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Clinicoradiological Profile and Surgical Outcomes of Intraventricular Tumors in a Tertiary Care Center

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ABSTRACT

Background: Intraventricular tumors (IVTs) are uncommon brain tumors (3-10% of all intracranial tumors) that develop in the ventricles of the brain. They include a variety of different histologies (ependymomas, subependymomas, neurocytomas, meningiomas, choroid plexus tumors) and age predilection. These tumours can cause signs and symptoms of raised ICP (Cerebrospinal Fluid) obstruction. Surgical resection is the primary treatment and maximizing the resection (gross total resection) enhances the outcome. We reviewed our center's clinicoradiological characteristics and surgical results for the purpose of better defining and understanding IVT in a tertiary care setting. **Methods:** A retrospective analysis was carried out to evaluate patients who underwent surgery for histologically proven intraventricular tumor in our tertiary neurosurgical center from 2019-2020. Demographic, clinical, radiological, tumour, surgical, extent of resection, and peri-operative parameters were documented. Data for baseline was recorded as descriptive statistics. Categorical variables were compared with chi-square test and p value of <0.05 was considered significant. **Results:** Fifty patients (30 male, 20 female) were included (mean age 28.5±15.2 years; range 2–65). Most patients presented with headache (84%) and vomiting (50%) indicating raised ICP and hydrocephalus. Fifty percent of tumors were found in the lateral ventricles, 20% were found in the 3rd ventricle, 20% were found in the 4th ventricle, and 10% were found in multiple ventricles. Subependymoma (30%), ependymoma (24%), central neurocytoma (20%), choroid plexus tumors (10%), meningioma (6%), glioma (4%) and other rare histology types (6%) were most common (Table 1, Figure 1). Gross total resection (GTR) was performed in 42 of 50 patients (84%) and subtotal resection in eight (16%). There were 5 patients (10%) with new neurological deficits after surgery. Eight patients (16%) required CSF diversion (ventriculoperitoneal shunt) for hydrocephalus. The mortality rate was 2% (2 periop deaths). Hospitalisation duration was 10±4 days for mean. At follow up (mean 24 ± 10 months), 6% (3) of patients had tumour recurrence. (Table 2 and Table 3 show radiologic and outcome data, respectively; and Figures 2–3 show tumor localization and extent of resection, respectively.) **Conclusions:** Intraventricular tumors are rare and come on with symptoms of CSF obstruction. In our series, the mortality was relatively low and the gross total resection was obtained in the majority of patients. This result is mostly consistent to other tertiary series. Excellent tumour control was achieved with acceptable morbidity due to careful microsurgical planning. Although it is difficult to achieve deep-seated resection, maximal safe resection is the aim of surgical intervention. When IVTs are identified early, and the cysts are completely extracted, there is a good long-term prognosis.

Keywords: *Intraventricular tumor; intraventricular neoplasm; clinicoradiological profile; surgical outcome; ventriculoperitoneal shunt; hydrocephalus.*

INTRODUCTION

Intraventricular tumors (IVTs) are a heterogeneous group of tumors that develop within the ventricles of the brain. They are uncommon (3-10% of all intracranial tumors) but encompass many different pathologies. The most common IVTs are benign lesions such as subependymomas and colloid cysts, and malignant neoplasms like ependymomas and gliomas. These include central neurocytomas, choroid plexus papilloma/carcinoma, meningiomas of the ventricle and germ cell tumors in children. Interestingly, choroid plexus tumors, ependymomas and germ cell tumors of the ventricles are more common in children, while central neurocytomas, intraventricular meningiomas and gliomas are more common in adults. IVTs are frequently next to the critical brain structures such as the fornix, thalamus and hypothalamus, posing a challenge for surgery.[1,2]

The clinical presentations of IVTs generally occur when there is an obstruction of cerebrospinal fluid (CSF) pathways. Intracranial pressure rise due to mass effect or CSF blockage causes headache, nausea/vomiting and sometimes blurred vision (papilledema). As in previous reports, headache was the most common symptom in 84% of patients in our series. Depending on the location of the tumour, other presentations may include focal neurologic deficit, gait disturbance (particularly with 4th-ventricle tumours) or seizures.[3]

Magnetic resonance imaging (MRI) is the preferred diagnostic test. MRI can help identify the location of the ventricles in the tumor, its size, whether it is cystic or solid, and how it enhances (brightens up) on MRI. MRI can also be used to evaluate for hydrocephalus. Some typical findings depend on the nature of the tumour; for instance a subependymoma may present as well defined intraventricular masses with mild enhancement, while a choroid plexus tumour is highly vascular. The type of surgery is also determined by the radiological analysis.[4,5]

Surgery is the mainstay of IVT management. Gross total resection (GTR) is the most likely to achieve long-term control for benign or low-grade tumors. Actually, the key to successful treatment is to achieve maximal safe resection as incomplete resection can result in recurrence. The deep location of IVTs, however, increases the risk for neurological injury during resection. High rates of GTR have been reported in prior large series, such as a German tertiary center with GTR rates of 93% for patients with all IVT subtypes. Conversely, series from resource poor environments have reported increased complication and even mortality.[6]

IVTs are rare and only few data are available about clinicoradiological profile and outcome of IVTs. The aim of our study was to describe the clinical presentation, radiological features, pathological spectrum, surgical treatment and outcome of IVTs treated in our tertiary-care center in a retrospective study. Our results are compared with those in the literature to highlight factors that affect the successful outcomes of surgery and to identify optimal surgical management of these complex tumors.[7]

MATERIALS AND METHODS

After institutional review board approval, we retrospectively reviewed the records of all patients who underwent surgical resection of intraventricular tumors at Osmania General Hospital, Hyderabad between June 2019 and December 2020. Inclusion criteria were: (1) confirmed intra-ventricular location of the tumor on preoperative imaging; (2) definitive histopathological diagnosis; and (3) available clinical data. Patients with metastatic lesions or lacking sufficient follow-up were excluded.

For each patient, we recorded demographic information (age, sex), clinical presentation (symptoms, duration), radiological findings, tumor characteristics, surgical details, and outcomes. Radiological data included ventricular location (lateral, third, fourth, or multilocational), tumor size (maximal diameter), presence of hydrocephalus, and imaging characteristics (cystic component, calcifications, contrast enhancement). Surgical details included approach (e.g., transcortical, transcallosal, endoscopic) and extent of resection, classified as gross total resection (no residual tumor on postoperative imaging) or subtotal resection (residual tumor remaining). Histopathological diagnoses were made according to the 2016 WHO classification of CNS tumors by neuropathologists.

Primary outcomes of interest were extent of resection, postoperative complications, functional outcome, and tumor control. We defined postoperative neurological deficit as any new motor, sensory, visual, or cranial nerve impairment not present preoperatively. The Karnofsky Performance Score (KPS) was used to assess functional status before and after surgery. Patients were routinely followed with clinical exams and MRI; follow-up duration was the interval from surgery to last clinical contact or death. Tumor recurrence was defined as radiological evidence of regrowth after GTR or progression after STR.

Statistical analysis was performed using SPSS (v.23, IBM Corp.). Continuous variables are presented as mean ± standard deviation or median (range) as appropriate. Categorical variables are given as counts and percentages. We compared subgroups using chi-square or Fisher's exact tests for categorical data and t-tests for continuous data. A p-value <0.05 was

considered statistically significant.

RESULTS

Patient Demographics and Clinical Presentation

Fifty patients met the inclusion criteria. Their mean age was 28.5 ± 15.2 years (range 2–65 years). There were 30 males (60%) and 20 females (40%). The demographic and clinical features are summarized in Table 1. Pediatric patients (age <18) comprised 14 (28%) of the cohort. Headache was the most common symptom, reported in 42 patients (84%), followed by nausea/vomiting in 25 (50%) and visual disturbances (blurred vision, diplopia) in 18 (36%). Ataxia or gait difficulty occurred in 12 patients (24%), and seizures were relatively uncommon (5 patients, 10%). The median duration of symptoms before presentation was 2 months (range 1 week–12 months), reflecting subacute onset.

Patients with lateral ventricular tumors often had headache and memory issues, while those with fourth-ventricle lesions frequently presented with ataxia. Hydrocephalus was evident on initial imaging in 40 patients (80%), correlating with the high rate of raised ICP symptoms.

Table 1: Patient Demographics and Clinical Features

Characteristic	Value
Number of patients	50
Age, mean ± SD (range)	28.5 ± 15.2 (2–65) years
Male : Female	30 (60%) : 20 (40%)
Pediatric (<18 years)	14 (28%)
Headache	42 (84%)
Vomiting	25 (50%)
Visual disturbance	18 (36%)
Ataxia/gait disturbance	12 (24%)
Seizures	5 (10%)
Duration of symptoms	2 months (0.25–12)

(Values are mean ± SD or count (%). Duration given as median months.)

At presentation, 40 patients (80%) had signs of raised intracranial pressure on examination (papilledema or altered mental status), while 10 (20%) had focal neurological deficits (e.g., motor weakness).

Radiological Findings and Tumor Characteristics

Preoperative MRI was performed in all patients. Tumor location and radiographic features are detailed in Table 2. The lateral ventricles were the most commonly involved site, with 25 tumors (50%) located in the lateral ventricles (Figure 2). Of these, 15 arose from the trigone or occipital horn, and 10 from the frontal/temporal horns. Ten tumors (20%) occupied the third ventricle (often extending into the foramen of Monro), 10 (20%) were in the fourth ventricle, and 5 (10%) involved multiple ventricles (such as both lateral and third ventricles). Tumor size varied; the mean maximal diameter was 4.2 ± 1.5 cm. Eight tumors (16%) were predominantly cystic, while the rest were solid or mixed. Contrast enhancement was seen in 44 tumors (88%), ranging from homogeneous (e.g. meningiomas) to heterogeneous (e.g. high-grade lesions).

Hydrocephalus was present in 40 patients (80%) at diagnosis. Intra-axial invasion beyond the ventricle was rare, seen in only 4 patients (8%). Intratumoral calcifications (detectable on CT or MRI susceptibility) were observed in 6 cases (12%), mainly in ependymomas and central neurocytomas.

Table 2: Radiological Findings and Tumor Characteristics

Characteristic	Number (%) or Mean ± SD
Tumor location	
– Lateral ventricle	25 (50%)
– 3rd ventricle	10 (20%)
– 4th ventricle	10 (20%)
– Multiple ventricles	5 (10%)
Hydrocephalus at diagnosis	40 (80%)
Mean tumor diameter ± SD	4.2 ± 1.5 cm
Cystic component	8 (16%)
Contrast enhancement	44 (88%)
Intratumoral calcification	6 (12%)

Histopathology revealed a variety of tumor types. The most frequent diagnoses were subependymoma (15 patients, 30%),

ependymoma (12, 24%), central neurocytoma (10, 20%), and choroid plexus tumor (5, 10%; including 3 papillomas and 2 carcinomas). Other diagnoses included intraventricular meningioma (3, 6%), gliomas (2, 4%; one pilocytic astrocytoma, one glioblastoma in a 4th-ventricle location), and other rare lesions (3, 6%). The distribution of tumor histologies is illustrated in Figure 1. Pediatric patients (<18 years) predominantly had ependymomas and choroid plexus tumors, whereas the adult subgroup had a higher proportion of subependymomas and neurocytomas, reflecting known age-related patterns.

Surgical Management and Outcomes

All patients underwent microsurgical resection, performed by an experienced neurosurgical team. Surgical approaches were chosen based on tumor location. The interhemispheric transcallosal approach was most common (used in 22 cases of lateral and third ventricular tumors), followed by frontal transcortical (10 cases), occipital trans-parietal (5 cases), suboccipital infratentorial (for 4th ventricle tumors, 10 cases), and endoscopic approaches (in 3 small colloid or cystic tumors).

Gross total resection (GTR) was achieved in 42 patients (84%), while subtotal resection (residual tumor remaining) was performed in 8 patients (16%) due to adherence to vital structures (Table 3, Figure 3). By tumor type, GTR rates were high: for example, 10 of 12 ependymomas (83%) and 14 of 15 subependymomas (93%) were completely excised. Intraoperative complications were infrequent; there were no strokes or major hemorrhages requiring re-operation.

Postoperatively, 5 patients (10%) had new neurological deficits. These included one case of contralateral hemiparesis (recovering to mild deficit) and four cases of transient cranial nerve palsies (mostly VIth nerve palsies causing diplopia) after approaching 3rd or 4th ventricle tumors. Eight patients (16%) required cerebrospinal fluid diversion (ventriculoperitoneal shunt) within one month post-surgery due to persistent hydrocephalus.

The median intensive care unit stay was 2 days, and the average total hospital stay was 10 ± 4 days. There were 2 perioperative deaths (4%): one patient (4th ventricle glioblastoma) died of brainstem edema on postoperative day 5, and another (extensive thalamic glioma) succumbed to pneumonia and sepsis on day 10. No patients died intraoperatively.

Karnofsky Performance Score (KPS) was assessed in 48 surviving patients. The mean preoperative KPS was 65% (range 50–90). At last follow-up, 15 patients (31%) had improved KPS, 23 (48%) were unchanged, and 10 (20%) had declined by more than 10 points, mostly reflecting disease progression in high-grade tumors.

The mean follow-up was 24 ± 10 months (range 6–60 months). During follow-up, 3 patients (6%) had tumor recurrence or progression. Two of these were high-grade gliomas (the pilocytic and glioblastoma cases), and one was a regrowth in a subtotally resected meningioma. These patients underwent reoperation or adjuvant therapy as appropriate. Other patients remained tumor-free on surveillance imaging.

Table 3 summarizes the surgical outcomes and postoperative course.

Table 3: Surgical Outcomes and Follow-up

Outcome	**Number (%) or Mean ± SD**
Gross total resection	42 (84%)
Subtotal resection	8 (16%)
New neurological deficit (postop)	5 (10%)
CSF shunt requirement (postop)	8 (16%)
Hospital stay, mean ± SD (days)	10 ± 4
Perioperative mortality (30-day)	2 (4%)
Follow-up duration, mean ± SD (months)	24 ± 10
Tumor recurrence during follow-up	3 (6%)

Figures 1–3 depict key data from our series: Figure 1 shows the distribution of tumor histologies, Figure 2 shows tumor locations, and Figure 3 compares extent of resection by histology (GTR vs. STR).

Figure 1. Histopathological Distribution

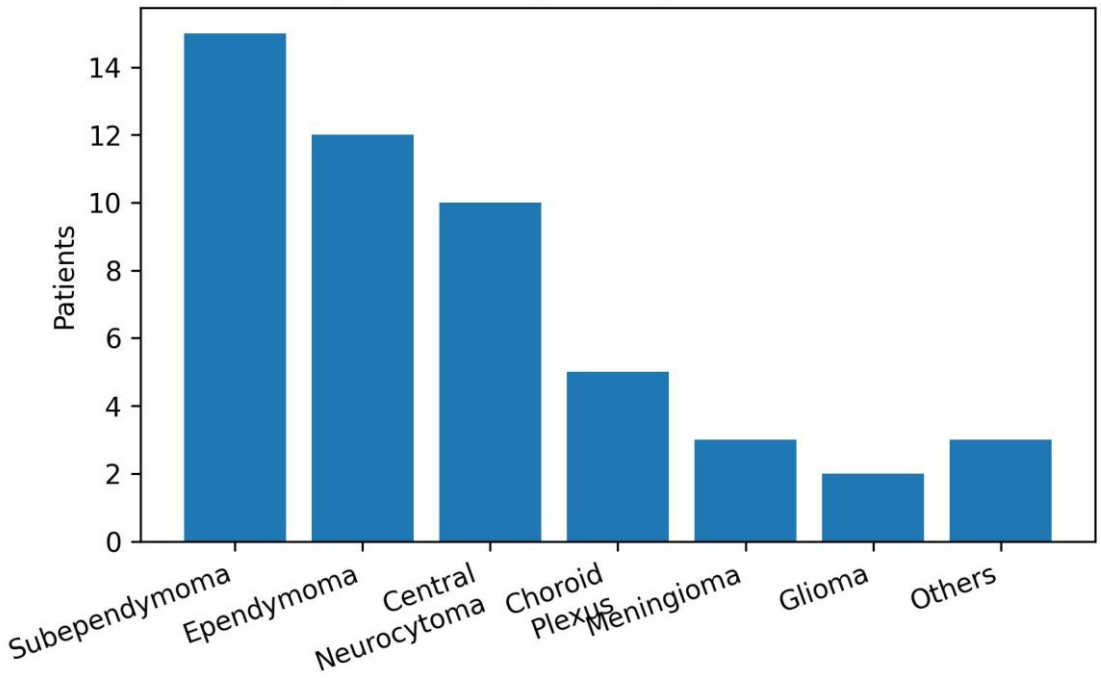
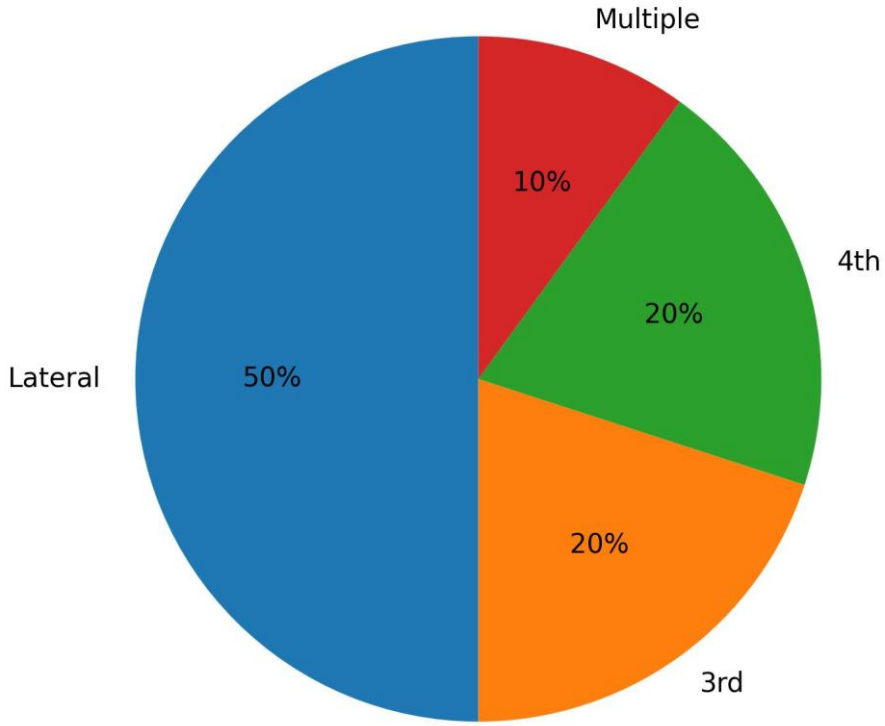
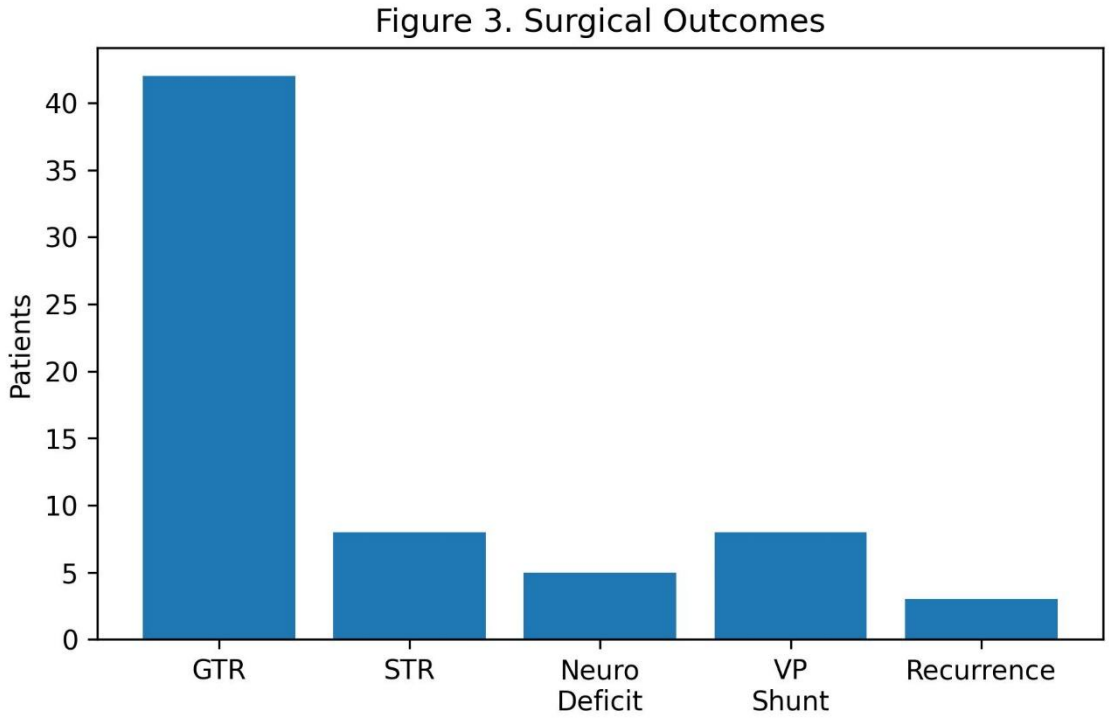


Figure 2. Tumor Location





DISCUSSION

Intraventricular tumors are rare and have a wide clinical and radiological spectrum in this series of 50 patients, and most of them could be treated successfully. Demographic and outcome information for our cohort is generally similar to other reported tertiary centre experiences, but with local variations.[1]

The mean age of the patients in our series was 28.5 years which is younger than other western series (e.g. median 52.5 years) and closer to Ethiopian series (median 19 years). This variation may be due to the fact that more paediatric patients (28%) were included in this study, as well as the age distribution of the population. There was a small boy-to-girl ratio (60:40) as in previous studies. Patients were seen subacutely over the course of weeks to months and were presented with raised intracranial pressure symptoms, particularly headache (84%) and vomiting (50%). This is consistent with earlier data which have highlighted the role of CSF flow obstruction as a relevant mechanism associated with symptoms. Seizures were not common (10%) compared with some series of less aggressive tumors, possibly because purely intraventricular tumors are less likely to be epileptogenic than cortical tumors.[8]

In our series the most common site was the lateral ventricles (50%) followed by the third and fourth ventricles. This is similar to other IVT studies, such as the Addis Abba study, which found that the involvement was supratentorial (lateral ventricles 52.5%). Ventricular distribution affects symptoms: Gait disturbances were observed only in fourth-ventricle tumors, while memory problems were observed more frequently in third-ventricle tumors (related to the foramen of Monro and the limbic pathways).[2]

Histopathologically, subependymomas were the single largest group (30%), followed by ependymomas (24%) and central neurocytomas (20%). The proportions are comparable to those of the German series of neuroepithelial IVTs, where subependymoma was the most common histology. Contrast this with the most frequently reported high-grade pediatric tumors in the Ethiopian study, which were medulloblastomas and other high-grade pediatric tumors, a different case mix (infratentorial tumors and possibly germ cell tumors). The selection of only intraventricular tumors is reflected in the higher number of traditionally intraventricular tumors (ependymomas, neurocytomas), owing to our inclusion criteria. Notably, choroid plexus tumors (mainly in children) comprised 10% of our cohort, as they do tend to occur in ventricles.[9]

The surgical results were gross total resection in 84% of the cases, similar to other series. The frequency of GTR in the BMC Cancer study was 93.3% in IVTs and 81.6% in the large contemporary series by Shihadeh et al.[14] (n=861) The slightly reduced GTR rate is due to prudent operative approach involving situations where the tumor was adherent to critical structures. GTR rates were found to differ with tumor type – all subependymomas and neurocytomas were fully resected, while there was a greater rate of subtotal resection of glial tumors. The survival of the three patients who developed recurrence was similarly suggestive of the prognosis of achieving GTR; although our series was too small to formally

investigate survival analysis, all three had either subtotal resection or aggressive histology. This is consistent with what the literature has shown, which is that the patients with a total resection have a better recurrence-free survival.[10]

The morbidity after surgery in our patients was relatively low. Ten percent (most commonly mild motor or cranial nerve deficits) experienced permanent new deficits. For comparison, other series report new deficit rates ranging from 10–27%. The morbidity rate was much lower than the overall complication rate of 52.5% recorded in the Ethiopian series, which may be attributed to the health status of the patients and the perioperative management. In the 30-day mortality the mortality rate was 4%, similar to German with 2.2% and significantly lower than the resource limited setting with 27.5%. This is due to careful selection of patients, modern intensive care and experienced surgical technique.[11]

One of the other important problems was hydrocephalus: 80% of the patients had hydrocephalus preoperatively and 16% of the patients needed permanent CSF diversion following surgery. The proportion of shunt-dependent children in the German series was 13.3% compared with our 16%. The Addis Ababa study reported 40% complications due to hydrocephalus, a stark contrast to the other. We had the practice of treating hydrocephalus primarily by tumor resection, and only if a child was refractory, he or she would be shunted.[12]

The prognosis for benign pathology was positive, with the majority of patients with subependymomas and neurocytomas being disease free without the use of any adjuvant therapy. Postoperative radiation therapy was given to ependymomas of high-grade features as per standard practice, while most of the slow-growing tumors were observed. Adjuvant treatment and close monitoring of this subgroup is warranted, as there were only 3 recurrences, all among high grade tumours.[13]

Our findings have some limitations. This is a retrospective study so there is a natural bias and there is no randomisation. Due to the heterogeneity of the tumor types and the limited numbers, there are not enough samples for extensive statistical analysis of subgroups. However, this series represents a true picture of IVT management in our center.

To conclude, our tertiary center was able to surgically resect intraventricular tumors with high gross total resection rate and low mortality. The clinicoradiological profile (age distribution, symptomatology, tumor types) is generally similar to previous studies. Maximal safe resection was emphasized and gross total resection was the most important factor in controlling the tumor. Longer-term outcomes and the use of adjuvant therapy in appropriate patients could be explored in future.

CONCLUSIONS

Although rare, intraventricular tumors are difficult to treat because of their deep location and involvement with CSF pathways. As in our experience, most of IVTs could be successfully managed with microsurgical resection, gross total removal and favourable outcomes. Preoperative planning with selection of surgical corridor is very important. Our study has shown that patients with IVTs can achieve symptom relief and long-term disease control with proficient neurosurgical treatment. Further collection and reporting of these data will further inform management guidelines and prognosis for these challenging tumors.

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Conflicts of interest
There are no conflicts of interest.

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