# Evaluation of Limited Anterior Transcallosal Approach for Excision of Anterior Lateral Intraventricular Tumours

*Hazem Abul-Nasr MD*
Neurosurgical Department Cairo University

## ABSTRACT

***Objective:*** *The purpose of this study is to analyze a subgroup of patients harboring anterior lateral intraventricular tumours operated via limited anterior transcallosal approach, as regard clinical presentation, neuropathology postoperative results and complications.* ***Method:*** *Twelve patients of anterior lateral intraventricular tumours were included in this study. They were 7 males and 5 females with age ranging from 7 to 42 years, and the median age was 21 years. The most common presenting complaint was headache (42%) followed by cognitive dysfunction (17%) and gait disturbance (17%) while visual deficits and focal fits were the least. Preoperative clinical and neuroradiological evaluation was performed for every patient including MRI and MRA or CT angiography to evaluate parasagittal venous drainage. The surgical technique was discussed and all patients were operated via the limited anterior transcallosal approach with a callosotomy 2 cm or less. Total tumour excision was accomplished in 10 patients (83%) and subtotal in the remainder. We had 4 cases of ependymoma (42%), 3 cases of Astrocytoma G II (25%), 3 cases of central neurocytoma, (25%) and one case of juvenile pilocytic astrocytoma, (8%) and one case of choroid plexus papilloma (8%). Regarding complications we had 2 cases of residual hydrocephalus who required ventriculoperitoneal shunting, (17%), one case of focal seizure due to a small venous infarction (8%), one case of subdural hygroma (8%) required burr hole drainage, and one case of transient mutism (8%). There were no disconnection syndromes, no further neurological deficits or any mortality.* ***Conclusions:*** *The limited transcallosal approach is an ideal route to reach tumours of the anterior lateral ventricle with very limited morbidity and mortality in comparison with other approaches, provided that good preoperative planning and meticulous operative technique are performed.*

## INTRODUCTION

Tumours of the lateral ventricle tend to grow slowly and are often benign; thus by the time that they present to the surgeon, most have reached a significant size[5]. There are several approaches to the lateral ventricle and the choice of the best route is largely dictated by the location of the tumour. The goal is to have the shortest possible route to the tumour, while minimally disturbing the intracranial anatomy5. The studies of Bogen and Sperry[13,14] confirmed the relative safety of callosal sectioning when the splenium is spared. As a result, the past years have witnessed an increased interest in the anterior transcallosal approach to reach the lateral and third ventricles.[6,15,16] It is well documented in the literature that section of the entire corpus callosum is followed by the disconnection syndrome (i.e. akintic mutism, motor apraxia, tactile agnosia, autiditory suppression, hemialexia and hemianopia) [17,18, 19]

Section of the anterior two thirds of the corpus callosum does not produce the disconnection syndrome, but only memory deficits that are of a lesser degree compared with those in patients undergoing complete commissurotomy[7]. Limited section

(2.5 cm or less) of the anterior portion of the corpus callosum does not produce any measurable memory deficits. Moreover, this approach is preferred by many authors because the lateral and third ventricles can be reached easily irrespective of ventricular enlargement, lower risk for secondary cortical damage, less incidence of postoperative epilepsy and motor deficits, and it offers a natural route for dissection ( Interhemispheric fissure) and anatomical landmarks for orientation [1].

## CLINICAL MATERIAL AND METHODS

*Patient population:*

Between October 2002 and December 2007 we selected 12 patients of anterior lateral intraventricular tumours in this study. The patients consisted of 7 males and 5 females with ages ranging from 7 to 42 years, with a median age 21 years. The disease course ranged from one month to 3 years. The various clinical manifestations are described in table 1.

**Table 1:** The clinical presentation of the patients in this series of lateral intraventricular tumours

| Clinical presentation | No. | % |
|---|---|---|
| Headache | 5 | 41.7 % |
| Cognitive dysfunction | 2 | 16.7 % |
| Gait disturbances | 2 | 16.7 % |
| Visual deficits | 1 | 8.3 % |
| Focal symptoms | 1 | 8.3 % |
| Focal fits | 1 | 8.3 % |

The most common presenting symptoms were headache (41.7%) which was insidious and of long duration in most cases. Headache was unilateral in 2 patients that was similar to migraine, and one of them reported positional changes of headache severity. Cognitive dysfunctions and gait disturbances were the second common presenting complaints. Cognitive affection was characterized by a marked drop in the performance IQ compared with the verbal IQ which points to the obstructive hydrocephalic changes accompanying these tumours. The patient with visual disturbances was suffering from bilateral papilloedema.

*Neuroradiological evaluation*

All patients were diagnosed via CT scan and MR images with contrast. MRI helped to define the site of the tumour in the lateral ventricle, its size, enhancement, attachment and its other image characteristics, and hence the pathological type of the tumour could be expected. Also accompanying hydrocephalus could be clearly shown. We did also for all cases magnetic resonance venography and/or computed tomographic venography to assess the venous anatomy and its distribution at the parasagittal region and if there was a significant venous tributaries draining into the superior sagittal sinus at the region of the coronal suture to reduce the potential for venous infarction during preparation of the corridor to the corpus callosum. We planned the approach from the nondominant side in all cases except one case in which a

wider corridor was available on the dominant side respecting the venous drainage of the other side.

*Surgical technique*

After the induction of general anesthesia, the patient is positioned supine, with head placed in the neutral, pin fixation and flexed to 15 degrees. A bicoronal skin incision was used, that afforded visualization of the coronal suture and at least the anterior 4 cm of the sagittal suture. We used a 6X4X4 cm trapezoid bone flap that is centered two-thirds infront of and one-third behind the coronal suture with complete sagittal sinus exposure, principally based on the right. A trapezoid dural opening was used, with the broad base placed medially toward the sinus. As the flap is reflected, the bridging veins are identified and preserved, although we have sacrificed bridging veins that reside anterior to the coronal suture without untoward effects, we have preserved any large parasagittal vein draining into the sinus behind the coronal suture especially if it was evident in the preoperative magnetic resonance venography or computed tomographic venography. The dura was then retracted across the midline taking care not to place too much tension on the dural flap, because this can partially or completely occlude the sagittal sinus.

The falx-cortical interface was then identified and the plane is developed by placement of cotton patty and by application of a 19 mm retractor blade from the right side. The interhemispheric corridor used was 5 cm in length and 1.5 cm in width so as to minimize retraction injury. Brain relaxation was also critically important to minimize retraction injury. A combination of hyperventilation, osmotic diuresis, and in few cases ventricular drainage was used to relax the brain.

The operating microscope was then brought and further dissection is continued separating the cingulated gyri, which has the typical tan-gray color of the cortical-pial surface, till reaching the corpus callosum which is relatively hypovascular and strikingly white. The white callosal carpet was better exposed between the two pericallosal arteries and 1X3 cm area was exposed. The callosal incision was 2 cm in length and was made with bipolar coagulation and suctioning with a 6-French suction tip. The corpus callosum can be variable in thickness, depending on the underlying tumour mass and/ or preexisting hydrocephalus, ranging from a thin layer to more than 1 cm.

Once the ventricle was entered the blade is advanced to retract the corpus callosum and the ipsilateral hemisphere. In most of the cases the intraventricular tumours were large enough to be encountered directly below the corpus callosum. In case of small tumours, intraventricular orientation is very important. In case of opening into the right lateral ventricle, the thalamostriate vein was found to the right side of the choroid plexus. If callosal opening has led to the contralateral ventricle, the septum pellucidum can be opened to gain access to the contralateral ventricle taking care to preserve the fornices at the base. Tumour resection was facilitated by maintaining the dissection plane between the ependyma and the lesion. Because in most cases the tumours were large we first decompressed the tumour from within and then identified the space between the tumour edge and ependyma. In case of vascular tumours early identification and transection of the

feeding vessels was only feasible in case of small and medium size tumours, while in case of large tumours the blood supply was encountered after sufficient debulking of the tumour. After tumour resection, it was important to ensure complete hemostasis, to prevent ventricular obstruction and hydrocephalus. The blood that may have accumulated should be gently irrigated out, and ventricles were filled with saline and a ventricular catheter was inserted and the wound was closed in the usual fashion.

*Postoperative care*

Ventricular drains were left in place for 24-48 hours, and intraventricular pressure was observed and monitored. The patients remained in the intensive care unit for 48 hours after surgery and computed tomography or MRI was performed in all patients within the first 24 to 48 hours postoperatively.

## RESULTS

A total number of 12 patients of purely anterior lateral intraventricular tumours were operated via the anterior transcallosal approach. Total resection of the tumour was accomplished in 10 cases (83.3%) and subtotal in two cases (16.7%). In these latter two cases one had a tumour attached to the thalamus below, and the other case had an attachment to the lateral ventricular wall. Both cases had astrocytoma G II. Regarding neuropathological features, all tumours encountered in this study were benign or low grade tumours see table 2.

**Table 2:** Pathological types of lateral intraventricular tumours in this series

| **Pathological type** | **No.** | **%** |
|---|---|---|
| Ependymoma | 4 | 33.3 % |
| Astrocytoma GII | 3 | 25 % |
| Central neurocystoma | 3 | 25 % |
| Juvenile pilocytic astrocytoma | 1 | 8.3 % |
| Choroid plexus papilloma | 1 | 8.3 % |

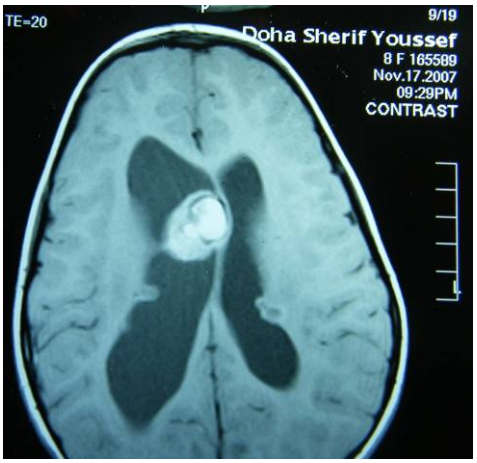
Regarding limitations of the transcallosal approach in this study, we had operated all cases via the non dominant right side, except one case whose preoperative MR venography showed a big parasagittal vein about one cm behind the coronal suture and we preferred to operate via the left side.

As regard complications see table 3, we had one case of postoperative contralateral seizures, and follow up MRI showed small venous infarction due to venous occlusion in the area of the coronal suture, which was controlled with antiepileptic medications. We had a case of subdural hygroma that collected after one month of surgery, and the patient presented with contralateral heaviness, see fig. F. After burr hole drainage it resolved completely and heaviness was cured. We had a case of transient mutism, which improved within one week after surgery. Two cases had residual ventricular dilation together with manifestations of increased ICP in spite of total tumour removal. Both cases required ventriculo peritoneal shunting.

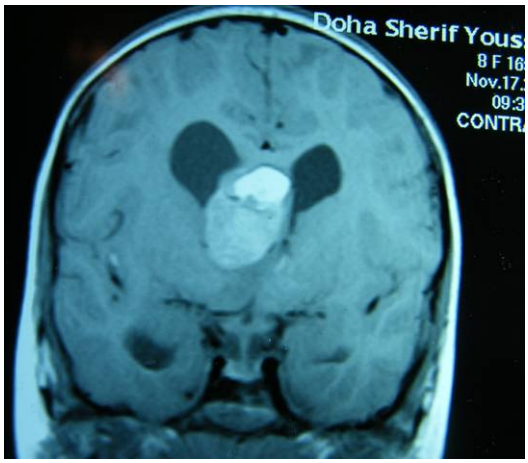
**Table 3:** Postoperative complications encountered in this series of lateral intraventricular tumours

| **Complications** | **No.** | **%** |
|---|---|---|
| Residual hydrocephalus | 2 | 16.7% |
| Seizure | 1 | 8.3% |
| Subdural hygroma | 1 | 8.3% |
| Transient mutism | 1 | 8.3% |

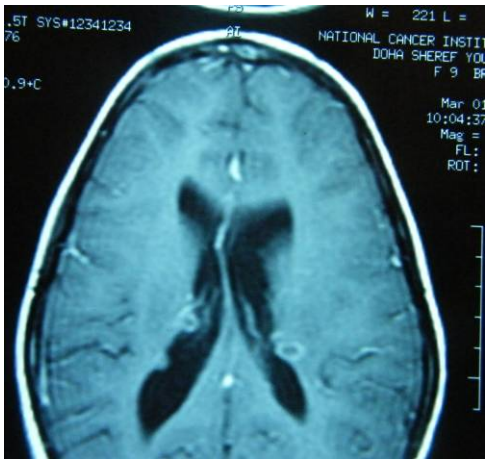
There were no disconnection syndromes, no further neurological deficits, or any mortality.



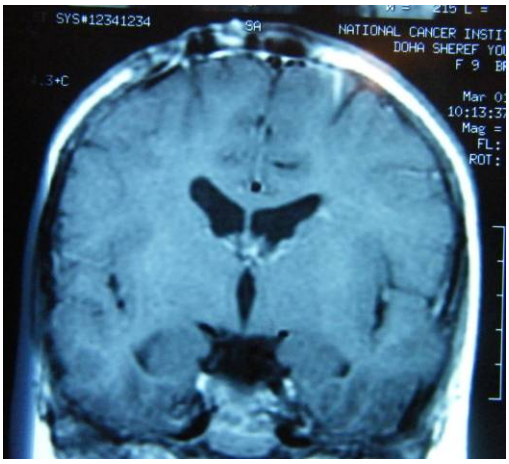

***A) Axial T1 MRI with contrast showing a tumour in the right anterior part of the body of the lateral ventricle with heterogenous enhancement and associated hydrocephalus.***



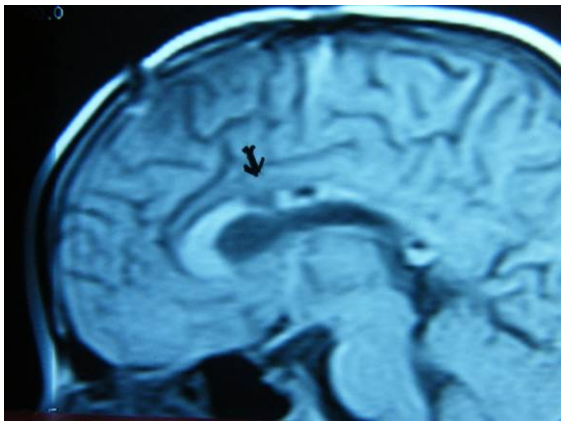

***B) Coronal T1 MRI with contrast for the same patient in A***



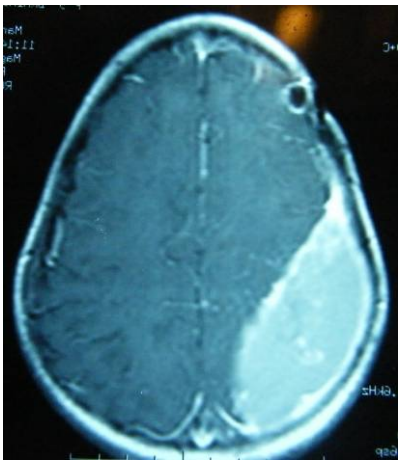

***C) Postoperative follow up axial T1 with contrast showing complete tumour excision and resolving hydrocephalus.***



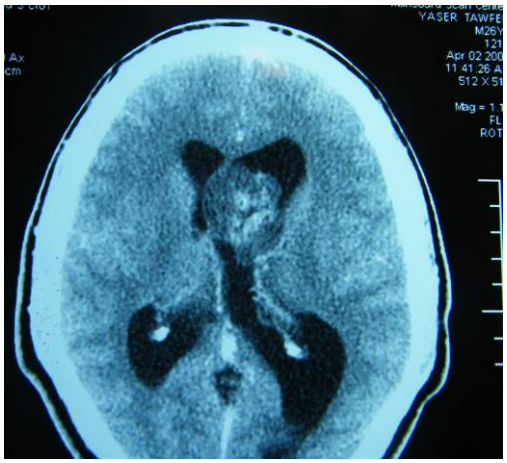

***D) Postoperative follow up of the same patient in C showing complete excision of the tumour and the transcallosal craniotomy***



***E) Follow up sagittal T1 MRI image showing the small callosotomy in the patient in C (arrow).***



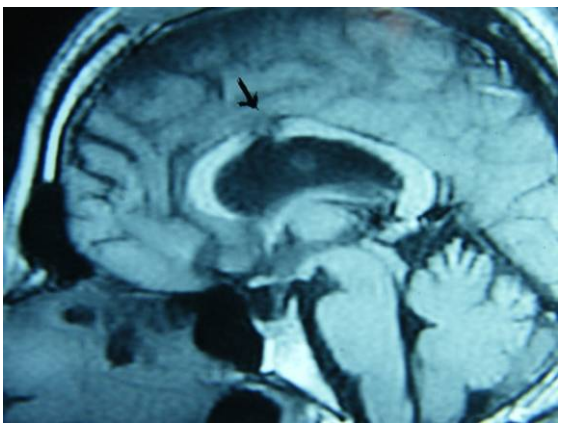
***F) Subdural hygroma developed in the same patient in C few months after surgery that required tapping.***



***G) CT scan of another case of anterior lateral intraventricular tumour with associated hydrocephalus.***

***H) Axial T1 MRI image with contrast of the same patient in G showing bright enhancement of the tumour.***


***I) Follow up axial T1 MRI with contrast of the same patient in G showing complete tumour excision.***



***J) Follow up sagittal T1 image of the same patient in G showing the small callosotomy.***

## DISCUSSION

Tumours of the lateral ventricles tend to present with similar symptoms. The clinical presentation depends more on location and less on individual pathology. Eighty-five percent of lateral ventricular tumours grow slowly; as a result most symptoms present insidiously and are of long-term duration. Most of these patients present with hydrocephalus, which is often obstructive and unilateral. Headaches (which can be unilateral), gait disturbance, and cognitive changes are the hallmarks of hydrocephalus[5,8,9]. In this study headache caused by obstructive hydrocephalus was the main presenting complaint, (42%). Cognitive dysfunctions (17%) and gait disturbances (17%) were also attributed to the obstructive hydrocephalic changes. Moreover, visual deficit was related to bilateral papilloedema in one case (8%), also caused by hydrocephalus. This means that, obstructive hydrocephalus caused most of the symptoms of the patients in this study (83%) while focal manifestations and fits were much less common.

Lateral ventricular tumours are varied in their pathology, and arise from cellular elements found within and around the ventricular walls. Most of these tumours are low-grade, slow-growing tumours[5]. These include low grade gliomas, which make up 50% of lateral ventricular tumours, and choroid plexus papilloma and meningromas which together account for an additional 30%. Neurocytomas, ependymomas, teratomas and metastases each account for about 5%. Recent use of immunohistochemistry has helped to identify neurocytomas that exhibit positive staining with synaptophysin, and it is likely that neurocytomas are more common than was previously recognized[10,11]. Regarding location, tumours of the anterior part of the lateral ventricle (body and frontal horns) account for 45% of lateral ventricular tumours, where gliomas and neurocytomas are more common, while ependymomas and meningiomas are less common.[5,10,11] In this study ependymomas were the most common (33.3%), which might be due to the relative young age and small number of cases in the study, followed by astrocytomas (25%) and central neurocytomas (25%).

In 1949 Greenwood [31] described an anterior transcallosal approach for the removal of a third ventricular colloid cyst. Because of the development of microneurosurgical techniques in the 1970s, the anterior transcallosal approach became widely used for the removal of lateral and third ventricular lesions[3,28,33,35,36]. This approach offers natural anatomical planes for dissection, and various anatomical landmarks that establish orientation. A cortical incision is not required; thus the risk of postoperative motor deficits and epileptic seizures is markedly reduced.[3,29,30,32,33,34] D'Angelo et al.[2] noted that drawbacks associated with transcortical approaches were related to postoperative seizures, intracerebral hemorrhage and in hydrocephalic patients the trajectory obtained from the exposure is not optimum after decompression of the ventricles by CSF drainage. They stated that traversing the cortex may predispose patients to seizure disorders and necessitate use of long-term anticonvulsant therapy. The reported risk of postoperative seizures after transcortical approaches ranges from 29 to 70%, whereas after transcallosal procedures, the reported risk is 0 to

10% [21, 22, 24, 25, 27, 32]. In our study we had one case of postoperative seizures (8.3%) caused by a small venous infarction at the area of the coronal suture caused by venous occlusion. This concludes that preservation of venous drainage overrides other considerations for placement of the craniotomy, and preoperative magnetic resonance venography and/or CT angiography are mandatory for preoperative planning.

Following transcallosal surgery the results of postoperative tests of attention, verbal memory, and disconnection are analyzed and compared with the preoperative results. D'Angelo et al.[2] found no correlation between the transcallosal approach and mental derangement noticed postoperatively, but there was definite correlation with the preoperative clinical condition, and longer or chronic history of hydrocephalus. Other reported drawbacks with transcallosal approaches include confabulations, aphasia and astereognosis[23,26], which occur mainly due to wide callosal incision more than 3 cm. These drawbacks were not detected in our patients as we used a limited callosal incision not exceeding 2 cm.

Mutism was reported after transcallosal surgery as one of the rare complications associated with bilateral cingulate gyrus retraction[26]. D'Angelo et al.[2] reported mutism in 2 out of 16 patients following transcallosal approaches, which resolved after one week. We had one case of mutism out of 12 patients, which resolved also within one week.

Despite good resection of intraventricular tumours, hydrocephalus persists in up to 33% of patients[5]. These patients require shunting. Furthermore these shunts may malfunction (in > 20%), likely because of the higher protein content in the CSF[5]. In this study 2 cases (17%) required postoperative shunting, in spite of complete tumour excision. Approximately 10% of patients who undergo ventricular surgery will require drainage of a subdural collection later on, and the more pronounced the preoperative ventriculomegaly, the higher the risk of this complication[5,12]. In our study one patient only (8%) developed subdural collection which required burr hole evacuation.

When transcortical and transcallosal techniques are compared for lateral and third ventricular tumour resection, it is apparent that transcallosal technique is superior with respect to cognitive function preservation[20]. Limited callosal incision (2 cm or less) was not associated with any worsening in cognitive, affective or behavioral tests and it does not cause interhemispheric disconnection syndromes[1,4,34]. We can finally conclude that reaching anterior part of the lateral ventricular cavity obliges the surgeon to choose a route that invariably requires an incision of the brain parenchyma. Therefore, the method of choice is that which cause the least amount of clinically relevant brain damage. In the transcallosal approach, microsurgical techniques limit the damage because a 2-cm opening of the corpus callosum allows visualization and treatment of intraventricular lesions with sufficient safety. Anatomically, the transcallosal approach has various advantages. The vascularity of the corpus callosum is modest and thus an incision does not cause great vessels sacrifice, both ventricles can be reached through the same incision, and the dimension of the ventricles does not represent a

contraindication to this approach. Last, dissection of the corpus callosum carries little or no incidence of postoperative epilepsy. Clinical and neuropsychological evaluations have documented that limited section of the anterior third of the corpus callosum (2 cm or less) does not, in itself cause significant deficits in personality or behavior, and it does not cause disconnection syndromes.

## CONCLUSIONS

We believe that the limited transcallosal approach is the route of first choice to approach tumours of the anterior part of the lateral ventricle because of its limited mortality and postoperative morbidity. Although this decision also implies some technical and surgical considerations, the restricted access, and the spatial limitations of the transcallosal route, along with the necessary attention to the manipulation of several structures (i.e. the bridging veins, the cortex of the medial aspect of the right hemisphere, the superior sagittal sinus, the pericallosal arteries, and the veins of the corpus callosum) have never prevented the treatment of these neoplasms.

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