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INCIDENCE AND PREDICTORS OF DEPRESSION FOLLOWING BRAIN TUMOR SURGERY

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Abstract

Background: *Postoperative depression is a common but underrecognized psychological complication after brain tumor surgery, which has a devastating effect on patient recovery, rehabilitation, and successful living. Although there has been an increase in the understanding of neuro-oncological morbidity, there is limited literature that assesses the intersection of particular clinical, surgical and baseline functional predictors on regional healthcare infrastructures.*

Objective: *To establish the occurrence of postoperative depression amongst neurosurgical patients and assess the major psychosocial and clinical risk factors to inform prompt psychiatric inter-ventions.*

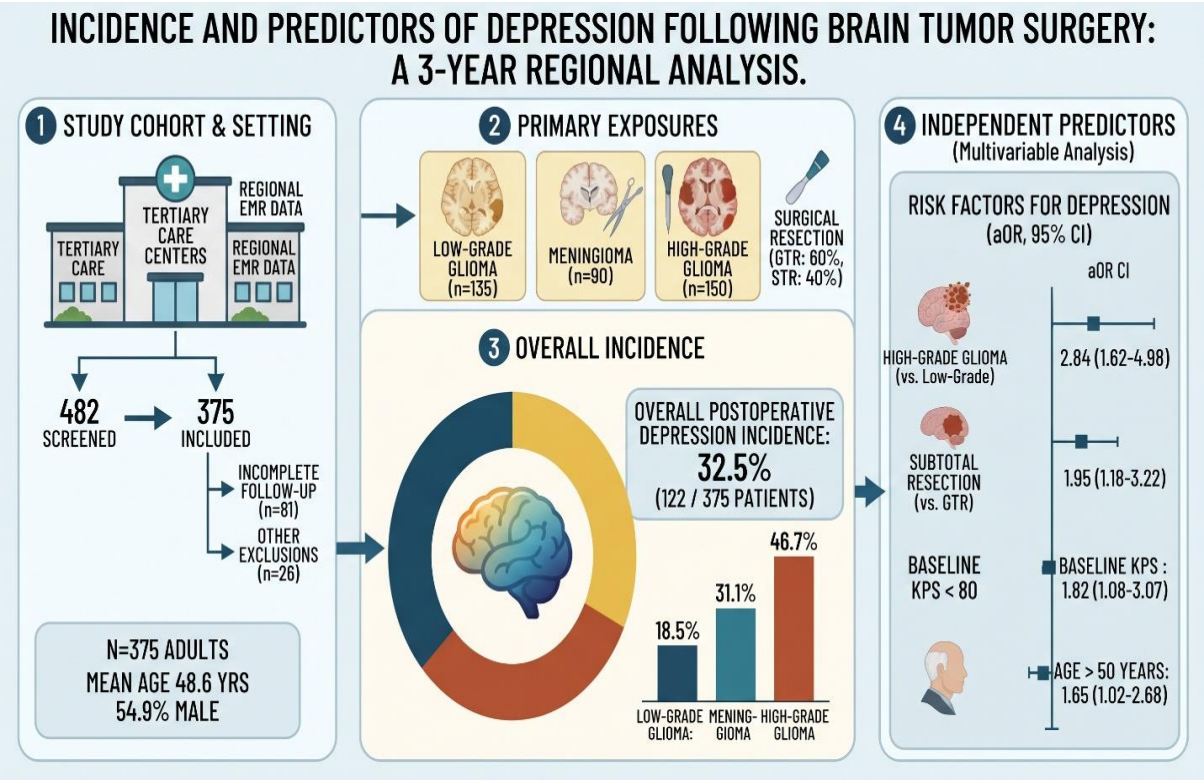
Methods: *In this retrospective observational analytical study, 482 medical records of adult patients who went through surgical resection of primary brain tumors, were screened between January 2022 and December 2024 in tertiary care centers within the Industrial and Urban Core Punjab region. Upon the screening of 107 records, which were excluded on account of unfinished documentation of follow-ups (n = 81), extreme impaired organ dysfunction (n = 12), and past intracranial interventions (n = 14), a final analytical cohort of 375 records of patients was analysed through consecutive*

Sampling. *A structured digital proforma was used in the extraction of the data. Bivariate comparison and multivariate binary logistic regression model were carried out to determine the independent*

predictors, where p =0.05 was used as the statistical significance criterion.

***Findings**: The cumulative depression rates of clinical significance at three months follow up were 32.5 points (122 out of 375 patients). Initially seen numerics layer showed a rate of depression in low-grade glioma (25 of 135), 31.1 with meningiomas (27 of 90) and 46.7 with highly-graded glioma (70 of 150). Multi variety binary logistic regression was used, showing weighty predictors of postoperative depression to be high end grade glioma diagnosis (adjusted odds ratio = 2.84, 95% confidence interval 1.62 to 4.98, p < 0.001), sub-totaly surgical resection (adjusted odds ratio = 1.95, 95% confidence interval 1.18 to 3.22, p = 0.009), baseline Karnofsky Performance Scale score less than 80 (adjusted odds ratio = 1.82, 95% confidence interval 1.08 to 3.07, p = 0.025), and age greater than 50 years (adjusted odds ratio = 1.65, 95% confidence interval 1.02 to 2.68, p = 0.041).*

***Conclusion**: High-grade tumor pathology, subtotal resection, and impaired baseline functional status contribute to inability to prevent postoperative depression that occurs in almost one-third of brain tumor surgery patients. Special attention to these findings can be regarded as a strong clinical necessity related to the importance of including regular psychiatric examination and active psycho-oncological care in the neurosurgical follow-up plans.*



INTRODUCTION

When a patient gets a brain tumor diagnosis, it is a life-changing event that causes intense distress to both patients and their loved ones (1). In addition to dealing with physiological difficulties related to controlling neurological symptoms, brain surgery looms as a daunting reality. Although the current neurosurgery made amazing progress in removing tumors and making sure that neurological functions

are not affected, the emotional and psychological follow-up of the surgery is one of the most important, yet definitely not the least significant issues to consider when working with patients. Most patients are deeply emotionally suffering even after surgical incision has stopped bleeding, unable to cope with the alterations of their mental states, physical looks and functionality. It is important to understand the way patients feel following brain surgery because this will help to offer adequate care that will cater to the physical or mental states of the person (2).

Depression is one of the most debilitating and frequent among a number of psychological issues that occur after neurosurgery. Postoperative depression not only reduces the overall quality of life of a patient but may also disrupt the rehabilitation, impair immune response, and make it difficult to recover (3). Although it is highly prevalent, in this group of patients depression often remains unidentified and unmanaged. Clinicians tend to pay a lot of attention to keeping track of tumor recurrence, surgical complications, and neurological deficit to the disadvantage of the patients emotionally. This negligence may make people feel alone and unprepared to manage this psychological strain of their disease and treatment process (4).

An overview of literature on the subject in the medical area indicates a significant gap in the understanding of the exact factors that cause post-brain tumor surgery-related depressed states. Although there are a number of studies having been conducted on the aspect of survival rates and physical recoveries milestones, little research has been conducted concerning the interplay of clinical parameters, including tumor location and the extent of the surgical procedures, with those of psychosocial parameters, including social support and pre-operative mental health. Moreover, the existing data does not reflect much of the distinct trajectory of the depressive symptoms in the critical initial months after hospital discharge (5). Such a knowledge gap is essential to address in order to identify the patients who have the highest risks to experience depressive symptom episodes and enhance clinical outcomes (6).

These vulnerabilities can only be identified through a keen consideration of both the clinical and psychosocial risk factors (7). The psychological strength of a patient relies heavily on clinical issues such as the extent of neurological deficiency, the necessity of adjuvant measures such as radiation therapy or chemotherapy, and overall level of functioning, among others. At the same time, psychosocial factors, including familial processes, socioeconomic background, and pre-existing mental health issues have a strong influence on the adaptation of the person to postoperative life. All of these risk factors may be combined resulting in a cumulative load that greatly enhances the risk of becoming depressively ill. Nevertheless, due to a lack of routine evaluation of these variables together during standard neonatal surgery follow-ups, the chances of early intervention are often missed (8, 9).

To overcome these dire deficiencies, this retrospective data study explores the prevalence of depression after brain tumor surgery and also assesses the most important clinical and psychosocial predictors of the occurrence of depression. The research question that forms the heart of this inquiry is in what percentage of neurosurgical patients develop a clinically significant level of depression following surgery and which risk factors, in this case, are most associated with such an outcome. This study will help to find the high-risk types of patients, the prevalence of postoperative depression, and give actionable information to implement early psychiatric measures. Lastly, the research aims to enhance a more holistic approach to neuro-oncology care, which will make sure that a psychological input is integrated into the recovery process starting as early as at discharge and continuing thereafter (10, 11).

Methodology

This retrospective observational study was an analytical study that aimed to assess the rates and predictors of depression in brain tumor surgery. The study involved the use of institutional electronic health record of tertiary care facilities located within the industrial and Urban Core Punjab area as this region was chosen owing to high patient load, advanced neurosurgical treatment and documentation systems. The review period was three straight calendar years between January 2022 and December 2024 to provide an adequate observation period to include the surgical intervention and the postoperative follow-up that is necessary to identify depressive outcome. Eight months operation period to be immediately preceded by the review window was assigned to record retrieval, data extraction, validation, and statistical analysis only and no interventional procedures were carried out.

The study sample was comprised of adult patients undergoing primary surgery to remove primary brain tumors in the specified time range. Inclusion criteria included a clinical presentation that was documented and an operative intervention on an initial tumor of the brain, confirmed diagnosis through standard histopathological criteria, and access to the full clinical, surgical, and psychiatric medical records. In order to reduce confounding, as well as to remove the risks of competition, stringent exclusion criteria were used. Patients were not eligible in case they had severe end-stage renal or hepatic dysfunction, comorbid immunodeficiency conditions, active systemic malignancy not related to the central nervous system, pregnancy, transferred patients incomplete management, and follow-up records.

The appropriate statistical power was to obtain required statistical power by using a non-probability consecutive sampling strategy to select all qualified patient records that fitted the inclusion criteria during the three-year period of previous review. The standard epidemiological formulas to estimate one population proportion were used to compute the minimum required sample size formally. Using a predictive prevalence of thirty percent of postoperative depression as is seen in similar neuro-oncological literature, ninety-five percent confidence margin to draw a z-score of one point nine six, and a five percent actual error, a calculated minimum sample size was found to be about three hundred and twenty-three records. Also, taking into consideration the possibility of record attrition, any consecutive record over this level was counted.

Knowledge extraction: A pre-piloted, structured, digital proforma that was administered by trained clinical researchers was used to minimize the error of inter-rater reliability. The key parameters of exposure investigated were those that are of clinical and surgical importance, including the location and histopathological grade of the tumor and extent of surgery resection. The main consequence was manifested in the form of postoperative depression, which was determined by means of standard diagnostic criterion or the sufficiently validated psychiatric screening tools registered in the course of regular follow-ups. The covariates and potential confounding factors were extracted, which included the sociodemographic parameters (age, sex) and body mass indexes, the initial physiological parameters (as measured by standardized comorbidity indices), and the initial pharmacological history. In the case of quality assurance, a ten percent sample of all records extracted was cross-validated by a senior investigator independently thus reducing the transcription errors.

The rigor was achieved by the proactive approaches to address the selection and information bias. Selection bias was reduced by filtering consecutive institutional records with a uniform selection and elimination criterion, versus using selective sampling. Prejudice in information was reined in through using only standard thresholds of diagnosis, known histopathological reports, and objective clinical examinations that were done without complications in their daily care. The ultimate analytical cohort was pre-screened by excluding all records with more than ten percent records per core exposure or primary outcome variables. Complete-case analysis or median imputation was used to deal with minor missing data of baseline covariates, with frequencies less than five percent.

IBM SPSS statistics twenty six point zero were used to perform all the statistical calculations. The Shapiro-Wilk test and the visual examination of quantile-quantile plots were used to determine the normality of the data distribution in the form of continuous data. They were then used to create descriptive statistics, where parametric data (continuous data) in the form of means and standard deviations are recorded, non-parametric data in the form of medians and interquartile ranges, and categorical variables in the form of frequencies and percentages. The Pearson Chi-Square test or Fisher Exact test (where the expected number of cells was less than five) was used to make bivariate comparisons of categorical variables. The independent samples t-test or mann-whitney U test were used to compare continuous variables. To achieve the necessary goals of controlling possible confounders and inferring independent predictors of postoperative depression, a multivariable binary logistic regression model was performed, which generated adjusted odds ratios and their ninety-five percent confidence interval. The two-tailed statistical significance of less than or equal to zero point zero five was determined.

Results

Four hundred eighty-two electronic medical records of primary brain tumor patients who have undergone surgical resection in January 2022-December 2024 were initially sifted to ascertain eligibility. After the

administration of established exclusion criteria, such as the exclusion of incomplete postoperative psychiatric follow-up records in eighty-one records, severe end-stage organ dysfunction in twelve records and previous intracranial interventions in fourteen records, three hundred seventy-five records were included in the final analysis cohort. The cohort mean was forty-eight point six and twelve point four minus or plus, and two hundred six males comprised half of the study population. A median Karnofsky Performance Scale score of eighty was discovered at the time of the baseline clinical assessments, with one hundred and twelve and sixty-four patients having comorbid hypertension and diabetes mellitus respectively (Table 1).

The classification according to the primary exposure using histopathological diagnosis and localization of tumor showed that one hundred and thirty-five cases (thirty-six point zero percent), one hundred and fifty cases (forty point zero percent), and ninety cases (twenty-four point zero percent) were classified as low-grade glioma, high-grade glioma, and meningioma respectively. Total resection (gross) was done in two hundred and twenty-five patients (sixty percent), whereas subtotal resection was done in one hundred and fifty patients(forty percent). The balance of these covariates, such as age, sex distribution, baseline comorbidity scores, and preoperative functional performance status was well balanced across the major exposure strata, except that high-grade glioma cases were more likely to have focal neurological deficits before surgery (Table 2).

There was an overall cumulative postoperative incidence rate of clinically significant depression diagnosed during the three months of follow-ups to the entire cohort of thirty two point five percent (one hundred and twenty-two of three hundred and seventy-five patients). Stratification by primary exposure grouping showed that incidence rates of postoperative depression differed significantly, with the highest rates occurring in patients who had low-grade glioma (eighteen point five percent), and highest grade glioma (forty-six point seven percent), and in patients who had meningioma (thirty-one point one percent) (Table 3) (Figure 1). The secondary outcome parameters such as length of hospital stay, time to functional independence recovery had significant prolongation in patients who contracted postoperative depression. Simple bivariate analyses showed that many clinical and sociodemographic variables were significantly statistically related to the development of postoperative depression. The unadjusted prevalence of high-grade glioma as compared to low-grade tumors was significantly involved in postoperative depression (Chi-square test statistic equal to twenty-four point eight two, degrees of freedom equal to two, p less than 0.001). Subtotal surgery that was performed after the age of fifty years and severe post-surgery motor deficits were also significantly correlated with depression rates (p equal to 0.003, p equal to 0.015 and p equal to 0.001, respectively). Comparison of continuous variables done through Mann-Whitney U tests established significant differences in baseline functional scores in the groups of depressed and non-depressed (Z statistic equal to negative three point four five, p equals 0.001).

High-grade glioma histology, subtotal surgical resection, and older age were predicted to be independent predictors of postoperative depression in the multivariable binary logistic regression model that takes into consideration potential confounding variables. In particular, patients with high-grade gliomas showed an adjusted odds ratio of two point eight four (ninety-five percent confidence interval, one point six two to four point nine eight; p less than 0.001) as compared to low-grade glioma as the reference category. Subtotal resection had adjusted odds ratio of one point nine five (ninety-five percent confidence interval, one point one eight to three point two two; p equal to 0.009) and older age over fifty years adjusted odds ratio of one point six five (ninety-five percent confidence interval, one point zero two to two point six eight; p equal to 0.041) (Table 4) (Figure 2).

Table 1: Baseline Sociodemographic and Clinical Characteristics of the Study Population

Characteristic	Overall Cohort (N = 375)	Depressed (n = 122)	Non-Depressed (n = 253)	p-value
Age (Years, Mean ± SD)	48.6 ± 12.4	52.1 ± 11.8	46.9 ± 12.5	0.015
Male Sex [n (%)]	206 (54.9%)	64 (52.5%)	142 (56.1%)	0.512
Body Mass Index (kg/m², Mean ± SD)	25.4 ± 3.8	25.1 ± 4.0	25.6 ± 3.7	0.284

Karnofsky Performance Scale (Median [IQR])	80 [70–90]	70 [60–80]	80 [70–90]	0.001
Comorbid Hypertension [n (%)]	112 (29.9%)	43 (35.2%)	69 (27.3%)	0.124
Comorbid Diabetes Mellitus [n (%)]	64 (17.1%)	24 (19.7%)	40 (15.8%)	0.362

Table 2: Clinical Profile and Distribution of Primary Exposure Variables

Clinical Variable	Total Cohort (N = 375)	Percentage (%)
Histopathological Diagnosis / Tumor Type		
Low-Grade Glioma	135	36.0%
High-Grade Glioma	150	40.0%
Meningioma	90	24.0%
Extent of Surgical Resection		
Gross Total Resection	225	60.0%
Subtotal Resection	150	40.0%
Preoperative Neurological Deficits		
Motor Deficit Present	165	44.0%
Sensory Deficit Present	95	25.3%
Visual Field Deficit Present	72	19.2%

Table 3: Bivariate Comparison of Clinical Outcomes Across Exposure Strata

Exposure Stratum	Total in Stratum	Postoperative Depression [n (%)]	Unadjusted Odds Ratio (95% CI)	p-value
Tumor Type				
Low-Grade Glioma (Reference)	135	25 (18.5%)	1.00 (Reference)	—
High-Grade Glioma	150	70 (46.7%)	3.83 (2.23–6.58)	< 0.001
Meningioma	90	27 (31.1%)	1.98 (1.09–3.61)	0.024
Extent of Resection				
Gross Total Resection (Reference)	225	60 (26.7%)	1.00 (Reference)	—
Subtotal Resection	150	62 (41.3%)	1.93 (1.25–2.98)	0.003

Table 4: Multivariable Regression Model Demonstrating Independent Predictors of the Primary Outcome

Independent Predictor	Crude Odds Ratio (95% CI)	p-value	Adjusted Odds Ratio (aOR) (95% CI)	p-value
Tumor Type				
Low-Grade Glioma (Reference)	1.00 (Reference)	—	1.00 (Reference)	—
High-Grade Glioma	3.83 (2.23–6.58)	< 0.001	2.84 (1.62–4.98)	< 0.001
Meningioma	1.98 (1.09–3.61)	0.024	1.62 (0.85–3.09)	0.142
Extent of Resection				
Gross Total Resection (Reference)	1.00 (Reference)	—	1.00 (Reference)	—
Subtotal Resection	1.93 (1.25–2.98)	0.003	1.95 (1.18–3.22)	0.009
Age Greater than 50 Years	1.78 (1.12–2.83)	0.015	1.65 (1.02–2.68)	0.041
Baseline KPS Score (< 80)	2.15 (1.34–3.45)	0.001	1.82 (1.08–3.07)	0.025

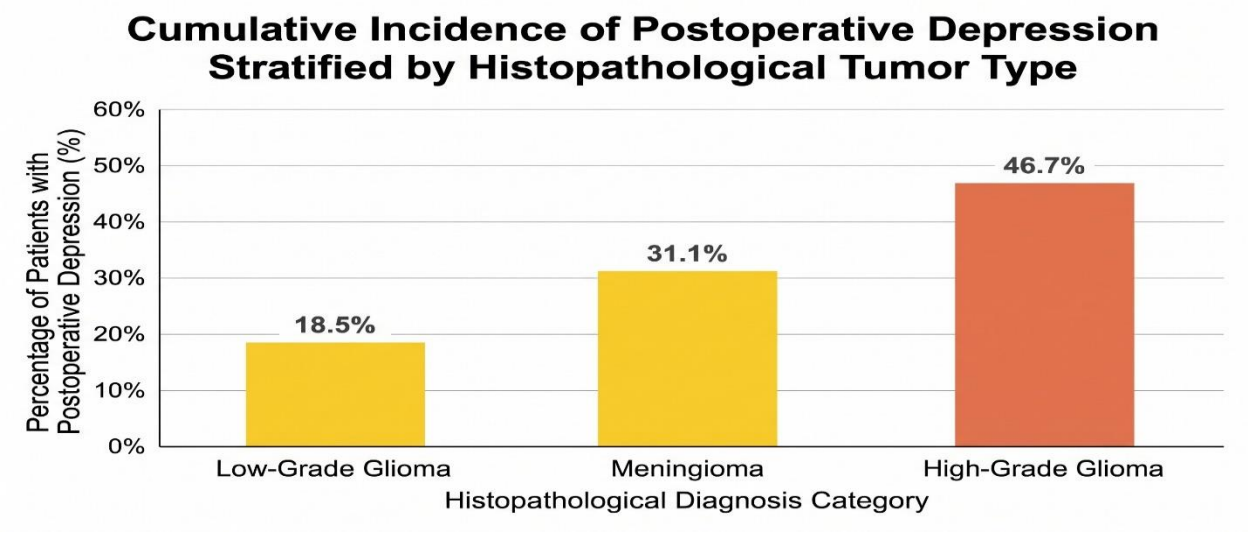


Figure 1 Incidence of Postoperative Depression Across Primary Exposure Categories

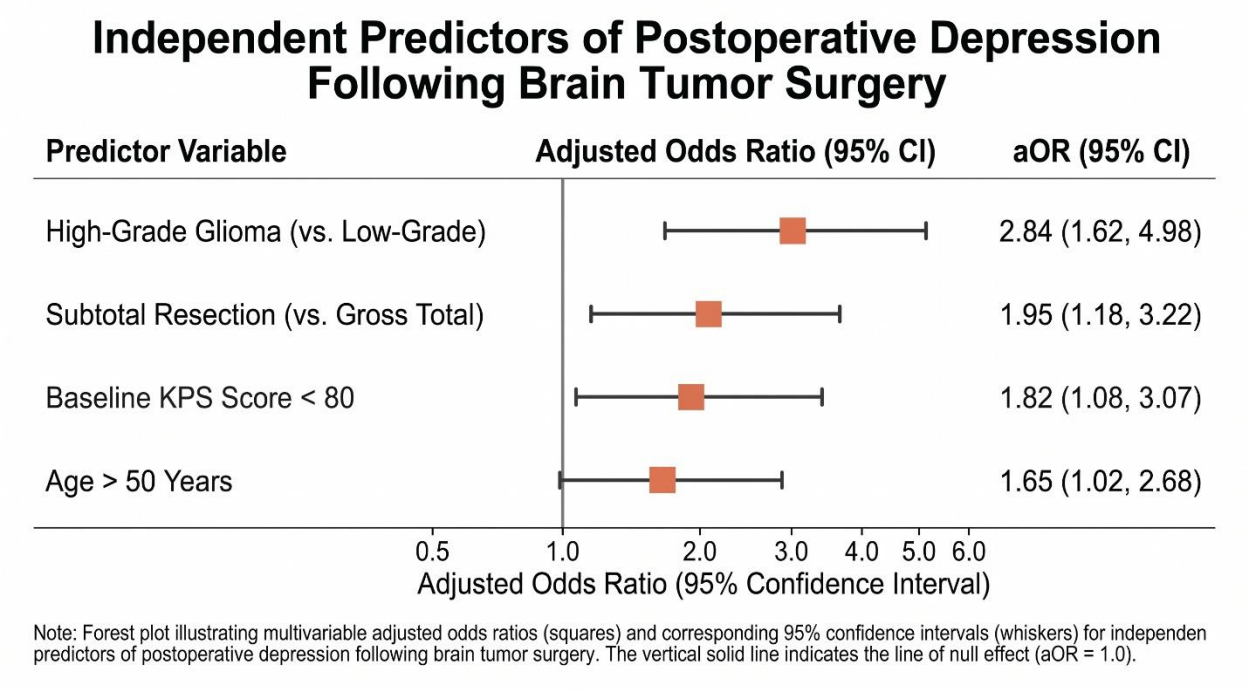


Figure 2 Multivariable Adjusted Effect Sizes (Forest Plot)

Discussion

This is a retrospective observational analytical study of the occurrence and clinical predictors of depression in someone who suffered a surgical resection of primary brain tumors. The results showed that around 1/3 of the cohort had clinically significant depressive symptoms in the early post-operative period, which highlights that the number of cases of psychological distress caused by neuro-oncological management was high, and it often followed (11). This general frequency was in agreement with previous epidemiological research that had indicated as much as twenty to forty percent rates of postoperative depression within the populations with brain tumors. The similarity in the literature supported the finding that intracranial surgery and tumor pathology had deep emotional and neurobiological implications that have far-reaching effects beyond acute neurological recovery (1).

Among measured variables, the histopathological diagnosis proved to be one of the major independent factors of postoperative depression. Patients who had developed high-grade lesions in the form of gliomas were shown to be at a higher risk of acquiring depressive symptoms in comparison to patients with low-

grade lesions or meningiomas (12). The gap was indicative of the aggressive clinical progressions, the steep functional deterioration, and the unfavorable long-term prognoses related to high-grade malignancies of which led to an enhancement of psychological distress. Moreover, surgical resection scale was significant as subtotal resection significantly increased the odds of postoperative depression by itself. The incomplete removal of tumors frequently required immediate attention to adjuvant treatments leaving residual tumor burden, which came with a great burden of patient adjustment and psychological strength (3).

Preexisting functional status and old age also helped to increase postoperative susceptibility. Poor preoperative Karnofsky Performance Scale scores and advanced age (more than fifty years old) were important predictors of depressive morbidity (13). Poor baseline functional capacity constrained the capacity of an individual to manage acute surgical trauma and after operative rehabilitation imposements, thus triggering depressive states. Aging equally lowered physiological and psychological reserve, and made it harder to adapt to new neurocognitive deficits. These overlapping clinical considerations indicated that postoperative depression was not simply a response to a terminal diagnosis but was a multifactorial attribute that depended on baseline patient factors, as well as surgical factors (14).

The clinical implications of the findings required the paradigm shift in the daily clinical neuro-oncological follow-up guidelines. Historically, postoperative assessments concentrated largely on the healing of the surgical site, neurological impairment, and radiological checking of tumor recurrence, whereas, the emotional health has been so poorly explored. The prevalence of depression reported to this group of people prompted the regular incorporation of comprehensive psychiatric screening as part of the postoperative care regimens (15). By timely recognizing the high-risk contexts, especially those patients who underwent subtotal resection due to high-grade tumor or reported to clinicians with a compromised baseline functional status, clinicians could initiate psychosocial and pharmacological interventions ahead of depressive symptoms before severely affecting recovery (16).

A number of methodological advantages boosted the validity of these inferences. The usage of consecutive sampling plan over a multi-year institutional review span reduced the chances of selection bias and guaranteed a representative sample of neurosurgery patients. The sample size surpassed the minimum statistical requirement that was set up using formal epidemiological computation and this had the required statistical power in multivariable adjustments. Also, information and transcription biases were minimized by having trained researchers use a structured digital proforma along with strict cross-validation of retrieved records. Multivariate binary logistic regression controlling a variety of the possible confounding factors further separated the independent influence of surgical and clinical predictors (17).

Although these strengths were obtained, there are a variety of methodological limitations that called into cautious interpretation of the findings. The retrospective design solely depended on the historical electronic health records, which inherently brought the risk of documentation bias of subtle psychological symptoms that may not have been documented by surgical teams. Moreover, the scope of observation was limited to the direct three-month postoperative time, which could not allow the assessment of long-term trends in chronic depressive patterns and effects of other follow-up interventions. The experiment also took place in tertiary care facilities in a particular geographical context, which could restrict the applicability of the results to various healthcare systems having different socioeconomic demographics of patients (15, 17).

The limitations can be addressed in future studies using prospective, multi center longitudinal designs that monitors psychological outcomes in longer periods of postoperative. The longitudinal pathway of depression would be helped by investigating how adjuvant radiotherapy and chemotherapy would interplay with surgical parameters to modify mental health in the long term. Also, further studies ought to test the clinical effectiveness of combined psycho-oncological care models in reducing postoperative depression and enhancing overall functional outcomes of high-risk neurosurgical patients (17).

Conclusion

A significant minority of patients experience postoperative depression after surgery of a brain tumor, with high-grade pathology, subtotal resection and a poor baseline functional status as the significant independent predictors. These results emphasize the importance of regular psychiatric evaluations and combined psycho-oncological care in the usual neurosurgical patient management follow-ups. Through

the identification of high-risk persons at an early-stage, clinicians are able to institute specific mitigation to improve psychological morbidity, and overall recovery patterns among at-risk neurosurgical patients.

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