ISSN: 2643-4474

Salazar AL, et al. Neurosurg Cases Rev 2026, 9:181
DOI: 10.23937/2643-4474/1710181
Volume 9 | Issue 1
Open Access

Neurosurgery Cases and Reviews

CASE REPORT

Keyhole Minimally Invasive Resection of an Atrial Intraventricular Meningioma: A Case Report

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Abstract

Intraventricular meningiomas of the atrium of the lateral ventricle are rare lesions that present surgical challenges due to their deep-seated location and proximity to eloquent structures. Minimally invasive approaches aim to reduce cortical disruption while allowing safe and effective tumor resection.

A 47-year-old female with a history of chronic headaches over several years was evaluated by the neurology service. Neuroimaging revealed a well-defined, rounded lesion measuring 2.3 × 1.7 cm, with homogeneous contrast enhancement, located in the left atrium of the lateral ventricle. Vascular supply was identified from a pedicle associated with the choroid plexus, with venous drainage related to the internal cerebral vein. The patient underwent planned surgical resection using a minimally invasive keyhole microsurgical approach via a posterior temporo-occipital transcortical parafascicular corridor. Circumferential tumor resection was achieved with careful microsurgical technique.

Postoperative imaging confirmed gross total resection. The patient had an uneventful recovery, with no new neurological deficits and improvement in symptoms.

Minimally invasive keyhole approaches for atrial intraventricular meningiomas are safe and effective when supported by detailed anatomical planning and precise surgical execution. This technique minimizes brain disruption while achieving favorable oncological and clinical outcomes.

Keywords

Intraventricular meningioma, Lateral ventricle atrium, Keyhole neurosurgery, Minimally invasive neurosurgery, Transsulcal approach, Transtemporal approach, Neuron avigation, Microsurgical resection

Introducción

Minimally invasive cranial neurosurgery represents a history of challenges and periodic successes. For decades, the primary concern of neurosurgery has been to minimize the neurovascular impact of surgery [1]. Axel Perneczky, pioneer of keyhole neurosurgery conceptualized the goal of minimally invasive neurosurgery-operating with a minimum of trauma while achieving maximal surgical efficiency. However, Perneczky's basic message was not only the limited cranial opening but the limited approach-associated surgical traumatization achieved with less exploration of the surgical site and less brain retraction [2].

Intraventricular meningiomas are rare tumors, accounting for approximately 0.5 to 3% of all intracranial meningiomas. The majority arise in the atrium of the lateral ventricle. The surgical management of these tumors remains a considerable challenge because of

Citation: Salazar AL, Ramirez MAB, Moreno M, et al. (2026) Keyhole Minimally Invasive Resection of an Atrial Intraventricular Meningioma: A Case Report. Neurosurg Cases Rev 9:181. doi.org/10.23937/2643-4474/1710181

Received: May 06, 2026 : **Accepted:** June 06, 2026 : **Published:** June 09, 2026

their deep location and proximity to critical structures [3]. Meningiomas that arise in the atria of the lateral ventricles poses a unique challenge for surgery due to their deep-seated location and proximity to critical white matter tracts. Size and anatomical variations can affect the best approach for these tumors, with several approaches described to access the atrium including the interhemispheric trans-precuneus, trans-supramarginal gyrus, distal trans-sylvian, supracerebellar trans-collateral sulcus, and finally the trans-intraparietal sulcus approach [4]. Visual field deficits (VFDs) may be present preoperatively due to effects of the tumor-compressing elements of the visual pathways (referred to herein as tumor visual field deficits). VFDs may also arise after IVM resection (referred to herein as surgical VFDs) from damage to the optic pathways such as Meyer's loop or optic radiations draping over the atrium of the lateral ventricles [5].

Clinical Case

A 47-year-old female patient with a known history of Parkinson's disease, currently under treatment by the neurology service, presented with a holocranial headache of moderate intensity, predominantly in the morning, described as oppressive in nature and unresponsive to oral analgesics. The headache was not associated with nausea or vomiting.

On neurological examination, the following findings were documented: Glasgow Coma Scale score of 15/15 and a Karnofsky Performance Status of 100/100. Pupils were equal, round, and reactive to light. Additional clinical findings were consistent with manifestations related to her underlying Parkinson's disease.

On computed tomography (CT), an isodense, homogeneous, well-circumscribed, round intraventricular lesion was identified, located in the left ventricular atrium. On CT angiography, the lesion demonstrated afferent vascular supply arising from the choroidal arteries, with partial venous drainage through efferent vessels into the internal cerebral vein. The lesion measured 2.3 × 1.7 cm. No significant mass effect was observed, and there were no signs of hydrocephalus (Figure 1).

Contrast-enhanced magnetic resonance imaging (MRI) confirmed a well-defined, non-infiltrative lesion with minimal enhancement following contrast administration. No significant signal changes were observed on FLAIR or T2-weighted sequences. There was no evidence of perilesional edema or involvement of adjacent structures (Figure 2). On reconstructed vascular imaging (Figure 3) from contrast-enhanced magnetic resonance imaging (MRI), the tumor vascular network is visualized, demonstrating arterial supply via a pedicle arising from the choroidal arteries, with venous drainage into the internal cerebral venous system.

Surgical Technique

Under balanced general anesthesia, the patient was placed in the supine position with the head rotated contralaterally to the right. A shoulder roll was positioned under the ipsilateral shoulder to facilitate adequate rotation and alignment of the entry point parallel to the floor. The head was secured using a three-point fixation system with a Mayfield head clamp.

Neuronavigation was used for surgical planning to precisely define the cortical entry point and trajectory toward the intraventricular lesion. The entry point was located 5.3 cm superior to the external auditory canal and 3.5 cm posteriorly (Figure 4), corresponding to the projection of the posterior third of the superior temporal gyrus.

A curvilinear skin incision of approximately 4 cm was made in the left posterior temporal region. Subsequently, a minimal craniotomy measuring 3 cm in diameter was performed, centered on the previously planned entry point, enabling a minimally invasive posterior transtemporal, transsulcal approach through the superior temporal gyrus. Under microscopic magnification, careful sulcal dissection was carried out to access the atrial trigone of the lateral ventricle.

Following a cruciate dural opening, microsurgical dissection was performed under visualization with an OPMI Pentero 800 surgical microscope through the posterior aspect of the superior temporal sulcus, preserving cortical anatomy and minimizing retraction. A parafascicular technique was employed, advancing through a controlled surgical corridor to reach the atrial trigone of the lateral ventricle.

Upon entering the left ventricular atrium, the intraventricular structures were clearly identified, highlighting the ependymal lining with its smooth and glistening appearance. The choroid plexus was recognized and served as a key anatomical landmark for intraventricular orientation and progression toward the lesion.

Using this reference, the tumor was identified as a bluish-white mass with smooth borders, well circumscribed, non-infiltrative, and clearly distinguishable from the surrounding parenchyma. The lesion was mildly adherent to the ventricular walls but demonstrated sufficient mobility to allow safe manipulation.

A vascular pedicle was identified at the posteroinferior aspect of the tumor and was successfully coagulated and divided, resulting in a substantial reduction of its arterial supply. Additionally, a venous drainage component toward the internal cerebral vein was identified at the superomedial pole, which was carefully controlled. This allowed complete isolation of the lesion, facilitating its

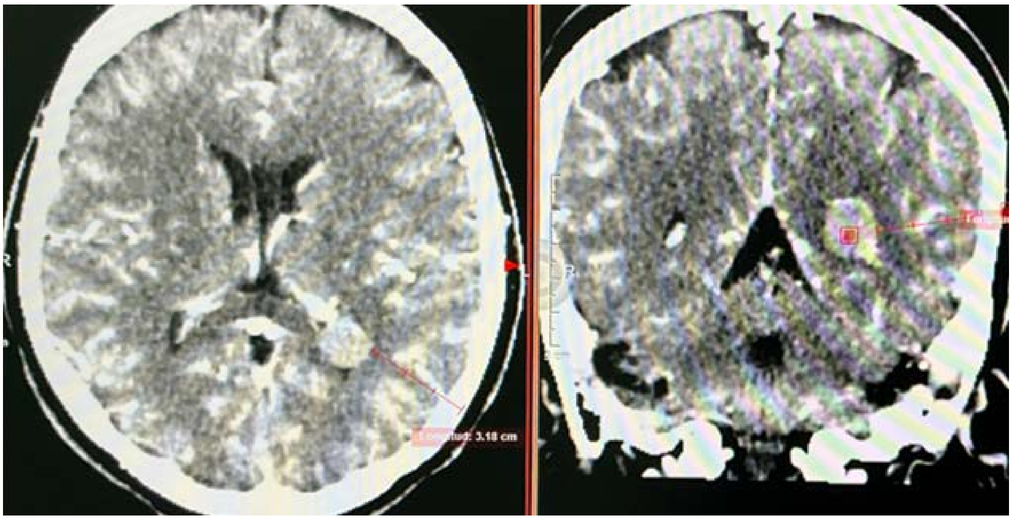

Figure 1: Visualization of a lesion in the left ventricular atrium on CT angiography, demonstrating minimal contrast enhancement and low vascularity.

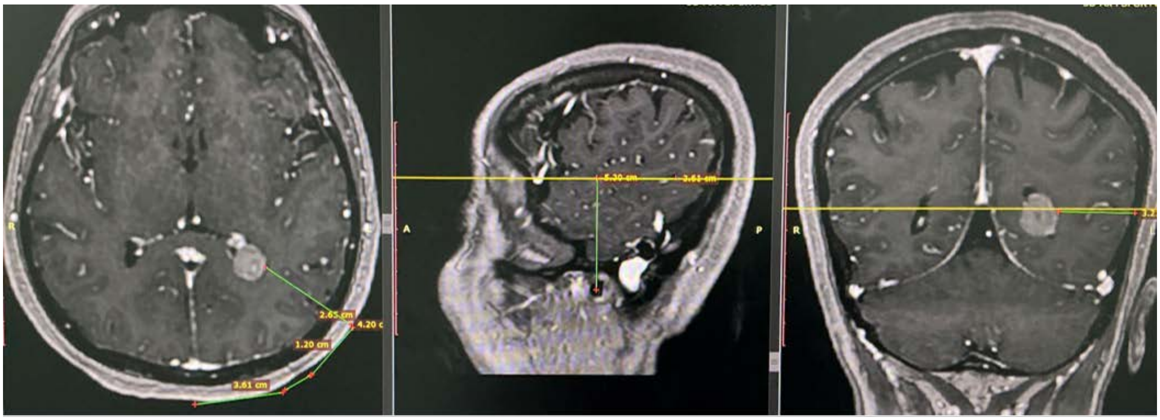

Figure 2: On contrast-enhanced magnetic resonance imaging (MRI), an iso- to hyperintense, homogeneous, well-circumscribed, round lesion is observed, located intraventricularly at the level of the left atrium.)

Figure 3: Three-dimensional vascular reconstruction image demonstrating the complex vascular network surrounding the intraventricular lesion.

Figure 4: The left image shows the marking of a minimally invasive 4 cm incision, with preservation of the patient's hair. The right image demonstrates neuronavigation confirming a minimally invasive posterior transtemporal, transsulcal entry point.

Figure 5: En bloc resected tumor specimen corresponding to an intraventricular meningioma. The lesion demonstrates a solid consistency and superficial vascularization, with macroscopic features consistent with a World Health Organization (WHO) Grade I diagnosis.

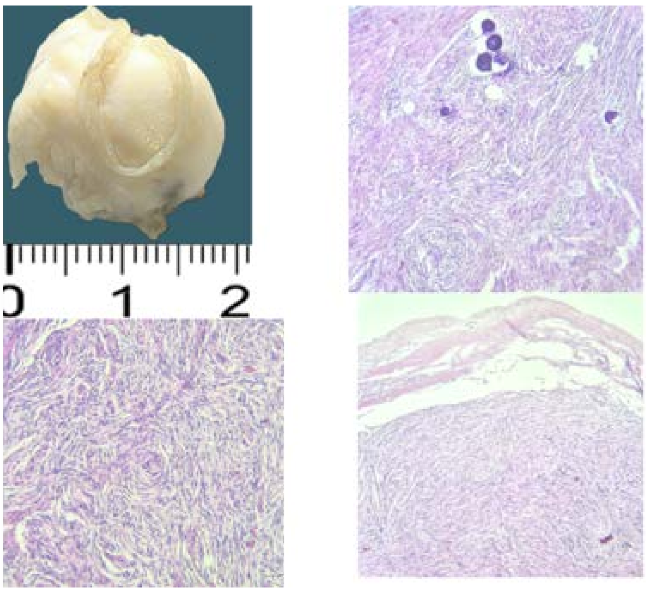

Figure 6: Photomicrograph of a fibrous meningioma composed of spindle-shaped cells with characteristic meningothelial whorl formation and psammoma bodies. The lesion appears well encapsulated. At 10 × magnification, prominent meningothelial whorls are observed, consistent with the histopathological features of this tumor.

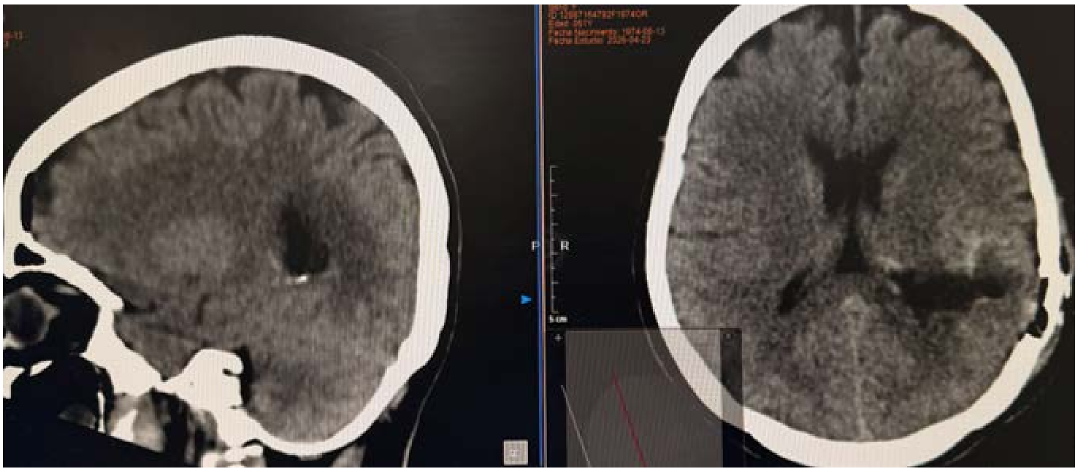

Figure 7: Postoperative control computed tomography (CT) images, including axial slices and sagittal reconstructions, confirming complete tumor resection without evidence of structural anatomical damage.

mobilization and en bloc resection (Figure 5). Complete resection was subsequently confirmed by electron microscopy studies in the pathology analysis (Figure 6).

Careful circumferential dissection was performed under continuous magnification using a surgical microscope, allowing optimal visualization with dynamic adjustment of focus, illumination, and zoom, while preserving adjacent intraventricular structures the lesion was progressively mobilized and ultimately resected in its entirety, achieving a gross total resection (Figure 7).

Discussion

Intraventricular meningiomas (IVMs) are uncommon tumors, representing approximately 0.5-5% of all intracranial meningiomas, with a predilection for the atrium of the lateral ventricle [6,7] Their origin from arachnoid cap cells within the choroid plexus accounts for both their intraventricular location and vascular supply from the anterior and posterior choroidal arteries [7].

Clinically, IVMs often present with nonspecific symptoms due to their slow growth and the compliance of the ventricular system, delaying diagnosis [8,9] In this case, the absence of hydrocephalus and minimal mass effect underscores the relevance of early neuroimaging, which facilitates consideration of minimally invasive surgical strategies.

Gross total resection remains the treatment of choice, particularly for WHO Grade I meningiomas, and is associated with excellent long-term outcomes [9,10] However, surgical access to the atrium remains challenging due to the need to traverse eloquent brain regions. Classical approaches-including superior parietal, temporoparietal, and transcallosal routes-are effective but may result in neurological deficits related to cortical or subcortical injury [11,12].

The posterior transtemporal approach provides a direct trajectory to the atrium, particularly for lesions located laterally or inferiorly [12]. In the present case, this approach was selected and refined using neuron avigation, allowing precise localization of the cortical entry point and minimizing unnecessary brain transgression [13].

The application of minimally invasive neurosurgical principles, particularly the keyhole concept, has significantly influenced the management of deep-seated lesions [14]. These techniques aim to reduce surgical morbidity by limiting craniotomy size, preserving cortical structures, and utilizing natural anatomical corridors. Transsulcal parafascicular approaches further enhance this strategy by allowing access through sulci while preserving white matter tracts [15,16].

An essential aspect of intraventricular tumor surgery is vascular control. IVMs often derive their blood supply from choroidal arteries, making early identification and coagulation of the arterial pedicle critical for minimizing intraoperative bleeding [7]. Additionally, preservation of the deep venous system, particularly the internal cerebral veins, is crucial to avoid severe complications [17].

Recent advances, including tubular retractors and high-definition microscopy, have improved the safety profile of minimally invasive approaches by reducing focal pressure on brain tissue and enhancing visualization within narrow corridors [16,18]. These technological adjuncts were instrumental in achieving safe tumor mobilization and en bloc resection in this case.

Despite these advantages, minimally invasive approaches require careful patient selection and technical expertise. Limitations include restricted maneuverability and dependence on advanced intraoperative tools [19,20].

This case demonstrates that a keyhole minimally invasive posterior transtemporal transsulcal approach can achieve complete tumor resection with preservation of neurological function. These findings support the growing role of minimally invasive techniques in the management of atrial intraventricular meningiomas.

Conclusion

Keyhole minimally invasive approaches represent a safe and effective strategy for the resection of selected atrial intraventricular meningiomas. When combined with neuron avigation and meticulous microsurgical technique, these approaches allow for gross total resection while minimizing surgical morbidity. Careful case selection and thorough anatomical planning remain essential to optimize outcomes.

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