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Original Article

Complications Avoidance in Transcortical Approach to Lateral Ventricle Tumors: Analysis of 38 Cases

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BACKGROUND: Lateral ventricular tumors could be approached through different corridors. Accurate selection of the surgical approach coupled with avoiding or minimizing the expected complications improves the surgical outcome.

OBJECTIVE: To analyze complications related to transcortical approach to lateral ventricle tumors. Moreover, to explain the causes behind these complications and their management.

PATIENTS AND METHODS: Prospective study evaluating outcome and complications of 38 patients with tumors of lateral ventricle, operated by transcortical approach. Clinical and imaging follow up were performed in all patients at 0, 3, 6 and 12 months.

RESULTS: Enrolled patients included 25 male and 13 female patients, operated by transcortical approach. The mean age was 30 years (Ranging from 2 to 65 years). Duration of symptoms ranged from 15 days to 6 months. The initial postoperative evaluation showed that 31% of patients had some neurological improvement and no direct post-operative surgical mortality. Gross total resection was achieved in 30 patients (78.9%).
Complications related to cortical incisions were mental changes in 5 patients that underwent frontal cortical incisions (left> right) and field defect in a single patient that underwent temporal cortical incision. Most common complications were intraventricular (IV) hemorrhage in 4 patients, postoperative seizures in 4 patients and acute hydrocephalus in 10 patients that needed post-resection shunts. Clinical follow-up at 12 months revealed good recovery in 31 patients (81%).

CONCLUSION: Proper patient preparation with appropriate selection of the cortical corridor and proper surgical techniques can decrease or even prevent the different complications encountered.

KEYWORDS: Complications, Cortical incisions, Lateral ventricular tumors, Transcortical approach.

INTRODUCTION

Microsurgical excision of lateral ventricle tumors is challenging and requires meticulous surgical planning. Accurate selection of the surgical approach coupled with avoiding or minimizing the expected complications, improves the surgical outcome and decreases perioperative morbidity.[1]

Lateral ventricular tumors could be approached through different corridors whether transcortical or transcallosal. Tew et al in 1995,[2] stated that the most appropriate approach is the one that provides a safe trajectory and an adequate field of vision with least brain retraction.

The transcortical-transfrontal-transventricular approach was first described by Dandy in 1922.[3] The middle frontal (F2) gyrus[3] is indicated to access lesions occupying the frontal horn and body of the ventricle, the trigone and occipital horn are accessed through the superior parietal (P1) gyrus and the interhemispheric parasplenial approach,[3] while the transtemporal approach, through the middle and inferior temporal (T2–T3) gyri is designed to access the temporal horn and trigone.[4]

Thus, we analyzed the different complications related to the transcortical approach to lateral ventricle tumors and tried to explain the causes behind these complications, their management and ways to avoid such complications.

PATIENTS AND METHODS

In the current prospective study, we analyzed the surgical outcome and complications of 38 patients diagnosed with tumors located in different parts of the lateral ventricle operated by different transcortical approaches. The neurological assessments and neuroimaging studies were performed preoperatively and postoperatively. The neuroimaging studies included computerized tomography (CT) scan of the brain as well as magnetic resonance imaging (MRI) of the brain with contrast. Complications were reported and analyzed.

Clinical assessments and neuroimaging follow up were performed in all patients on the postoperative day (0) and at 3, 6 and 12 months.

Ethical Consideration

A written informed consent was obtained from all patients pre-operatively before enrollment in the study. The study was approved by the local ethical committee of the Faculty of Medicine, Alexandria University, approval number: 0306370.

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RESULTS

The enrolled patients included 25 male and 13 female patients diagnosed with tumors of the lateral ventricle, operated by transcortical approach. The mean patients' age was 30 years (Ranging from 2 to 65 years).

The main clinical manifestation was raised intracranial pressure (ICP) in the form of headache and papilledema (51%), while the most common presenting symptom was headache in 35 patients (92.1%). Mental changes were the main clinical manifestations for lesions located in the frontal horn and ventricular body. Tumors in the temporal horn were characterized by manifestations of increased ICP and seizures. Hydrocephalus was present in all patients (100%) and hemiparesis in only four patients (10.5%) **(Table 1).**

(Table 1): Preoperative clinical presentations in 38 patients diagnosed with tumors of the lateral ventricle:

Neuropathological features

Sixty-one percent of the lesions were benign and low-grade tumors. The most frequently encountered tumors were; 16 cases (42%) were central Neurocytoma, 8 cases (21%) were Ependymomas, 6 cases (16%) were Choroid Plexus Papilloma, 4 cases (10.5%) were Pilocytic Astrocytomas , 2 cases (5%) were SEGA Astrocytoma, 2 cases (5%) were Glioblastoma Multiforme (GBM) tumors.

Neuroimaging studies

In 33 patients (68.8%) the lesions were hyperdense to the brain by CT scan and in 32 patients (84%) the lesions were enhancing in MRI with contrast while all patients had imaging signs of hydrocephalus.

Surgical approach

All patients received levetiracetam perioperatively and underwent surgical excision of the tumor through a transcortical approach, whether right or left frontal transcortical, superior parietal or middle temporal gyrus approach.

Examples of cases:

Case 1: An eighteen-year-old male patient presenting with manifestations of increased ICP and epilepsy. Surgical excision of the tumor was performed through left middle frontal gyrus approach. A Ventriculo-peritoneal (VP) shunt was needed 24 hours after the definitive surgery. Pathology revealed a subependymal giant cell astrocytoma. **(Fig. 1).**

Case 2: A thirty-year-old male patient presenting with headache. Surgical excision of the tumor was performed through left middle frontal gyrus approach (left F2). Hydrocephalus improved without the need for shunt insertion. Pathology revealed a central Neurocytoma. **(Fig. 2).**

Case 3: A fifteen-year-old female patient presented with fits. Surgical excision of the tumor was performed through left middle temporal gyrus approach (left T2). Pathology revealed a Choroid Plexus Papilloma. **(Fig. 3).**

Case 4: A twenty-year-old male patient presenting with headache and blurring of vision. Surgical excision of the tumor was performed through left frontal transcortical incision. Patient developed contralateral extradural hematomas (EDH), which was evacuated safely and the patient recovered well. Pathology revealed a central Neurocytoma. **(Fig. 4).**

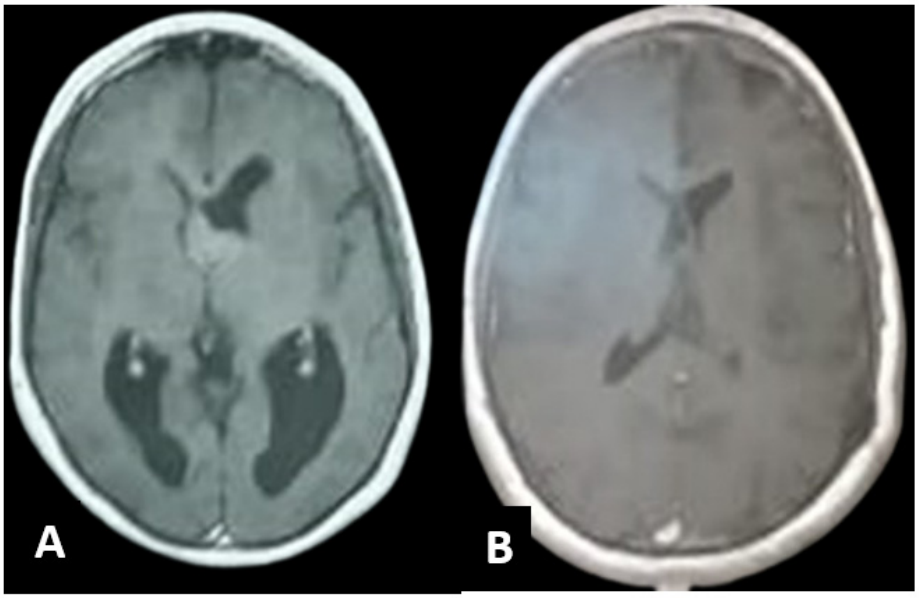

Fig 1: (A) Pre-operative axial MRI with contrast showing an enhancing intraventricular space occupying lesion with associated ventricular dilatation and (B) Post-operative axial MRI with contrast (at 3 months follow up) showing gross total resection of the lesion.

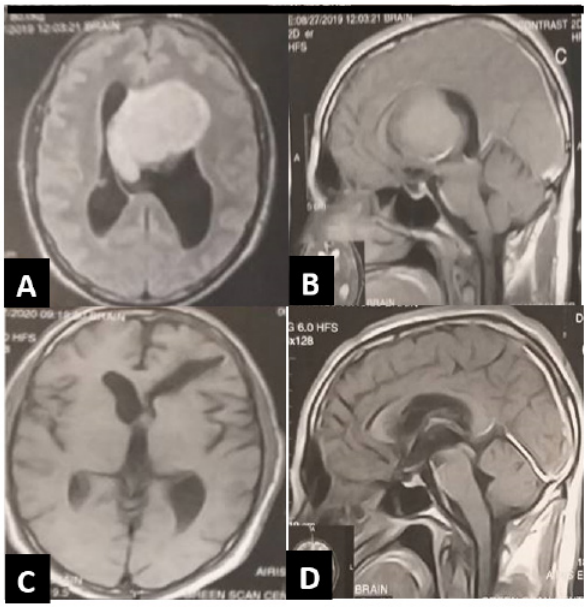

Fig 2: (A): Preoperative axial MRI with contrast: showing huge hyper intense intraventricular space occupying lesion and hydrocephalus, (B): Preoperative sagittal MRI with contrast, (C): Postoperative axial MRI with contrast showing gross total resection of the lesion and (D): Postoperative sagittal MRI with contrast showing gross total resection of the tumor.

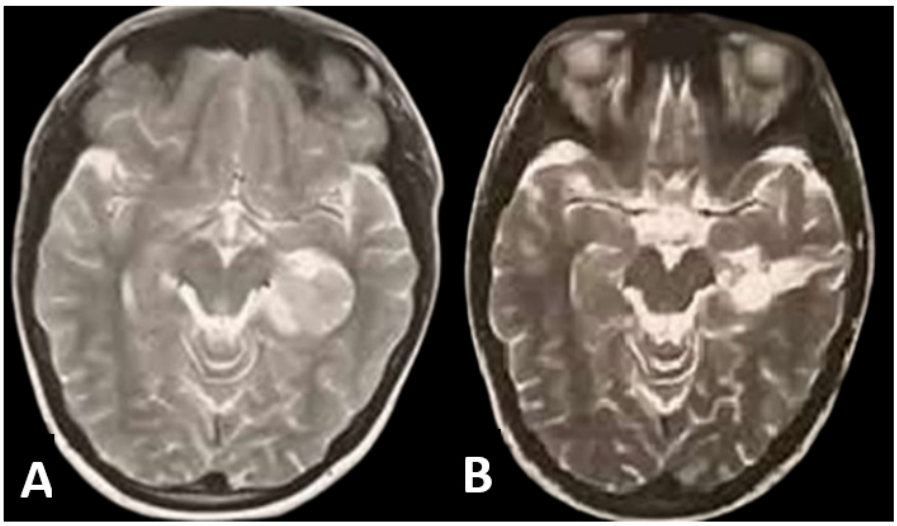

Fig 3: (A) Preoperative axial MRI (T2 sequence) showing left temporal horn intraventricular space occupying lesion and (B): Post-operative axial MRI brain (at 3 months follow up) showing gross total resection of the lesion.

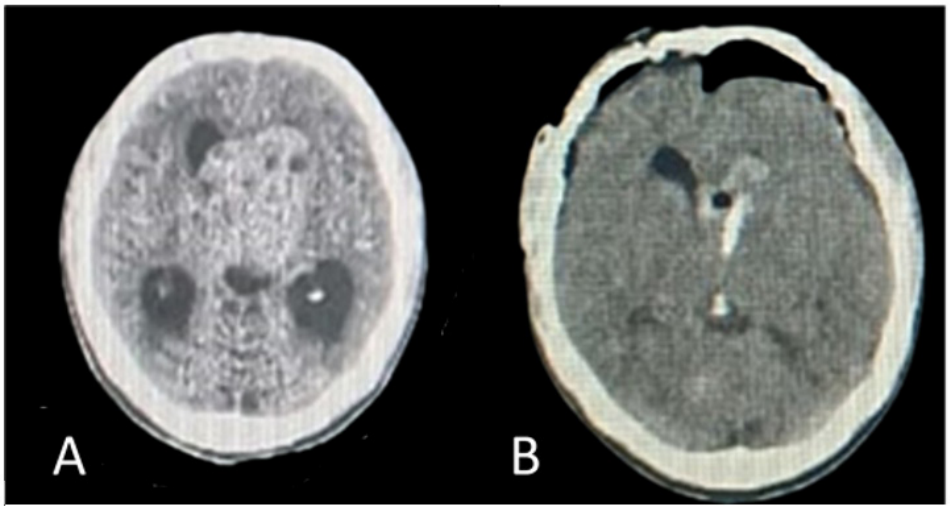

Fig 4: (A): Pre-operative CT brain showing intraventricular lesion at left frontal horn of the lateral ventricle and (B): Post-operative CT scans showing evacuated contralateral extra dural hematoma and inserted left frontal external ventricular drain.

Complications

There were no surgical mortalities and complications encountered were cortical trajectory contusion in a single patient, venous infarct in a single patient, subdural hygromas in 2 patients, transient memory loss in 2 patients, EDH in 3 patients, hemiparesis in 3 patients, minimal Intra ventricular (IV) hemorrhage in 4 patients, postoperative seizures in 4 patients and acute hydrocephalus in 10 patients that needed post-resection shunts.

All 38 patients (100%) had pre-operative hydrocephalus. One patient had VP shunt inserted in another institute before definitive surgery and presented with shunt obstruction. External ventricular drain (EVD) was left in all patients (100%) following tumor resection and was removed in 28 patients (73.7%) with no need for postoperative shunt placement. However, hydrocephalus did not resolve postoperatively in 10 patients (26.3%) and needed post resection VP shunts.

Intraventricular hemorrhage (IV) is usually minimal with meticulous hemostasis, however it usually develops in dependent horns. Minimal IV hemorrhage occurred in 4 patients (10.5%).

Epidural hematoma (EDH) occurred in 3 patients (7.9%) in our series, ipsilateral in 2 patients (5.2%) and contralateral in one patient (2.6%). Of them, 2 patients (5.2%) needed surgical evacuation and one patient (2.6%) was managed conservatively.

Complications related to cortical incision in the frontal right or left sides included; mental changes which usually occurs more in left approaches and usually improves over 1 month. (developed in 5 patients, 13%). In the Temporal especially the dominant lobe, dysphasia and field defects developed in 1 patient, (2.6%) and could be avoided by being as low and as anterior as possible.

Partial complex seizures, which are usually controlled medically, (developed in 4 patients, 10.5%).

Transient hemiparesis occurred in 3 patients (7.9%). It occurred in huge lesions infiltrating the floor.

Transient memory loss which was caused by unilateral forniceal edema, that improved gradually. (occurred in 2 patients, 5.2%). Subdural hygromas which occurred in 2 patients (5.2%).

Clinical assessment and neuroimaging follow up

The initial postoperative clinical evaluation showed 31% of patients with some neurological improvement, 59% with no changes and 10% with worsened symptoms. No direct post-operative surgical mortality occurred.

The Glasgow Outcome Scale five-point system was used to evaluate the final clinical follow-up at 12 months. Thirty-one patients (81%) had good recovery, 16 % developed moderate disability and a single mortality occurred.

Gross total resection (GTR) of the lesion was achieved in 30 patients (78.9%), while subtotal excision was achieved in 8 patients (21.1%). Residual tumors were usually located at the roof of the ventricle or infiltrated the floor of the ventricle.

Pathological assessment of the resected tumor revealed that 80% of tumors were benign and low-grade tumors.

Table 1: Preoperative clinical presentations in 38 patients diagnosed with tumors of the lateral ventricle

	Patients	%
Headache	35	92.1
Mental changes	5	13.1
Seizures	4	10.5
Papilledema	20	52.6
Hemiparesis	4	10.5
Hydrocephalus	38	100

DISCUSSION

Different surgical approaches are used to resect lateral ventricular tumors. These approaches provide adequate corridors with minimal risks. They include different transcortical, transcallosal and combined approaches.[5] Different factors are responsible for the selection of the suitable approach including tumor location, size as well as surgeon preference.[6]

The availability of different approaches in managing these lesions, with lack of standardization makes it difficult to compare overall morbidity and mortality rates among the series. Operative mortality reported in lateral ventricle tumor series ranges from 0 to 12%, while morbidity ranges from 10 to 70%.[7]

Strategies in transcortical approaches used in resecting lateral ventricle tumors include the choice of the shortest and safest corridor, low suction power, decreasing brain retraction, central debulking and visualization of normal ependyma/tumor interface.[7] In the current study, we focused on the transcortical approach with its different corridors reporting different complications, their avoidance and management.

The enrolled patients included 25 male and 13 female patients diagnosed with tumors of the lateral ventricle,

operated by transcortical approach, with a mean age of 30 years (Ranging from 2 to 65 years). The main clinical manifestation was raised ICP (51%). Hydrocephalus was present in all patients favoring the choice of a transcortical approach, however, in a study published by Alayouty et al., in 2018,[8] reported that only 3/8 of their cases that underwent surgical excision through transcortical approach did not have hydrocephalus. Hydrocephalus facilitates the transcortical approach by creating a space for surgical resection, however, the absence of hydrocephalus is not a contraindication for transcortical approaches, especially with the assistance of the neuro-navigation techniques.

In the current study GTR was achieved in 78% of patients. These results may be different from those published by Wang et al., in 2018,[9] who reported GTR in 54% of the 63 patients in their series. This discrepancy may be attributed to the difference in sample size. In the current study, 80% percent of the resected tumors were benign and low-grade tumors which is close to what was mentioned by Elkallaf et al, in 2021.,[10] who reported that 85% of their lesions were also benign.

The main point of interest in this study was complications avoidance and management, thus, each complication was thoroughly analyzed and mentioned in detail.

Hydrocephalus: In the current study all 38 patients (100%) had preoperative hydrocephalus. EVD was left in all patients (100%) after tumor resection. EVD was removed in 28 patients (73.7%) without the need for postoperative shunt placement. The application of EVD postoperatively was mandatory for safe drainage of bloody cerebro-spinal fluid (CSF) postoperatively, weaning of EVD was started on day 3 after serial CT following the final decision of whether to shunt or not.

However, hydrocephalus persisted in 10 patients (26.3%), which needed postoperative shunt placement. Several factors could explain the persistence of hydrocephalus in these patients including the development of IV hemorrhage, subtotal resection of the tumor or the lack of re-establishment of the natural CSF corridor. According to Ellenbogen, in 2001,[11] 10 to 50% of patients will ultimately require CSF diversion. In his series, only 10.3% of the patients required placement of a shunt, most of which had high grade tumor, usually choroid plexus carcinoma.

In our opinion, GTR of the tumor and establishing the natural corridor by direct microscopic inspection of the foramen of Monro with superadded septostomy and frequent ringer's lactate irrigation to clear the bloody CSF with the insertion of EVD are the golden pearls that could decrease the need for post-resection shunt insertion after removal of EVD.

Intraventricular hemorrhage: The most common cause for IV hemorrhage is blood trickling to the most dependent parts of the ventricular system which are usually the occipital horns while resecting IV tumors. To prevent this common complication different techniques were implemented in the form of meticulous hemostasis, placing a cottonoid posterior to the lesion once the ependymal lining of the ventricle was exposed, exploration of the occipital horns at the end of surgery, suction of any IV blood clots in these dependent horns as well as continuous irrigation of the ventricular system and placing an EVD.

Epidural hematoma: EDH occurred in 3 patients (7.9%) in our series. It is usually attributed to large sized lesions and associated hydrocephalus, with decrease in ICP related to CSF drainage and tumor excision. It may occur under the craniotomy (ipsilateral in 2 patients) or at remote sites (contralateral in one patient). 2 of our 3 cases needed surgical evacuation and one was managed conservatively.

To guard against their occurrence, we recommend tenting sutures before opening the dura, gradual CSF drainage and decreasing the dehydrating measures following CSF drainage by the anesthesiologists. However, in our opinion the most important point to guard against ipsilateral EDH is to recheck the tenting sutures after closure of the dura, by removing them if needed and rechecking the epidural spaces at the end of surgery then re-suturing them again. Till now the literature is lacking in reporting percentages of EDH as a complication as well as how to prevent their occurrence.

Subdural hygroma: Subdural hygromas occurred twice (5%), in our series. They usually occur with pediatric tumors, which is attributed to the large size of these lesions and marked hydrocephalus associated with them. They were treated with subduroperitoneal shunts. Ellenbogen, in 2001,[11] reported that 13.5% of his patients developed subdural hygroma and filling the ventricles with sterile saline or lactated Ringer solution, while leaving a subdural catheter in place may reduce their incidence.[11] Several authors also suggested that placement of fibrin glue over the cortical incision significantly decreased the rate of subdural fluid collections.[12,13]

Complications related to the cortical incision: These are usually caused by brain retraction, lobe edema and aeroceles. In our opinion, it could be decreased by intermittent retraction and proper cortical incision design from the start. Different authors described well known cortical trajectories that minimize the risks including the middle frontal gyrus, middle temporal gyrus and the superior parietal lobule to reach different parts of the ventricular system.[11,13-15]

In the current study mental changes were the most common complications related to the cortical incision and were related to frontal cortical incisions (5 patients) whether right or left (more in left side). These mental changes were transient, which improved over 1 month.

Other complications related to cortical incision included dysphasia and field defect (developed in 1 patient), related to temporal lobe incisions. This complication could be

avoided by being as low and as anterior as possible while designing the cortical incision.

Cortical approaches are usually blamed for high risk of associated fits. However, in the current study fits were in the form of partial complex seizures in only 4 patients (10.5%) and were easily controlled medically. These fits could be avoided by using prophylactic levetiracetam, intermittent retraction and avoiding coagulation of the cortical veins. However, we had a short follow up period of 12 months representing a limitation in this study and a longer follow up period is recommended for better evaluation of epileptic risks in transcortical approaches.

Ellenbogen, in 2001,[11] reported persistent postoperative epilepsy in 6.8% of his patients that required medication. Furthermore, the incidence of cortical incision–related fits is difficult to determine due to the presence of several factors that may induce them including the tumor pathology, presence of preoperative seizures, subtotal tumor resection with residual tumor, subdural hygroma and associated hydrocephalus. A wide range of postoperative seizures have been reported in the literature ranging from 19 to 75% in the pre-microsurgical era.[16]

Hemiparesis: Other complications reported in our series included hemiparesis which occurred in 3 patients (7.9%) in huge lesions infiltrating the floor. Ellenbogen, in 2001,[11] reported hemiparesis in large trigone or ventricle body tumors. He attributed the cause of the weakness mostly due to retraction pressure and reported it to be transient.[11] However, the incidence of permanent motor loss has been reported to be as high as 30% in some series.[16]

In our opinion, lowering the risk of hemiparesis could be achieved by avoiding injury of lateral boundary of foramen of Monro, avoiding ependymal transgression and avoidance of coagulation of veins (venous infarct) as well as intermittent retraction.

A golden rule, the number of veins sacrificed during a transcortical approach should be kept to a minimum.[11] Sacrifice of both deep and superficial veins can cause deficits which can be either insignificant or devastating.[11] Dandy, claimed that one internal cerebral vein can be sacrificed without effect,[3] however, other surgeons have found this observation to be incorrect.[17] In our opinion every effort should be exerted to avoid sacrificing any vein unless it clearly compromises access to the IV mass.

In the current study, we reported 2 patients with post-resection transient memory impairment caused by Forniceal edema. This complication could be avoided by early identification of the Fornix (medial boundary of foramen of Monro) in midline underneath the Septum Pellucidum and avoiding venous coagulation at the floor of the ventricle.

In the current study, at 12 months follow-up; 81% of patients achieved good recovery and 16% had moderate disability. This is consistent with Ellenbogen, in 2001,[11] who reported good clinical outcome in 86% of cases and he concluded that transcortical surgery–related postoperative morbidity and outcome are dependent more on tumor histological type and site of origin than on approach.[11,18]

In more modern series, the mortality rates mentioned are far lower than 10% usually attributed to hemorrhage or pulmonary emboli.[19]

GTR was achieved in 30 patients (79%) and subtotal resection was feasible in only 8 patients. Elayouty et al 8 reported achievement of GTR in 75% of their patients. Residual parts were usually related to the roof of the ventricle or adherent to the deep venous system and invading the floor.[8]

In the current study the residual lesions were usually located at the roof of the ventricle or invading the floor. The residual lesion related to the roof could be controlled with the use of microsurgery assisted endoscopy.

The risk for complications in the surgical management of lateral ventricular tumors is relatively high regardless of the surgical approach.[16] However, the possibility for GTR and favorable clinical outcome is high with transcortical approach. Coincidently, transcallosal approach is not associated with postoperative neuropsychological sequelae or seizures, thus, this route is also chosen by many surgeons,[5,20] however, considering the giant size that certain lateral ventricle tumors could reach, sometimes transcortical approach becomes mandatory.

Limitations of the study

Short follow up period of 12 months was the main limitation to this study and a longer follow up period is recommended in future studies for better evaluation of epileptic risks in transcortical approaches.

Most of the lesions were benign and low grade making a comparison against high grade lesions in this study impossible. A larger cohort with a larger number of high grade cases to establish the correlation between the extent of resection and histopathology is recommended in future studies.

In this cohort we tried to mention how to avoid different complications related to transcortical approach, no comparisons were done between different transcortical trajectories or other approaches as most of the lesions were approached through frontal transcortical corridor whether right or left. A larger cohort using different approaches is recommended in future studies.

CONCLUSION

The advances in microsurgical techniques have led to decreased risk of cortical incision complications. It is a favorable alternative that permits access to all regions of the lateral ventricle with an adequate field of vision that allows easy navigation and control of microsurgery. Furthermore, the application of ultrasonography, endoscopy, stereotactic and intraoperative imaging technology has certainly improved the transcortical

removal of tumors in the lateral ventricle. In selected cases, as in large tumors with significant hydrocephalus or under thinned cortex, the transcortical approach is the most appropriate approach and should be considered by the neurosurgeon.

List of Abbreviations

CSF: Cerebro-spinal fluid.
CT: Computerized Tomography.
EDH: Extradural hematomas.
EVD: External ventricular drain.
GBM: Glioblastoma Multiforme.
GTR: Gross total resection.
IV: Intra ventricular.
MRI: Magnetic Resonance Imaging.
SEGA: Subependymal Giant cell Astrocytoma
VP: Ventriculo-Peritoneal shunt.

Disclosure

The authors report no conflict of interest in the materials or methods used in this study or the findings specified in this manuscript.

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