Endoscope-assisted infratentorial–supracerebellar approach to the third ventricle: an anatomical study

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Object. The authors studied the microsurgical anatomy and endoscopic features of the pineal region and third ventricle to describe a combined microsurgical–endoscopic infratentorial–supracerebellar approach to the posterior third ventricle. Such an approach exposes the pineal gland and its complex neurovascular structures so that the third ventricle can be reached through a minimally invasive parapineal incision.

Methods. The approach was studied in 10 adult cadaveric heads, six fresh and four formalin fixed, by using an operative microscope with a magnification level of 6 to 40 and the assistance of an endoscope.

The endoscope-assisted infratentorial–supracerebellar approach affords a complete view of the third ventricle from a posterior perspective. The third ventricle is entered through a parapineal incision using the natural space between the internal cerebral vein and the vein of Rosenthal located above the superior colliculi.

Conclusions. The infratentorial–supracerebellar approach to the third ventricle follows a natural corridor and requires minimal retraction and resection of critical neural structures. With the use of the endoscope, an unsurpassed view into the third ventricle from a posterior perspective is obtained.

Keywords • pineal region • third ventricle • endoscopy • microsurgical anatomy • infratentorial–supracerebellar approach • pediatric neurosurgery

Materials and Methods

The pineal region was examined in 10 human cadaveric heads, six fresh and four formalin fixed. Colored silicone rubber (Dow Corning Corp., Midland, MI) was injected under pressure into the arterial and venous systems via the internal carotid and vertebral arteries and internal jugular veins. An operating microscope (Carl Zeiss Co., Oberkochen, Germany) set at a magnification level of 6 to 40 was used for all dissections. All procedures were performed with the assistance of endoscopes (3 and 5 mm, with operative channels of 30, 45, and 70°; Karl Storz GmbH & Co. Tuttingen, Germany).

The cadaveric heads were positioned upright. The area in question was exposed using a midline skin incision starting 1 cm above the external occipital protuberance and extending down to the spinous process of C-2. A standard suboccipital craniectomy measuring 3 × 5 cm was performed by drilling the bone and skeletonizing the transverse sinus. The dura mater was opened in a Y fashion. After gentle dissection of the arachnoidal adhesion between the tentorium and the superior surface of the cerebellum and division of bridging veins, access was obtained to the supracerebellar–infratentorial corridor. Aided by gravity, we created an access space approximately 1.5 cm wide (to assure an adequate exposure of the region). This width of exposure provided visualization of the tentorial incisura; below it, in the
depths of the operating field, was the vein of Galen, which was covered medially by the superior vermian vein (Fig. 1). The pineal gland was covered by the venous system that is a tributary of the vein of Galen. At this point, an accurate arachnoid dissection of the cistern of the quadrigeminal plate and of the galenic venous complex was performed. Once the venous network has been exposed, we identified the veins converging into the vein of Galen. Because the venous system often shows anatomical variations, it is critical to identify surgical landmarks to maintain proper orientation, especially in the endoscope-assisted view (Fig. 2).

**Results**

The two occipital veins are situated laterally and superiorly to the vein of Galen. Between these two veins it is possible to see and reach the two basal veins of Rosenthal. Next, the splenium of the corpus callosum, situated posterolaterally to the vein of Galen at the point where it reaches the tentorium, can be identified. The vein of Galen, which appears vertically oriented when the head is upright, bends posteriorly at the level of the splenium of the corpus callosum and, 1 cm from it, receives the two internal cerebral veins. Originating from the velum interpositum of the tela choroidea of the third ventricle, these two veins form an angle of approximately 30˚ with the basal veins of Rosenthal.

It important to consider several landmarks that serve as points of anatomical reference, such as the superior cerebellar vein, which is a continuous tributary of the vein of Galen. Major tributaries of the superior cerebellar vein are the veins of the cerebellomesencephalic fissure (draining the V-shaped neural structure located above the roof of the fourth ventricle, between the cerebellum and the mesencephalon), which receive the two veins of the superior cerebellar peduncles (draining the dentate nucleus and superior cerebellar peduncles). The two veins of the cerebellomesencephalic fissure drain into the superior vermian vein or, rarely, directly into the vein of Galen.\(^\text{12,15}\)

A small, triangular anatomical region, both symmetrical and paramedian, can be seen clearly using a 30˚ endoscope. This region is bounded medially by the vein of Galen and laterally by the tentorium in its descending part. In this space the pulvinar and the splenium of the corpus callosum can be visualized laterally and medially, respectively (Fig. 3). Below it, the habenular triangle is found. Underneath the habenular triangle lie the superior colliculi, which are highly vascularized neural structures. Arteries supplying

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**Fig. 1.** Endoscopic view (0˚) after gentle retraction of the superior cerebellar surface showing the tentorial incisura (a), vein of Galen (b), and superior vermian vein (c).

**Fig. 2.** *Left and Center:* Endoscopic view (0˚) showing the dissected arachnoid adhesion and displacement of the superior vermian vein. The tentorium (a), vein of Galen (b), superior vermian vein (c), internal cerebral vein (d), and vein of Rosenthal (e) can be seen here. *Right:* Drawing of the anatomical landmarks visible in the endoscopic views.

**Fig. 3.** Endoscopic view (30˚) of the tentorium (a), vein of Galen (b), pulvinar (c), and splenium of the corpus callosum (d).
this area include the posteromedial choroidal artery, which crosses the upper margin of the quadrigeminal plate and continues medially and superiorly, eventually forming a dense vascular network defined by Yasargil as the “pericollicular group.” This network lies over the pineal region and continues into the choroidal plexus of the third ventricle.

The pineal gland, characterized by its brownish-gray color, is circumscribed by the habenular commissure and the internal cerebral vein superiorly; the posterior commissure is not visible because it is covered by the gland itself (Fig. 4).

Once the region of interest is adequately exposed, the next essential step is the actual entrance into the third ventricle. The endoscope is placed along the side of the pineal gland (~1.5 mm over the quadrigeminal colliculus and under the internal cerebral vein; Figs. 5 and 6). It is then steered slowly toward the midline by using a point 2.5 cm above the nasion as a craniocaudal landmark. The size of the parapineal incision necessary to insert the endoscope should not exceed 3 mm in diameter (5 mm if a working channel is needed; Fig. 7). A 0˚ endoscope offers an adequate view at the beginning of the third ventricle exploration and facilitates correct orientation inside the ventricle.

Once inside the third ventricle, the interthalamic adhesion (which can be absent in 10–25% of cases) is an important landmark, dividing the chamber of the ventricle into an anterior and a posterior portion. In the approach we propose, the posterosuperior part of the third ventricle is entered first and the choroid plexus, another important anatomical landmark, is localized (Fig. 8). The interthalamic adhesion lies inferior to the point of entrance into the ventricle. To access the anterior portion of the third ventricle, the endoscope is advanced over the interthalamic adhesion. Two structures are then visible in the anterior wall of the ventricle: the column of fornix, connected medially by the anterior commissure; and the triangular recess, a triangular-shaped space that is delimited laterally by the two columns of fornix and by the anterior commissure at its base. In the inferior portion of the anterior wall of the third ventricle, the protuberance formed by the optic chiasm and upper optic recess can be seen (Fig. 9). Between the anterior commissure superiorly and the optic chiasm inferiorly, the lamina terminalis can be visualized from a posterior view that is not available when other more conventional approaches to this region are used. Inferiorly and posteriorly to the chiasm, the infundibular recess and the floor of the third ventricle are clearly visualized (Fig. 10). The use of 30 and 70˚ endoscopes improves visualization of more laterally situated structures and allows for exploration of the two foramina of Monro (Fig. 11).

**Discussion**

Lesions involving the posterior portion of the third ventricle constitute challenging surgical problems. Posterior approaches to the pineal region and the posterior portion of the third ventricle are difficult to execute given the complexity and importance of the vital neurovascular structures that are tightly packed in these areas. We propose an endoscopic approach that minimizes the need for manipulation of these neurovascular structures and provides an unsurpassed view of the entire third ventricle from a posterior perspective.

In the past, the pineal region has been reached primarily via three surgical routes: the infratentorial–supracerebellar, the occipital transtentorial, and the posterior transcaldoscal interhemispheric. The infratentorial–supracerebellar approach was originally used by Horsley and then by Krause in 1926 for lesions located in the pineal region and the posterior part of the third ventricle. More recently popularized by Stein, this approach allows for adequate exposure of lesions positioned in the midline. Pineal region tumors that extend into the third ventricle can be removed...
using this route. For more laterally positioned pathological entities, Yasargil, Labordé, et al., and Vishteh, et al., have described modifications of the original infratentorial–supracerebellar approach.

Tumors primarily localized in the posterior portion of the third ventricle and not extending to the pineal region can be reached through a posterior transcallosal interhemispheric route. This approach, however, is hampered by the presence of bridging cortical veins. Moreover, dissection through the posterior portion of the corpus callosum often results in disconnection syndromes. In an attempt to circumvent these problems, Konovalov and Pitskhelauri proposed in 2001 a method of reaching the posterior third ventricle through the suprapineal recess and the tela choroidea. In our opinion, access to the third ventricle through the suprapineal recess, which is near the internal cerebral vein and the habenular commissure, increases the risk of damaging the critical neurovascular structures that are closely packed together in this area.

We propose entering the third ventricle through a small parapineal incision approximately 3 mm lateral to the pineal gland, underneath the internal cerebral vein, and parallel to the upper margin of the superior colliculi. To identify the parapineal target once the pineal region has been exposed completely, the internal cerebral vein is recognized...
and followed retrogradely toward the tela choroidea on the roof of the third ventricle, which represents the higher point of the entry zone. The vein of Rosenthal, which forms a 30˚ angle with the internal cerebral vein, is the lateral boundary of the target area. At this level, the veins and the target area are enclosed in arachnoidal adhesions that must be carefully divided using sharp dissection. The choice of this para-pineal entry area is based on the simple anatomical concept that the vein of Rosenthal and the internal cerebral vein are more distant from each other in the parapineal area than in the suprapineal recess. This wider natural space is the main advantage of the parapineal entry into the posterior third ventricle and is the main difference between the access and the suprapineal entry advocated by Konovalov and Pitskhelauri.

As demonstrated in our anatomical dissections, the addition of the endoscope provides an unsurpassed view of the third ventricle from a posterior perspective.

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References


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