Clinicopathological Patterns and Surgical Outcomes of Primary Brain Tumors Managed at a Tertiary Hospital in Arusha, Tanzania:a Cross-sectional Analysis.

Faraja M. Magwesela (fm3magwesela@gmail.com)
Arusha Lutheran Medical Center
Doreen Msemakweli
Kilimanjaro Christian Medical Center
Happiness Rabiel
Arusha Lutheran Medical Center

Article

Keywords: Brain tumor, surgical outcomes, survival, neurosurgery, Tanzania

Posted Date: April 8th, 2022

DOI: https://doi.org/10.21203/rs.3.rs-1515499/v1

Abstract

Purpose: The epidemiology of brain tumors varies globally between different countries and there is observed poor outcomes in lower- and middle-income countries. Our aim is to analyze the clinicopathological pattern of intracranial tumors in our setting and their post-surgical outcomes.

Methods: This is a retrospective study. Data was obtained from clinical records of patients with intracranial tumors treated at our neurosurgery unit between 2019 and 2020. Only patients with primary brain tumors who underwent surgical intervention were included. Analysis was done to identify factors associated with patient outcomes (mortality/survival and performance status).

Results: 39 patients with primary brain tumors underwent surgery (adults 72.8%, males 53.8%, mean age 35.8years). Gliomas (46.2%) comprised the most common tumor diagnosis overall and craniopharyngiomas were the most common tumors in pediatric patients (27.3%). Most patients (83.3%) had a poor performance status before surgery. Gross tumor resection (25.6%) was low and few patients (31.4%) underwent adjuvant therapy. 30-day mortality rate (10.3%) and one year mortality rate (46.2%) were high. Pediatric patients had a much worse outcome (46.2% mortality rate compared to 25% in adults, and 80% with poor performance status) as did males (38.1% mortality rate compared to 27.8% in females). Gliomas accounted for majority (69.2%) of the deaths.

Conclusion: Delayed presentation and poor access to adjuvant therapies are important contributors of the high mortality and abandonment of treatment. Inadequate long-term follow-up is a hinderance to optimal neurooncological care in our setting.

Background

Cancer is an increasing global health problem and is emerging as a significant public health threat in low- and middle-income countries (LMICs)[1]. Cancer is a leading cause of death globally and about 64–70% of cancer related deaths occur in LMICs[1, 2]. In 2020, central nervous system tumors contributed to 1.6% of all cancer diagnoses and 2.5% of all cancer related deaths[3]. The epidemiology of brain tumors varies globally between different countries, with an increased incidence in high income countries (HICs) as compared to LMICs[2]. Also, the epidemiology of brain tumors differs by age and gender as has been shown in the increased occurrence of meningiomas in females than in males and the occurrence of craniopharyngiomas and medulloblastomas in children more than in adults[4, 5].

Complete tumor resection has been shown as the most important modality of treatment for various brain tumor types with some other subtypes necessitating adjuvant therapy[6]. Goals of cancer treatment are to decrease recurrence rate, increase progression free survival and overall survival[6]. Despite advances in cancer treatment, primary brain tumors are associated with poor outcomes in terms of survival and functionality as a result of the tumor itself or the treatment received[7].

Data on brain tumors in Tanzania is limited. This study is a retrospective review of patients with primary brain tumors who underwent surgical intervention at Arusha Lutheran Medical Center in Arusha, Tanzania from 2019 to 2020. We describe the distribution of brain tumors by demographics, location, clinical presentation, histological diagnosis, surgical treatment and outcomes after treatment.

Methods

A retrospective database of 39 patients with primary brain tumors treated at ALMC between 2019 and 2020 was used to collect inpatient data. Records search was done from the neurosurgery department admissions and theatre log, followed by retrieval of patient's clinical data. The database included patient demographics, presenting complaints, tumor location, surgical intervention, tumor histological diagnosis, preoperative and postoperative Karnofsky performance status (KPS), post-surgery complications and patient/relative phone numbers. We excluded patients with primary brain tumors who did not undergo surgery and those with secondary brain tumors. Also, patients with missing data preventing analysis were removed (histopathological diagnosis, type of surgery undertaken).

Convenience sampling technique was employed to obtain sample. Using the Fisher formula for sample size calculation, the estimated sample size was 40 based on prevalence taken from a study done by Miranda-Fihlo et al.,[8]. From the eligibility criteria, we included 39 patients for analysis, we excluded 6 patients for a variety of reasons (see Fig. 1).

The diagnosis of the brain tumor was confirmed in all patients with magnetic resonance imaging and tissue biopsy. The tumors were classified based on the World Health Organization (WHO) classification of 2016[9]. Patients with KPS score of 70 and above were labelled as independent and those with score of less than 70 as dependent. The extent of surgery was determined by the surgeon's intraoperative judgement. Postoperative KPS scores were calculated during patient discharge.

Postoperative clinic visits were scheduled at one-week after hospital discharge, then at one month, 3 months, at 6 months and at one year. Patients who failed to come for visits were contacted via phone interviews and those who failed to come for clinic visits and also could not be contacted by phone at the end of one year were labelled as lost to follow-up.

Potential sources of bias in this study include; selection bias and information bias. Selection bias could not be avoided due to the sampling method. Primary brain tumor is not a common diagnosis, therefore to ensure that we have a good sample size, convenience sampling method was used which is a potential source of selection bias. Information bias was managed by ensuring complete patient records were retrieved in the selected cases and also where information was lacking, phone calls were made to the patients and/or relatives to obtain the missing information.

SPSS version 25 (IBM, Armonk, NY) was used for data analysis. Descriptive statistics were used to asses demographics, quality of life measures and mortality. Chi square tests were used to compare the different patient and tumor characteristics and outcomes. P values less than 0.05 were considered as significant.

Kaplan Meier curves were drawn to estimate median survival with censoring of patients lost to follow-up and those still alive at follow-up.

This study was reviewed by the Arusha Lutheran Medical Center Ethics Committee and waived ethical approval and patient informed consent to participate due to retrospective nature of this study and the anonymization of the data. All methods used in this study were performed in accordance with the Declaration of Helsinki guidelines.

Results

During the study period 45 patients were admitted in the neurosurgical department with brain tumors. We excluded 1 patient with secondary brain tumor, 1 patient with no histopathological diagnosis and type of surgery undertaken, and we also excluded 4 patients who did not undergo surgical intervention (they were referred to another center) (see figure 1).

39 patients with primary brain tumors (PBTs) underwent surgery between 2019 and 2020. We determined the distribution of PBTs as shown in tables 1 and 2. Tumors predominantly originated from the frontal lobe (30.8%) and most were of neuroepithelial origin (59%). No difference was found in occurrence between the right and left-brain hemispheres.

Table 1

Patient characteristics

Clinicopathological parameter		Frequency, n (%)	Clinicopathological parameter		Frequency, n (%)
Gender	Male	21 (53.8)	Adjuvant treatment	Yes	11 (31.4)
	Female	18 (46.2)		No	14 (28.6)
Residency	Urban	24 (61.5)		Unknown	3 (8.6)
	Rural	15 (38.5)		Not required	11 (31.4)
Tumor location	Parietal lobe	3 (7.7)	Pre-op KPS	<70	30 (83.3)
	Frontal lobe	12 (30.8)		>70	6 (16.7)
	Temporal lobe	5 (12.8)	Post-op KPS	<70	23 (60.5)
	Brainstem	2 (5.1)		>70	15 (39.5)
	Cerebellum	2 (5.1)	1 year mortality	Yes	13 (33.3)
	Ventricle	5 (12.8)		No	21 (53.8)
	Sphenoid	5 (12.8)		Unknown	5 (12.8)
	Sellar turcica	2 (5.1)	Surgical extent	GTR	10 (25.6)
	Other	3 (7.8)		STR	26 (66.7)
				CSF diversion	3 (7.7)

Adjuvant treatment include radiotherapy and chemotherapy. ‘Not required’ under adjuvant treatment means the patient’s tumor histology did not require chemotherapy and/or radiotherapy. Those labeled ‘Unknown’ under adjuvant treatment means they were lost to followup after surgical therapy though they were supposed to undergo some form of adjuvant therapy. KPS – Karnofsky performance status; GTR – gross tumor resection; STR subtotal tumor resection; CSF – cerebrospinal fluid.

Table 2

Histological diagnosis by gender and age group

	Gender (%)		Age in years (%)				
WHO Class	Male	Female	0-17	18-39	40-59	60-79	Total (%)
Neuroepithelial tumors	16 (59.6)	7 (30.4)	6 (26.1)	7 (30.4)	3 (13)	7 (30.4)	23 (59)
Medulloblastoma	2	0	2	0	0	0	2
Glioblastoma	7	4	2	1	2	6	11
Glioma	1	1	2	0	0	0	2
Diffuse astrocytoma	3	2	0	3	1	1	5
Anaplastic astrocytoma	1	0	0	1	0	0	1
Pilocytic astrocytoma	1	0	0	1	0	0	1
Pineal tumor	1	0	0	1	0	0	1
Craniopharyngioma	0	3	3	0	0	0	3 (7.7)
Meningioma	2 (20)	8 (80)	1 (10)	2 (20)	5 (50)	2 (20)	10 (25.6)
Lymphomas	1	0	0	1	0	0	1 (2.56)
Hypervascular schwannoma	1	0	0	1	0	0	1 (2.56)
Hemangioblastoma	1	0	1	0	0	0	1 (2.56)
Total	21 (53.8)	18 (46.2)	11 (28.2)	11 (28.2)	8 (20.5)	9 (23.1)	39

WHO – World Health Organization.

Glioblastoma was the most commonly diagnosed tumor subtype (28.2%), followed by meningioma (25.6%). However, among females, meningioma was the most common tumor subtype (44.4%) followed by glioblastoma (22.2%). Among males, glioblastoma was the most common tumor subtype (33.3%), followed by diffuse astrocytoma (14.3%).

Neuroepithelial tumors were more common in adults than in children (73.9% vs 26.1%, respectively), whereas craniopharyngiomas occurred exclusively in pediatrics. Meningiomas were also seen mostly in adults than in pediatrics (90% vs 10%, respectively). The most common meningioma seen was meningotheliomatous meningioma (60%).

Presentation and Outcomes

Three patients had no KPS recorded pre-operatively. Headache and focal neurological deficits were the most common presenting symptoms (56.4% and 51.3% respectively), others being; gait disturbances (17.9%), visual disturbances (17.9%), convulsions (12.8%), vomiting (10.3%) and altered level of consciousness (10.3%). Most patients (83.3%) had a preoperative KPS score of less than 70.

Postoperatively, complications included; focal neurological deficit (n=9, 23.1%), new onset convulsions (n=2, 5.1%), pseudo-meningocele (n=2, 5.1%), pneumocephalus (n=1, 2.6%), difficulty in breathing (n=1, 2.6%) and persistent vomiting (n=1, 2.6%). Postoperatively, 60.5% of the patients had a KPS score of less than 70.

5 patients (12.8%) were lost after initial surgical management, 33.3% (13 patients) had died by 1 year post op and 53.8% (21 patients) were still alive one year after the initial surgery for tumor resection. Of the 13 patients that had died, 4 died within the first 30 days post-surgical intervention, 4 patients died between 2- and 6-months post-surgery and 5 died more than 6 months post-surgery.

Patient age, gender, tumor histology, preoperative KPS score, residency, reception of adjuvant treatment and type of surgery done, were analyzed for survival/mortality prediction. Those that were found to be statistically significant (p-value <0.05) were; type of surgery done (p-value 0.005) and receiving adjuvant treatment (p value 0.007) (see table 3).

Rates by age

Among adults (18years of age and above), 11 (39.3%) were 18-39years of age, 8 (28.6%) being 40-59years and 9 (32.1%) were 60-79years. Pediatric patients ranged from 2years to 17years.

All children seen had a pre-operative KPS score of < 70, while among adults, 83.3% had a pre-operative KPS score of <70 (mostly in those 60-79years of age, 88.9%). Poor post-surgery KPS score (< 70) was also highest in the pediatric population (80% of pediatrics) and those aged 60-79years of age (55.6% of adults).

Overall, mortality rates were slightly higher in adults compared to pediatric population (7 of 13 deaths occurred in adults - 53.8%). Among adults, mortality rates were highest in those 40-59 years of age (42.9% mortality by age group; 42.9% of all adult mortality), followed closely by those aged 60-79 years of age (37.5% mortality by age group; 42.9% of all adult mortality). Those aged 18-39 years of age had the lowest mortality overall (11.1% per age group; 14.2% of all adult mortality).

Survival rates (at one-year post-operatively) were lowest in the pediatric population (40% survival rates by age group; 19% overall), compared to adults (70.8% overall). Those aged 18-39 years of age, had the best survival rates (38.1% overall; 80% by age group).

Rates by sex

Of the PBTs diagnosed, males accounted for 21 cases (53.8%) and females 18 cases (46.2%). Rates of tumor diagnoses was higher among males for all tumor subtypes except for meningioma and craniopharyngioma that showed female predominance (table 2).

Being female was associated with poor KPS score both pre-operatively (88.2% vs 78.9% in males) and post-operatively (70.6% vs 52.4% in males). Mortality was however highest among males (61.5% overall; 47.1% mortality rate by gender) than in females (38.5% overall; 29.4% mortality rate by gender). Overall survival rates at one year were higher in females (57.1%) as compared to males (42.9%) (table 3).

Table 3

Factors associated with mortality/survival after PBTs intervention.

Patient Characteristics	Study sample (N=39), n(%)	Survived (n=21, 53.8%), n (%)	Mortality (n=13, 33.3%), n (%)	P value
Age				
0-17	11 (28.2)	4	6	0.191
19-39	11 (28.2)	8	1	
40-59	8 (20.5)	4	3	
60-79	9 (23.1)	5	3	
Gender				
Male	21	9	8	0.33
Female	18	12	5	
Histology				
Neuroepithelial tumor	20	8	9	0.19
Meningioma	10	8	2	
Others	9	5	2	
Pre-op KPS				
>70	6	4	1	0.474
<70	30	17	9	
Residence				
Rural	15	7	5	0.926
Urban	24	14	8	
Adjuvant treatment				
Yes	11	6	5	0.007
No	14	3	7	
Type of resection				
GTR	10	6	2	0.005
STR	26	15	9	
Diversion	3	0	3	

KPS – Karnofsky performance status; GTR – gross tumor resection; STR subtotal tumor resection; CSF – cerebrospinal fluid.

Rates by geographic distribution

Most of our patients came from an urban setting (61.5%). 13 out of 14 patients from a rural setting presented with a poor KPS score (92.8%), this is different as compared to those from an urban setting whereby 77.2% (17 out of 22) presented with a poor KPS score. There was no difference noted in those who received adjuvant treatment between rural and urban residents. There was also no difference observed among those who were lost to follow-up between rural and urban residents. No difference was found in post-operative mortality between those from rural or urban setting.

Treatment

10 of our patients (25.6%) underwent gross tumor resection, 26 (66.7%) underwent subtotal tumor resection, and 3 (7.7%) underwent diversion procedures alone. A total of 7 patients underwent CSF diversion procedures as either VPS (5 patients) or ETV (2 patients). Four of the six patients who underwent diversion procedures subsequently underwent tumor resection.

Adjuvant treatment as chemotherapy and/or radiotherapy was required in 71.8% (28) of the patients. However, 13 patients (33.3%) refused further treatment after surgery, 4 (10.3%) patients died before or shortly after starting adjuvant treatment. Only 11 patients (28.2%) of the 28 that required adjuvant therapy underwent adjuvant treatment.

Those who underwent gross tumor resection (GTR) had better survival at one year (75% survival rates) compared to those who underwent subtotal tumor resection (62.5%). Those who underwent diversion procedures alone, had the worst outcome (100% mortality at one year). Similarly, those who underwent adjuvant treatment (as chemotherapy and/or radiotherapy) had the best survival rates (54.5% one-year survival rates) as compared to those who did not undergo adjuvant treatment (30% one-year survival rates).

Discussion

Our study reports for the first time the outcomes of patients with primary brain tumors (PBTs) who underwent surgical treatment and followed up for one year on average. Our facility is one of the few hospitals in Tanzania with a practicing neurosurgeon, who is serving the entire Northern Zone of Tanzania.

Presentation

Most of our patients (73.9%) were adults similar to other studies[2, 7, 10, 11]. The mean age in our study was 35.8years, corresponding to other Sub-Saharan studies[2, 5, 12]. Most of our cases occurred in a younger population, (56.4% in those less than 40years, 95% CI 28–43), different from other parts of the world[10, 13]. This variability illustrates the global variations of PBTs epidemiology. Further studies in our

setting need to be performed to determine factors that may account for the relatively younger age at presentation seen in our study.

The mean age of diagnosis for our pediatric cases was 8.9years, consistent with studies done in Nigeria (8.3-9years) and in Sudan (9years)[5, 14, 15]. Conversely, other studies show lower mean ages such as Kakusa et al., Ogun et al., and Suresh et al., whereby the reported mean ages among pediatric patients were; 7years, 7.2years and 4years respectively[8, 12, 16].

In our series there was an overall male predominance of 53.8%, which concurs with findings of other studies[2, 8, 17]. Conversely other studies have reported a higher rate of PBTs among females than males[4, 12, 18]. Some studies have shown no gender predominance[5]. These differing rates of PBTs occurrence by gender could be explained by the higher rates of meningiomas in some studies that preferentially affect women.

Congruent to other studies, we found that headache and focal neurological deficits were the most common presenting symptoms (56.4% and 51.3% respectively)[10, 12]. The common occurrence of headache in most studies for PBTs shows how common headache complaints can be mismanaged in primary care settings.

Tumor characteristics

Gliomas were the most common tumor subtype (46.2%) followed by meningioma (25.6%), correlating with studies done in Ghana, India, and United States of America[4, 12, 18]. Other studies have however documented a predominance of meningioma to gliomas[2, 5, 11, 17].

Occurrence of meningioma in our study was more common in females (80%) than in males similar to other studies[4, 6], although other published data have shown no significant gender preference for meningioma occurrence[5, 17]. Consistent with other studies, we found male predominance (65%) in patients diagnosed with gliomas and most cases (80%) occurred in adults[19, 20].

In this study, craniopharyngioma (27.3%) was the commonest tumor diagnosed in pediatrics followed equally by medulloblastoma, glioblastoma and gliomas (18.2% for each). Various studies in pediatrics have reported varying rates of occurrence of various tumor subtypes[5, 11–13, 16]. These differences have been hypothesized to be influenced by viral and bacterial infections, ionizing radiation and other environmental factors[2].

Intervention

Surgical services for brain tumors in our setting are a challenge. Firstly, the cost of surgical intervention is higher than most people can afford. Secondly, we lack advanced surgical technology for surgical removal tumors.

Gross tumor resection in our study was accomplished in 25.6%, subtotal resection in 66.7%. Compared to SSA, studies done in High-Income-Countries (HICs) have shown higher rates of tumor resection[2, 11, 18].

This low rate of surgical intervention for brain tumors in SSA is attributed to the fact that neurosurgery is one of the largely undeveloped surgical field in SSA with inadequate technological advancements restricting aggressive tumor surgery[22].

We observed low rates of adjuvant therapy in our patients; 31.4% underwent treatment, 28.6% refused treatment and 12.8% (5patients) were lost to follow-up after surgical treatment. Poor accessibility to neurooncological services in our region has been identified as an impediment to optimal care of brain tumors in developing countries including our country[23].

Outcomes

In our study, patients who were lost to follow-up were 5 out of 39 (12.8%). Inadequate long-term follow-up for survivors of brain tumor in developing countries is a limiting factor to optimal neurooncological care of patients in these regions[23].

Patients in our study overall showed an improvement in functional status as assessed by KPS score, from 16.7% having a preoperative KPS score of > 70, to 39.5% with a postoperative KPS score of > 70. This illustrates that tumor resection can improve quality of life as has been shown in other studies[12]. We observed poor KPS scores both pre- and postoperatively in women, although males accounted for 61.5% of all mortality agreeing with the observed national data on cancer mortality[1]. We could not find valid reasons for this observation.

Improved postoperative KPS scores was seen in meningiomas (from 20% with preop KPS > 70 to 40% with postop KPS > 70) similar to other studies[6]. Patients with gliomas were more likely to have poor KPS scores preoperatively as has been shown in other studies[17].

30 day and one year mortality rates in our study were 10.3% and 46.2% respectively, higher compared with other studies done in similar settings[11]. This could be attributed by the low number of our patients receiving adjuvant therapy and most of them presenting with poor functional status due to delayed presentation to surgical care. We found that pediatric patients had the worst outcomes compared to adults as they contributed to most of the deaths (46.2%) followed equally by those aged 40-59years and 60-79years at 23.1% each, and also 80% of pediatric patients had a postoperative KPS score of < 70 compared to 53.6% in adults with a postoperative KPS score of < 70. Other studies have failed to show a difference in outcomes between adults and children[11].

Patients with gliomas in our series accounted for 69.2% of overall mortality compared to 15.4% for meningioma. The postoperative mortality for patients with meningioma in our series was 10% similar to a study done in Ethiopia, though much higher compared to a study done in Sweden[6, 24]. For gliomas, our 30day postoperative mortality rate was 15% almost similar to other studies done in SSA[17].

Pediatrics Treatment and Outcomes

Few of our pediatric patients (9.1%) underwent gross tumor resection, unlike in other studies that report higher rates of gross tumor resection[13, 16, 23]. Similarly, we also observed that few (36.4%) of our

pediatric patients underwent adjuvant therapy as compared to other studies[14, 16]. These low rates of adequate tumor therapy might have contributed to the low survival rates observed in our pediatric patients (36.4% in one year) when compared to others in similar settings[13, 23, 25]. Half of these deaths were of those with gliomas, and there was no difference in gender mortality rates. The poor outcomes seen in our study could be attributed to patient delay to tertiary care as indicated by the low preoperative KPS scores (81.8% had a preoperative KPS score of < 70). There was however a slight improvement of KPS score postoperative, from 20% with > 70 preoperative to 27.3% postoperative KPS > 70.

Limitations

The retrospective nature of our study is a hinderance to accurate medical records. Also, our study is a single institution study with a relatively small patient cohort which may have accounted for some measurement bias in this study. Short period of post-operative analysis (1year) is also a hinderance to the true measure of outcomes of patients with brain tumors.

Conclusions

We cannot make a conclusion on the overall epidemiology of primary brain tumors in Tanzania, further studies in other regions of Tanzania are required. However, delayed presentation and poor access to adjuvant therapies are important contributors of the high mortality and abandonment of treatment. Long-term follow-up is required in order to optimize neurooncological care.

Declarations

Funding;

We received no funding for this study.

Competing interests;

The authors declare that they have no competing interests. No financial aid was received for this study.

Authors' contributions

Conceptualization – Magwesela FM, Rabiel H, Msemakweli D.

Data curation – Magwesela FM, Rabiel H.

Formal Analysis – Magwesela FM, Msemakweli D.

Funding acquisition – Not applicable (no funding was acquired or sort)

Investigation – Magwesela FM, Rabiel H, Msemakweli D.

Methodology – Magwesela FM, Rabiel H.

Project administration – Magwesela FM, Rabiel H.

Resources – Magwesela FM, Rabiel H.

Software – Magwesela FM, Msemakweli D.

Supervision – Magwesela FM.

Validation – Magwesela FM, Rabiel H, Msemakweli D.

Visualization – Magwesela FM.

Writing – original draft – Magwesela FM, Msemakweli D.

Writing – review & editing – Magwesela FM, Rabiel H, Msemakweli D.

Data availability;

The datasets generated during the current study are available from the corresponding author on request.

Acknowledgements;

We thank the medical records at Arusha Lutheran Medical Center for their valuable support during acquisition of the records.

Ethics approval;

As this is an observational study, the ethics committee of Arusha Lutheran Medical Center, confirmed that no ethical approval is required.

Consent to publish;

We failed to obtain patient consent for publication due to the retrospective nature of this study. We however made sure to anonymize the findings to prevent identification of individuals and we also sought approval from the dataset owners (Arusha Lutheran Medical Center) who confirmed that no ethical approval was required.

References

1. Lyimo EP, Rumisha SF, Mremi IR, *et al.* Cancer mortality patterns in Tanzania: A retrospective hospital-based study, 2006-2015. *J Glob Oncol* 2020;**6**:224–32. doi:10.1200/JGO.19.00270
2. Hatef J, Adamson C, Obiga O, *et al.* Central nervous system tumor distribution at a tertiary referral center in Uganda. *World Neurosurg* 2014;**82**:258–65. doi:10.1016/j.wneu.2014.06.040
3. Sung H, Ferlay J, Siegel RL, *et al.* Global Cancer Statistics 2020: GLOBOCAN Estimates of Incidence and Mortality Worldwide for 36 Cancers in 185 Countries. *CA Cancer J Clin* 2021;**71**:209–49.

doi:10.3322/caac.21660

4. Ekpene U, Ametefe M, Akoto H, *et al.* Pattern of intracranial tumours in a tertiary hospital in Ghana. *Ghana Med J* 2018;**52**:79–83. doi:10.4314/gmj.v52i2.3
5. Jibrin P, Ibebuike K, Ado-Wanka AN. Histo-pathological pattern of intracranial tumours in the national hospital, Abuja. *Afr Health Sci* 2018;**18**:281–6. doi:10.4314/ahs.v18i2.12
6. Laeke T, Biluts H, Sahlu A. Clinical Outcome of Operated Intracranial Meningiomas: An Ethiopian Experience. *World Neurosurg* 2019;**128**:e81–6. doi:10.1016/j.wneu.2019.04.002
7. Jiang T, Tang GF, Lin Y, *et al.* Prevalence estimates for primary brain tumors in China: A multi-center cross-sectional study. *Chin Med J (Engl)* 2011;**124**:2578–83. doi:10.3760/cma.j.issn.0366-6999.2011.17.003
8. Miranda-Filho A, Piñeros M, Soerjomataram I, *et al.* Cancers of the brain and CNS: global patterns and trends in incidence. *Neuro Oncol* 2016;**19**:now166. doi:10.1093/neuonc/now166
9. Louis DN, Perry A, Reifenberger G, *et al.* The 2016 World Health Organization Classification of Tumors of the Central Nervous System: a summary. *Acta Neuropathol* 2016;**131**:803–20. doi:10.1007/s00401-016-1545-1
10. Piñeros M, Sierra MS, Izarzugaza MI, *et al.* Descriptive epidemiology of brain and central nervous system cancers in Central and South America. *Cancer Epidemiol* 2016;**44**:S141–9. doi:10.1016/j.canep.2016.04.007
11. Kakusa BW, Xu LW, Vaca SD, *et al.* Central Nervous System Tumors in Uganda: Outcomes of Surgical Treatment and Complications Assessed Through Telephone Survey. *World Neurosurg* 2019;**129**:e866–80. doi:10.1016/j.wneu.2019.06.060
12. Mondal S, Pradhan R, Pal S, *et al.* Clinicopathological pattern of brain tumors: A 3-year study in a tertiary care hospital in India. *Clin Cancer Investig J* 2016;**5**:437. doi:10.4103/2278-0513.197861
13. Ndubuisi C, Ohaegbulam S, Ejembi G. Paediatric brain tumours managed in Enugu, Southeast Nigeria: Review of one centre experience. *Niger Postgrad Med J* 2018;**25**:186. doi:10.4103/npmj.npmj_132_18
14. Elhassan MMA, Mohamedani AA, Osman HHM, *et al.* Patterns, treatments, and outcomes of pediatric central nervous system tumors in Sudan: a single institution experience. *Child's Nerv Syst* 2019;**35**:437–44. doi:10.1007/s00381-018-04032-9
15. Ogun GO, Adeleye AO, Babatunde TO, *et al.* Central nervous system tumours in children in Ibadan, Nigeria: A histopathologic study. *Pan Afr Med J* 2016;**24**:1–11. doi:10.11604/pamj.2016.24.34.9344
16. Suresh S, Srinivasan A, Scott J, *et al.* Profile and outcome of pediatric brain tumors – Experience from a tertiary care pediatric oncology unit in South India. *J Pediatr Neurosci* 2017;**12**:237. doi:10.4103/jpn.JPN_31_17
17. Ndubuisi CA, Ohaegbulam SC, Iroegbu LU, *et al.* Histologically Confirmed Intracranial Tumors Managed at Enugu, Nigeria. *J Neurosci Rural Pract* 2017;**08**:585–90. doi:10.4103/jnrp.jnrp_155_17

18. Darlix A, Zouaoui S, Rigau V, *et al.* Epidemiology for primary brain tumors: A nationwide population-based study. *J Neurooncol* 2017;**131**:525–46. doi:10.1007/s11060-016-2318-3
19. Graus F, Bruna J, Pardo J, *et al.* Patterns of care and outcome for patients with glioblastoma diagnosed during 2008-2010 in Spain. *Neuro Oncol* 2013;**15**:797–805. doi:10.1093/neuonc/not013
20. Liang J, Lv X, Lu C, *et al.* Prognostic factors of patients with Gliomas- A n analysis on 335 patients with Glioblastoma and other forms of Gliomas. *BMC Cancer* 2020;**20**:1–7. doi:10.1186/s12885-019-6511-6
21. TAMIMI AF, JUWEID M. Epidemiology and Outcome of Glioblastoma. *Glioblastoma* 2017;:143–53. doi:10.15586/codon.glioblastoma.2017.ch8
22. Coburger J, Leng LZ, Rubin DG, *et al.* Multi-Institutional Neurosurgical Training Initiative at a Tertiary Referral Center in Mwanza, Tanzania: Where We Are after 2 Years. *World Neurosurg* 2014;**82**:e1–8. doi:10.1016/j.wneu.2012.09.019
23. Uche EO, Shokunbi MT, Malomo AO, *et al.* Pediatric brain tumors in Nigeria: Clinical profile, management strategies, and outcome. *Child's Nerv Syst* 2013;**29**:1131–5. doi:10.1007/s00381-013-2105-9
24. Corell A, Thurin E, Skoglund T, *et al.* Neurosurgical treatment and outcome patterns of meningioma in Sweden: a nationwide registry-based study. *Acta Neurochir (Wien)* 2019;**161**:333–41. doi:10.1007/s00701-019-03799-3
25. Stagno V, Mugamba J, Ssenyonga P, *et al.* Presentation, pathology, and treatment outcome of brain tumors in 172 consecutive children at CURE Children's Hospital of Uganda. The predominance of the visible diagnosis and the uncertainties of epidemiology in sub-Saharan Africa. *Child's Nerv Syst* 2014;**30**:137–46. doi:10.1007/s00381-013-2297-z

Figures

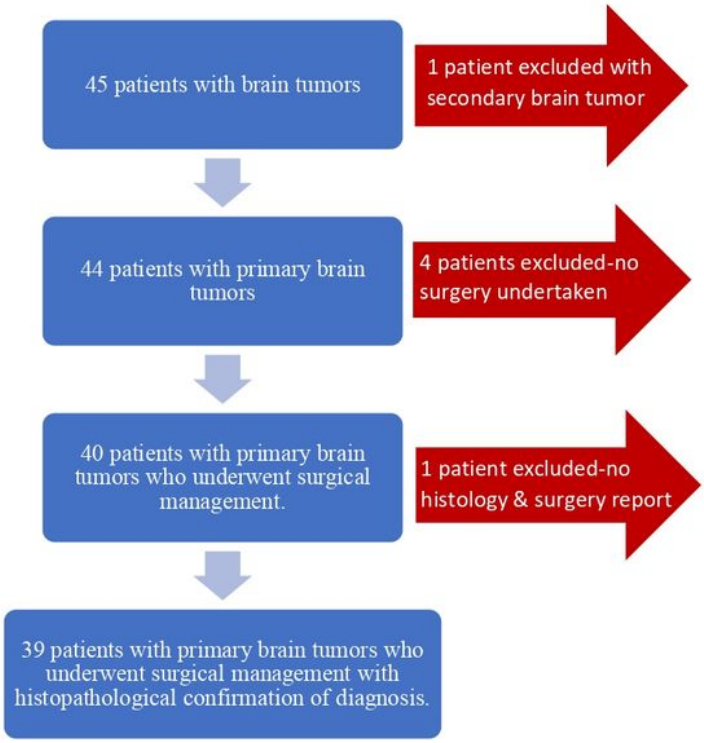

Figure 1. Flow diagram for inclusion of cases. 1 patient with metastatic brain tumor from breast cancer, 4 patients referred to another center before surgical intervention and 1 patient with no histology report and surgery report were excluded.

Figure 1

Please See image above for figure legend.