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HOW I DO IT - NEUROSURGICAL ANATOMY

# The transcallosal transchoroidal approach to the diencephalic-mesencephalic junction: how I do it

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## Abstract

**Background** Different approaches have to be considered for lesions of the diencephalic-mesencephalic junction based on the localization, extension of the lesion, and relationship to the ventricular system.

**Method** We present the case of a young lady who presented with a cavernoma of the junction of midbrain and diencephalon after an episode of hemorrhage. The microsurgical anatomy of the trans-callosal trans-choroidal approach for this lesion is described along with its advantages and limitations.

**Conclusion** The trans-choroidal approach allows adequate access to lesions of the diencephalic-mesencephalic junction that project into the third ventricle.

**Keywords** Cavernous malformation · Choroid fissure · Transchoroidal approach · Mesencephalon · Diencephalic-mesencephalic junction

## Surgical anatomy

The important structures for the interhemispheric approach are the falx, the superior frontal gyrus, and the bridging veins. The callosomarginal arteries course along the cingulate sulcus in an antero-posterior direction, while the pericallosal arteries are generally situated deeper on the surface of the corpus callosum (Fig. 1A). The callosum is white in color and relatively avascular when compared to the cingulate gyrus. The callosum, septum pellucidum, caudate/thalamic nucleii forms the roof, medial, and lateral walls of the lateral ventricles, respectively. The forniceal columns form the superior and anterior margins of the foramen of Monroe (FM).

The choroidal fissure starts at the posterior edge of the FM as a cleft between the body of the fornix and thalamus. It contains the choroid plexus (CP), which is attached by the tenia fornicis (medial) and tenia thalami (lateral) to the fornix and thalamus, respectively (Fig. 2A). The vascular structures that converge on the choroidal fissure include the thalamostriate, anterior/posterior septal, caudate and superior choroidal veins, and medial/lateral choroidal arteries. The thalamostriate veins course between the caudate nucleus and the thalamus and traverse through the posterior margin of the FM to drain into the internal cerebral veins (ICV) (Fig. 1B). The anterior/posterior septal veins cross the roof of the frontal horn and body of the lateral ventricle and the septum pellucidum. The anterior caudate and the superior choroidal veins cross the lateral wall of the ventricle and join the thalamostriate vein at its anterior edge [3]. The superior choroidal vein and branches of the medial/lateral posterior choroid arteries course on the surface of the CP. The ICV and the medial posterior choroidal arteries run through the roof of the third ventricle within the velum interpositum, the space between the upper and lower layers of the tela chorioidea. The CP in the lateral ventricle extends through the posterior margin of the FM onto the roof of the third ventricle [3].

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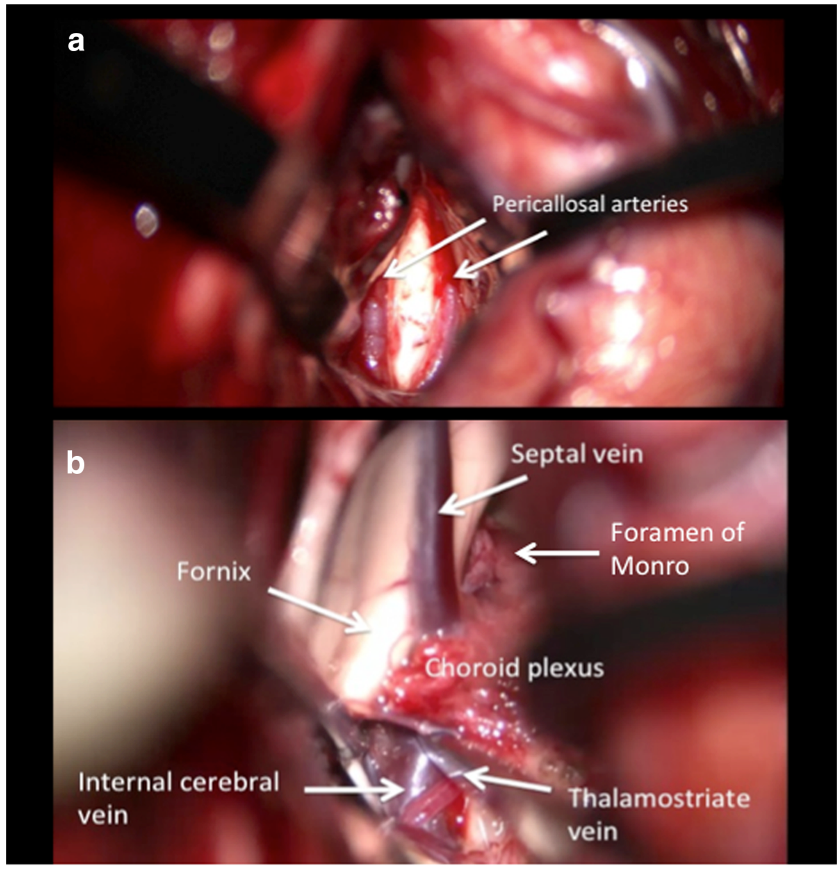


**Fig. 1** Intra-operative image showing the pericallosal arteries on the surface of the corpus callosum visualized through an interhemispheric approach (**A**). The entry into the body of the right lateral ventricle through a callosotomy reveals the intraventricular structures (**B**). The septal and thalamostriate veins join to form the internal cerebral vein, which can be visualized through the trans-choroidal approach that involves the lateralization of the choroid plexus and division of the tenia fornicis

The anterior boundaries of the third ventricle are the anterior commissure, lamina terminalis, chiasmatic recess, and the chiasm while the aqueduct, dorsal midbrain, posterior commissure, pineal recess, and habenular

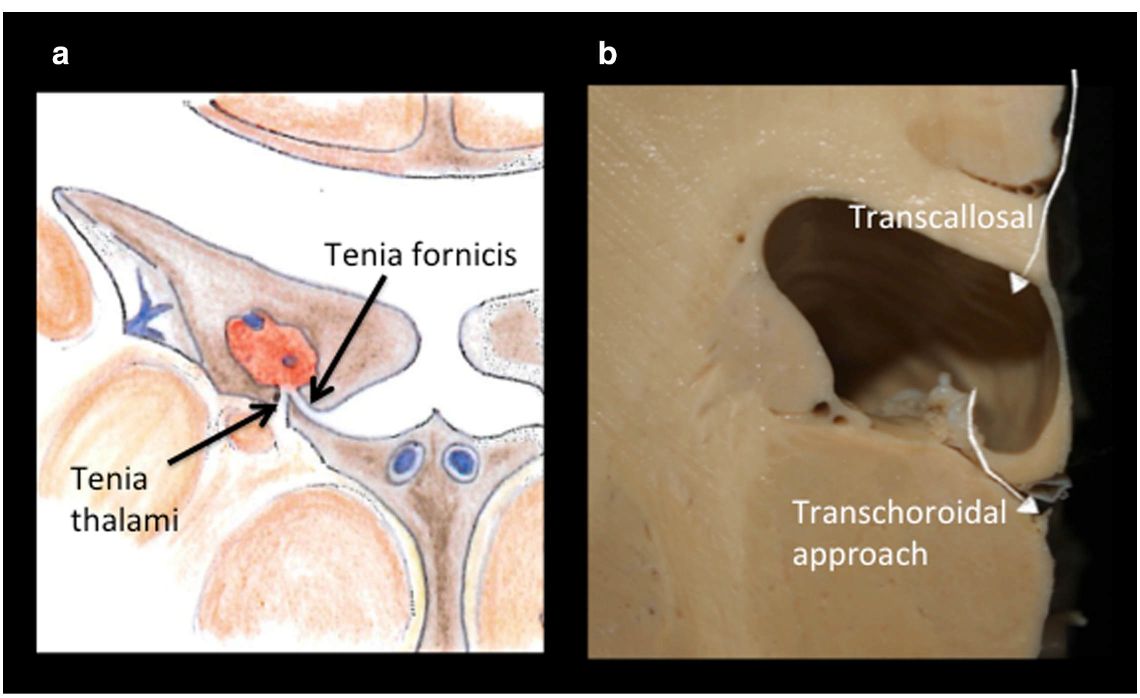


**Fig. 2** The diagrammatic (**A**) and cadaveric preparation (**B**) to illustrate two approaches to the third ventricle namely the trans-choroidal and sub-choroidal approaches. The former is an approach through the tenia fornicis, while the latter involves division of the tenia thalami

commissure are situated posteriorly. The infundibular recess and mammillary body form the floor while the massa intermedia traverses the ventricular cavity more posteriorly (Fig. 3).

## Description of the surgical technique

The patient was positioned supine with the head fixed in neutral position and flexed to 20°. Motor and somatosensory evoked potentials were monitored. A curvilinear incision on the coronal suture, allowed a parasagittal craniotomy on the right side, sufficient to expose the lateral part of the superior sagittal sinus (SSS). The dura was pedicled medially and gently retracted to obtain access to the interhemispheric fissure, with preservation of all bridging veins across the fissure. In the depth of the fissure, the callosomarginal arteries and the cingulate gyrus were identified, followed by the pericallosal arteries and corpus callosum (Fig. 1A). A 10-mm anterior callosotomy was performed, allowing entry into the frontal horn on the right side. The CP posterior to the FM was mobilized laterally to expose the fornix. The entry into the third ventricle was achieved through the tenia fornicis. The velum interpositum was opened allowing access between the two ICV's (Fig. 1B). The lesion was identified within the third ventricle at the ipsilateral diencephalic-mesencephalic junction, just dorsal to the aqueduct of Sylvius (Figs. 3 and 4). Following internal decompression, the cavernous malformation was dissected off adjacent structures and completely removed (Fig. 4). Long- and low-profile micro-instruments are essential to work in such a deep surgical field between neurovascular structures that traverse the surgical field at different depths. Hemostasis has to be meticulous in this region. Venous bleeding is usually amenable to hemostatic agents combined with compression (with micropathies). Arterial bleeders were coagulated with microbipolar forceps. Lighted suction tubes are particularly useful to visualize the bleeding points. An external ventricular drain was left in place and the dura was closed in a watertight fashion.

## Indications for the transchoroidal approach

This approach is used for lesions within or projecting into the third ventricle like diencephalic/mesencephalic cavernomas, thalamic gliomas, and other intraventricular tumors. This approach is ideal for lesions principally situated behind the FM, while more anterior lesions are usually accessed through the trans-foraminal route [1].

The transchoroidal approach provides direct access to the lesion without stretching the foramen, thus avoiding forniceal injuries. The entry into the third ventricle can be achieved

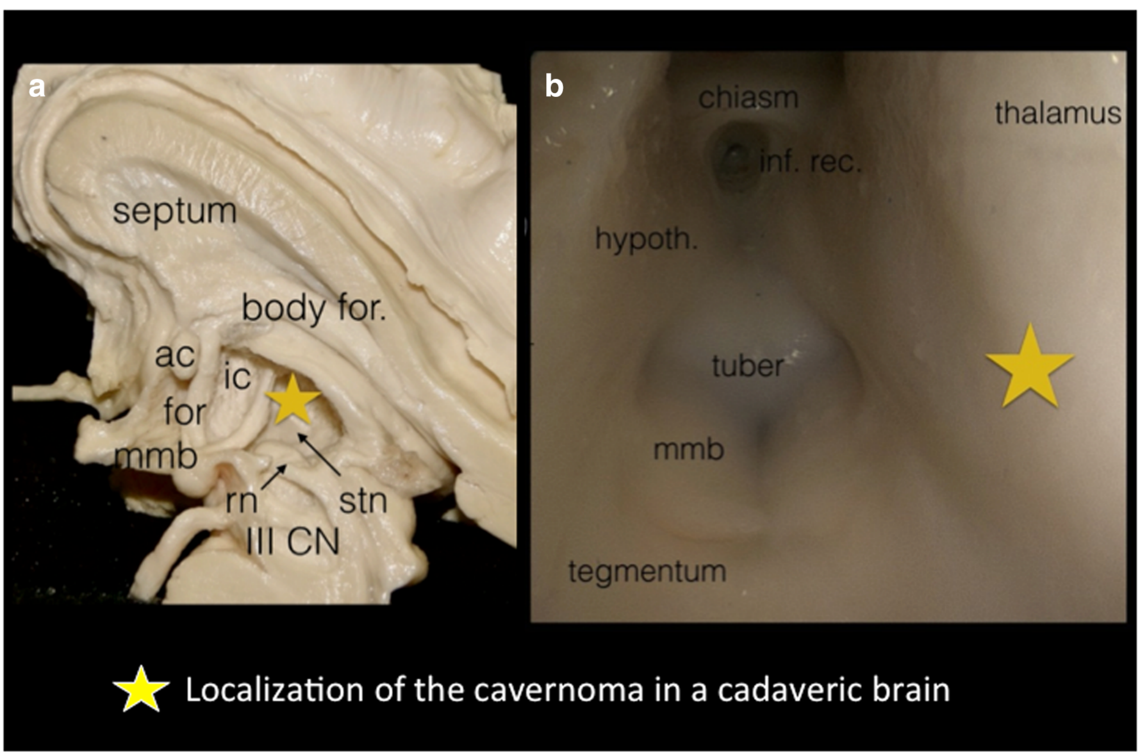


**Fig. 3** **A** Shows a cadaveric preparation in the sagittal plane, while **B** shows the intraventricular anatomy with a star that shows the localization of the cavernoma at the midbrain diencephalic junction in our patient. Abbreviations: Ac, anterior commissure; CN, cranial nerve; for, fornix; hypoth, hypothalamus; ic, internal capsule; inf rec, infundibular recess; mmb, mammillary body; rn, red nucleus; stn, subthalamic nucleus

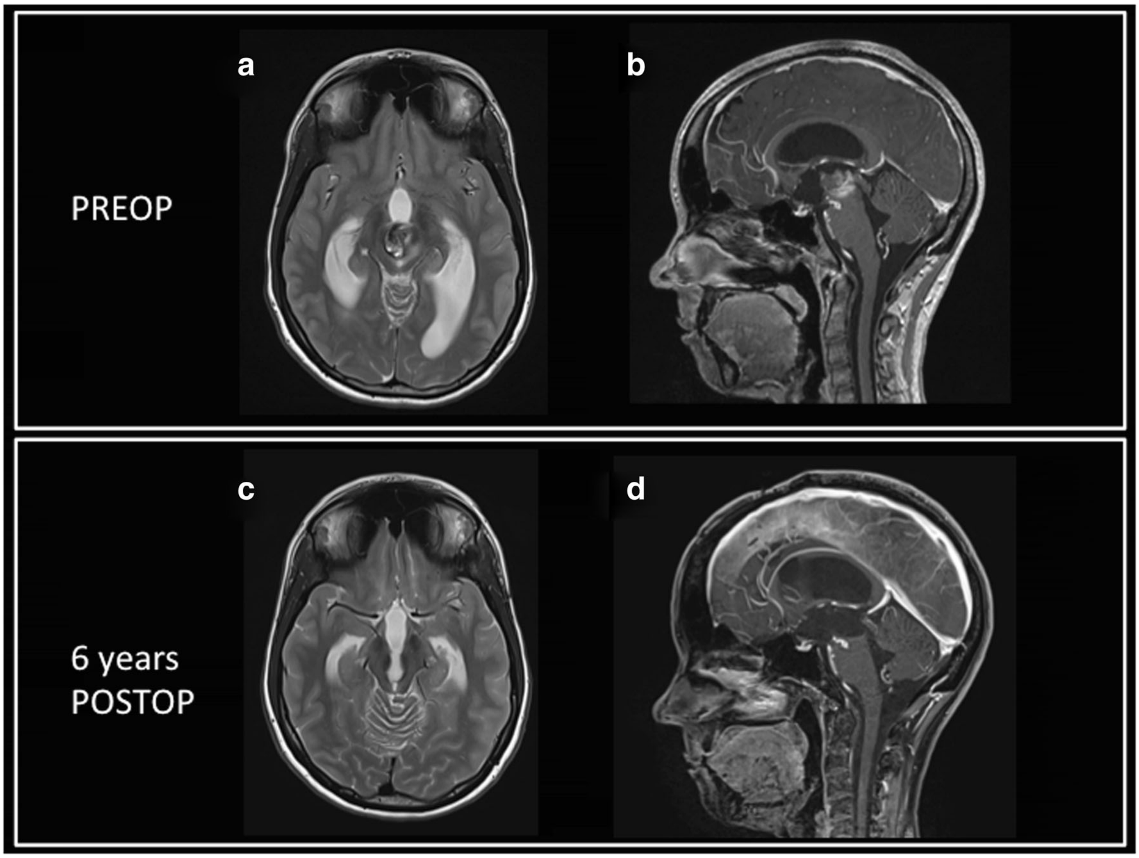


**Fig. 4** This 24-year-old lady presented with sudden onset of headache and diplopia for a month followed by increasing symptoms since 3 days on arrival at our hospital. Clinical examination revealed a confused state with the presence of Parinaud's syndrome. **A** and **B** show the axial T2W images and sagittal T1W images. Note the presence of the cavernoma at the diencephalic-mesencephalic junction on the right side associated with a developmental venous anomaly (DVA). The cavernoma was accessed through a transcallosal transchoroidal approach on the right side. She had a complete neurological recovery and is currently asymptomatic at follow-up. **C** and **D** show the total excision of the cavernoma as can be seen on axial T2W and sagittal T1W images at 6 years following surgery. Note the complete resolution of hydrocephalus. Note the sparing of the DVA

either through the trans-choroidal or the subchoroidal route, as first described in 1978 [2]. The subchoroidal route involves the opening of the tenia thalami with a medialization of the CP. While it has the advantage of lesser manipulation of the fornix, this approach very often needs the sacrifice of the thalamostriate vein or its branches. The transchoroidal approach is performed by lateralization of the CP with a trajectory between the CP and the fornix unilaterally [1]. The unilateral mobilization of the fornix is rarely problematic and allows adequate access (Fig. 2B).

## Limitations of the approach

This approach uses a long and narrow working corridor, but it is usually sufficient to access the lesion and the adjoining structures. It necessitates a retraction of the medial part of the frontal lobe and a stretching of the bridging veins, which can cause complications [1]. The columns of the fornix may limit the access to the anterior portion of the third ventricle and their manipulations should be minimized to avoid injuries to the fornix and to the deep venous system [4].

## Tips to avoid complications

The craniotomy and location of the callosotomy should be carefully planned, as the access remains limited. The superficial/deep venous anatomy should be analyzed in detail. The exposed part of SSS should be covered with wet gelfoam to avoid sinus thrombosis. Coagulation of septal/thalamostriate veins should be avoided as far as possible, as the consequences may be unpredictable. Attention should be given to avoid thrombosis or damage to the internal cerebral veins or its tributaries as well as the choroidal arteries.

## Specific perioperative considerations

### Preoperative workup

A detailed neurological evaluation is necessary to evaluate the baseline neurological status. The MRI should be carefully analyzed focusing on the anatomical location of the lesion, its extensions and relationship to the corticospinal tracts, red nucleus, substantia nigra, and tectal nucleii. The superficial venous anatomy should be analyzed to plan the craniotomy and estimate the ideal entry point to split the interhemispheric fissure. The position of septal, caudate, thalamostriate and cerebral internal veins should be studied to evaluate the ease and adequacy of the transchoroidal approach.

A preoperative neuropsychological assessment should be performed to evaluate cognitive functions, in particular the presence of attention and memory deficits, and to establish a baseline to evaluate the postoperative cognitive status.

### Instructions for the postoperative care

The patient should be hospitalized in the intermediate or neurointensive care unit during the first 48–72 h after surgery to enable a close neurological surveillance. Hydrocephalus and venous thrombosis are the most frequent complications in the early postoperative period. Careful monitoring of the external ventricular drainage is necessary. Adequate hydration needs to be maintained to avoid venous thrombosis.

An MRI is obtained in the early postoperative period to evaluate the extent of resection and the presence of surgical complications such as arterial/venous ischemic events or hydrocephalus. Delayed complications like venous infarcts or hydrocephalus can be avoided by a careful clinico-radiological follow-up.

### Specific information to give to the patient about surgery & potential risks

The patient should be aware of the risk of neurological deterioration (new cranial nerve palsies and/or hemiparesis) after surgery. These risks should be balanced with the inherent risks related to the natural history of the pathology to be treated. The risks of hydrocephalus, hemorrhages, and venous ischemia are possible along with the rare chance of having a prolonged/permanent alteration of consciousness related to bi-thalamic involvement (manipulation or ischemic complications). The limited opening in the anterior portion of the body of callosum does not generally result in disconnection syndromes but an early and delayed neuropsychological assessment should be performed.

#### Key points

1. The transchoroidal approach is a versatile approach to access lesions situated within the third ventricle predominantly behind the foramen of Monro.
2. The anatomy of the bridging veins should be studied to plan a safe and adequate craniotomy.
3. Neuronavigation could be helpful in estimating the positions of the venous structures in the approach and the ideal trajectory to the lesion in order to perform an adequate placed callosotomy.
4. The anatomy of the lesion in relation to the anatomy of the deep venous system, namely the septal, thalamostriate and internal cerebral veins should be carefully analyzed on the pre-operative MRI.
5. The pre-operative MRI along with DTI should be analyzed to estimate the displacement of important projection fibers in relation to the lesion.
6. Great respect needs to be given to all the venous structures and any sacrifice of a vein should be made with caution.
7. The complications related to the thalamostriate vein and its branches occur much less frequently when compared to the subchoroidal approach.
8. The thalamo-geniculate and thalamo-perforating arteries should be carefully preserved during peri-lesional dissection.
9. Post-resection external ventricular drainage can be helpful in avoiding early postoperative hydrocephalus.
10. In cases of diencephalic-mesencephalic lesions, steroids could be helpful in reducing edema in the early postoperative period.

### Compliance with ethical standards

**Conflict of interest** The authors declare that they have no conflict of interest.

**Patient consent statement** The patient consented to the submission of this paper and video for publication.

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