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Postoperative Complications in Neurosurgery: Risk Factors and Mitigation Strategies for Brain Tumor Patients

Dr. Mohammed Muneam Duhis

M.B.Ch.B., A.B.H.S. \ (Neurosurgery) Lecturer, Iraqi Ministry of Higher Education and Scientific Research, University of Basra, Medical Collage, Basrah, Iraq,
Iraqi Ministry of Health, Basrah Health Directorate, Mawani Teaching Hospital, Basrah, Iraq
mohammed.duhis@uobasrah.edu.iq

Abstract: Background:

After brain tumor surgery, perioperative results are a crucial sign of the effectiveness and safety of the procedure.

Aim

This study is significantly discovered the evaluation of postoperative outcomes after neurosurgery as well as determining risk - factors of brain tumors at patients.

Methods

The surgical outcomes of 87 patients with brain tumors aged 4-40 years who underwent craniotomy in the neurosurgical departments of various hospitals in Basrah, Iraq, were documented in a recent study. The study enrolled postoperative outcomes, including mortality, complications, length of hospital stay, and other parameters. A general questionnaire was administered to assess postoperative quality of life, which evaluates the general health of brain tumor patients. The identification of patient-related risk factors was facilitated through a comprehensive review of clinical, demographic, and surgical characteristics.

Results

The current results showed infratentorial (17.24%) and supratentorial (82.76%), tumor size < 3 got 75.86%, glioma tumors with 68.97%, operation time ≥ 3 had 56.32%, hospital stay ≥ 6 days had 24.14%; mortality rate was 8.05%, postoperative complications had 34 cases, risk factors included duration of surgery, and tumor size, giloma, and emergency surgery, which are most factors affect patients.

Conclusion

Craniotomy surgery performs a critical role in the management for brain tumors, significantly changing patient health outcomes.

Keywords: Brain tumors; Neurological outcomes; Craniotomy surgery; Complications; and Risk factors.

Introduction

The occurrence of complications following neurosurgical procedures is a frequent phenomenon [1]. A review of the database of the National Surgical Quality Improvement Program revealed an overall morbidity rate of 13.6%, 32.5%, and 39.4% for intracranial shunt placement surgeries, craniotomies/craniectomies, and repairs of intracranial defects, respectively. These findings are based on a sample of approximately 10,000 neurosurgical procedures performed between 2017 and 2019 in the United States. The mortality rate within the initial 30 days in this population ranged from 0.2% to

1.6% [2,3,4]. A number of studies have indicated that pediatric neurosurgery exhibits the highest morbidity rate among the various pediatric surgical subspecialties, with rates of 14.8%, 2.4%, and 7%, respectively, when compared to orthopedic and general surgery. [5,6]

Risk factors for complications have been identified, and avoidance of these factors minimizes the risk of morbidity and mortality after elective or emergency neurosurgery [7,8]. The timely identification and treatment of complications is of paramount importance. The optimal postoperative management of neurosurgical patients is contingent upon multidisciplinary care and cooperation between nurses, anesthesiologists, intensivists, and neurosurgeons. [9,10,11,12]

Patients and methods

A cross-sectional study was conducted on 87 brain tumor patients in the neurosurgical departments of different hospitals in Basrah, Iraq. Patients aged 4-40 years were recruited during a 15-month follow-up period from February 2023 to April 2024. Electronic medical records and demographic characteristics of brain tumor parameters were identified, including age, sex (72.41% male, 27.59% female), body mass index (BMI), comorbidities, smoking, education, and economic status. Demographic parameters and patient data (mean ± standard deviation for continuous variables) and percentages for categorical variables were analyzed using SPSS software (0.22). All patients underwent preoperative physiotherapy, and their diets were completed before surgery. Ultrasonography was performed preoperatively and intraoperatively for brain tumor patients. Both inclusion and exclusion criteria were used to collect patient data. Inclusion criteria included patients aged 4-40 years, patients who smoked, patients with comorbidities such as hypertension, diabetes, and other diseases, and patients who underwent emergency or urgent surgery. Exclusion criteria included infants, elderly patients, pregnant or lactating women, and patients who did not complete the questionnaire or had no preoperative or postoperative records during the follow-up period. Patients were evaluated by ultrasound and clinical examination, including tumor location, type, histology, and size. A general assessment was performed to determine the extent of functional status in brain tumor patients using the Karnofsky Performance Scale (KPS). A popular tool for determining a patient's functional status, especially in cancer and palliative care settings, is the Karnofsky Performance Scale (KPS). It assesses three primary areas: level of activity, ability to work, and ability to self-care. The scale ranges from zero to one hundred, with 100 representing normal functioning and 0 representing death. This measure is critical in predicting patient outcomes and determining the appropriate level of treatment.

All patients underwent craniotomy, with some (12.64%) and others (87.36%) undergoing emergency craniectomy at different hospitals in Basrah, Iraq. They underwent total and partial craniectomies, with 64 specimens undergoing total craniectomies and 23 undergoing partial craniectomies at both supratentorial and infratentorial sites. Surgical parameters included operative time, type of resection, length of hospital stay, intensive care unit (ICU) admission, and mortality and morbidity rates. Postoperative data included neurological, regional, and systemic complications. In addition, univariate analysis was performed to assess risk factors for surgery and pre-and postoperative patient health status. Postoperative patient perception was also assessed. The Glasgow Coma Scale (GCS) is a popular tool used to determine the level of consciousness of patients, especially in acute medical situations involving trauma. Full consciousness is represented by a score of 15, while deep coma or unresponsiveness is indicated by a score of 3. A general quality of life questionnaire was also used to assess patients' postoperative health status, which was scored on a scale of 0-100, with higher scores representing optimal patient status and 0 representing death.

Results

Eighty-seven patients undergoing craniotomy were recruited from different hospitals in Basrah, Iraq. Table 1 shows the demographic characteristics of the patients before surgery. Our results showed that the majority of the participating patients were <20 years old (68.97%). Males were more common than females (72.41%). 63.22% of the patients had no other comorbidities. 32.18% of the patients had been treated previously.

Table 1: Enroll demographic data of patients.

Features	Number of patients {87}	Percentage, {%}
Age		
< 20	60	68.97%
≥ 20	27	31.03%
Sex		
Male	63	72.41%
Female	24	27.59%
Body mass index, {kg/m2}		
Normal	24	27.59%
Overweight	30	34.48%
Obesity	33	37.93%
Comorbidity		
No	55	63.22%
Hypertension	15	17.24%
Diabetes	12	13.79%
Others	5	5.75%
Smoking		
Present	14	16.09%
Absent	73	83.91%
Prior treatment		
Yes	28	32.18%
No	59	67.82%
Education status		
Primary	25	28.74%
Secondary	42	48.28%
University	20	22.99%

Table 2 presents a comprehensive overview of the patient's clinical characteristics, which were instrumental in determining the parameters of the patient during the examination. It is noteworthy that 64.37% of the patients exhibited preoperative neurological deficits. The functional status of the patients was assessed, with 60.92% exhibiting poor function, defined as a score of ≥ 65. Furthermore, 12.64% of patients underwent emergency craniotomy, while 87.36% underwent elective craniotomy. Furthermore, 17.24% of patients underwent subtentorial craniotomy, while 82.76% underwent supratentorial craniotomy. Furthermore, 24.14% of the patients had large tumors, defined as ≥ 3 cm. The study found that 68.97% of the patients had gliomas.

Table 2: Determining clinical features of brain tumors in patients.

Features	Number of patients {87}	Percentage, {%}
Preoperative neurological deficits		
Yes	56	64.37%
No	31	35.63%
Preoperative altered sensorium		
Yes	16	18.39%
No	71	81.61%
Karnofsky Performance scale		
< 65	34	39.08%
≥ 65	53	60.92%
Selection of surgery		
Emergency	11	12.64%

Elective	76	87.36%
Location		
Infratentorial	15	17.24%
Supratentorial	72	82.76%
Tumor size, cm		
< 3	66	75.86%
≥ 3	21	24.14%
Histology		
Glioma tumors	60	68.97%
Astrocytic tumor	39	65%
Oligodendroglial tumor	9	15%
Ependymal tumor	6	10%
Both	6	10%
Non - glial tumors	27	31.03%
Metastases tumor	18	66.67%
Embryonal tumor	7	25.93%
Others	2	7.41%

In Table 3, the surgical outcomes of craniotomy were documented, revealing that 56.32% of patients underwent a surgical duration of ≥ 3 hours, 73.56% underwent complete resection, 26.44% underwent partial resection, and 29.89% underwent intraoperative ultrasound. A subset of patients exhibited a prolonged hospital stay of at least six days (24.14%), 13 were transferred to the intensive care unit (ICU), and the morbidity rate was 27 patients, while the mortality rate was seven patients.

Table 3: Surgical outcomes.

Variables	Number of patients {87}	Percentage, {%}
Surgery time, hours		
< 3	38	43.68%
≥ 3	49	56.32%
Resection		
Gross total	64	73.56%
Subtotal	23	26.44%
Intraoperative ultrasound		
Yes	26	29.89%
No	61	70.11%
Length of stay hospital, days		
< 6	66	75.86%
≥ 6	21	24.14%
ICU admission		
No	74	85.06%
Yes	13	14.94%
Morbidity		
Yes	27	31.03%
No	60	68.97%
Mortality rate		
Yes	7	8.05%
No	80	91.95%

As illustrated in Table 4, complications were documented post-craniotomy, affecting 39.08% of patients. The most prevalent complication was the deterioration of the neurological condition, which

occurred in 13 patients, with four patients experiencing slight neurological deterioration and nine patients experiencing severe neurological deterioration.

Table 4: Frequency of postoperative complications on all patients.

Complications	Number of patients {n = 87}	Percentage
Neurological worsening	13	14.94%
Minor	4	4.60%
Major	9	10.34%
Regional complications	11	12.64%
Wound leak	5	5.75%
Wound gape	2	2.3%
Surgical site infection	1	1.15%
Meningitis	1	1.15%
Seizures	2	2.3%
Systemic complications	10	11.49%
Coagulopathy	2	2.3%
Hemodynamic	2	2.3%
Metabolic	6	6.9%

Table 5: Univariate analysis of risk factors impact on patients with brain tumors.

Risk factors	**Or**	**CI 95%**
Age		
< 20	2.7	1.3 – 4.8
Duration of surgery		
≥ 3, hours	3.3	2.5 – 4.6
Tumor size		
≥ 3	2.5	2.0 – 3.1
Comorbidity		
Hypertension	2.6	1.8 – 3.1
Surgery		
Emergency	2.4	2.0 = 5.0
Extend of surgery		
Gross total	1.5	0.8 – 3.0
Histology		
Giloma	2.7	2.4 – 3.3
Length of stay in hospital		
> 6 days	3.6	1.9 – 5.8
Complications		
Neurological worsening	1.6	0.9 – 3.7
Regional complications	2.4	2.1 – 5.0
Systemic complications	3.2	2.7 – 6.3

Table 6: Assessment of the level of consciousness at patients after surgery using Glasgow Coma Scale (GCS).

Items	**Number of patients {87}**	**Percentage**
Eye Opening		
1: No eye opening	2	2.3%
2: Eye-opening in response to pain	2	2.3%
3: Eye opening to verbal command	5	5.75%
4: Eyes open spontaneously	78	89.66%

Verbal Response		
1: No verbal response	3	3.45%
2: Incomprehensible sounds	6	6.9%
3: Inappropriate words	5	5.75%
4: Confused conversation	12	13.79%
5: Oriented and converses normally	61	70.11%
Motor Response		
1: No movement	7	8.05%
2: Extension to pain	5	5.75%
3: Flexion to pain	5	5.75%
4: Withdrawal from pain	7	8.05%
5: Localizes pain	8	9.2%
6: Obeys commands	55	63.22%

The assessment of patient's health status included the determination of their level of consciousness, with two patients not opening their eyes, six patients exhibiting slurred speech following surgery, seven patients experiencing loss of movement, and seven others manifesting local pain. Accordingly, a general questionnaire was conducted to assess the health status of the patients, which identified the two highest areas of health as physical (62.12 ± 6.43) and psychological (55.82 ± 8.32).

Table 7: Evaluation of health quality of life at patients with brain tumors after surgery.

Items	QOL scores
Physical function	62.12 ± 6.43
Psychological function	55.82 ± 8.32
Social and emotional functions	51.50 ± 6.65
Daily activity	53.16 ± 7.22

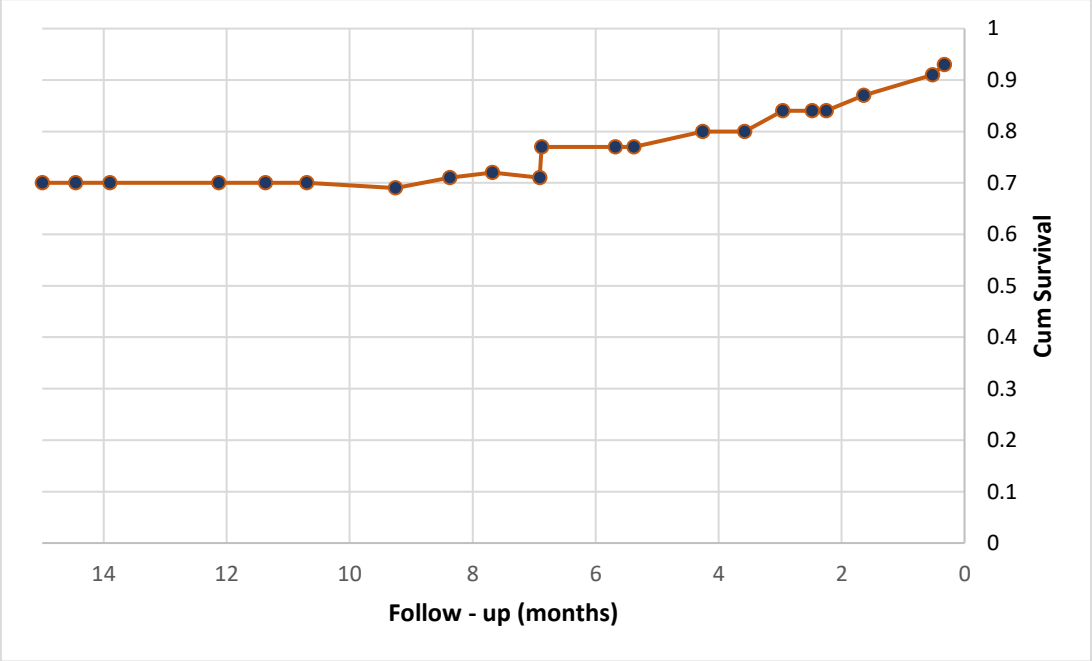

Figure 1: Postoperative overall survival.

Discussion

It is critical to distinguish between treatment-related and tumor-related effects when using multimodality therapy to treat brain tumors [13]. It is also critical to determine how different treatment modalities contribute to treatment-related effects. Patients having supratentorial malignant gliomas may experience neurological abnormalities (particularly cognitive ones) as a result of the tumor, surgery, or radiation therapy. It is crucial to conduct appropriate evaluations at many pertinent time periods, including baseline. [14]

In comparison to the claimed age, our patients were much younger. Furthermore, the percentage of patients with large tumors was significantly higher [15]. Larger tumors undoubtedly pose a higher difficulty during surgery and can negatively impact the perioperative results, even though the impact of a preoperative tumor size for long-term outcomes is debatable [16]. Furthermore, as was the case with us, individuals with bigger tumors probably have changed neurological conditions and increased intracranial pressure [17]. The preoperative neurological state did not reach significance in the multivariate model while being a substantial risk factor for total morbidity and death on univariate analysis. [18]

The Karnofsky performance scale (KPS) is used in the majority of research as a stand-in indicator of clinical state. Despite being an impartial evaluation instrument, the KPS has a number of drawbacks [19,20]. It frequently understates neurological morbidity and could not fully represent all neurological impairments. Only KPS abnormalities have been documented in some trials, whereas neurological deterioration has been recorded in a few numbers. The KPS might not show a little but distinct and quantifiable neurological deterioration. [21]

More specialized neurological outcome measures, including the NIH Stroke Score, have been used by others [22,23]. However, a scoring system tends to group results and overlooks minor (but frequently clinically important) variances, even while it guarantees uniformity in evaluation. However, identifying particular neurological deficiencies might exaggerate neurological results (both improvement and deterioration). [24,25,26]

The majority of these impairments were corrected at the time of discharge, but our data indicated that neurological deterioration (new deficits for 11.8% as well as aggravation in the existing deficits for 19.5%) was a substantial concern. In addition, the likelihood that the current neurological disorders would improve was high (almost twice, 38%). [27,28]

Conclusion

In the treatment of brain tumors, craniotomy surgery is crucial and has a big influence on the health of the patient. By directly removing the tumors, this surgical technique can reduce symptoms, enhance quality of life, and possibly increase survival. Following a craniotomy for the removal of a brain tumor, postoperative complications are still an important issue affecting long-term results and patient recovery.

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