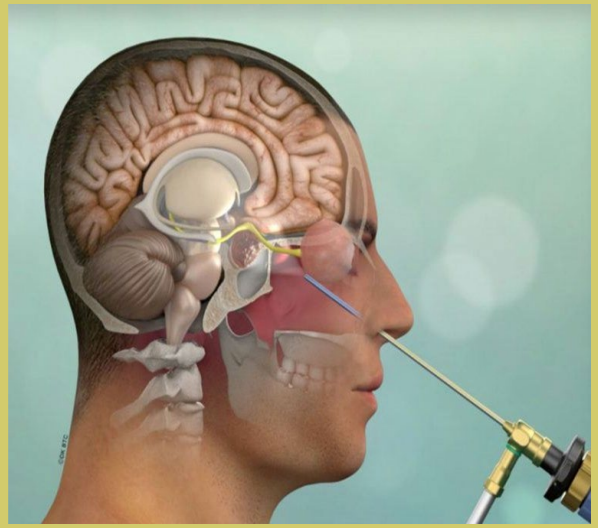
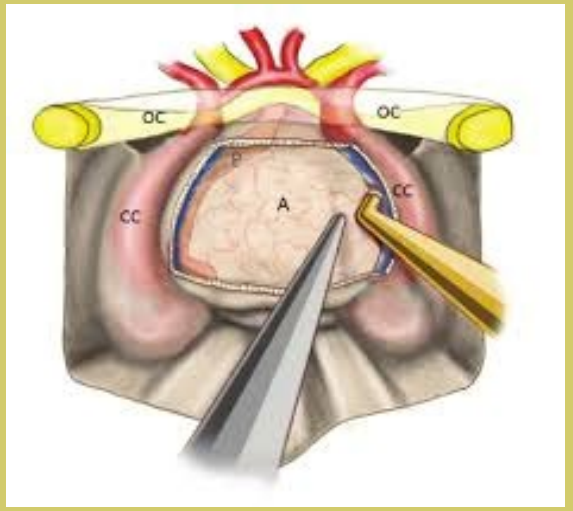
ADVANCEMENTS IN PITUITARY TUMOR SURGERY: THE ENDOSCOPIC ENDONASAL APPROACH



Ochsner Neuroscience Symposium
2023

Joseph Keen, D.O.
Department of Neurosurgery
Ochsner Medical Center



NO DISCLOSURES OR CONFLICTS OF INTEREST

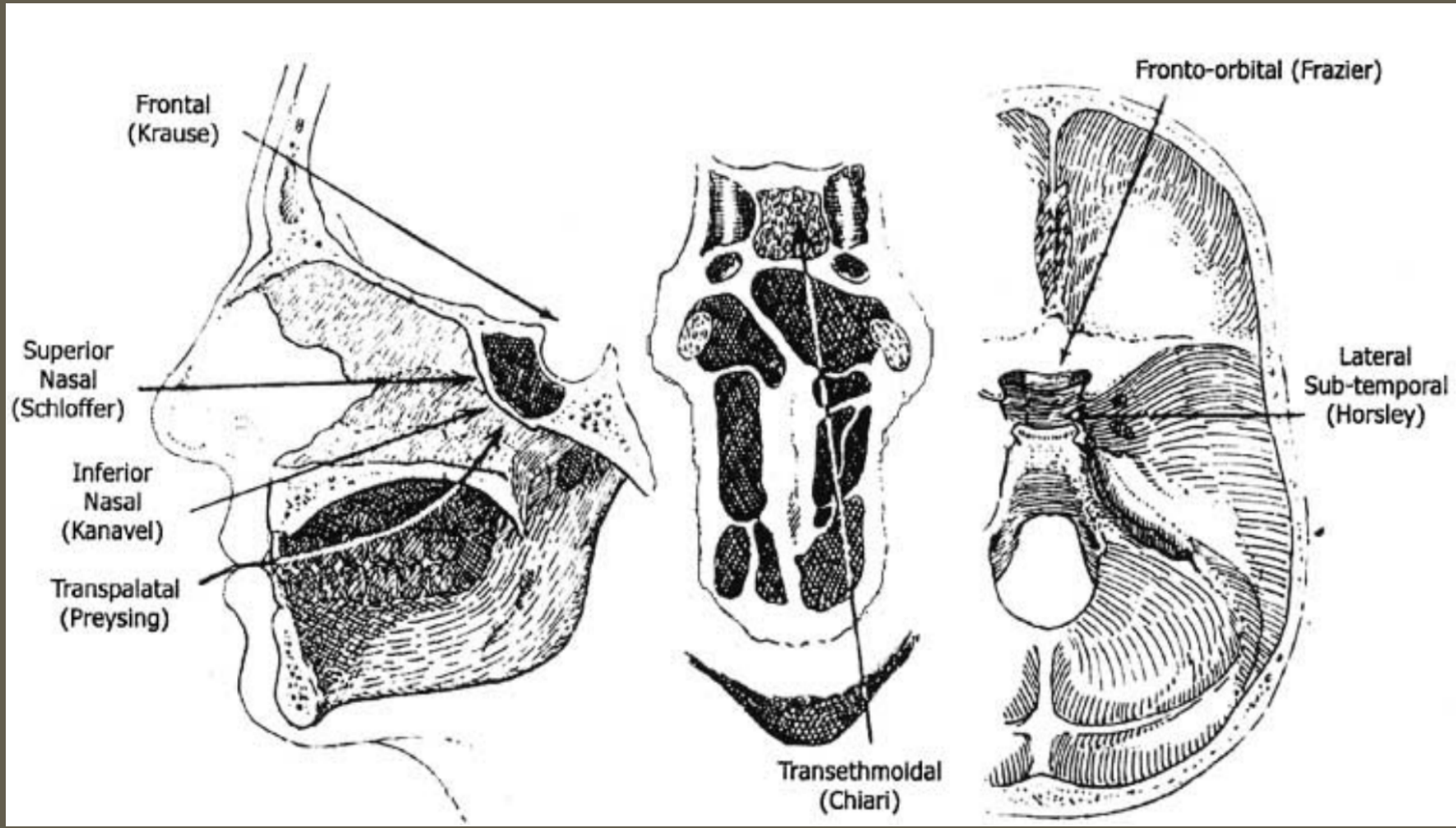
OVERVIEW

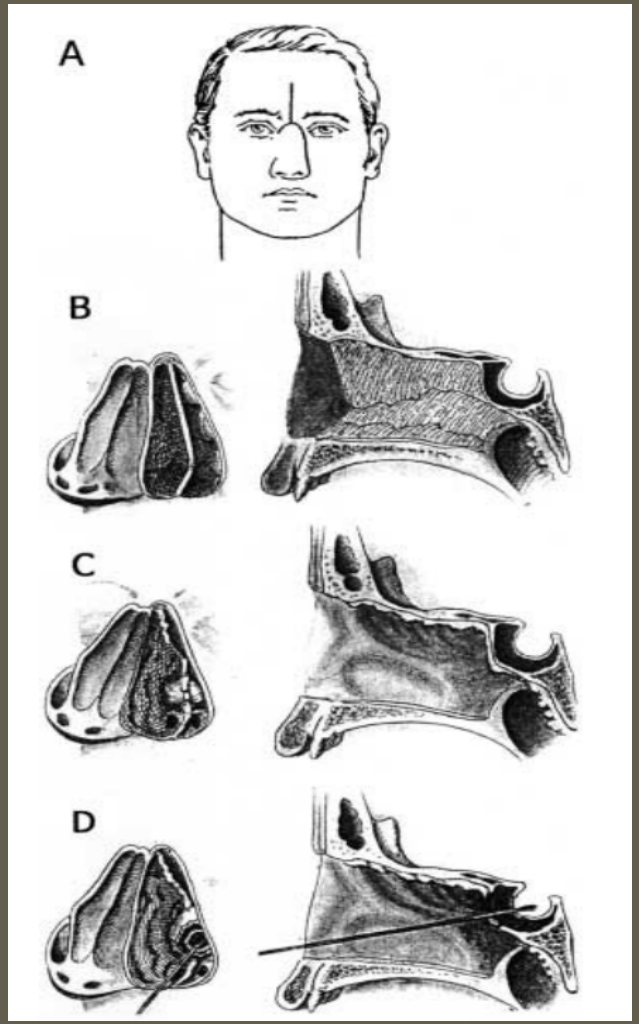
- History of Approaches
- Microscopic vs. Endoscopic
- Relevant anatomy
- Endoscopic Approach
- Complications and Outcomes
- Cases

HISTORY OF APPROACHES TO PITUITARY GLAND

HISTORY OF APPROACHES TO THE PITUITARY GLAND

- Initially transcranial/transfacial:
  - 1890's: Sir Victor Horsley - subfrontal, lateral middle fossa (20% mortality)
  - 1907: Austrian Hermann Schloffer - superior transphenoidal approach
    - Infection, poor cosmesis
  - 1909: Emil Kocher proposed submucosal dissection of the nasal septum
  - 1910: Oskar Hirsch - endonasal, transethmoidal
  - 1910: Albert E. Halstead - sublabial gingival incision
    - Immediately adopted by Cushing


Frontal
(Krause)
Superior
Nasal
(Schloffer)
Inferior
Nasal
(Kanavel)
Transpalatal
(Preysing)
Transethmoidal
(Chiari)
Fronto-orbital (Frazier)
Lateral
Sub-temporal
(Horsley)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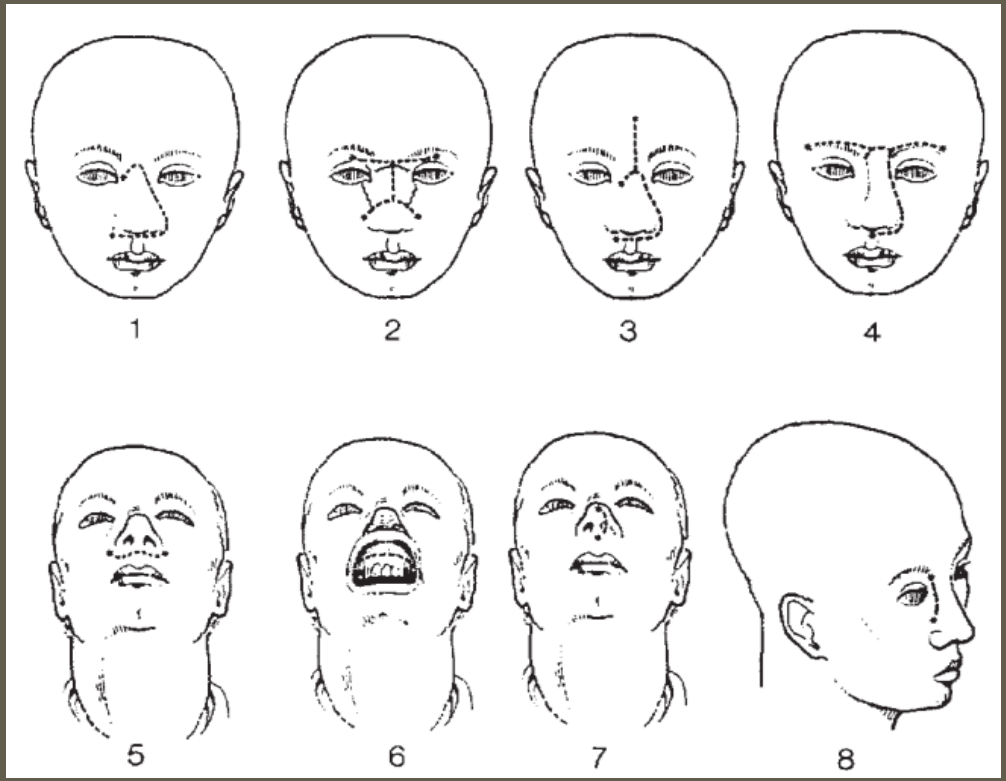
B
C
D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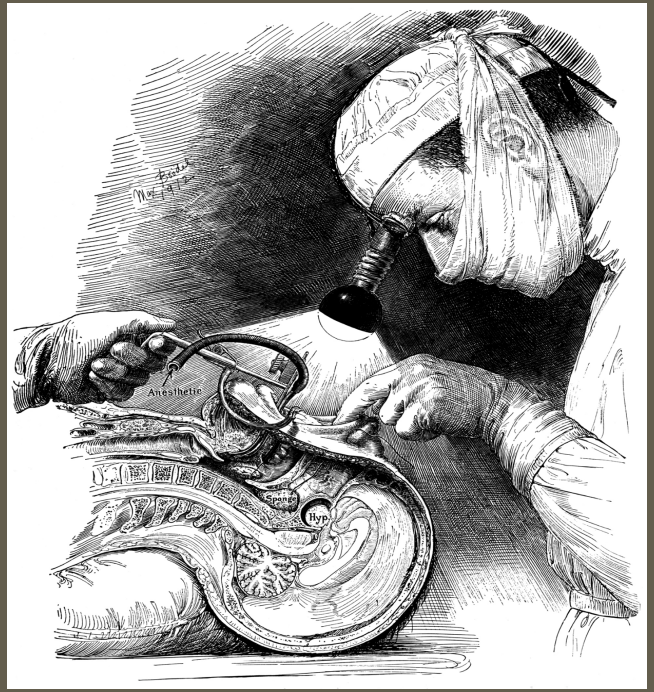
8

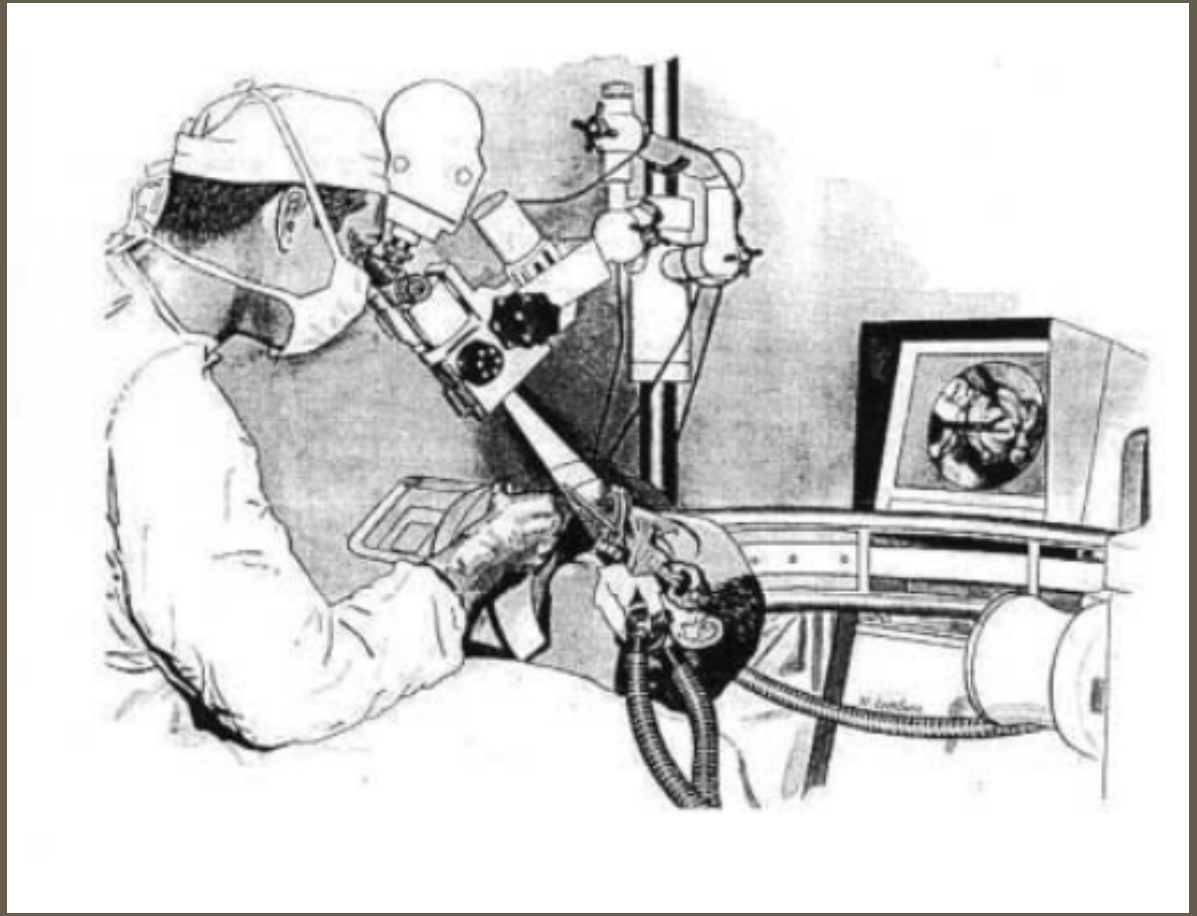
HARVEY CUSHING

- 1912: Cushing adopted both the **sublabial** incision and **submucosal** resection of the septum
  - 1910-1925: 231 pituitary tumors treated (mortality rate 5.6% before antibiotics)
  - Early 1930's: abandoned transphenoidal for transcranial approaches
    - Rapid decline of transphenoidal approach



THE TRANSSPHENOIDAL BREAKTHROUGH

- Three Key Figures
  1. Norman Dott of Edinburgh (Cushing fellow 1923)
     - Designed a lighted nasal speculum that improved illumination of the surgical site
     - By 1956 performed 80 consecutive transphenoidal surgeries without any deaths
  2. Gerard Guiot of Paris (Dott fellow)
     - Introduced image intensification and fluoroscopy - allowed for visual confirmation of depth and position of surgical instruments
     - 1000+ pituitary adenoma cases
     - Applied the transphenoidal approach in treating craniopharyngiomas, clival chordomas, and parasellar lesion
  3. Jules Hardy of Montreal (Guiot fellow)
     - Introduced binocular microscope, defined the concept of macroadenoma and selective removal (1965)
     - Developed and designed his own microsurgical instrumentation
     - No deaths or serious morbidities occurred in the first 50 patients

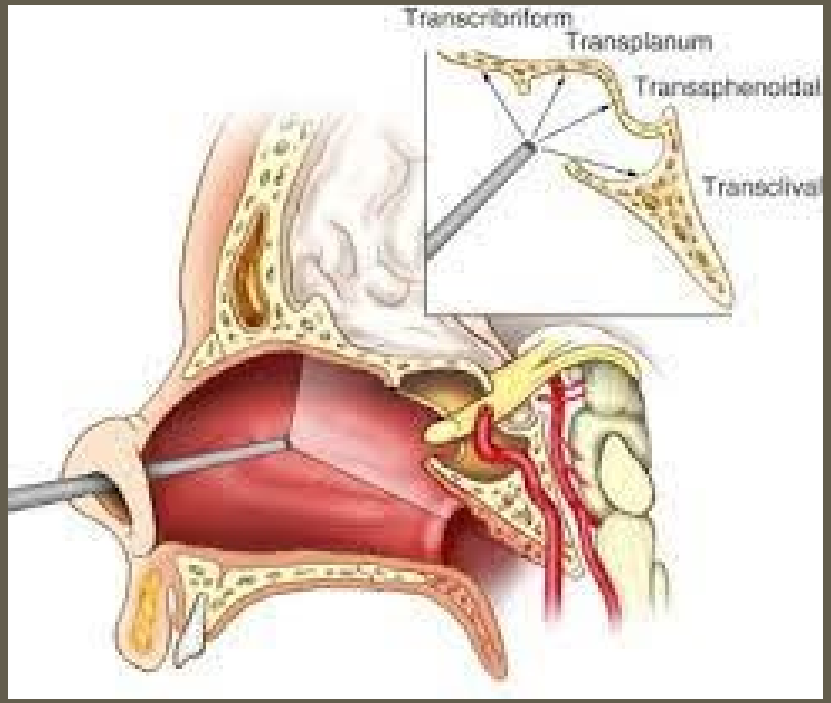


INTRODUCTION AND EVOLUTION OF THE ENDOSCOPE

- 1960's: Guiot, et al - first used endoscope to inspect sellar cavity at end of transsphenoidal procedure.
  - At this time, endoscopic vision quality was far poorer than microscope
  - For 2 decades microsurgical techniques and advancements in microscopes relegated endoscope to a supportive role
  - 1977 - Michael Apuzzo "adjunctive endoscopy"
- 1990's: Tremendous improvements in endoscope quality
  - 2 types of endoscopic procedures:
    - 1) ventricular
    - 2) endonasal transphenoidal
  - Neurosurgery and ENT collaboration led to the development of "pure endoscopic" transphenoidal technique

RECENT HISTORT

- 1996: Jho and Carrau used endoscope to remove pituitary adenomas and established guidelines for fully endoscopic procedure
  - Fully endonasal without speculum
- Extended Approach to Sellar Tumors
  - Oldfield, Laws, Kassam
- Where we are now:
  - Minimally invasive access
  - High definition endoscopy: 2D vs 3D visualization
  - Angled scopes and instrument
  - Neuronavigation
  - Advanced closure techniques



INDICATIONS FOR ENDOSCOPIC TRANSPHENOIDAL APPROACH

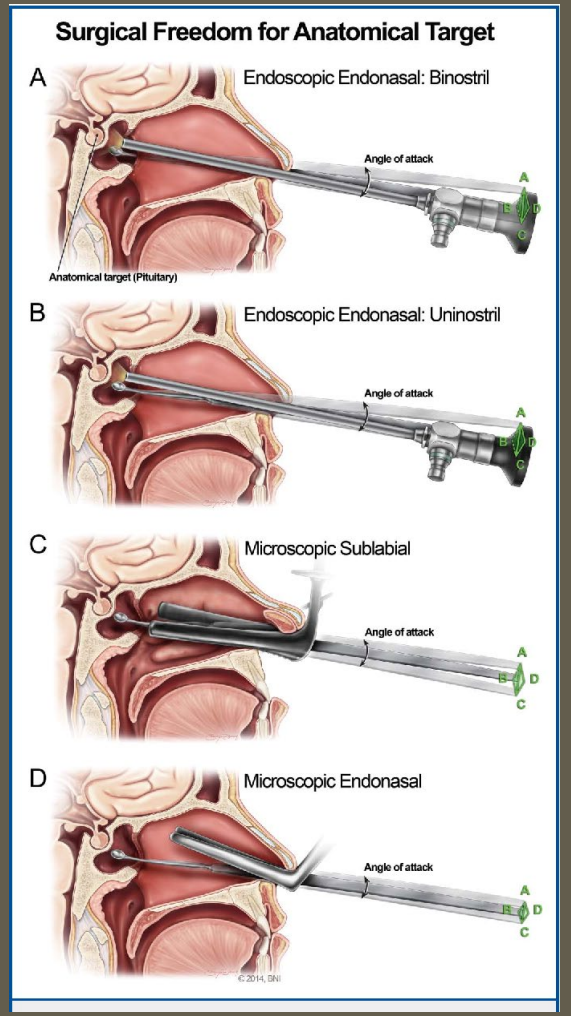
- Effectiveness of the endoscopic, endonasal approach
  - Improved field of view
  - Direct midline exposure without any brain or neurovascular retraction/manipulation
  - Possibility early devascularization in certain skull base lesions
- Direct route to infra- and supra-diaphragmatic and intraventricular midline lesions
- Lesions that are midline:
  - Pituitary adenomas
  - Rathke cleft cysts
  - Craniopharyngiomas
  - Meningiomas
  - Chordomas

CURRENT OPTIONS

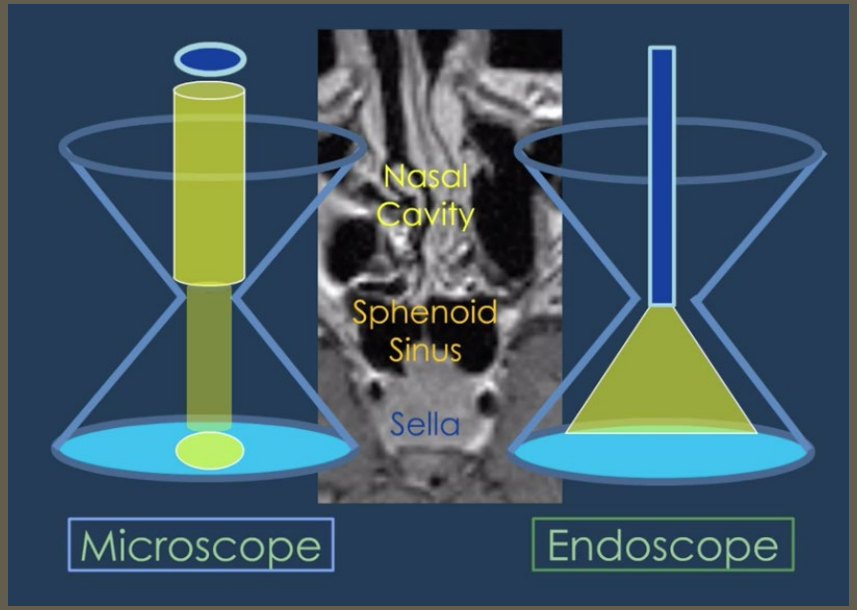
MICROSCOPIC

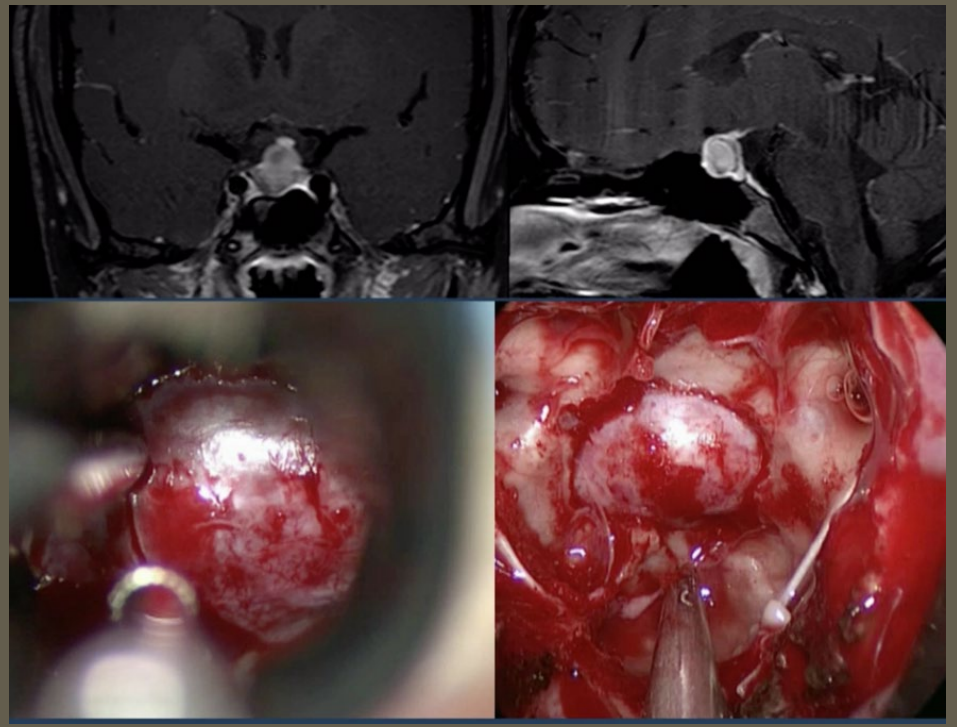
ENDOSCOPIC

CURRENT OPTIONS



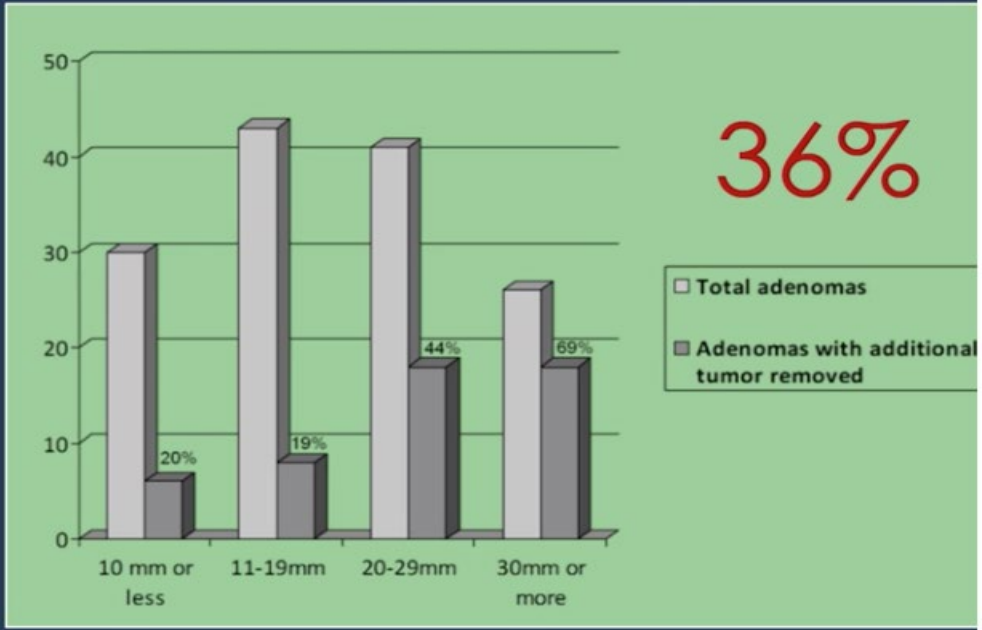
KEYHOLE CONCEPT





Value of endoscopy for maximizing tumor removal in endonasal transsphenoidal pituitary adenoma surgery

Additional Tumor Removal with Endoscopic Visualization by Tumor Size (N = 140 patients)

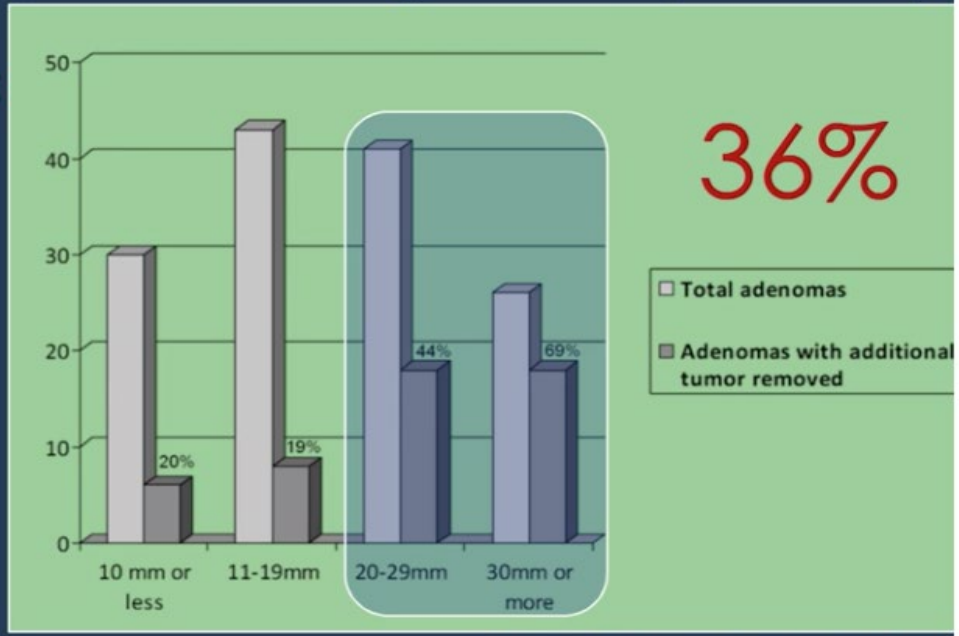


McLaughlin et al 2012 JNS

Value of endoscopy for maximizing tumor removal in endonasal transsphenoidal pituitary adenoma surgery

Additional Tumor Removal with Endoscopic Visualization by Tumor Size (N = 140 patients)

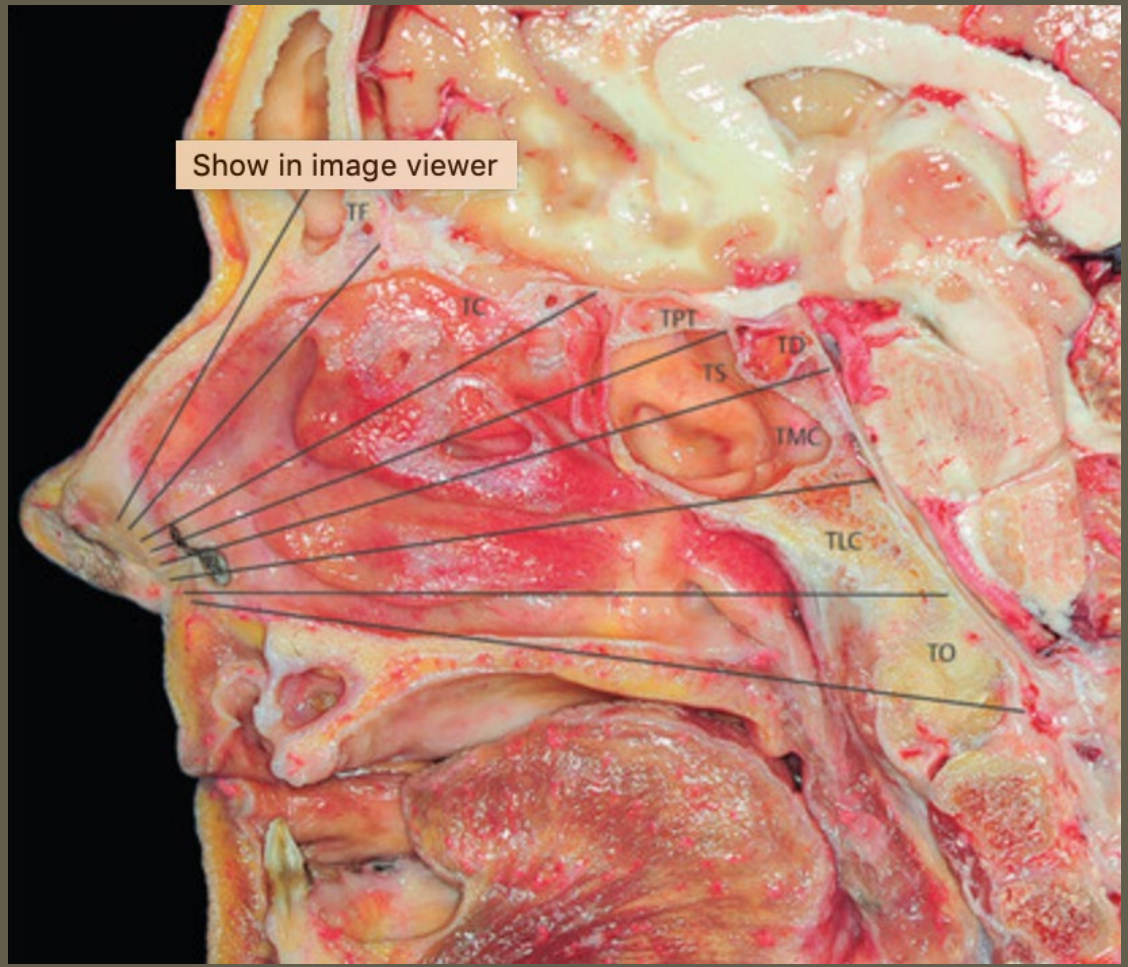
Tumor Diameter:
< 2 cm 19%
≥ 2 cm: 54%
(p < 0.0001)



McLaughlin et al 2012 JNS

RELEVANT ANATOMY


Show in image viewer
FPA
FS
OBu
GR
PSph
TSe
A1
DoS
NB
SER
ON
CrP
PE
Hyp
BA
MT
AE
ST
SpS
Po
SpF
LoC
MOb
IT
ToT
VA
NaF
LoCM
SoP
Ar
OP
C2
C3


Show in image viewer
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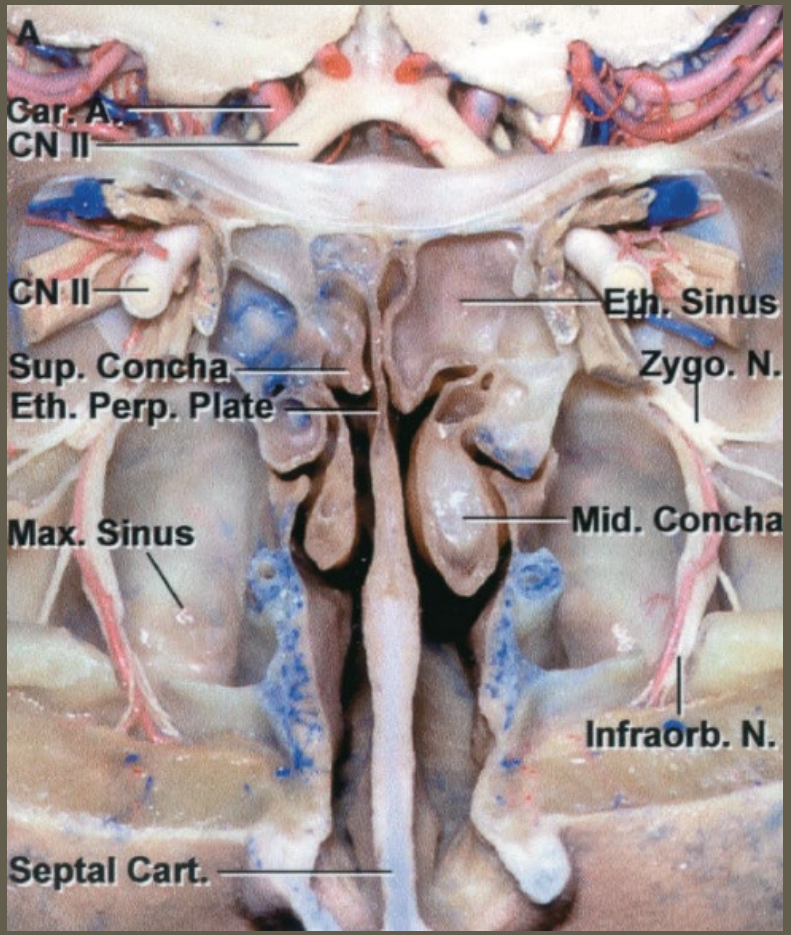
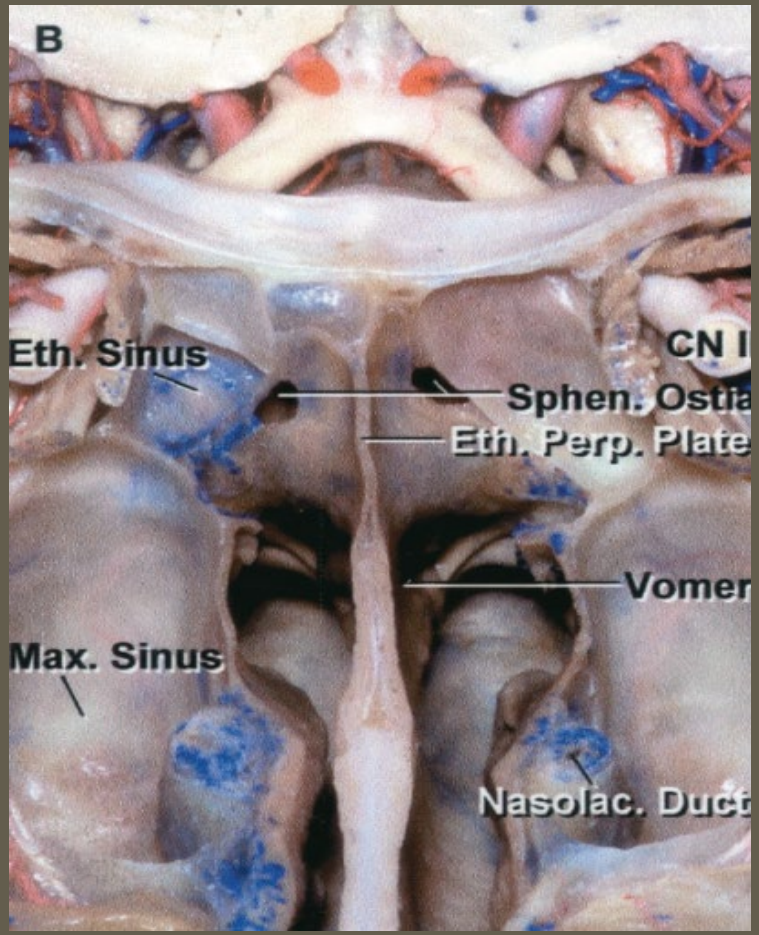
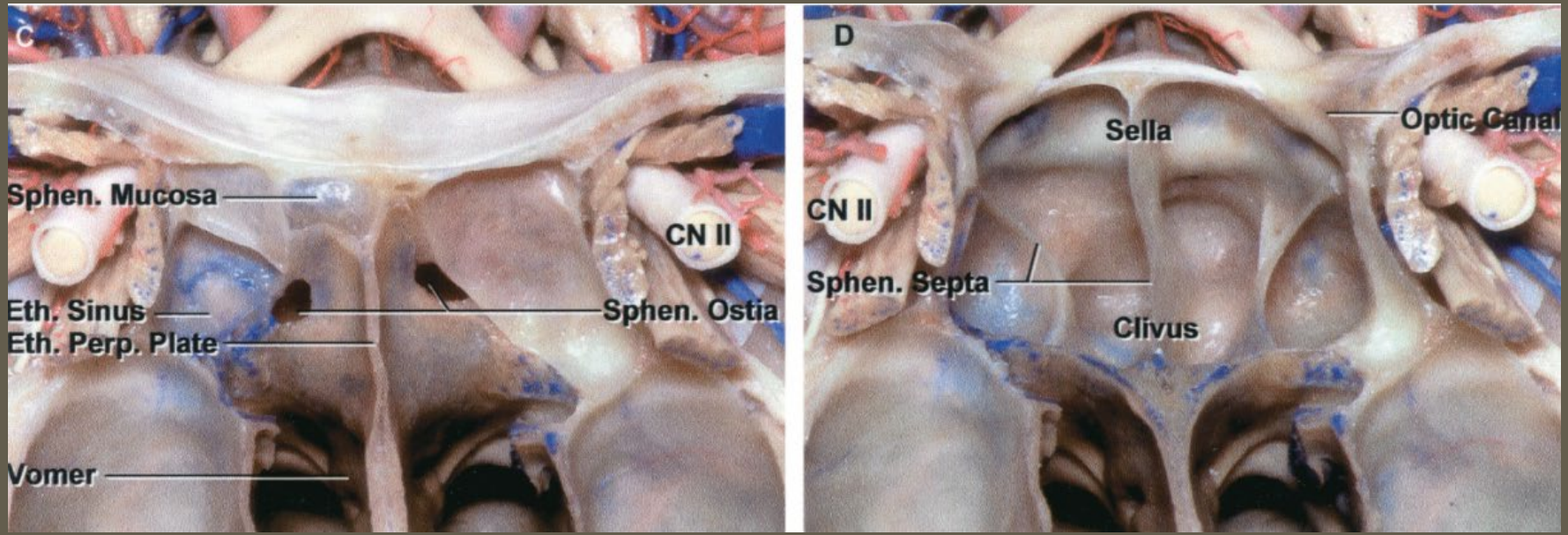
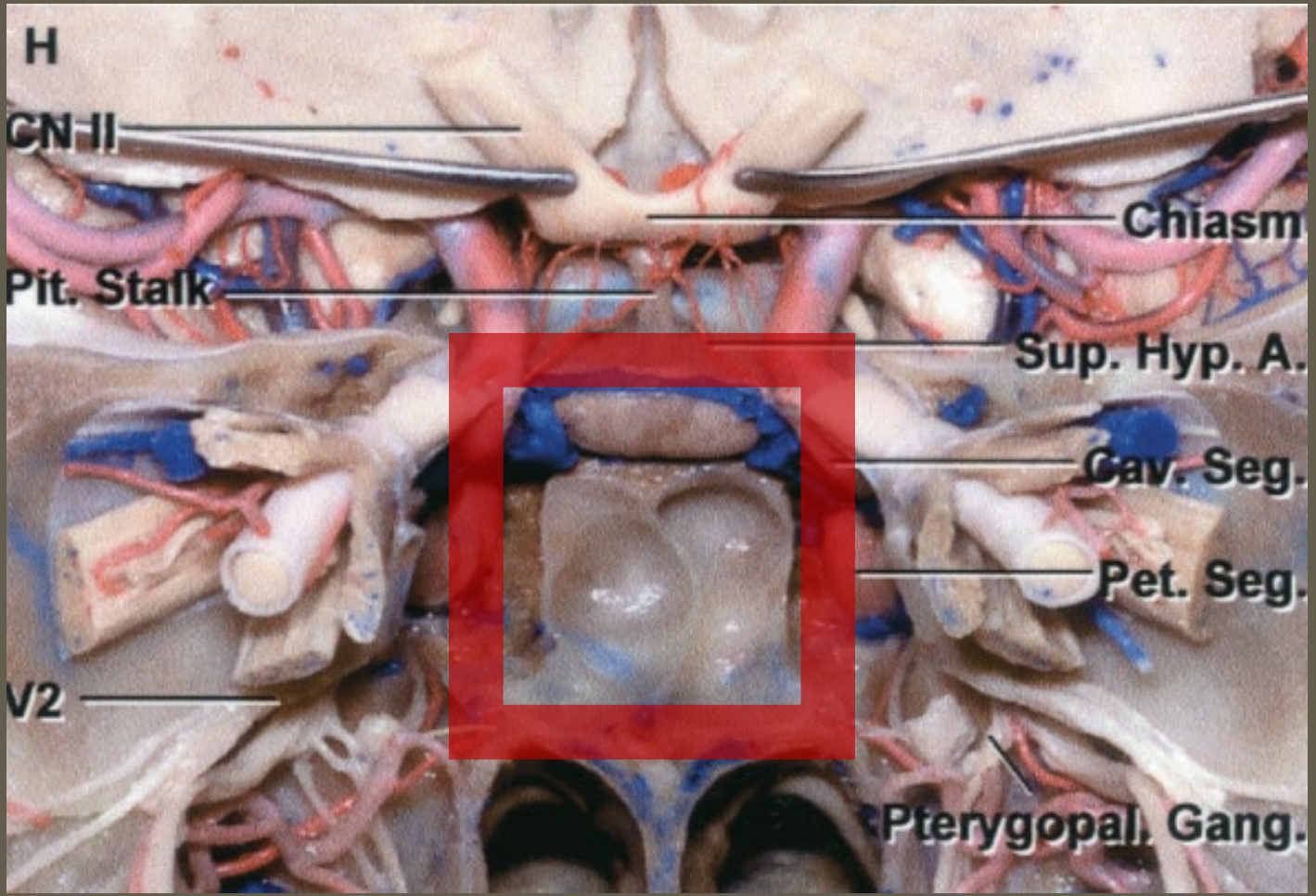
TC
TPT
TD
TS
TMC
TLC
TO

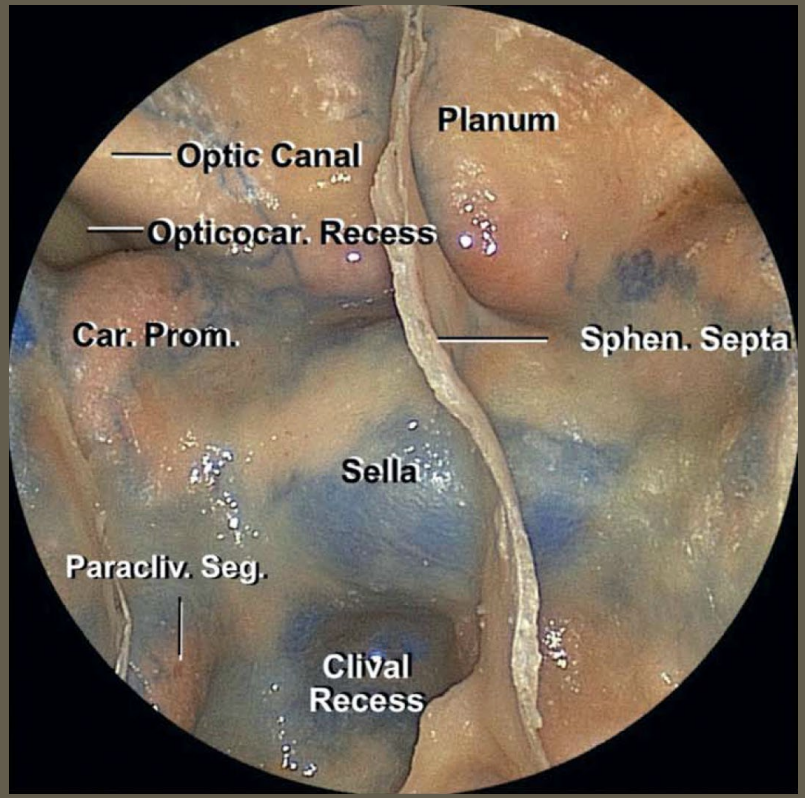

A
Car. A.
CN II
CN II
Eth. Sinus
Sup. Concha
Zygo. N.
Eth. Perp. Plate
Mid. Concha
Max. Sinus
Infraorb. N.
Septal Cart.

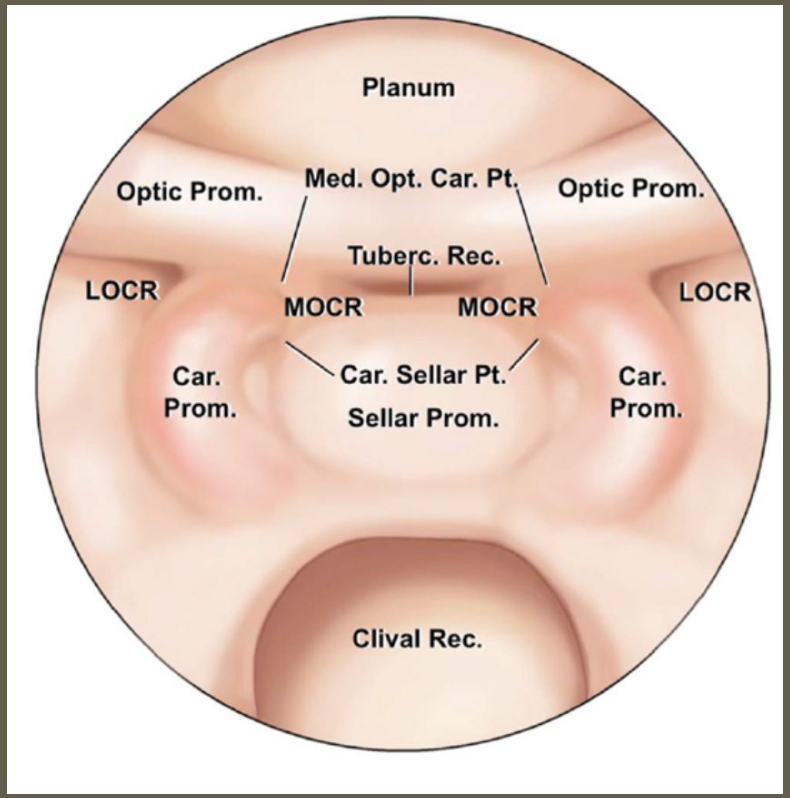

B
Eth. Sinus
CN I
Sphen. Ostia
Eth. Perp. Plate
Vomer
Max. Sinus
Nasolac. Duct

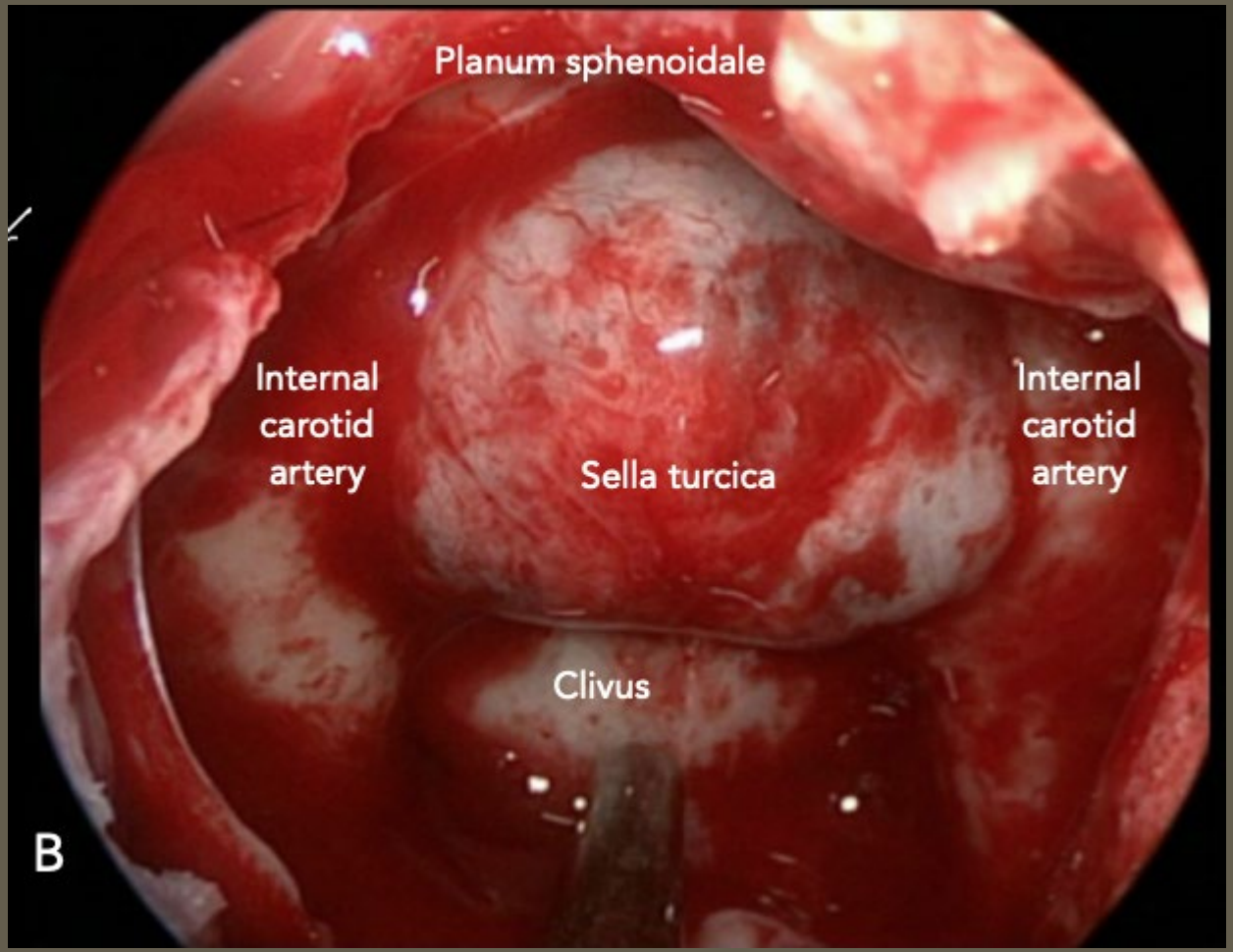

C
Sphen. Mucosa
CN II
Eth. Sinus
Sphen. Ostia
Eth. Perp. Plate
Vomer
D
Sella
Optic Canal
CN II
Sphen. Septa
Clivus


H
CN II
Chiasm
Pit. Stalk
Sup. Hyp. A.
Cav. Seg.
Pet. Seg.
V2
Pterygopal. Gang.

OPERATIVE ANATOMY



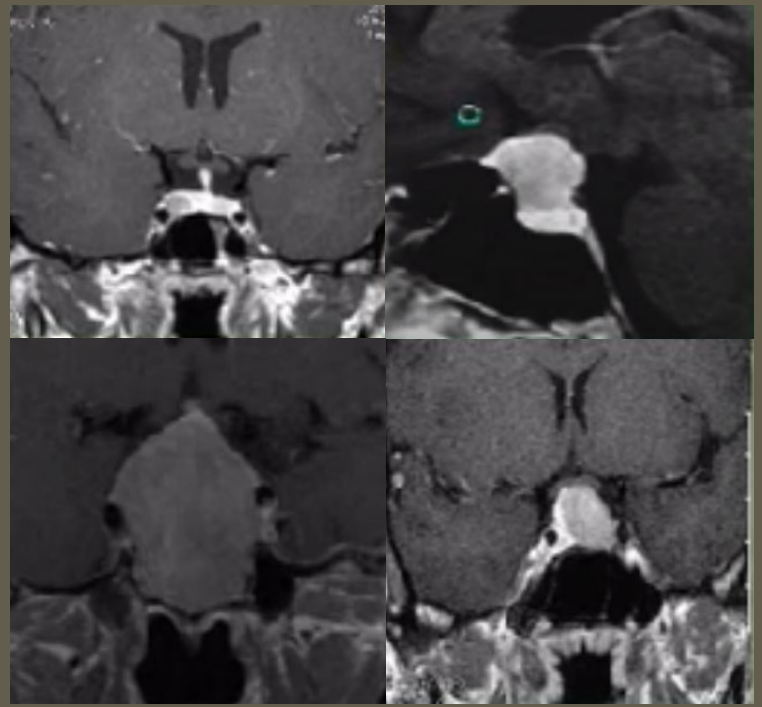



Planum sphenoidale
Internal carotid artery
Sella turcica
Internal carotid artery
Clivus
B

ENDOSCOPIC APPROACH

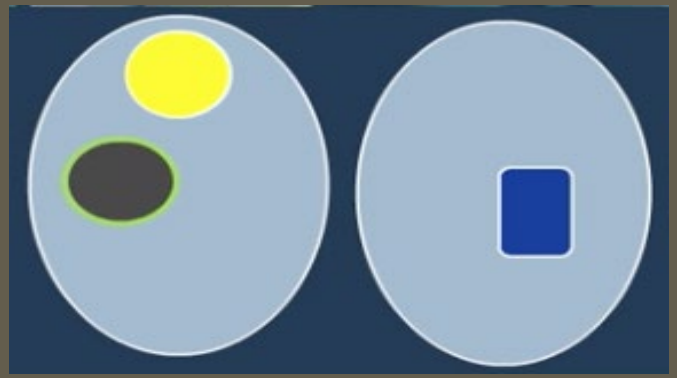
PREOPERATIVE WORKUP

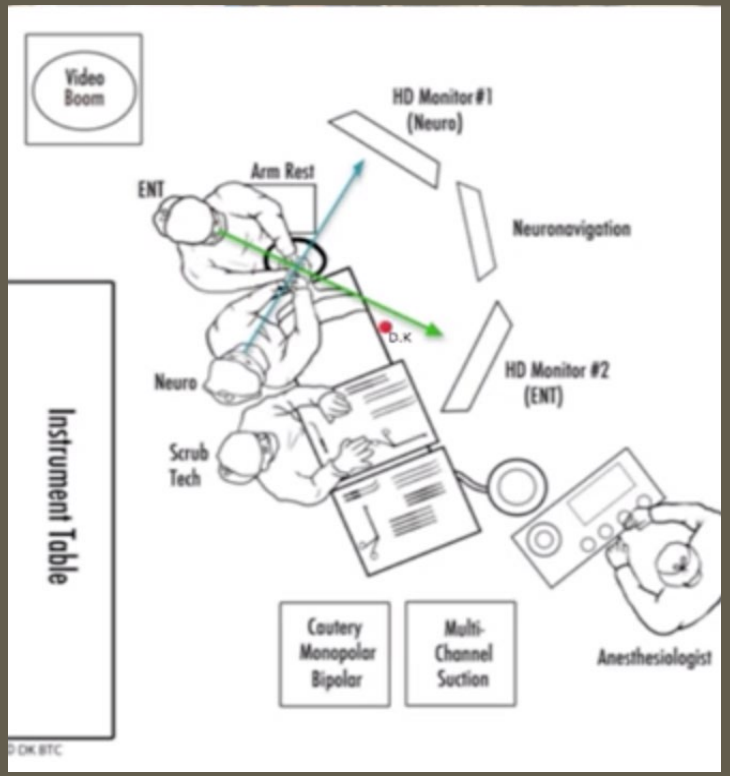
- Neuroendocrine evaluation
  - Pituitary hormone panel (esp. prolactin, cortisol, and thyroxine levels)
- Neuroophthalmologic evaluation
  - Visual field testing
- ENT evaluation
  - Evaluate sinonasal cavities
  - Prior sinonasal disease or surgery
- Preoperative Imaging:
  - MRI, CT, CTA
  - Identify gland to avoid hypopituitarism
  - Location of carotids, optic apparatus, bony anatomy, tumor extension
- Need for lumbar drain placement
- Need for fat or fascia lata graft



OPERATIVE BASICS

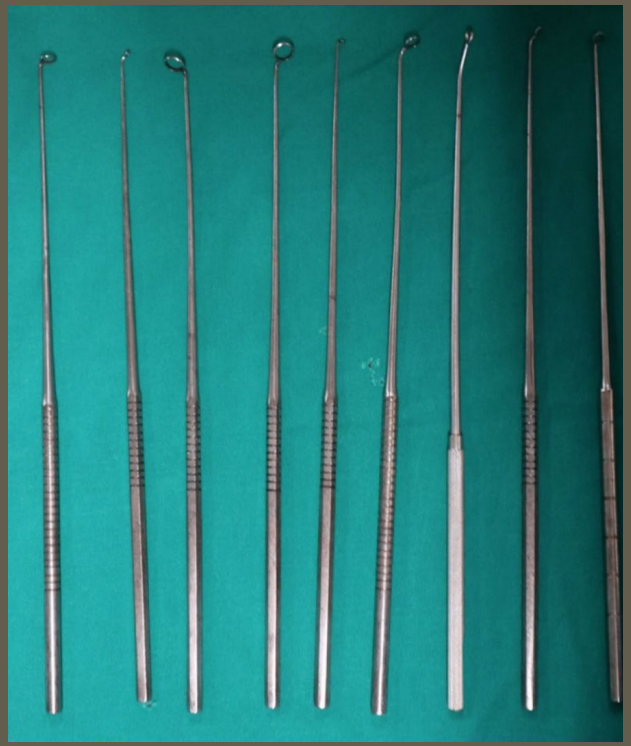
- Work closely with ENT colleagues - 2 surgeons
- Binostril or 1.5 nostril technique:
  - One surgeon working bimanually, the other driving the endoscope





INSTRUMENTS

- Endoscopes: 0, 30, 45 degree
- Lens washer (endoscrub)
- Microdebrider
- Cottle, Freer elevators
- Straight cutting, noncutting forceps
- Kerrison punches
- Drill
- Doppler
- Blades, scissors
- Dissectors, extended Rhotons
- Ring curettes
- Suction
- Suction bovie
- Endoscopic Bipolar

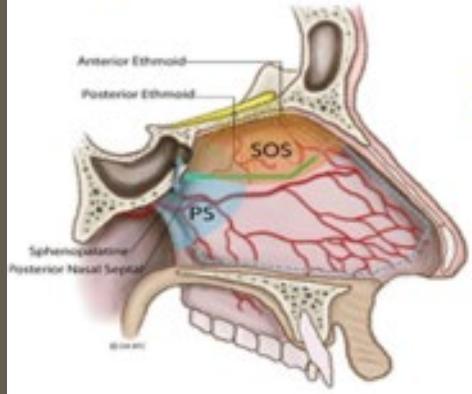


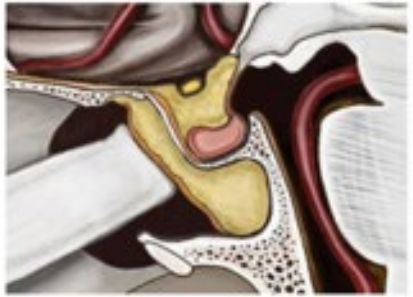
APPROACH TO THE SELLA

- Introduce scope and instruments
- Identify the inferior and middle nasal turbinates
  - Mobilize laterally
  - Middle turbinate may be removed if interfering, but can usually be preserved
- Identify the sphenoid ostia
- Remove posterior septum
  - Avoid inferior dissection to preserve arteries
- Create wide sphenoidotomy
  - Important to avoid "sword fighting" and allow greater manipulation
  - Must be able to see bilateral landmarks
- Remove the sphenoid mucosa
- Perform partial posterior ethmoidectomies
- Drill down bony septations in the sphenoid sinus
  - Sphenoid septum is not always midline
- Remove thin sellar bone

WORKFLOW

Complication Avoidance Protocols in Endoscopic Pituitary Adenoma Surgery





Rescue Flap Technique

Doppler Probe for ICA Localization

Pseudocapsular Dissection & Gland Incision Techniques

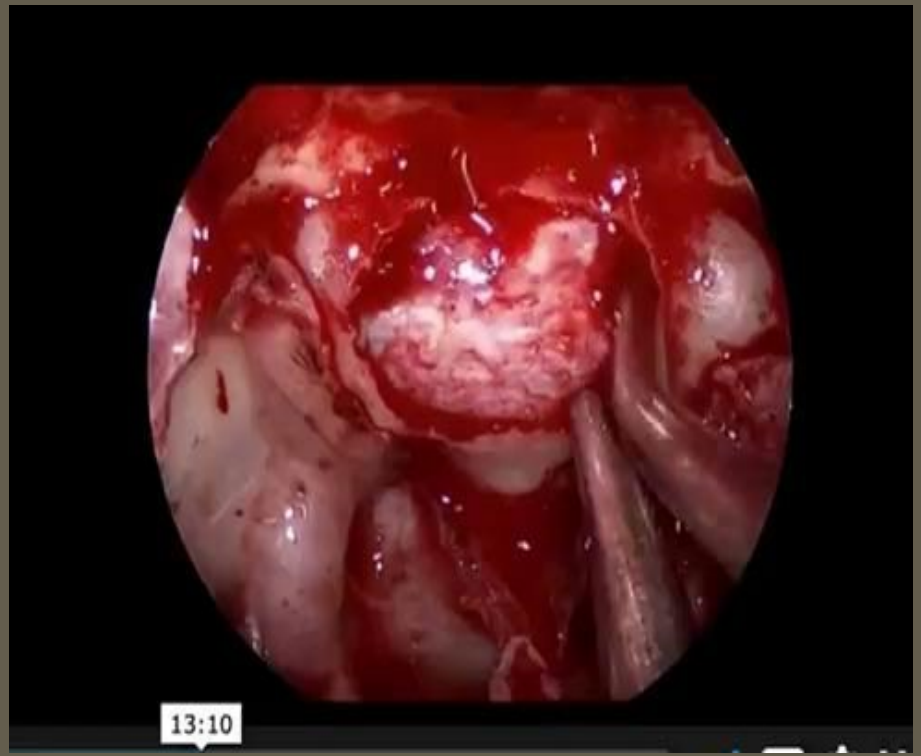
Graded Repair of CSF Leaks

Sinonasal Approach → Sellar Exposure → Adenoma Resection → Sellar & Skull Base Reconstruction

HD Monitor #1

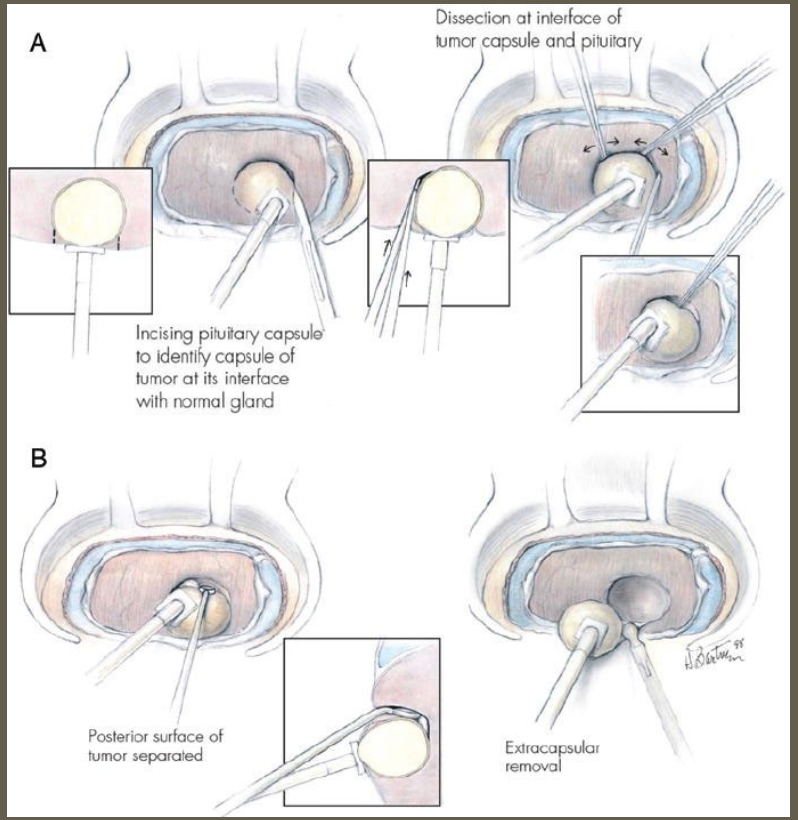
CAROTID ARTERY LOCALIZATION

- Carotid injury most feared complication
- Can be devastating
- Use doppler or navigation
- Lack of knowing where the carotids are can lead to overly conservative and suboptimal exposure



DURAL OPENING AND DISSECTION

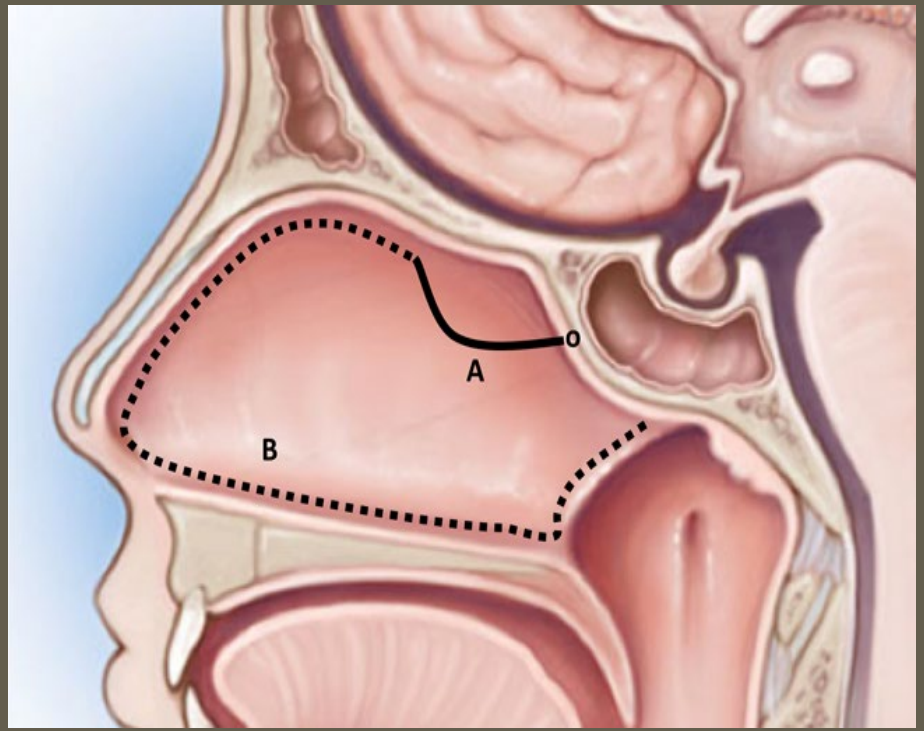
- Cruciate dural opening
- Avoid opening into tumor or gland
  - Visualize gland early to protect it
- Find pseudocapsule (Oldfield technique)
  - Helps achieve GTR vs piecemeal
- Peel tumor away from gland
- Inferior, lateral, superior (back to front)
  - Diaphragma will fall and obscure view
- Endoscope to view along cavernous sinus and suprasellar space
  - Can miss tumor between sinus wall and diaphragma
- Same techniques as open surgery apply
  - Extracapsular dissection
  - Counter traction, sharp/blunt dissection
  - Neurovascular control, early identification

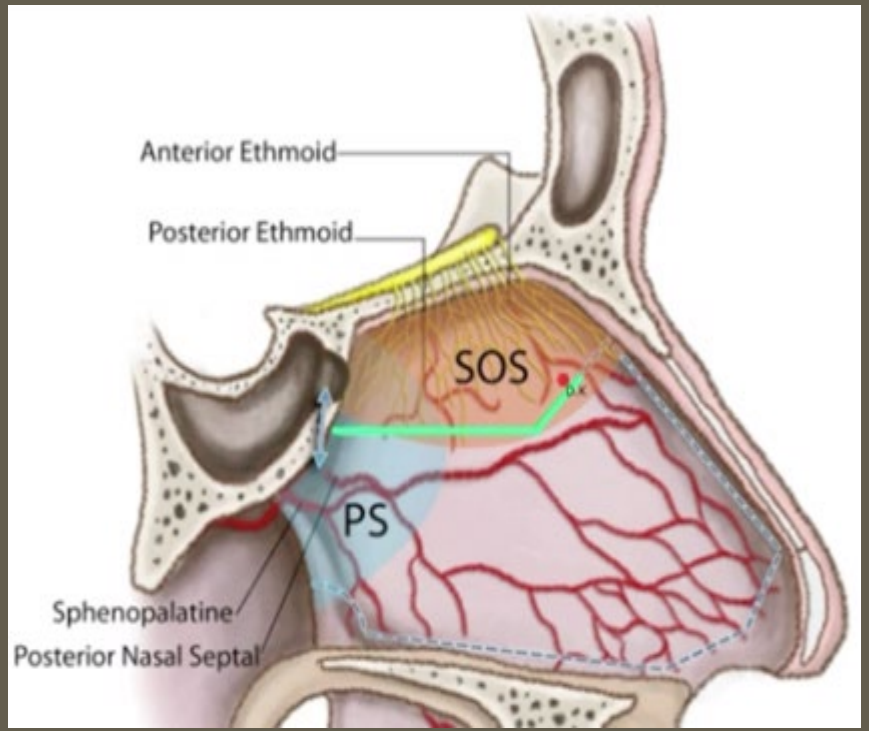


CLOSURE

- CSF leak? – low vs high flow, low vs high pressure
- Fat graft to fill resection cavity
- Dura flapped down
- Cover sella with dural substitute or collagen graft
- Buttress with harvested bone graft/fascia lata
- Nasoseptal flap
- Tissue glue
- Nasal packing
- Lumbar drain?

NASOSEPTAL FLAP





POSTOPERATIVE CONSIDERATIONS

- Endocrine status (both inpatient and outpatient)
  - Diabetes insipidus
  - Hypocortisolemia
  - Hypothyroidism
- Monitor for CSF leak
- Nasal precautions
  - No straining, blowing nose,, straws,, bending over
  - No positive pressure ventilation
- ENT follow up
  - Nasal saline sprays
  - Debridement

COMPLICATIONS

COMPLICATIONS?

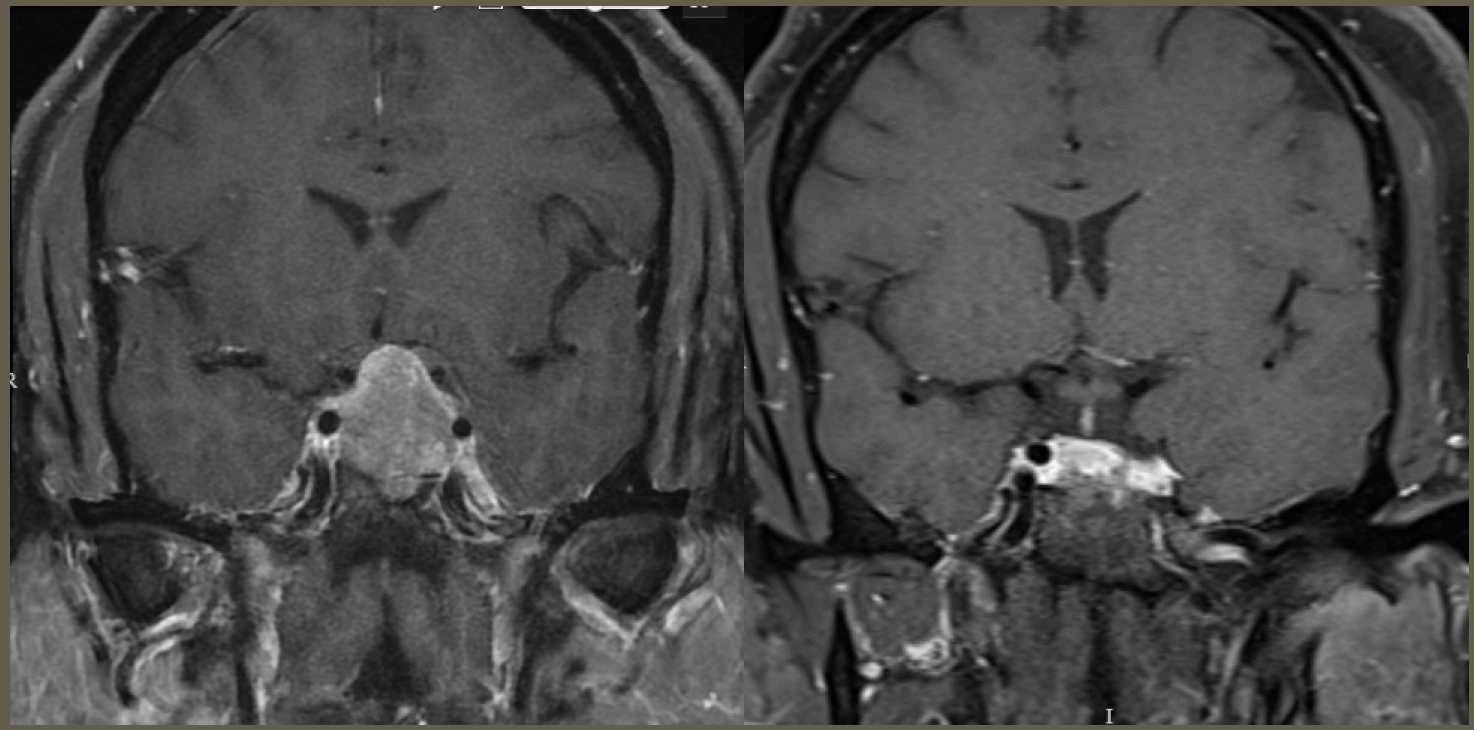
Complications of endoscopic surgery of the pituitary adenomas: analysis of 570 patients and review of the literature

Mustafa Berker · Derya Burcu Hazer · Taşkın Yücel · Alper Gürlek · Ayşenur Cila · Mustafa Aldur · Metin Önerci

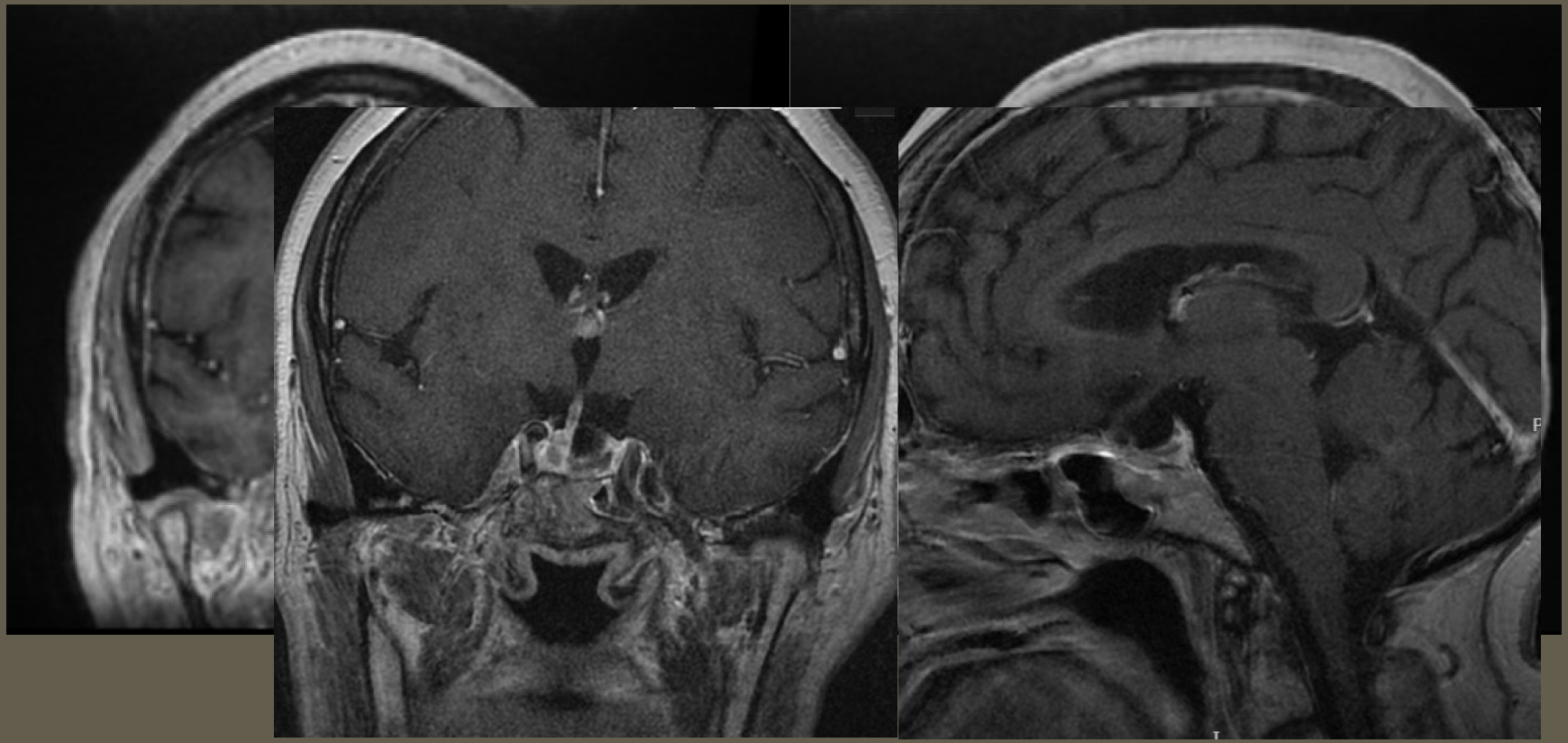
- 624 procedures, 570 patients
- 5 groups: rhinological, CSF leak, infection, vascular and endocrinologic
- Total of 76 complications (12.1%)
- Rhinological complications
  - 8 patients (1.3%): 4 epistaxis (0.6%) and 4 hyposmia (0.6%)
- Postoperative CSF leaks occurred in 8 patients (1.3%)
- Infectious complications
  - 8 patients: 3 cases of sphenoidal sinusitis (0.4%), 5 cases of meningitis (0.8%)
- Vascular: One case of internal carotid aneurysm rupture
- Endocrinologic complications
  - 51 (8.1%) patients: Anterior pituitary deficiency in 12 (1.9%), transient diabetes insipidus (DI) in 29 (4.6%), permanent DI in 3 (0.4%) and SIADH in 7 (1.1%)
- No mortality directly related

CASES

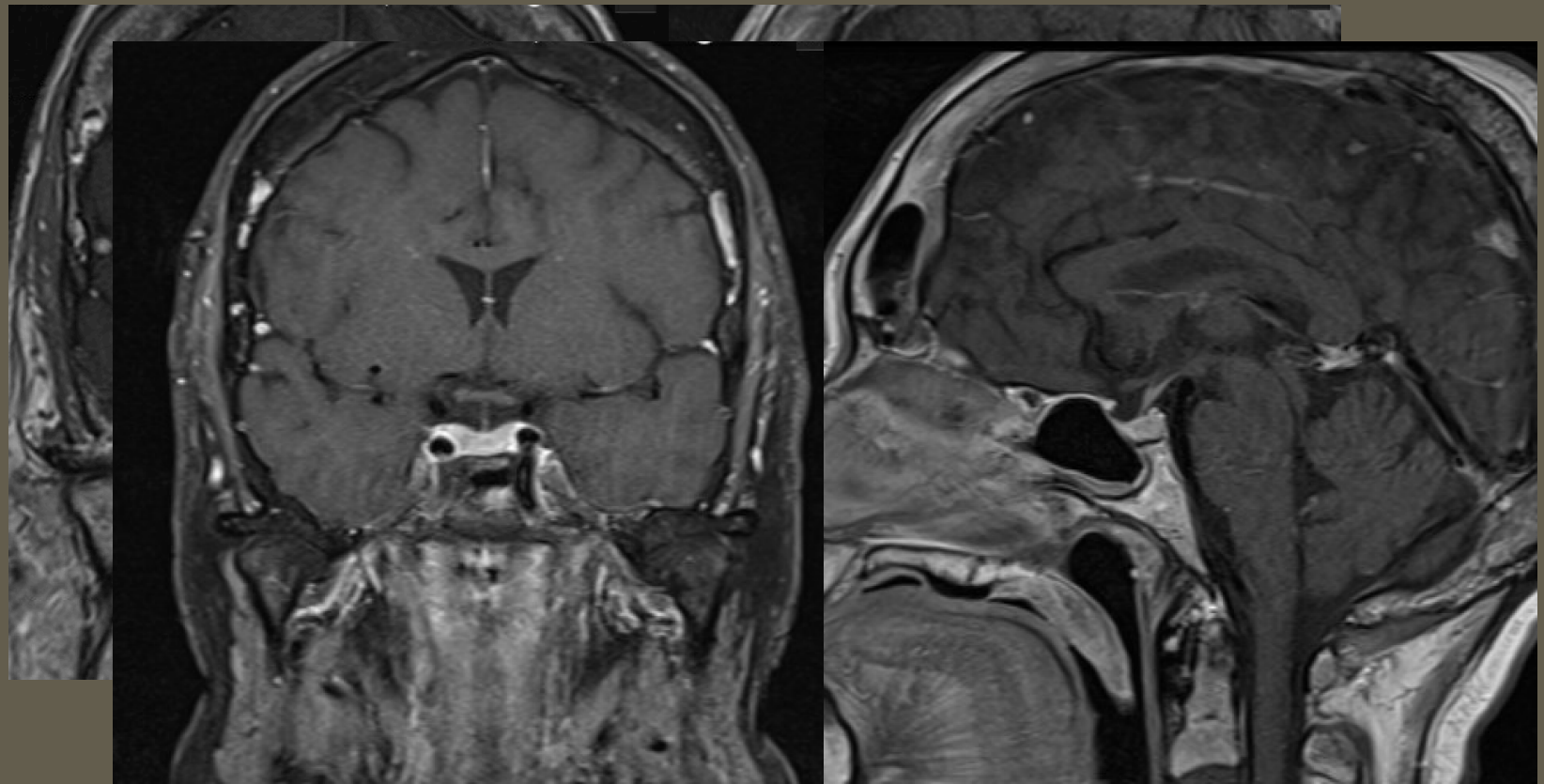
NON-FUNCTIONING MACROADENOMA



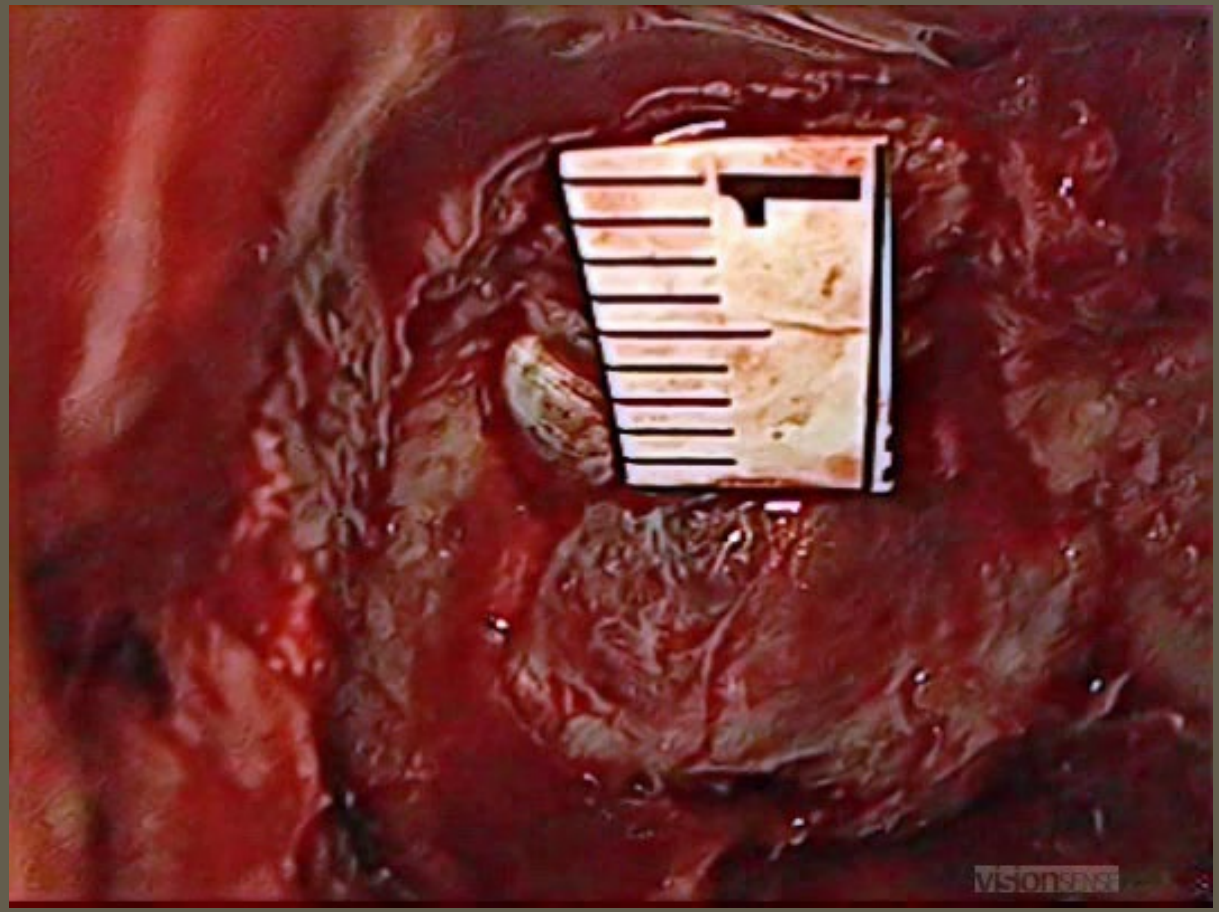
NON-FUNCTIONING MACROADENOMA



FUNCTIONAL GROWTH HORMONE ADENOMA - ACROMEGALY



CRANIOPHARYNGIOMA



OUTCOMES

NONFUNCTIONING PITUITARY ADENOMAS

Endoscopic Versus Microscopic Transsphenoidal Surgery in the Treatment of Pituitary Adenoma: A Systematic Review and Meta-Analysis

Aijun Li, Weisheng Liu, Peicheng Cao, Yuehua Zheng, Zhenfu Bu, Tao Zhou

- Review with 23 studies, 2272 patients (endo vs micro)
- Endoscopic was associated with a higher incidence of gross tumor removal
  - 52% increase
- Endoscopic had no significant effect on the risk of cerebrospinal fluid leak
- Endoscopic was associated with a 22% reduction in risk of diabetes insipidus
  - Difference was not statistically significant
- Endoscopic significantly reduced the risk of septal perforation
- For other complications, no significant differences were found

SUMMARY: ENDONASAL VS TRANSCRANIAL

- EEA is minimally invasive but…
  - Extensive nasal dissection needing aggressive nasal care
- Easier to perform difficult maneuvers with microscope (dissecting small arteries)
- Use EEA when it provides a specific anatomical advantage
- Advantages
  - Less brain retraction
  - Visualization of optic apparatus, allows for decompression
  - Not crossing arteries/nerves
  - Removal of involved dura, bone - radicality of resection
- CSF leak major disadvantage
- Olfactory loss if extensive dissection needed
- Occasionally need combined approaches for large tumors