analyzed the time course of psychological burden as measured by an external assessment in comparison to patients' self-assessment [16].

In the present analysis, we focus on 1) the patients' psychological burden assessed by the PHQ-4 compared to the results of the self-assessment by the Hornheide Screening Instrument (HSI), Distress Thermometer (DT), as well as the HRQoL assessment; 2) We aimed to statistically determine an optimal cutoff score for the PHQ-4 for this patient cohort, in order to enable implementation of this ultra-short screening instrument in neuro-oncological clinical routine.

Methods

Study setting and participants

Patients were recruited after having undergone surgery in one of two neurosurgical departments in Germany (clinic 1 = university medical center, clinic 2 = community hospital), as previously described [16]. In brief, patients with first diagnosis of a benign or malignant, primary or secondary brain tumor were approached after surgery and histopathological confirmation of the tumor entity. Informed consent was obtained after surgery by MR, AKH, and MNO.

The following inclusion criteria were applied: a) a primary diagnosis of an intracranial tumor of any histology; b) age > 18 years; c) the absence of any significant postsurgical neurocognitive deficits, evaluated by a neurological examination including a Mini Mental Status Test (MMST, score > 26/30), or dysphasia; and d) provided informed consent. We excluded patients with neurocognitive impairment as measured by the MMST in order to obtain high-quality data with little missings/incorrect answers. Patients had to understand and complete several questionnaires requiring a certain attention span and ability to concentrate.

Patients were screened three times for psychological burden, general health perception, quality of life, and distress using the PHQ-4, the Hornheide Screening Instrument (HSI) [17, 18], the NCCN Distress Thermometer (DT) [13], and the European Organization for Research and Treatment of Cancer Quality of Life Questionnaire and the corresponding brain cancer module (EORTC QLQ-C30 and EORTC QLQ-BN20) [19, 20]. Furthermore, patients were asked if they wished support to address their psychological burden, regardless of the screening results.

Screenings were performed postoperatively during the inpatient period at days 5–7 after surgery once the diagnosis was confirmed (t1), 3 (t2), and 6 months (t3) postoperatively during the routine outpatient visits. In case of benign neoplasms, the third assessment was performed over the phone and questionnaires needed to be filled in by the patients were sent by pre-stamped return mail, with no cost to the patient.

Additionally, demographic data and data on tumor entity, tumor location, extent of resection and pre- as well as postoperative Karnofsky Performance Scale (KPS) scores were collected. A flow chart of the study is provided in supplement Fig. 1.

Applied instruments and questionnaires

The Patient Health Questionnaire for Depression and Anxiety (PHQ-4) screens for core symptoms of a depression and anxiety disorder. It was validated by Loewe et al. by combining the two items of PHQ-2 with the two items of the Generalized Anxiety Disorder Scale (GAD-2) [21]. Consisting of a total of

four items, the PHQ-4 assesses the frequency of feeling depressed or loss of interest in doing things (indicating depression), feeling nervous/anxious/on edge, and not being able to stop or control worrying (indicating anxiety) over the past 2 weeks (on a Likert scale, 0 = not at all, 3 = nearly every day). PHQ-4 scores of ≥ 6 are recommended by Kroenke et al. as “yellow flags,” and PHQ-4 scores of ≥ 9 as “red flags” indicating a depressive or an anxiety disorder [15]. So far, the instrument has not been validated in brain tumor patients.

The Hornheide Screening Instrument (HSI) was developed from the Hornheide questionnaire and was initially applied to evaluate the psychosocial burden of skin tumor patients [18, 22]. The HSI has been demonstrated to be as valid and reliable as the more extensive questionnaire. For the clinical application, the HSI uses a cutoff score of > 4 or a discriminant analysis provided and evaluated by Strittmatter et al. in order to detect patients in need of psychosocial support [23].

The National Comprehensive Cancer Network (NCCN) Distress Thermometer (DT) measures distress of cancer patients in terms of a single item presented as an 11-point numerical analogue scale with scores from 0 (not distressed) to 10 (extremely distressed) along with an additional 40 items that patients can select ranging from concerns with financial, physical, emotional, and spiritual difficulties. In brain tumor patients, a score of 6 or above is recommended as a cutoff score for a clinically significant level of distress, as the instrument has been validated for brain tumor patients by Goebel et al. [13, 24].

The European Organization for Research and Treatment of Cancer Quality of life core Questionnaire (EORTC QLQ-C30) is a self-report outcome measure that includes 30 items assessing the health-related quality of life in oncological patients [19]. The items form five functional scales (physical = physf, role = rolef, emotional = emof, social = socf and cognitive = cogf functioning), three symptom scales (fatigue, nausea and vomiting, pain), six single-item scales (dyspnea, insomnia, appetite loss, constipation, diarrhea, and financial difficulties), and one global health status/QoL scale (GHS). The brain module (EORTC QLQ-BN20) comprises 20 items developed for brain tumor patients with four functional scales (three neurological deficit scales and one future uncertainty scale) as well as seven single items for treatment- and disease-related symptoms [20].

Statistical analysis and outcomes

Descriptive information is provided for demographic and tumor-related data as well as KPS.

The primary outcome was the prevalence of anxiety and depression in patients with intracranial tumors according to the PHQ-4. At t1, group differences were analyzed using the Wilcoxon/Mann-Whitney *U* test, or the Kruskal-Wallis test. The association between age and PHQ-4 was analyzed using

ordinal logistic regression, to identify possible differences in patients at different stages of life, as their social integration and personal needs may vary and thus their need for support and distress. $P < 0.05$ was considered statistically significant. *p* values in analyses of the PHQ-4 were adjusted using the Benjamini-Hochberg (false discovery rate) method.

Correlation analysis for PHQ-4 and DT, EORTC global health score GHS and the emotional functionality subscale of the EORTC (emof) were performed using Spearman's correlation. Correlations > 0.5 were described as strong [25]. To assess agreement between screening tools based on the respective cutoff scores proposed in the literature Cohen's kappa statistics were applied. $\kappa = 0.81\text{--}0.99$ was defined as almost perfect, $\kappa = 0.61\text{--}0.80$ as substantial, $\kappa = 0.41\text{--}0.60$ as moderate, $\kappa = 0.21\text{--}0.4$ as fair, and $\kappa = 0.01\text{--}0.2$ as slight agreement [26]. No formal *p* value adjustment for multiple testing was carried out; therefore, results have to be interpreted with caution and regarded as exploratory. Missing data was not imputed.

HRQoL and psychosocial distress as well as the need for support are closely linked to each other. Our group has analyzed correlations of the EORTC instrument with psychosocial screeners previously in order to allow screening of patients with less extensive tests and/or less screening tools for better implementation in clinical routine. Based on these results, cutoff values, calculated by applying receiver operating characteristic (ROC), for the PHQ-4 were determined indicating a need for support (HSI, need for treatment; emof, cutoff 70.8) or increased distress (DT, cutoff 6; emof, cutoff 62.5). The cutoff values indicating positive cases based on the EORTC emof were selected based on the results of our study group in a different patient sample [27]. The area under the curve (AUC) was used to evaluate the accuracy of the PHQ-4 to distinguish between groups as follows: highly accurate differentiation with an AUC > 0.9 , moderately accurate differentiation with an AUC of 0.7–0.9, low accuracy in differentiation with an AUC 0.5–0.7, and random results with an AUC < 0.5 . The cutoff values for PHQ-4 were selected based on the best balance between sensitivity and specificity [28]. For the ROC- and correlations analyses all assessment were assumed to be independent samples and therefore cumulated, because the current state of psychosocial burden was assessed at each assessment using different screening tools evaluating their agreement and no specific psycho-oncological treatment was initiated in between possibly influencing the following screening. Similarly, Martin-Mittag et al. cumulated their data of patients at different time points [29].

Based on PHQ-4 results and patients' wish for support EORTC scores and DT-scores were compared between the corresponding groups using mixed ordinal regression (PHQ-4 ≥ 6 vs. < 6 , PHQ-4 ≥ 9 vs. < 9 , wish vs. no wish for support).

All analyses were performed using SPSS, version 18.0 (IBM Corp., North Castle, NY, USA) and the statistical environment R (version 3.5.1, R Core Team 2018).

Ethics

This study was performed in accordance with the Helsinki declaration after approval by the local ethics committees (No. 837.220.12 (8312-F)). The responsible clinical investigators (MR, AKH, and MNO) informed eligible patients verbally and handed out written information about the study, upon which participants provided their written informed consent. Each participant was assigned a patient identifier to ensure data confidentiality.

Results

Patients

Data of 139 patients, recruited between September 2012 and September 2014, was analyzed. The mean age of patients was 56 years. A slight female predominance was noted in both centers (54%). No serious clinical impairment was observed after surgery, the majority of patients had a KPS ≥ 70 pre- and postoperatively. Most patients suffered from malignant gliomas (35%) and meningiomas (30%). Metastases from solid tumors occurred in 22% of cases. Most tumors were located in the frontal lobe ($n = 38$, 27%). In the majority of cases a gross total resection (GTR) could be achieved ($n = 96$, 74%) as displayed in Table 1.

Results of PHQ-4 at t1, t2, and t3

The PHQ-4 was conducted in 130 participating patients at t1, in 112 at t2 and in 94 at t3, respectively (patient attrition of the study: t2 $n = 23$, t3 $n = 20$). When patients completed the PHQ-4, no missing values occurred, however patients did not fill in all questionnaires at all measurements.

At t1, the mean PHQ-4 total score was 3.7 (SD = 3.0), at t2 2.5 (SD = 2.6) and at t3 2.4 (SD = 2.5). Thirty-two patients achieved a total score ≥ 6 (25%) at t1 and at t2, 12 patients out of 112 (11%) scored ≥ 6 . Finally at t3 8 patients, out of 94 (9%) scored ≥ 6 . Results are displayed in more details in Table 2.

At t1, PHQ-4 scores did not differ significantly between male and female patients (means, 3.3. resp. 3.9; Wilcoxon, $p = 0.3$) and between different age groups (means, 18–40 y; 4.1, 41–60 y; 3.6, 61–80 y; 3.1, > 80, 8.5, ordinal regression, $p > 0.99$). Similarly, no significant differences were seen regarding tumor laterality (means, left hemispheric, 3.4; right hemispheric, 3.6; Mann-Whitney U , $p = 0.9$).

Table 1 Patients' characteristics of all in analysis included subjects

Variable	N= (%)
Age (years)	55.9 \pm 11.6
Gender	
Male	64 (46)
Female	75 (54)
Karnofsky Performance Scale	
≥ 70 preoperatively	113 (81)
≥ 70 postoperatively	127 (91)
Tumor-entity	
Metastasis	30 (22)
Astrocytic tumor/malignant glioma	49 (35)
Meningioma	42 (30)
Other	15 (11)
n.a.	3 (2)
Tumor localization	
Frontal	38 (27)
Temporal	20 (14)
Parietal	14 (11)
Occipital	13 (10)
Infratentorial	20 (14)
Other	17 (12)
n.a.	3 (2)
Multiple	14 (10)
Extent of resection	
Gross total resection	96 (74)
Subtotal resection	34 (26)

The results of DT and HSI

At t1, 50 (36%) patients were identified as being in need of support per DT. After 3 and 6 months, 28 patients (25%) and 21 (23%), respectively, scored ≥ 6 on the DT. Applying the HSI, comparable percentages of patients in need of psychosocial help were identified (t1, $n = 39$, 28%; t2, $n = 40$, 36%; t3, $n = 31$, 33%). In addition to the reported dropouts, we observed $n = 20$ missings at t1 for DT, at t2 $n = 31$ and at t3 $n = 52$ ("missing" regarding DT was defined by missing the numerical analogue scale and/or missing items in the "problem list"). Similarly, additional missing values were noted for the HSI: $n = 4$ at t1, $n = 31$ at t2, and $n = 49$ at t3.

DT, HSI, EORTC, and PHQ-4

After surgery, patients who were in need of psycho-oncological support according to the DT and HSI had significantly higher PHQ-4 scores than those who were not (DT, $p < 0.0001$ and HSI, $p = 0.001$, Wilcoxon). Similar results were observed during the remainder of the observational

Table 2 Results of PHQ-4 in all patients

Measurement (n=)	Mean (SD) n = (%)	Median (range) n = (%)	Patients scoring ≥ 6	Patients scoring ≥ 9
t1 (130)	3.7 (3.0)	3 (0–12)	32 (25%)	10 (8%)
Male	3.3 (2.8)	3 (0–11)		
Female	3.9 (3.1)	4 (0–12)		
t2 (112)	2.5 (2.6)	2 (0–12)	12 (11%)	4 (4%)
Male	2.8 (2.4)	2 (0–12)		
Female	2.2 (2.4)	1 (0–12)		
t3 (94)	2.4 (2.5)	2 (0–12)	8 (9%)	2(2%)
Male	2.3 (2.1)	2 (0–7)		
Female	2.4 (2.7)	1 (0–12)		

period at t2 and t3 (DT and HSI both, $p < 0.0001$, Wilcoxon) as shown in Fig. 1a and b.

Patients with scores on the PHQ-4 rating as increased (≥ 6 and ≥ 9) scored significantly worse on most of the EORTC QLQ-c30 function and symptom scales, supplement Table 1.

Association between patients’ wish for support and screening results

Thirty-four (24%) patients expressed a wish for psychological support after a confirmed diagnosis (t1). After 3 months ($n = 12$, 11%) and 6 months ($n = 11$, 12%), patients immediately asked for psychological help. Patients expressing their wish for psychological support scored significantly higher on the PHQ-4 than those who did not (means 5.09 vs. 3.09, $p < 0.001$, Wilcoxon) at all assessments (t1–t3). The results are displayed in Fig. 1c). Furthermore, these patients scored

significantly lower on most EORTC functions and symptoms, as well as higher on the DT scale (supplement Table 1).

Correlation and agreement between screening tools

Strong pairwise correlations were seen between PHQ-4 and EORTC emof ($r = -0.72$, $p < 0.0001$; 95% CI, -0.80 to -0.63), DT ($r = 0.70$, $p < 0.0001$, 95% CI, 0.60 – 0.77) and EORTC GHS ($r = -0.51$, $p < 0.0001$; 95% CI, -0.63 to -0.38).

The best agreement between screening tools was seen for PHQ-4 and DT, using 6 as the cutoff for both tests (kappa = 0.31 , $p < 0.001$), yet this agreement was only fair. Fair agreement was also demonstrated between the PHQ-4 and HSI, if the PHQ-4 cutoff of 6 was applied. When testing with a PHQ-4 cutoff of 9, only slight agreement between tests was detected. Furthermore, irrespective of the PHQ-4 cutoff, agreement between PHQ-4 results and patients’ wish for support was

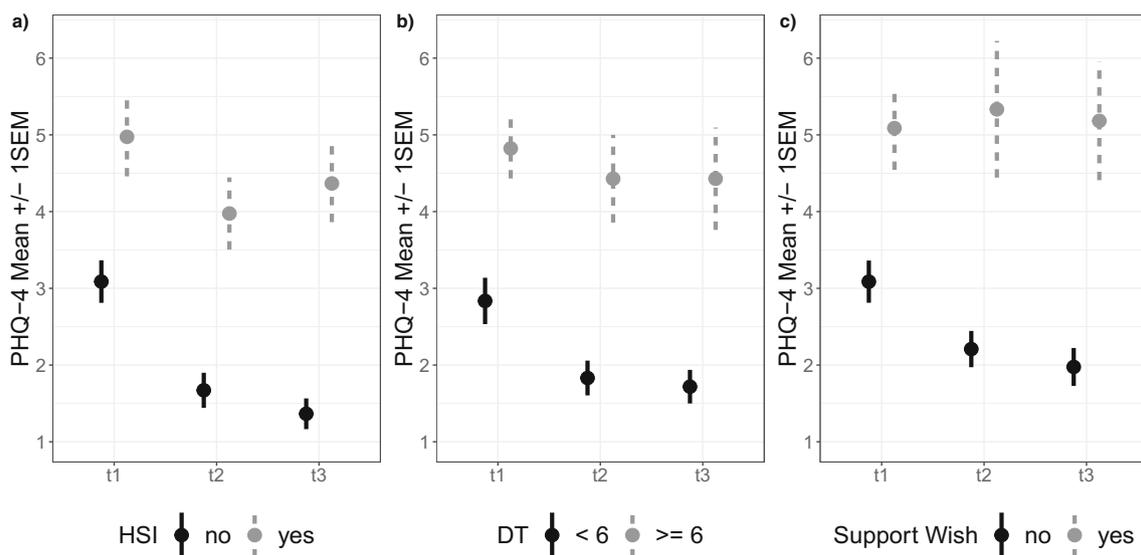


Fig. 1 Patients expressing their wish for psychological support scored significantly higher on the PHQ-4 than those, who did not (means 5.09 vs. 3.09, $p < 0.001$, Wilcoxon) at all assessments (t1–t3)

only fair. Complete results for agreement between tests are described in supplement Table 2.

PHQ-4 cutoff indicating increased distress and need for support in patients with intracranial tumors

A cutoff value of 2.5 was identified to moderately discriminate between patients in or not in distress (sensitivity 76.8%) and between patients wishing or not wishing to receive further, specific support (sensitivity 82.5%). The same cutoff value (PHQ-4, 2.5) was determined by using the cutoff of values proposed by our study group for EORTC emof indicating increased distress (cutoff, 62.5) or need for support (cutoff, 70.8) to indicate positive cases. Complete results are displayed in supplement Table 3 and ROC curves in Fig. 2.

Discussion

This longitudinal study evaluating patients with intracranial tumors demonstrated the first application of the PHQ-4. This study suggests that, when solely applying the recommended PHQ-4 scores of ≥ 6 and ≥ 9 for the presence of mild or severe depression or an anxiety disorder, the proportion of patients in need of support detected by the PHQ-4 was lower than by DT

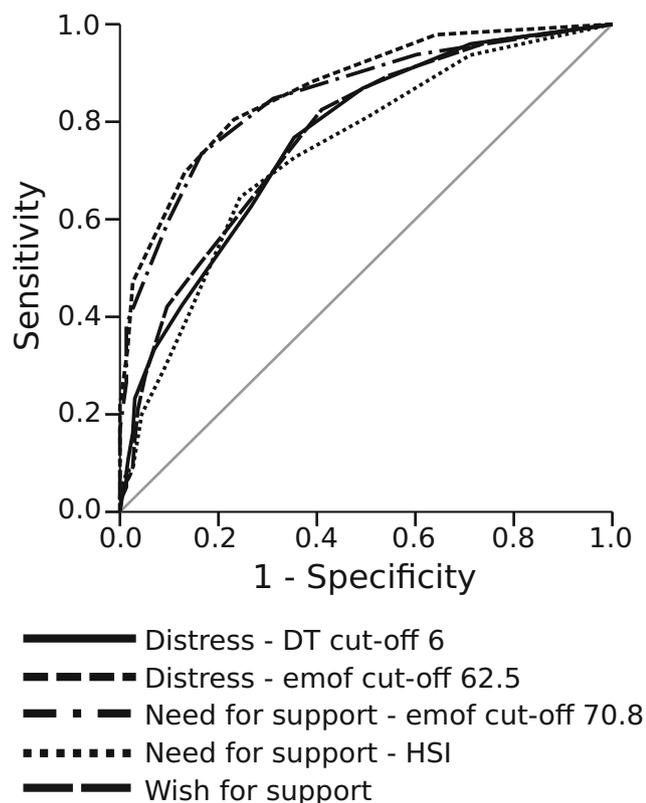


Fig. 2 Complete results of increased distress (cutoff, 62.5) or need for support (cutoff, 70.8)

and HSI. Additionally, patients who were in need of support according to the HSI and DT as well as patients requesting for support showed significantly higher PHQ-4 scores (e.g., mean PHQ-4 of patients with DT < 6 : 2.84 vs. mean PHQ-4 of patients with DT ≥ 6 , 4.82, supplement Table 1). Furthermore, we found only fair agreement between the different tools when applying the recommended cutoff scores. An ROC analysis revealed a lower cutoff score for PHQ-4 of 2.5 that may be necessary in order to discriminate between patients in need of support or not.

PHQ-4 as ultra-short screening instrument in brain tumor patients

Regarding the data quality, we observed no missing items on the PHQ-4 whereas missings occurred in both, the DT and HSI, indicating that ultra-short screening instruments could lead to a higher coverage rate in screening procedures. As already shown by Mitchell et al., the accuracy of very short screening instruments, even single-item tools, seems comparable to longer questionnaires with higher efficiency [12]. In brain tumor patients, due to cognitive deficits, shorter instruments or maybe even a direct verbal question and a careful clinical assessment are possible alternatives to lengthy patient reported outcomes [11, 12, 30, 31].

However, fewer patients were identified by the PHQ-4 instrument as in need of support in comparison to DT and HSI as well as to the data reported in the literature [1, 5]. In our opinion this is due to several reasons. Of note, although the PHQ-4 was completed fully by the participating patients, we observed many drop-outs during the course of the study, leading to a certain selection bias. Especially in one center a particularly high level of drop-outs and a lower general condition of the recruited patients were observed. Others have shown that general condition is a main predictor for study resignation and drop out [32]. Indeed, it is possible that, patients who would have been screened as in need were not included or already dropped out of the study. Especially in brain tumor patients, neurocognitive deficits play a major role and may contribute to study resignation [30, 31, 33, 34]. However, our observation is in line with other longitudinal observational studies suffering from study resignation, missing data and selection bias, as already reported previously [35].

Correlation to other screening instruments and to the EORTC questionnaire

The correlations between PHQ-4 scores and the more established EORTC emof, the DT score, and results of the HSI indicate that these screening instruments may all be applied in patients with intracranial tumors. All of the aforementioned instruments focus on the emotional well-being of the patients and a large correlation further underlines that results

are overlapping and screening procedures could possibly be performed more focused especially in patients with concentration and neurocognitive deficits. Yet, the different tools have different focus as indicated by the agreement analysis: EORTC emof measures emotional functioning in the light of HRQoL, DT measures the distress being experienced, and the HSI and PHQ-4 measures depression and anxiety. Therefore, correlation analyses should be interpreted with caution.

The most EORTC symptom and functioning scales were significantly worse in patients scoring ≥ 6 and ≥ 9 on the PHQ-4. This further highlights the link between scoring as in need of support on psychologically oriented screening tools and general patient reported quality of life. Thus these patients could benefit from early intervention to improve quality of life and outcome.

Cutoff value of PHQ4 in brain tumor patients

A lower cutoff value may be better able to detect patients with intracranial tumors as in need of psychological support. In this cohort, a cutoff of 2.5 reliably discriminated between patients in distress and/or need of further support and those without increased distress/need for support. It is our contention that, cutoff scores should be adapted for the demanding situation of those patients, as already shown for other screening tools in brain tumor patients (e.g., within the DT: 5 vs. 6 according to Goebel et al. [13, 24]). Furthermore, Weihs et al. have recently described an adjusted cutoff score of ≥ 3 for the PHQ-4, which performed moderately in breast cancer patients [36].

Interestingly, in this patient sample, the same cutoff also led to the best tradeoff between sensitivity and specificity when EORTC emof functioning cutoffs were used to indicate positive cases, which have been determined previously by our study group in a different cohort of glioma patients only [27]. These findings indicate that the need for lower cutoff values may not be specific to this cohort, but necessary for patients with intracranial tumors in general to reliably detect those in need of support and/or distress.

Even though the previously proposed cutoff values for the PHQ-4 led to only slight agreement with patients' wish for support, the results of all screening tools were significantly worse in patients seeking support. Therefore, even though single instruments may not adequately identify a patient in need of further help, patients should always be asked directly, as their wish for assistance may effectively identify those in need of psychological support. However, the benefit of applying an ultra-short screening tool like PHQ-4 over the direct question "would you like to receive support?" is that patients who are developing depressive symptoms but do not actively express their burden may be detected by the screening and could be missed by a direct question.

Limitations and strengths of the study

The heterogeneous patient sample reduces the generalizability of study results. However, it is worth noting that the demographic characteristics of our study population mirror the characteristics of patients with intracranial tumors observed in neurosurgical departments, given that we conducted the study in a university medical center and a community hospital. Though, we did not evaluate decliners and patients who underwent surgery during this period without meeting the inclusion criteria, the representativeness and generalizability of the data may be limited.

Further, as described above, we observed a relevant dropout rate and had a significant amount of missing data in the patient population in particular for the DT and HSI. Additionally, not all patients completed all instruments at all three measurements, what may reduce the quality of data and generalizability of study results. We did not verify the results by clinical assessment but compared the results to other validated and well-established tools.

The strengths of this study are the longitudinal assessments with an included analysis on gender differences in our analysis. Although gender differences regarding psychosocial burden in brain tumor patients are well known [37], they remain unattended in most of the studies. Further, the assessment directly after surgery in a neurosurgical department with follow up screenings performed by the same treating physicians led to a relatively high protocol adherence. The patients are diagnosed and treated for their illness for the first time and should have the first contact to psychosocial support immediately. Therefore, beside the limitations, we feel that the study reflects a true clinical routine and results can be transformed to the clinical situation especially in neurosurgical departments.

Clinical implications

Psycho-oncological assessment of brain tumor patients remains challenging. During clinical routine a short questionnaire like the PHQ-4 may be filled in by more patients than a lengthy questionnaire with a demanding scoring algorithm [6, 38–40].

Conclusion

Patients with intracranial tumors experience relevant psychosocial burden. The PHQ4 can be applied in this patient cohort to detect those with relevant psychological comorbidities. However, the cutoff value should be re-evaluated in a larger cohort as we observed that a cutoff of 6, as recommended previously, may be too high in order to detect affected patients adequately.

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Compliance with ethical standards

Conflict of interest The authors declare that they have no conflict of interest. The first author has full control of all primary data and agrees the journal to review the data if requested.

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