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# Surgical Approaches for Lateral Ventricular Trigone Meningioma

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## 1. Introduction

Intraventricular meningiomas account for 9.8-14% of all intraventricular tumors and for 20% of lateral ventricle tumors [1,2]. Meningiomas of the lateral ventricle constitute 0.5-4.5% of all intracranial meningiomas [3,4]. Between 60% and 94% of them arise from the choroid plexus at the trigone. The predilection for the trigone may be attributed to the abundance of choroid plexus arachnoidea. The clinical manifestations of lateral ventricular meningiomas depend on the tumor size [5]: A small tumor causes no clinical symptoms because the lateral ventricle has a relatively large compensating space. The most common initial symptoms are headaches, vomiting and consciousness disturbance related to increased intracranial pressure. Sensori-motor deficits, clumsiness, ataxia, and cognitive impairment including dysphasia, dyslexia, dysgraphia, and dyscalcula, are sometimes observed according to the tumor location. Visual field deficits and seizures are present, especially in patients with large tumors. Other unusual symptoms, such as epilepsy, can also occur [6]. Cushing and Eisenhardt grouped the symptoms caused by large ventricular meningiomas into the following types [7]: (a) headache caused by increased intracranial pressure; (b) contralateral spotted homonymous hemianopsia; (c) contralateral sensory disturbance and hemiparesis; (d) symptoms of cerebellar damage; and (e) possible paralexia in patients with tumors located on the left side.

The radiological appearance of intraventricular meningiomas is similar to those at other locations. CT and MRI demonstrate the tumors as a well-defined mass. Most tumors display homogeneous and strong enhancement with contrast medium. Perifocal edema is evident, and minimal to massive calcifications are present in 47% of cases [4,8,9,10,11]. Hydrocephalus or a trapped occipital horn can be observed in patients with large tumors. Angiography shows the tumors to be supplied by both the anterior and posterior choroidal arteries, or by the posterior choroidal arteries only. The cisternal and initial ventricular segment is pushed down and forward by the enlarging temporal horn. The blood supply is predominantly from the anterior choroidal artery, and large tumors receive a significant supply from posterior choroidal artery. Intraventricular meningiomas show the characteristic histological appearance of meningioma. Bertalanffy et al. reported that the majority (75%) of such tumors were of the meningothelial or mixed type, and that 19% were atypical.

## 2. Surgical approach

Surgical approaches for trigone meningioma is challenging, because excessive cortical dissection or brain retraction carries a risk of post-operative visual field deficit, speech disturbance, or epilepsy. Occlusion of posterior and anterior choroidal blood supplies is also important to achieve tumor hemostasis. Thus, there is still a degree of controversy regarding the optimal surgical approach for this tumour. Several surgical approaches have been described for trigone meningiomas, each with their proponents (Figure 1-A and B). In this chapter, recognised benefits and drawbacks of previously-reported approaches and the optimal approach for lateral ventricular trigone meningioma are discussed.

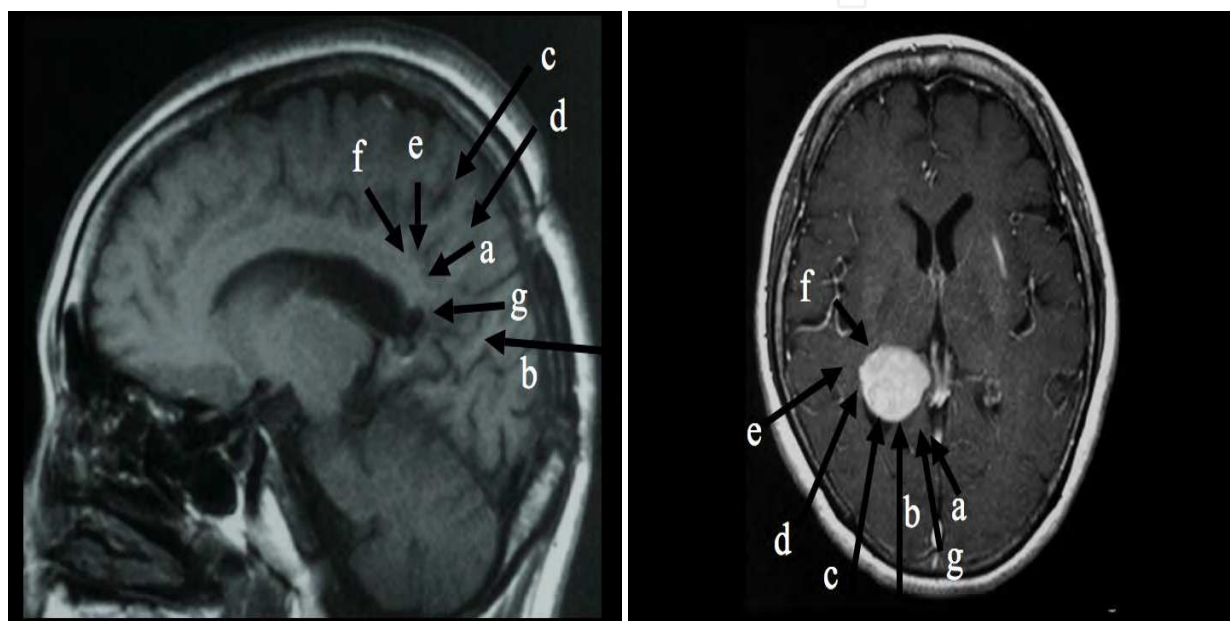


Fig. 1. (A: sagittal view, B: axial view) Surgical approaches devised for trigone meningiomas (a: occipital trans-callosal, b: lateral occipital, c: high parietal paramedian, d: inferior parietal, e: temporal horn, f: lateral trans-sulcal, g: occipital interhemispheric)

### 2.1 Occipital trans-callosal approach (Figure 1-a)

The trans-callosal approach is an appropriate choice for excision of third-ventricular lesions when the corpus callosum section is limited to the anterior two thirds of the body and the genu. Occipital craniotomy and a trans-callosal approach reduce the incidence of postoperative seizures, speech disturbance and visual field deficits [13], and facilitate early exposure of the posterior choroidal artery. This procedure can be performed without significant postsurgical deficits attributable to the disconnection procedure, especially for small trigonal tumors. The disadvantage of this approach is complete section of the splenium of the corpus callosum, which interrupts the transfer of cortical visual information from the non-dominant hemisphere to the speech centres. When right homonymous hemianopsia is associated with complete section, alexia without agraphia may occur. Also, preoperative right homonymous hemianopsia is a relative contraindication for the trans-callosal approach.

## 2.2 Lateral occipital approach (Figure 1-b)

Lateral occipital lobectomy can reduce the degree of cerebral retraction, although the vascular pedicles may not be easily accessible [14]. When the brain surface is incised near the angular gyrus, it can result in homonymous hemianopsia or alexia [15]. Use of this approach is limited to avascular tumors and patients with homonymous hemianopsia caused by relatively large tumors.

## 2.3 High parietal paramedian approach (Figure 1-c)

A high parietal paramedian incision usually extends from the postcentral to parieto-occipital fissure, approximately 3 cm from the falx, and lies medial to the majority of visual fibers, and running parallel to their projection [16]. A high parietal paramedian incision, which may avoid damage to the optic radiation or creation of a permanent speech deficit, sometimes causes motor weakness or seizures. However, Fornari et al. reported that although this approach caused no permanent motor or speech deficits, it preserved visual function in only 2 of 18 patients [9]. This approach can cause postoperative neurological deficits associated with parietal lobe function and visual-spatial processing. Apraxia and acalculia may occur in the dominant hemisphere. Another drawback of this approach is that it cannot provide early exposure of the feeding arteries.

## 2.4 Inferior parietal approach (Figure 1-d)

An inferior parietal incision minimising the depth of brain that needs to be traversed, brings the surgeons close to the tumor. However, homonymous hemianopsia can occur if the lateral aspect of the optic radiation is divided [17,18]. Manipulation of the angular gyrus in the dominant hemisphere also carries a risk of language impairment including agraphia, alexia, acalculia, and sometimes Gerstmann's syndrome. In the non-dominant hemisphere it jeopardises retention of visual information or spatial perception. Another serious drawback is that early exposure and hemostasis of the feeding arteries are difficult with this approach, and it is particularly contraindicated for highly vascular tumors.

## 2.5 Middle temporal and temporal horn approach (Figure 1-e)

A temporal horn approach through the middle temporal gyrus allows preliminary occlusion of the anterior choroidal artery [19]. This approach can minimize the depth of brain that needs to be traversed. Postoperative homonymous visual field impairment may occur, but damage to the optic radiation can be minimized if the incision is parallel to the optic fibers. However, it can cause speech and auditory comprehension deficits. Anomic aphasia can occur after excision of a meningioma in the dominant hemisphere via a middle temporal gyrus incision [19]. An anterior temporal horn and trigone approach via a more inferior temporo-occipital incision, lessening the degree of speech deficit [20], can cause a superior quadrant field defect. Damage to the dominant middle temporal gyrus may impair capabilities for reading, naming and phoneme identification [20]. The non-dominant middle temporal gyrus is associated with recognition of emotion. While the posterior choroidal artery is not visible until the majority of the tumor has been removed, early control of the anterior choroidal artery can be achieved. This approach can be a first choice for vascular meningioma of the non-dominant hemisphere, fed mainly by the anterior choroidal artery.

## 2.6 Lateral trans-sulcal approach (Figure 1-f)

A lateral trans-sulcal approach involves opening of the posterior part of the sylvian fissure or superior temporal sulcus [21]. This approach through the former and latter has been adopted for patients with a wide and a narrow sylvian cistern, respectively, and can reduce the risk of morbidity even in the dominant ventricle by minimizing any damage to the temporal gyrus. Nagata et al. have reported that patients with meningiomas in the dominant hemisphere exhibited transient amnesic aphasia and dyscalculia postoperatively, but the symptoms disappeared in a few days or weeks [21].

## 2.7 Occipital interhemispheric subcortical approach (Figure 1-g)

This approach invariably minimises postoperative neurological deficits including any damage to the lateral aspect of the optic radiation or corpus callosum [22]

*Patient position and extent of craniotomy:* When this approach is performed with the patient in a sitting position, there has been significant concern about the risk of venous air embolism. Also, it is occasionally difficult to reach the para-splenic cisterns for release of cerebrospinal fluid (CSF). The occipital interhemispheric approach can be performed in the lateral semi-prone position (Figure 2). Positioning the head of the patient so that the tumour-containing ventricle is oriented downwards and laterally allows easy access to the para-splenic cisterns without risk of venous embolism. As the tumour-containing occipital lobe is pulled down by gravity, retraction of the medial surface of the hemisphere can be reduced. In most cases of meningioma, this approach does not require preoperative lumbar spinal drainage or intraoperative ventricular tap. Before the cortical incision, the arachnoid around the bridging veins entering the great vein of Galen should be dissected and safely released. Retraction becomes progressively easier as the tumour is debulked and cerebrospinal fluid is released from the ventricle, thus decreasing the risk to the visual cortex resulting from retraction. After releasing CSF from the para-splenic cistern, a brain retractor is used so as not to pull back the occipital lobe, but only to open the incised brain surface. Occipital craniotomy seems adequate for surgical manipulation of the tumour, because the occipital interhemispheric fissure often lacks important bridging veins in comparison with the parieto-occipital interhemispheric fissure.

*Tumor landmark:* The area of cortical incision is important for minimally invasive microsurgery. Intraoperative navigation to identify the tumours can allow easy access to the tumour surface (about 1 cm in depth) and minimise any brain damage. Ultrasonography can be used for tumor identification (Figure 3), and the great vein of Galen is a good landmark. Small tumours less than 2.5 cm in diameter can be removed via an incision less than 1.5 cm long.

*Hemostasis of tumor vasculature:* Most lateral trans-cortical and trans-sulcal approaches, except for the temporal horn approach, do not allow early access to the vascular pedicles, as blood supply is sparser in the lateral aspect of the tumour. This approach, allowing early exposure of the medial surface of the tumour without injury to the splenium, is as useful as the trans-callosal approach. The posterior and anterior choroidal blood supplies are usually from the posterior- and anterior-medial aspects of the tumour, respectively (Figure 4). Debulking of the medial part of the tumour first allows early control of the posterior, and then anterior, choroidal blood supplies to the lesion.





Fig. 2. Lateral semi-prone position, positioning the head of the patient so that the tumour-containing ventricle is oriented downwards and laterally



Fig. 3. Intraoperative ultrasonography used for tumor identification as well as intraoperative navigation (arrow: tumour contour)

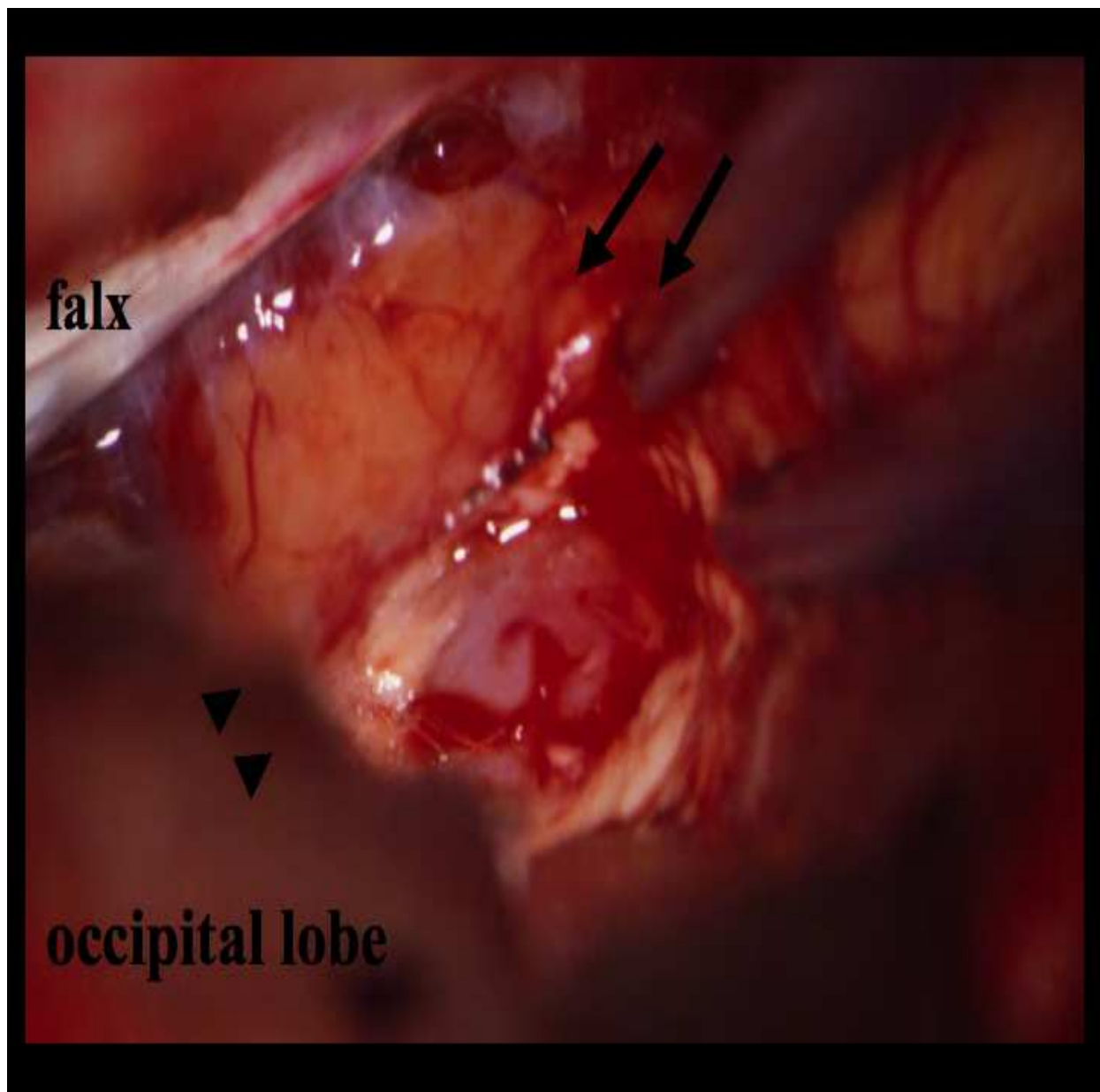


Fig. 4. Intraoperative view of the trigone meningioma. In cases of meningioma, the posterior and anterior choroidal blood supplies coming from the posterior- (arrowhead) and anterior-medial aspects (arrow) of the tumour, respectively.

*Special remarks:* Immediately after surgery, some patients have mild left-sided visual agnosia, but this resolves completely within one day after the operation. After surgery, there is a lower incidence of postoperative seizures, and no risk to speech function. One pitfall of this approach is possible transient memory disturbance in the dominant hemisphere. Special care must be taken so as not to injure the fornix, as this can cause permanent sequelae, even in cases where the tumour is located in the non-dominant hemisphere. Cognitive function should be carefully evaluated when this approach is adopted for a trigone meningioma in the dominant hemisphere. An occipital inter-hemispheric and transcortical approach with the patient in the lateral semiprone position is useful for decreasing the risk of post-operative hemianopia, epilepsy, or speech disturbance, even in patients with a tumour in the dominant hemisphere.



*Similar approach to other brain tumors:* The occipital interhemispheric approach has been used for pineal region tumors and tentorial meningioma (Figure 5). The occipital interhemispheric transcortical approach can be used in patients with occipital tumors (Figure 6) or other trigone tumors (Figure 7). Special attention must be paid to brain edema, especially in patients with malignant tumors (Figure 7). Immediate and direct approaches to the trigone for release of CSF, or preoperative CSF drainage, are sometimes necessary. The blood supply of a malignant tumor differs from that of meningioma. Unlike meningioma, malignant tumors tend to have the vascular pedicles as a blood supply over the whole tumor surface. Also, CSF dissemination can occur in cases of malignant tumor, because this procedure is performed via the ventricle.

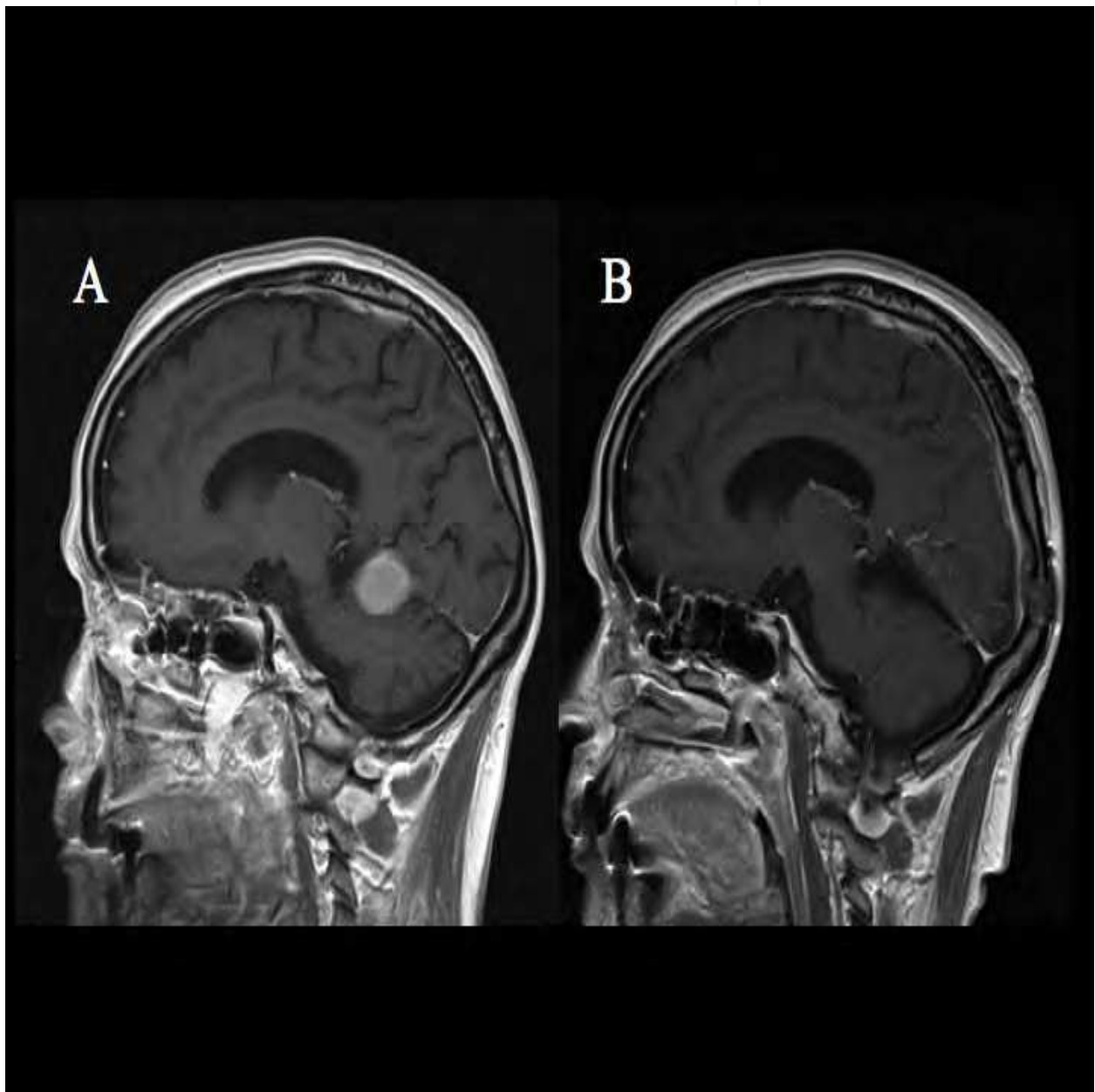


Fig. 5. tentorial meningioma. (A: preoperative MRI revealing left tentorial meningioma. B: postoperative MRI demonstrating total removal of the tumour)

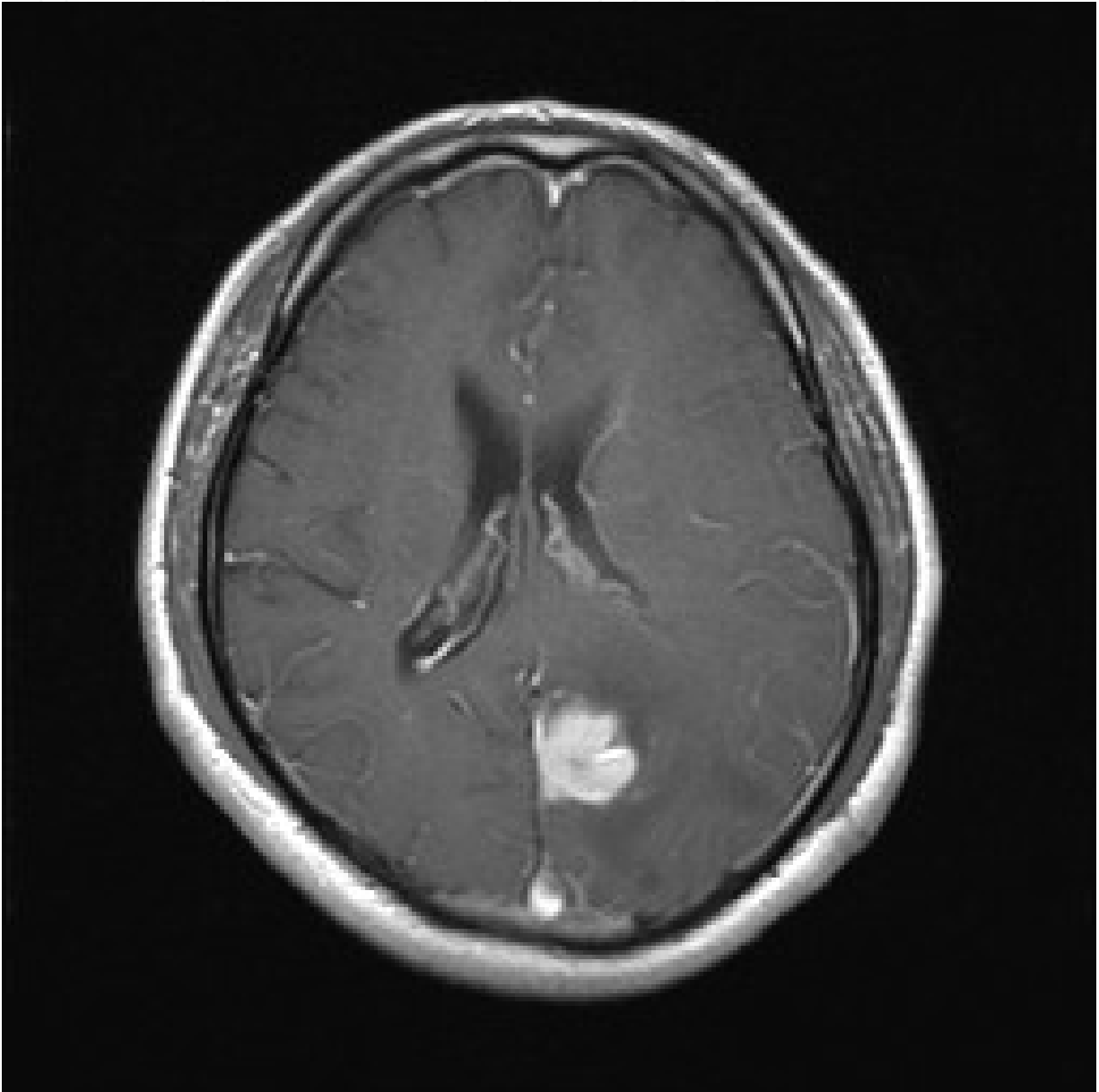


Fig. 6. Left occipital malignant lymphoma

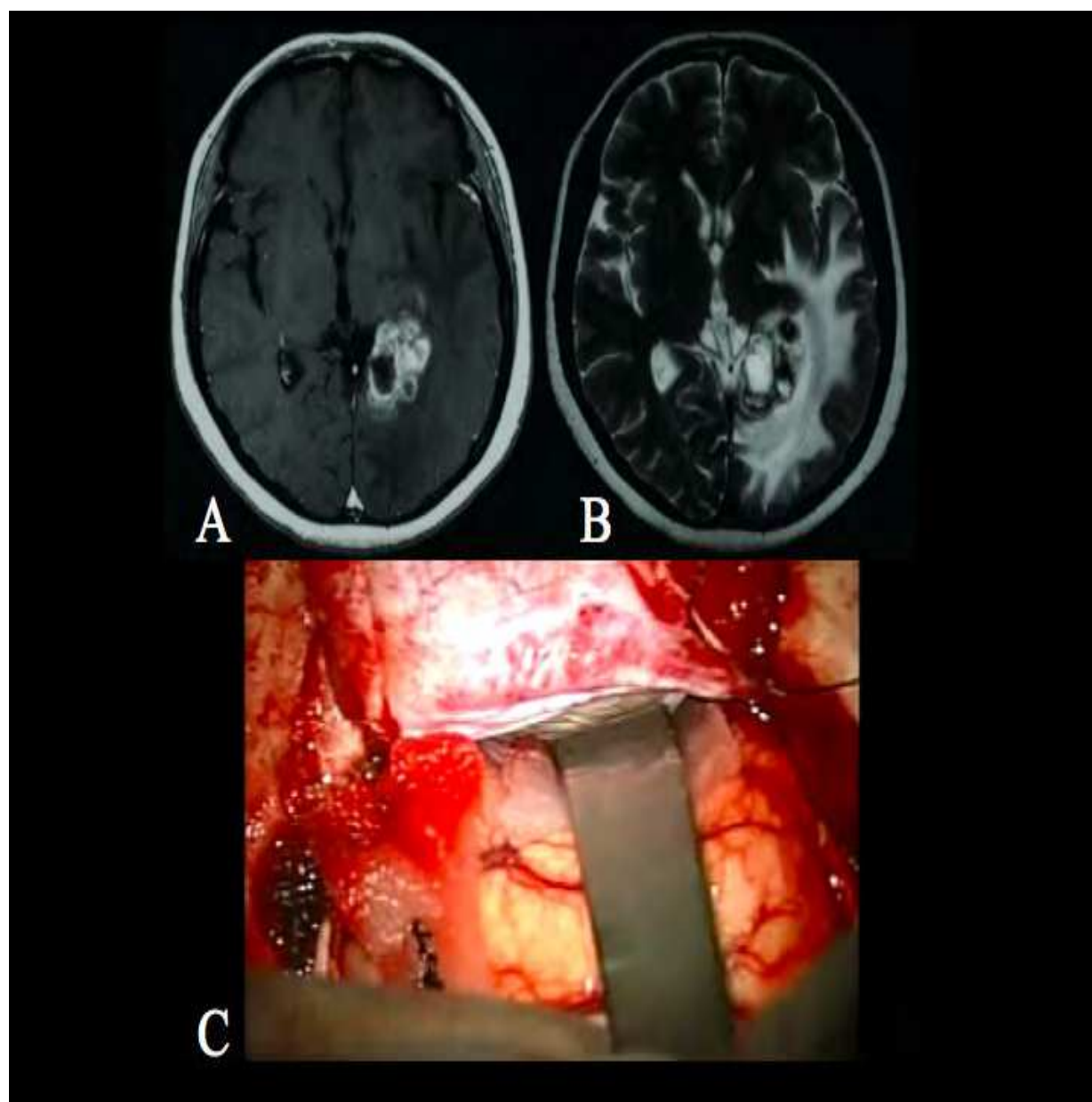


Fig. 7. Metastatic trigone tumor of the left trigone (A: T1-weighted image, B: T2-weighted image, and C: intraoperative view of the left occipital lobe)

## 2.8 Decision-making regarding the surgical approach for trigone meningiomas

The basic approach for a trigone meningioma is an occipital interhemispheric and transcortical one. A small or medium-sized tumor with a major blood supply from the posterior choroidal artery can be totally removed by this approach, even in patients with a tumor in the dominant hemisphere. A small or medium-sized trigone tumor supplied mainly by the anterior choroidal artery can also be removed via this single approach, although some blood loss can occur. For very large and vascular tumors fed equally by both the anterior and posterior choroidal arteries, an occipital interhemispheric and transcortical approach can be considered. For large vascular tumors in the non-dominant hemisphere fed mainly by the anterior choroidal arteries, an anterior temporal horn approach via an inferior

temporo-occipital incision can be considered, although speech disturbance, epilepsy, or a visual field defect may occur. Large vascular tumors in the dominant ventricle fed mainly by the anterior choroidal arteries are potentially the most hazardous. Piecemeal resection of the tumor is mandatory when the occipital interhemispheric approach is used. Blood loss can be fatal, especially in pediatric patients. No single approach seems adequate for tumor excision. The anterior part of the tumor is first removed via an anterior temporal horn and trigone approach using an inferior temporo-occipital incision without incising the posterior middle temporal gyrus, and at second surgery, the posterior part of the tumor can be removed using an occipital interhemispheric approach. At the first operation, awake surgery by mapping cortical speech areas before reaching the tumor, may be useful to prevent speech and auditory comprehension deficits.

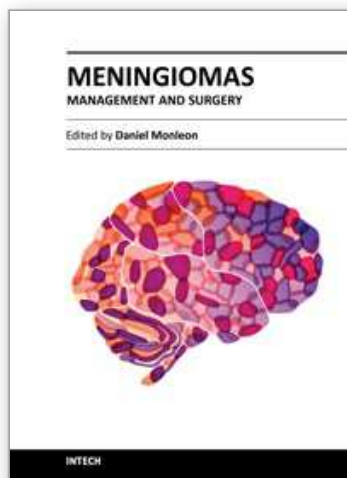
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