



## Case Report

# An alternative path to atrial lesions through a contralateral interhemispheric transfalcine transcingular infra-precuneus approach: A case report

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## ABSTRACT

**Background:** The surgical management of lesions located in the trigone of the lateral ventricle remains a neurosurgical challenge. Previously described approaches to the atrium include the transtemporal, parietal transcortical, parietal trans intraparietal sulcus, occipital transcingulate, posterior transcallosal, and transfalcine transprecuneus. However, reaching this area specifically through the cingulate cortex below the subparietal sulcus has not been described thus far.

**Case Description:** We present here the removal of a left atrial meningioma through a right parietal “contralateral interhemispheric transfalcine transcingular infra-precuneus” approach and compare it with previously described midline approaches to the atrium. To accomplish this, a right parietal craniotomy was performed. After the left subprecuneus cingulate cortex was exposed through a window in the falx, a limited corticotomy was performed, which allowed the tumor to be reached after deepening the bipolar dissection by 8 mm. Postoperative magnetic resonance imaging showed complete resection of the lesion sparing the corpus callosum, forceps major, and sagittal stratum. Although this approach disrupts the posterior cingulate fasciculus, no deficits have been described so far after unilaterally disrupting the posterior cingulate cortex or the posterior part of the cingulate fasciculus. In fact, a thorough postoperative cognitive examination did not show any deficits.

**Conclusion:** The “contralateral interhemispheric transfalcine transcingular infra-precuneus” approach combines the advantages of several previously described approaches. Since it conserves the major white matter tracts that surround the atrium and has a shorter attack angle than the contralateral transfalcine transprecuneus approach, we believe that it could be a potentially new alternative path to reach atrial lesions.

**Keywords:** Atrium of the lateral ventricle, Case report, Contralateral interhemispheric approach, Posterior cingulate cortex, Tumor

## INTRODUCTION

The surgical management of lesions located in the ventricular atrium remains a neurosurgical challenge. The deep location, eloquence of surrounding cortices, and close relationship with important white matter tracts make the approach to this area challenging. Considering that these white matter fibers are mainly on the lateral surface of the atrium, many neurosurgeons have shifted to midline approaches to reach this area. Thus, approaches through the precuneus or

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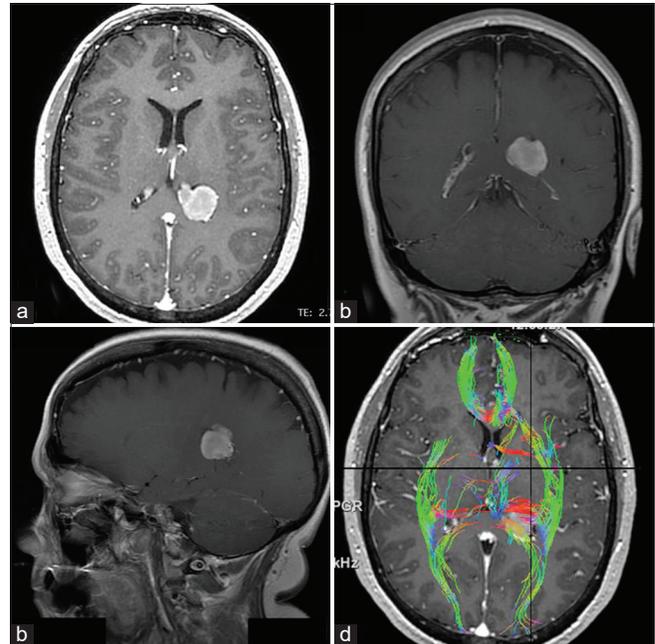
the isthmus of the cingulum are gaining acceptance within the neurosurgical community.<sup>[2,10,12,15,17,20]</sup> However, reaching this area specifically through the cingulate cortex below the subparietal sulcus (precisely the dorsal posterior cingulate cortex [dPCC]) has not been described so far.<sup>[9]</sup> We present here the removal of a left atrial meningioma through a right parietal “contralateral interhemispheric transfalcine transcingular infra-precuneus” (CITTI) approach, comparing it with previously described midline approaches to the atrium. The Institutional Review Board approved this study (IRB approval # 1/0088).

## CASE ILLUSTRATION

We present the case of a 56-year-old female who had been treated for uterine cervical cancer for the past 2 years. During a follow-up positron emission tomography-computed tomography (CT) scan, a hypermetabolic lesion was found in her left brain hemisphere. Further studies showed a lesion in her left atrium, which was homogeneously enhanced after gadolinium administration [Figure 1]. Considering her cancer history (FIGO Stage IIIc), surgical excision was decided together with the oncology department. The patient and her family were duly informed of the risks and benefits of the procedure and ultimately provided their consent. To accomplish the task, we performed a right contralateral interhemispheric transfalcine transcingular infra-precuneus approach to the left trigone.

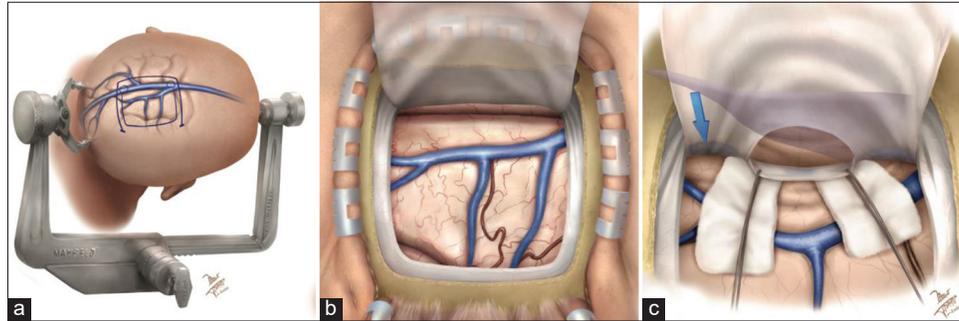
## Technique

After general anesthesia was induced, arterial and central lines were introduced. The patient was placed in a right three-quarter prone position, with her head rotated 90° clockwise from vertical (to orient the midline horizontally) and secured in a Mayfield head holder. Optical neuronavigation (Tracker Navigation System, Física Médica SRL, Córdoba, Argentina) was introduced to aid in the design of the skin incision and plan the trajectory to the contralateral atrium. A right parietal horseshoe incision and parietal craniotomy were performed, to allow gravity to retract the right parietal lobe. In this way, the contralateral atrial tumor was in line with the surgeon's line of view [Figure 2]. After opening of the dura based on the superior sagittal sinus, the surgical microscope was used. Under the microscope, the parietal right interhemispheric fissure was dissected, preserving two bridging veins that were lying in the middle of the craniotomy. With the aid of neuronavigation, a window was made in the falx at the level of the cingulum, inferior to the subparietal sulcus, and above the inferior sagittal sinus. After the left subprecuneus cingulate cortex was exposed [Figure 3], a limited corticotomy was performed, which allowed the left atrial tumor to be reached after deepening the

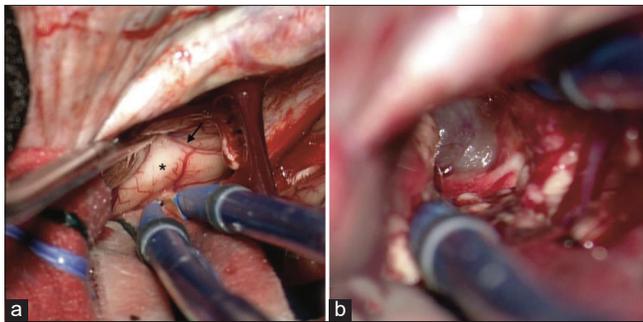


**Figure 1:** (a) Axial T1-weighted contrast-enhanced magnetic resonance imaging (MRI) revealing a 4 cm homogeneously enhancing mass in the atrium of the left lateral ventricle. (b and c) Coronal and sagittal T1-weighted contrast-enhanced MRI showing the tumor. (d) Diffusion tensor imaging superimposed on an axial T1-weighted contrast-enhanced MRI, depicting the tumor surrounded laterally by the sagittal stratum, anterolaterally by the internal capsule, and posteromedially by the splenium of the corpus callosum and forceps major.

bipolar dissection by 8 mm. The tumor was easily removed in a piecemeal manner, after first coagulating feeders from the choroid plexus. After total removal of the lesion, final hemostasis was achieved, and a silastic ventricular catheter remained in the left lateral ventricle for 24 hours. The dura mater and craniotomy were closed in a usual fashion. The patient was awakened in the operating room and transferred to the intensive care unit, where she remained for 24 hours. Following a routine computed tomography (CT) that showed no signs of hemorrhage and complete tumor resection, she was transferred to the general ward and discharged 72 hours after an uneventful procedure. Serial neurological examinations revealed no new neurological deficits. Postoperative magnetic resonance imaging was conducted 6 months after the resection of the tumor (a WHO Grade I meningothelial meningioma), showing complete resection of the lesion, sparing the corpus callosum, forceps major, and sagittal stratum. Given the utilized approach, only a small portion of the left tapetum and posterior aspect of the left cingulate fasciculus were found to be disrupted [Figure 4]. Moreover, a thorough cognitive examination was performed 8 months after surgery, and no deficits were found [Table 1].



**Figure 2:** (a) Artistic rendering showing the patient's head position, skin incision, and craniotomy outline. This position allows the use of gravity retraction to mobilize the right hemisphere away from the falx, thereby avoiding the need for self-retaining retractors on the left hemisphere. (b) Initial exposure of the right parietal lobe. The vein anatomy of this area should be thoroughly studied preoperatively. (c) A window in the falx above the inferior sagittal sinus (blue arrow) has been created. This window exposes the cingulate cortex below the subparietal sulcus. The lateral ventricle and atrium are depicted in transparency.



**Figure 3:** (a) Intraoperative microscopic photograph showing the exposure of the left dorsal posterior cingulate cortex (black asterisk). Note the subparietal sulcus limiting the area superiorly (black arrow). (b) Corticotomy exposes the tumor with minimal disruption of the normal cortex.

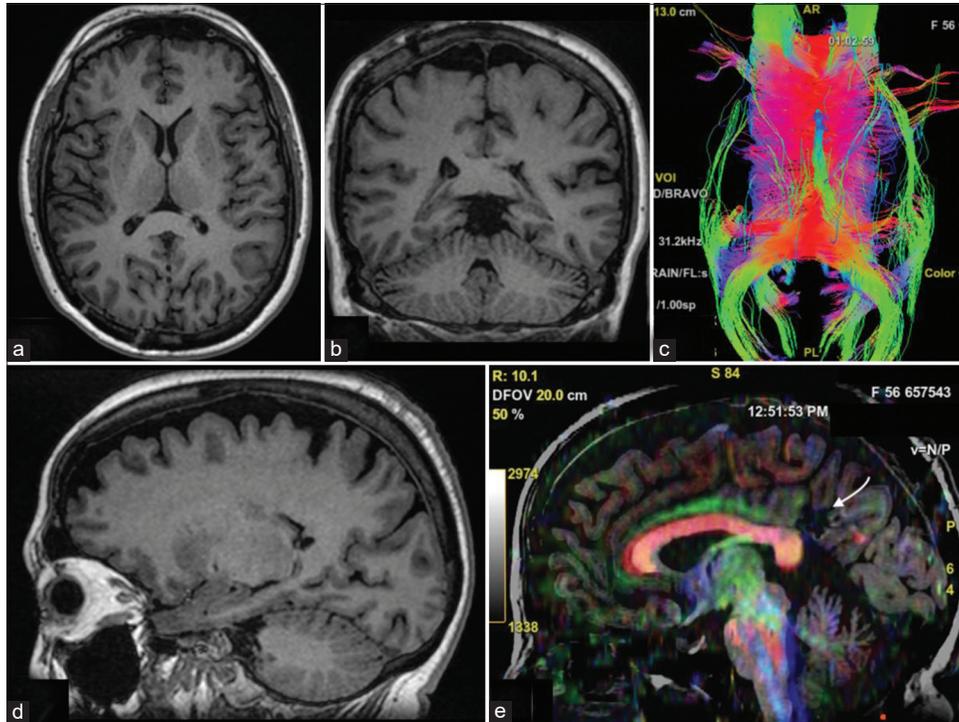
## DISCUSSION

Previously described approaches to the trigone include the transtemporal, parietal transcortical, parietal transintraparietal sulcus, occipital transcingulate, and posterior transcallosal and the recently described transfalcine transprecuneus approach.<sup>[2,6-8,11,17]</sup>

The intraparietal transsulcal approach has been traditionally preferred for its direct access to lesions in the trigone of the lateral ventricle. However, this approach has been associated with neurological deficits, including apraxia, acalculia, and visual field deficits, of which the most common is homonymous hemianopsia.<sup>[16]</sup> In addition, this approach does not involve a constant sulcus.

The occipital transcingulate approach, Yasargil's preferred method, has the main disadvantage of being unilateral, with its known limited angle of attack.<sup>[1,18]</sup> A more technically demanding method but offering better working angles, the posterior interhemispheric transfalcine transprecuneus approach (PITTA), was proposed by Wang *et al.* and described

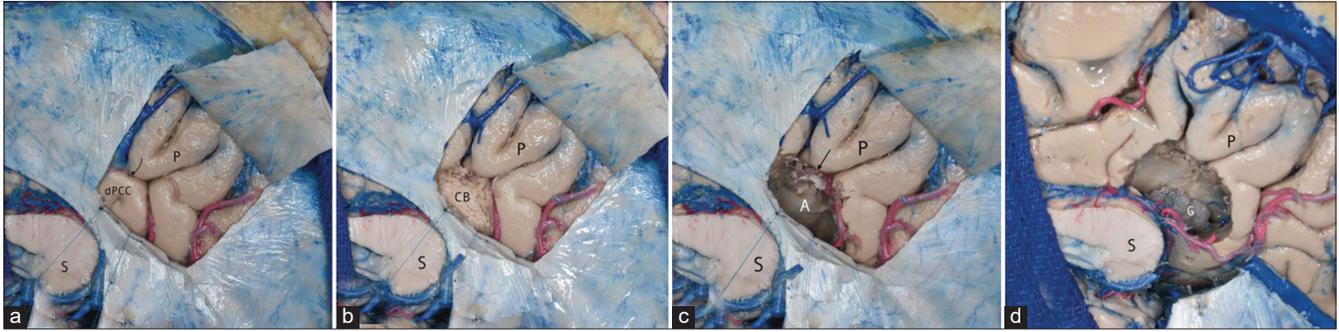
by Bohnstedt *et al.* in a series of 14 cases.<sup>[2,15]</sup> They believe that this new approach "improves the working angle and avoids excessive ipsilateral hemispheric retraction." However, the route to the trigone through the precuneus is longer compared with our approach. In addition, working through the cingulate cortex lowers the risk of injuring vessels in the subparietal sulcus. Therefore, we propose reaching the ventricular atrium through the subprecuneus cingulum, as shown in the laboratory dissection of this approach [Figure 5]. This region, regarded by Vogt as the dPCC, corresponds to Brodmann's areas d23 and the anterior portion of area 31 [Figure 6].<sup>[9,13,14]</sup> This route disrupts only the posterior portion of the cingulate fasciculus and a portion of the tapetum, the same as in Yasargil's approach. However, no deficits have so far been described after unilaterally disrupting the posterior cingulate cortex or the posterior part of the cingulate fasciculus.<sup>[3,4,9]</sup> Reaching the ventricles through the cingulate cortex is hardly a new concept. However, it has been mainly described for lesions deep to the anterior or middle cingulate cortices.<sup>[5,19]</sup> As previously stated, Yasargil described a unilateral parieto-occipital interhemispheric approach (also known as occipital transcingulate approach). Unlike our technique, this approach transects the ventral posterior cingulate cortex (Brodmann's areas v23 and the posterior portion of area 31) through the occipital interhemispheric fissure ipsilaterally, with the risk of injuring the visual cortex. Hence, we believe that our approach has the advantage of reaching the posterior cingulate cortex (ultimately the atrium) without retraction, with the superiority of the working angles provided by contralateral approaches. Further, contralateral transcingulate approaches give better surgical freedom and vertical angle of attack than that provided by either the contralateral or ipsilateral transcallosal approaches.<sup>[1]</sup> Moreover, it utilizes a shorter path to the atrium than the PITTA approach, as clearly shown in [Figure 6c and d]. Notably, midline approaches to the atrium allow for the initial coagulation of tumor feeders coming from the choroid plexus, simplifying the resection.



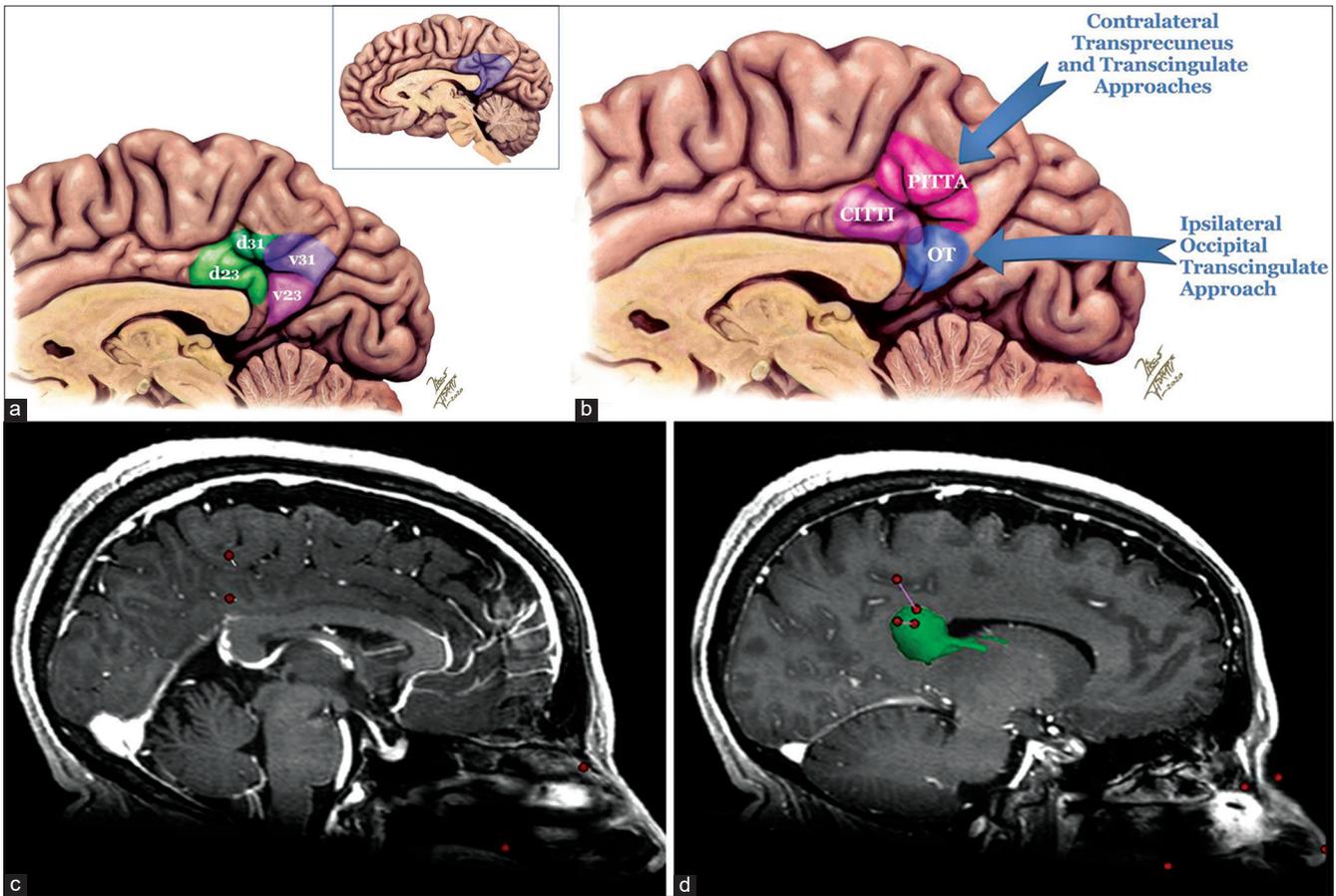
**Figure 4:** (a and b) Six-month postoperative axial and coronal T1-weighted magnetic resonance imaging (MRI) showing complete resection of the tumor. (c) Postoperative tractography depicting the sparing of the fornix, forceps major, and splenium of the corpus callosum, with a small window in the left tapetum. (d) Postoperative sagittal T1-weighted MRI. (e) Sagittal diffusion tensor imaging depicting the corticotomy area and the attack angle on the left dorsal posterior cingulate cortex (white arrow).

**Table 1:** Pre- and postoperative cognitive assessment. All results are based on Z-scores, except for Mini-Mental State Examination, frontal assessment battery, and clock drawing test.

Tests	Preoperative values	Postoperative values (8 months postoperatively)
Mini-Mental State Examination	30	30
Frontal assessment battery	30	30
Clock drawing test	13	13
Digit repetition	Direct 1.8 Inverse 1.5	Direct 1.8 Inverse 2.2
Trail making test A	1.48	1.7
Trail making test B	1.06	1.8
Rey complex figure test	Immediate recall 0.1 Delay recall -0.1	Immediate recall 0.1 Delay recall 0.7
Stroop test	1.7	2
Boston vocabulary test	0.5	0.8
Semantic verbal fluency test	0.9	2.14
Phonological verbal fluency test	0.15	0.3
Rey auditory verbal learning test	Immediate recall 0.5 Delay recall 0	Immediate recall 3.1 Delay recall 0.6
WAIS-R block design subtest	0	0
WAIS-R digit symbol subtest	-3	-1.5
Tactile object recognition	Left hand: normal Right hand: normal	Left hand: normal Right hand: normal
Hand pose imitation	Normal	Normal
Oral naming of visual perception	Normal	Normal
Written naming of visual presentation	Normal	Normal
Praxis assessment	Normal	Normal



**Figure 5:** (a) Cadaveric laboratory dissection of the medial aspect of the right hemisphere through a window in the falx. P: Precuneus, S: Splenium of the corpus callosum, dPCC: Dorsal posterior cingulate cortex. Curved black arrow: subparietal sulcus. (b) Stepwise dissection through the dPCC reveals the cingulate bundle (CB). (c) Exposure of the atrium of the right lateral ventricle (A). An arterial branch is seen in the subparietal sulcus (straight black arrow). This vessel could be potentially injured in a transprecuneus approach. (d) Visualization of the glomus of the choroid plexus (G). The inferior sagittal sinus has been cut only for teaching purposes. This maneuver was not necessary during the procedure.



**Figure 6:** (a) Artistic rendering showing the approximate locations of posterior cingulate cortex subdivisions based on cytoarchitectonics, with associated Brodmann areas. (b) Artistic rendering comparing the corticotomy location of the CITT approach with the previously described posterior interhemispheric transfalxine transprecuneus approach (PITTA) and the ipsilateral occipital transcingulate approach. (c and d) Sagittal T1-weighted images comparing the trajectories of the CITT versus PITTA approach. (c) Measures were taken from the cortices of the precuneus and the dorsal posterior cingulate cortex to the tumor. (d) Note the shorter intraparenchymal path from the cortex to the atrial tumor (highlighted in green) through the CITT approach (8 mm) compared with the PITTA approach (19 mm). In addition, the subparietal sulcus (with its vessels) is preserved with our approach.

Thus, this approach has a real advantage over the intraparietal transsulcal approach. However, we must acknowledge that we have removed a medium-sized tumor through this approach. Tumors larger than 5 cm projecting higher than the subparietal sulcus might require cutting into the precuneus for removal. Furthermore, the presence of numerous large parasagittal veins draining into the sagittal sinus overlying the contralateral hemisphere should preclude the use of either this or the PITTA approach, because they could potentially jeopardize both hemispheres. Finally, utilizing neuronavigation is necessary, since it is difficult to get a proper orientation before opening the falx in a location where the inferior sagittal sinus joins the straight sinus.

## CONCLUSION

The “contralateral interhemispheric transfalcine transcingular infra-precuneus” approach combines the advantages of several previously described approaches. Since it conserves the major white matter tracts that surround the atrium and has a shorter attack angle than the “PITTA” approach, we believe that it could be a potential new path to reach atrial lesions.

## Declaration of patient consent

Patient's consent not required as patients identity is not disclosed or compromised.

## Financial support and sponsorship

Nil.

## Conflicts of interest

There are no conflicts of interest.

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