Original Article

Complications Following Craniotomy for Supratentorial Tumors

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Abstract

Background: Craniotomy can lead to certain complications like all other surgical procedures. **Objectives:** to examine the possible complications encountered within 30 days of operation in patients undergo craniotomy for supratentorial intracranial tumors with identifying patients at great risk for development of such complications and recording time of occurrence of it. **Material and Methods:** our study carried out during the period from Jan.2019-Jan. 2021 in Basrah neurosurgery center in Al-Sader teaching hospital on 60 randomly selected patients undergo elective craniotomy for supratentorial intracranial tumors and followed up for 30 days for postoperative complications especially hematoma, postoperative infections and death. **Result:** Postoperative complications occurred in 35% of patients with hematoma occurred in 6.7% and postoperative infection in 8.3%. Morality was 8.5%. Hematoma mostly developed during intensive care unit (ICU) observation with site of tumors can predict hematoma and death complications. **Conclusion:** Morbidity and mortality following elective craniotomy does not appear to depend on tumor histology, revision surgery or primary surgery, presence or absence of chronic illness but does depend on tumor location and age of patients. Morbidity rate was 35% and mortality rate was 8.5%; so elective craniotomy for supratentorial tumors carries high complications rate with postoperative hematoma and death are the most seriously encountered complications. Our study shows that most serious complications occurred in the first 24hrs and death occurred in the patients who were not recovered from anesthesia therefore, surgical judgements, technical skills and proper anesthesia play important roles in minimizing these complications.

Keyword: Craniotomy, supratentorial intracranial tumors, hematoma, postoperative infections.

Introduction

Harvey Cushing, often referred to as the father of neurosurgery, noted: Even to the painstaking final approximation of the scalp wound, every detail of the operation and the local after-treatment must be followed with the greatest care, if one wishes to avoid that most distressing of all complications, a fungus cerebri, which I am happy to say has occurred to me only twice. [1] Craniotomy is the surgical procedure in which a part of the skull bone is temporarily removed to expose the brain and perform an intracranial procedure and many of conditions can be treated via this approach include brain tumors, aneurysms, arterio-venous malformations and intracerebral hematomas. [2] Like all other surgical procedures, craniotomy can also lead to certain complications, which is either surgery related or medical complications. Important surgical complications after cranial surgery include cerebral edema, hemorrhage, infarction, wound infection, seizure and neurological deficits etc. [3]

Medical complication after a neurosurgical procedure is defined as an unanticipated adverse event that is not directly related to the neurosurgical technique or procedure. These complications content a lot of conditions such as venous thromboembolism, cardiorespiratory complications and renal impairment etc. [4] Complications after intracranial surgery occur in 13–27% of patients and can occur at any time postoperative: in the intensive care unit, in the neurosurgical ward or after discharge to home. [5] According to my knowledge this is the first study in Basrah for assessing the postoperative complications of craniotomy for supratentorial brain tumors with special concern on postoperative surgical complications. This study aims to examine the possible complications encountered within 30 days of operation in patients undergo craniotomy for supratentorial intracranial tumors. Identify patients at great risk for development of complication following craniotomy. This study records timing of complication and analyze the best use of neuro intensive care unit for such patients group.

Materials and Methods

Study design

This is a prospective observational analytic study carried out during the period from Jan, 2019-Jan, 2021 in Basrah neurosurgery center in Al-Sader teaching hospital. Randomly selected patients undergo craniotomy for supratentorial intracranial tumors, were included in this study and followed up for 30 days to observe the postoperative complications. The prevalence and time of occurrence of postoperative complications after brain tumor surgery are evaluated with concentration on hematoma, infections and death. Complications include postoperative intracranial hematoma, infections (wounds or deep infections), postoperative death and others such as seizure, deterioration of consciousness, neurologic deficit, and postoperative medical complication. Patients also classified whither they develop their complications in the intensive care unit (ICU) or in the neurosurgical ward or after their discharge to home.

Study population

The study included 60 randomly selected patients of different age groups and different gender who undergo craniotomy for supratentorial intracranial tumors, were assessed for different postoperative complications.

Inclusion criteria:

Elective procedures, different age and gender, craniotomy for supratentorial tumor, newly diagnosed or recurrent tumors, intra axial and extra axial tumors, primary or secondary lesions.

Exclusion criteria:

Infratentorial tumors or craniotomy for others brain lesions, patient preference, emergent procedures and incomplete data or loss of follow up.

Study Procedure

Each patient was admitted to the neurosurgical ward 1-2 days before operations and undergo clinical and neurological assessment, and blood investigations including CBC, RBS, RFT, LFT, Serum electrolytes, bleeding profile, viral markers. ECG, C x-rays and prepare blood pints. All patients received preoperative treatments including dexamethasone ampule (4 mg * 4), mannitol fluid and anticonvulsants (carbamazepine tab 200 mg * 2). Other anticonvulsants, if the patient was under treatment, were continued at the same dosage. Ceftiaxone vial was given at time of surgery and continuous after it for several days. Acetaminophen was given 30 minutes before the end of surgery, and followed after surgery. All patients had gastrointestinal prophylaxis.

Clipping of hair was done at table time. Each patient was assessed postoperative for any neurological deterioration or deficits and followed up in ICU, daily in neurosurgical ward and after they get discharge on day 30 postoperative for any complications followed the surgery. Glasgow coma score (GCS) is used for conscious level assessment and brain CT scan used for hematoma detection. Special formula had been used for data collection (questioner).

Statistical analysis

The data was coded and analyzed by using statistical package of social science SSPS version 26. Significance was tested by Chi and fisher exact test. A P- value of less than 0.05 was the criterion of statistical significance.

Ethical considerations

Verbal consent had been taken from the patient and his\her relative.

Results

During the study period of two years from Jan, 2019 to Jan, 2021, 60 patients were followed for postoperative complications after they undergo craniotomy for supra- tentorial intracranial tumors. The mean age of patients was 42.23 years (range 2–92 years) and most common age group was more than 40 years which involved 34 (56.7%) of patients. Twenty- one (35%) male and 39 (65%) females as described in Table (1). Of those patients, 51 (85%) have no chronic illness, 5 (8.3%) have hypertension (HT) and diabetes mellitus (DM), 4 (6.7%) of patients have previous cancer.

Table 1: Demographic characteristics of patients.

variable		Number	Percentage %
Age (years)	< 20	11	18.3
	20-40	15	25.0
	>40	34	56.7
Gender	male	21	35.0
	female	39	65.0

It was the first craniotomy in 49 (81.7%) of patients (Figure 1).

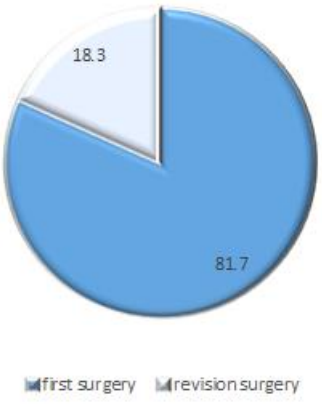

Figure 1: Pie chart show percentage of patients with virgin or revision surgery.

The most encountered tumor type was glioblastoma multiforme (GBM) 22(36.7%) and meningioma 18 (30%) as shown in Table (2). Of these tumors 19 (31.7%) were WHO grade I, 6 (10%) were WHO grade II, 3 (5%) were grade III, and 27 (45%) were grade VI, the remaining 5(8.3%) patients included 2 metastasis and 3 cannot reached to their histopathological exam and as shown in table (3).

Table 2: Histopathological types of tumors.

Type of tumors	Number	Percentage (%)
GBM	22	36.7
Meningioma	18	30
Low grade glioma	4	6.7
Anaplastic glioma	3	5
metastasis	2	3.3
ganglioglioma	1	1.7
gliosarcoma	1	1.7
ATRT	2	3.3
PXA	2	3.3
sPENT	2	3.3
Lost	3	5
total	60	100

GBM=glioblastoma multiforme, ATRT=atypical teratoid rhabdoid tumor, PXA=pleomorphic xanthoastrocytoma, sPENT=supratentorial primitive neuroectodermal tumor, lost= those patients who we cannot reach to their histopathological exam.

Table 3: WHO grade of tumors.

WHO grade	Frequency	Percent (%)
I	19	31.7
II	6	10
III	3	5
IV	27	45

*The remaining 5 patients of 60 (8.3%) patients included 2 metastasis and 3 cannot reached to their histopathological exam.

The left frontal lobe was the most common site for tumors, it was in 14 (23.3%) of patients in our study followed by 8 (13.3%) in right frontal, 7 (11.7%) in olfactory groove and 6 (10%) in right parietal etc. as in table (4).

Table 4: Site of tumors.

Site	Frequency	Percent (%)
Rt frontal	8	13.3
Lt frontal	14	23.3
Rt parietal	6	10
Lt parietal	3	5
Rt temporal	4	6.7
Lt temporal	7	11.7
Rt occipital	2	3.3
Lt occipital	2	3.3
Rt thalamic	2	3.3
Lt thalamic	1	1.7
Rt insula	0	0
Lt insula	1	1.7
Olfactory groove	7	11.7
Sphenoid wing	3	5
Total	60	100

Tumors are classified as 42 (70%) as intra-axial and 18 (30%) as extra-axial tumors; showed in table (5).

Table 5: Position of tumors.

Positions	Frequency	Percent (%)
Intra-axial	42	70
Extra-axial	18	30
total	60	100

Thirty- nine (65%) of patients show no any kind of complications, complications occur 21 (35%). four (6.7%) of patients had been developed intracranial hematoma and 2 of them required reoperation. Infection occurred in 5 (8.3%) patients. Death occurred in 5 (8.3%) of patients, others complications include seizure in 5 (8.3%), deterioration of consciousness (DLC) in 3 (5%), dysphasia in 1 (1.7%), fascial palsy in 1 (1.7%), chest infection in 1 (1.7%). The frequency of each complication is reported in table (6).

Table 6: The frequency of complications.

Complications	Frequency	Percent (%)
Intracranial hematoma	4	6.7
infection	5	8.3
death	5	8.3
seizure	5	8.3
DLC	3	5
dysphasia	1	1.7
Fascial palsy	1	1.7
Chest infection	1	1.7

* Total percentage exceeds 100% because a subject may have more than one complication.

The result of association of the main complications involved in our study (hematoma, infection, death) include significant association of hematoma and site of tumors (P value 0.015). no significant association of hematoma with age, gender, position of tumors (intra-axial or extra-axial), WHO classification, chronic disease (HT, DM, other cancer) and whether primary or recurrent surgery, that showed in table (7).

Table 7: Factors association with hematoma.

Variables				Intracranial hematoma				P value
				present		Absent		
				No.	%	No.	%	
Age/ years	< 20			1	1.7	10	16.7	0.380
	20-40			2	3.3	13	21.7	
	> 40			1	1.7	33	55	
Gender	Male			1	1.7	20	33.3	0.664
	Female			3	5	36	60	
Position of tumors	Intra-axial			3	5	39	65	0.821
	Extra-axial			1	1.7	17	28.3	
WHO classification	I			1	1.7	18	30	0.707
	II			0	0	6	10	
	III			0	0	3	5	
	IV			2	3.3	25	41.7	
	No WHO grade			1	1.7	4	6.7	
Site of tumor	Rt frontal	8	13.3	0	0	8	13.3	0.015
	Lt frontal	14	23.3	1	1.7	14	23.3	
	Rt parietal	6	10	0	0	6	10	
	Lt parietal	3	5	0	0	3	5	
	Rt temporal	4	6.7	1	1.7	4	6.7	
	Lt temporal	7	11.7	0	0	7	11.7	
	Rt occipital	2	3.3	0	0	2	3.3	
	Lt occipital	2	3.3	0	0	2	3.3	
	Rt thalamic	2	3.3	1	1.7	2	3.3	
	Lt thalamic	1	1.7	1	1.7	1	1.7	
	Rt insula	0	0	0	0	0	0	
	Lt insula	1	1.7	0	0	1	1.7	
	Olfactory Groove	7	11.7	0	0	7	11.7	
	Sphenoid Wing	3	5	0	0	3	5	
Chronic disease	No chronic disease			4	6.7	47	78.3	0.685
	HT/DM			0	0	5	8.3	
	Cancer			0	0	4	6.7	
Primary or recurrent surgery	Primary			4	6.7	45	75	0.327
	Recurrent			0	0	11	18.3	

There are no significant associations of postoperative infections with age, gender, position of tumors (intra-axial or extra-axial), WHO classification, site of tumors, chronic disease (HT, DM, other cancer) and whether primary or recurrent surgery, as showed in table (8).

Table 8: Factors association with postoperative infections.

Variables				Intracranial Hematoma				P value
				present		Absent		
				No.	%	No.	%	
Age/ years	< 20			2	3.3	9	15	0.423
	20-40			1	1.7	14	23.3	
	> 40			2	3.3	32	53.3	
Gender	Male			2	3.3	19	31.7	0.807
	Female			3	5	36	60	
Position of tumors	Intra-axial			4	6.7	38	63.3	0.610
	Extra-axial			1	1.7	17	28.3	
WHO classification	I			1	1.7	18	30	0.696
	II			0	0	6	10	
	III			0	0	3	5	
	IV			3	5	24	40	
	No WHO grade			1	1.7	4	6.7	
Site of tumor	Rt frontal	8	13.3	2	3.3	8	13.3	0.577
	Lt frontal	14	23.3	1	1.7	14	23.3	
	Rt parietal	6	10	0	0	6	10	
	Lt parietal	3	5	0	0	3	5	
	Rt temporal	4	6.7	0	0	4	6.7	
	Lt temporal	7	11.7	0	0	7	11.7	
	Rt occipital	2	3.3	0	0	2	3.3	
	Lt occipital	2	3.3	0	0	2	3.3	
	Rt thalamic	2	3.3	1	1.7	2	3.3	
	Lt thalamic	1	1.7	0	0	1	1.7	
	Rt insula	0	0	0	0	0	0	
	Lt insula	1	1.7	0	0	1	1.7	
	Olfactory Groove	7	11.7	1	1.7	7	11.7	
	Sphenoid Wing	3	5	0	0	3	5	
Chronic disease	No chronic disease			4	6.7	47	78.3	0.530
	HT/DM			1	1.7	4	6.7	
	Cancer			0	0	4	6.7	
Primary or recurrent surgery	Primary			5	8.3	44	73.3	0.268
	Recurrent			0	0	11	18.3	

There is significant association between postoperative death in postoperative 30 days and age of patients (P value= 0.039) with death more

common among age group less than 20 years, also there is significant association between death and WHO classification and site of tumor (P value=0.001, 0.018 respectively). No significant association between death and gender, position of tumors (intra-axial or extra-axial), chronic disease (HT, DM, other cancer) and whether primary or recurrent surgery, as showed in table (9).

Table 9: Factors association with postoperative death.

Variables				Intracranial Hematoma				P value
				Present		Absent		
				No.	%	No.	%	
Age/ years	< 20			3	5	8	13.3	0.039
	20-40			1	1.7	14	23.3	
	> 40			1	1.7	33	55	
Gender	Male			2	3.3	19	31.7	0.807
	Female			3	5	36	60	
Position of tumors	Intra-axial			4	6.7	38	63.3	0.610
	Extra-axial			1	1.7	17	28.3	
WHO classification	I			1	1.7	18	30	0.001
	II			0	0	6	10	
	III			0	0	3	5	
	IV			1	1.7	26	43.3	
	No WHO grade			3	5	2	3.3	
Site of tumor	Rt frontal	8	13.3	0	0	8	13.3	0.018
	Lt frontal	14	23.3	2	3.3	14	23.3	
	Rt parietal	6	10	0	0	6	10	
	Lt parietal	3	5	0	0	3	5	
	Rt temporal	4	6.7	0	0	4	6.7	
	Lt temporal	7	11.7	0	0	7	11.7	
	Rt occipital	2	3.3	0	0	2	3.3	
	Lt occipital	2	3.3	1	1.7	2	3.3	
	Rt thalamic	2	3.3	1	1.7	2	3.3	
	Lt thalamic	1	1.7	1	1.7	1	1.7	
	Rt insula	0	0	0	0	0	0	
	Lt insula	1	1.7	0	0	1	1.7	
	Olfactory Groove	7	11.7	0	0	7	11.7	
	Sphenoid Wing	3	5	0	0	3	5	
Chronic disease	No chronic disease			5	8.3	46	76.7	0.618
	HT/DM			0	0	5	8.3	
	Cancer			0	0	4	6.7	
Primary or recurrent surgery	Primary			5	8.3	44	73.3	0.268
	Recurrent			0	0	11	18.3	

Most of hematoma's complication were occurred in intensive care unit (ICU) 3 (5%) and 1 (1.7%) was occurred in the neurosurgical ward. Infections were occurred mostly after home discharge about 3 (5%) of patients, 1 (1.7%) in ward and 1 (1.7%) in the ICU. Death mostly 4 (6.7%) of 5 patients was occurred in ICU, with 3 of them were children, who did not awake from anesthesia and die in the next few hours and one die from renal impermeant, and 1 (1.7%) was in the ward with sudden onset of death. The time of occurrence of complications whether in ICU or neurosurgical ward or after discharge to home is show in table (10).

Table 9: Time of occurrence of complications.

Complication	ICU		Neurosurgical ward		After home discharge		Total	
	No.	%	No.	%	No.	%	No.	%
Hematoma	3	5	1	1.7	0	0	4	6.7
Infection	1	1.7	1	1.7	3	5	5	8.3
Death	4	6.7	1	1.7	0	0	5	8.3

Discussion

In this is prospective cohort study carried out during two years period from Jan, 2019-Jan, 2021 in Basrah neurosurgery center in Al-Sader teaching hospital. Randomly selected 60 patients undergo elective craniotomy for supratentorial intracranial tumors had been studied and followed up for 30 days to observe the postoperative complications.

Complications occurred in 21 (35%) of patients in our study. Lonjaret et al. [6] in his prospective observational analytic study had showed that 45%of patients had at least one complication during the first 24 hours following surgery, but his study done for patients aged more than 18 years old and included emergency operations, with observation only for 24hrs for all types of

brain tumors, in comparison to our study. An analysis of a large database from the American College of Surgeons included over 38,000 neurosurgical cases from hundreds, which showed complications occurred in 23.6% of cranial procedures. [7]

In our study, postoperative hematoma occurred in 4 (6.7%) of patient and there were no significant association of hematoma with the age, gender of patients, position of tumors (intra-axial or extra-axial), WHO classification, chronic disease (HT, DM, other cancer) and whether primary or recurrent surgery. Seifman et al. [8] by reviewing literatures in their research that the rates of postoperative hematoma following intracranial procedures reported in the literature vary greatly, ranging from 0.8% to 50.0%, there were no published evidence linking gender and risk of hematoma, the results for age were variable, showing either no significant age difference or an increased risk with ageing. Certain tumors, intraoperative hypertension, hypertension and DM show increased risk. In our study, the reason beyond that hypertension not a risk factor for postoperative hematoma; may be that our study included elective surgery with control HT.We found that most hematoma complications occurred in ICU about 3 cases of 4 patients who developed hematoma and this agrees with Basali et al. [9] who found that the medium time of postoperative intracranial hemorrhage was first 21hr.

There is significant association of hematoma and postoperative death with the site of tumors in our study. This disagrees with Rhondali et al. [10], who were found no association of the location of the brain lesion with the occurrence of postoperative complications. Ziai et al. [11] found in their retrospective study of 158 patients after brain tumor resection, that the risk of a prolonged stay in ICU for more than 24 hours was found to relate to tumor location and its mass effect so that it agree with our study, that the site of tumor can predict subsequent complications and prolong ICU care.

In our study, there is no difference in occurrence of hematoma, infection and death whether the patients had the first craniotomy or recurrent brain lesion surgery and this look similar to the results of Chang et al. [12] in their retrospective study (Perioperative complications and neurological outcomes of first and second craniotomies among patients enrolled in the Glioma Outcome Project), that the rates of wound infection, seizures, thromboembolic disease, hemorrhage and length of hospital stay were similar among patients in both groups, but systemic infection and depression occurred more frequently in those with the second craniotomies group and neurological outcome was worse for patients got the second craniotomy.

Postoperative infections occurred in 5 (8.3%) in our study whether other studies as Dashti et al. [13] showed 50 (0.5%) patients reoperate for infections postoperatively out of 16,540 patients for both elective and emergency procedures. McClelland and Hall [14] reported their experience with postoperative central nervous system infection after 1587 elective cranial operations with excluding 4 cases of meningitis, the reported a postoperative in 5 (1.1%) patients out of 448 craniotomy for brain mass , which is not in line with our findings. Nonetheless, there are several differences between the studies that make direct comparison difficult. The series by McClelland and Hall was a single-surgeon series, and all cases were elective, Dashti included all intracranial procedures, our study was multiple surgeons and includes all types of infection even simple wound infections that not required reoperation. An overall infection rate of

8% is identified by O' Keeffe et al. [15] of total 245 craniotomies.

There is no significant association between postoperative infections and chronic disease in our study and this agree with Hardy et al. [16] that found glucose level was not a significant factor in postoperative surgical site infection (P value 0.83) after adjusting for duration of surgery and adherence to antibiotic prophylaxis, and also no significant association with HT and other cancer, also this study agree with us that age not a significant associated factor postcraniotomy for brain tumors. There is no difference in occurrence of infection whether the patients had the first craniotomy or recurrent brain surgery and this look similar to the results of Chang et al. [12]. Korinek et al. [17] observed an increased risk of nosocomial meningitis after craniotomy in males, where our study shows on significant gender association. According to my knowledge no previous study shows the relation of WHO classification or site of tumor with infection.

Most of postoperative infection occurred after home discharge in our study to agree with Bunag et al. [18] that included a total of 30 post craniotomy surgical site infections (SSI) identified among 390 cases included in the study, resulting in an overall infection rate of 7.7% and the mean time between surgery and the onset of infection was 11.8 +/- 21.8 days (median 10 days) but in there study all craniotomies were involved.

Postoperative death during 30 days (i.e., postoperative mortality) was 5 (8.5%) in our study, in other study included total of 2630 consecutive craniotomies at the Oslo University Hospital from 2003 to 2008, mortality was 2.3%. [19]

There is significant association between postoperative death and age of patients (P value 0.039) with death more common among age group less than 20 years, 3 of the 5 death were children within 2 years old who not awake from surgery and transfer to ICU without extubating but in the other study, age more than 60 years were shown to be significantly associated with increased surgical mortality [19], this difference may be because our study was included younger age group include children. Whether, Lassen et al. [20] in his study on pediatric shown mortality of only 0.4% with complication rates after craniotomy for pediatric brain tumors compare favorably with similar data from adult series. There were significant associations between death and WHO classification and site of tumor (P value 0.001, 0.018 respectively), no significant association between death and gender, position of tumors (intra-axial or extra-axial), chronic disease (HT, DM, other cancer) and whether primary or recurrent surgery in our study. In the comparable study above, Lassen et al. [19] were shown that meningioma's compared with high grade glioma were associated with a lower surgical mortality (P value 0.05), no significant association with gender, primary or recurrent surgery. Most of death occurred in ICU in patients not awake from anesthesia and transferred intubated to it. No previous study shows the median time of postoperative death according to my knowledge and as each tumor has its own survival.

Conclusion

Morbidity and mortality following elective craniotomy does not appear to depend on tumor histology, revision surgery or primary surgery, presence or absence of chronic illness but does depend on tumor location and age of patients.

Morbidity rate was 35% and mortality rate was 8.5%; so elective craniotomy for supratentorial tumors carries high complications rate with

postoperative hematoma and death are the most seriously encountered complications.

Our study shows that most serious complications occurred in the first 24hrs and death occurred in the patients who were not recovered from anesthesia therefore, surgical judgements, technical skills and proper anesthesia play important roles in minimizing these complications.

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