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Intracranial intraventricular tumors: long-term surgical outcome of 25 patients

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Background/aim: The aim of this paper is to provide the long-term surgical outcome of patients with intracranial intraventricular tumors.

Materials and methods: Twenty-five patients operated on for intraventricular tumors between June 1999 and June 2014 are reviewed. Data from before, during, and after surgery were obtained from the patients' files and patients were followed regularly after surgery.

Results: The group of patients comprised 15 females and 10 males with a mean age of 31.6 ± 16 years. The majority were adults and only 3 children were included. Three, 4, and 18 patients had tumors in the 4th, 3rd, and frontal horn of the lateral ventricles, respectively. All patients showed a varying degree of hydrocephalus and headache was the most common presenting symptom. Overall, central neurocytoma was the most common pathological diagnosis. Complications were found in only 4 patients and, in long-term follow-up, 3 patients had died due to the malignant nature or upgrading to a malignant tumor and the rest were alive.

Conclusion: Total removal of the intraventricular tumor increases survival because the majority of these tumors are benign and slow-growing. The type of surgical intervention should be chosen according to the location of the tumor in the ventricular system.

Key words: Intraventricular tumors, long-term, transcallosal, transcortical, follow-up, ventricle

1. Introduction

Intraventricular tumors of the brain are rare clinical entities that account for 10% of all intracranial tumors (1) and the lateral ventricle is the commonest location to be involved within the ventricular system (2). They generally are benign and slow-growing, such that patients may not show any signs or symptoms until tumors reach large sizes. Since they generally cause obstruction of cerebrospinal fluid (CSF) circulation, signs and/or symptoms of increased intracranial pressure due to hydrocephalus are the most common presentations.

It is clear from the current literature that the best treatment option for these tumors is surgical removal, which should aim for total removal as much as possible (3,4). The type of surgical approach generally depends on the location of the tumor in the ventricular system and planning the approach should allow minimal normal parenchyma retraction and maximal tumor resection. Type of surgical approach, such as using natural ways such as sulci or interhemispheric sulcus or transcortical way especially in tumors located in the lateral ventricle, is a still matter of discussion. However, the common idea is that any surgical approach causing less damage to the surrounding neural structures and providing maximum resection should be chosen. In addition to the microsurgical removal, recent years show us that endoscopic resection of these tumors is also possible, which is minimally invasive surgery (5). We have to underline that every surgical approach to these deep-seated tumors has its own advantages and disadvantages.

In this paper, we aimed to provide long-term surgical outcomes (i.e. follow-up of at least 1 year) of 25 patients with intraventricular tumors, and our intention is not to claim that one approach is superior to another. Data in the current literature with respect to long-term surgical outcome of intraventricular tumors are scarce and a realistic assessment of these tumors will only become possible as we get more experience based on reports from all over the world.

2. Materials and methods

2.1. Patients

This retrospective analysis included 25 consecutive patients who were operated on for intraventricular tumors between June 1999 and June 2014 in the Department of Neurosurgery, Cerrahpaşa Medical Faculty of İstanbul

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University. Data from before, during, and after surgery were retrieved from the patients' charts. All patients were operated on by the same surgery and anesthesiology teams and were followed regularly. Before and early after (within 72 h) surgery, magnetic resonance imaging (MRI) with and without contrast agent was done for all patients and they were seen in our outpatient clinic every year. At the last follow-up, all patients were checked by MRI for evaluation of recurrence or progression of any residue. Clinical and seizure outcomes and medication use, especially antiepileptic drug (AED) use, were also evaluated. Since this is a retrospective analysis, approval from the local ethics committee was not requested. All patients were discussed with respect to type of surgical intervention at our routine "preoperative meeting" in the department.

2.2. Statistical analysis

We used a commercially available statistical software package (SPSS 14.0, SPSS Inc., Chicago, IL, USA) for all the statistical analyses. Results were summarized by using mean ± standard deviation for each parameter. The chi-square test for categorical variables was used as appropriate. Differences were considered statistically significant if $P < 0.05$.

3. Results

3.1. Patients' demographics

The 25 patients included 15 females (60%) and 10 males (40%) with a mean age of 31.6 ± 16 years, ranging from 6 to 60 years. No statistically significant difference was found regarding sex in this series ($P = 0.31$; χ^2 test). The majority of patients except three were adults and ages of the three children were as follows: 6, 7, and 8 years. Table 1 summarizes the patients' demographics.

3.2. Clinical characteristics

The presenting symptom was headache, found in 14 patients (56%), followed by nausea/vomiting (12%) and vertigo (12%). In 2 patients, tumors were found incidentally while seeking medical attention for some other reason. One patient complained of decrease in vision and the other had weakness on one side. Interestingly, seizure was the sole symptom in only one patient. Neurologic examination depending on the Royal Medical Research Council Grading Scale (6) disclosed nothing abnormal in 14 patients (56%) and 3 patients had weakness on one side. Two patients showed cerebellar signs included dysmetria and dysdiadochokinesia and had a tumor in the 4th ventricle. Nystagmus was found in 2 patients with fontal horn tumor (Table 1).

3.3. Tumor characteristics

Since imaging characteristics have been reported in detail in the current literature, radiological features will not be discussed here. Three in the 3rd, four in the 4th, and 18 (72%) tumors in the frontal horn of the lateral ventricle were identified by head MRI. There were no side preferences regarding frontal horn location and all except one in the lateral ventricle occupied frontal horn and the body. One patient had a tumor involving the frontal horn and body that had extended to the atrium. Almost all had caused hydrocephalus but none required a ventriculoperitoneal shunt (VP-shunt) before tumor removal. None of them required cerebral angiography before surgery.

3.4. Surgery

Every patient was discussed in detail at a preoperative meeting and the type of surgical intervention was chosen depending on tumor location in the ventricular system and imaging characteristics. Three patients with 4th ventricular tumors were best treated by suboccipital craniectomy and a telovelar approach. In 4 patients with 3rd ventricular tumors, interhemispheric-transcallosal intervention was performed in 3 and in one patient a transcortical-transforaminal (foramen of Monro) route was chosen. In 18 patients with lateral ventricular tumors, 6 (33.3%) were removed by interhemispheric-transcallosal intervention, and in 10 (55.5%) transcortical intervention was preferred. Two patients had combined surgical procedures because of the extension of the tumor to the atrium. The main reason for the interhemispheric-transcallosal approach in this series was closeness of tumor to the midline, and if it extended to the lateral part and compressed the caudate nucleus and thalamus, the transcortical approach was the first choice in order to not cause any harm to these vital neuronal structures. In addition, for tumor size of more than 3 cm in diameter, a transcortical approach is better tolerated by patients and removal of the parts close to the lateral roof is possible. It is difficult to see the part of the tumor close to the lateral roof of the ventricle under a microscope by interhemispheric-transcallosal approach. One of the two patient merits discussing here why we performed combined procedures. That patient (no. 16 in the tables) (Figures 1a–1g) was treated by interhemispheric-transcallosal approach and the tumor had to be removed subtotally because of difficulty to see and manipulate the lateral part of the tumor under the lateral roof of the ventricle. Therefore, a second intervention, which was transcortical, was performed, and total removal was achieved.

The total number of surgeries was 33 and eight patients were operated on twice or three times because of recurrence or removal of residue (Table 2). In the first surgery, 16 (64%) and 9 (36%) total and subtotal removals, respectively, were performed (Table 2). The major reasons for subtotal removal were the facts that some tumors showed massive bleeding, some showed invasion of the vital structures, and, in some, total removal was thought to be performed after surgery but on early imaging residue

Table 1. Summary of clinical data of the 25 patients included here.

No.	Age	Sex	Symptoms	Findings	Side	Site	First pathology
1*	25	F	Headache	None	Right	Frontal horn	SEGA (I)
2	40	F	N/V	Ataxia	Left	Frontal horn	Ependymoma (II)
3	55	F	None	Paresis	Midline	3rd ventricle	Craniopharyngioma (I)
4	55	M	Headache	Cerebellar findings	Midline	4th ventricle	Papilloma (II)
5*	7	F	Headache	None	Midline	4th ventricle	Ependymoma (II)
6	37	M	Headache	None	Left.	Frontal horn	Neurocytoma (II)
7	60	F	Headache	Cerebellar findings	Left	Frontal horn	GBM (IV)
8	50	F	Headache	None	Right	Frontal horn	Epidermoid cyst (I)
9	31	F	Headache	None	Midline	3rd ventricle	Colloid cyst
10	27	F	Headache	None	Right	Frontal horn	Colloid cyst
11	50	F	Headache	None	Left	Frontal horn	Subependymoma (II)
12	29	F	Headache	Nystagmus	Left	Frontal horn	Neurocytoma (II)
13	36	F	Vertigo	Paresis	Midline	4th ventricle	Ganglioglioma (I)
14*	13	M	Headache	None	Left	Frontal horn	Astrocytoma (II)
15	8	M	Headache	None	Midline	3rd ventricle	Craniopharyngioma (I)
16*	26	F	Headache	Nystagmus	Left	Frontal horn	Neurocytoma (II)
17	28	M	Headache	None	Right	Frontal horn	Neurocytoma (II)
18	30	M	Vertigo	None	Right	Frontal horn	Neurocytoma (II)
19	23	M	Weakness	Paresis	Right	Frontal horn	Neurocytoma (III)
20	6	M	Seizure	None	Left	Frontal horn	Ependymoma (III)
21*	39	M	Vertigo	None	Right	Frontal horn	Ganglioneurocytoma**
22	33	M	None	None	Right	Frontal horn	Low-grade glioma (II)
23	22	F	D/V	Paresis	Right	Frontal horn	Neurocytoma (II)
24*	21	F	N/V	None	Midline	3rd ventricle	Low-grade glioma (II)
25	40	F	Headache	None	Left	Frontal horn	Ependymoma (II)

D/V: Decrease in vision; GBM: glioblastoma multiforme; SEGA: subependymal giant cell astrocytoma; N/V: nausea and vomiting. *Patients had more than one surgery. **Malign ganglioneurocytoma. Cerebellar findings include dysmetria and dysdiadochokinesia.

was seen. In two of the six patients who underwent second surgeries, subtotal resection had to be done, and 2 patients underwent third surgeries in which total removal was achieved.

3.5. Pathological findings

Histopathological diagnosis after the first surgery revealed that the most common finding was central neurocytoma, which was seen in 7 patients (28%), followed by ependymoma in 4 patients (16%) (Table 1). After the first surgery, the majority of tumors were diagnosed as low-grade (grades I and II), seen in 21 patients (84%), and in 4 patients they were high-grade, such as glioblastoma multiforme (GBM; grade IV), neurocytoma (grade III), ependymoma (grade III), and malignant ganglioneurocytoma. Histopathologic diagnosis after the second surgery was unchanged in 4 patients, but one patient was upgraded to anaplastic astrocytoma (grade III) within 6 months (patient no. 14 in the tables) and another one was upgraded to GBM (grade IV) within 12 months (patient no. 24 in tables). Two patients underwent a third surgery and the diagnoses were malignant ependymoma (grade III) upgraded from grade II ependymoma (patient no. 5 in tables) and GBM (grade IV) upgraded from anaplastic astrocytoma (grade III) (patient no. 14 in tables). During the follow-up period, upgrading was encountered in three patients (12%). In the 3rd ventricle, 2 had craniopharyngioma, one had a colloid cyst, and in one GBM was diagnosed. After the first surgery choroid plexus papilloma, ependymoma, and ganglioglioma were the three diagnoses in the 4th ventricle. In 18 patients with lateral ventricle tumors, the most common pathology was central neurocytoma seen in 7 patients (38.8%), followed by 3 (16.6%) ependymomas.

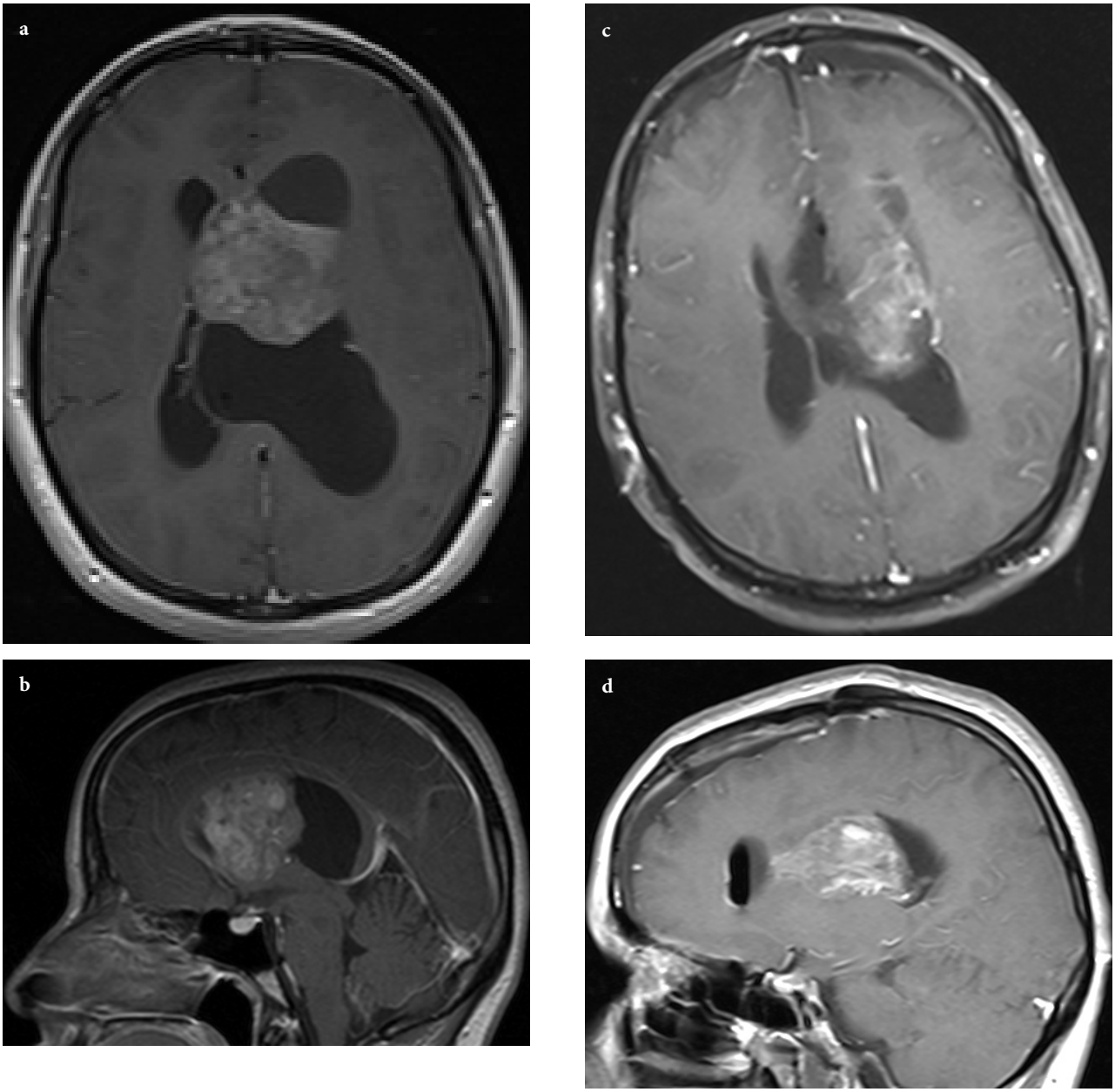
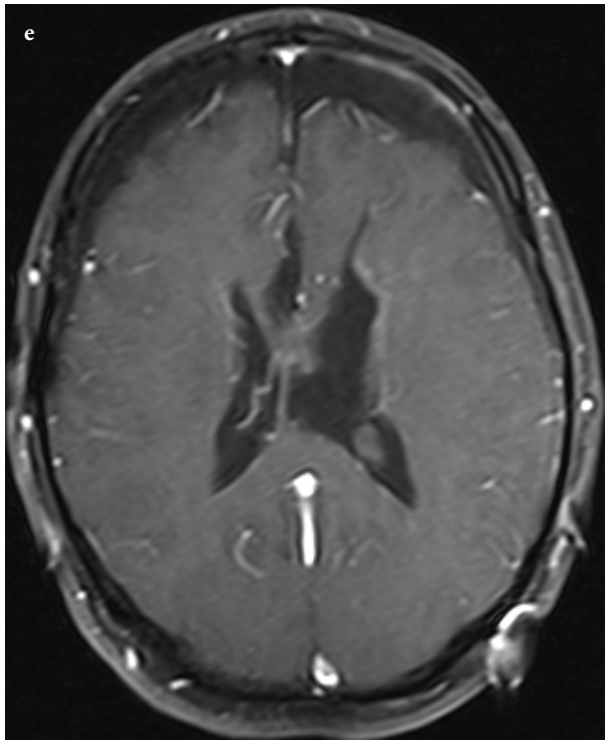
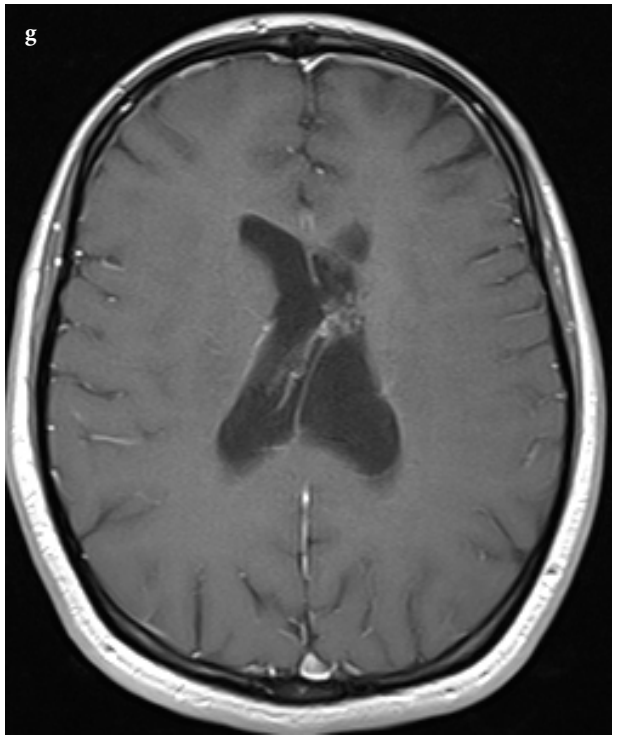


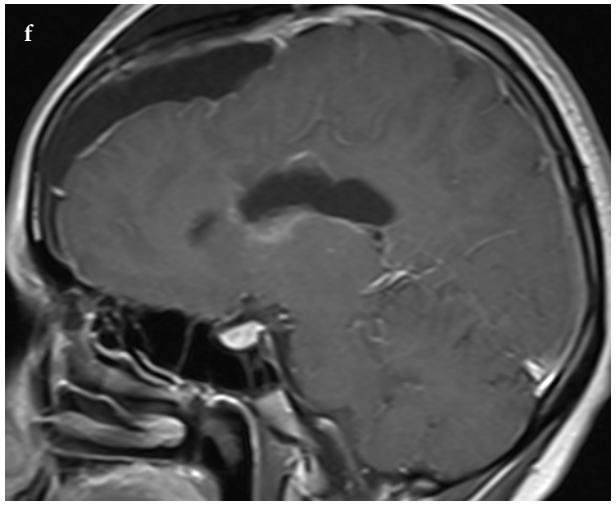
Figure 1. This 26-year-old female (patient no. 16 in the tables) was admitted to our clinic complaining of headache. Contrasted axial (a) and sagittal (b) planes of the head MRI showed heterogeneous mass lesion within the left frontal horn of the lateral ventricle causing massive dilatation of the ventricles. The tumor was mainly located in the atrium and the body. The patient underwent surgery, in which an interhemispheric-transcallosal approach was chosen. After becoming certain that the entire tumor was removed, the surgery was terminated. However, early head axial (c) and sagittal (d) MRI showed a residue on the most lateral part of the ventricle. A second surgery was planned and this time a transcortical approach to the left middle frontal gyrus was performed. The rest of the tumor was removed in toto and head MRI after the second surgery showed no tumor (e and f). The patient was diagnosed with neurocytoma (grade II) and discharged from the hospital without any clinical sequelae. At the last follow-up (28 months after surgery), contrasted head MRI (g and h) showed no residue or recurrence and the patient was doing well without any medications.

3.6. Early postoperative care and complications

After completion of tumor resection, an external ventricular drain (EVD) was inserted into the ventricular system to drain CSF and blood. As our routine surgical procedure the EVD was kept for 3 days and then was closed to see whether patients tolerated it. If no clinical signs/symptoms existed, it was removed. All patients were transferred to our intensive care unit and stayed overnight







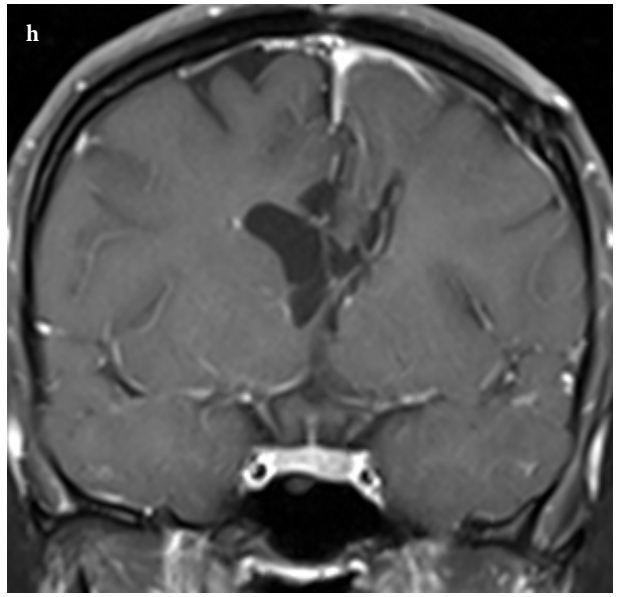


Figure 1. (Continued).

and AEDs were given to all, except for patients who were operated on for 4th ventricular tumors. Any patient who was diagnosed with high-grade tumors (grade III and IV) was advised to receive radiation and chemotherapy for further treatment.

A total of 4 patients (16%) showed complications early after surgery: three patients after the first surgery and one after the third surgery. One had hydrocephalus after the EVD was removed and underwent a VP-shunt. At the last follow-up, the patient was free of any clinical problems. One had a CSF fistula after removal of a tumor within the 4th ventricle and underwent repair. At the last follow-up, the patient was doing well. One patient who was 7 years old showed dysphasia and respiratory problems after the third surgery. The patient underwent a tracheotomy and at the last follow-up (2 months after the third surgery) the patent still had the tracheotomy without neurological deficit. Another patient who was operated on for a 3rd ventricular

Table 2. Surgical outcome at the last follow-up of the 25 patients.

No.	1st Sx	2nd Sx	3rd Sx	Clinical findings	Head MRI	Survival time (months)
1	STR	STR	-	None	No tumor	51/alive
2	GTR	-	-	Ataxia	No tumor	49/alive
3	GTR	-	-	None	No tumor	50/alive
4	GTR	-	-	Cerebellar findings	No tumor	51/alive
5	STR	STR	GTR	None	No tumor	48/alive
6	GTR	-	-	None	No tumor	24/alive
7	GTR	-	-	Hemiparesis (4/5)	Recurrence	13/died
8	GTR	-	-	None	No tumor	33/alive
9	GTR	-	-	None	No tumor	29/alive
10	GTR	-	-	None	No tumor	29/alive
11	GTR	-	-	None	No tumor	12/alive
12	GTR	-	-	None	No tumor	47/alive
13	STR	-	-	Dysarthria, dysphagia	Residue	43/alive
14	STR	GTR	GTR	Decreased consciousness	Recurrence	12/died
15	STR	-	-	Visual field defect	Residue	17/alive
16	STR	GTR	-	None	No tumor	28/alive
17	GTR	-	-	Hemiparesis (4/5)	No tumor	20/alive
18	GTR	-	-	None	No tumor	23/alive
19	GTR	-	-	None	No tumor	47/alive
20	GTR	-	-	None	No tumor	52/alive
21	STR	GTR	-	None	Residue	61/alive
22	GTR	-	-	None	No tumor	50/alive
23	STR	-	-	None	Residue	53/alive
24	STR	GTR	-	None	Recurrence	24/died
25	GTR	-	-	None	No tumor	13/alive

GTR: Gross total resection; Sx: surgery; STR: subtotal resection. Cerebellar findings include dysmetria and dysdiadochokinesia.

tumor showed diabetes insipidus and medical treatment was started. At the last follow-up, the patient was doing well. Complication rates showed no significant difference between interhemispheric-transcallosal and transcortical approaches ($P = 0.13$; χ^2 test).

3.7. Long-term follow-up

3.7.1. Clinical and radiological outcome

The mean follow-up period in this series was 35.1 ± 15.9 months, ranging from 12 to 61 months (Table 2). Three patients (12%) died during follow-up. One patient (patient no. 7 in tables) diagnosed with GBM (grade IV) died 13 months after surgery. Clinical examination of the patient showed hemiparesis (4/5) and recurrence was noted. The second patient (patient no. 14 in tables) died after three surgeries at 12 months of follow-up. The patient's first diagnosis was astrocytoma (grade II). Because of upgrading, first to anaplastic astrocytoma (grade III) and finally to GBM (grade IV) with a sarcomatous component, radiation treatment and chemotherapy were given. The third patient (patient no. 24 in tables) was operated on twice and diagnoses were astrocytoma (grade II) and GBM, respectively. The patient received radiation and chemotherapy but died at 24 months of follow-up. Considering survival in this series, it was found that the survival rate was satisfactory and 22 patients (88%) were still doing well. The last follow-up showed that 18 patients (81%) had no tumor upon MRI and normal clinical examination. However, in 4 patients, MRI detected some degree of residue without progression.

3.7.2. Seizure and antiepileptic drug outcome

Before surgery only one patient (patient no. 20 in tables) was using AEDs because of seizures that had started 1

month before surgery. Following surgery, as a routine procedure, all patients except three patients with 4th ventricular tumors (i.e. 22 patients) were put on one AED regimen but at the last follow-up all patients were free of AEDs without seizure.

4. Discussion

Intraventricular tumors are in general benign in nature and slow-growing tumors such that clinical symptoms may not be seen until they reach a certain size. Although males tend to have these tumors more commonly than females, there is no sex predominance and the group differences are not significant (3,6–9). In the present study, females had these tumors more commonly than males, but the difference is not significant. In the current literature, it is clearly seen that there is no specific age range in which intraventricular tumors are more common (3,10,11). These tumors can be seen at any age but preferences of location may be different as children generally have these tumors in the 4th ventricle. Our patient group was composed mainly of adults and only three children were included. Thus, depending solely on our limited number of cases, we cannot comment on the specific age group. Lateral ventricles are the commonest location reported so far, followed by 3rd and 4th ventricles (2,3). Our findings are in line with literature reports that the lateral ventricle was the most common location. Incidentally our series included consecutive patients who had tumors mainly located in the frontal horn of the lateral ventricles, so our discussion is mainly limited to this area.

Clinical symptoms are often nonspecific in nature and they do not develop until the ventricles reach a certain size. Symptoms are due to increased intracranial pressure and headache is the most common presentation. Nausea and vomiting are generally accompanying symptoms. Other symptoms depending on the location of the tumor may include imbalance, visual field defects, vertigo, paresis, and seizures (12,13). Considering patients in this series, all showed a varying degree of hydrocephalus and headache was the most common symptom. As reported previously (12,13), the majority of our patients had normal neurological examinations.

There have been no side preferences reported so far, as was the case in our group. It has been demonstrated that the age of patient, location of tumor in the ventricular system, and radiological features may provide some clues about the tumor type or differential diagnosis before surgery (1–3). In the 3rd ventricle colloid cysts and hypothalamic glial tumors predominate. In children and adolescents medulloblastoma and pilocytic astrocytoma are common in the 4th ventricle. In the lateral ventricle, choroid plexus tumors are common in children and older age groups generally show meningiomas, malignant gliomas, or metastasis. Central neurocytomas have been reported to be more common at 40 years of age (8). Subependymomas are common around the foramen of Monro. Astrocytomas actually may originate from every part of the ventricular system. Based on the present series we cannot discuss the pathology of the 3rd and 4th ventricular system because of our limited number of patients. Considering the lateral ventricle, here, for the frontal horn of the lateral ventricle, central neurocytoma is the most common type, followed by ependymoma. We have to underline that clinical reports show different results regarding this diverse group of tumors because of different numbers and specific ages of patients included in the series.

The ventricular system is surrounded by vital neuronal structures and surgical interventions should aim to remove the tumor as much as possible with minimal or without severe neurological deficits. Thus, the shortest distance to the tumor should be chosen. However, there is no common consensus about the type of surgical approach to the frontal horn of the lateral ventricle. The surgical route is straightforward when tumors located in the temporal and occipital horns and atrium can be removed by a transcortical approach. For 4th ventricular tumors, suboccipital craniectomy and telovelar approaches have been reported to be safe (14). There are several ways to remove 3rd ventricular tumors that have been very well explained in the literature (15). Since tumors in the 3rd ventricle were mainly located in the anterior and superior parts, we performed an interhemispheric-transcallosal approach in the present group of patients. The discussion starts when the tumor is located in the frontal horns of the lateral ventricle. In the literature, it has been reported that the ipsilateral anterior horn and body of the lateral ventricle are best approached by transcortical intervention (3,4,8,16). In the case of the small ventricle, tumors involving both the frontal horn and midline are best removed by an interhemispheric-transcallosal approach. Some reports further stated that if the ventricular border is close to the surface, such as less than 2 cm or close to the very most lateral border, a transcortical approach should be chosen (8). Decreased incidences of seizure, porencephalic cyst formation, and subdural hygroma were reported to be advantages of interhemispheric-transcallosal approaches (3,4,16). On the other hand, easy access to the ventricles and manipulation of the tumor, and decreased incidence of damage to the superior sagittal sinus, large veins, and vital arteries are advantages of the transcortical route (3,4). We underline that each route alone or a combination of both procedures can be used safely with minimal damage to neurovascular structures. The main reason for choosing a transcortical approach in our series was the closeness of large tumors to the very lateral side of the ventricle. It is very hard to see or control the lateral or superior

border of large tumors by removing them only by an interhemispheric-transcallosal approach. In some tumors located at the midline and extending to one side, they can be removed safely by a combination of procedures, as we did in two cases. Thus, there are no strict criteria to choose one procedure over another and microsurgical techniques together with the experience of surgical and anesthesia teams provide satisfactory outcomes. Incidence of seizure seems to be the same in both types of surgery and subdural hygroma does not generally cause clinical problems in these patients.

The complication that required intervention (VP-shunt) was hydrocephalus, seen in one patient in our series. The number of patients requiring VP-shunts is based on different factors and overall 10% to 50% of patients have been reported to have hydrocephalus requiring VP-shunts in the literature (17,18). Since the present study included patients who had tumors in the frontal horn of the lateral ventricles only and limited numbers of patients had 3rd and 4th ventricular tumors, the number of patients who required a VP-shunt or showed hydrocephalus after surgery was very small. The true incidence of postoperative seizures, especially after transcortical incision, is hard to determine and reports showed different results. Reported incidence of seizure has been demonstrated from as low as 3% to as high as 75% (3,4,6,9,16). However, recent reports showed that increased surgical techniques together with a new generation of AEDs has reduced the incidence of seizures and no differences were reported between transcortical and interhemispheric-transcallosal approaches (9). We agree with this idea that seizure is not common after a transcortical approach and only 4 patients (18.2%) had seizures, which were controlled with AEDs. In the long-term follow-up no one was taking AEDs and all were free of seizures. We did not have surgical-related mortality in the present series and mortality and morbidity rates were reported to be low (3,4,16). Three deaths in our group were mainly due to the malignant nature of the tumors or upgrading of the malignancy in long-term follow-up.

There are methodological limitations to this study. First, this study is retrospective and retrieving the data from patients' files may have caused bias. Second, the study should have included a large population of patients and we included a limited number of patients. Thus, we suggest that future studies should be prospective and include a greater number of patients.

In conclusion, surgical removal of intraventricular tumors is the best option and one approach over another is not superior in the case of involvement of the frontal horn of the lateral ventricular. The complication rate is low when an appropriate surgical route is used. Since the majority of these tumors are low-grade, total removal should be the goal of surgery.

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