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EXTENDED ENDOSCOPIC ENDONASAL TRANSPHENOIDAL APPROACH TO THE SUPRASellar AREA: ANATOMIC CONSIDERATIONS—PART 1

INTRODUCTION: Interest in using the extended endonasal transsphenoidal approach for management of suprasellar lesions, with either a microscopic or endoscopic technique, has increased in recent years. The most relevant benefit is that this median approach permits the exposure and removal of suprasellar lesions without the need for brain retraction.

MATERIALS AND METHODS: Fifteen human cadaver heads were dissected to evaluate the surgical key steps and the advantages and limitations of the extended endoscopic endonasal transplanum sphenoidale approach. We compared this with the transcranial microsurgical view of the suprasellar area as explored using the bilateral subfrontal microsurgical approach, and with the anatomy of the same region as obtained through the endoscopic endonasal route.

RESULTS: Some anatomic conditions can prevent or hinder use of the extended endonasal approach. These include a low level of sphenoid sinus pneumatization, a small sella size with small distance between the internal carotid arteries, a wide intercavernous sinus, and a thick tuberculum sellae. Compared with the subfrontal transcranial approach, the endoscopic endonasal approach offers advantages to visualizing the subchiasmatic, retrosellar, and third ventricle areas.

CONCLUSION: The endoscopic endonasal transplanum sphenoidale technique is a straight, median approach to the midline areas around the sella that provides a multi-angled, close-up view of all relevant neurovascular structures. Although a lack of adequate instrumentation makes it impossible to manage all structures that are visible with the endoscope, in selected cases, the extended endoscopic endonasal approach can be considered part of the armamentarium for surgical treatment of the suprasellar area.

KEY WORDS: Cranial base, Endoscope, Endoscopic anatomy, Skull base, Suprasellar lesions, Transsphenoidal surgery

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During the last 20 years, neurosurgeons experienced in performing transsphenoidal surgery (which was originally adopted for the surgical treatment of sellar lesions [13, 14, 27, 30]) have occasionally used this approach to remove suprasellar-supradiaphragmatic lesions. The suprasellar space was usually reached by opening the diaphragma of an enlarged sella, and therefore the technique is called the trans-sellar transdiaphragmatic approach (12, 15, 25). In 1987, Weiss (36) first reported the surgical management of a purely suprasellar lesion using a modified transsphenoidal approach that required additional bone

removal from the anterior cranial base. On the basis of this experience, others began to extend the standard approach and apply it to the pituitary fossa, tuberculum sellae, and posterior portion of the sphenoidal planum (18, 20, 21, 23, 29). This transsphenoidal transtuberculum approach allows direct access to the supradiaphragmatic space.

Recent progress in diagnostic imaging techniques and intraoperative neuronavigation systems combined with the introduction of the endoscope for surgical visualization via an endonasal route (2, 4, 9, 16) have boosted the rapid development and diffusion of the extended

transsphenoidal technique for removal of suprasellar lesions. Giant pituitary adenomas with a prevalent suprasellar extension; purely suprasellar lesions, such as some craniopharyngiomas; Rathke's cleft cysts; and tuberculum sellae meningiomas are but a few examples of lesions that can now be treated by experienced hands via an extended transsphenoidal route, using either microsurgical or endoscopic techniques (3, 7, 8, 10, 11, 17–21, 23, 26, 28, 29, 36).

Both of these techniques have advantages and limitations. The endoscope yields a wider visualization of the anatomic landmarks on the posterior wall of the sphenoid sinus. Furthermore, the close-up and multiangled views provided by the endoscope allow the surgeon to maintain constant control of the neurovascular structures during dissection, despite the depth of the surgical field. The microscope provides superior, direct, binocular, three-dimensional images, compared with the computer-processed, bidimensional screen views that are conveyed by the endoscope. The microscopic view of the surgical field is reduced by the presence of the sphenoid retractor, and it becomes even smaller with magnification of the deeper intradural structures.

Among the specific characteristics of this technique, the most obvious is that it is a median approach that permits one to expose suprasellar lesions (which are median) without the need for brain retraction. With use of the extended transsphenoidal approach, the view of the suprasellar neurovascular structures after lesion removal is similar, if opposite, to that of the bilateral subfrontal approach, which offers the best exposure of the suprasellar area.

We designed this anatomic study in response to these considerations and the growing interest in anatomic studies using endoscopic transsphenoidal approaches (1, 5, 6, 35, 38). We provide a detailed description of the endoscopic endonasal approach to the midline areas around the sella and analyze the anatomic conditions that may influence surgical technique.

To evaluate the advantages and limitations of the endonasal approach with respect to the transcranial route, we provide a transcranial microsurgical view of the suprasellar area as explored via a subfrontal bilateral approach and compare this with the anatomy of the same region as visualized via the extended endoscopic endonasal approach.

MATERIALS AND METHODS

This study was performed on 15 human cadaver heads that were dissected in two separate anatomy laboratories. Five fresh, latex color-injected cadaver heads and two fixed cadaver heads were dissected at the Center of Anatomy and Cell Biology, Microsurgical and Endoscopic Study Group of the Medical University of Vienna, and 10 fresh, non-color-injected heads were dissected at the Institute of Forensic Medicine of the Department of Justice of Republic of Turkey.

All dissections were conducted under surgical conditions with heads positioned to simulate the orientation used in the operating room. Microanatomic dissections were performed (by LMC, OdD, SA and AM) at $\times 3$ to $\times 40$ optical magnification under an operating microscope (OPMI; Zeiss, Oberkochen, Germany). For endoscopic dissections, we used a rigid endoscope (Karl Storz, Tuttlingen, Germany)

that is 4 mm in diameter and 18 cm in length, with 0-, 30-, and 45-degree lenses. The endoscope was connected to a light source via a fiber-optic cable and to a camera fitted with three charge-couple device (CCD) sensors. The video camera was connected to a 21-inch monitor that supports the high resolution of the three-CCD technology. We used a digital video recorder system to obtain a suitable file of anatomic images (both microscopic and endoscopic).

To compare the neurovascular structures explored through the opposite points of view, we divided the midline areas around the sella into four compartments. This division was made with consideration of the optic chiasm and dorsum sellae positions, as these structures are particularly relevant during the intradural part of the surgical procedure.

Two ideal planes, one passing through the inferior surface of the chiasm and the mammillary bodies, and one passing through the posterior edge of the chiasm and the dorsum sellae, divide the suprasellar region into four regions: the suprachiasmatic, subchiasmatic, retrosellar, and ventricular areas (Fig. 1). The anatomy of each zone is described from transcranial and endonasal perspectives, and the different spatial relationships of the two approaches in the four areas are analyzed.

Endoscopic Endonasal Transsphenoidal Transplanum Approach

Once the main anatomic landmarks inside the nasal cavity (inferior and middle turbinate and nasal septum) were visualized, we began the procedure with a middle turbinectomy. This is a critical step because it involves enlarging the corridor through one nostril to allow introduction of the endoscope and other instruments (Fig. 2). Removal of the middle turbinate provides easier access to the posterior nasal cavity, where the choana, sphenothmoid recess, and sphenoid ostium are located. The nasal septum is then elevated from the sphenoid ostium and, using a retrograde bone rongeur, its posterior portion is removed for approximately 2 cm. It is important to avoid removing too much nasal septum in the anterior direction, to avoid injuring the olfactory nerve terminations or the cribriform plate of the ethmoid, and also in the inferior direction below the choana, because that is useless for the approach to the planum.

The middle turbinate of the contralateral nostril is lateralized to allow introduction of another instrument.

To expose the suprasellar region and the planum sphenoidale, it is not sufficient to simply enlarge the sphenoid ostium and remove the rostrum, as is common in the standard endoscopic approach to the sellar region. The suprasellar region and the sphenoid planum are attained through a more anterior trajectory than that required for the sellar region. This requires a wider opening of the superior portion of the anterior wall of the sphenoid sinus, which is obtained by removing the superior and/or supreme turbinates on one or both sides, in accordance with the space inside the nasal cavities. The superior and/or supreme turbinates are removed along their base on the turbinate lamina while taking care not to damage the lamina. During such maneuvers, it is important to avoid damaging the posterior ethmoidal artery, a branch of the ophthalmic artery that passes through a thin, bony channel along the ethmoid roof (Fig. 3).

After a wide anterior sphenoidotomy is performed, all of the septa within the sphenoid sinus are removed up to their attachment on the posterior and superior walls of the sphenoid sinus. This yields a panoramic view of the planum sphenoidale and the tuberculum sellae.

Depending on the degree of pneumatization of the exposed sphenoid cavity, a series of protuberances and depressions are recognizable in correspondence with the posterior and lateral walls. Knowledge of these landmarks is fundamentally important with regard to identifying the correct opening of the sphenoid planum. The sellar floor is at the

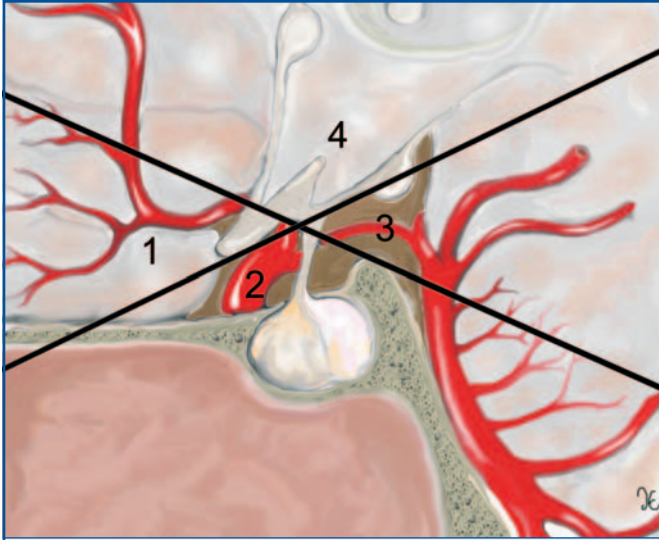


FIGURE 1. Areas that can be explored using the endoscope via the transtuberculum-transplanum sphenoidale approach. Regions include 1, suprachiasmatic; 2, infrachiasmatic; 3, retrosellar; and 4, intraventricular areas.

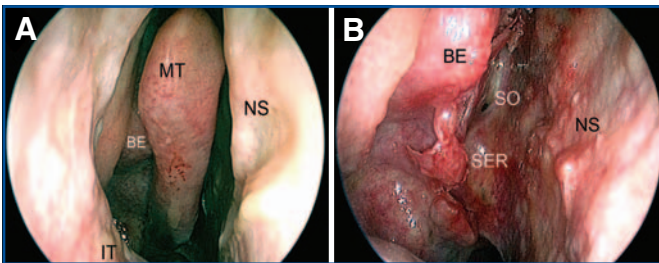


FIGURE 2. Removal of the middle turbinate allows a wider view and better maneuverability of the surgical instruments on the posterior part of the nasal cavity. Viewing the area before (A) and after (B) removal of the right middle turbinate. MT, middle turbinate; NS, nasal septum; IT, inferior turbinate; BE, bulla ethmoidalis; SO, sphenoid ostium; SER, sphenothmoid recess.

center, the sphenothmoid planum is above, and the clival indentation is below; lateral to the sellar floor, the bony prominences of the intracavernous carotid artery and the optic nerve can be observed. Between the intracavernous carotid artery and the optic nerve is the lateral optocarotid recess, which is molded by the pneumatization of the optic strut of the anterior clinoid process.

The lateral optocarotid recess it is not directly involved in the approach because it is inferior to the optic nerve and lateral to the carotid artery; however, it is a useful landmark for identifying the position of the medial optocarotid recess. The superior border of the lateral optocarotid recess is covered by a thickening of the dura and periosteum. These form the distal dural ring, which separates the optic nerve from the clinoidal segment of the internal carotid artery (ICA). The inferior border of the lateral optocarotid recess is also covered by a thickening of the dura and periosteum, which form the proximal dural ring and envelope the oculomotor nerve within the cavernous sinus in the direction toward the superior orbital fissure (Fig. 4).

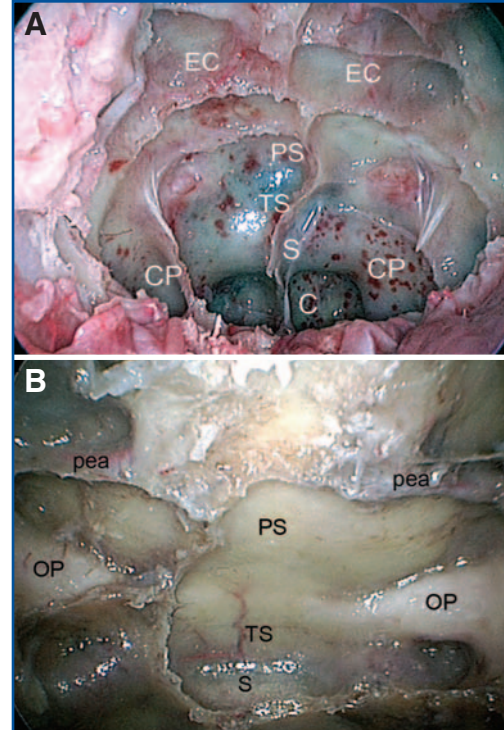


FIGURE 3. A, wide sphenoidotomy and bilateral posterior ethmoidectomy were performed to obtain a wider view of the planum sphenoidale. B, both of the posterior ethmoidal arteries are clearly visible. These are considered a dangerous landmark and usually represent a limit when opening the planum sphenoidale. EC, ethmoid cell; PS, planum sphenoidale; TS, tuberculum sellae; CP, carotid protuberance; S, sella turcica; C, clivus; OP, optic protuberance; pea, posterior ethmoid artery.

The medial optocarotid recess corresponds intracranially to the medial clinoid process, which is present in approximately 50% of patients and it is only rarely visible from the cavity of the sphenoid sinus. The medial optocarotid recess can be identified using the lateral optocarotid recess and the bony prominences of the carotid artery and the optic nerve as landmarks. Removing bone at the level of the medial optocarotid recess on both sides is important for attaining wider views of the supraclinoid portion of the ICA and the optic nerve.

Bone removal over the sella begins with the drilling of the tuberculum sellae, which when observed through the sphenoid sinus cavity, corresponds to the angle formed by the planum sphenoidale with the sellar floor. The drilling is then extended bilaterally toward both of the medial optocarotid recesses. The upper half of the sella is removed to obtain access to the superior intercavernous sinus. Using a drill with a 2-mm diamond burr, the tuberculum sellae (drilled from the two medial optocarotid recesses and from the planum sphenoidale) is gently dissected from the dura and periosteum and then removed. A 2-mm-footplate Kerrison's rongeur is used to complete the bone removal from the planum to reach the falciform ligament. This useful landmark usually represents the anterior limit of the bone and dural opening; however, this limit may be exceeded in patients with lesions that are anterior in position.

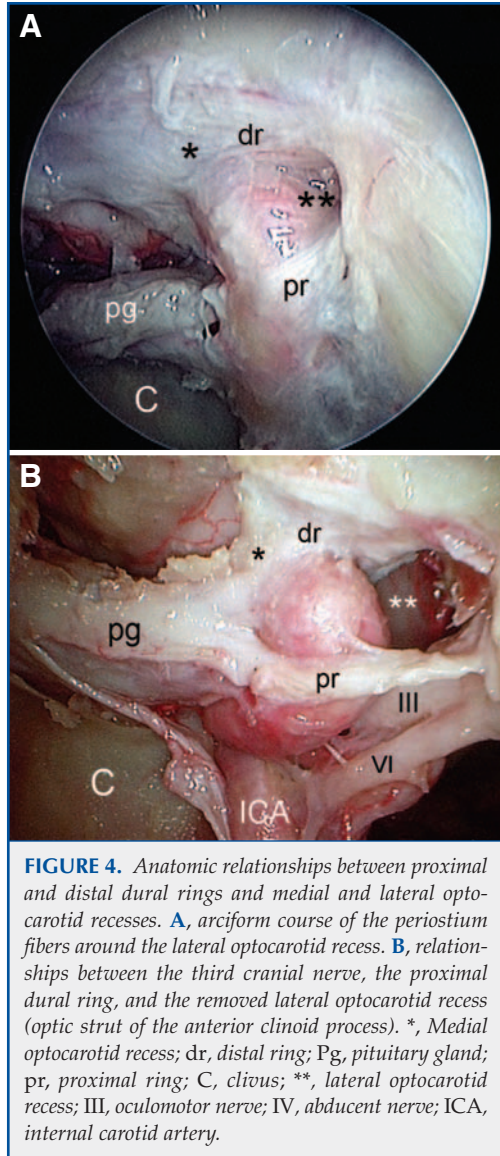


FIGURE 4. Anatomic relationships between proximal and distal dural rings and medial and lateral optocarotid recesses. **A**, arciform course of the periosteum fibers around the lateral optocarotid recess. **B**, relationships between the third cranial nerve, the proximal dural ring, and the removed lateral optocarotid recess (optic strut of the anterior clinoid process). *, Medial optocarotid recess; dr, distal ring; Pg, pituitary gland; pr, proximal ring; C, clivus; **, lateral optocarotid recess; III, oculomotor nerve; IV, abducent nerve; ICA, internal carotid artery.

The bone opening from the planum can be extended in a posteroanterior direction for 1.5 to 2 cm, but to avoid damaging the cribriform plate and olfactory nerve fibers, it cannot extend beyond the level of the anterior wall of the sphenoid sinus. Laterally, the extension of the bone opening is limited by the optic nerve protuberances, which diverge toward the optic canal. Thus, the opening over the planum is trapezoidal in shape, with the short base at the level of the tuberculum sellae (Fig. 5).

After the bone is removed, the superior (or anterior) intercavernous sinus is identified and isolated, the dura over the planum is opened, and the suprasellar neurovascular structures are exposed.

Bilateral Subfrontal Microsurgical Approach

The bilateral subfrontal microsurgical approach offers wide exposure of the anterior cranial base with a good overview of the sellar, suprasellar, and parasellar areas. It also affords an excellent midline

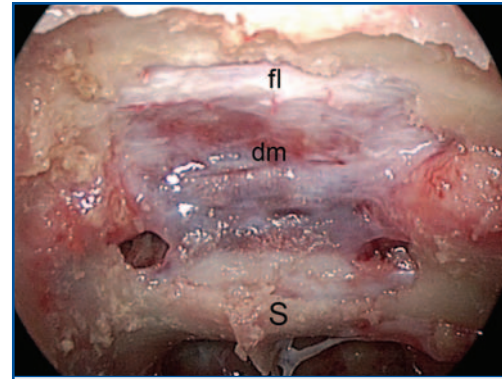


FIGURE 5. Endoscopic transsphenoidal view after removal of the tuberculum sellae and planum sphenoidale up to the falciform ligament. fl, Falciform ligament; dm, dura mater; S, sella turcica.

orientation. The surgical protocol begins with a coronal skin incision, and a bifrontal craniotomy just above the orbital rims is performed. The dura is opened transversely in a U-shape along the anterior orbital bone edge and is reflected posteriorly. The falx cerebri is cut and the frontal lobes are retracted, thereby permitting visualization of the suprasellar area.

RESULTS

Area 1: The Suprachiasmatic Region

Transcranial Subfrontal View

The subfrontal bilateral approach offers the best view of the suprachiasmatic area. The entire surface of the anterior cranial base up to the sella is exposed. The optic nerves, the chiasm the ICA, the ICA bifurcation, and the anterior part of the arteries of the circle of Willis are well visualized in a symmetric orientation (Fig. 6).

Endonasal Endoscopic View

After the dura mater is opened over the planum sphenoidale and the tuberculum sellae, the chiasmatic cistern and the lamina terminalis cistern are exposed. In the chiasmatic cistern, the anterior margin of the chiasm and the medial portion of the optic nerves are clearly visible. Once the arachnoid of the lamina terminalis cistern is opened, the A1 segments of both of the anterior cerebral arteries, the anterior communicating artery, the recurrent artery of Heubner, and the A2 segments and gyri recti of the frontal lobes are visible. If the space between the chiasm and the anterior communicating artery is widened, it is possible to observe the lamina terminalis (Fig. 7).

Area 2: The Subchiasmatic Region

Transcranial Subfrontal View

Opening the arachnoid between the two optic nerves provides access to the subchiasmatic space. The first structure

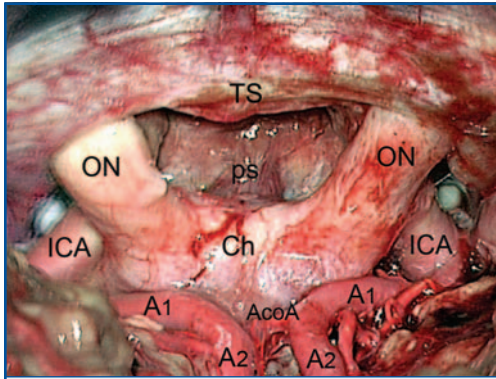


FIGURE 6. Panoramic view of the suprachiasmatic area via the microsurgical bilateral subfrontal transcranial approach. TS, tuberculum sellae; ON, optic nerve; ps, pituitary stalk; ICA, internal carotid artery; Ch, chiasm; A1, anterior cerebral artery; AcoA, anterior communicating artery; A2, anterior cerebral artery.

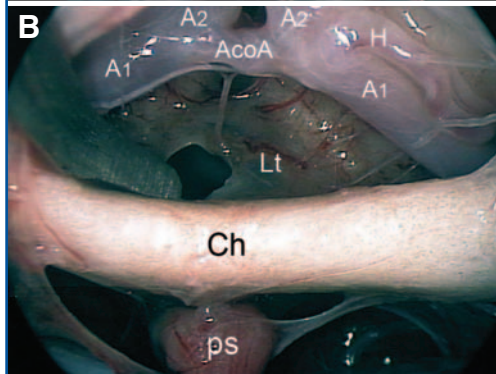
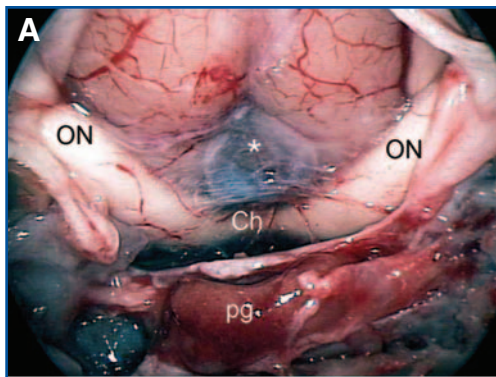


FIGURE 7. Endoscopic endonasal view of the suprachiasmatic area, before (A) and after (B) opening of the lamina terminalis. ON, optic nerve; *, cistern of the lamina terminalis; Ch, chiasm; pg, pituitary gland; A2, anterior cerebral artery; A1, anterior cerebral artery; AcoA, anterior communicating artery; H, Heubner's artery; Lt, lamina terminalis; ps, pituitary stalk.

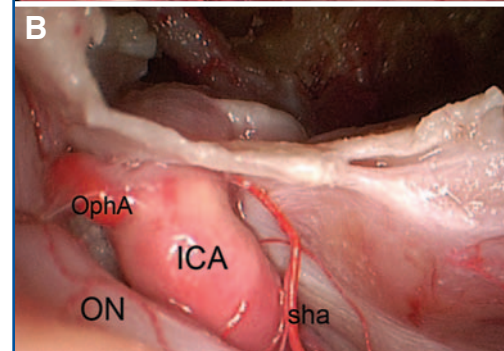
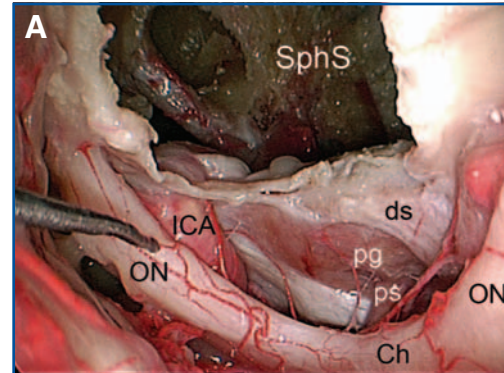


FIGURE 8. Endoscopic transcranial view of the subchiasmatic area. The planum sphenoidale was already opened through the endonasal route. A, pituitary gland and its stalk. B, superior hypophyseal artery and ophthalmic artery are revealed after elevation of the optic nerve. SphS, sphenoid sinus; ds, diaphragma sellae; pg, pituitary gland; ps, pituitary stalk; ON, optic nerve; Ch, chiasm; OphA, ophthalmic artery; ICA, internal carotid artery; sha, superior hypophyseal artery.

encountered is the pituitary stalk, which is visible from its middle third up to its entrance into the pituitary fossa, through the diaphragma sellae. The entire course of the superior hypophyseal artery, from its origin at the ICA to the superior surface of the pituitary gland and pituitary stalk, is identified. Small branches that extend toward the inferior surface of the optic chiasm are also visible. If the optic nerve is displaced laterally, the origin of the ophthalmic artery from the superior surface of the ICA becomes visible. If the optic chiasm is elevated superoposteriorly, it is possible to observe the superior third of the pituitary stalk and the infundibular recess of the third ventricle (Fig. 8).

Endonasal Endoscopic View

Once the dura is opened, the pituitary stalk can be seen below the optic chiasm. The superior hypophyseal artery and the perforating branches for the inferior surface of the optic chiasm and nerves are apparent. Laterally, the origin of the ophthalmic artery below the optic nerve is also visible. When the endoscope is advanced below the chiasm, a lateral view reveals the ICA, its bifurcation, and the first A1 segment before it

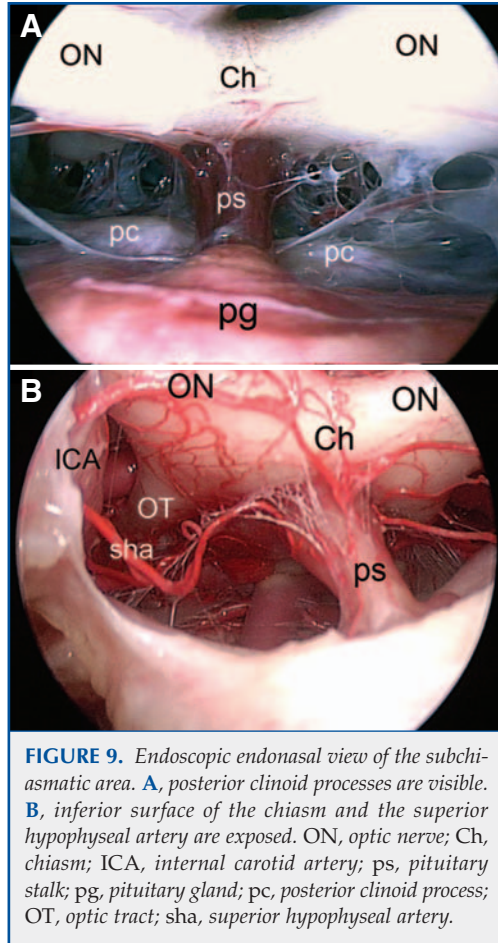


FIGURE 9. Endoscopic endonasal view of the subchiasmatic area. **A**, posterior clinoid processes are visible. **B**, inferior surface of the chiasm and the superior hypophyseal artery are exposed. ON, optic nerve; Ch, chiasm; ICA, internal carotid artery; ps, pituitary stalk; pg, pituitary gland; pc, posterior clinoid process; OT, optic tract; sha, superior hypophyseal artery.

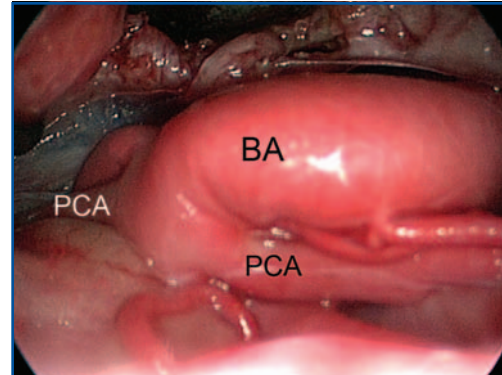


FIGURE 10. Endoscopic transcranial view of the retrosellar space. The endoscope was inserted via the right optocarotid corridor. BA, basilar artery; PCA, posterior cerebral artery.

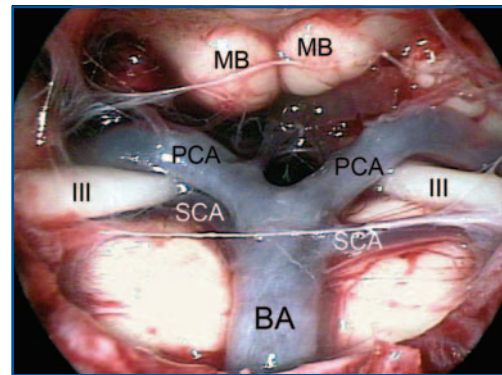


FIGURE 11. Endoscopic endonasal view of the retrosellar space. MB, mammillary bodies; PCA, posterior cerebral artery; III, oculomotor nerve; SCA, superior cerebellar artery; BA, basilar artery.

reaches the superior surface of the optic chiasm. The superior surface of the pituitary gland and the dorsum sellae are also well visualized (Fig. 9).

Area 3: The Retrosellar Region

Transcranial Subfrontal View

Beyond the optocarotid corridor lies the retrosellar region. The Lilliequist’s membrane is opened and the interpeduncular cistern is entered. The tip of the basilar artery, the posterior cerebellar artery, the superior cerebellar artery, and the oculomotor nerves are visible (Fig. 10).

Endonasal Endoscopic View

The retrosellar region is reached by passing the endoscope between the pituitary stalk and the ICA above the dorsum sellae. It is possible to recognize, by looking in an inferosuperior direction, the upper third of the basilar artery and the pons below it, the superior cerebellar arteries, the oculomotor nerve, and the posterior cerebral arteries. The mammillary bodies and the floor of the third ventricle are also visible (Fig. 11).

Area 4: Ventricular Region

Transcranial Subfrontal View

When the subfrontal approach is used, access to the third ventricle is obtained through the fenestration of the lamina terminalis. This membrane, which is composed of a thin layer of gray matter covered by the pia mater, forms the inferior third of the anterior wall of the third ventricle. Once the lamina terminalis is opened, the ependyma that covers the lateral ventricle walls is visible (Fig. 12).

Endonasal Endoscopic View

Passing the endoscope into the retrosellar space reveals the floor of the third ventricle in front of the mammillary bodies (Fig. 13). Opening the floor permits access to the ventricle. Advancing the endoscope further provides a panoramic view of the ventricular cavity. The lateral ventricle walls, which are formed by the medial portion of the thalami, are visible, as is the interthalamic commissure. The foramina of Monro are vis-

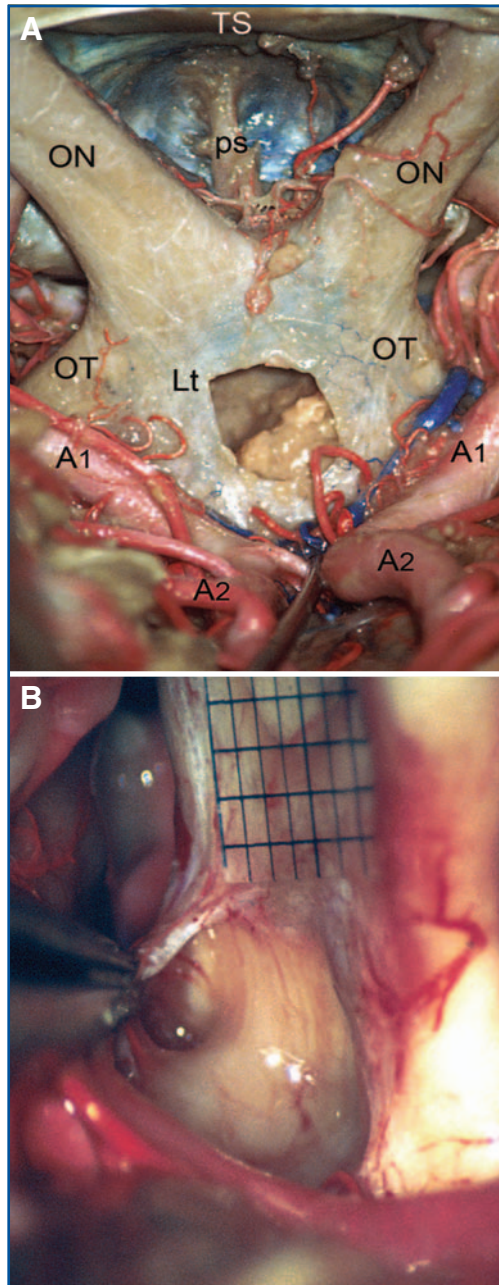


FIGURE 12. Microsurgical transcranial view after the lamina terminalis was opened to access the cavity of the third ventricle. **A**, panoramic view. **B**, after magnification. TS, tuberculum sellae; ps, pituitary stalk; ON, optic nerve; OT, optic tract; Lt, lamina terminalis; A1, anterior cerebral artery; A2, anterior cerebral artery.

ible superiorly. Using the endoscope to follow the interthalamic adhesion (or mass) toward the posterior ventricle wall, the pineal and suprapineal recesses, the posterior commissure, the habenular commissure, the habenular trigona, and the begin-

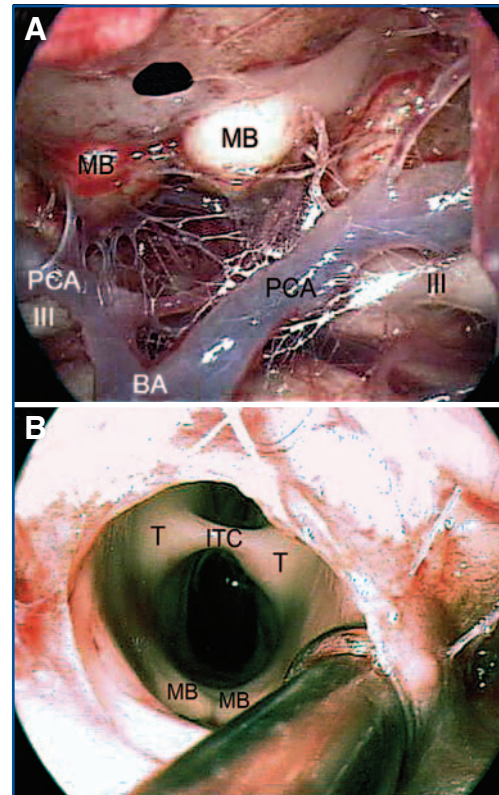


FIGURE 13. Endoscopic endonasal view of the third ventricle cavity. **A**, partially opened pre-mammillary area. **B**, interthalamic adhesion is visible once the pre-mammillary area is completely open. MB, mammillary bodies; PCA, posterior cerebral artery; III, oculomotor nerve; BA, basilar artery; T, thalamus; ITC, interthalamic commissure.

ning of the aqueduct come into view. Once the roof of the third ventricle is opened, the pineal gland and the internal cerebral veins lateral to the pineal gland are visible (Fig. 14).

DISCUSSION

In this article, we do not discuss the anatomic conditions that can facilitate or hinder the exploration of the suprasellar area via the transcranial route because these are already well known. However, we have identified anatomic conditions that can influence exploration of the suprasellar area via the endonasal route. Several of these are already familiar to surgeons involved in transsphenoidal surgery. We discuss how these conditions also apply to the extended endoscopic transsphenoidal approach to the suprasellar area.

The degree of pneumatization of the sphenoid bone is an important factor with respect to endonasal procedures. The greater the degree of sphenoid sinus pneumatization, the easier it is to identify the bony protuberances and depressions inside the sphenoid sinus. In patients with presellar or conchal

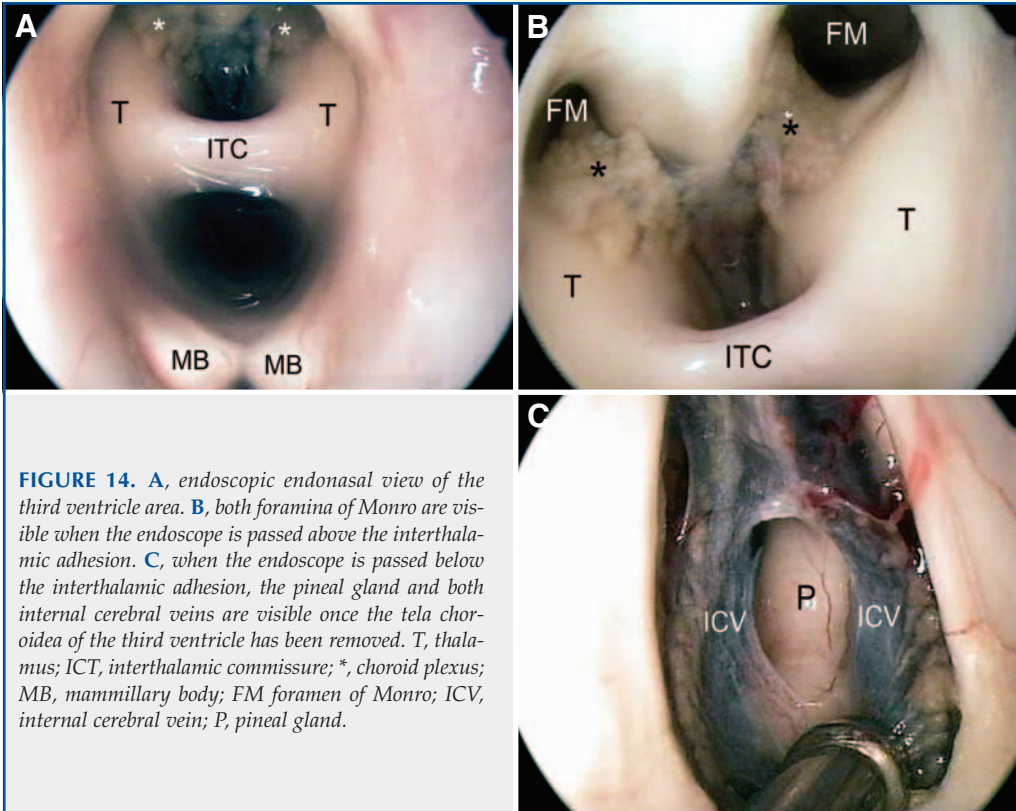


FIGURE 14. **A**, endoscopic endonasal view of the third ventricle area. **B**, both foramina of Monro are visible when the endoscope is passed above the interthalamic adhesion. **C**, when the endoscope is passed below the interthalamic adhesion, the pineal gland and both internal cerebral veins are visible once the tela choroidea of the third ventricle has been removed. T, thalamus; ITC, interthalamic commissure; *, choroid plexus; MB, mammillary body; FM, foramen of Monro; ICV, internal cerebral vein; P, pineal gland.

types of sphenoid sinus, most of the landmarks within the sphenoid sinus are not visible, which makes the removal of the tuberculum and the planum more difficult. This translates to an elevated risk of injury to the intracavernous carotids and the optic nerves of these patients.

The sella size is of utmost importance with regard to the approach to the planum. In approximately 72% of patients (32), the shortest distance between both of the carotid prominences in the sphenoid sinus is the area just below the tuberculum sellae. The average distance between the carotid arteries at the level of the tuberculum sellae is 14 mm, with a remarkable range of 9 to 24 mm (24). These data are essential for preoperative planning to determine the surgical approach. In patients with small sella and short distances between the optic nerves and the carotid arteries, access to the suprasellar area is more restricted and, as a consequence, potentially more dangerous.

Another factor to consider is the shape of the tuberculum sellae. When the patient's sphenoid sinus is small, the tuberculum sellae and the planum are thicker, and their removal requires extensive use of the microdrill. When the sphenoid sinus is wide, however, these structures are relatively thin and are easier to remove.

The size and location of the superoanterior intercavernous sinus can also influence the removal of the tuberculum sellae. If bleeding occurs in the superoanterior intercavernous sinus, the surgical procedure will be slower and more difficult.

The height of the dorsum sellae and the size of the posterior clinoids can influence the endoscopic exploration of the retrosellar region. If the dorsum sellae is tall or the posterior clinoids have a high level of pneumatization, advancement of the endoscope into the retrosellar space can be extremely difficult.

Chiasm position influences exploration of the different midline areas around the sella when the endoscopic endonasal approach is used.

In patients with a prefixed chiasm (5 to 15% of patients) (22, 34), the optic chiasm is close to the prechiasmatic sulcus of the sphenoid bone. This lowers the optic chiasm position, so it is nearer to the diaphragma sellae. During the transsphenoidal opening of the upper portion of the sellar floor (as in the extended trans-tuberculum approach), this condition exposes the optic

chiasm to a higher risk of iatrogenic injury. In the majority of patients (75%), the optic chiasm is located in a more posterior position over the posterior aspect of the diaphragma sellae and near the dorsum sellae (22, 34). This presents a more favorable condition for removal of a suprasellar lesion. In such circumstances, the optic chiasm is not in the area of interest. The remaining patients are those who have the optic chiasm located on and behind the dorsum sellae (a postfixed chiasm, which accounts for 4 to 10% of patients) (22, 34). In these patients, the intracranial course of the optic nerves is longer, and this represents the best condition for removal of suprasellar lesions. Although not frequently encountered in normal subjects, another favorable scenario is when a suprasellar mass in the prechiasmatic area displaces the chiasm posteriorly, thereby creating a de facto postfixed chiasm.

Regarding a comparison of the endonasal and transcranial views, there are several differences, as expected.

The first segment explored is the suprachiasmatic area. Investigation of this region is obviously more restricted if the endonasal approach is used, even when a large planum removal is performed. The superior surfaces of the optic nerves and chiasm are hidden by the frontal lobes; furthermore, the posterior surface of the anterior communicating artery is not easy to see from below, and only the first portion of the A2 segment of the anterior cerebral artery is visible.

Conversely, the subchiasmatic region is better exposed when an endonasal endoscopic rather than a transcranial approach is

used. The endoscope offers a close-up, high-definition view of the pituitary stalk, the superior hypophyseal artery, and the perforating branches emanating from the internal carotid, anterior cerebral, and posterior communicating arteries. These facts are useful when dissecting suprasellar lesions that occur below the chiasm, such as some craniopharyngiomas, because the chiasm vascularization is preserved, whereas a transcranial exploration of this requires a degree of neurovascular manipulation. Moreover, in patients with prefixed chiasm, access to the subchiasmatic area is more difficult when the transcranial subfrontal approach is used.

The endoscopic endonasal approach offers a better view of the retrosellar neurovascular structures. Through this route, one can obtain straight, midline, and close-up views of one of the deepest areas of the brain: the upper brain stem and its related vascular structures, namely, the basilar tip. The feasibility of retrosellar region exploration using an endoscopic endonasal approach is directly related to the dorsum sellae position and the posterior clinoid process morphology. In patients with a high dorsum sellae and considerable pneumatization of the posterior clinoid process, access to the interpeduncular cistern (37) through the suprasellar area is extremely difficult. In these situations, retraction of the chiasm and/or drilling of the dorsum sellae and the posterior clinoid processes is necessary. Access to the retrosellar region using the transcranial approach can be achieved via different surgical corridors (33). However, even for surgeons who are experienced in microsurgical technique, these procedures are not easy, and require neurovascular manipulation. Also, the exposure obtained is oblique, not median.

The ventricular area is the most remote region that can be reached using a transnasal endoscopic approach. The third ventricle is entered via the preammillary area, which allows for a simple and wide-view exploration of the third ventricle cavity, from the foramina of Monro to the first tract of the aqueduct of Sylvius. The endoscopic endonasal approach offers a more panoramic and detailed view of the intraventricular structures in a more familiar orientation when compared with the transcranial view (31).

CONCLUSION

In this anatomic study, the endoscopic endonasal transplanum approach provides a straight, multiangled, and close-up view of the midline areas around the sella.

There are some anatomic conditions, such as a low level of pneumatization of the sphenoid sinus, small sella size, and a thick tuberculum sellae that could prevent or hinder the realization of this approach.

When compared with the subfrontal bilateral microsurgical view, the endoscopic endonasal approach offers advantages in the visualization of the subchiasmatic, retrosellar, and intraventricular areas, which are usually considered to be the most difficult areas to reveal using the transcranial route.

At this point, two questions may arise: Using the endoscope, how far is it possible to see, and how far is it safe to work?

Actually, not all of the narrow areas that are visible with the endoscope can be managed under endoscopic conditions because surgical instruments suitable for this work are still being developed. Nevertheless, some lesions occupying the suprasellar region and extending in the retrosellar or intraventricular areas and displacing the neurovascular structures are within a suitable surgical corridor for the available endoscopic instrumentation. For this reason, this approach can be considered for management of some selected midline suprasellar and/or retrosellar lesions.

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COMMENTS

Cavallo et al. reaffirm the scientific stature of the formidable group of neurosurgeons from Federico II University of Naples by presenting an anatomic study on the extended endoscopic endonasal transsphenoidal approach to the suprasellar area. This approach is gaining popularity because it allows direct median access to the suprasellar area, thereby limiting brain and neurovascular manipulation. At pres-

ent, only surgical experience using this approach has been reported; an anatomic study has been lacking. The present study fills this void.

The technique and anatomic details of the region are reported, and the authors suggest the anatomic conditions that influence the feasibility of the procedure. The authors analyze the differences between the endoscopic and microscopic extended approaches, which are mainly ascribed to the wider bidimensional view of the endoscope in comparison with the more-restricted, tridimensional view of the microscope. I believe that an underestimated advantage of the microscopic technique may be the absence of the optical instrument (the endoscope) in the narrow surgical corridor, as its presence increases the crowding of instruments and the difficulty involved in their maneuverability. It is hoped that the development of proper instrumentation will overcome this problem in the near future.

Finally, the authors compare the surgical view obtained using the endoscopic transsphenoidal extended approach with the view obtained using the microsurgical subfrontal bilateral approach. The comparison demonstrates that the transcranial approach gives a superior view of the suprachiasmatic area, but conversely, the extended transsphenoidal approach allows a perfect and detailed view of the subchiasmatic, retrosellar, and ventricular areas, having the advantage of an easier orientation owing to the median exposure.

Keeping in mind the advantages of the extended transsphenoidal approach, I completely agree with the final consideration that the endoscopic extended transsphenoidal approach “can be considered for management of some selected midline suprasellar and/or retrosellar lesions.” I would also like to emphasize that some surgical corridors that anatomically appear to be very narrow are widened in pathological conditions by the expanding process and that a good strategy may be to follow the direction of tumor growth, which creates the route of access to the surrounding areas, from the suprasellar to the retrochiasmatic and ventricular areas.

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Little doubt remains that the use of the endoscope in neurosurgery is becoming widely accepted with the increasing scope of its application. Indeed, its utility in the endonasal transsphenoidal approach to sellar/parasellar lesions is well documented. Given this, it is natural that the limitation of this approach is being explored by extending the exposure gained through the standard procedure. The first step toward the clinical application of a surgical approach remains a clear definition of the anatomic details. In this article, a well-respected group of surgeons and anatomists provide readers with an organized, step-by-step description of the anatomy of the sellar and suprasellar areas via the endoscopic transsphenoidal approach. They compare the visualization of various compartments of the suprasellar space with that gained via the conventional transcranial bilateral subfrontal approach and discuss the various advantages and disadvantages of each alternative. There is no doubt that certain anatomic details are much better visualized using the endoscopic transsphenoidal approach. In addition, the authors' experience with endoscopic transsphenoidal surgery lends considerable insight to anatomic variations that would limit the extended endoscopic transsphenoidal approach. As the authors point out, the scope of this anatomic study is to define what is possible to visualize through the endoscope via the extended transsphenoidal approach. The limits of clinical utility are another issue that deserves additional study.

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This is an excellent anatomic comparison of the midline extended transsphenoidal approach with the bilateral subfrontal approach. I particularly like *Figure 1*, which divides the parasellar area into four regions. This division is helpful in picturing the anatomy and corridors of visualization that we will encounter when performing surgery. It makes the advantages of each approach for these regions far more evident. Having such a clear image of the anatomic structures is mandatory for obtaining adequate exposure during surgery while maintaining a high degree of safety for these structures. This is true both for exposure and for removal of the pathology.

Every student of neurosurgery ought to have experience with this type of anatomic study in the laboratory before embarking on live surgery.

The authors make a valuable point in noting that these studies show exposure and ideal corridors for various parasellar regions, but that actual surgery is not as readily performed as anatomic dissections. The instrumentation for these endoscopic, extensive, deep corridors has thus far not advanced to what we would like and need to have to perform surgery safely. The size and flexibility of the scopes themselves must be improved to allow entry as deep as these anatomic studies have ventured. However, improved instrumentation should be available in the near future, and anatomic studies and exercises such as these are mandatory before embarking on surgery. This experienced team makes it look easy, which it is not.

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This article discusses anatomic considerations of the transnasal endoscopic-assisted access to the suprasellar region compared with the subfrontal craniotomy approach. The transnasal endoscopic-assisted

access represents a significant contribution to surgery of the skull base, and it is an excellent option for treatment of lesions that involve the areas either below or above the optic chiasm around the region of the tuberculum sella.

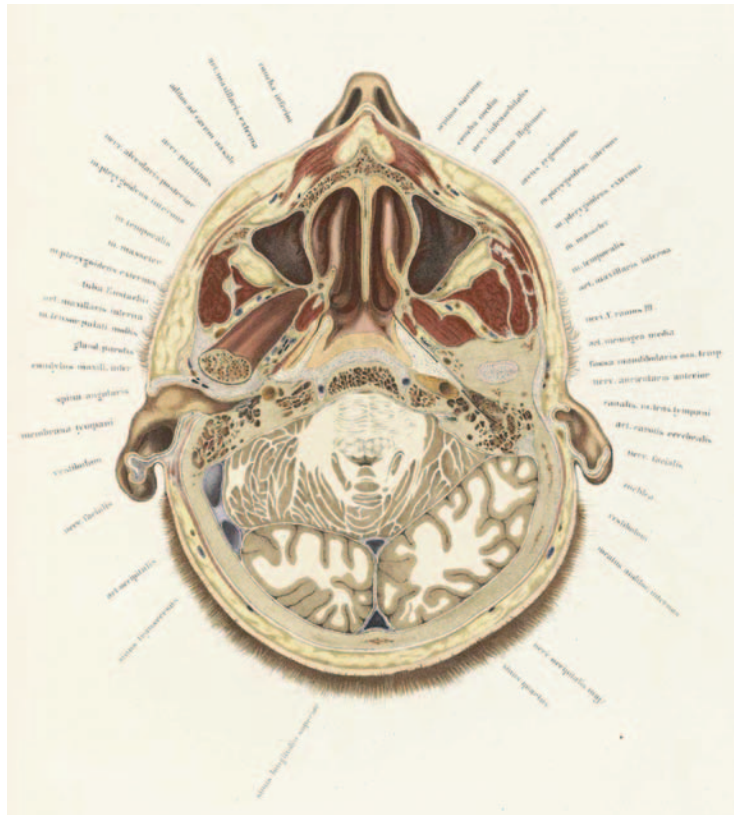
Nevertheless, the access provided by the endonasal endoscopic-assisted approach can present some anatomic limitations, principally relating to the size of the sphenoid sinus, the distance between the two internal carotid arteries, and the space available to control bleeding from the venous system of the cavernous sinus and its intercommunications.

In the article, the anatomic comparison of the surgical accesses provided by the endonasal endoscopic-assisted approach and the subfrontal craniotomy exposure clearly demonstrates the advantages and disadvantages of each method or technique. When authors discuss the advantages of the endonasal approach and mention less retraction of the brain, we completely agree; however, we don't believe there is a significant difference between the two approaches with respect to the amount of neurovascular manipulation.

The authors conclude that the endoscopic-assisted transplanum approach offers an increased risk of cerebrospinal fluid leak and control of bleeding (especially intradurally). These are potential complications of surgery using this type of access. However, these conclusions are theoretical, and probably go beyond the scope of a purely anatomic study.

Certainly, endoscopic-assisted transplanum access represents an important advance in the treatment arsenal for many lesions of the suprasellar region.

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