Introduction to Third Ventricular Tumors

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The tumors of the third ventricle have fascinated neurosurgeons because of the technical challenges associated with their exposure and resection. Walter Dandy refined and popularized the surgery within this chamber.

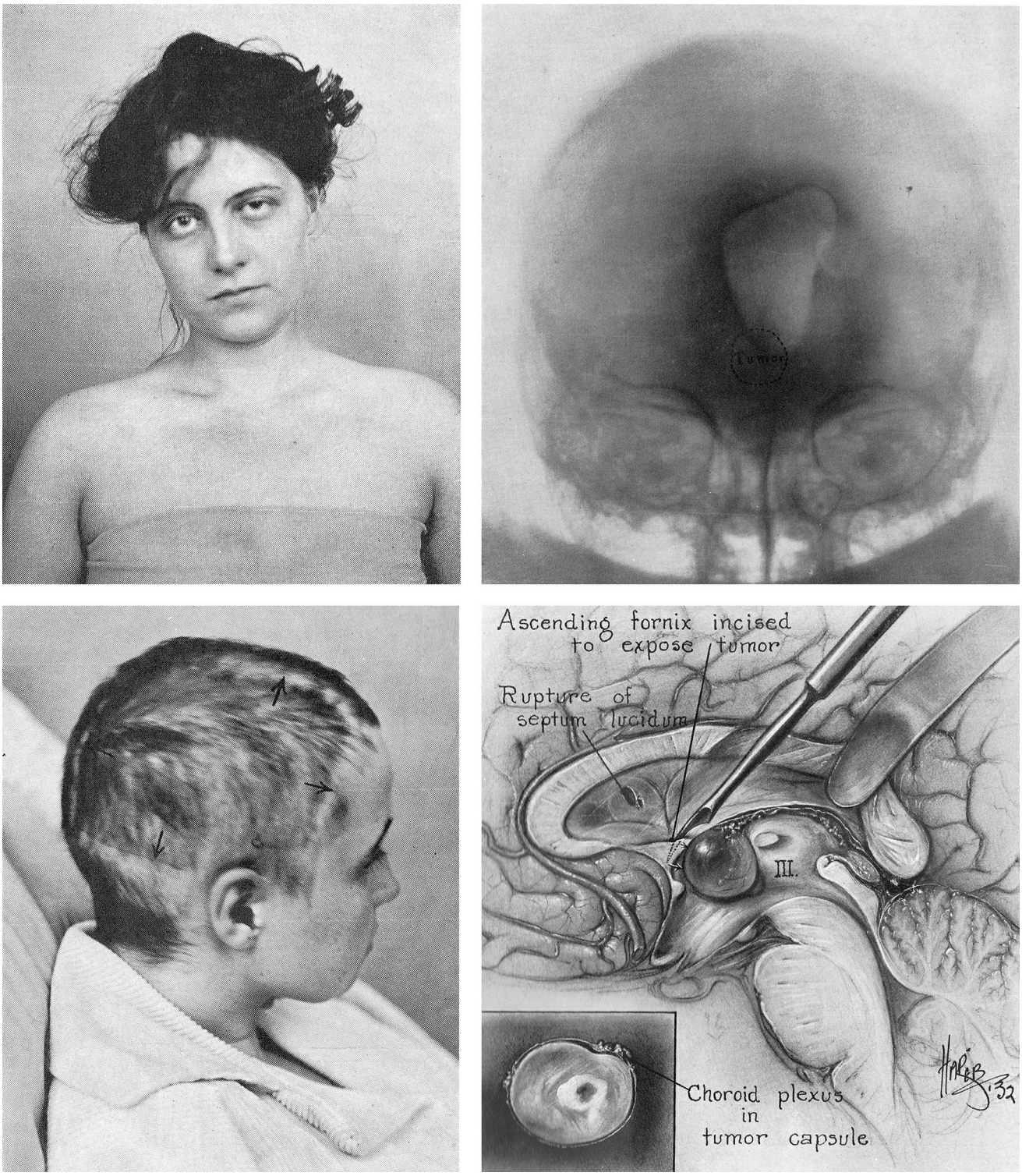


Figure 1: These images show one of the earliest patients who underwent resection of her colloid cyst by Walter Dandy (left upper). The ventriculogram (right upper image) demonstrated noncommunicating ventriculomegaly. Dandy wrote: “The tremendous bone flap as indicated by the incision was the pioneer attack upon this tumor” (left lower image). The illustration (right lower image) details Dandy’s technique.

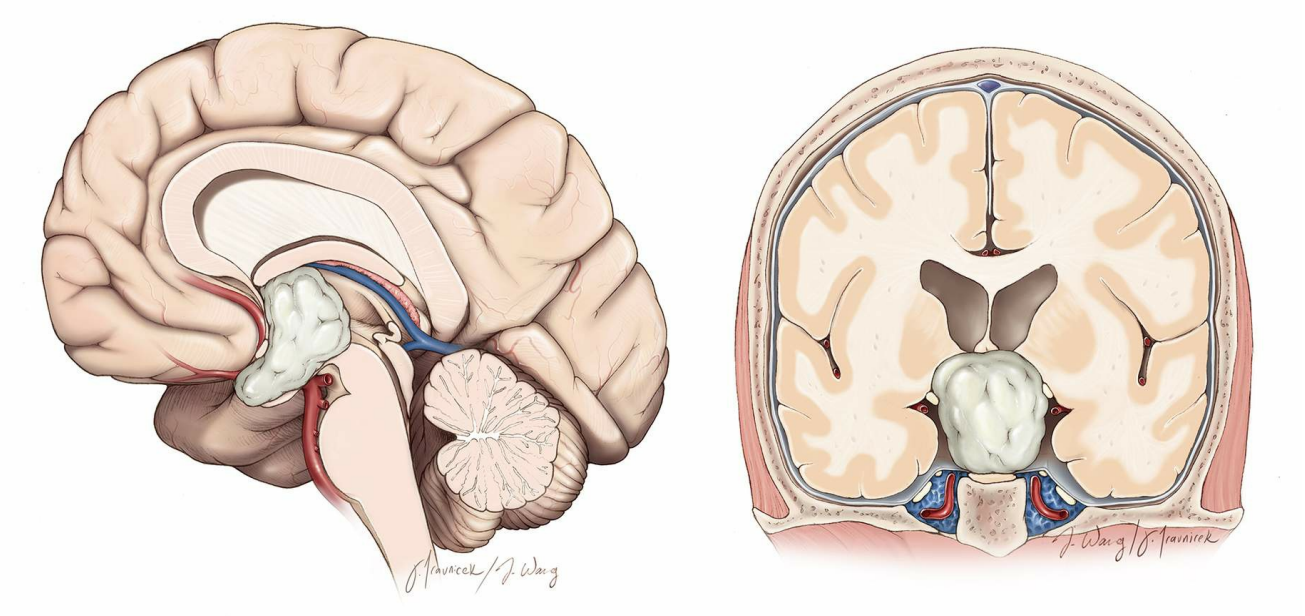


Figure 2: The topography of third ventricular tumors is demonstrated. The deep midline position of these tumors situates them adjacent to multiple vital structures, including the pituitary stalk, optic chiasm, thalamus, hypothalamus, fornices and internal cerebral veins.

Diagnosis and Evaluation

For a general discussion of diagnosis and evaluation for ventricular tumors, see the Principles of Intraventricular Surgery chapter where Table 1 provides a summary of radiologic features consistent with each tumor type.

Tumors commonly encountered in the third ventricle include colloid cysts, craniopharyngiomas, ependymomas, gliomas, and pineal region tumors. Cavernous malformations and tectal tumors can also secondarily involve the third ventricle and should be considered in the differential diagnosis. For a more detailed description of these tumors, see the Ventricular Tumors chapter.

Indications for Surgery

For a general discussion of the indications for surgery in the setting of ventricular tumors, see the Principles of Intraventricular Surgery chapter.

Preoperative Considerations

The complexity of the surgical approach and the need for some degree of

normal brain transgression warrants thorough preoperative radiographic evaluation of the tumor and neurovascular structures on the operative pathway. Acquisition of high-resolution magnetic resonance imaging (MRI) data is necessary for intraoperative neuronavigation.

Tumors that affect the third ventricular floor require preoperative endocrinologic and neuro-ophthalmologic evaluation to establish a baseline. These data will facilitate identification of new postoperative deficits and guide repeat imaging during follow-up evaluations.

A number of ingredients influence the choice of operative corridor. The risks and benefits of each approach must be carefully balanced. The surgeon should be familiar with all operative routes to the third chamber, regardless of his or her training. The safety of the approach for the individual tumor rather than the surgeon's preference should dictate the operative strategy.

I believe the following considerations (listed in the order of importance) should be carefully analyzed before tackling an intraventricular tumor and selecting a safe operative access route:

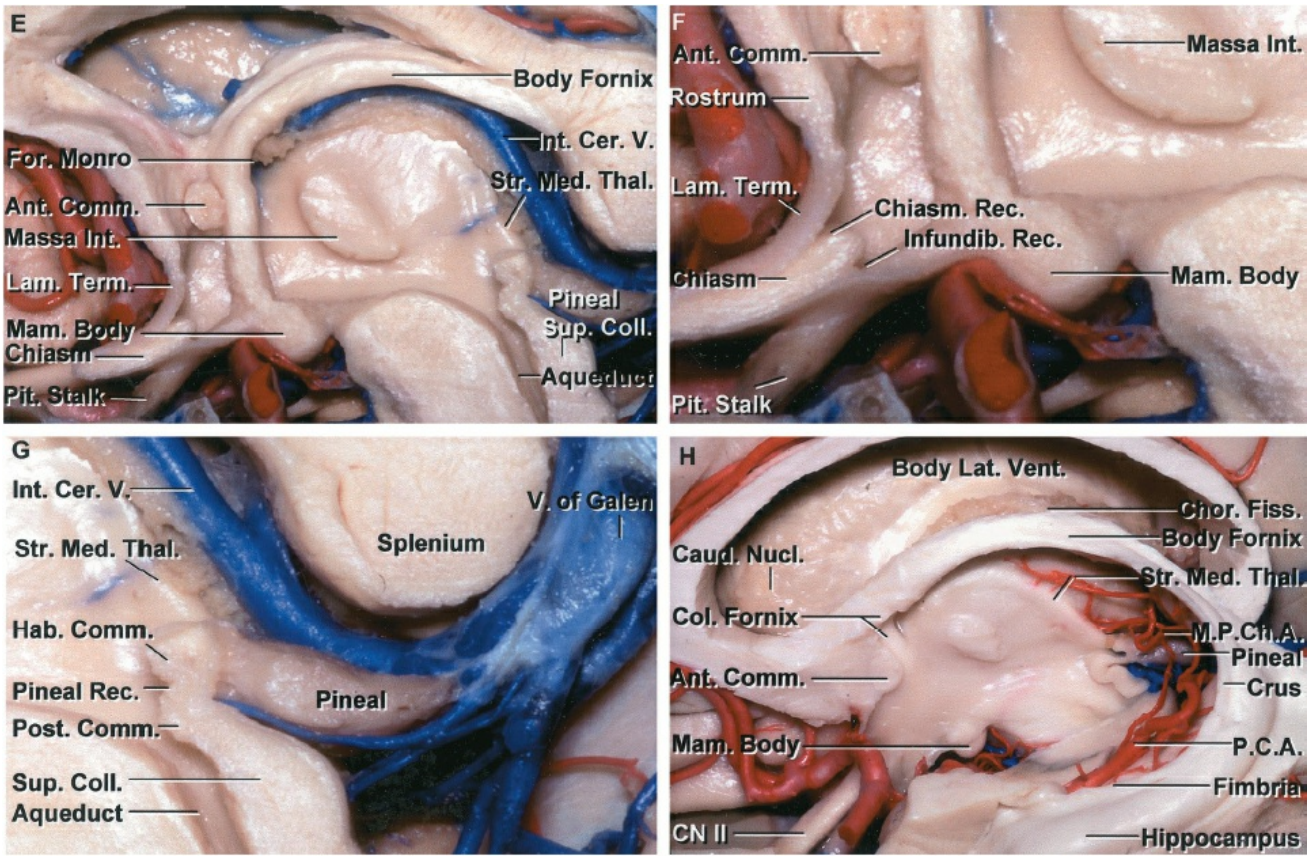
1. minimal transgression and retraction of normal/functional brain,
2. expanded working angles to allow effective gross total tumor resection,
3. early exposure of vital structures and access to the tumor's blood supply, and
4. the technical difficulty of the operative route.

The technical complexity of the approach is the least important consideration. Deep-seated lesions provide the most opportunity for the operator to be innovative in designing new operative approaches to avoid brain transgression. For example, contralateral interhemispheric approaches provide more flexible angles to the intraventricular tumors located away from the midline under less ipsilateral brain retraction.

Operative Anatomy

Familiarity with the anatomy of the deep brain nuclei and midline ventricular system is vital to successfully access and manipulate third ventricular tumors.

The third ventricle serves as a passageway from the lateral ventricles to the fourth ventricle. The regional anatomy of the third ventricle can be broken up into anterior, posterior, lateral, caudal (floor), and cranial (roof) borders.



Click here to view the interactive module and related content for this image.

Figure 3: The anterior segment of the third ventricle is composed of the region between the optic chiasm and the foramen of Monro. The composing structures of this region include the optic chiasm, lamina terminalis, anterior commissure, and columns of the fornix. The posterior segment of the third ventricle is composed of the region between the aqueduct of Sylvius and the suprapineal recess. The composing structures of this region include the posterior commissure, pineal body, and habenular commissure.

The lateral border of the third ventricle includes the thalamus and hypothalamus. The massa intermedia, or interconnection between the adjacent lateral walls of the third ventricle, is present in 75% of the population. The roof is bordered superiorly by the foramen of Monro and extends to the suprapineal recess.

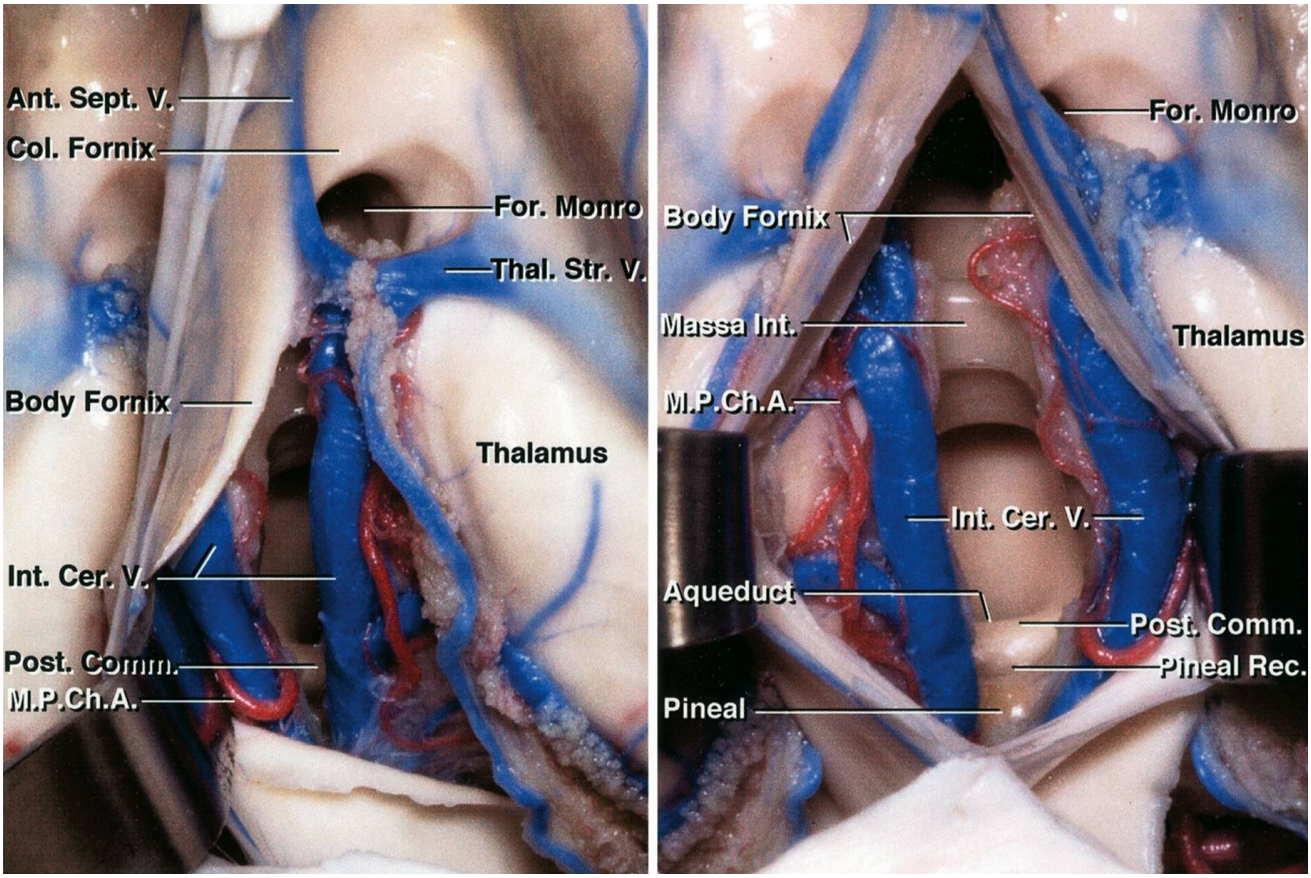


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Figure 4: The roof is composed of five distinct structural layers, herein listed in the order of deep to superficial: a choroid plexus layer, a tela choroidea layer, a vascular layer (velum interpositum) composed of the medial posterior choroidal arteries and internal cerebral veins), an additional tela choroidea layer, and the forniceal layer.

The floor of the third ventricle stretches from the aqueduct of Sylvius to the optic chiasm. The structures that make up this border include the posterior perforated substance, mammillary bodies, tuber cinereum, and infundibulum.

The U-shaped venous angle, composed of the anastomosis of the thalamostriate vein and the anterior septal vein to form the internal cerebral veins, is located along the posterior edge of the foramen of Monro. This landmark is important intraoperatively and can easily be visualized on computed tomography and magnetic resonance or catheter angiograms.

The venous angle is located 3 to 7 mm beyond the posterior margin of the foramen of Monro in approximately 30% of the population. This anatomic detail is important for expanding the transforaminal approach. In other words, a posteriorly-located venous angle allows enlargement of the foramen and facilitates access via the anterior choroidal fissure.

The midline internal cerebral veins extend along the superolateral aspect of the pineal body. These veins unite inferior to the splenium of the corpus callosum to form the vein of Galen.

The complexity of navigating the third ventricle requires a thorough understanding of the above landmarks to successfully extract any lesion. Primary tumors of the third ventricle have three distinct regions of origin. These regions include:

1. *Periventricular*: suprasellar and sellar masses commonly include craniopharyngiomas, pituitary adenomas, and optic gliomas. These lesions protrude into the ventricle.
2. *Ventricular wall*: thalamic and hypothalamic gliomas protrude into the ventricle.
3. *Intraventricular*: choroid plexus papillomas and meningiomas fill the ventricular space.

For more details, please refer to the Anatomy of the Ventricular System chapter.

APPROACHES TO THIRD VENTRICULAR LESIONS

Numerous operative approaches to the third chamber are available to the

neurosurgeon. A detailed knowledge of the indications, advantages and disadvantages of each route is imperative.

Table 1: Third Ventricular Approaches

Suggested approaches for location-specific access to the tumors in the third ventricle

Lesion Location	Suggested Approaches
Anterior	• Anterior interhemispheric transcallosal expanded transforaminal transvenous transchoroidal • Subfrontal translamina terminalis • Transcallosal interforniceal
Parasellar	• Endoscopic transnasal translamina terminalis
Posterior	• Posterior interhemispheric transcallosal intervenous/paravenous • Supracerebellar transventricular
Pineal region	• Infratentorial supracerebellar • Posterior interhemispheric transcallosal intervenous/paravenous

Anterior Interhemispheric Transcallosal Expanded Transforaminal Transvenous Transchoroidal Approach

This is my preferred approach for reaching anterior and middle third ventricular lesions. The transcallosal approach exposes the ipsilateral lateral ventricle. Next, the foramen of Monro is enlarged through transection of the septal vein and its disconnection from the thalamostriate vein.

This maneuver allows enlargement of the foramen through a minimal anterior transchoroidal dissection without significant manipulation of the thalamus or thalamostriate vein. This approach is not ideal for very posterior lesions, including the ones affecting the pineal region. Please refer to the corresponding chapter in the Anterior Third Ventricular

Tumors section.

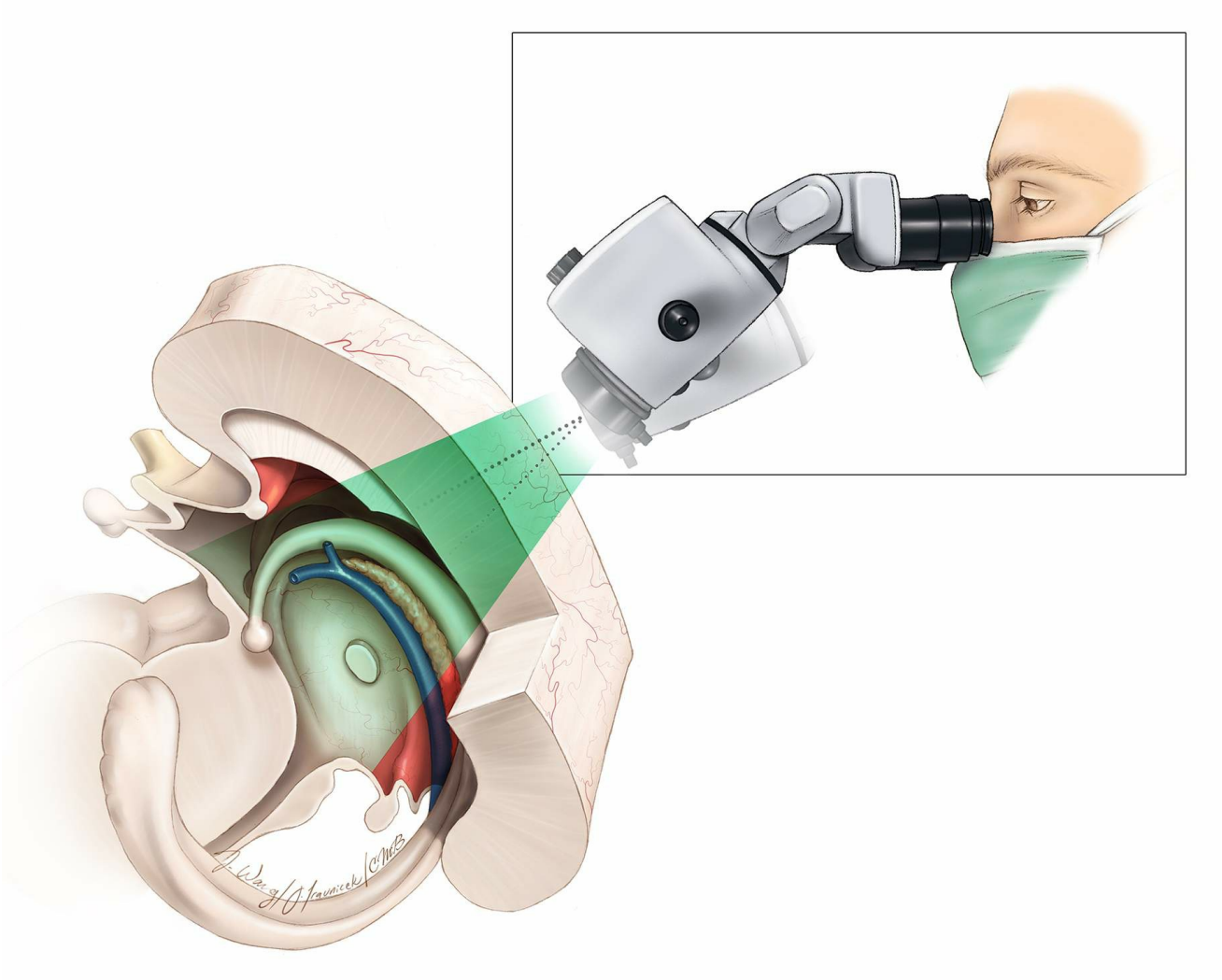

Figure 5: The anterior interhemispheric transcallosal expanded transforaminal transvenous transchoroidal approach provides flexible and generous exposure of the ventricle (marked in green).

Subfrontal Translamina Terminalis Approach

This approach is a reasonable one for small lesions that are within the anterior segment of the third ventricle, particularly those anterior to a plane running from the cerebral aqueduct to the anterior margin of the foramen of Monro. It is especially favorable if the tumor is extending through the lamina terminalis and has a suprasellar component.

Most of the tumors that are candidates for this approach can be effectively resected via the endoscopic transnasal transsphenoidal translamina terminalis approach unless the solid intraventricular component of the tumor is more prominent than the suprasellar

component.

This approach offers the advantage of providing excellent visualization of the lamina terminalis, optic nerves, optic chiasm, bilateral internal carotid arteries, anterior communicating artery complex, bilateral A2 segments, posterior communicating arteries, perforating branches, and the pituitary stalk.

However, its reach for tumors that do not enlarge the lamina terminalis is limited because the safe working space and angles through the nonenlarged lamina terminalis are nonflexible and restrictive. Gross total tumor resection can be problematic. The anterior interhemispheric variation of this approach may provide more extended, albeit still inadequate, operative space. Please see the dedicated chapter on subfrontal translamina terminalis approach.

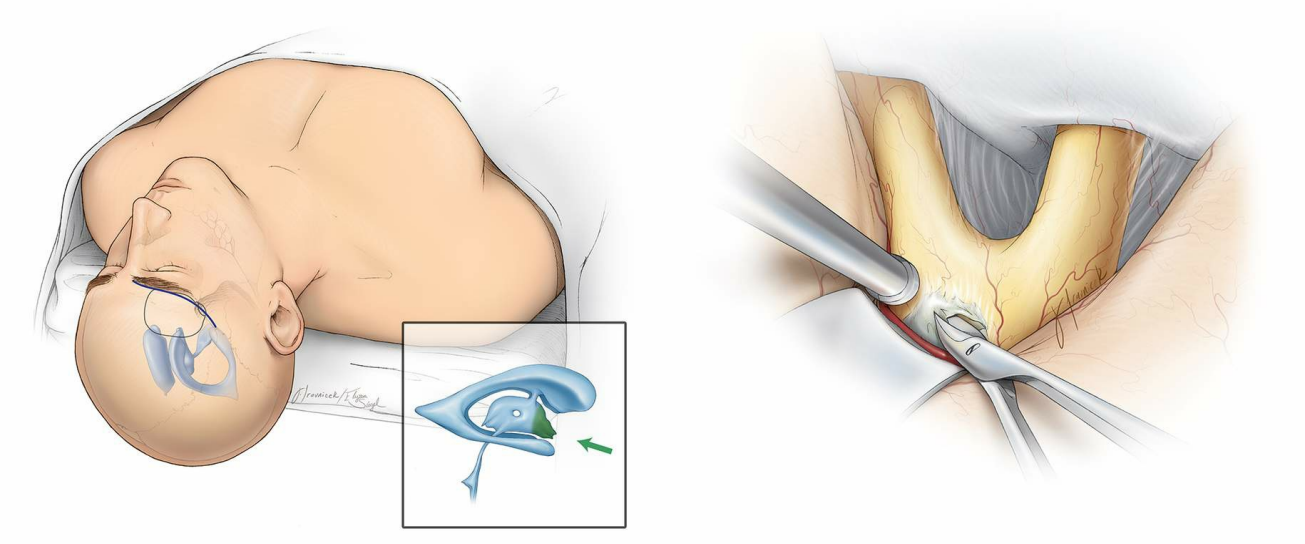

Figure 6: The subfrontal translamina terminalis approach provides a limited exposure to the anterior third ventricle and is suitable for lesions enlarging the lamina terminalis and the operative pathway.

Transcallosal Interforniceal Approach

The interforniceal approach is a variation of the transcallosal route and involves working within the interforniceal raphe to reach the third ventricle. I do not use this approach unless the raphe is expanded in the presence of a cavum septum pellucidum. The associated risks of dissecting the normally fused forniceal bodies away from each other are significant

and not justified. Please see the dedicated chapter on transcallosal interforniceal approach.

Endoscopic Transnasal Transsphenoidal Translamina Terminalis Approach

This approach is very useful and favorable for resection of parasellar lesions with third ventricular extension. These tumors are often a craniopharyngioma, pituitary adenoma, or Rathke's cleft cyst. This route places the trajectory of dissection along the long axis of the tumor and is minimally disruptive.

The major disadvantage of this approach is the difficulty in performing sufficient microdissection for tumors of dense consistency and adherence to the third ventricular wall, optic apparatus, or perforating vessels. These limitations have been recently overcome with the use of angled endoscopes and endoscopic microsurgical instruments.

Figure 7: The endoscopic transnasal transsphenoidal translamina terminalis approach provides excellent exposure of third ventricular tumors that have enlarged the lamina terminalis. This corridor is parallel to the long axis of the tumor and allows effective gross total tumor resection through a minimally invasive pathway.

Please see the dedicated chapter on craniopharyngioma resection.

Posterior Interhemispheric Transcallosal Intervenous/Paravenous Variant

The posterior interhemispheric transcallosal intervenous/paravenous variant is appropriate for lesions primarily within the posterior third ventricle, quadrigeminal plate, and pineal region.

It provides a unique and suitable operative exposure of the area anterior to the posterior internal cerebral veins, ventral to the straight sinus, vein of Galen, and pineal region. This area is not accessible via the dorsal supracerebellar approach because of the deep veins draping over the posterior pole of the tumor.

The parasagittal veins are more indispensable in the posterior frontal region; their sacrifice can predispose the patient to venous infarction. Other disadvantages of this approach include injury to the posterior corpus callosum. Despite preservation of the splenium, the risk of auditory deficits, amnesia, mutism, and dyslexia remains.

After the callosotomy, I work between (intervenous) or around (paravenous) internal cerebral veins. These veins diverge within the posterior roof of the third ventricle and are often further displaced away from each other by the tumor. For more details, please refer to the chapter on Posterior Third Ventricular Tumors.

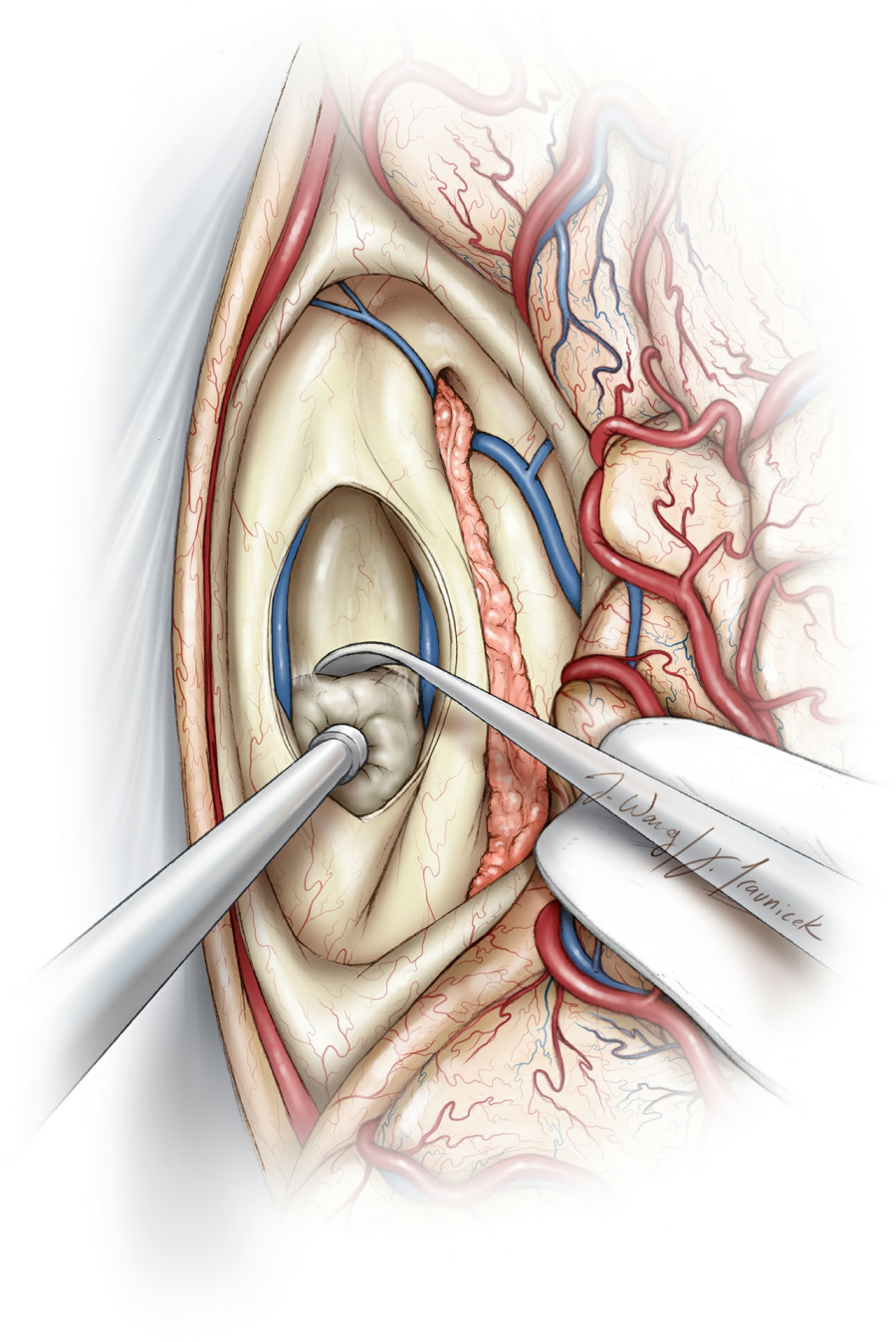

Figure 8: The posterior interhemispheric transcallosal intervenous/paravenous variant is a practical route for exposing the posterior third ventricle. The forniceal bodies have slightly diverged away from each other at this location and displaced by the tumor and are not usually at risk.

Infratentorial Supracerebellar Transventricular Approach

The supracerebellar approach has some utility for reaching small, very posterior third ventricular lesions affecting the pial surface of the tectum, such as cavernous malformations, even if the lesion is not primarily within the pineal region. The anatomy of the deep veins (Galen, etc) should be

favorable to allow a reasonable safe operative corridor underneath them. The pulvinar can be gently manipulated without significant effects.

The disadvantages of this approach obviously include the vulnerability of the habenula, vein of Galen, and quadrigeminal plate.

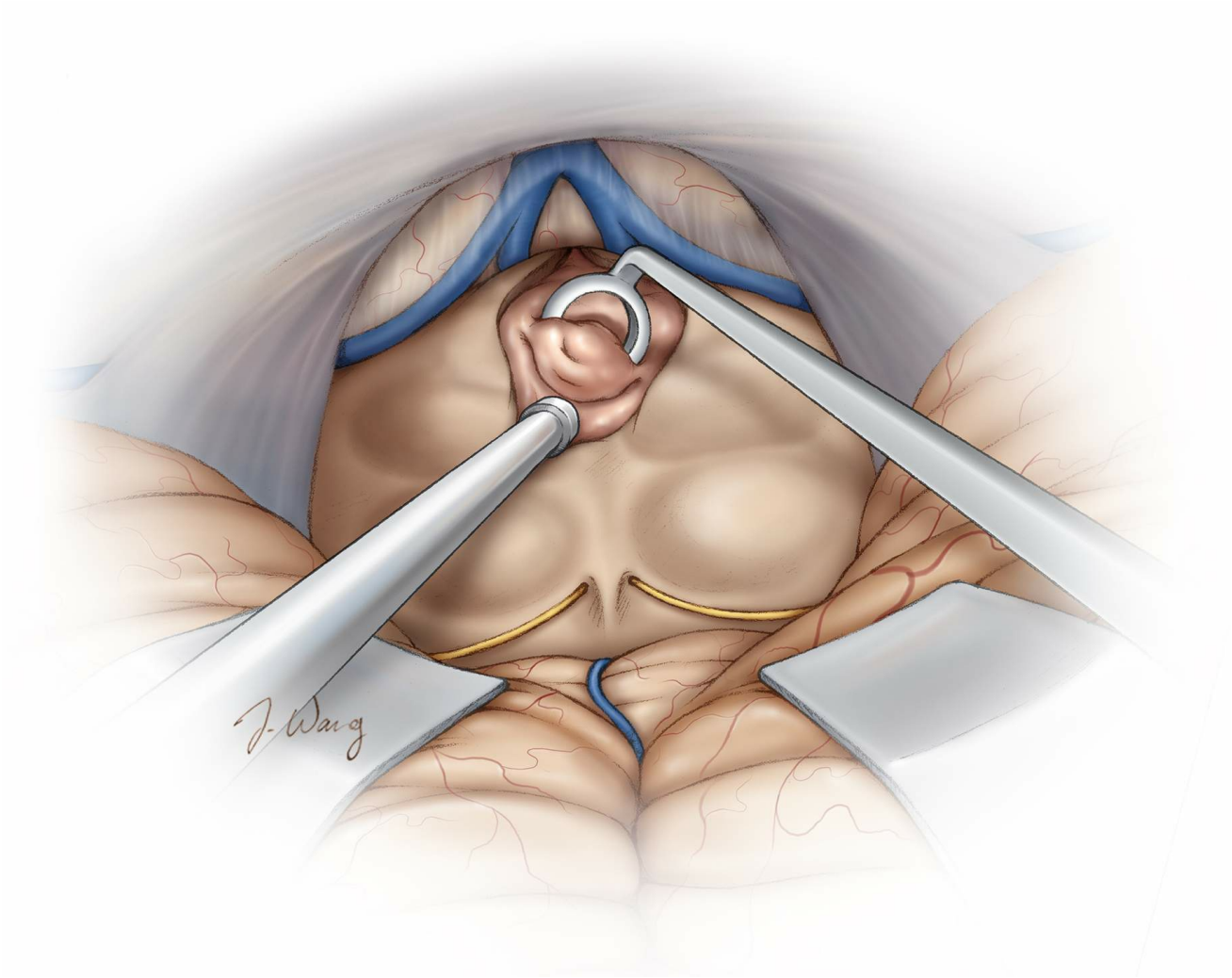

Figure 9: Small posterior third ventricular tumors can be exposed through the supracerebellar route. A careful study of preoperative imaging is necessary to evaluate the location of the deep veins (Galen, etc.) and the feasibility of this approach.

Please see the dedicated chapter on supracerebellar transventricular approach.

Personal Reflections

Patient selection remains an important aspect of intraventricular surgery in defining outcomes. Once the decision has been made to proceed with operative intervention, I preoperatively plan when to stop and when to

continue aggressive resection. I refine my strategy intraoperatively. My most dreaded complications occurred because I believed I will get away with resecting more adherent tumor at the walls of the ventricle while not controlling my “surgeon’s enthusiasm” to stop. The walls of the ventricle and their veins as well as the fornices seem not to get the attention they deserve. Forniceal injury, no matter how minor or unilateral, leads to significant impairments in the patient’s quality of life.

Surgery of the third ventricle requires detailed familiarity with the relevant anatomy and technical facility using microsurgical techniques within small operative corridors. The use of dynamic retraction and mouthswitch is especially important in efficient execution of safe operative maneuvers. Bimanual dexterity is imperative to exploit dynamic retraction and continue safe dissection under direct vision in the absence of a retractor blade.

Dynamic retraction is even more important during intraventricular surgery because the use of fixed retractor blades on the ventricular walls is prohibited. The operative reach through the restricted corridors can be extended using endoscopic-assisted microsurgery rather than extending the vector of retraction.

Finally, poor outcomes teach me important lasting lessons but they do not adversely affect my continued passion for conquering more difficult operative challenges.

Closure and Postoperative Considerations

For a detailed discussion of recommendations for closure and postoperative care of patients with ventricular tumors, see the Principles of Intraventricular Surgery chapter.

Pearls and Pitfalls

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execution of safe operative maneuvers.

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The Lateral and Third Ventricles