Transsphenoidal approach and extension to the sagittal plane

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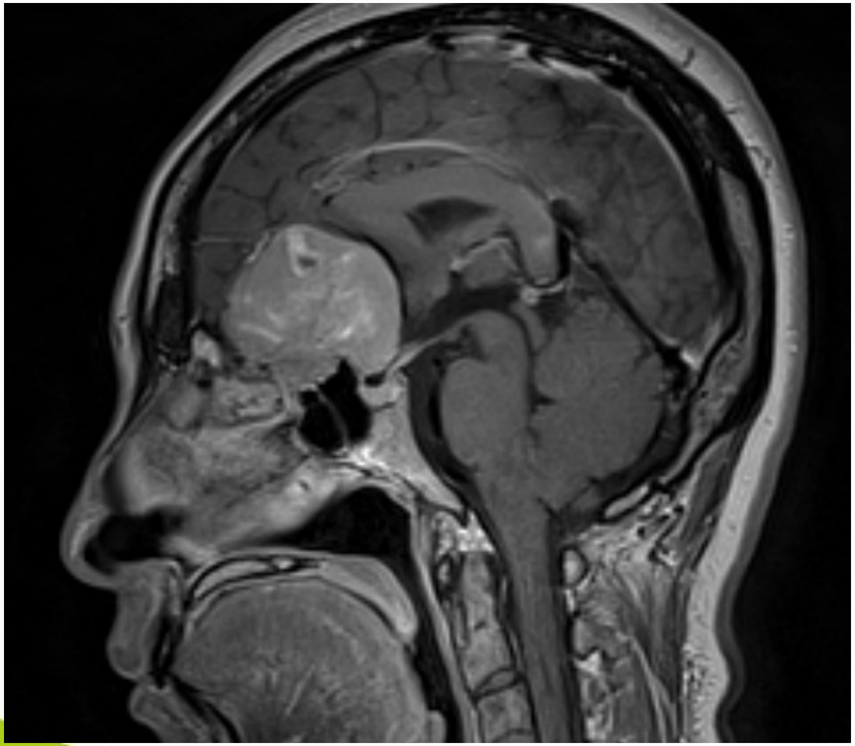
Level of Endoscopic Surgery

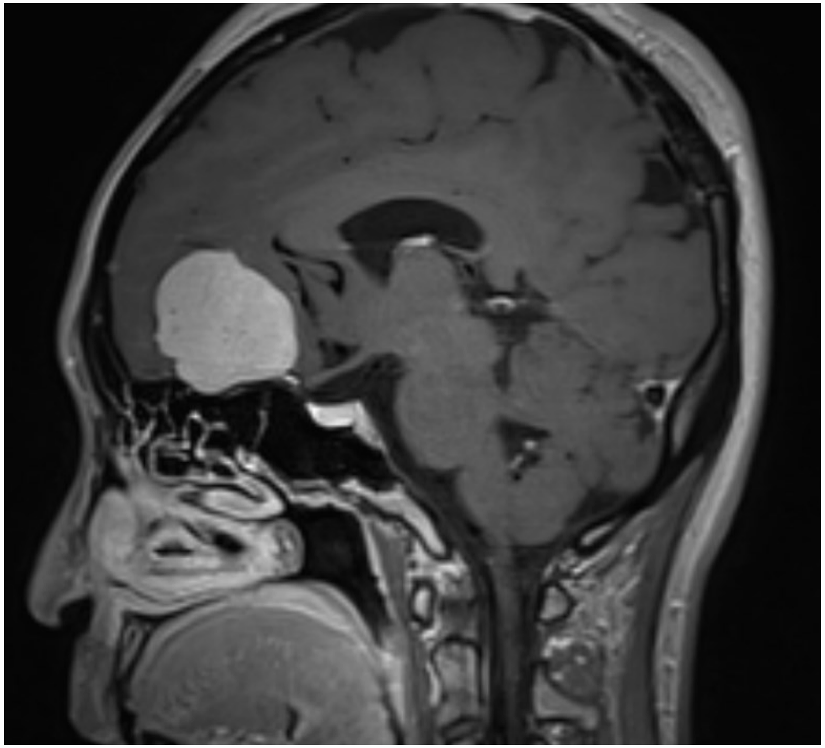
Level I	• **Endoscopic sinonasal surgery** • **Endoscopic sphenoethmoidectomy** • **Sphenopalatine artery ligation** • **Endoscopic frontal sinusotomy**	**Level IV (Intradural)**	**A. Presence of a cortical cuff** • **Transplanum approach** • **Transcribriform approach** • **Pre-infundibular craniopharyngioma** **B. Absence of cortical cuff (direct vascular contact)** • **Transplanum approach** • **Transcribriform approach** • **Infundibular and retro-infundibular craniopharyngioma** • **Transclival approach** • **Foramen magnum approach**
Level II	• Cerebrospinal fluid leaks • Lateral recess sphenoid • Pituitary surgery		
Level III (Extradural)	• Medial orbital decompression • Optic nerve decompression • Petrous apex (medial expansion) • Transclival approaches (extradural) • Transodontoid approach (extradural)	**Level V (Cerebro-vascular surgery)**	A. Coronal plane (paramedian) • Suprapetrous and infrapetrous carotid approaches • Transpterygoid approach • Inferotemporal fossa approach • Jugular foramen approach • Hypoglossal canal approach B. Vascular disease • Aneurysms • Vascular malformation

Cortical Cuff

Without cortical cuff



With cortical cuff



Introduction

- Indications
  - Trans-sellar approach
    - Pituitary adenomas
    - Rathke cleft cysts
  - Trans-tubercular/planar approach
    - Craniopharyngiomas
    - Meningiomas (Tuberculum sellae meningiomas, Diaphragm sellae meningiomas)

Introduction

- Transclival approach
  - Meningiomas (foramen magnum, clival)
  - Chordomas
  - Chondrosarcomas
  - Schwannomas (Lower CN)

  - Degenerative (osteo- or rheumatoid) Arthritis
  - And so on…

Contents

- **Surgical anatomy**
- **Surgical procedures**
- **Updates in cavernous sinus anatomy**

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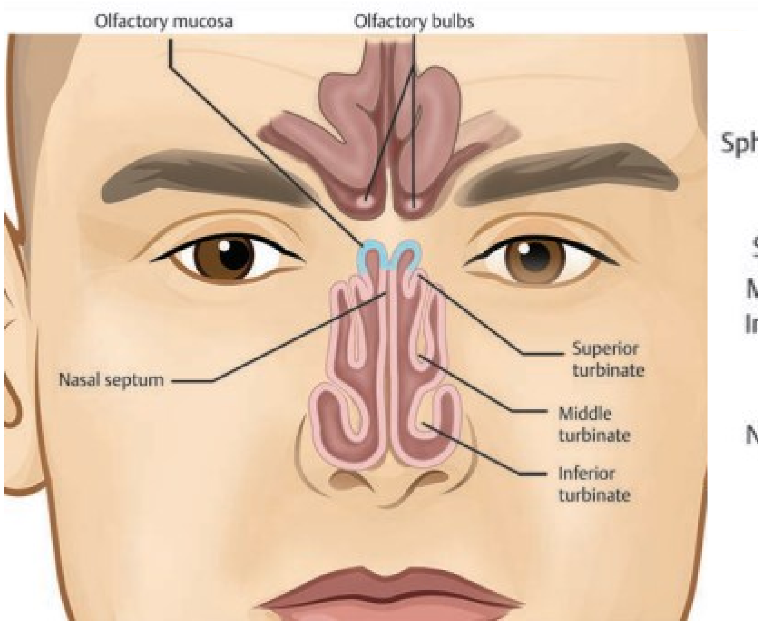
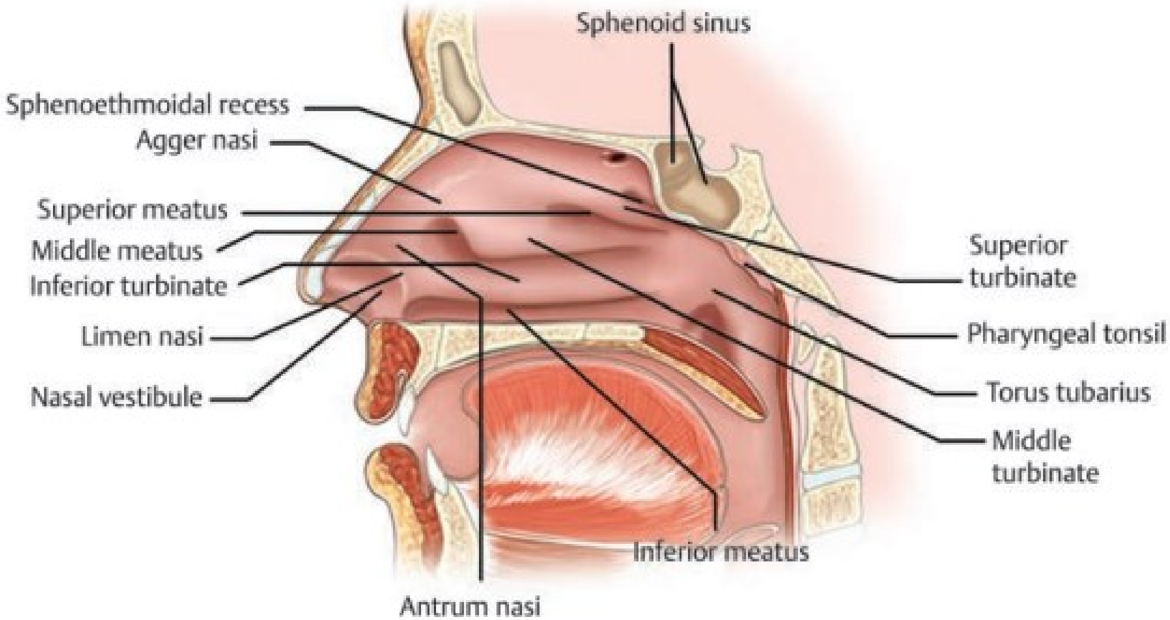
Courtesy of Pf. Do Hyun Kim

TRANS-NASAL PASSAGE TO THE SPHENOID SINUS

Nasal corridors





Endoscopic Dissection

- Step 1: Exploration of the inferior nasal corridor.
- Step 2: Lateralization of the inferior turbinate.
- Step 3: Exploration of the inferior nasal meatus.
- Step 4: Exploration of the middle nasal corridor.
- Step 5: Lateralization of the middle and superior turbinates.
- Step 6: Exploration of the middle nasal meatus.
- Step 7: Exposure of the sphenopalatine artery.
- Step 8: Exploration of the superior nasal corridor

Step 4: Exploration of the middle nasal corridor

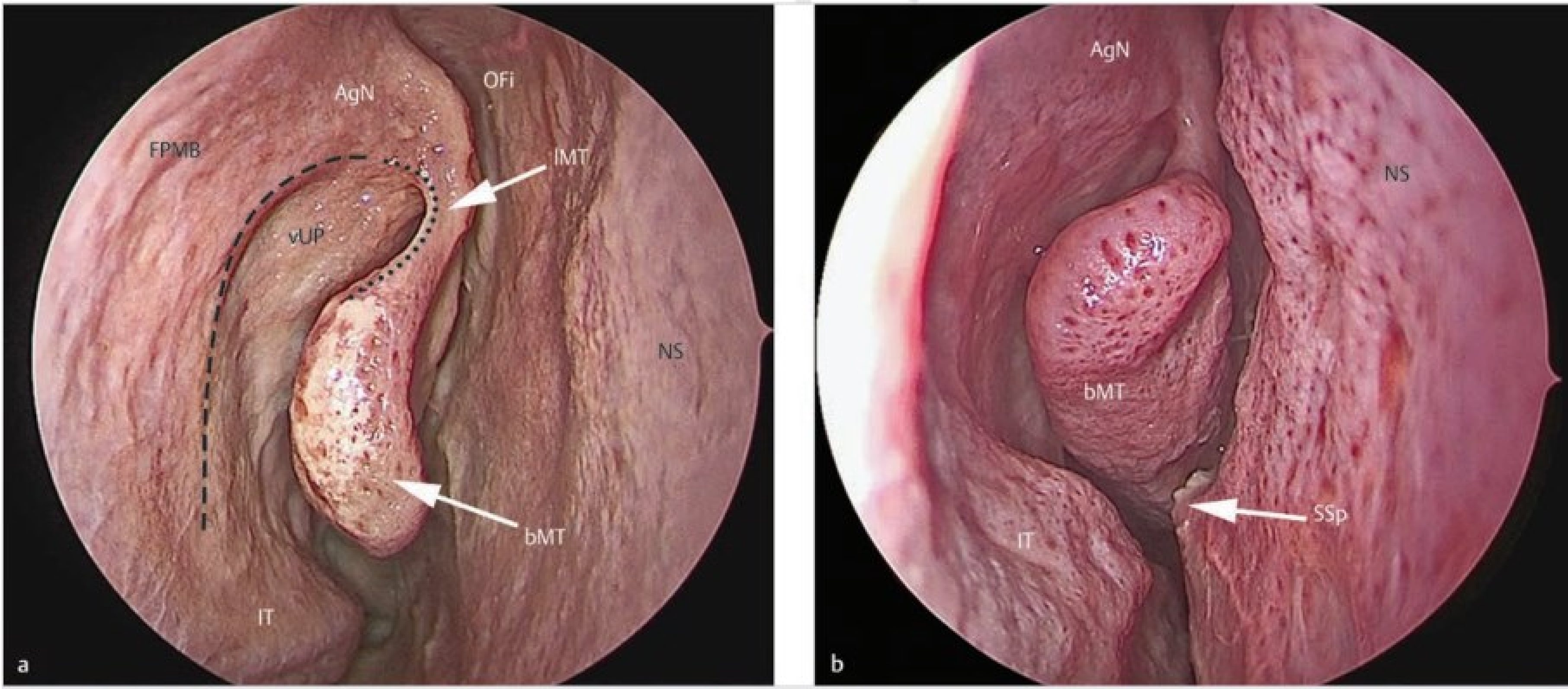


Fig. 2.12 (a, b) Step 4 (part 1). The middle nasal corridor is comprised between the bulbous portion of the middle turbinate (bMT) laterally and nasal septum (NS) medially. It can be narrowed by a hypertrophic or pneumatized middle turbinate, septal spur (SSp), or hypertrophic Zuckerkandl tubercle. The middle turbinate is composed of the bulbous and laminar portion (lMT). The latter structure inserts superiorly on the agger nasi (AgN), which is a lateral-to-medial prominence of the lateral nasal wall. The junction between the frontal process of the maxillary bone (FPMB) and the vertical portion of the uncinate process (vUP) is called maxillary line (*black dashed line*) and almost corresponds to the suture between the maxilla and lacrimal bone. The axilla of the middle turbinate is made up by the maxillary line and the laminar portion of the middle turbinate (*black dotted line*). IT, inferior turbinate; OFi, olfactory fissure.

Step 4: Exploration of the middle nasal corridor

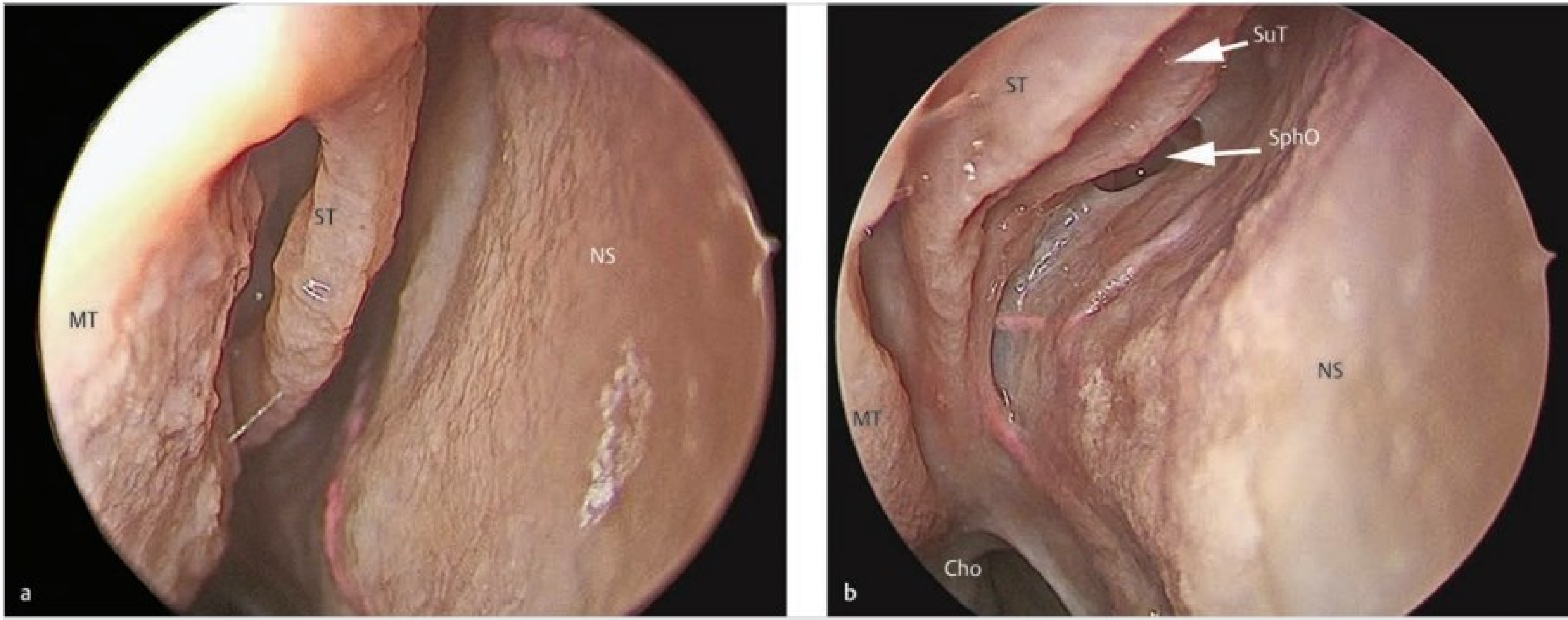


Fig. 2.13 (a, b) Step 4 (part 2). The superior turbinate (ST) is identified by moving the scope posteriorly through the middle nasal corridor. According to the size and pneumatization of the superior turbinate, the sphenoethmoidal recess, which is the space between the superior turbinate and the anterior wall of the sphenoid sinus, can be seen proceeding further posteriorly with the scope. In the posteromedial portion of the sphenoethmoidal recess, it is possible to identify the sphenoidal ostium (SphO) between the superior turbinate and nasal septum. The sphenoethmoidal recess can be partially filled by the supreme turbinate (SuT), when present. Cho, choana; MT, middle turbinate; NS, nasal septum.

Step 5: Lateralization of the middle and superior turbinates

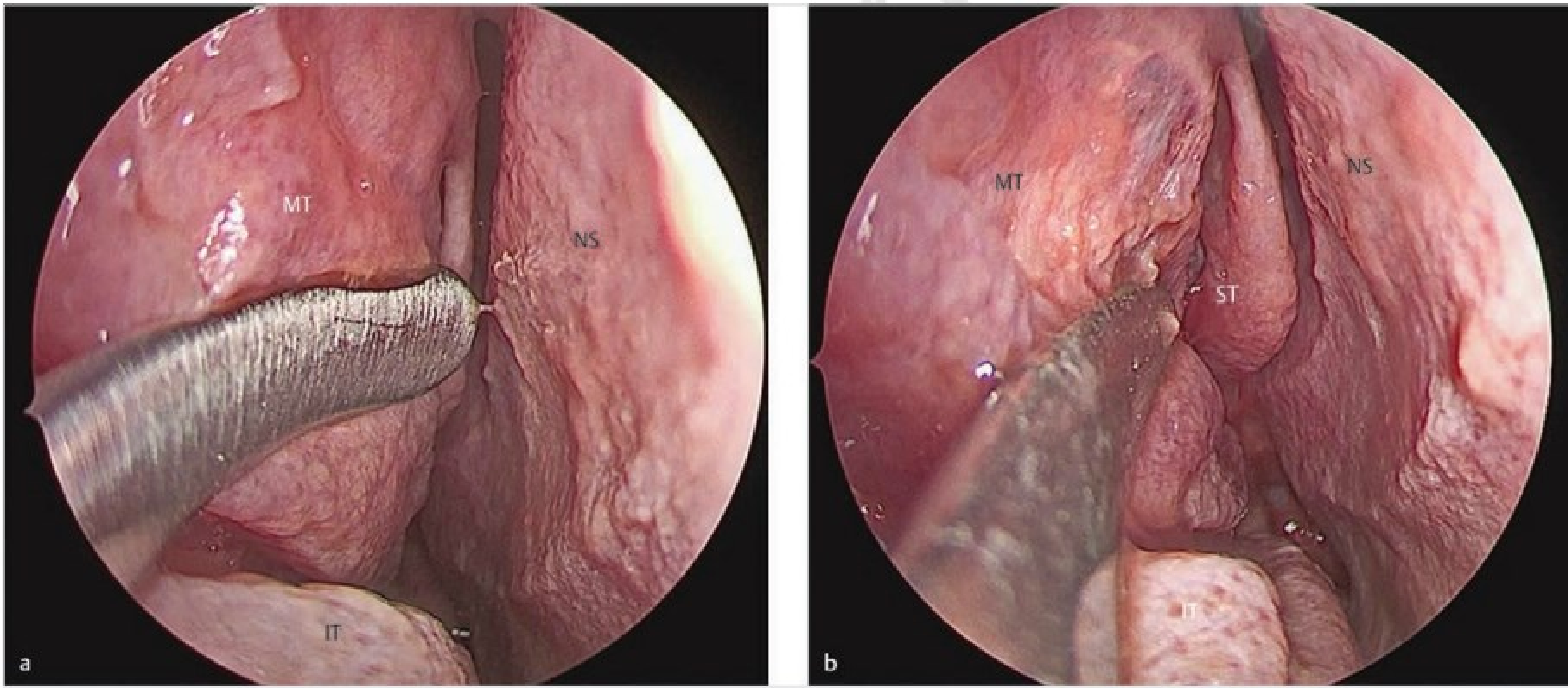


Fig. 2.14 (a, b) Step 5. To widen the middle nasal corridor, a dissector is used to push the bulbous portion of the middle turbinate (MT) laterally. The same maneuver can be repeated for the superior turbinate (ST). It is important to avoid lateralization of the laminar portion of the middle turbinate as this structure is directly connected to the cribriform plate and its manipulation can result in the injury of the skull base. IT, inferior turbinate; NS, nasal septum.

Step 6: Exploration of the middle nasal meatus

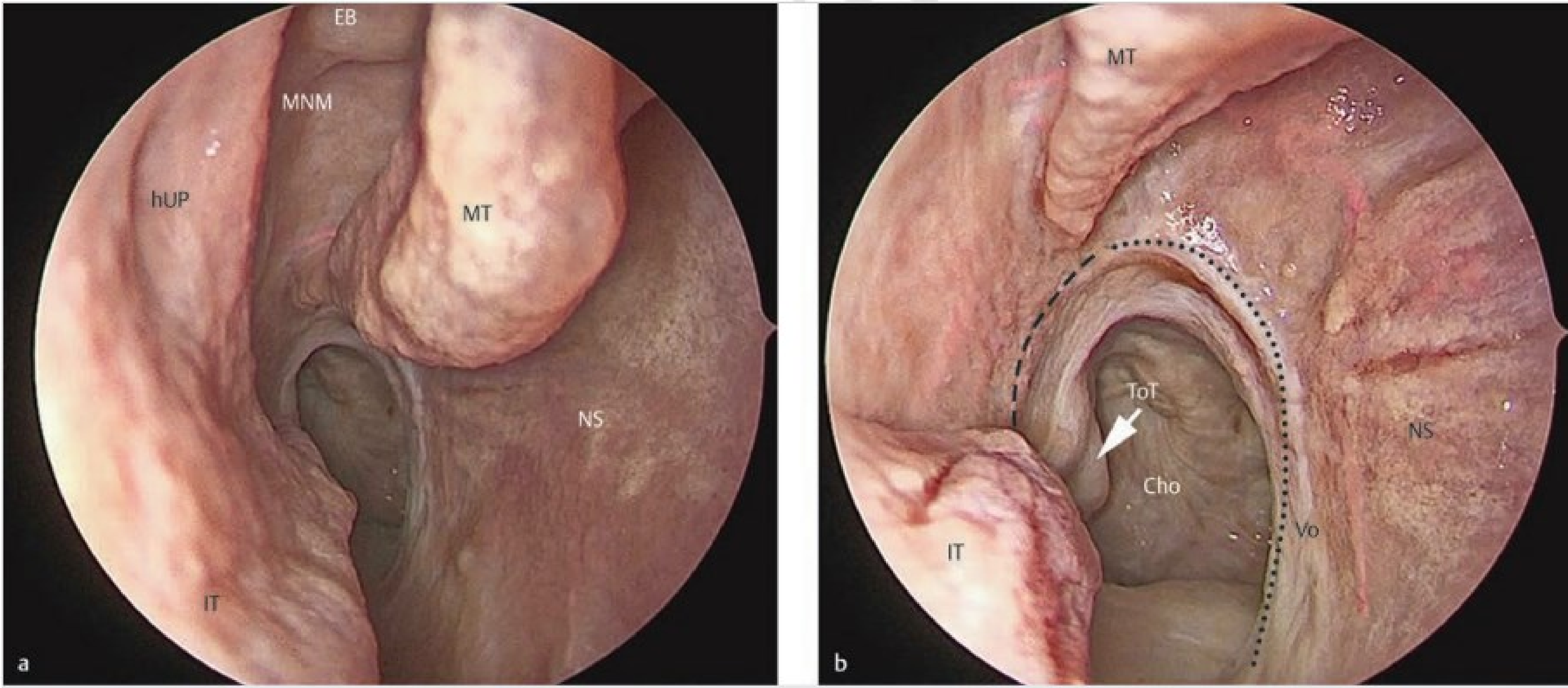


Fig. 2.16 (a, b) Step 6 (part 2). The scope is moved through the middle nasal meatus (MNM) below the ethmoid bulla (EB). The area of the tails of the turbinates is reached proceeding between the horizontal portion of the uncinate process (hUP) and the middle turbinate (MT). The tails of the inferior (IT) and middle turbinate mark the position of the perpendicular process of the palatine bone (*black dashed line*), which forms the choana (Cho) together with the posterolateral margin (*black dotted line*) of the vomer (Vo) and nasal floor. Of note, the tail of the inferior turbinate can be used as a landmark for the torus tubarius (ToT). NS, nasal septum.

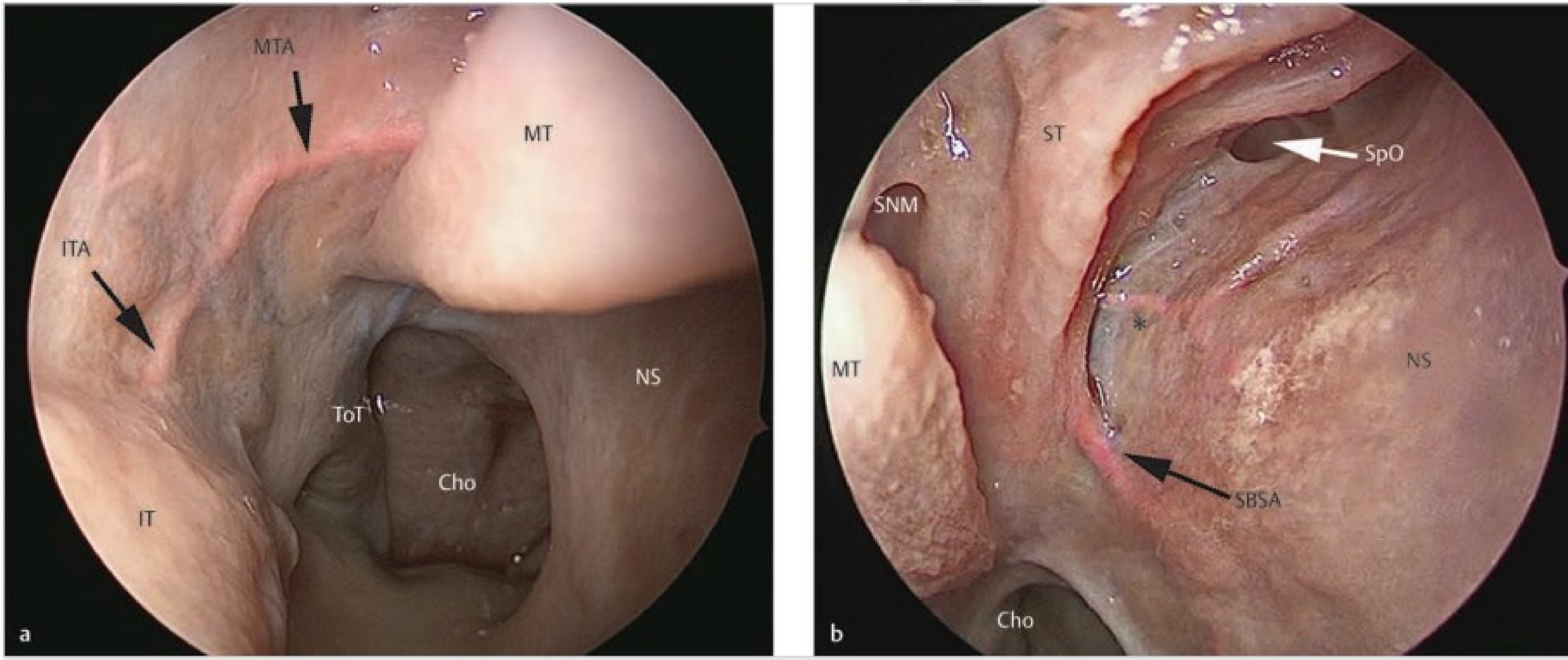


Fig. 2.18 (a, b) Branches of the sphenopalatine artery. Some of the main branches of the sphenopalatine artery can be identified just underneath the mucosa that covers the nasal meati and sphenoethmoidal recess. The inferior (ITA) and middle (MTA) turbinal arteries can be identified in the area of the tails of the turbinates where they run toward the inferior (IT) and middle (MT) turbinates, respectively. The septal branch of the sphenopalatine artery (SBSA) can be identified in the area of the sphenoethmoidal recess and choana (Cho). It runs above the tail of the superior turbinate (ST) toward the nasal septum (NS). Very frequently, a small artery (*black asterisk*) supplying the posterosuperior portion of the nasal septum can be found just inferior to the sphenoid ostium (SpO). This artery can be confused with the septal branch of the sphenopalatine artery. SNM, superior nasal meatus; ToT, torus tubarius.

Step 7: Exposure of the sphenopalatine artery

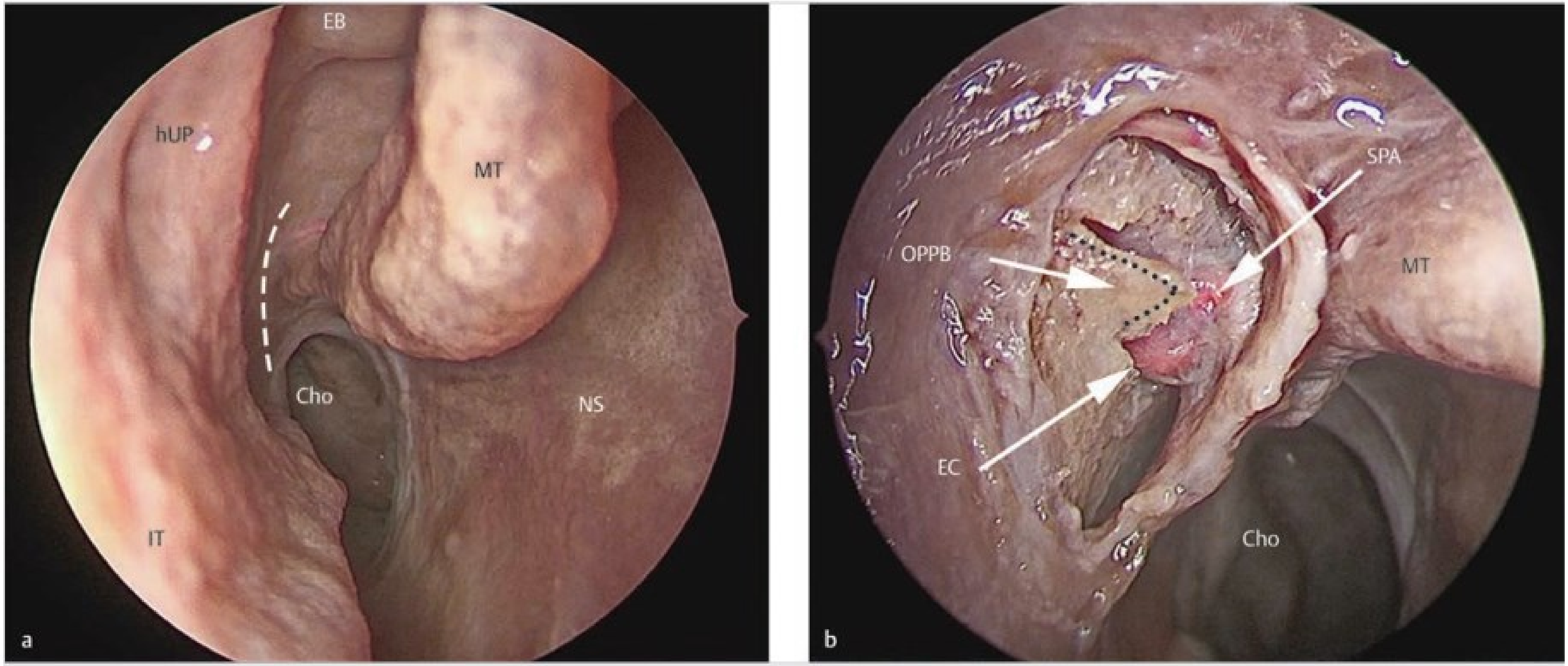


Fig. 2.19 (a, b) Step 7. A small vertical incision (*white dashed line*) is made along the lateral wall of the posterior portion of the middle nasal meatus, in front of the tail of the middle turbinate (MT). By performing a subperiosteal dissection along the orbital process of the palatine bone (OPPB), the anterior portion of the ethmoid crest (EC) is identified. This structure forms a lateral-to-medial pointer (*black dotted line*), which marks the position of the sphenopalatine foramen and the direction of the sphenopalatine artery (SPA). Cho, choana; EB, ethmoid bulla; hUP, horizontal portion of the uncinate process; IT, inferior turbinate; NS, nasal septum.

Step 8: Exploration of the superior nasal corridor

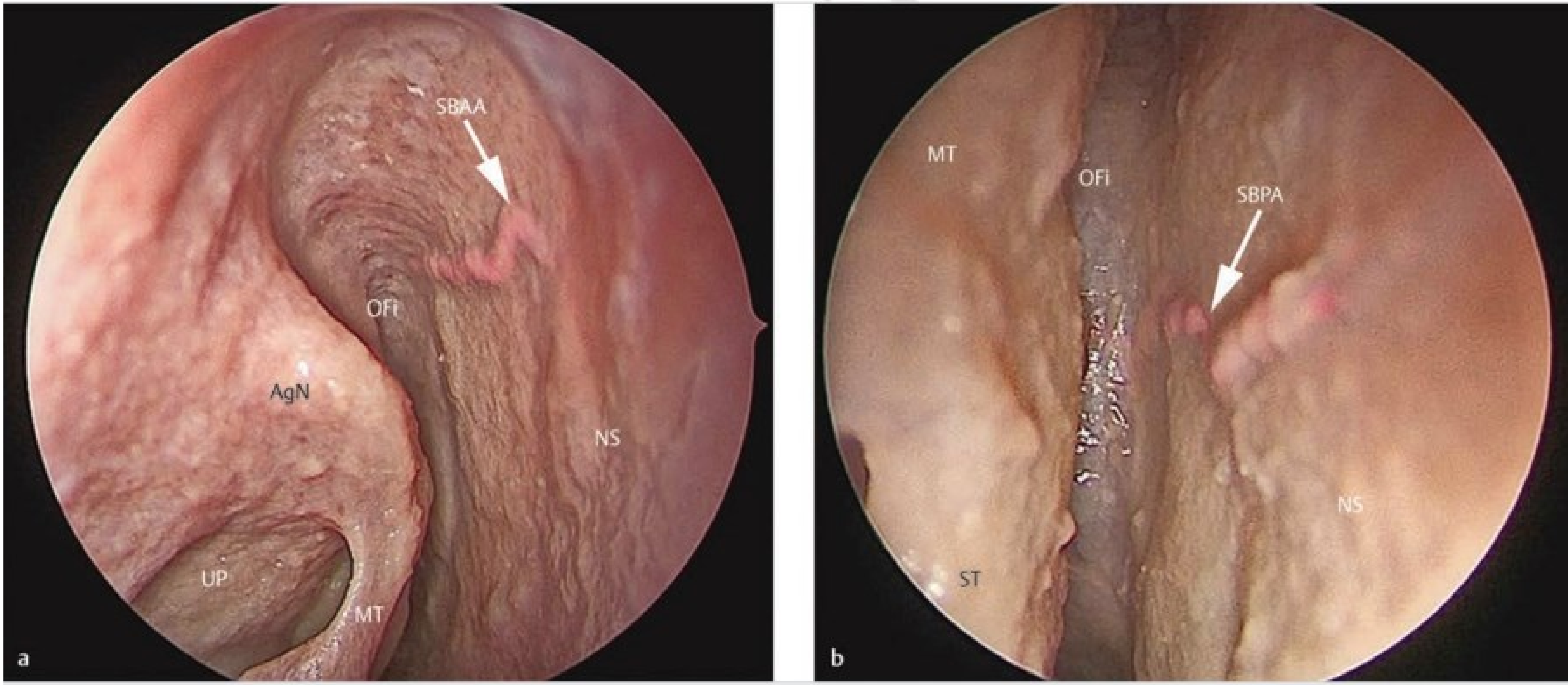
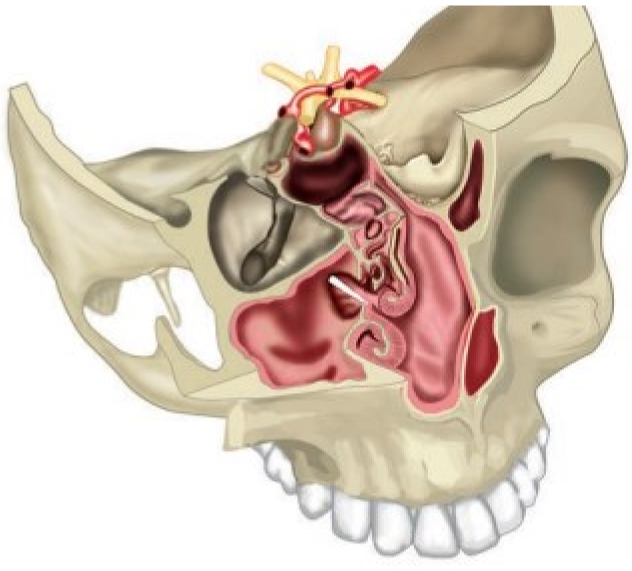
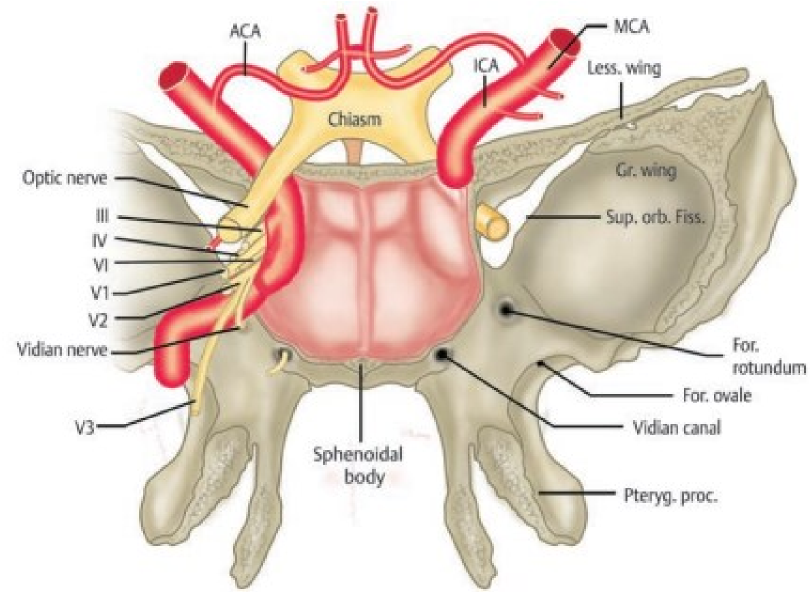


Fig. 2.20 (a, b) Step 8. The superior nasal corridor is limited by the laminar portions of the middle (MT) and superior turbinates (ST) laterally, the superior portion of the nasal septum (NS) medially, and the olfactory fissure (OFi) superiorly. The olfactory fissure houses the olfactory mucosa and lies superior to the level of the axillae of the middle and superior turbinates. The superior nasal corridor can be narrowed by a prominent agger nasi (AgN), deviation of the nasal septum, or hypertrophic Zuckerkandl tubercle. The septal branch of the anterior ethmoidal artery (SBAA) can be identified with a 0-degree scope just underneath the mucosa in the most anterior and superior portion of the nasal septum. The septal branch of the posterior ethmoidal artery (SBPA) is identified with a 70-degree scope turned upward and positioned at the passage between middle and superior turbinates. The former has a diagonal trajectory from posterosuperior to anteroinferior, while the latter runs from cranial to caudal. UP, uncinate process.

Corridor to Sella turcica, surrounding areas, posterior skull base, and cervical spine





Endoscopic Dissection

- Step 1: Partial superior turbinectomy (if needed).
- Step 2: Paraseptal sphenoidotomy.
- Step 3: Subseptal sphenoidotomy.
- Step 4: Transrostral sphenoidotomy.
- Step 5: Extended transrostral sphenoidotomy.
- Step 6: Modular (a) or functional (b) transethmoidal sphenoidotomy.
- Step 7: Posteroinferior septectomy.
- Step 8: Removal of the floor of the sphenoid sinus.

Step 2: Paraseptal sphenoidotomy

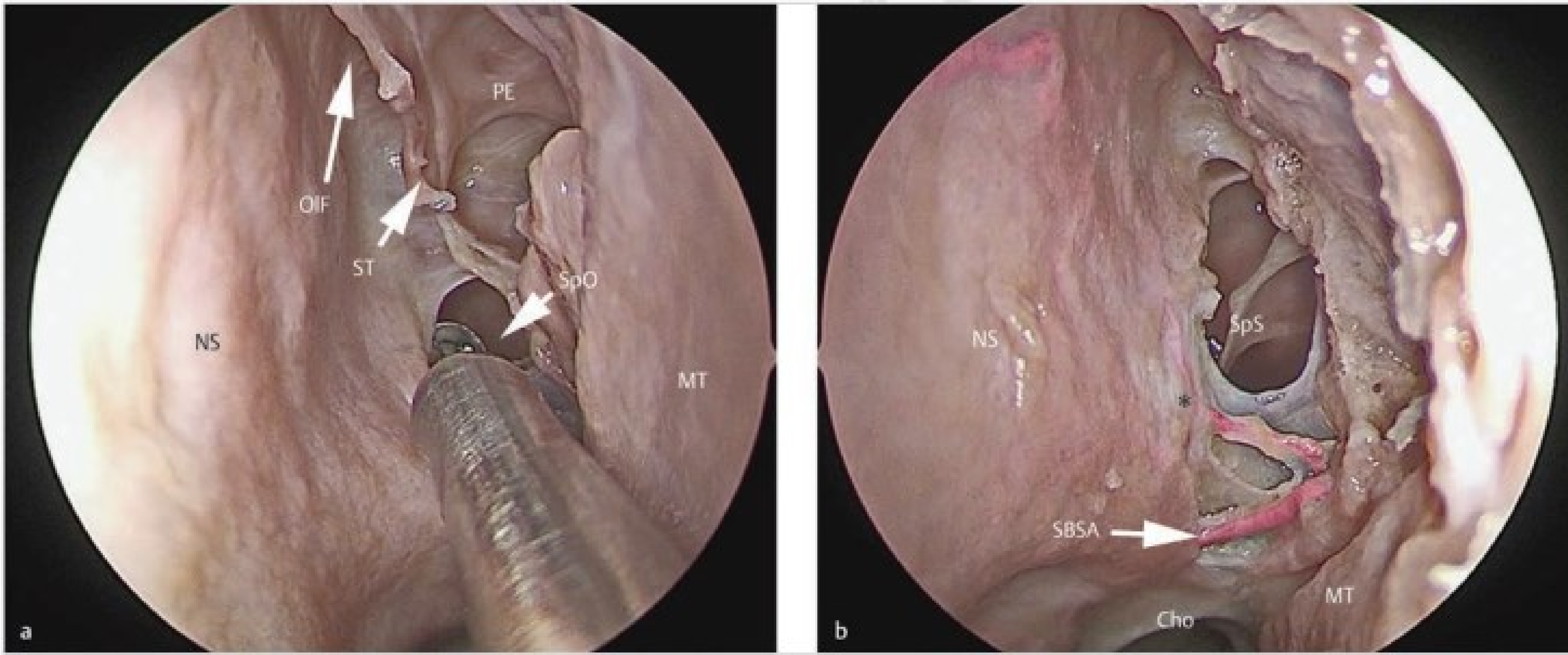


Fig. 4.10 (a, b) Step 2 (part 1). A straight punch is used to enlarge the sphenoid ostium (SpO). While extending inferiorly the aperture of the sphenoid sinus (SpS), a small artery (*black asterisk*) is encountered early; this artery can be misinterpreted as the septal branch of sphenopalatine artery (SBSA), which runs from the sphenopalatine ostium to the nasal septum (NS) in a more caudal plane located almost midway between the bony sphenoid ostium and the superior border of the choana (Cho). MT, middle turbinate; OlF, olfactory fissure; PE, posterior ethmoid; ST, superior turbinate.

Step 3: Subseptal sphenoidotomy

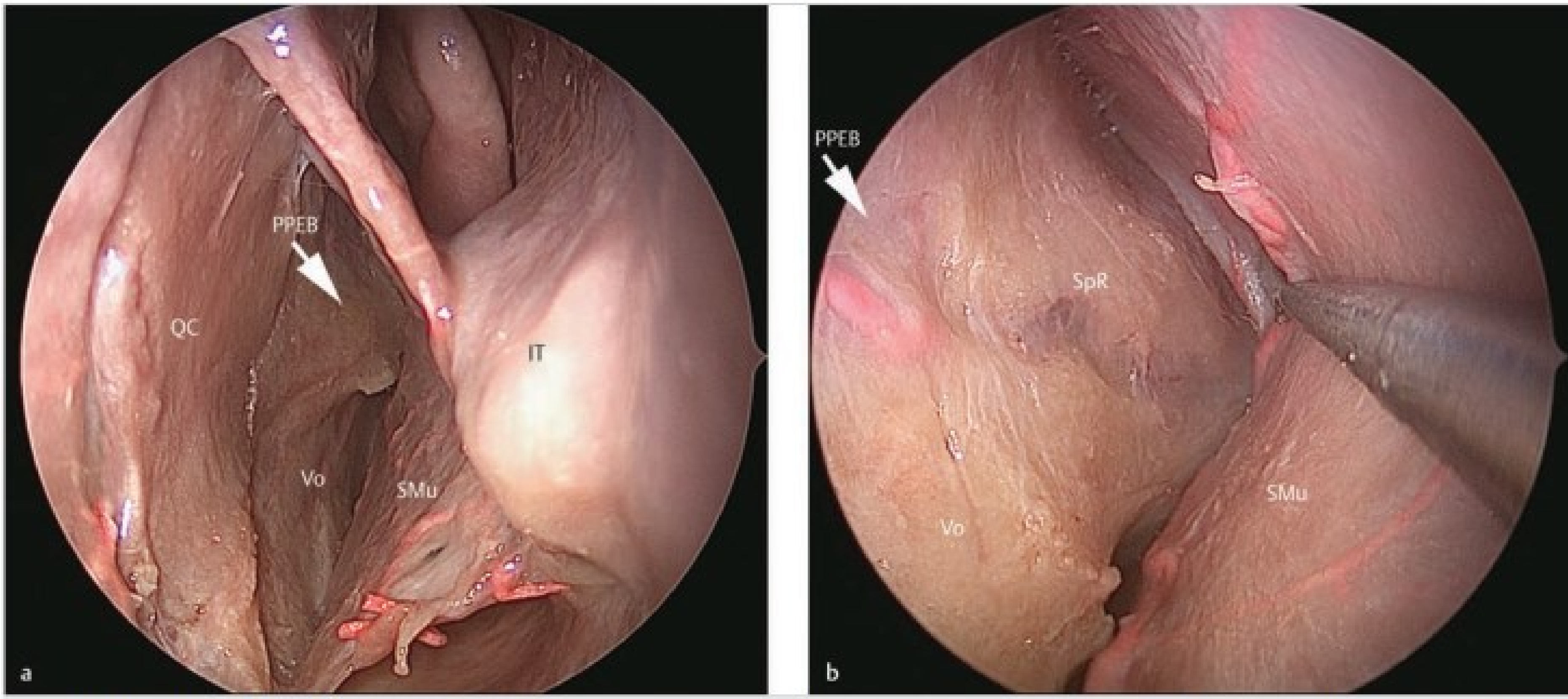


Fig. 4.13 (a, b) Step 3 (part 2). The subperichondrial–subperiosteal dissection is extended posteriorly along the quadrangular cartilage (QC), perpendicular plate of the ethmoid bone (PPEB), and vomer (Vo). The sphenoidal rostrum (SpR) is identified where the bony plane turns from sagittal to coronal above the nasal choana. IT, inferior turbinate; SMu, septal mucosa.

Step 4: Transrostral sphenoidotomy

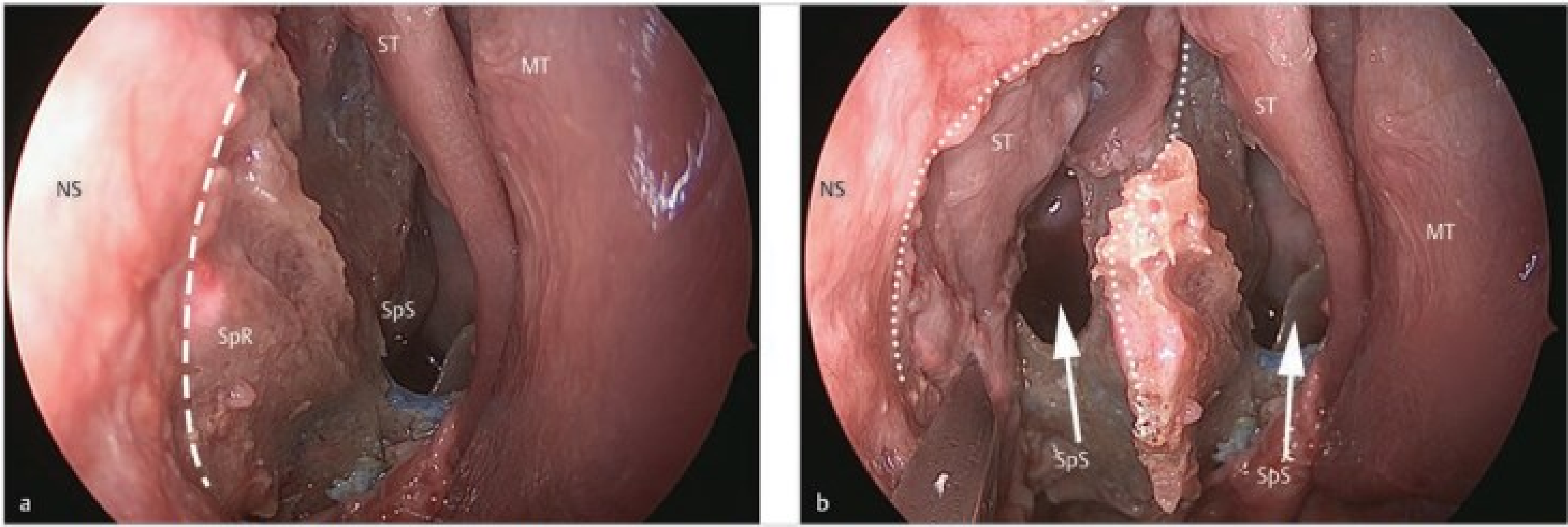


Fig. 4.18 (a, b) Step 4 (part 2). A dissector or chisel is used to fracture the nasal septum (NS) at the junction (*white dashed line* before fracture and *white dotted lines* after fracture) between the sphenoidal rostrum (SpR) and perpendicular plate of the ethmoid bone. After completing this maneuver, both sphenoid sinuses (SpS) are identified through paraseptal sphenoidotomies. MT, middle turbinate; ST, superior turbinate.

Step 5: Extended transrostral sphenoidotomy

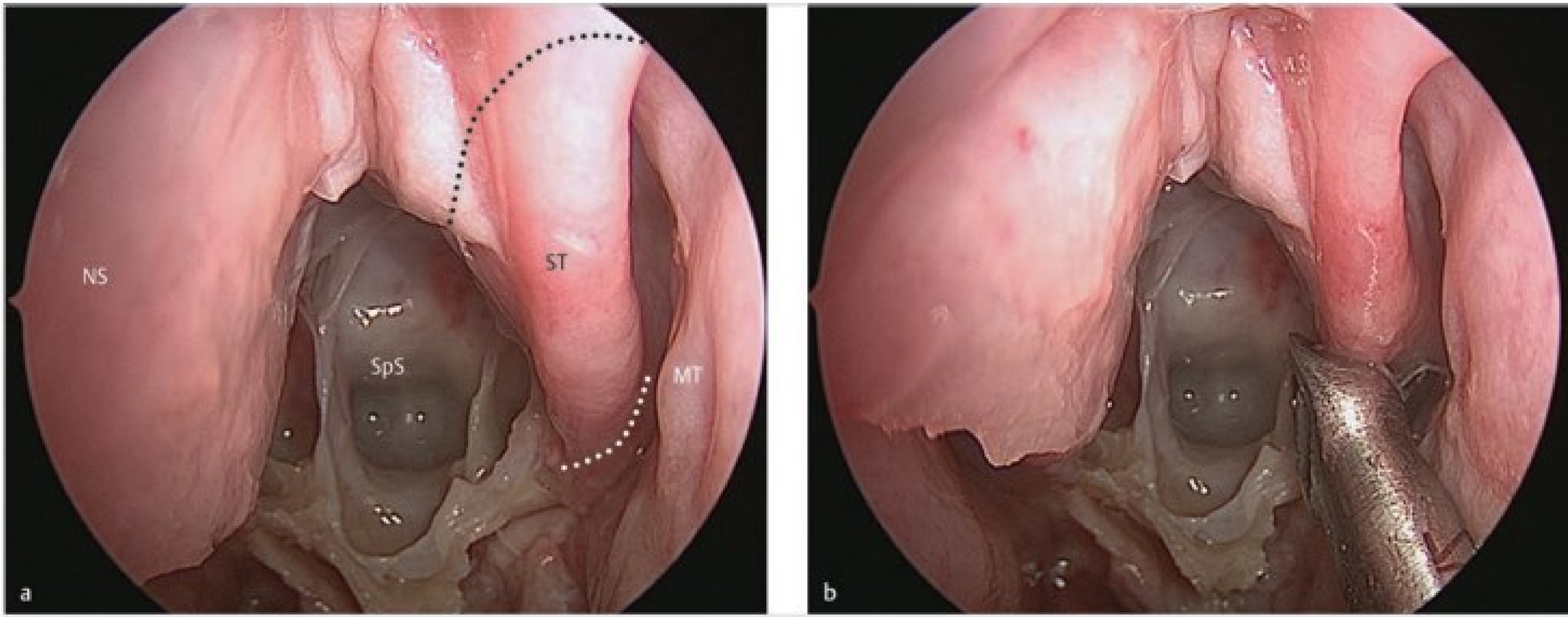


Fig. 4.21 (a, b) Step 5 (part 1). Both laminar and bulbous portions of superior turbinate (ST) are removed with a cutting instrument (*black and white dotted lines*). MT, middle turbinate; NS, nasal septum; SpS, sphenoid sinus.

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Step 5: Extended transrostral sphenoidotomy

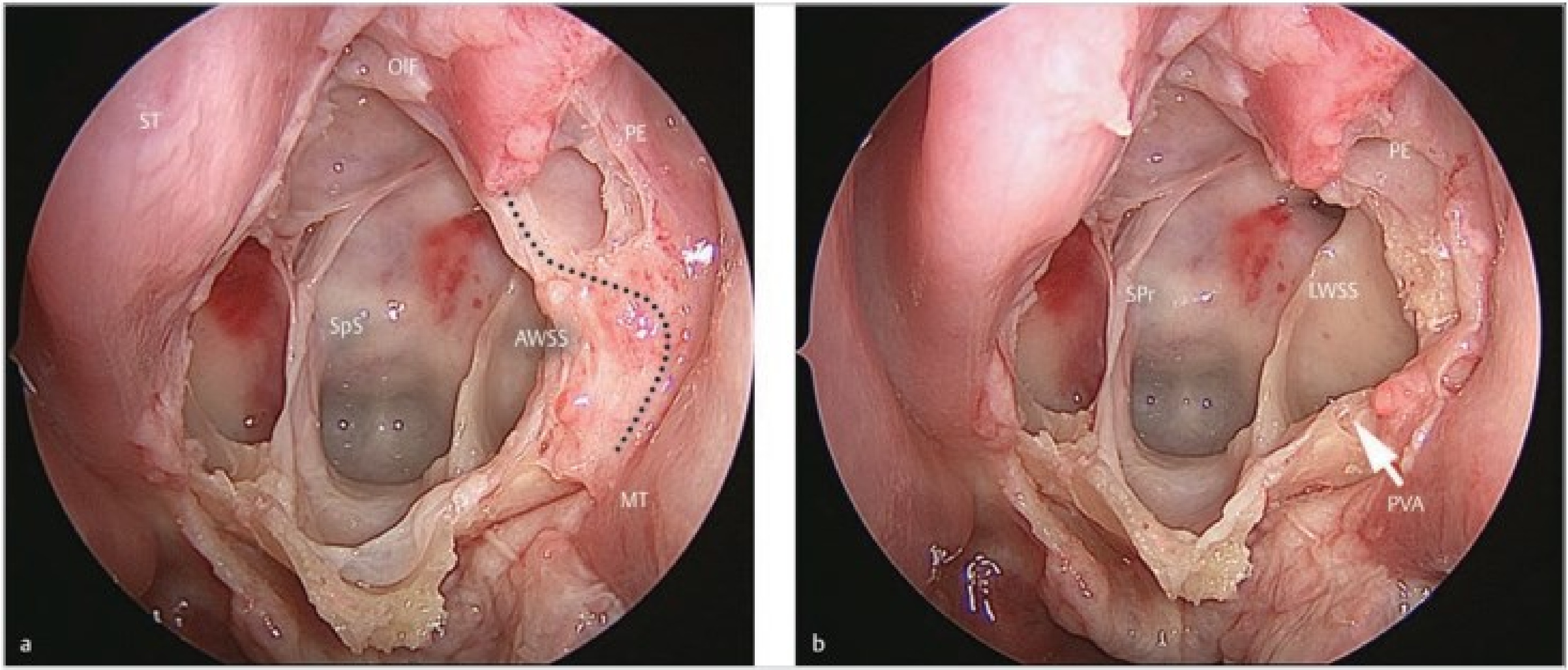
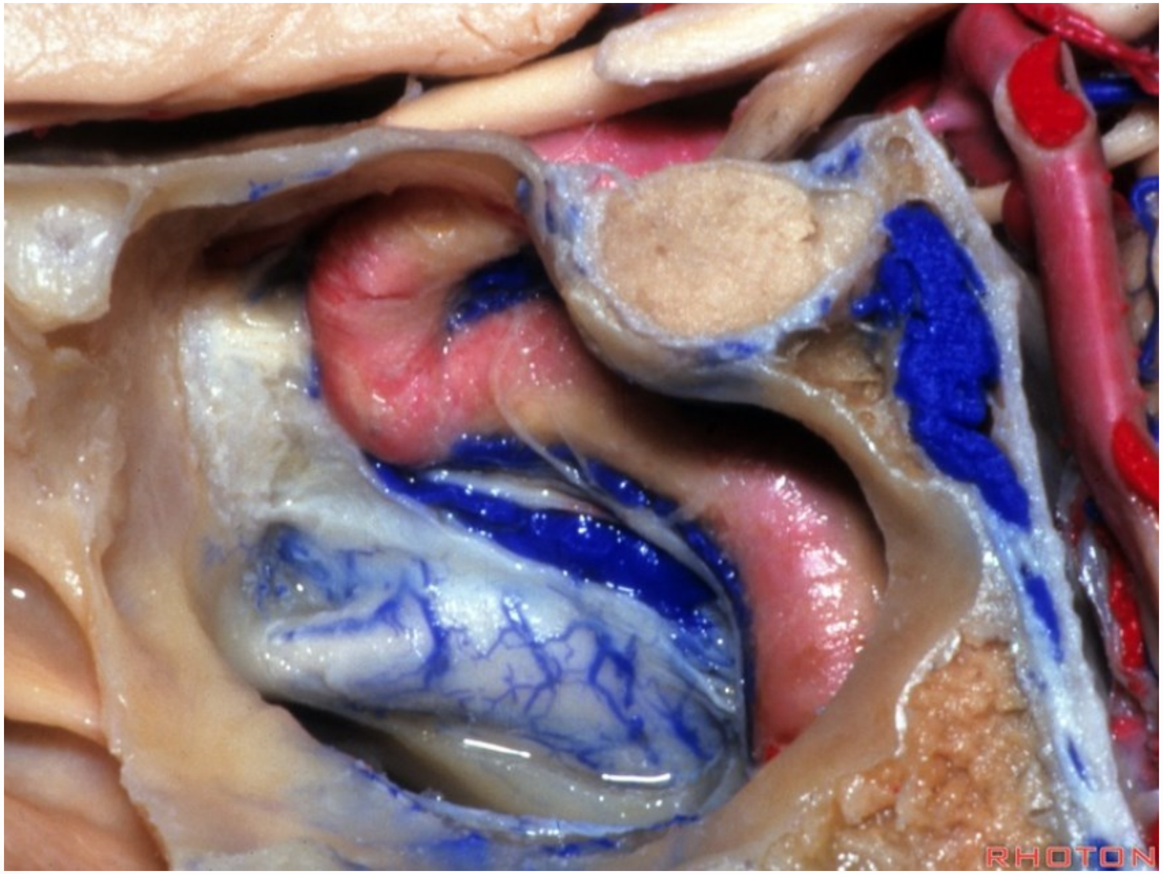


Fig. 4.22 (a, b) Step 5 (part 2). The portion of the anterior wall of sphenoid sinus (AWSS) that lies medial to the posterior insertion of the superior turbinate (*black dotted line*) is removed. The palatovaginal artery (PVA) can be identified in the inferolateral corner of the extended transrostral sphenoidotomy, above the tail of the middle turbinate (MT). LWSS, lateral wall of sphenoid sinus; MT, middle turbinate; OlF, olfactory fissure; PE, posterior ethmoid; SPr, sellar prominence; SpS, sphenoid sinus.



SURGICAL ANATOMY
-TRANS-SELLAR AND TRANS-TUBERCULAR/PLANAR APPROACH

Sphenoid Sinus

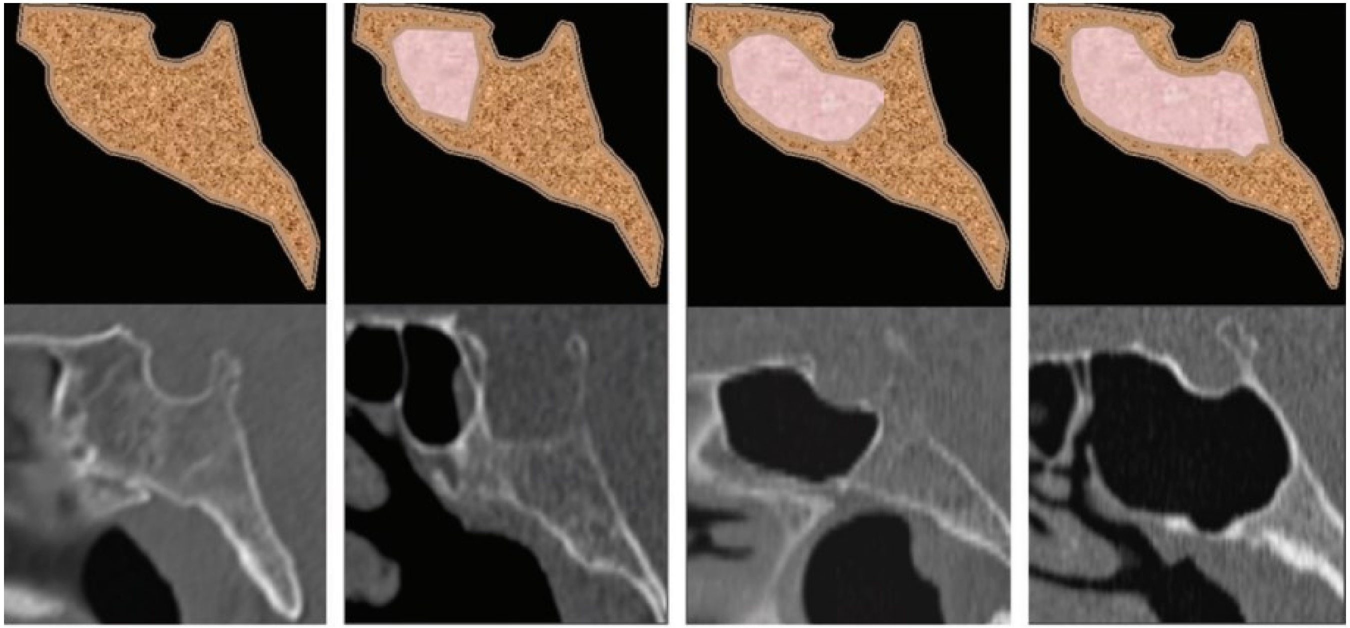


Figure 10. Traditional classification of sphenoid pneumatization. Drawings (top row) correlate with sagittal CT images (bottom row). **(a)** Conchal: The region below the sella is completely ossified and consists of a solid block of bone with no air cavity. **(b)** Presellar: The air cavity does not penetrate beyond a vertical plane parallel to the anterior sellar wall. **(c, d)** Sellar: The sphenoid sinus is well pneumatized, with bulging of the sellar floor into the sinus. The air cavity either extends into the body of the sphenoid, below the sella (incomplete sellar type) **(c)**, or continues to the posterior margin of the clivus, forming a clival recess (complete sellar type) **(d)**.

García-Garrigós E, Arenas-Jiménez JJ, Monjas-Cánovas I, Abarca-Olivas J, Cortés-Vela JJ, De La Hoz-Rosa J, Guirau-Rubio MD. Transsphenoidal Approach in Endoscopic Endonasal Surgery for Skull Base Lesions: What Radiologists and Surgeons Need to Know. Radiographics. 2015 Jul-Aug;35(4):1170-85. doi: 10.1148/rg.2015140105. Epub 2015 Jun 5. PMID: 26046941.

Sphenoid Sinus Septum

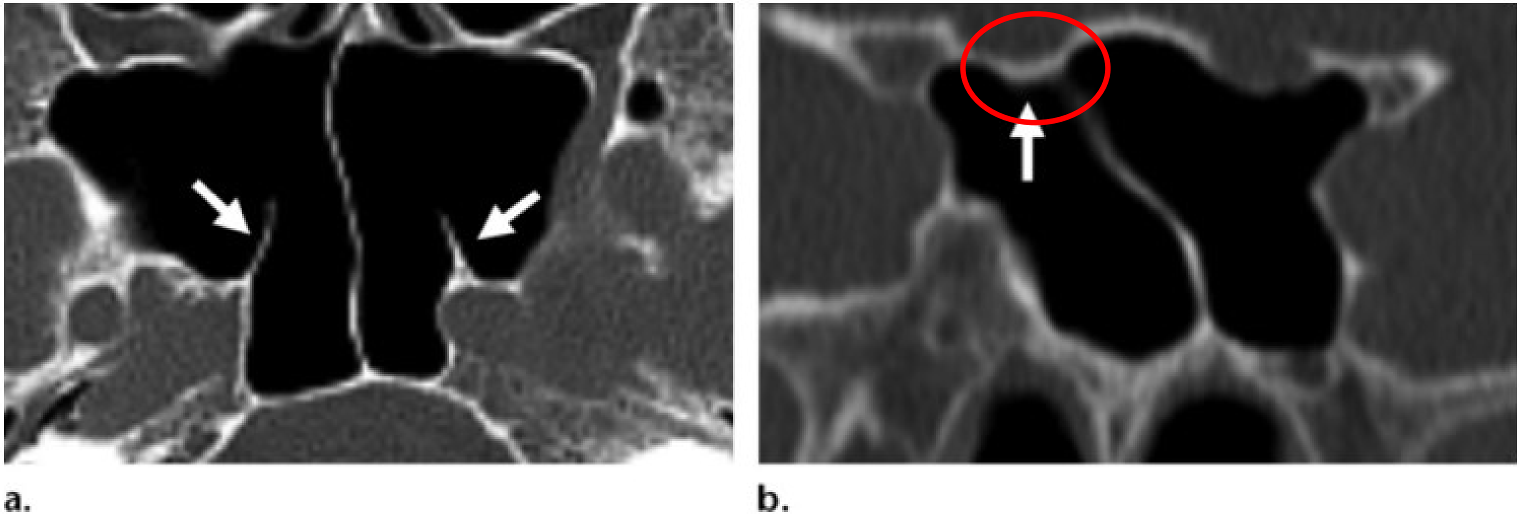
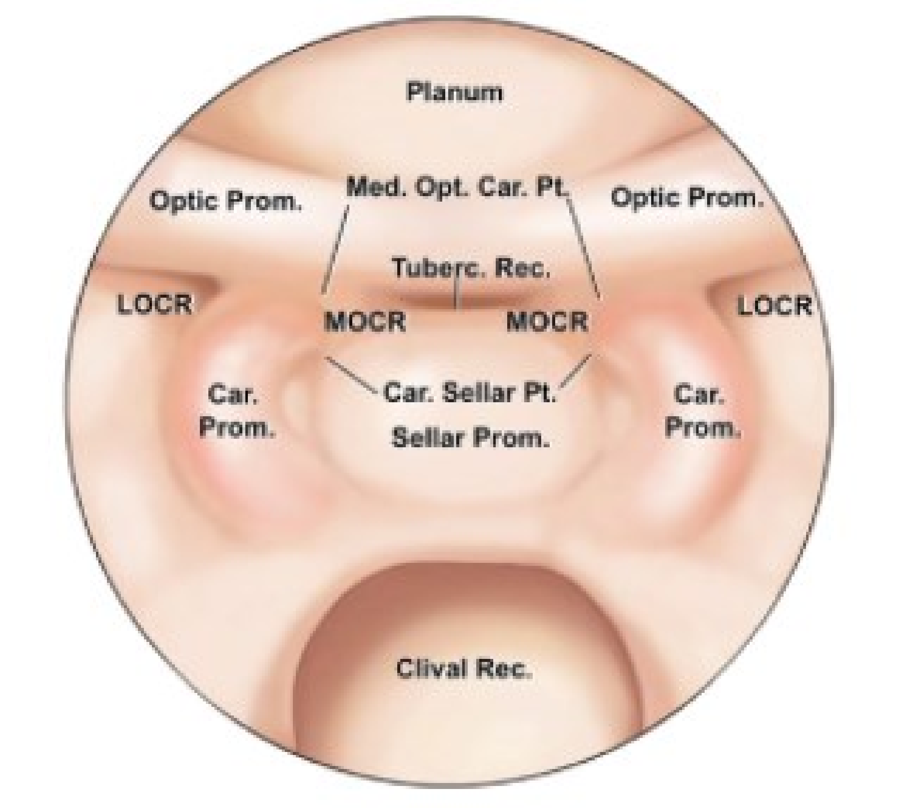
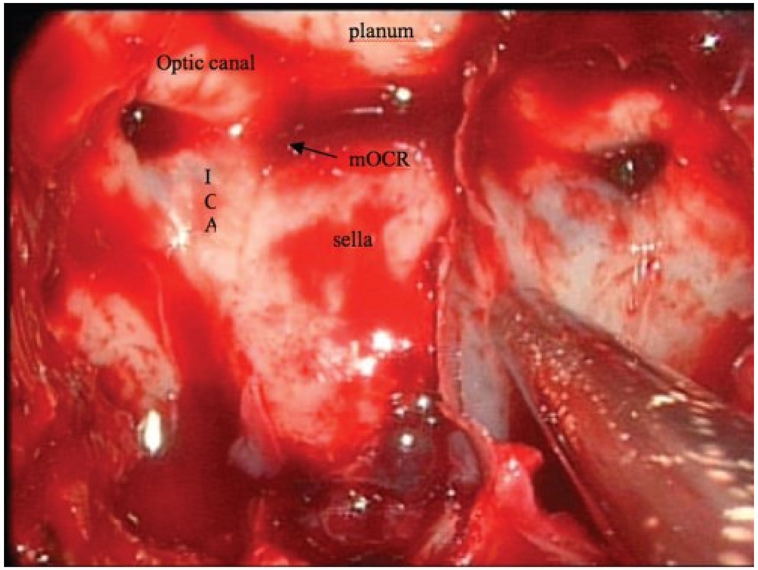


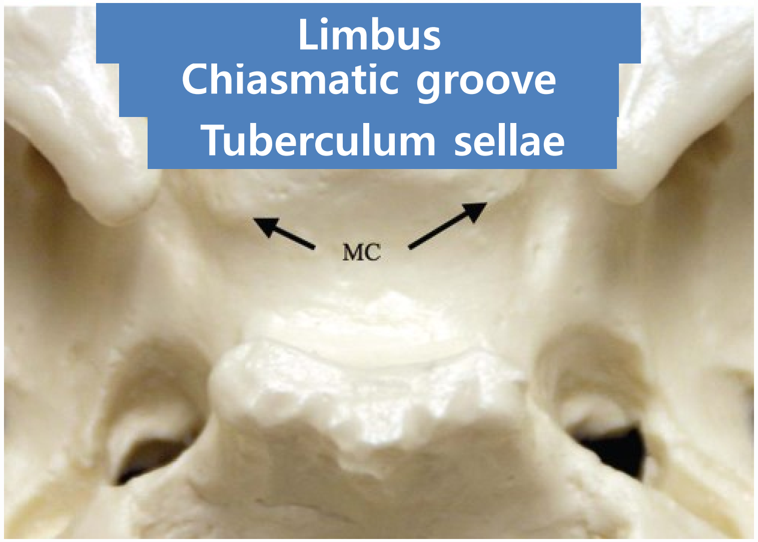
Figure 16. Intrasphenoidal septal insertions. **(a)** Axial CT image shows bilateral accessory septa (arrows) inserting over the paraclival internal carotid arteries. **(b)** Coronal CT image shows the intersinus septum inserting over the right optic nerve canal (arrow).

- Bilateral sphenoidal sinuses are normally separated by an intersinus septum and may also be subdivided by accessory septa
- Up to 50-70% of people have a sphenoidal septum that inserts off the midline; often this septum attaches to the carotid canal

Sella Floor -Inferior View







Sella Floor -Inferior View

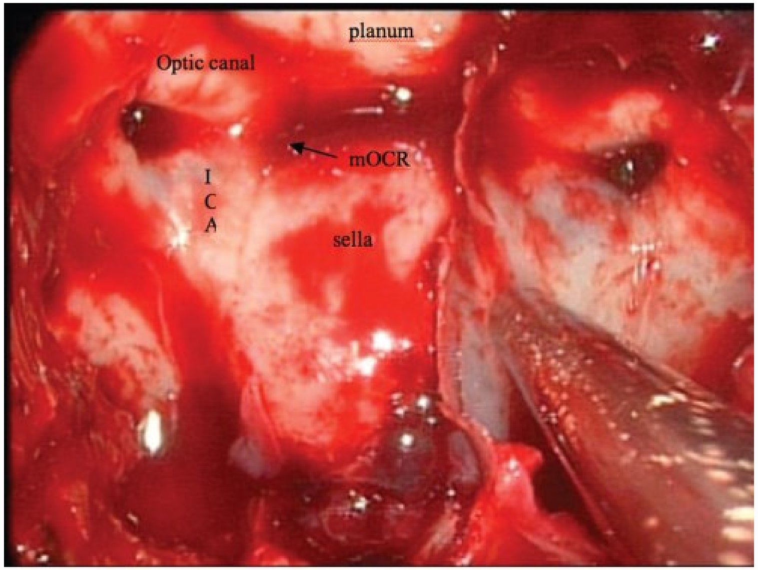
Upper: Intraoperative endoscopic view

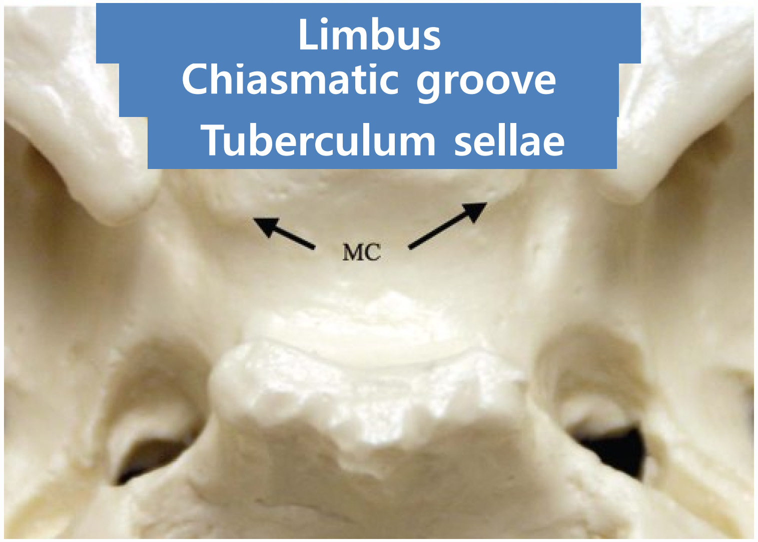
The <u>mOCR (medial optic-carotid recess)</u>

: ~~corresponding to the middle clinoid (MC)~~

: provides control of and access to the critical structures involved in suprasellar approaches.

Lower: superior view of a skull model





Medial OCR (Optico-carotid recess)

TUMOR — *Surgical Anatomy and Technique*

The Medial Opticocarotid Recess: An Anatomic Study of an Endoscopic "Key Landmark" for the Ventral Cranial Base

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BACKGROUND: The medial opticocarotid recess (MOCR) has become an important landmark for endoscopic approaches to the cranial base.

OBJECTIVE: To examine the anatomy of the MOCR and outline its role as a "key landmark" for approaches to the sellar and suprasellar regions.

METHODS: Ten silicone-injected cadaveric specimens and 96 dry crania were examined. Dissections were done endoscopically and microscopically.

RESULTS: The lateral tubercular recess is an osseous depression located at the lateral edge of the tuberculum when viewed from the sphenoid sinus. Intracranially, it corresponds to the lateral tubercular crest (LTC), a ridge situated at the superomedial aspect of the carotid sulcus. The MOCR is a teardrop-shaped osseous indentation formed at the medial junction of the paraclinoid carotid canal and the optic canal. Dorsally, it is represented by a teardrop-shaped area with vertices at the inferior aspect of the LTC, the medial aspect of the junction of the superior and posterior surfaces of the optic strut, and the superolateral aspect of the tuberculum. The middle clinoid process is situated inferior to the LTC. The distal osseous arch of the carotid sulcus connects the lateral opticocarotid recess to the lateral tubercular recess and is a landmark for the paraclinoid internal carotid artery. Only 44% of the specimens had middle clinoid processes.

CONCLUSION: The MOCR and middle clinoid process are distinct structures. Because of its location at the confluence of the optic canal, the carotid canal, the sella, and the anterior cranial base, the MOCR is a key landmark for endoscopic approaches.

KEY WORDS: Distal osseous arch of the carotid sulcus, Endoscope, Key landmark, Lateral tubercular crest, Lateral tubercular recess, Middle clinoid process, Medial opticocarotid recess

Neurosurgery 72[ONS Suppl 1]:ons66–ons76, 2013 DOI: 10.1227/NEU.0b013e31827f6614

One of the fundamental concepts in neurosurgery is that of the "keyhole," as first proposed by Wilson[1] in 1971. Over the next 4 decades, multiple keyholes have been proposed to approach different areas in the cranial fossa.[2,3] Common to all of these keyholes is the concept of providing minimally traumatic and maximally effective access to the areas of interest. For example, the McCarty keyhole, defined as a burr hole that simultaneously exposes the supraorbital dura mater and the periorbita at its depth, has become an important landmark for most frontal, pterional, and orbitozygomatic approaches.[4-6]

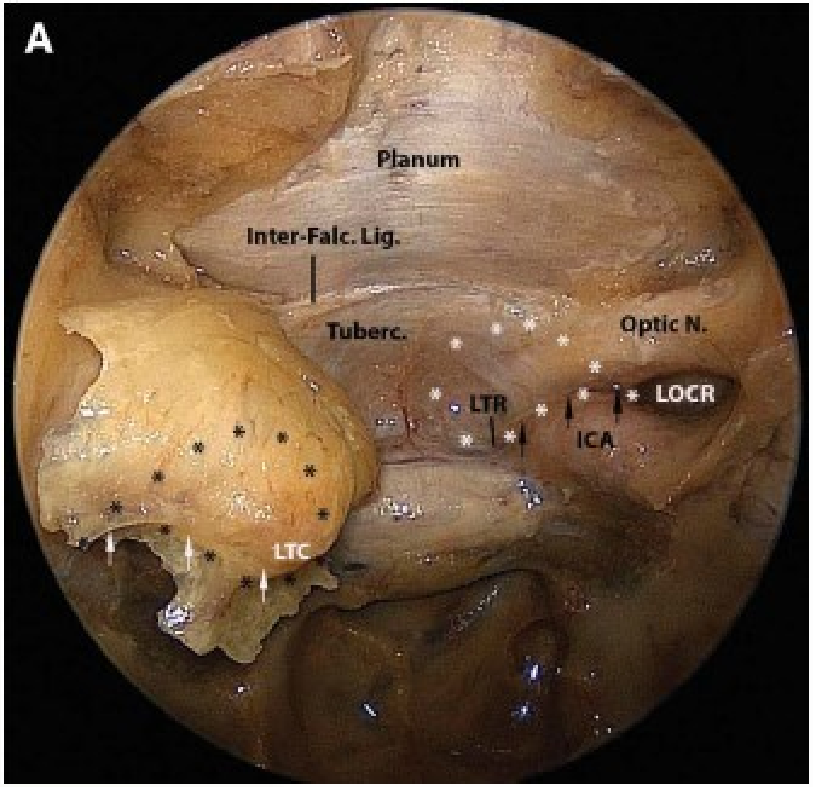
At the heart of minimally invasive neurosurgery are the expanded endoscopic endonasal approaches. These approaches incorporate a series of anatomic keyholes that facilitate the identification of landmark structures, thus, minimizing tissue injury and maximizing surgical efficiency while approaching a lesion. Planning and performing these keyholes safely and efficiently are predicated on the development of a thorough understanding of cranial base anatomy from an endoscopic ventral perspective.

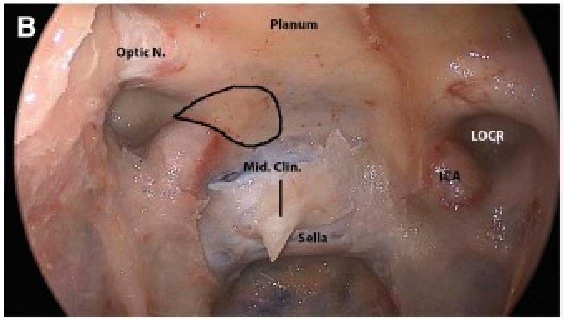
The sellar and parasellar spaces are among the areas most commonly approached endoscopically.

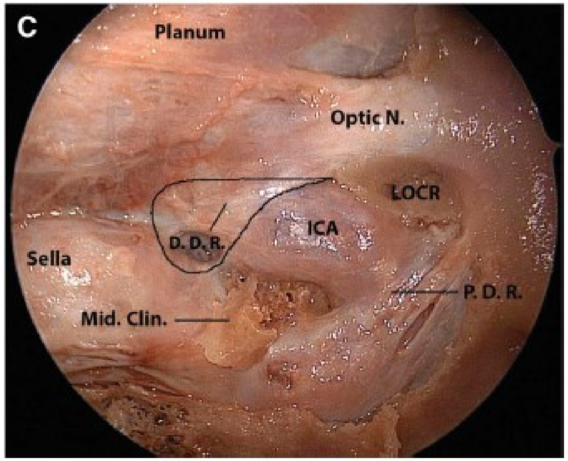
ABBREVIATIONS: DOA, distal osseous arch; **ICA,** internal carotid artery; **LOCR,** lateral opticocarotid recess; **LTC,** lateral tubercular crest; **LTR,** lateral tubercular recess; **MOCR,** medial opticocarotid recess

- Middle clinoid process were only present in 44.3% of the specimens
- When the middle clinoid process is present, it is situated inferior to the mOCR

Medial OCR (Optico-carotid recess)

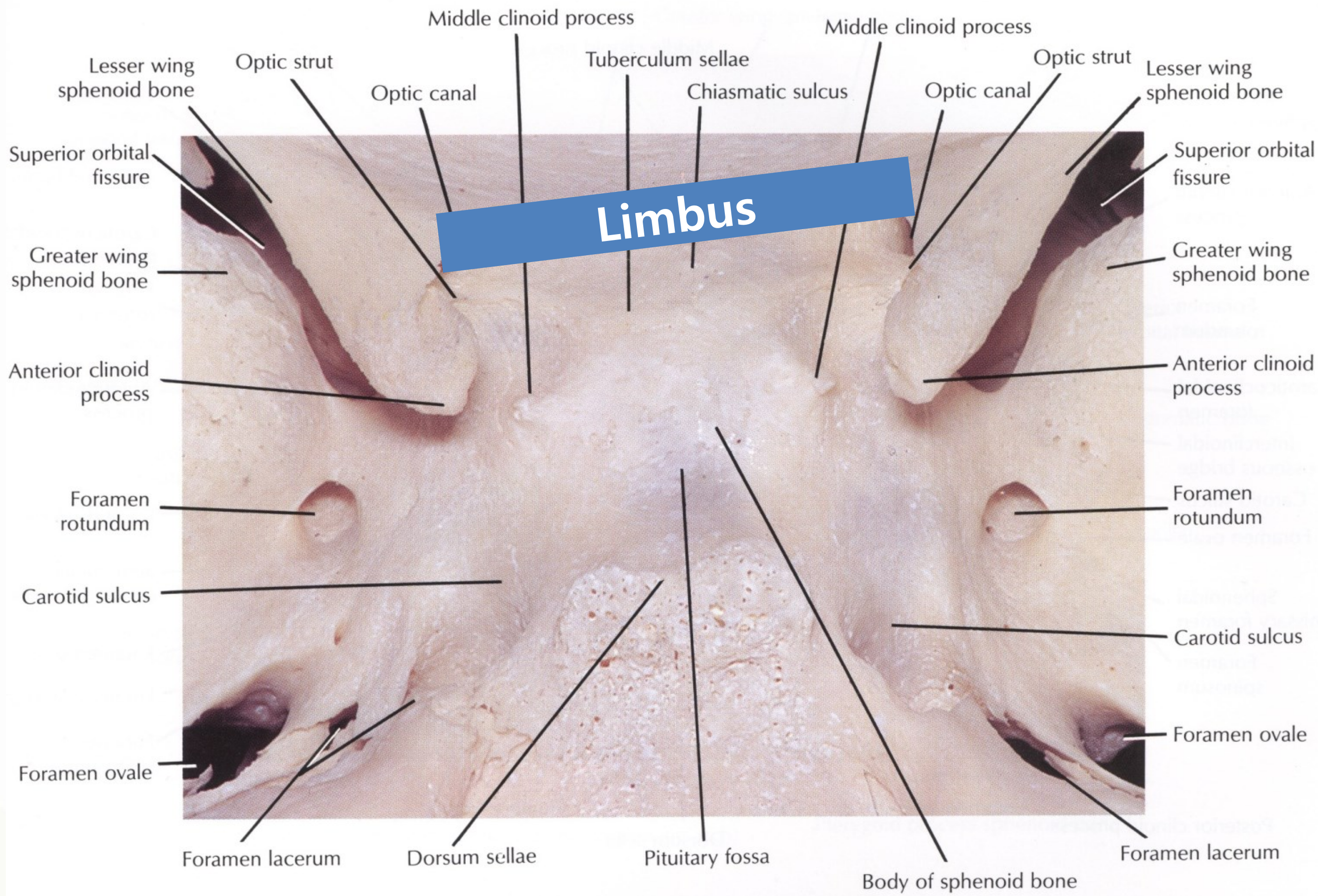




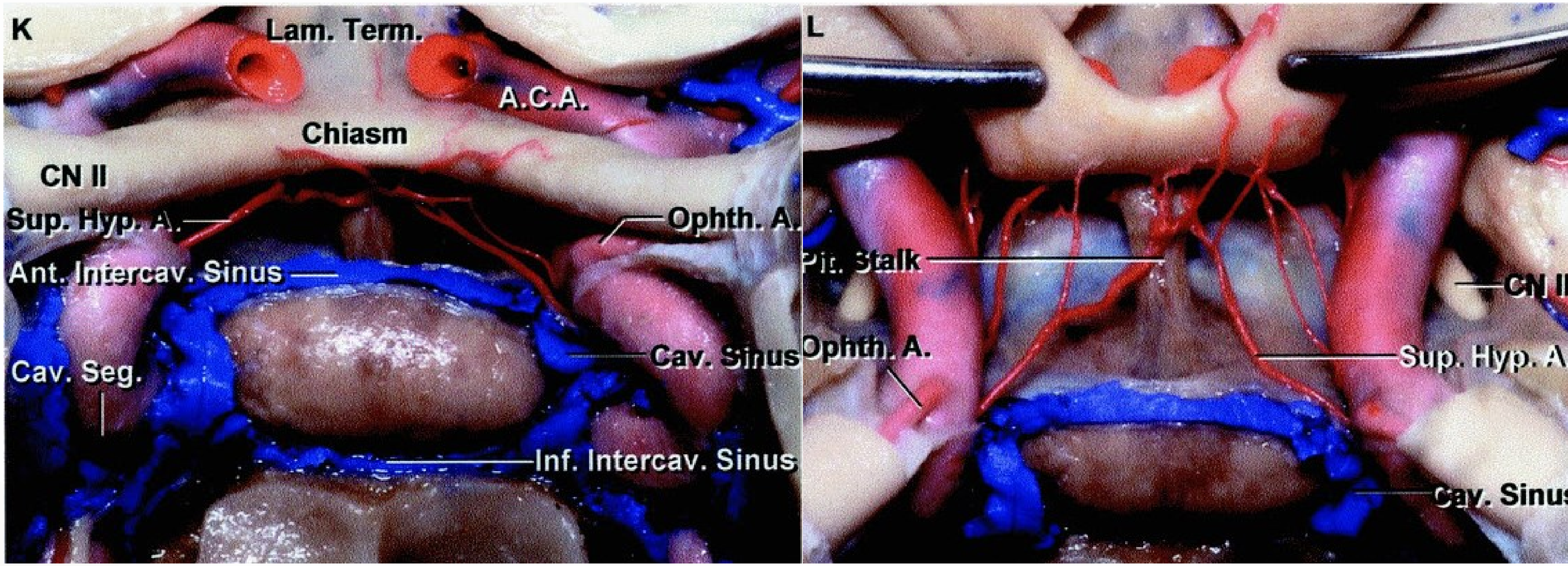


The distal and proximal dural rings of the ICA meet at the MCP

Sella Floor
-Superior View



Anterior View



Superior Hypophyseal Artery

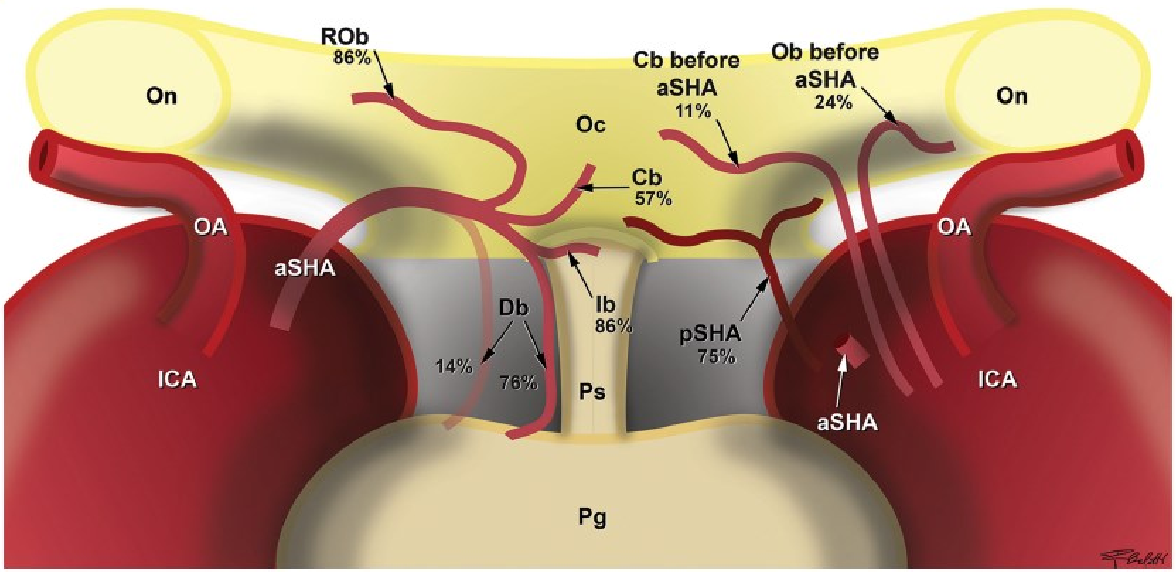
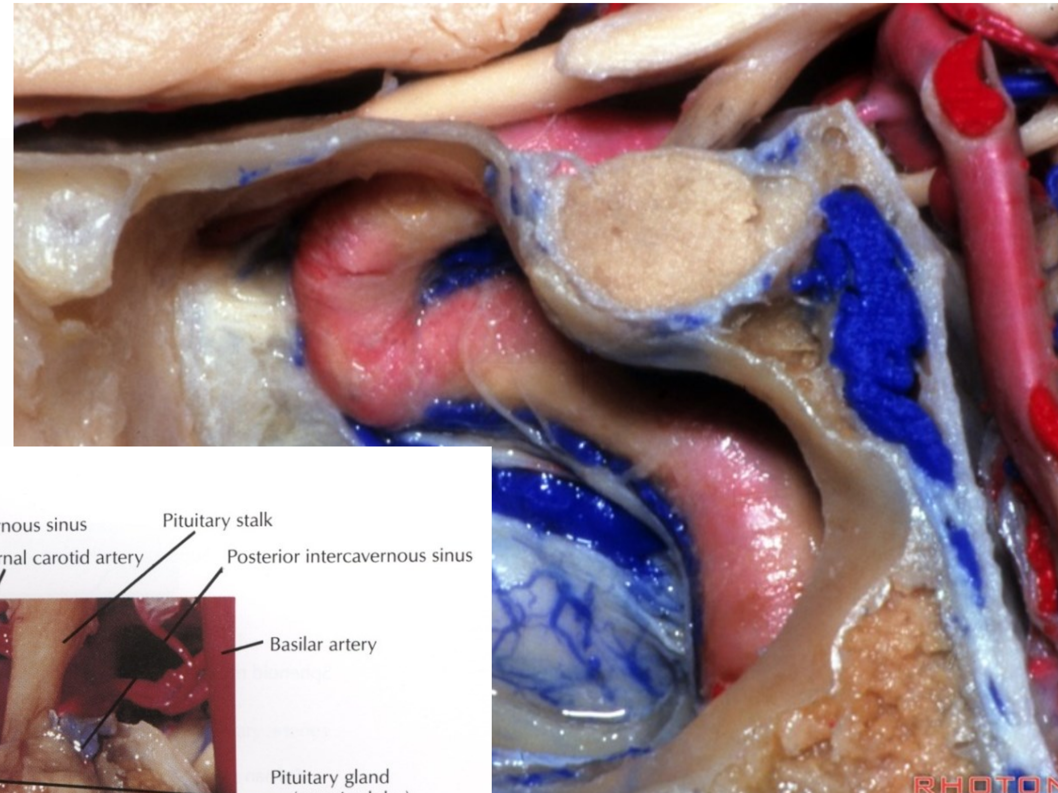
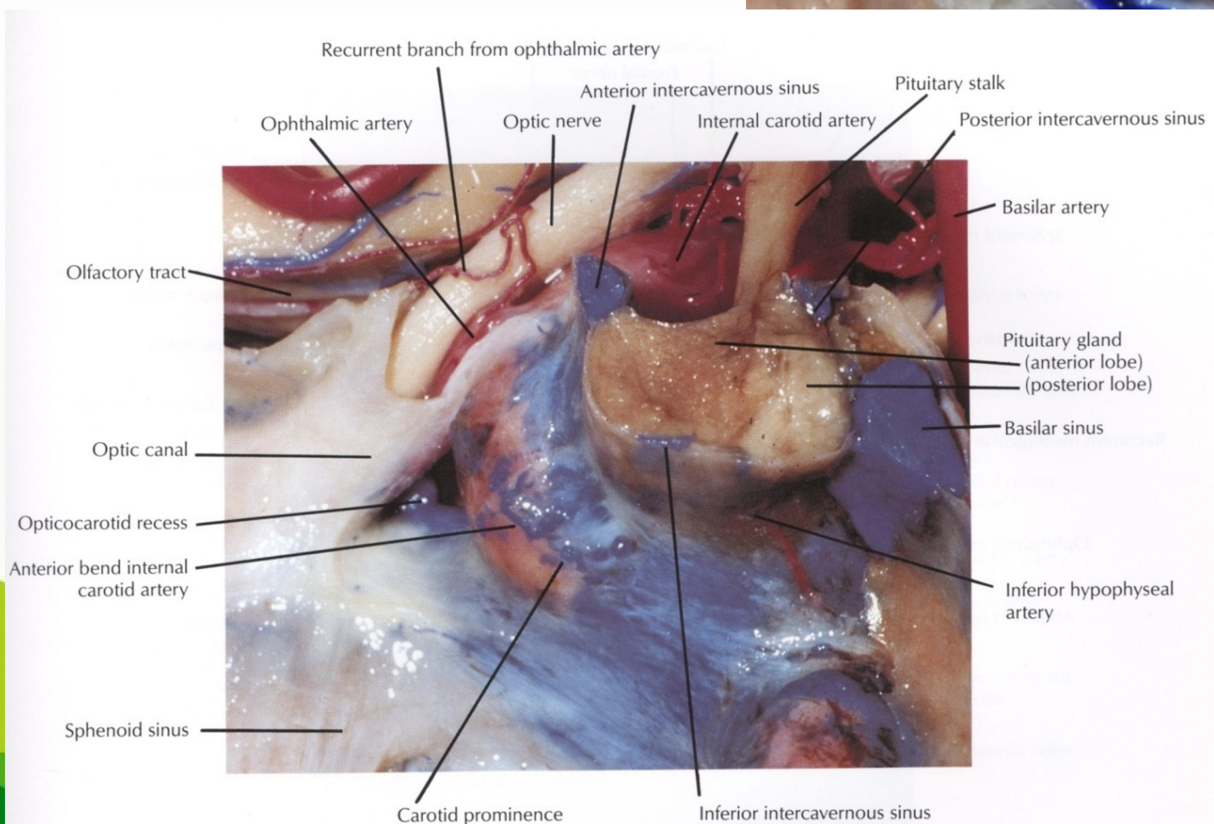


FIGURE 2. *Schematic drawing showing on the left side of the image (simulating a right side in a patient) the most common, "candelabra like", configuration of the SHA, reporting the prevalence of the different branches of aSHA. Notice how the descending branch/es act as a liana attached to the tree made by the pituitary stalk, optic nerve and chiasm with the other SHA branches. On the right side, the prevalence of other, less common, findings are summarized. aSHA, anterior superior hypophyseal artery; Cb, chiasmatic branch; Db, descending branch; Ib, infundibular branch; ICA, internal carotid artery; OA, ophthalmic artery; Ob, optic branch; Oc, optic chiasm; On, optic nerve; Pg, pituitary gland; Ps, pituitary stalk; pSHA, posterior superior hypophyseal artery; ROb, recurrent optic branch.*

Doglietto F, Prevedello DM, Belotti F, Ferrari M, Lancini D, Schreiber A, Raffetti E, La Rocca G, Rigante M, Lauretti L, Hirtler L, Buffoli B, Nicolai P, Fontanella MM, Rodella L, Gentili F, Tschabitscher M. The Superior Hypophyseal Arteries: Anatomical Study with an Endoscopic Endonasal Perspective. Oper Neurosurg (Hagerstown). 2019 Sep 1;17(3):321-331. doi: 10.1093/ons/opy393. PMID: 30649535.

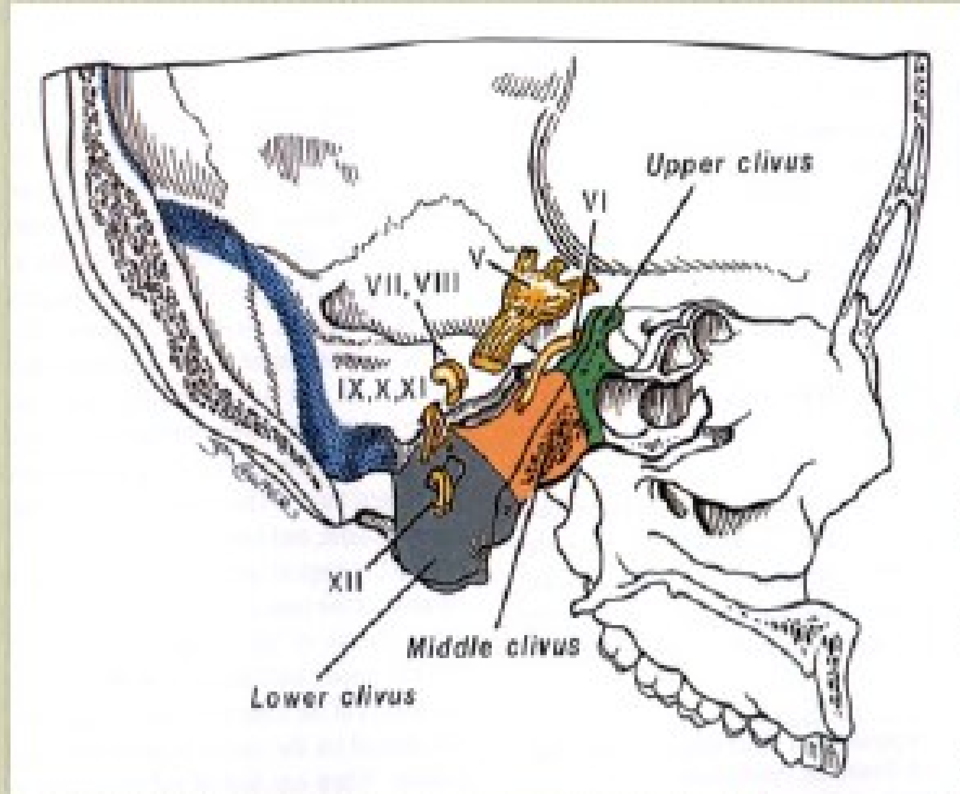
Sagittal View

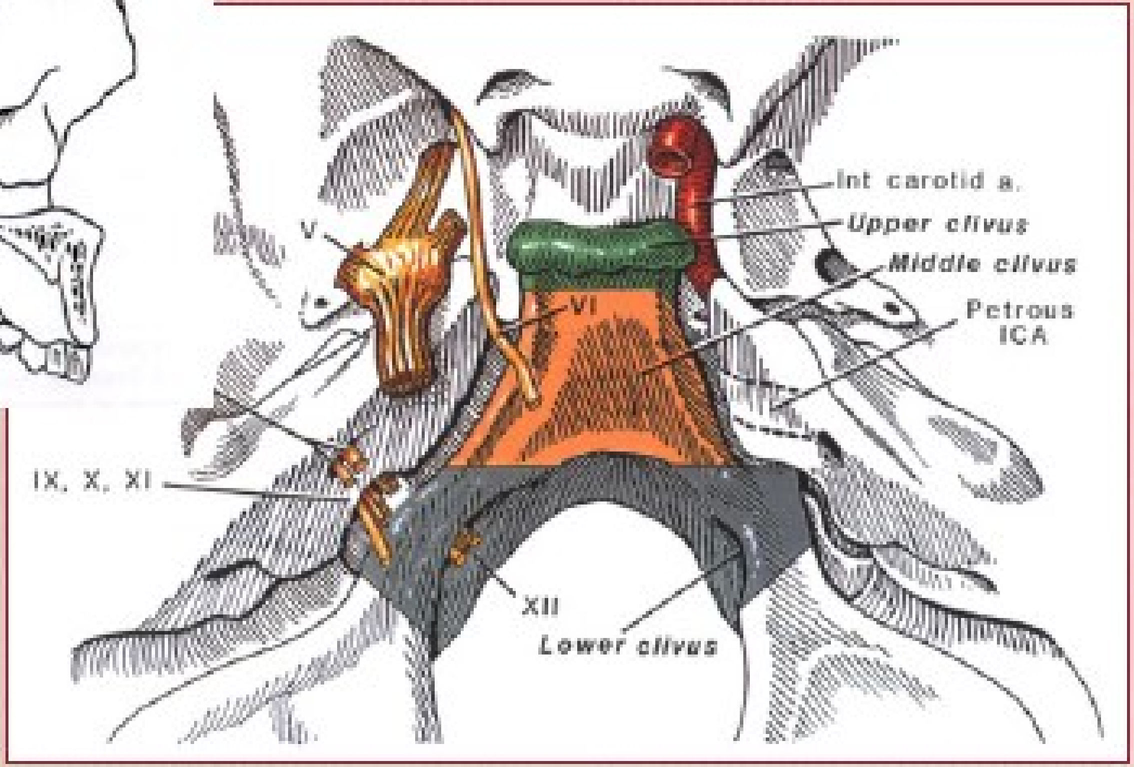




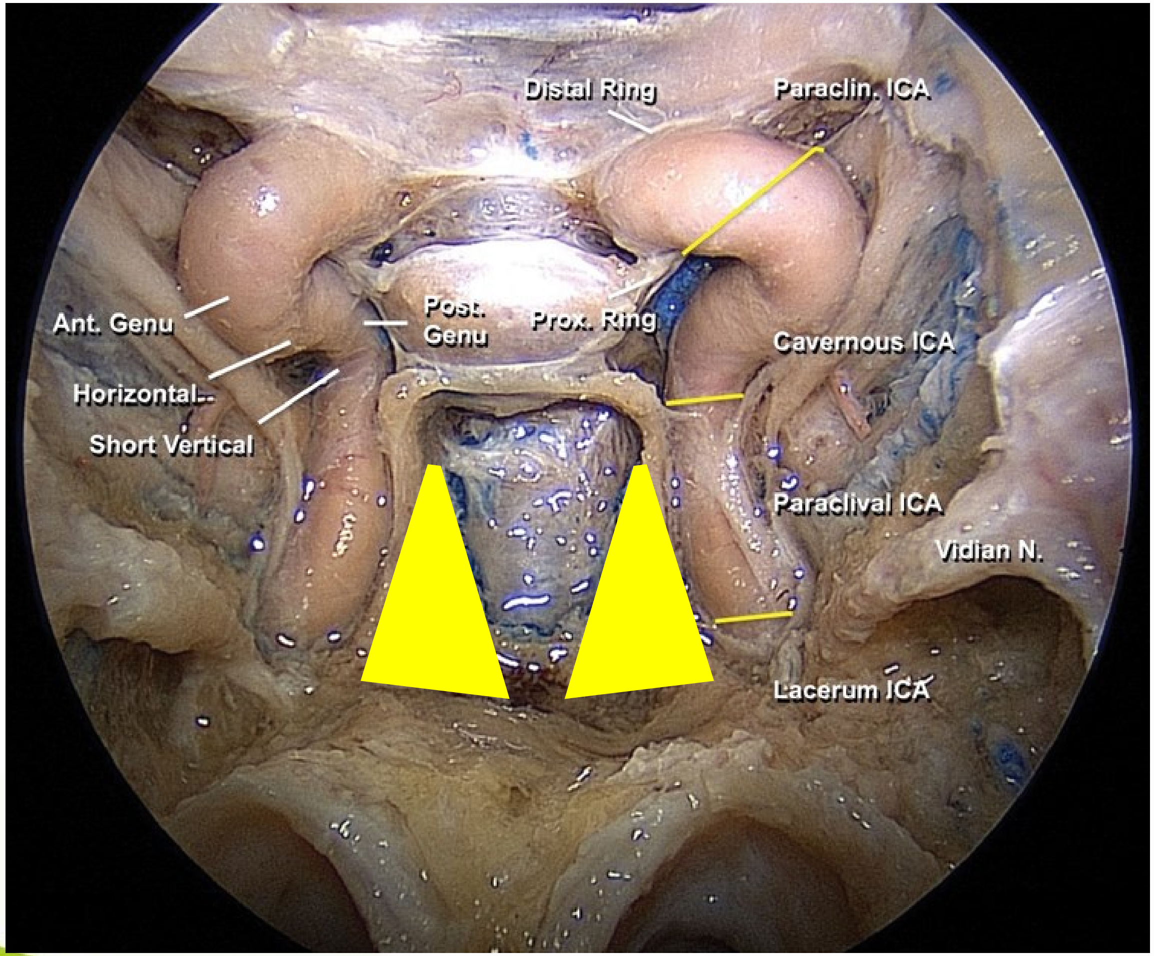
SURGICAL ANATOMY
-TRANSCLIVAL APPROACH

Clivus- Divided into Thirds

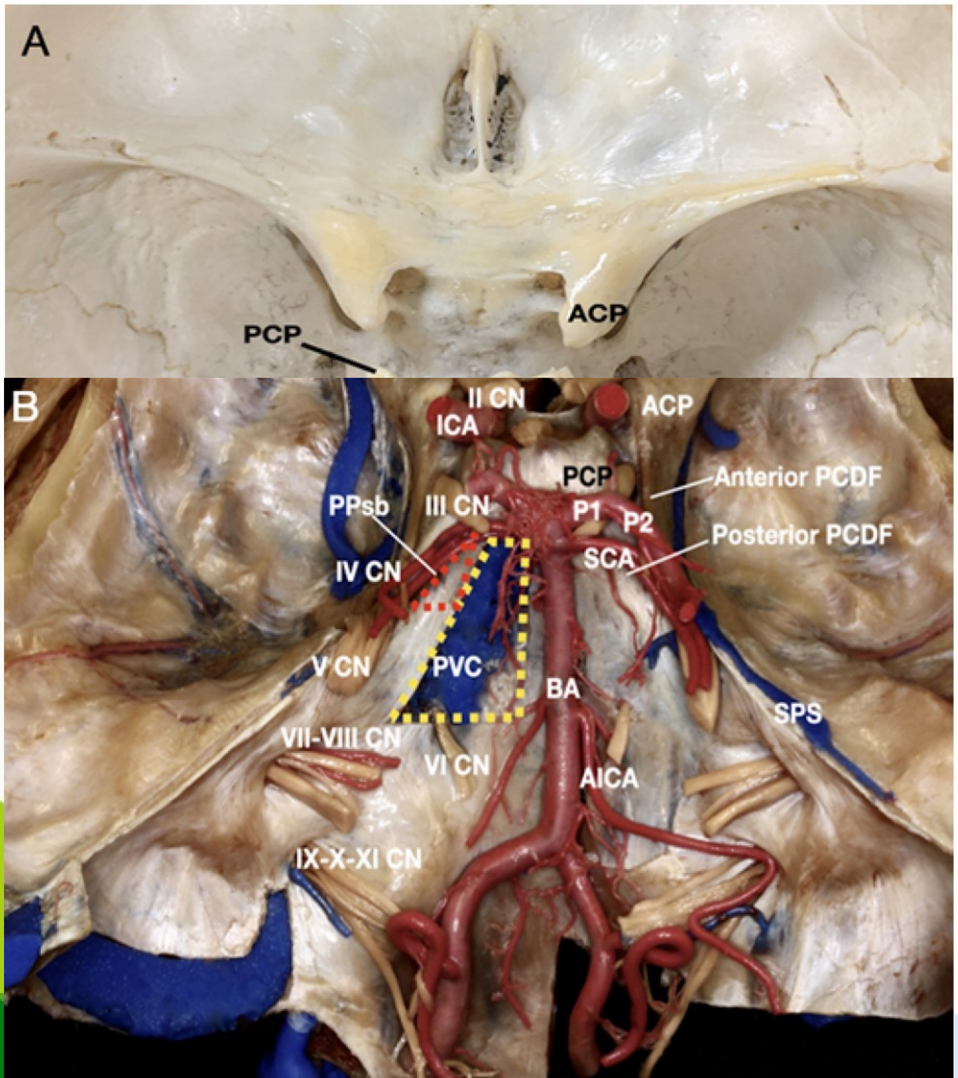




Parasellar ICA Anatomy

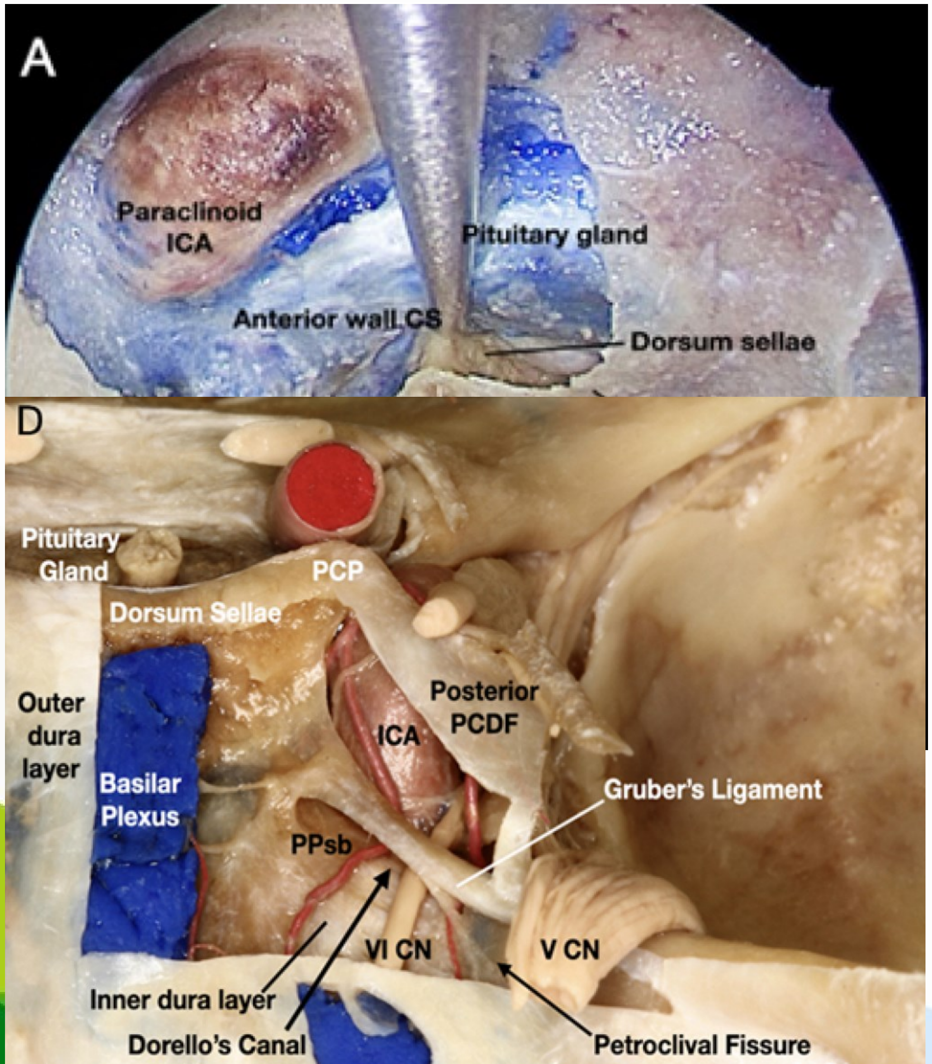


Petrosal Process of the Sphenoid Bone (PPsb)



- A triangular bony prominence, with its base medially adjacent to the dorsum sellae and its apex pointing posterolaterally toward the petrous apex.
- Anterior to the petroclival venous confluence, superomedial to the inferior petrosal sinus, and inferomedial to the superior petrosal sinus;

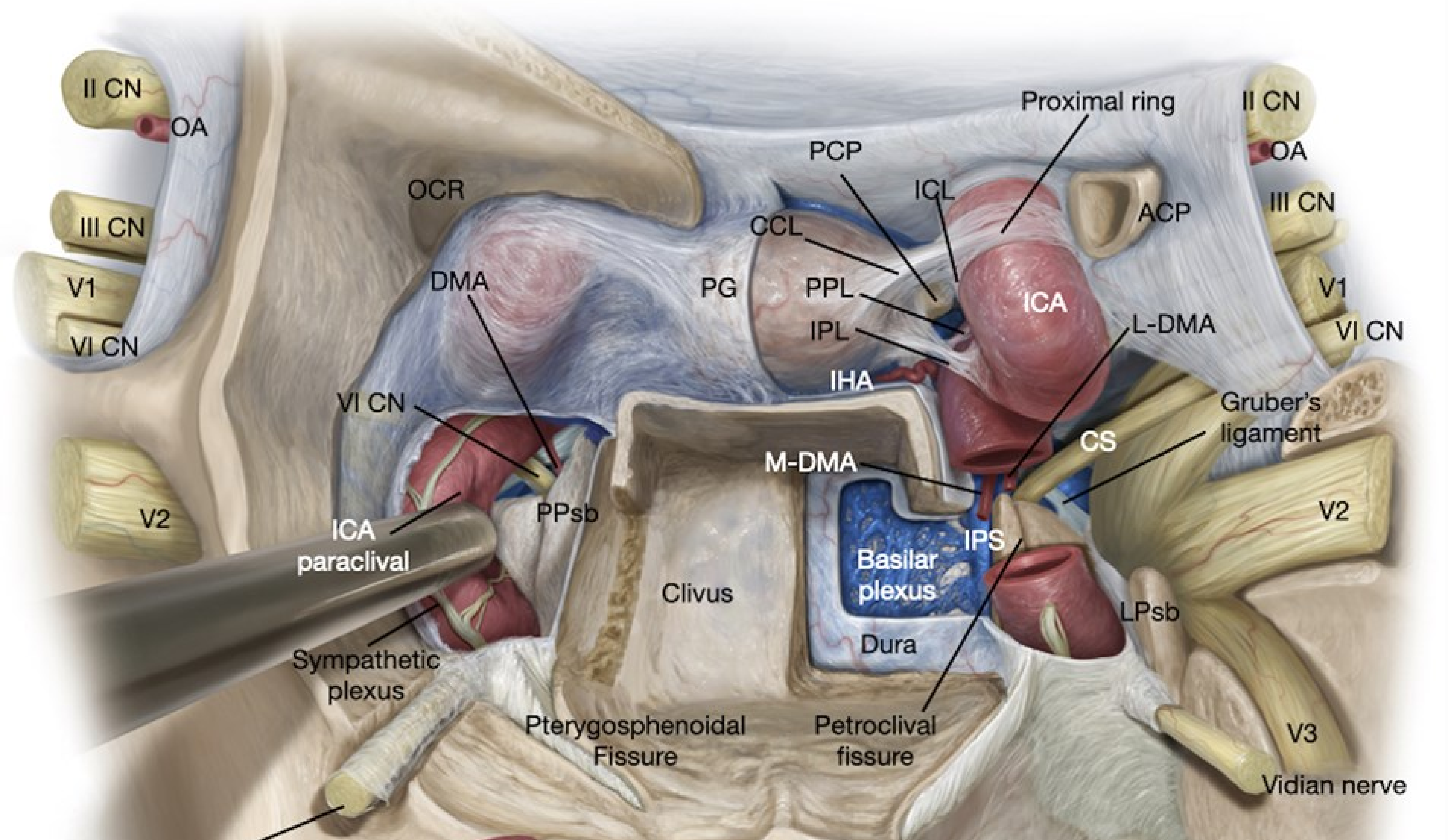
Petrosal Process of the Sphenoid Bone (PPsb)



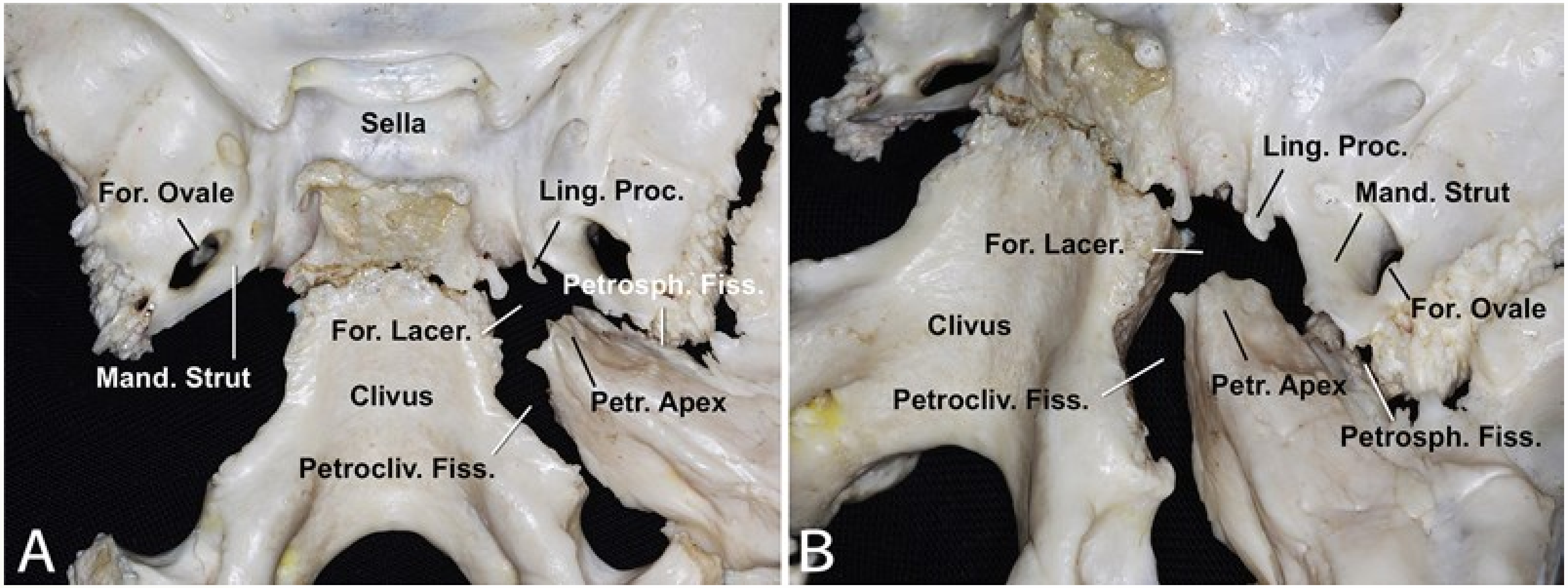
- Constitutes the inferomedial limit of the cavernous sinus; and delimits the upper limit of the paraclival internal carotid artery (ICA) before the artery enters the cavernous sinus.

- Anterior and medial to and below the sixth cranial nerve, forming the floor of Dorello's canal.

Petrosal Process of the Sphenoid Bone (PPsb)

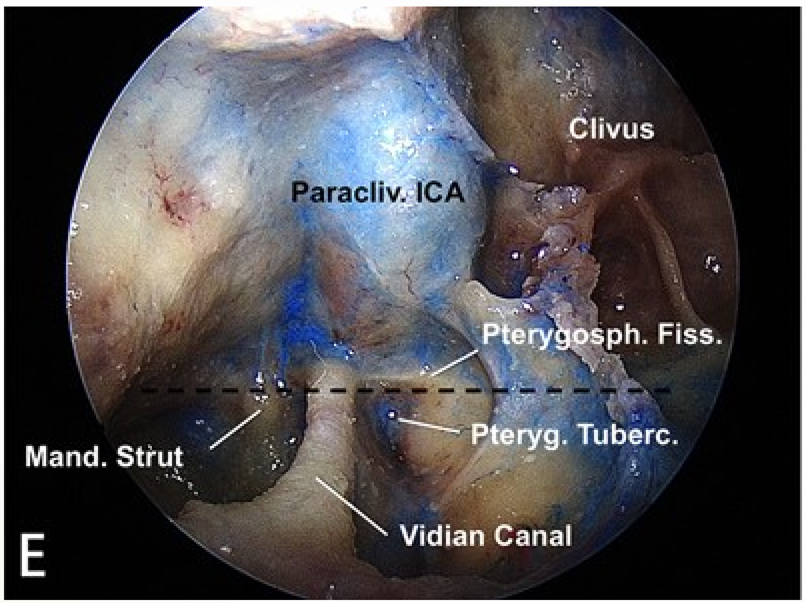


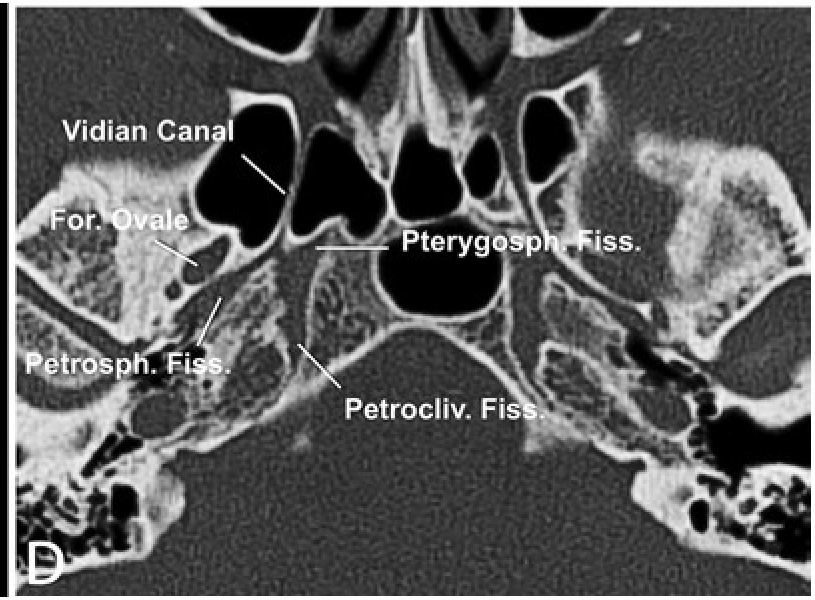
Foramen Lacerum



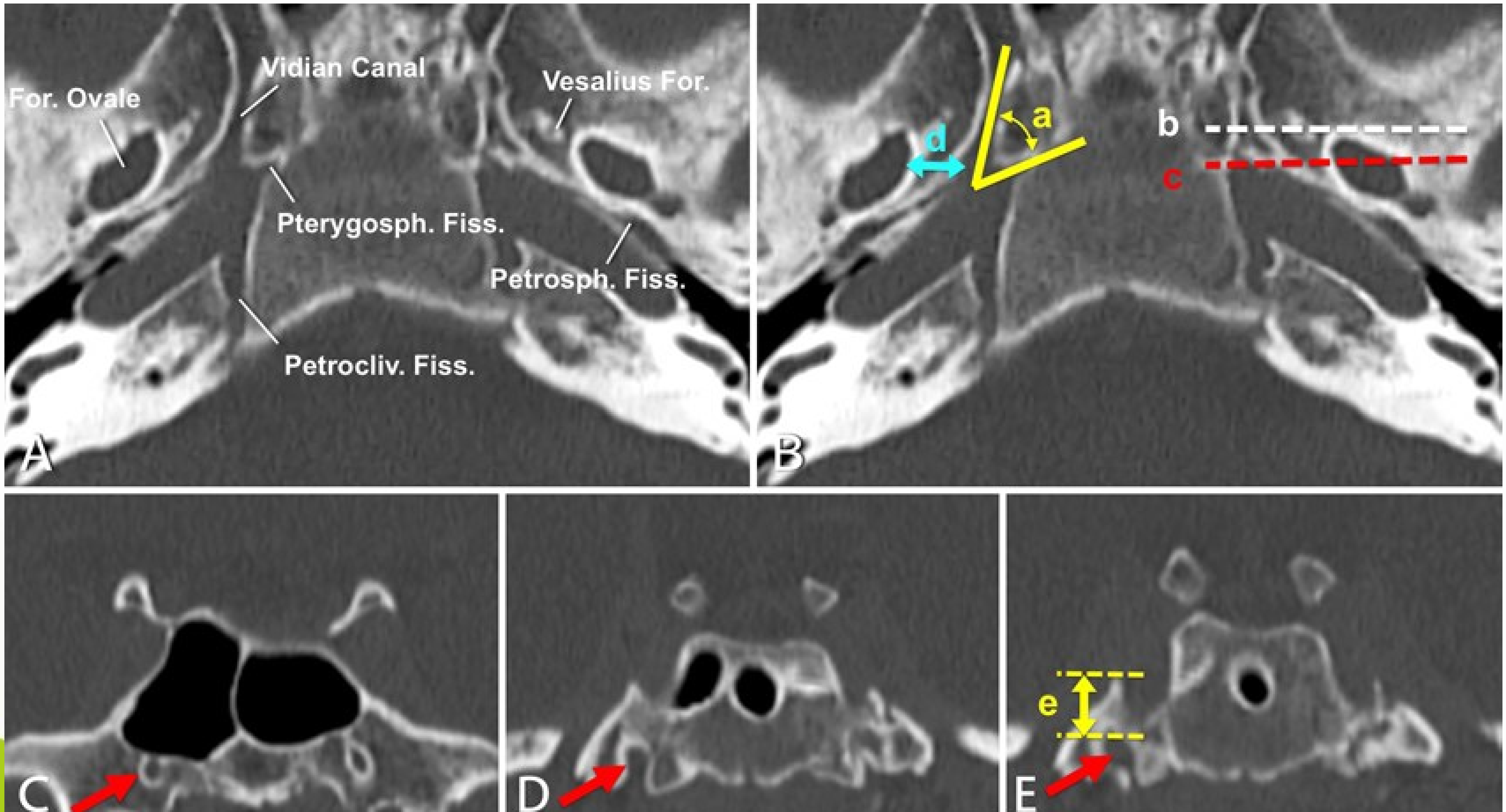
Wang WH et al., The foramen lacerum: surgical anatomy and relevance for endoscopic endonasal approaches. J Neurosurg 2018

Foramen Lacerum



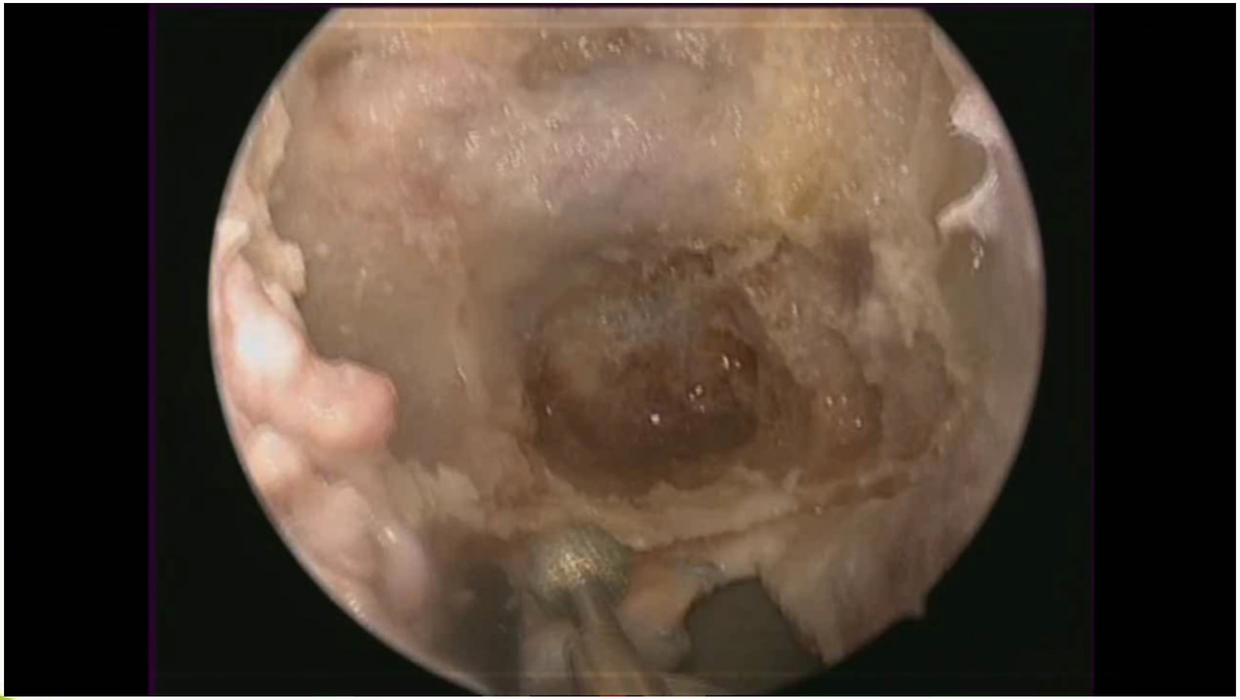


Foramen Lacerum

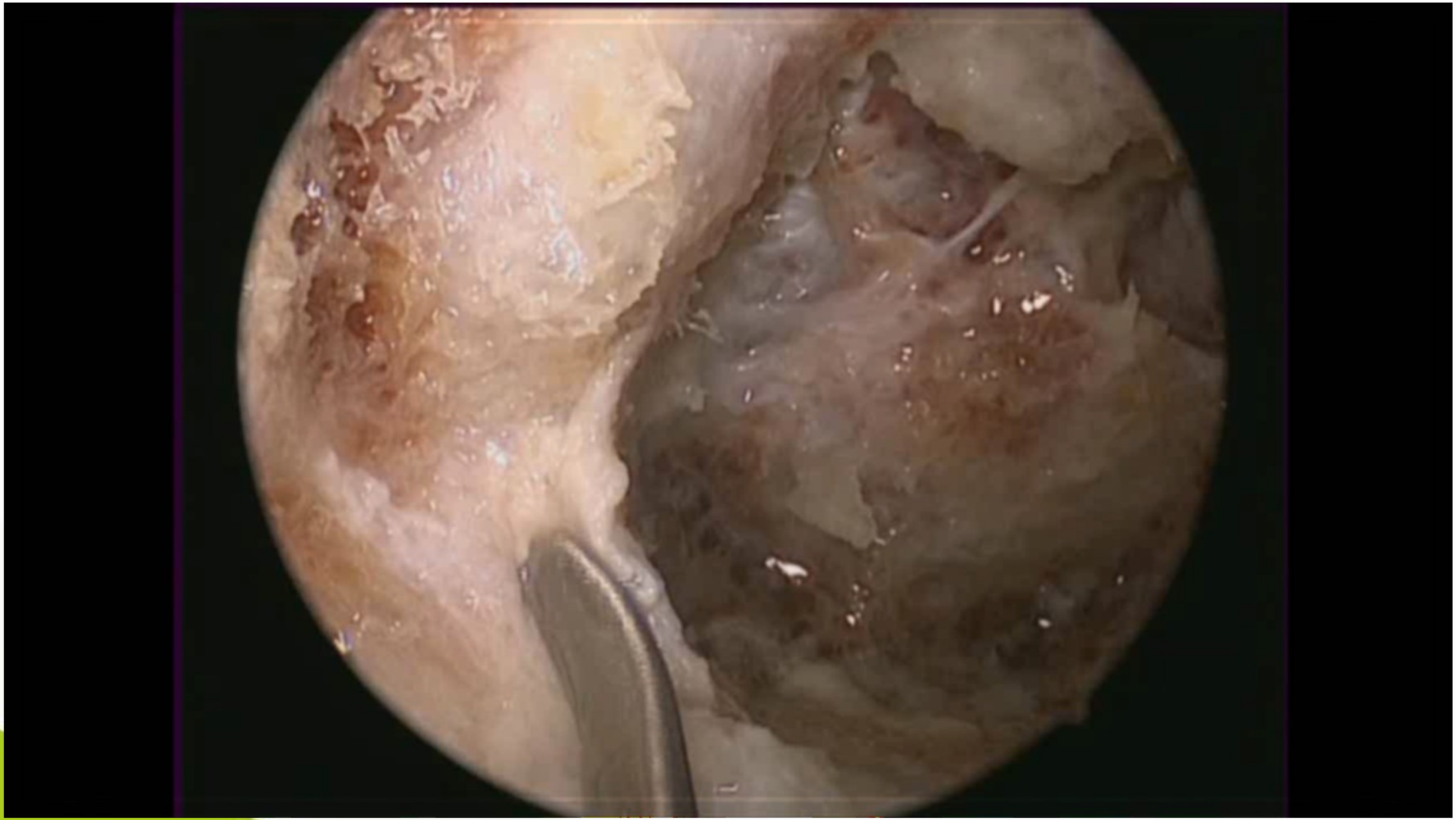


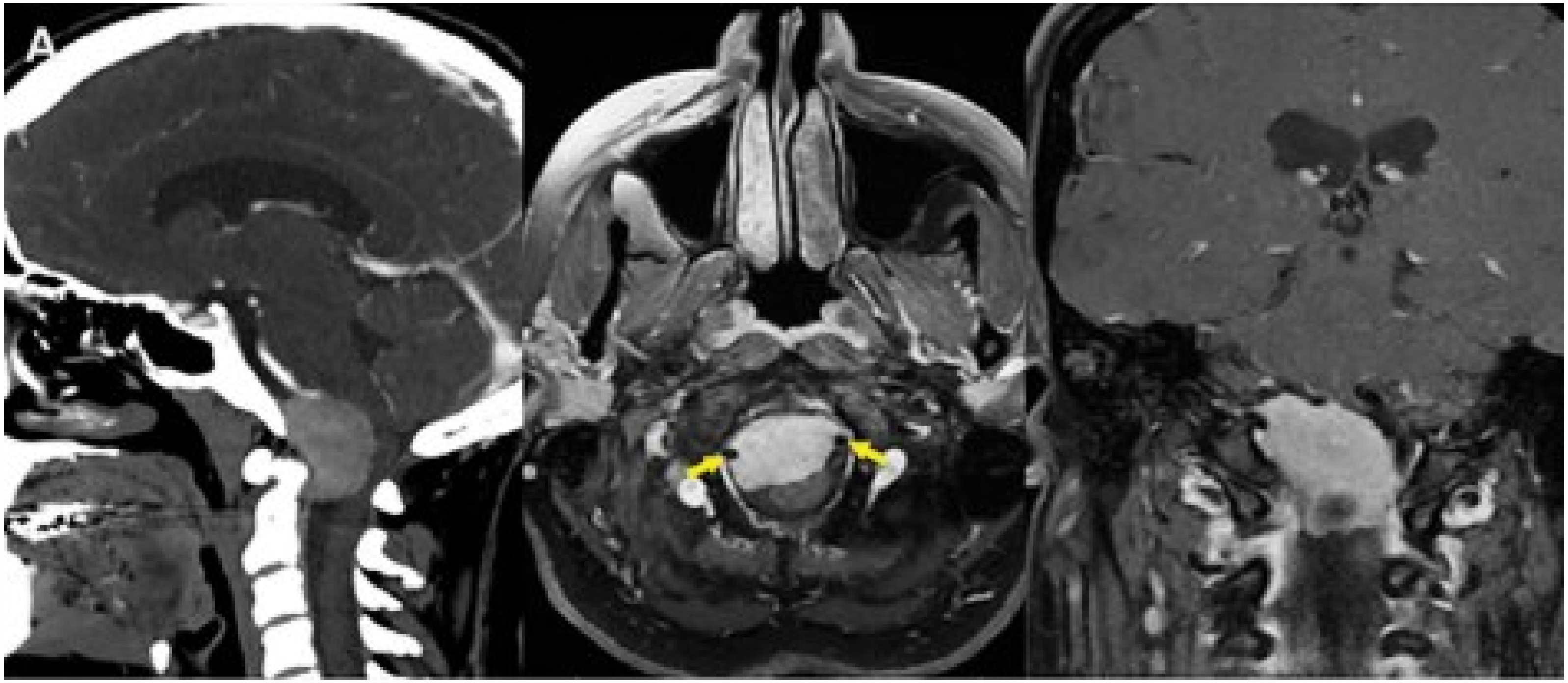
Pterygosphenoidal Fissure

- More reliable landmark to find the foramen lacerum and lacerum ICA
- Constantly converges with the posterior end of the vidian canal at a 45° angle



Foramen lacerum

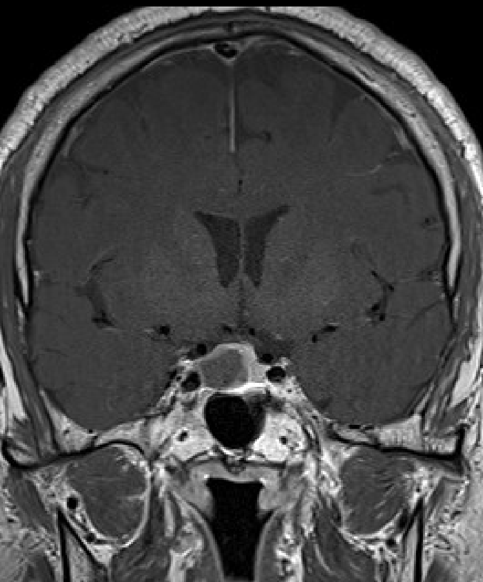


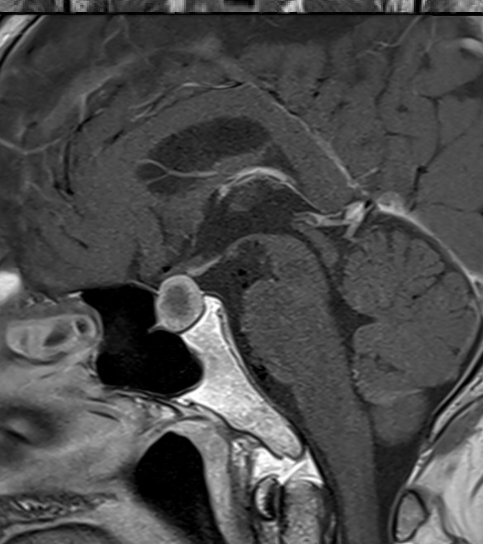


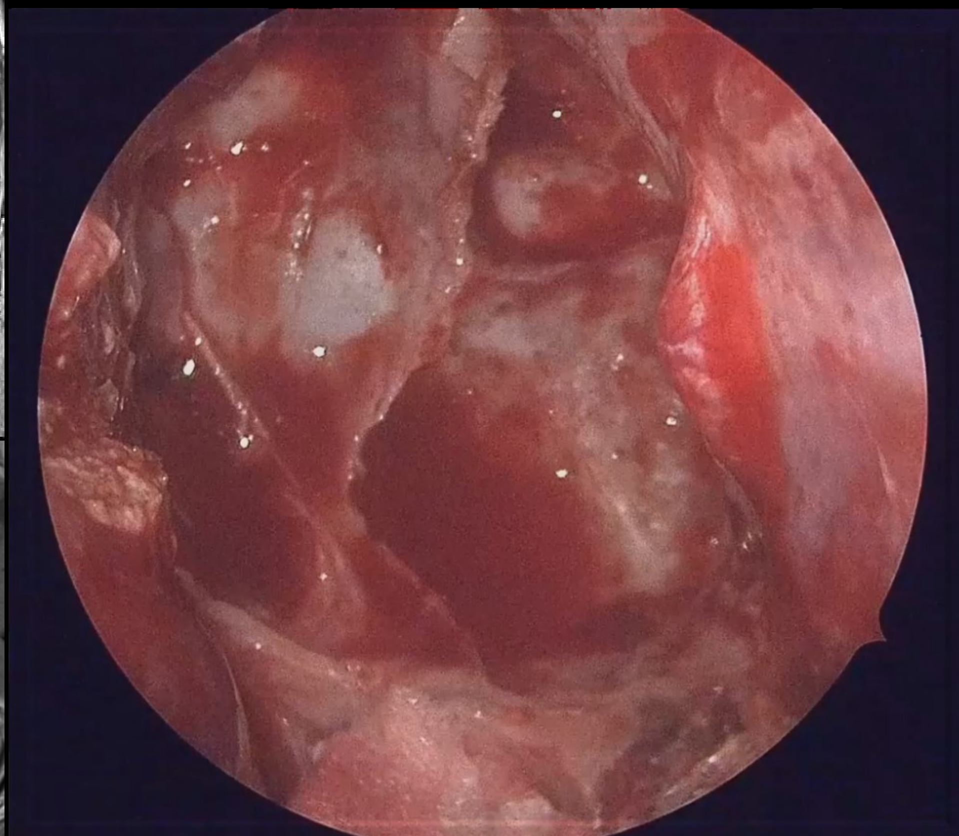
SURGICAL PROCEDURES

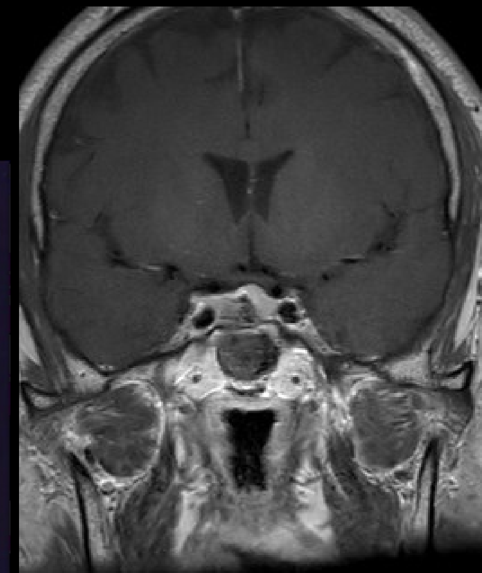
Pituitary Macroadenoma

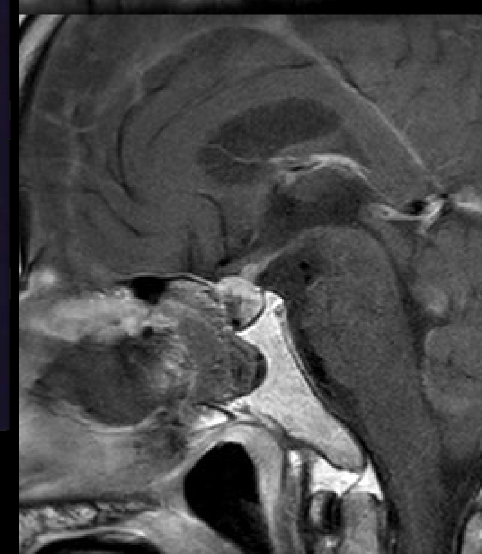
M/50 Tumor growth





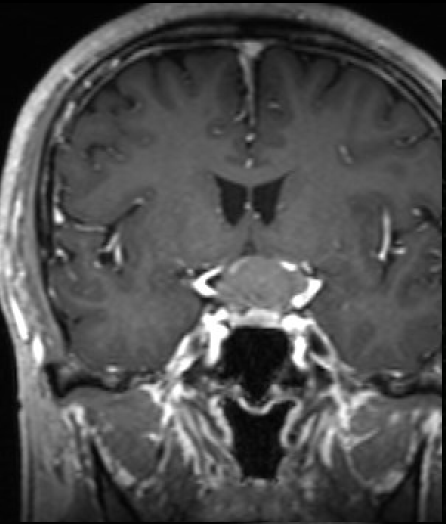


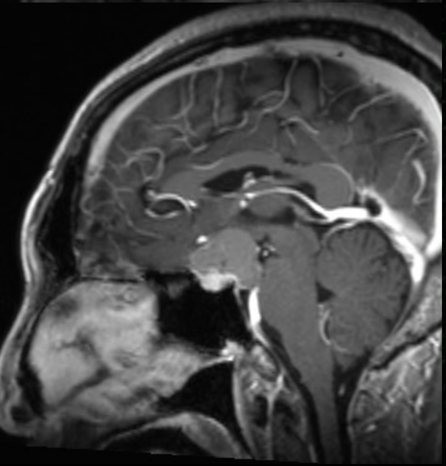


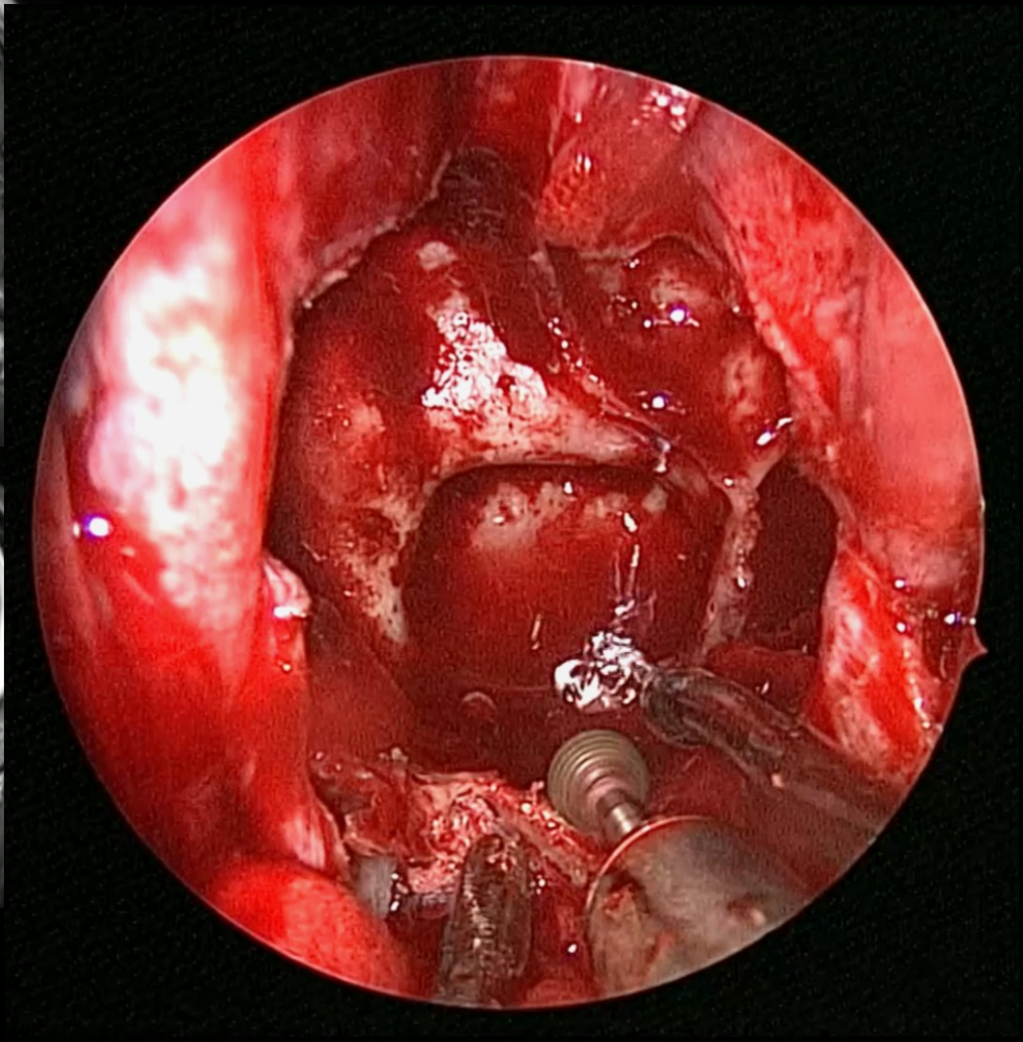


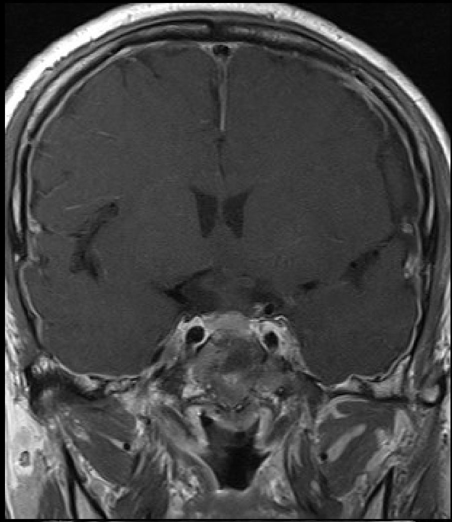
Craniopharyngioma

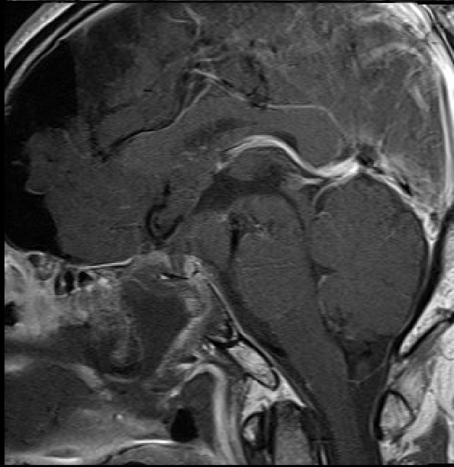
M/61 Visual deterioration (OS)











UPDATES IN CAVERNOUS SINUS ANATOMY

Introduction

- Cavernous sinus
  - Defined by Winslow in 1734
  - In 1967, Parkinson reported Transcavernous repair of carotid cavernous fistula
  - From the 1970s to the 1980s, many pioneer doctors located over 10 triangles of anatomic landmarks (Parkinson, Dolenc, Fukushima, Hakuba, Kawase, Mullan, Glasscock)

Treatment Outcomes

TABLE 1. Different Treatment Outcomes of Cavernous Sinus Meningioma[a]

Authors	Year	Cases, n	Mean Follow-up Period, mo	Treatment	Total Resection Rate, %	Mortality, %	Complication Rate, %	Tumor Control Rate, %
Dolenc and Rogers[18]	2003	388	NA	Surgery alone	46	1	5	NA
Abdel-Aziz et al[13]	2004	24	96	Surgery alone	91.6	0	16	89.5
		20	96	Accelerator-based stereotactic radiosurgery or fractionated conformal radiotherapy	...	0	NA	90
Sindou et al[16]	2007	100	99.6	Surgery alone	12	5	5	87.75
Sughrue et al[17]	2010	435[a]	47	Surgery alone	50.1	NA	59.6	STR, 89.2; GTR, 89.9
		250	47	Fractionated radiotherapy	...	NA	25.7	96.8
Iwai et al[20]	2003	43	49.4	GKS	...	0	7	90.5
Kondziolka et al[28]	2003	85	109.2	GKS	...	0	5.9	93
Kuo et al[21]	2004	57	42	GKS	...	0	2.2	97
Liscák et al[27]	2004	86	36	GKS	...	0	9	98
Skeie et al[30]	2010	100	82	GKS	...	0	6	90.4
Hayashi et al[22]	2012	19	47	GKS	...	0	5	100
Zeilor et al[19]	2012	30	36.1	GKS	...	0	0	92.3
Slater et al[31]	2012	72	NA	Fractionated proton radiotherapy	...	0	8.3	96

[a]GKS, Gamma Knife surgery; GTR, gross total resection; NA, not available; STR, subtotal resection. Sughrue et al[17] reported 2065 cases including 435 patients who underwent surgery as the only treatment and 250 patients treated with fractionated radiotherapy alone.

Treatment Outcomes

TABLE 2. Different Treatment Outcomes of Cavernous Sinus Hemangioma[a]

Authors	Year	Cases, n	Mean Follow-up Period, mo	Treatment	Total Resection Rate, %	Mortality, %	Complications Rate, %	Tumor Control Rate, %
Zhou et al[32]	2003	13	36	Surgery alone	92.3	0	NA	100
Goel et al[33]	2003	13	45	Surgery alone	92.3	0	NA	100
Suri et al[34]	2007	7	23.7	Surgery alone	85.7	0	85.7	100
Yin et al[35]	2013	22	53	Surgery alone	81.8	0	76	NA
Pecker et al[36]	2004	5	34.2	GKS[b]	. . .	0	0	100
Yamamoto et al[37]	2010	30	53	GKS	. . .	0	3.3	100
Chou et al[39]	2010	7	51	GKS	. . .	0	0	100
Hayashi et al[22]	2012	6	52	GKS	. . .	0	0	100
Li et al[38]	2012	16	21.5	GKS	. . .	0	0	100

[a]GKS, Gamma Knife surgery.
[b]One patient was diagnosed only neuroradiologically. Other patients underwent surgery and were then referred for Gamma Knife radiosurgery for residual tumors.

JNS

LABORATORY INVESTIGATION
J Neurosurg 129:430–441, 2018

Cavernous sinus compartments from the endoscopic endonasal approach: anatomical considerations and surgical relevance to adenoma surgery

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[1]Department of Neurological Surgery, University of Pittsburgh Medical Center; and [2]Department of Otolaryngology, University of Pittsburgh, Pennsylvania

OBJECTIVE Tumors with cavernous sinus (CS) invasion represent a neurosurgical challenge. Increasing application of the endoscopic endonasal approach (EEA) requires a thorough understanding of the CS anatomy from an endonasal perspective. In this study, the authors aimed to develop a surgical anatomy–based classification of the CS and establish its utility for preoperative surgical planning and intraoperative guidance in adenoma surgery.

METHODS Twenty-five colored silicon–injected human head specimens were used for endonasal and transcranial dissections of the CS. Pre- and postoperative MRI studies of 98 patients with pituitary adenoma with intraoperatively confirmed CS invasion were analyzed.

RESULTS Four CS compartments are described based on their spatial relationship with the cavernous ICA: superior, posterior, inferior, and lateral. Each compartment has distinct boundaries and dural and neurovascular relationships: the superior compartment relates to the interclinoidal ligament and oculomotor nerve, the posterior compartment bears the gulfar segment of the abducens nerve and inferior hypophyseal artery, the inferior compartment contains the sympathetic nerve and distal cavernous abducens nerve, and the lateral compartment includes all cavernous cranial nerves and the inferolateral arterial trunk. Twenty-nine patients had a single compartment invaded, and 69 had multiple compartments involved. The most commonly invaded compartment was the superior (79 patients), followed by the posterior (n = 64), inferior (n = 45), and lateral (n = 23) compartments. Residual tumor rates by compartment were 79% in lateral, 17% in posterior, 14% in superior, and 11% in inferior.

CONCLUSIONS The anatomy-based classification presented here complements current imaging-based classifications and may help to identify involved compartments both preoperatively and intraoperatively.

https://thejns.org/doi/abs/10.3171/2017.2.JNS162214

KEY WORDS cavernous sinus; endonasal endoscopic approach; pituitary adenomas; cranial nerves; internal carotid artery; pituitary surgery; anatomy

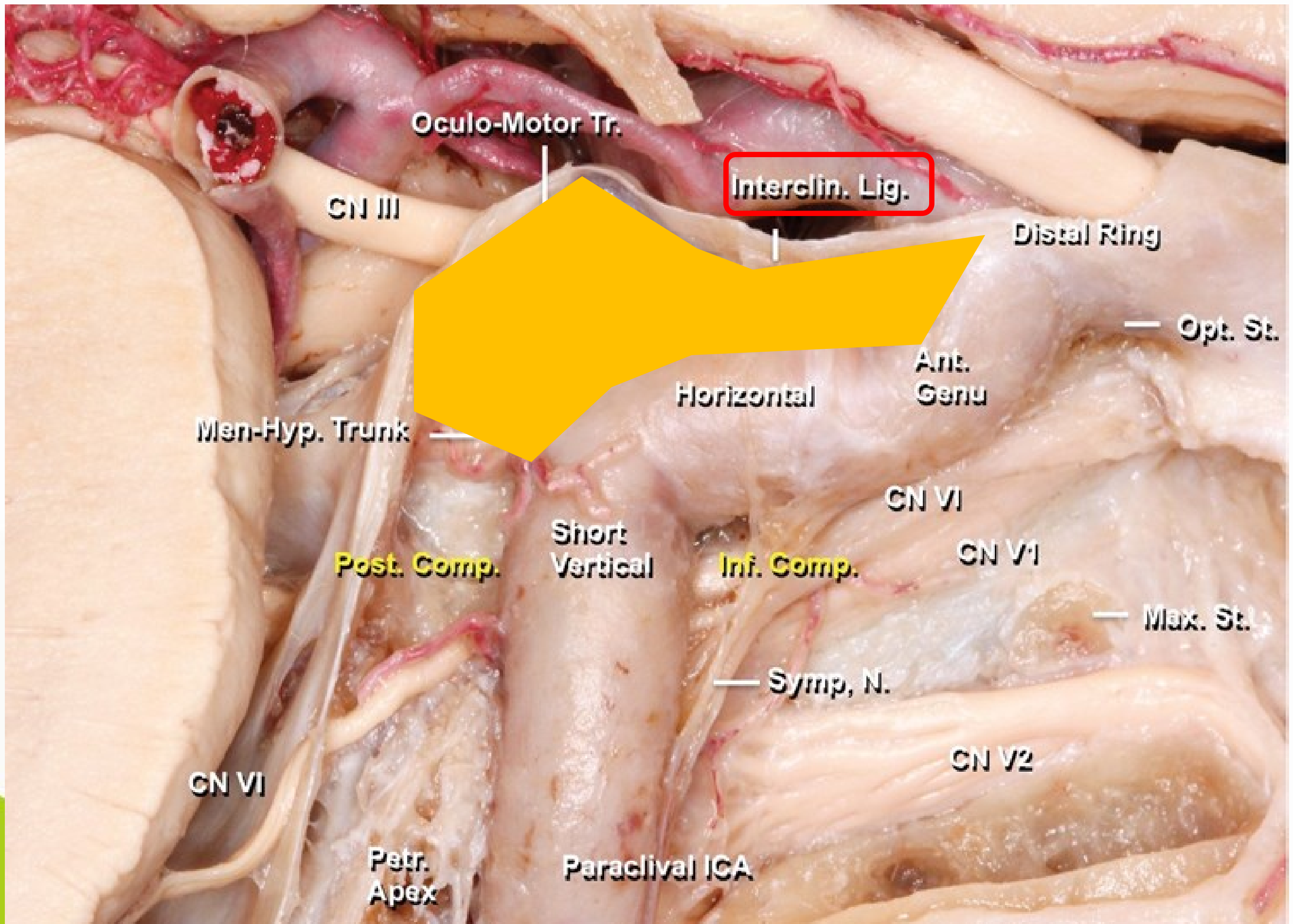
Four CS compartments described

- Superior
- Posterior
- Inferior
- Lateral

Most commonly invaded compartment was the superior, followed by the posterior, inferior and lateral

Residual tumor rates by compartment were 79% in lateral, 17% in posterior, 14% in superior, and 11% in inferior

CS Compartments

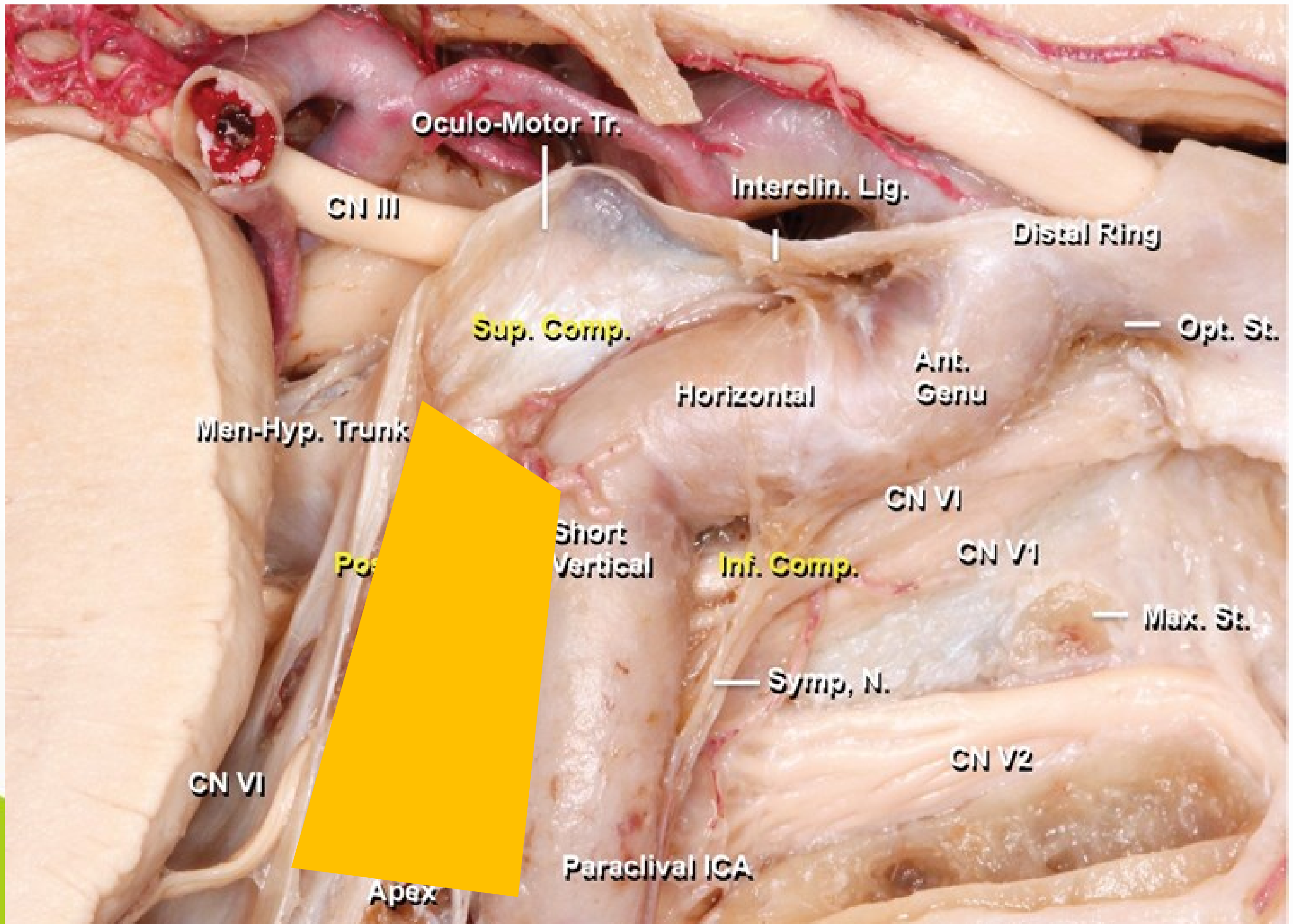


Superior compartment

- Boundaries
  - Superior to the horizontal cavernous ICA
  - Posterior to the anterior genu
  - Limited by the roof of the CS superiorly and laterally
- Key structures
  - Oculomotor nerve
  - Interclinoidal ligament

https://vimeo.com/209613074

CS Compartments

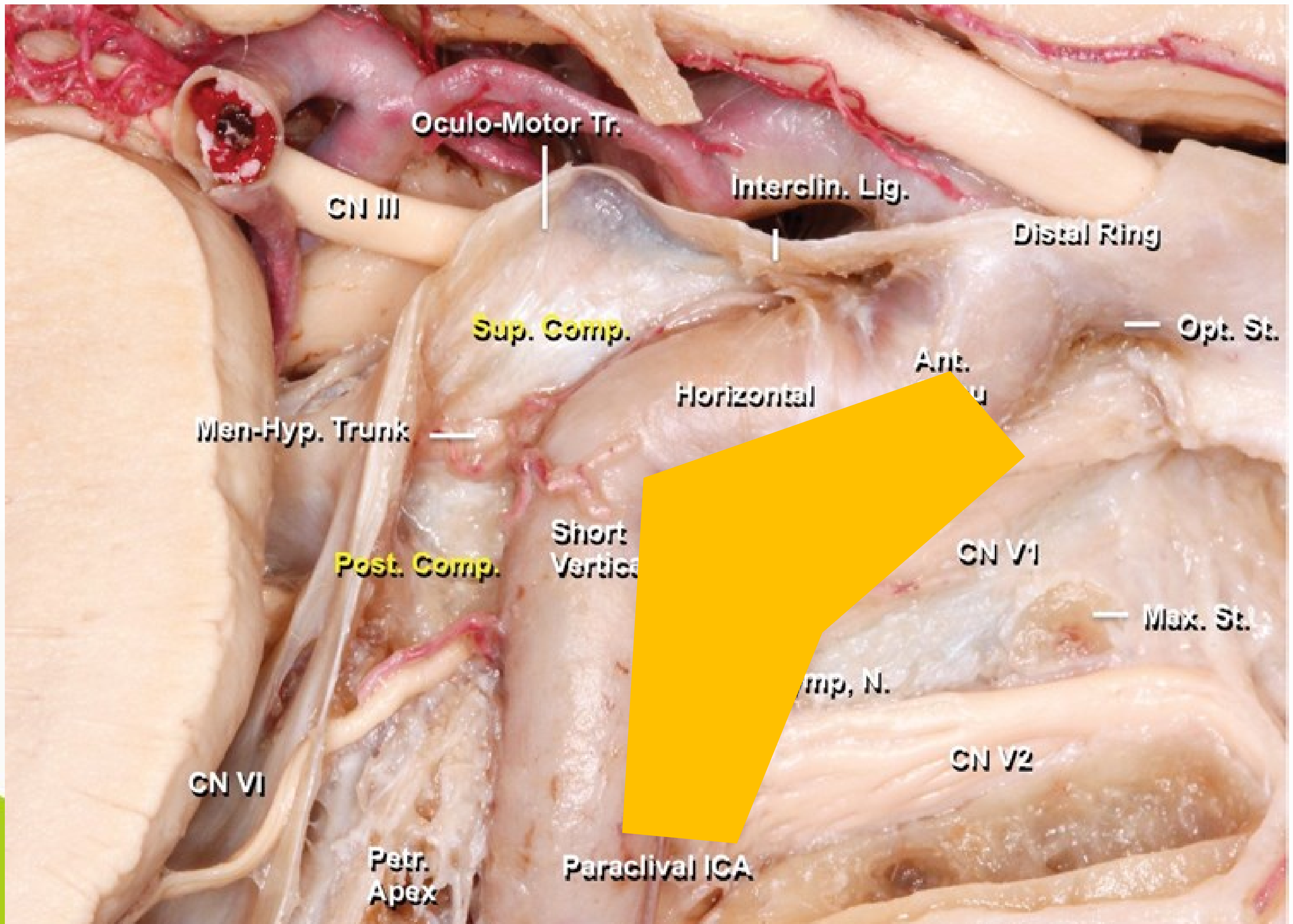


Posterior compartment

- Boundaries
  - Posterior to the short vertical cavernous ICA
  - Anterior to the lateral petroclival dura
- Key structures
  - Meningohypophyseal trunk
  - Inferior hypophyseal artery
  - Abducens nerve (gulfar segment)

https://vimeo.com/209613907

CS Compartments

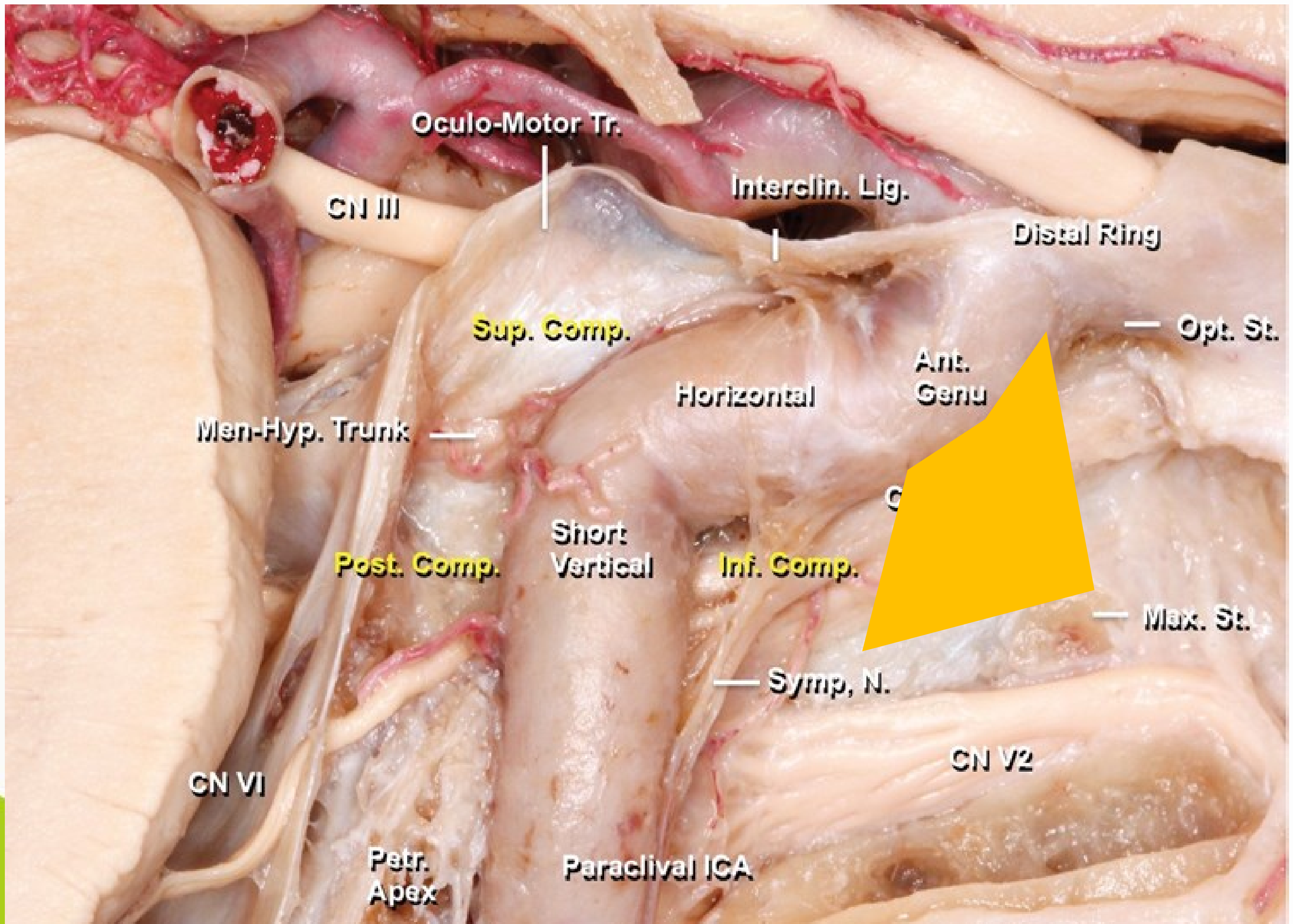


Inferior compartment

- Boundaries
  - Inferior to the horizontal and anterior genu subsegments of the ICA
  - Anterior to the short vertical subsegment
- Key structures
  - Sympathetic nerve or plexus
  - Abducens nerve (distal cavernous segment)

https://vimeo.com/209614526

CS Compartments



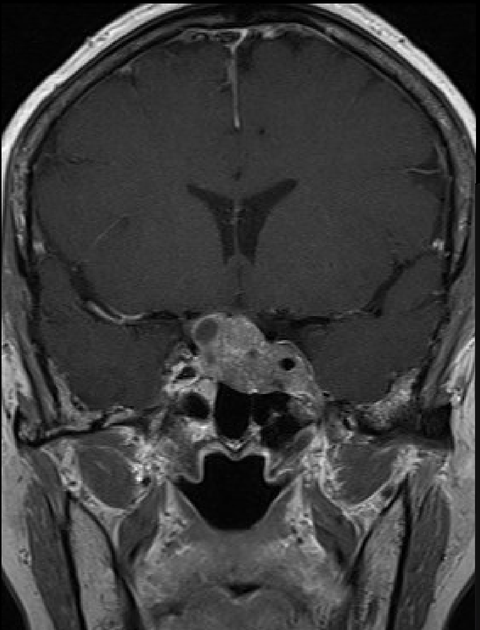
Lateral compartment

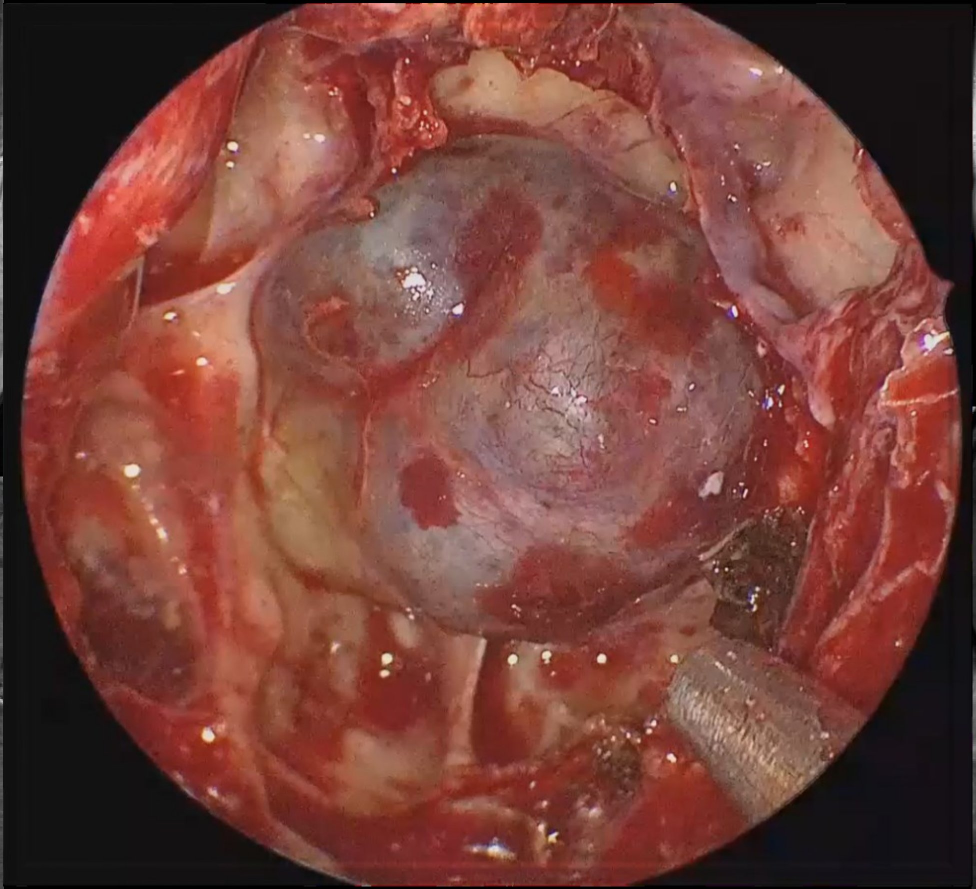
- Boundaries
  - Lateral to the anterior genu and horizontal ICA subsegments
  - Upper limit of this compartment is formed by the proximal dural ring
  - Maxillary strut marks the inferior limit of the lateral compartment
- Key structures
  - Third and fourth CNs, and the first division of the trigeminal nerve
  - Arterial branches of the inferolateral trunk

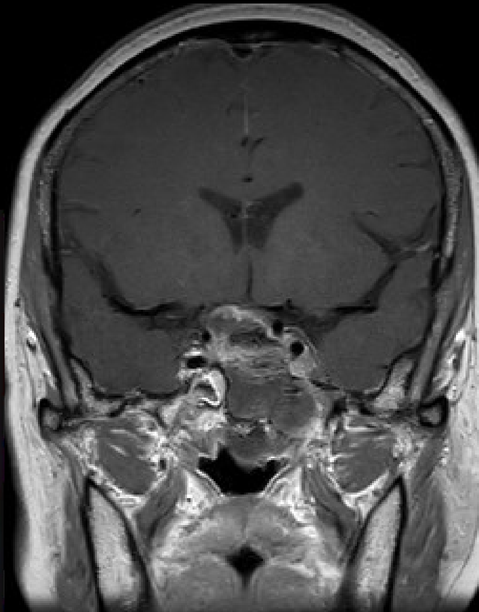
https://vimeo.com/209614925

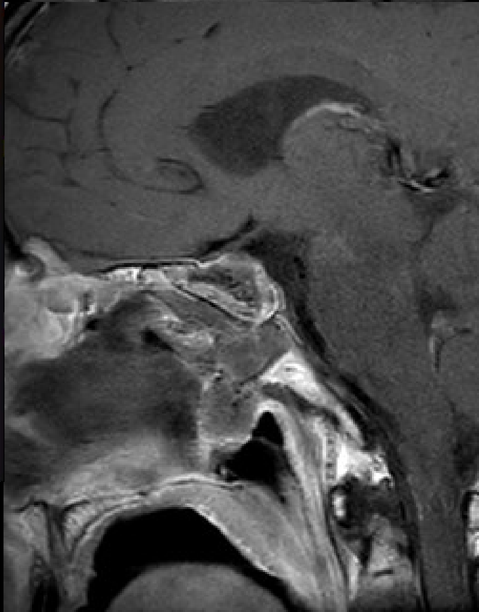
Pituitary Macroadenoma w/ CS Invasion

F/56 Visual field defect









Thank You for Listening