Intracranial Meningiomas

Dr. Nidal Abuhadrous MD, MRCS, ABHS(NS)
Consultant Neurosurgeon
Head of Neurosurgery – Nasser Medical Complex

Location

- Intracranial (the most common location)
- Intraorbital
- Intraspinal

❑ Intracranial Meningioma:

Slow growing, extra-axial tumor, usually benign, arise from arachnoid (not dura)

Epidemiology

- Meningiomas are the most common primary intracranial tumors in adults
- 39% of primary intracranial tumors.
- 54.5% of non-malignant tumors
- 10% are histologically malignant and/or rapidly growing
- Multiple in up to 8% of cases, which is more common in NF
- Female: Male ratio is 2.3:1
- The median age at diagnosis is 65 years (risk increases with age)
- 19–24% of adolescent meningiomas occur in patients with NF1

Risk factors

- Ionizing radiation
- Female gender
- Postmenopausal women
- NF1 & NF2

Histological subtypes (15)

Grade 1	Grade 2	Grade 3
• Meningothelial • Fibrous • Transitional • Psammomatous • Angiomatous • Microcystic • Secretory • Lymphoplasmacyte-rich • Metaplastic	• Chordoid • Clear cell • Atypical	• Anaplastic (malignant) • Rhabdoid (most of them) • Papillary (most of them)

Grading meningiomas

▷ Meningioma WHO Grade 2◁

4 to 19 mitotic figures in 10 consecutive HPF of each 0.16 mm^2 (at least 2.5/mm^2)

OR

unequivocal brain invasion (not only perivascular spread or indentation of brain without pial breach)

OR

specific morphological subtype (chordoid or clear cell; see text)

OR

at least 3 of the following:

- increased cellularity
- small cells with high N:C ratio
- prominent nucleoli
- sheeting (uninterrupted patternless or sheet-like growth)
- foci of spontaneous (non-iatrogenic) necrosis

▷ Meningioma WHO Grade 3◁

20 or more mitotic figures in 10 consecutive HPF of each 0.16 mm^2 (at least 12.5/mm^2)

OR

frank anaplasia (sarcoma-, carcinoma-, or melanoma-like appearance)

OR

TERT promoter mutation

OR

homozygous deletion of *CDKN2A* and/or *CDKN2B*

Ki-67 & Recurrence Rate

Table 46.1 Ki-67 proliferation index and recurrence rates in meningiomas[8a]

Description & WHO grade	Mean Ki-67 index[a]	Recurrence rate
common meningioma (WHO grade 1)	0.7%	9%
atypical meningioma (WHO grade 2)	2.1%	29%
anaplastic meningioma (WHO grade 3)	11%	50%

[a]not to be used as sole discriminant for grading (see text)

Presentation

- Depends on the location of the tumor
- Some specific locations are associated with well-described symptom complexes

➢ Seizures (supratentorial meningiomas)

➢ Mass under the scalp (convexity meningioma after invading the skull)

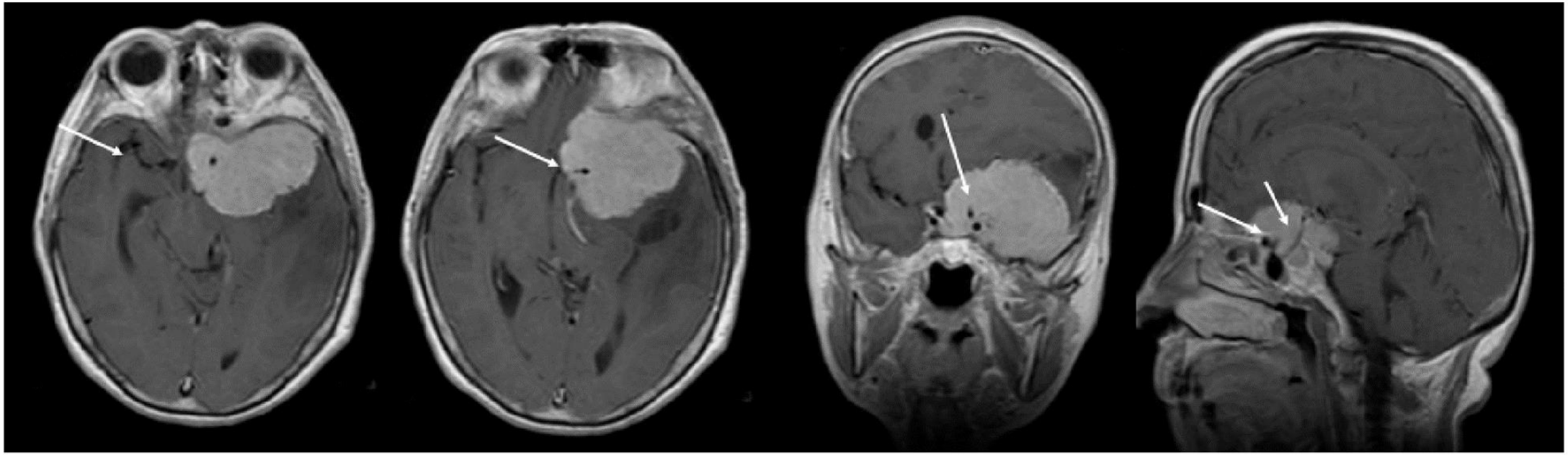
➢ Asymptomatic (incidental)

Meningioma Locations

Table 46.2 Location of adult meningiomas (series of 336 cases[11])

Location	%
parasagittal	20.8
convexity	15.2
tuberculum sellae	12.8
sphenoidal ridge	11.9
olfactory groove	9.8
falx	8.0
lateral ventricle (intraventricular)	4.2
tentorial	3.6
middle fossa	3.0
orbital	1.2
spinal	1.2
intrasylvian	0.3
extracalvarial	0.3
multiple	0.9

Sphenoid wing (ridge) meningiomas



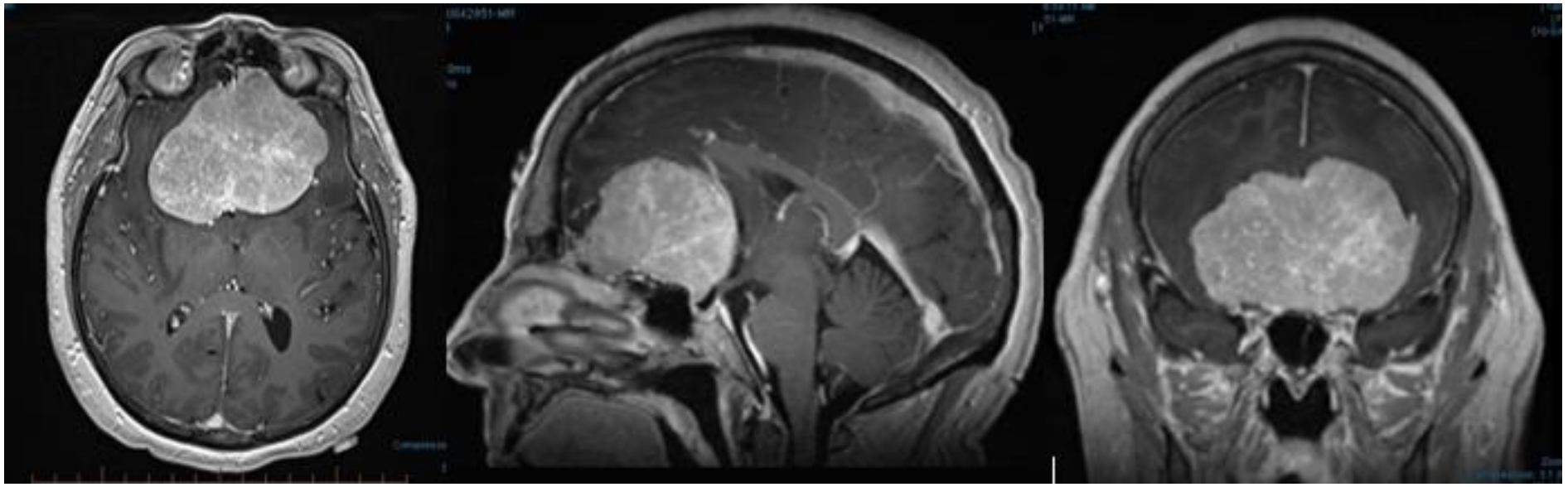
Sphenoid wing (ridge) meningiomas

1. Lateral sphenoid wing (pterional): similar to convexity meningioma

2. Middle third (alar)

3. Medial (clinoidal): tend to encase the ICA and the MCA as well as cranial nerves in the region of the superior orbital fissure and the optic nerve. May compress brainstem. Total removal is often not possible

Olfactory groove meningiomas



Olfactory groove meningiomas

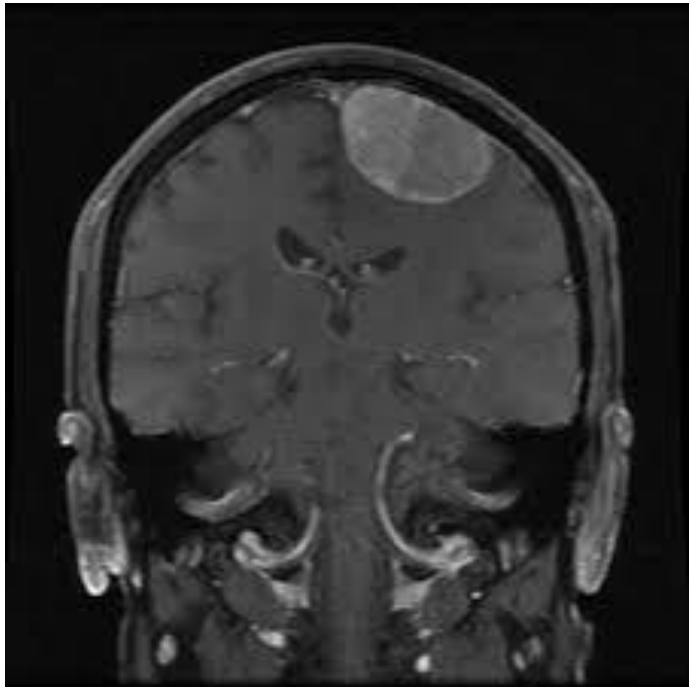
- Asymptomatic until large
- Foster Kennedy syndrome (If the tumor is asymmetrically situated)
- Mental status changes
- Urinary incontinence
- Visual impairment (in posteriorly located lesions)
- Short-term memory loss (large tumor compressing the fornix)
- Seizure

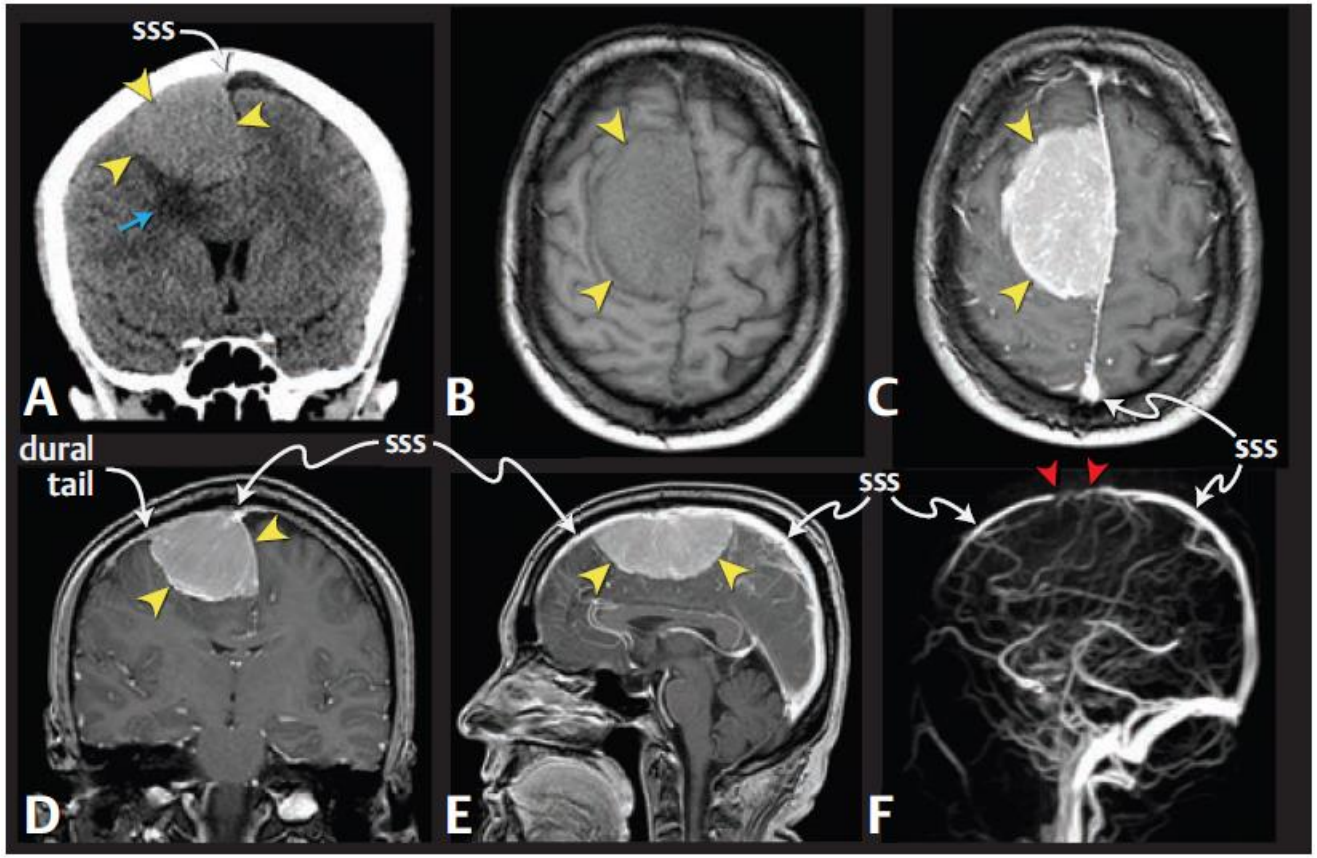
Olfactory groove meningiomas

- If > 3 cm: M&M ↑, total removal ↓

- Pre-op MRA, CTA or angiogram
  - location of anterior cerebral arteries
  - Blood supply: 80% from the anterior ethmoidal artery, which is usually not embolized due to risk to ophthalmic artery (blindness)

Parasagittal and Parafalcine meningiomas





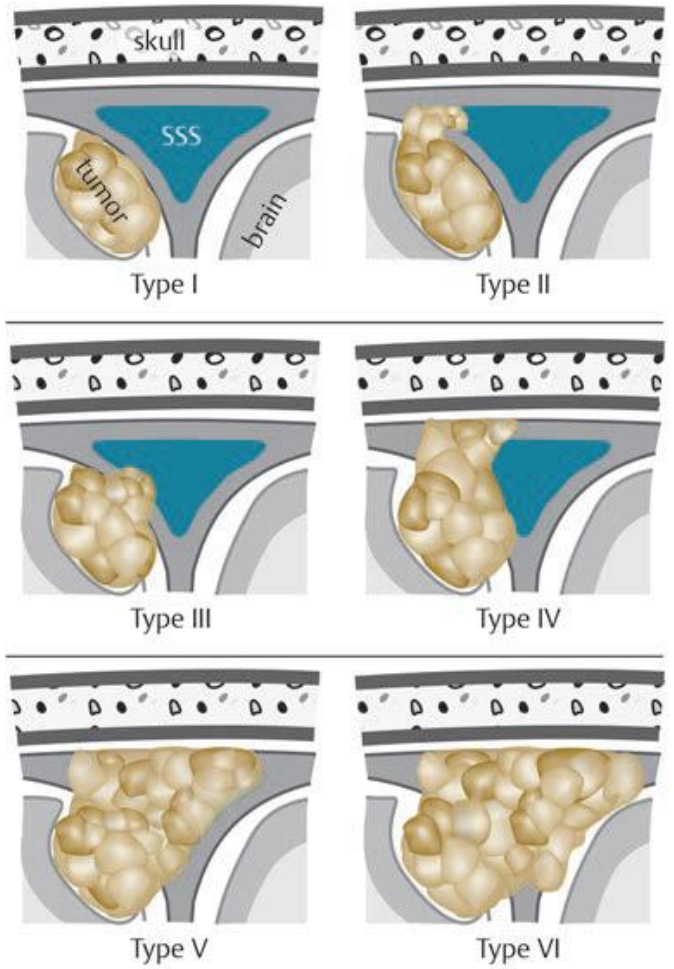
Parasagittal and falx meningiomas

- Anterior: present with H/A and mental status changes
- Middle: between coronal and lambdoidal sutures. Present as Jacksonian seizure & progressive monoplegia. (contralateral foot drop)
- Posterior: H/A, visual symptoms

Parasagittal and falx meningiomas

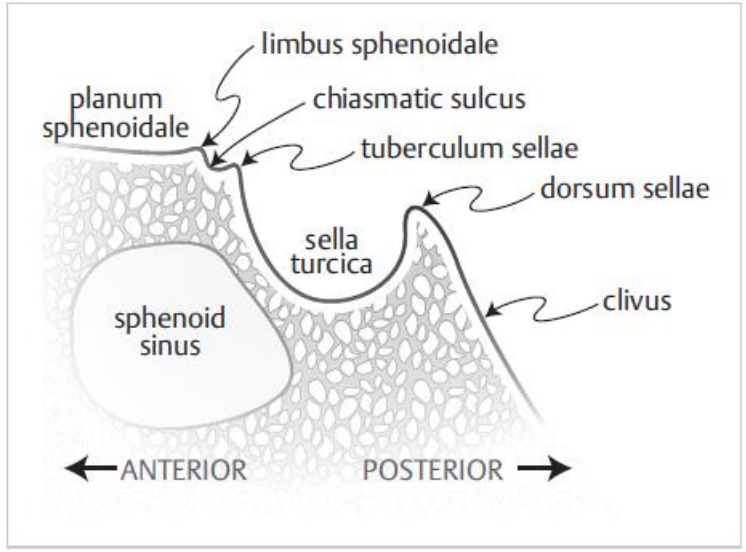
Sindou grading system for meningioma invasion of the superior sagittal sinus

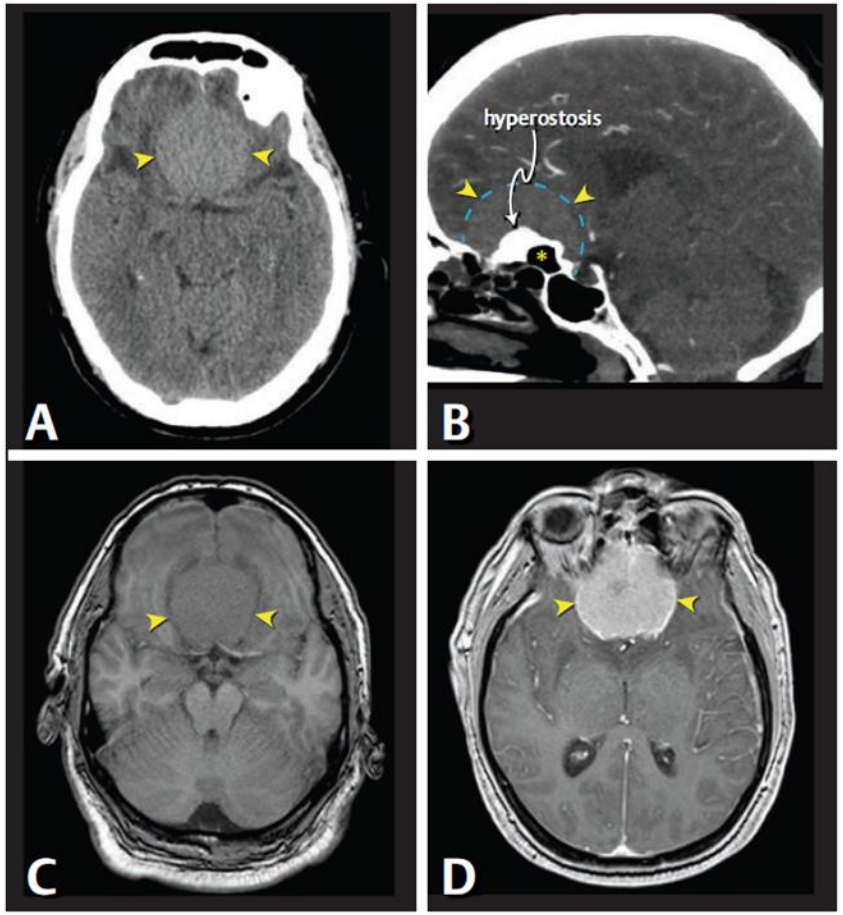
- Type I = attachment to lateral wall of sinus.
- Type II = invasion of lateral recess.
- Type III = invasion of lateral wall.
- Type IV = invasion of lateral wall and roof.
- Type V = total sinus occlusion, contralateral wall spared.
- Type VI = total sinus occlusion, invasion of all walls.



Planum sphenoidale meningiomas

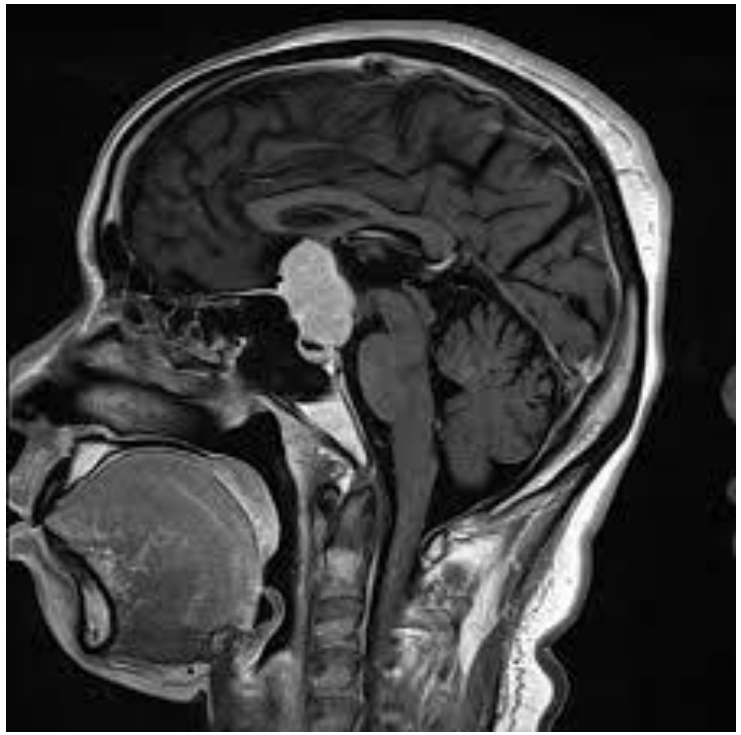
- Anterior fossa tumor
- Difficult to differentiate from olfactory groove meningiomas





Tuberculum sellae meningiomas (TSM)

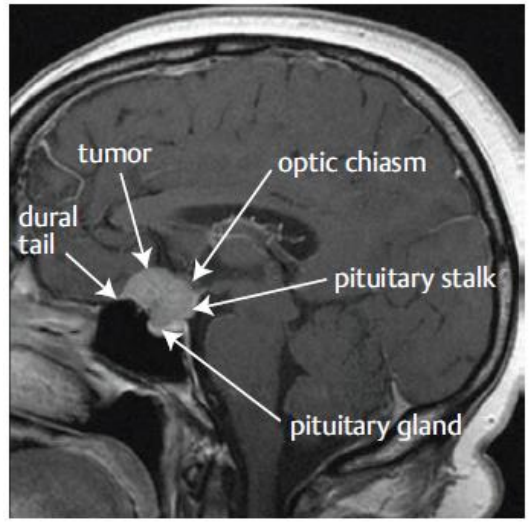
- Middle fossa tumor
- Producing visual loss (chiasmal syndrome = primary optic atrophy + bitemporal hemianopsia)
- May be mistaken for a pituitary macroadenoma

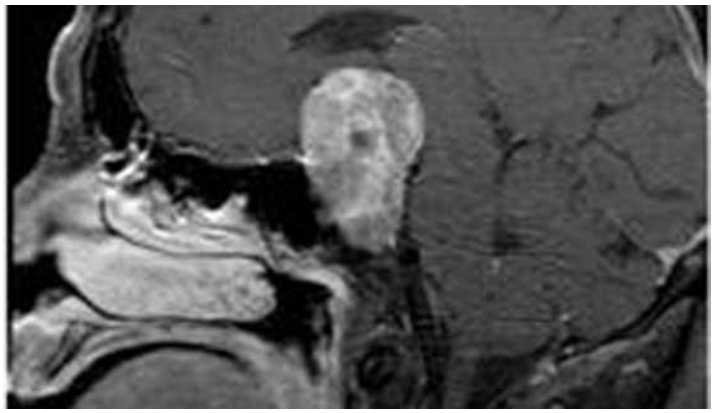


Tuberculum sellae meningiomas (TSM)

Features differentiating from pituitary adenoma

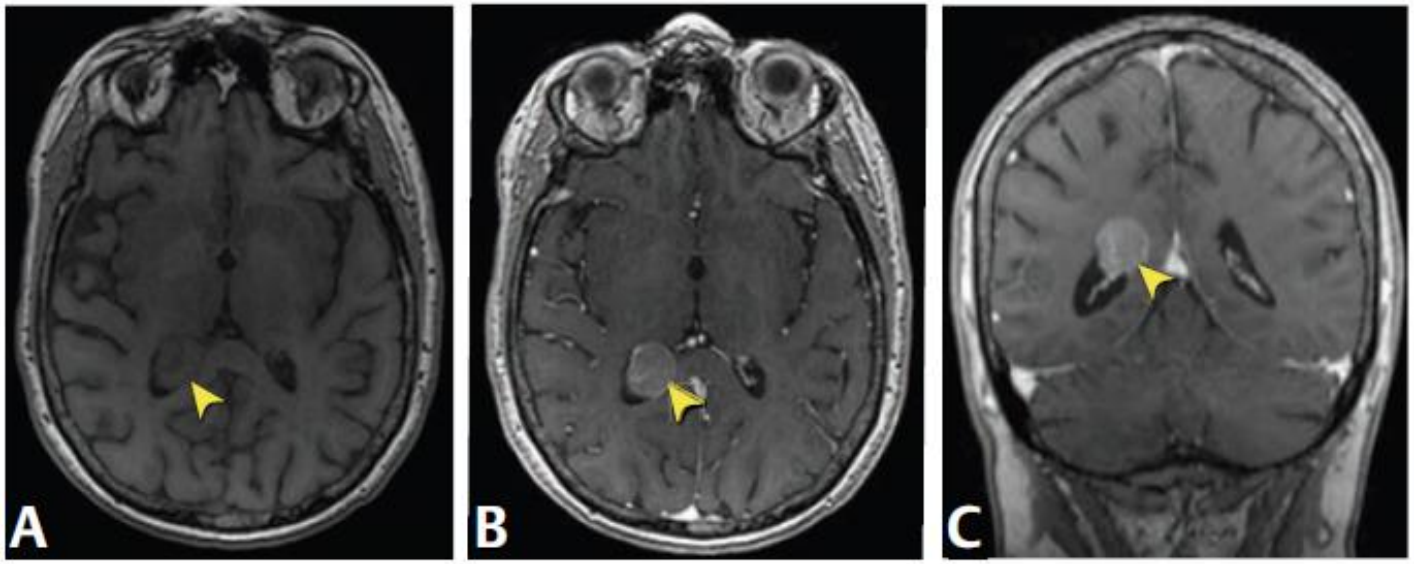
- Bright homogeneous enhancement
- Suprasellar epicenter
- Dural tail
- Sella is usually not enlarged
- No endocrine disturbances
- Intact sellar floor





Intraventricular meningiomas

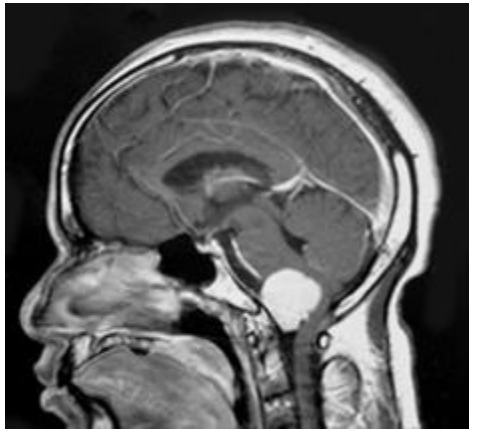
Most are located in the atrium of the lateral ventricle

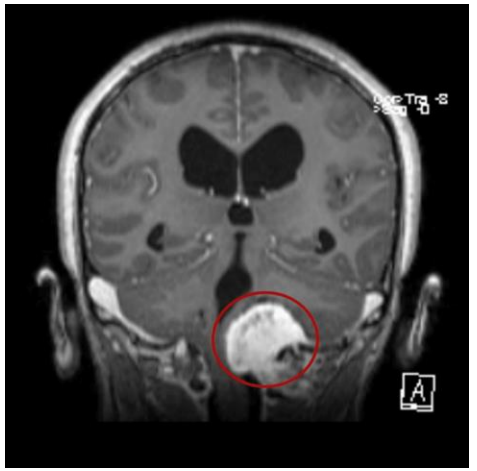


Foramen magnum meningiomas

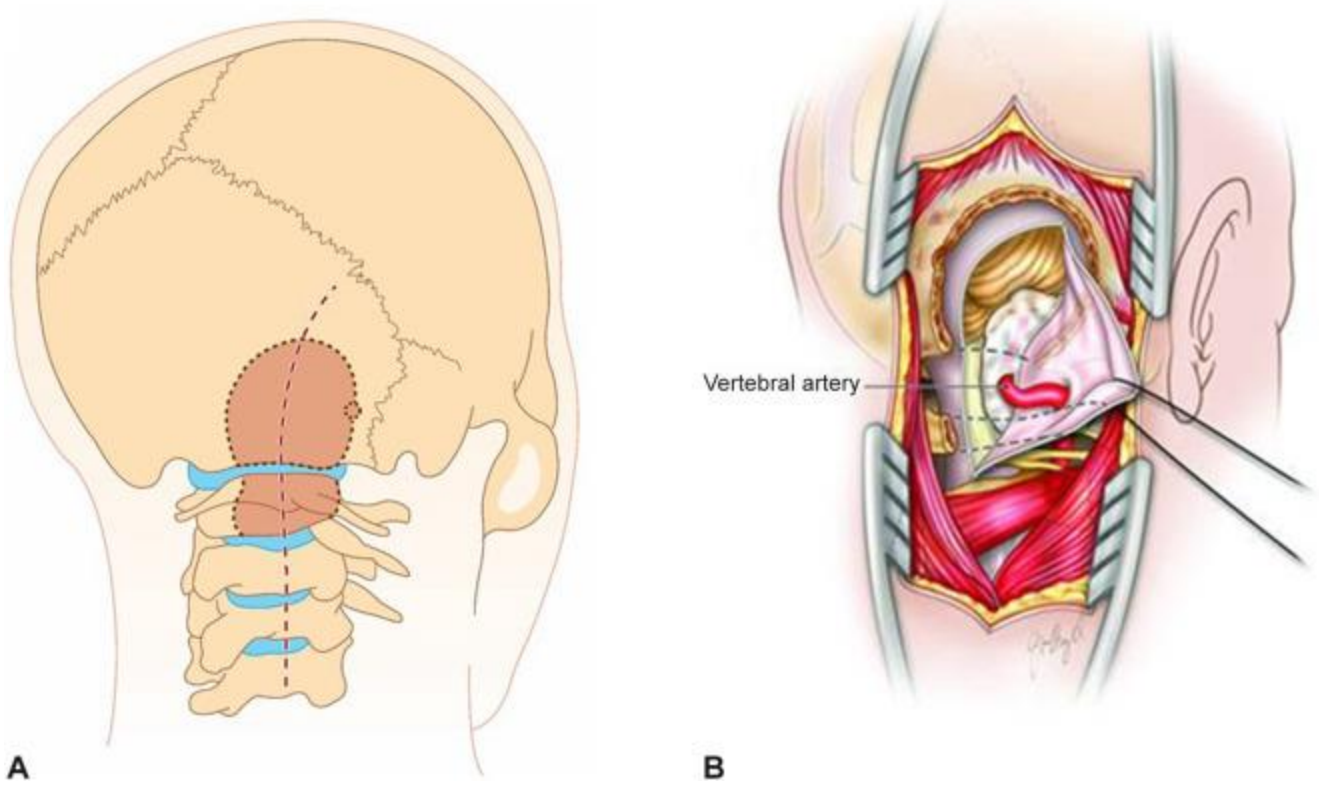
- 56% were lateral
- Most are intradural
- May be above, below, or on both sides of vertebral artery

- Craniocervical pain
- Dissociated sensory loss
- Rotating paralysis





Foramen magnum meningiomas

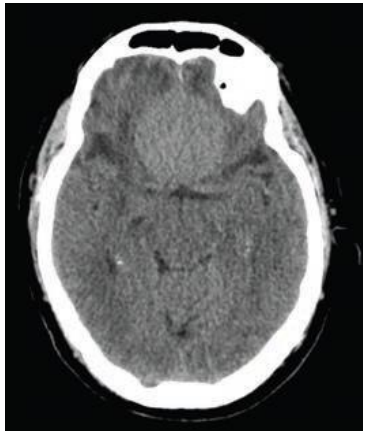


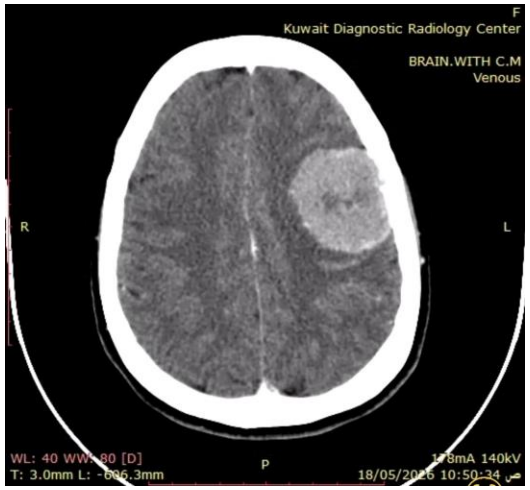
Evaluation

- Brain MRI, without and with contrast, is the diagnostic study of choice
- CT without and with contrast scan (second choice)
  - Calcification
  - Bone invasion
  - Surgical planning
- Angiography
  - Vessels location, encasement, Blood supply, Possibility of embolization, Dural sinus occlusion
- Metastatic workup: if metastasis is suspected

CT

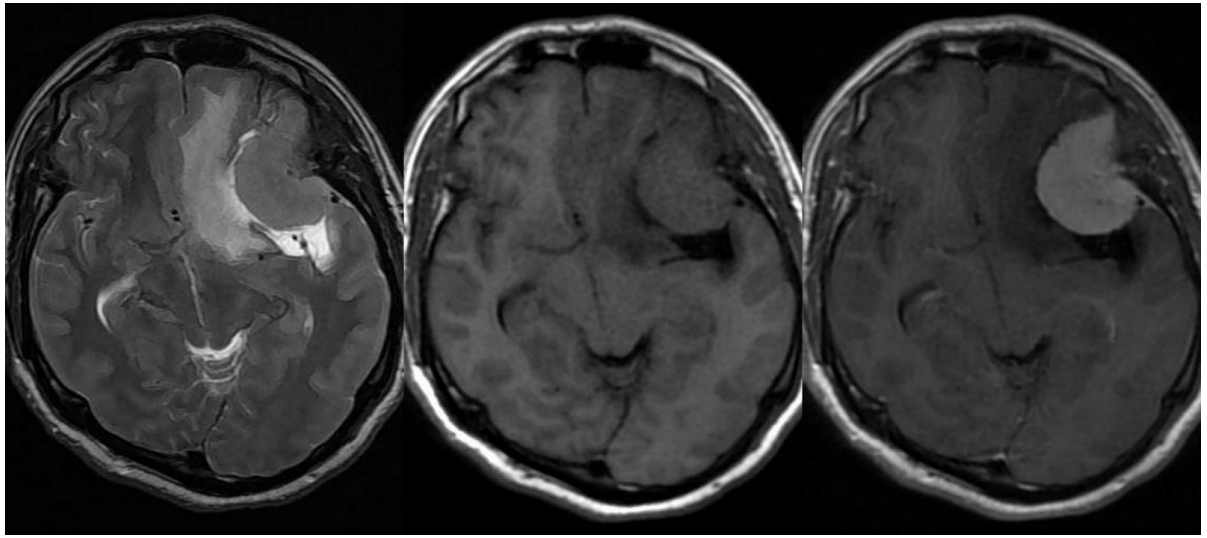
- Homogeneous, isodense or slightly hyperdense to brain
- 20-30% have areas of calcification
- Hounsfield numbers of 60–70
- Intense homogenous enhancement
- Prostate & Breast cancer may mimic meningioma





MRI

- Isointense to brain on T1 or T2 images (difficult to visualize)
- Intense homogenous enhancement
- Calcifications appear as signal voids
- Gives information regarding patency of dural venous sinuses



Characteristic findings on CT or MRI

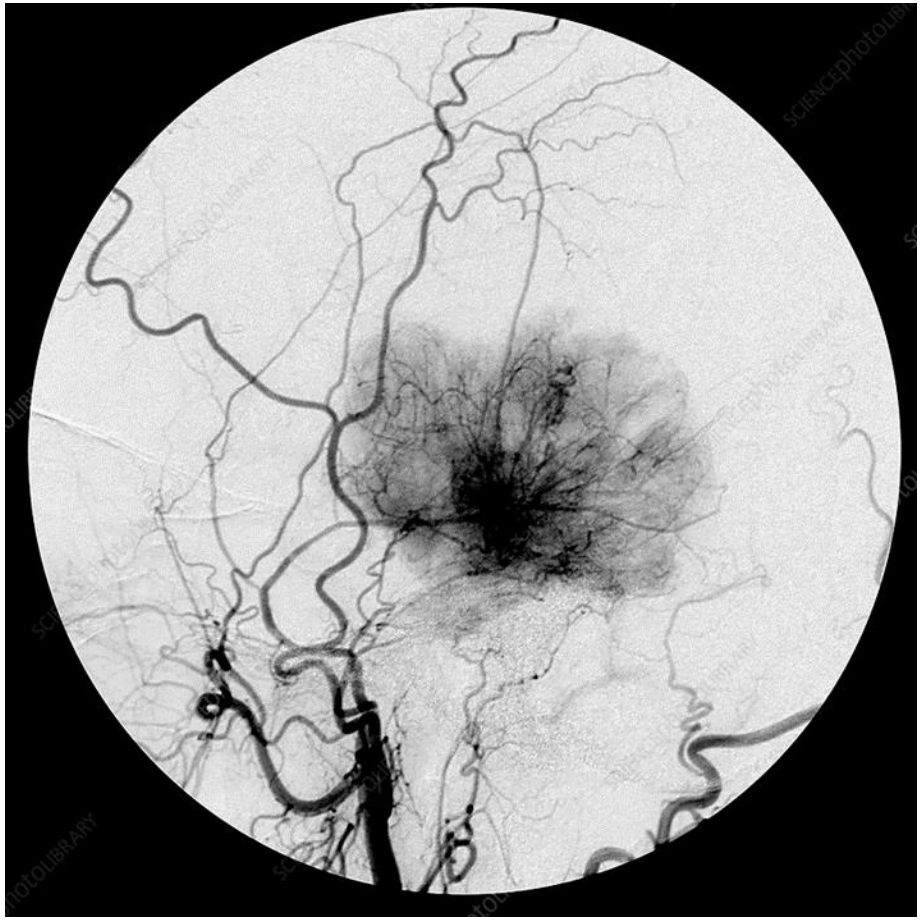
- Broad base of attachment
- Dural tail
- Hyperostosis (better on CT)
- Edema
- Enhancement

Angiography

- “comes early, stays late”. The "mother-in-law sign"
- Have external carotid artery, except:
  - Olfactory: from ethmoidal from ophthalmic
  - Suprasellar: from ophthalmic
  - Parasellar: from ICA
  - Petroclival: from the artery of the tentorium (a branch of the meningohypophyseal trunk) AKA the artery of Bernasconi & Cassinari (the “Italian” artery)
- Information about occlusion of dural venous sinuses
- Preop embolization

Angiography

External carotid arteriogram, lateral view, shows a large, vascular blush in the temporal region (meningioma)



Differential diagnosis

- Pleomorphic xanthoastrocytoma (PXA)
- Solitary fibrous tumor (formerly hemangiopericytoma)
- Gliosarcomas
- Metastatic Cancer: Breast, Prostate

- Note: Multiple meningioma → ? NF2

Indications for treatment

- Symptoms (not controlled)

- Significant growth on serial imaging studies (any of the next)
  - 2-5mm increase in diameter over 1 year
  - 1 cc increase in volume in 1 year
  - 15% increase in volume over 1 year

- Edema (more than minimal)

❑ Note: 32% of incidentally discovered meningiomas do not grow over 3 years follow-up

Treatment options

- Surgery:
  - The treatment of choice for accessible meningiomas
  - Morbidity rate is higher in > 70 years old (23%) than in those < 70 (3.5%)
- Radiation therapy (XRT):
  - For some cases: Gr 2 recurrence or incomplete resection, All Gr 3
  - Primary (not surgical candidates or for some deep tumors)
- Laser interstitial thermal therapy (LITT): used in recurrent tumor, in not surgical candidates, already given XRT
- Focused ultrasound (FUS): non-invasive, used for deep tumors

Surgery

The treatment of choice

G
T
R

Table 46.4 Simpson grading system for removal of meningiomas[50]

Grade	Degree of removal	Recurrence rate (%)
I	macroscopically complete removal with excision of dural attachment and abnormal bone (including sinus resection when involved)	9
II	macroscopically complete with endothermy coagulation (electrocautery or laser) of dural attachment	19
III	macroscopically complete without resection or coagulation of dural attachment or of its extradural extensions (e.g., hyperostotic bone)	29
IV	partial removal leaving tumor in situ	44
V	simple decompression (± biopsy)	N/A

- Simpson Grade 0 (Al-Mefty): Supratotal resection (GTR + 2 cm wide dural margin + bone clearance)

Surgery

Simpson Grade 0

› Neurosurgery. 1993 Sep;33(3):394-9; discussion 399. doi: 10.1227/00006123-199309000-00007.

Grade zero removal of supratentorial convexity meningiomas

T Kinjo [1], O al-Mefty, I Kanaan

Affiliations + expand

PMID: 8413869 DOI: 10.1227/00006123-199309000-00007

Surgery

General principles of meningioma surgery

- The head should be elevated ≈ 30° above the right atrium
- The craniotomy should be large enough (ideally 1-2cm beyond the tumor attachment)
- Early interruption of the arterial blood supply
- Avoid excessive retraction on the brain
  - ➢ Alternate internal decompression with surrounding dissection
- Removal of involved dura/ bone when possible (graft/ cr.plasty)
- Meningiomas are often very bloody
  - ➢ Preoperative embolization
  - ➢ Pre-op autologous blood donation

Surgery

Parasagittal and falx meningiomas

Location	Position	Skin incision
Anterior third	Supine semi-sitting position	Bicoronal skin
Middle third	Lateral position with the side of the tumor down, the neck tilted 45° toward the upward shoulder	Horseshoe incision based in the direction of the major scalp feeding vessels
Posterior third	Prone position	

- If SSS involved: It is almost always preferable to leave residual tumor and follow with serial imaging. If it grows, consider SRS therapy
- For tumors that cross the midline, burr holes are placed to straddle the SSS

Recurrence after surgery

- The extent of surgical tumor removal is the most important factor in the prevention of post-op recurrence

- The most powerful histopathologic predictor of recurrence is WHO grade

Postop Radiation therapy (XRT) suggestions

Fractionated therapy to a dose of 55–60 Gy

Grade 1		Grade 2		Grade 3
GTR	FU	New + GTR	FU	XRT
STR	FU	New + STR	XRT	
STR + progressive growth	Surgery	Recurrent	XRT	
STR + progressive growth & surgery is not an option (Pt not tolerating, not willing, not accessible tumor)	XRT			

Prognosis

- 5-year survival for patients with meningioma: 91.3%

- With anaplastic meningiomas, median survival ranges from < 2 years to > 5 years depending on completeness of removal and use of adjuvant XRT

Thanks



Any Questions?