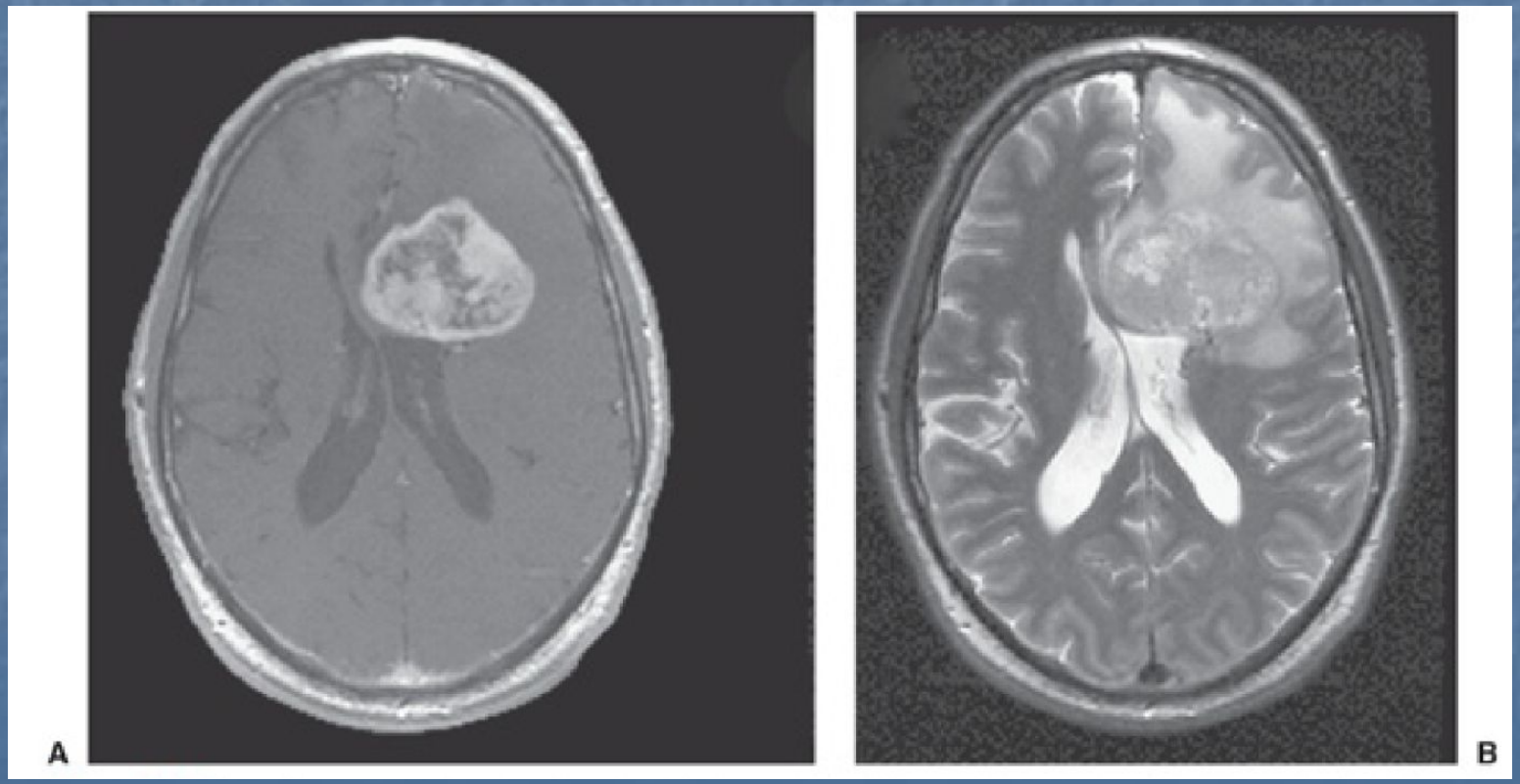
NEURO-ONCOLOGY

- Primary tumor
  - brain
  - spinal
- Secondary tumor
  - brain
  - spinal
- Paraneoplastic syndrome

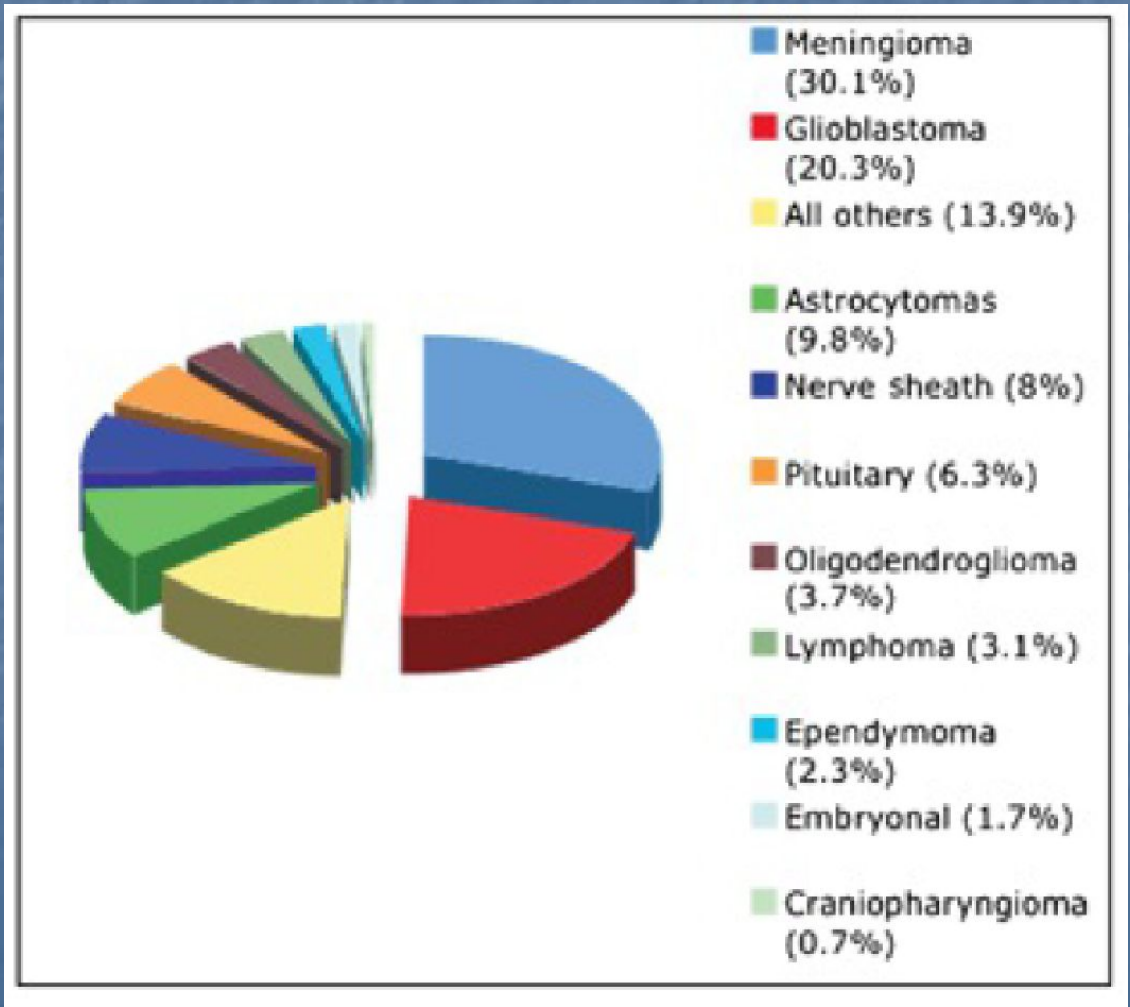
Imaging for Brain Tumors

- **Skull X-rays:**
  - Rarely necessary.
  - Useful in demonstrating calcification, erosion, or hyperostosis
- **CT:** *Most widely used for diagnosis of brain tumors*
  - Will detect >90% of tumors, but might miss:
    - Small Tumors (<0.5 cm)
    - Tumors Adjacent to bone (pituitary adenomas, clival tumors, and vestibular schwannomas)
    - Brain Stem Tumors
    - Low Grade Astrocytomas
  - More sensitive than MRI for detecting acute hemorrhage, calcification, and bony involvement
- **MRI:** *Nowadays the "golden standard" for diagnosis and follow-up of most brain tumors*
  - More sensitive than CT scans
  - Can detect small tumors
  - Provides much greater anatomic detail
  - Especially useful for visualizing skull base, brain stem, & posterior fossa tumors

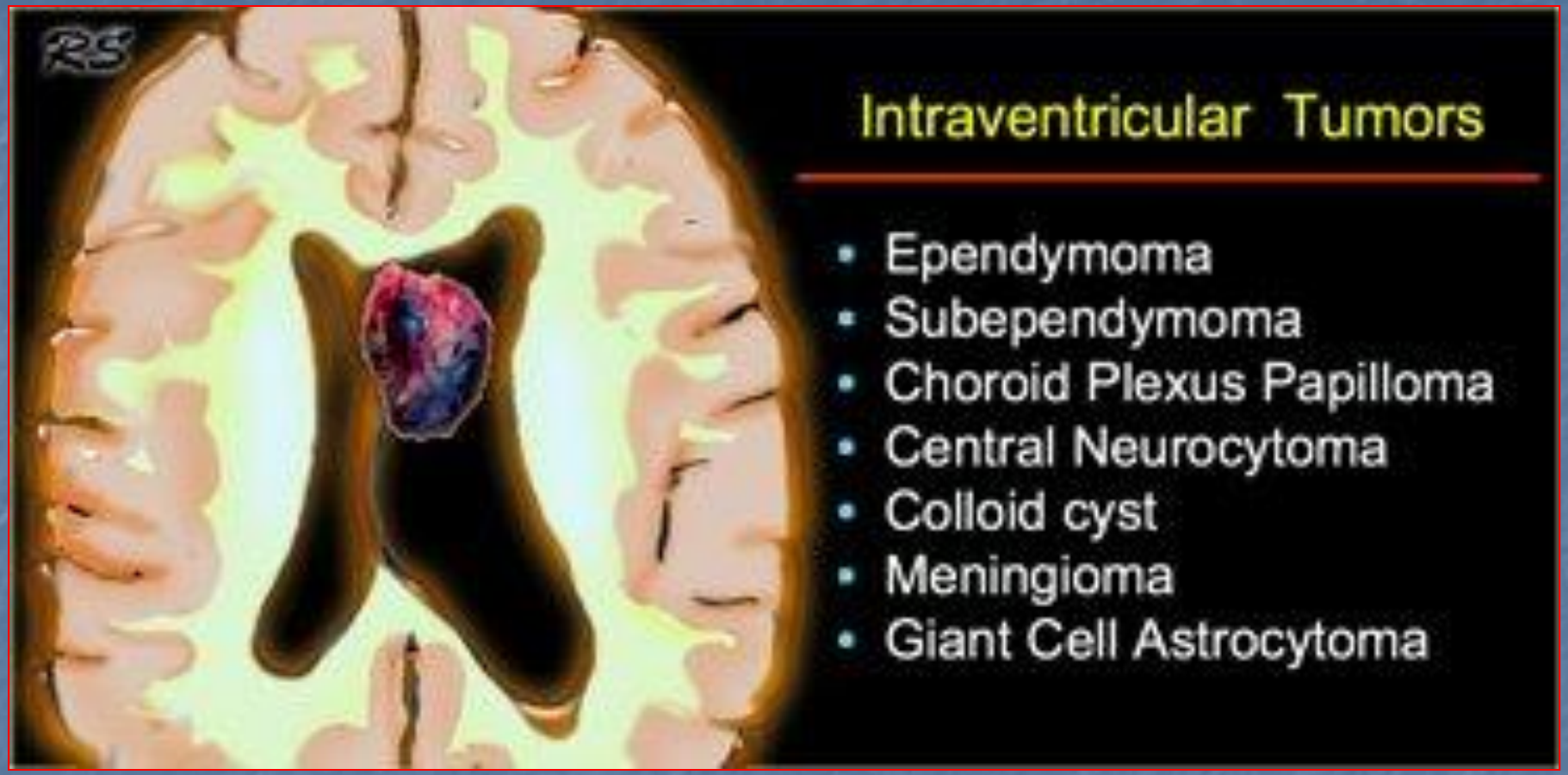
MRI brain T1 vs T2



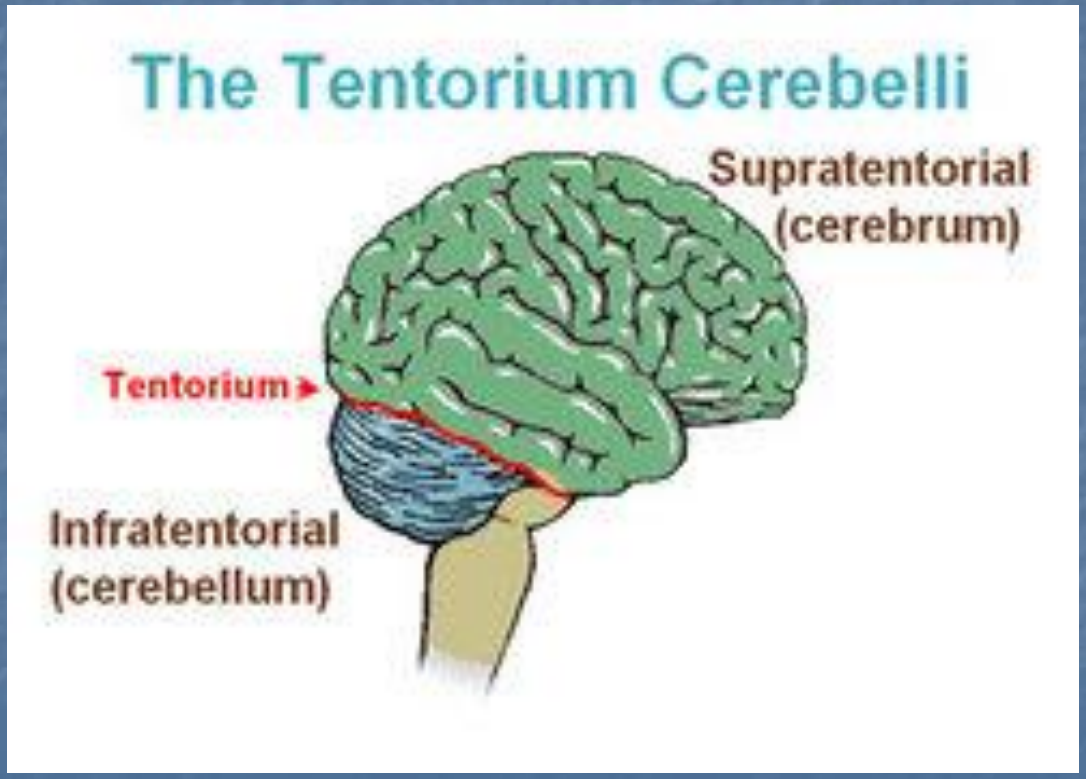
Epidemiology



TUMOR	CHILDHOOD, PERCENT	ADULT, PERCENT	OLDER ADULT, PERCENT
Neuroepithelial tumors (glial origin)	78.1	44.6	41.9
Pilocytic astrocytoma	19.8	0.7	0
Glioblastoma	3.8	23.2	29.3
Malignant glioma	8.9	1.5	3.1
Diffuse astrocytoma	1.5	0.8	0.6
Anaplastic astrocytoma	2.5	4.4	2.7
Other astrocytoma	9.2	4.1	3.8
Oligodendroglioma	2.3	3.4	0.7
Anaplastic oligodendroglioma	0.8	1.5	0.4
Ependymomas	6.4	0.5	0.4
Mixed glioma	0.8	1.1	0.2
Embryonal/primitive/ medulloblastoma	16.0	0.5	0
Meningeal tumors	4.3	29.9	39.6
Meningioma	3.1	28.4	39.1
Hemangioblastoma	0.8	1.2	0.4
Lymphoma	0.5	2.4	2.7
Sellar tumors	6.4	8.7	3.9
Pituitary adenoma	0.8	8.0	3.8
Craniopharyngioma	3.6	0.6	0
Cranial and spinal nerve tumors	2.0	11.3	3.4
Germ cell tumors	4.3	0	0
Local extension from regional tumors	0.5	0.2	0
Unclassified	3.8	2.8	8.5
Total	100.0	100.0	100.0


Intraventricular Tumors
Ependymoma
Subependymoma
Choroid Plexus Papilloma
Central Neurocytoma
Colloid cyst
Meningioma
Giant Cell Astrocytoma

Infratentorial vs Supratentorial Tumors



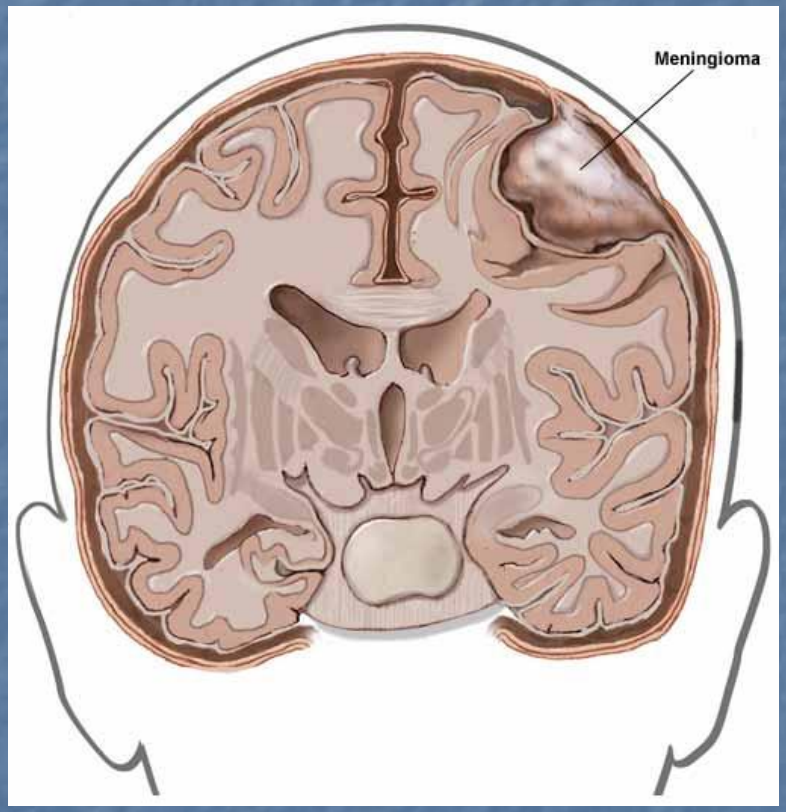
infratentorial

Common Intra-Axial Tumors in Adult

Supratentorial:	Infratentorial:
Metastases ++	**Metastases ++++**
Gliomas (25%) • Fibrillary Astrocytoma • Anaplastic Astrocytoma • Glioblastoma Multiformi • Oligodendroglioma	Hemangioblastoma

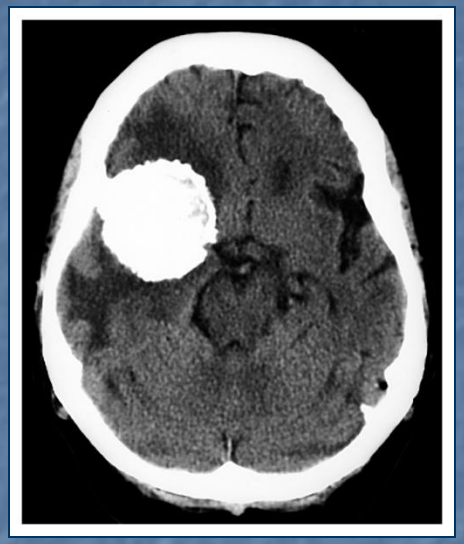
MENINGIOMA[1,2,3]

- Epi:
  - 2nd most common primary brain tumor after gliomas, incidence of ~ 6/100,000
  - Usual age 40-70
  - F>M
- Facts:
  - Arise from arachnoidal cap cell type from the arachnoid membrane
  - Usually non-invasive
  - Associated with NF-2
- Location:
  - Parasagittal region
  - Sphenoid wing
  - Parasellar region
- Presentation:
  - Asymptomatic
  - Symptomatic: focal or generalized seizure or gradually worsening neurologic deficit

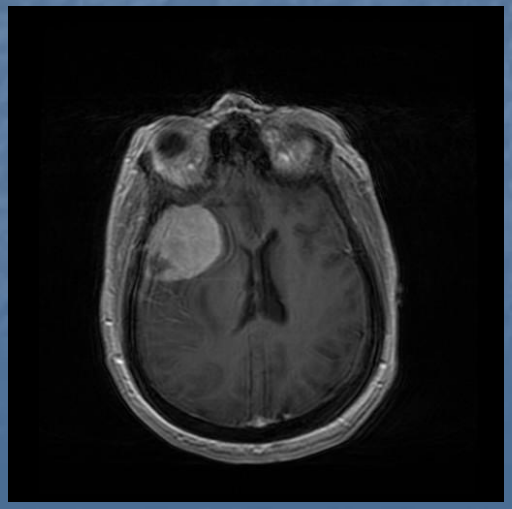


MENINGIOMA

- On Imaging
  - CT:
    - isodense or hypodense,
    - homogenous extra-axial mass with smooth or lobulated, clearly demarcated contours which enhance homogenously and densely with contrast
    - Frequently have areas of calcification and produce hyperostosis of adjacent bone.



- MRI
  - Isointense with gray matter on T1 images
  - Enhance with contrast – often with enhancing dural trail extending from the tumor attachment

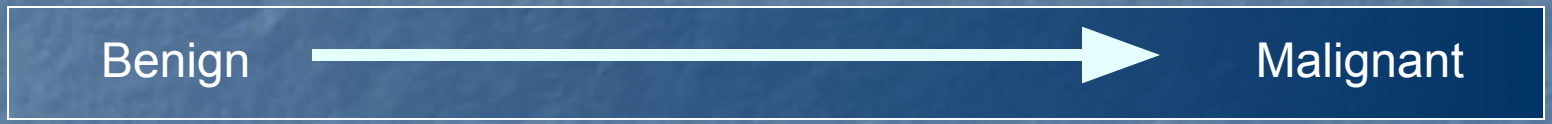


GLIOMAS

Arise from Glial Cells

- Astrocytomas

  Astocytomas fall on a gradient that ranges from benign to malignant



Low Grade Pilocytic Astocytomas

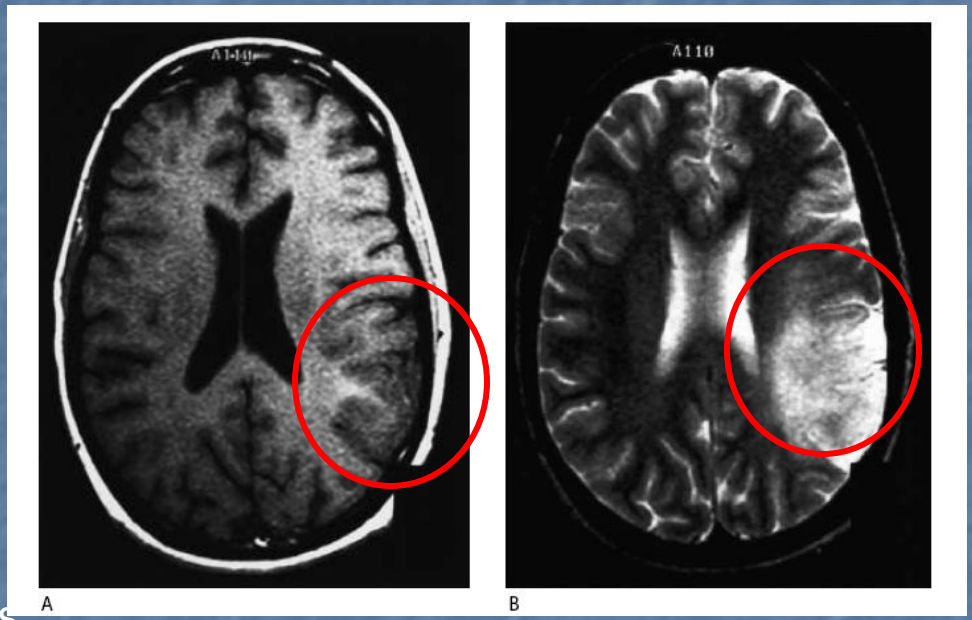
Diffuse Low Grade Astrocytomas

Glioblastoma multiforme

- Oligodendrogliomas

Diffuse Low Grade Astrocytoma

- Epi:
  - 15% of Astrocytomas
  - Young Adults
- Facts:
  - Widely Infiltrate surrounding tissue
- Location:
  - Frontal Region
  - Subcortical white matter
- Presentation:
  - Seizures
  - Headache
  - Slowly progressive neurologic deficits
- On Imaging:
  - CT: Well circumscribed, non enhancing, hypodense or isodense lesion
  - MRI: MRI more sensitive than CT – useful for identification and establishing extent
    - T1 image shows abnormal areas of decreased signal
    - T2 image shows abnormal areas of increased signal
    - Usually no enhancement



T1 weighted T2 weighted

High Grade glioma: Glioblastoma

- Epi:
  - The 2-nd place of primary brain tumor in adults
  - Age of presentation: 40-60, M>F
- Facts:
  - May arise de novo or evolve from a low-grade glioma
  - Tumor infiltrates along white matter tract and can cross corpus callosum
  - Poor Prognosis
  - Can look like a butterfly lesion
- Location:
  - Frontal & Temporal Lobes
  - Basal Ganglia
- Presentation:
  - Seizures,
  - Headache
  - Slowly progressive neurologic deficits

High Grade glioma: Glioblastoma

- On Imaging: *Variable*
  - CT:
    - Hypodense or Isodense
    - Central hypodense area of necrosis surrounded by thick enhancing rim
    - Surrounding edema
  - MRI:
    - T1 image shows low signal intensity
    - T2 image shows high signal intensity

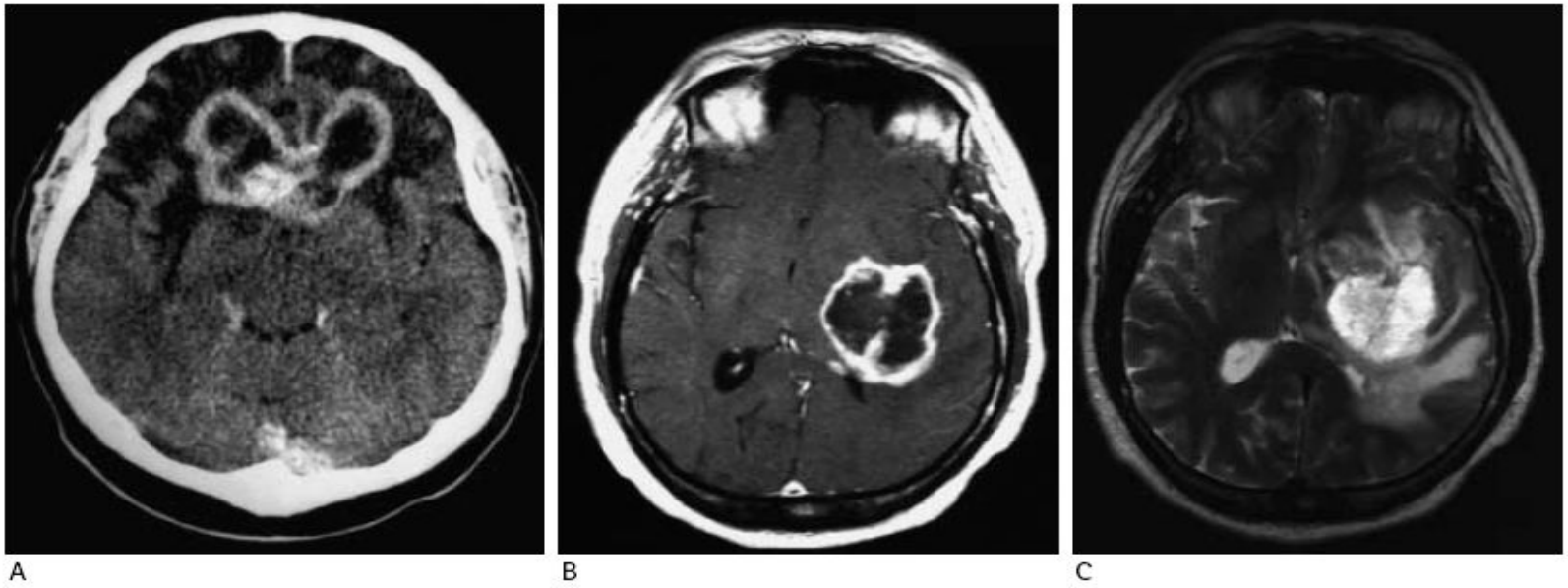
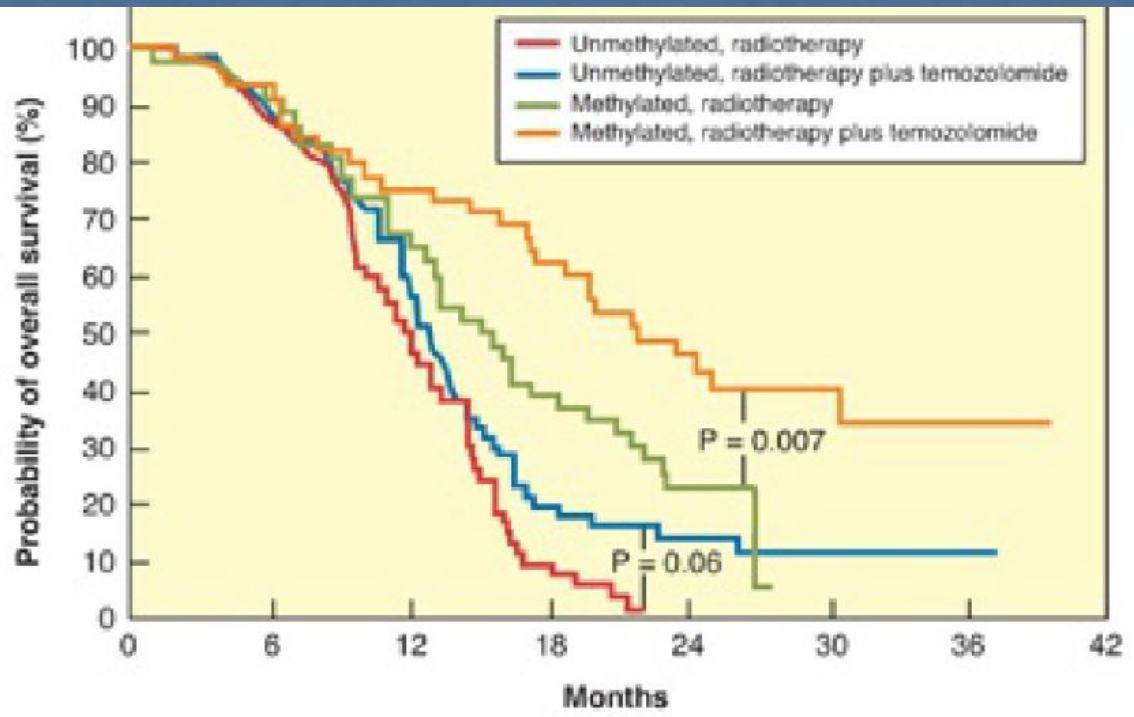


Figure 11.12 Glioblastoma. (A) Contrast enhanced CT scan showing a ring enhancing lesion involving the corpus callosum and both frontal lobes with surrounding edema (butterfly glioma). (B) Contrast enhanced axial MRI showing a glioblastoma in the left mesial temporal lobe. (C) Axial T_2-weighted image of the same tumor showing the surrounding edema.

High Grade glioma: Glioblastoma

Treatment: steroids
surgical removal
radiotherapy
chemotherapy (temozolomide)
anticonvulsive drugs

Survival



Number at risk							
Unmethylated, radiotherapy	54	47	25	5	0	0	0
Unmethylated, radiotherapy plus temozolomide	60	53	34	11	7	4	1
Methylated, radiotherapy	46	42	30	18	8	0	0
Methylated, radiotherapy plus temozolomide	46	42	34	28	16	7	1

OLIGODENDROGLIOMA

- Epi:
  - 5-10% of primary brain tumors
  - Mean age of onset 40 years
- Facts:
  - Distinguished pathologically from astrocytomas by the characteristic "fried egg" appearance.
  - Arises from Myelin
- Location:
  - Superficially in Frontal Lobes
- Presentation:
  - Seizures most common
  - Headache
  - Slowly progressive neurologic deficits

OLIGODENDROGLIOMA

- On Imaging:
  - CT:
    - Well circumscribed, hypodense lesions with heavy calcification
    - Cystic degeneration is common but hemorrhage & edema are uncommon
  - MRI:
    - Hypointense or isointense on T1-weighted images
    - Hyperintense on T2-weighted images with variable enhancement

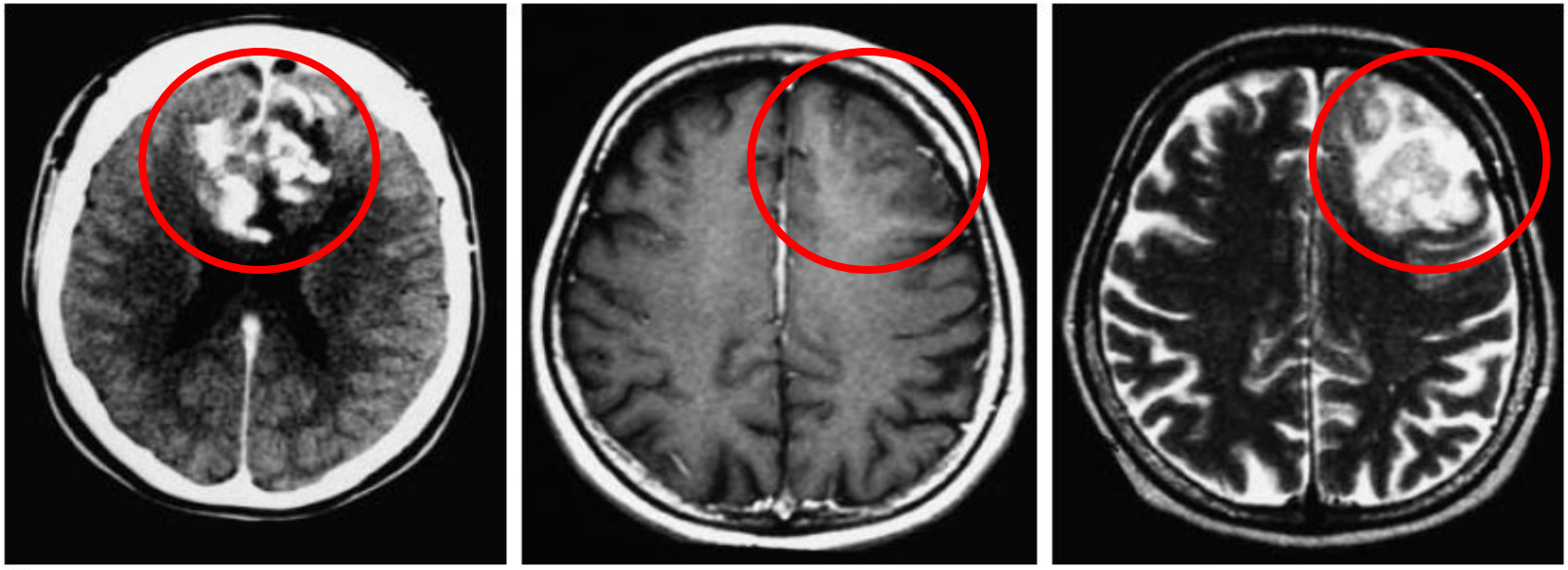


Figure 11.14 Oligodendroglioma. (A) Enhanced postoperative CT scan showing showing large residual tumor involving the corpus callosum and both frontal lobes with areas of heavy calcification. (B) Axial MRI with gadolinium showing a non-enhancing left frontal oligodendroglioma which is much better seen on (C) axial T_2-weighted image.

OLIGODENDROGLIOMA

Treatment:

Surgical excision

radiation therapy

anticonvulsive drugs

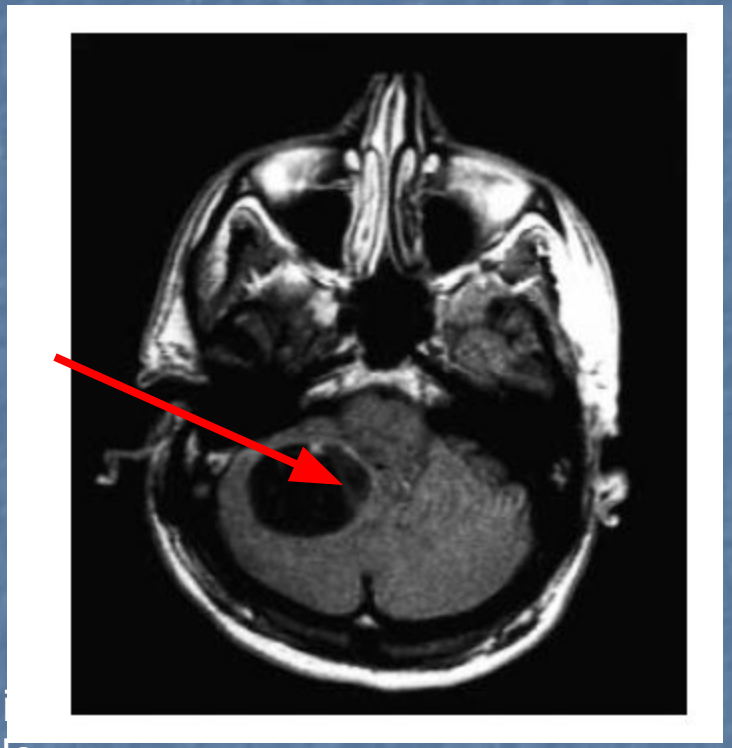
The median survival over 7 years.

INFRATENTORIAL TUMORS

- Choroid plexus papillomas
- Cerebellar astrocytomas
- Medulloblastomas
- Hemangioblastomas
- Ependymomas
- Brainstem gliomas
- Schwannomas
- Pituitary adenomas
- Craniopharyngiomas

CEREBELLAR ASTROCYTOMA

- Epi:
  - Most often occurs in childhood
- Facts:
  - Most potentially curable of the astrocytomas
- Location:
  - Posterior Fossa
- Presentation:
  - Headaches
  - Nausea/Vomiting
  - Gait Unsteadiness
  - Posterior head tilt with caudal tonsillar herniation
- On Imaging:
  - CT or MRI:
    - Tumor arising from vermis or cerebellar hemi
    - Large cyst with single enhancing mural nodule

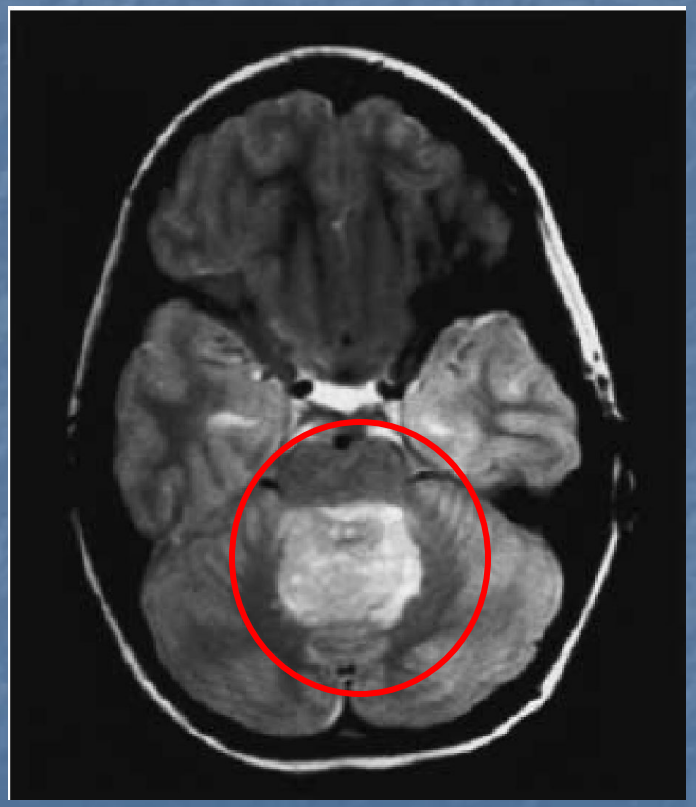


MEDULLOBLASTOMAS

- Epi
  - Represent 7% of primary brain tumors
  - 2nd most common posterior fossa tumor in children
  - 70% of patients are diagnosed prior to age 20 with peak incidence between 5-9 years of age;
- Facts
  - Primitive neuroectodermal tumors (PNET)
  - Soft, friable tumors, often necrotic
  - Can metastasize via CSF tracts
  - Highly radiosensitive
- Location
  - About 75% arise within the cerebellar vermis
- Presentation
  - Most frequently present with signs of intracranial pressure
  - Cranial nerve deficits may also occur

MEDULLOBLASTOMAS

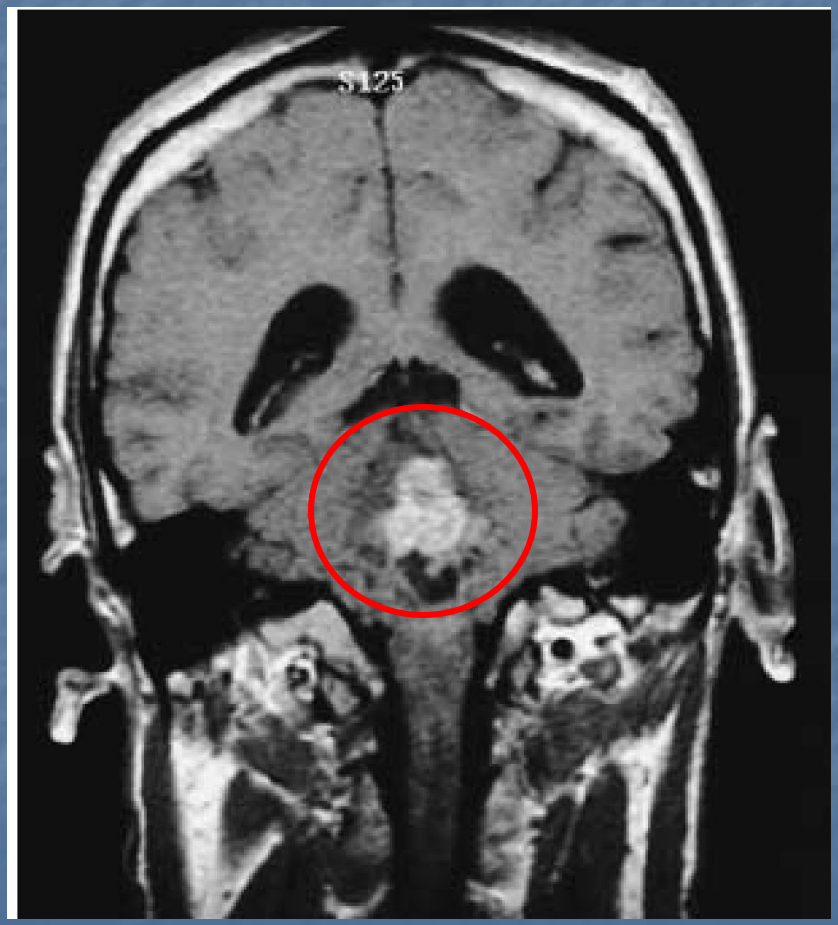
- Imaging
  - MRI reveals a contrast-enhancing midline or paramedian tumor which often compresses the 4th ventricle;
  - Gadolinium enhancement will most likely be heterogeneous and may show evidence of necrosis, hemorrhage, or cystic change;



EPENDYMOMAS

- Epi
  - Accounts for 10% of CNS lesions;
  - Male=Female
  - Median age at diagnosis is 5 years old
- Facts
  - Derived from primitive glia
  - Overall survival at 10 years is 45-55%
- Presentation
  - Most patients present with symptoms of increased intracranial pressure
- Location
  - Typically arise within or adjacent to the ependymal lining of the ventricular system.
  - In children, 90% are intracranial with 60% arising in posterior fossa (4^{th} ventricle is the most common infratentorial site)
  - Most common spinal cord glioma (in adults, 75% arise within spinal cord);;

EPENDYMOMA

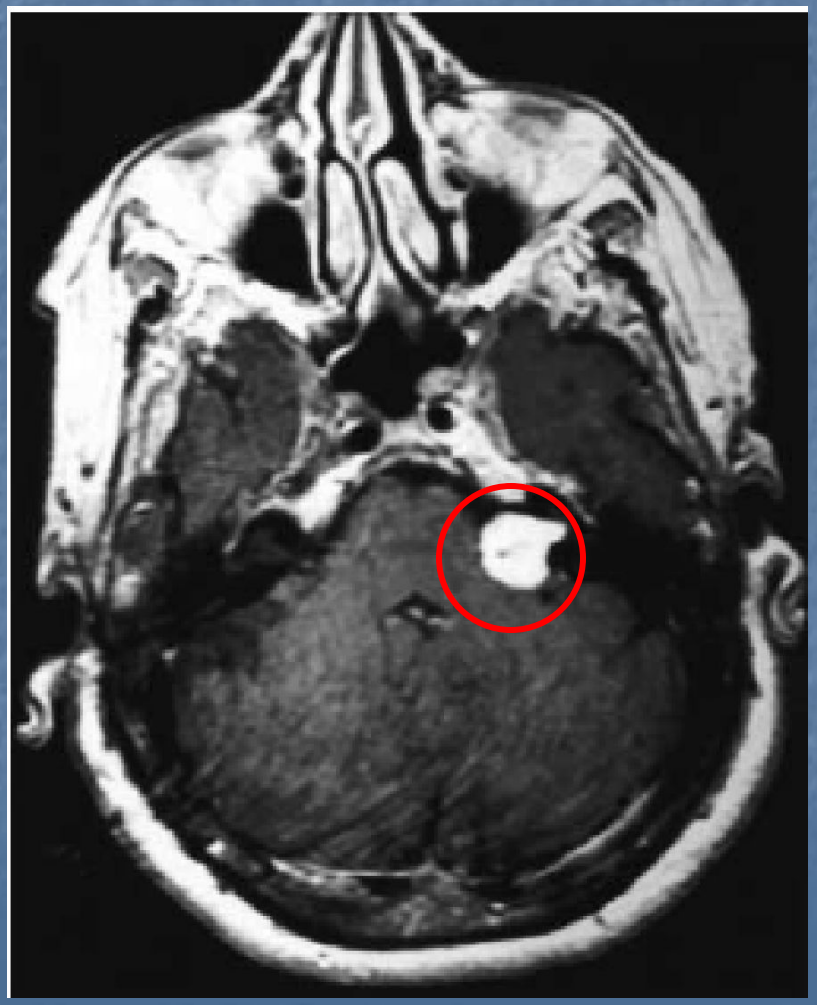


- Imaging
  - Usually well demarcated with frequent areas of calcification, hemorrhage, and cysts;
  - CT: Appear hyperdense with homogeneous enhancement
  - MRI: ependymomas have a hypointense appearance on T1 and are hyperintense on T2;

SCHWANNOMAS

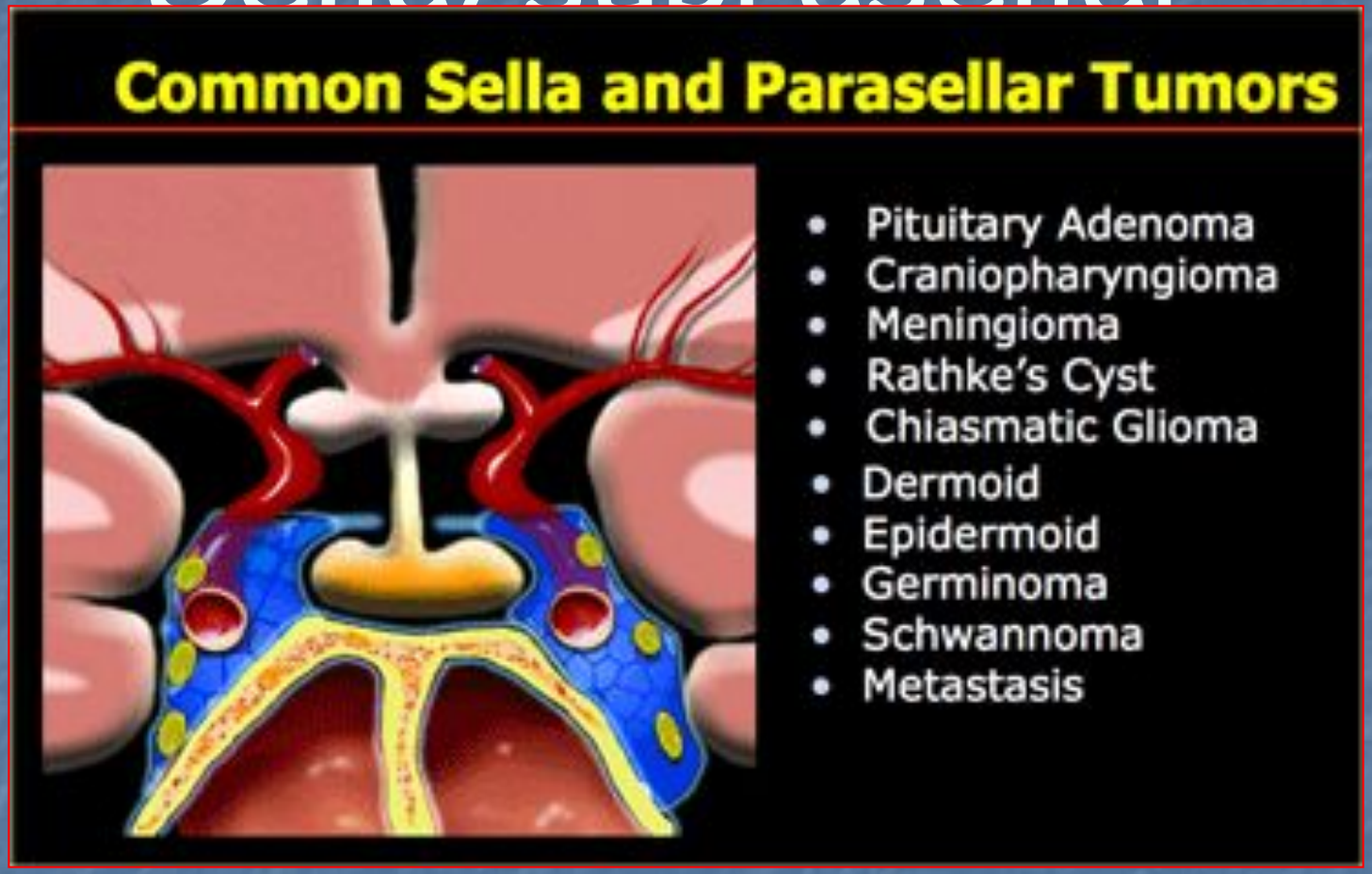
- Epi
  - Female>male
  - Median age at diagnosis is 50
  - Account for 80-90% of cerebellopontine angle tumors
  - Comprise 8% of intracranial tumors in adults; rare in children (except with NF-2)
- Facts
  - Unilateral in 90% of cases (R=L);
  - Bilateral acoustic neuromas are diagnostic of NF-2;
- Presentation
  - Patients may present with asymmetric sensorineural hearing loss, tinnitus
  - Fluctuating unsteadiness while walking, vertigo (although only 1% of patients with vertigo had schwannomas);
  - If CN V nerve is affected, facial numbness, pain, and hyperesthesia may be present;
  - If CN VII is affected, facial paresis may be present.
  - Tumor progression may lead to compression of brainstem or cerebellum leading to ataxia, tonsil herniation, and hydrocephalus
- Location
  - Arise from vestibular division of CN VIII; majority benign

SCHWANNOMAS



- Imaging
  - MRI: with gadolinium is more sensitive in detection of Schwannomas (when compared to CT); it can detect tumors as small as 1-2 mm; seen as enhancing lesion in the region of CPA;
  - Fine-cut CT through internal auditory canal can detect large or medium tumors.

Sella/suprasellar



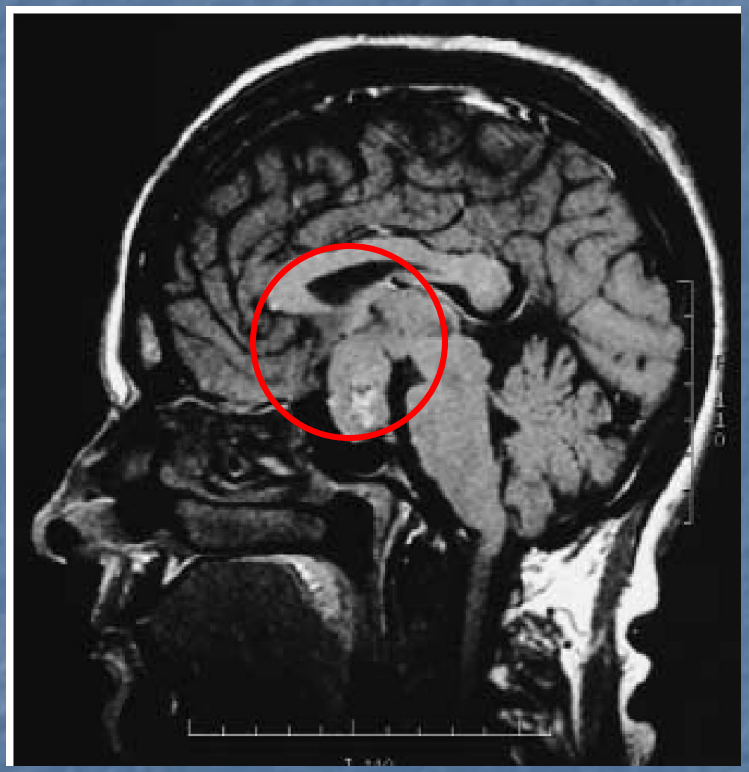
In this region it is important to keep the possibility of an aneurysm in the differential diagnosis

PITUITARY ADENOMAS

- Epi
  - Most common tumors of pituitary gland
  - Represent 8% of primary brain tumors
- Facts
  - Out of pituitary adenomas, prolactinomas are the most common;
- Presentation
  - May cause hypopituitarism and visual field defects;
  - Patients should have endocrine, radiographic, and ophthalmologic assessments.

PITUITARY ADENOMAS

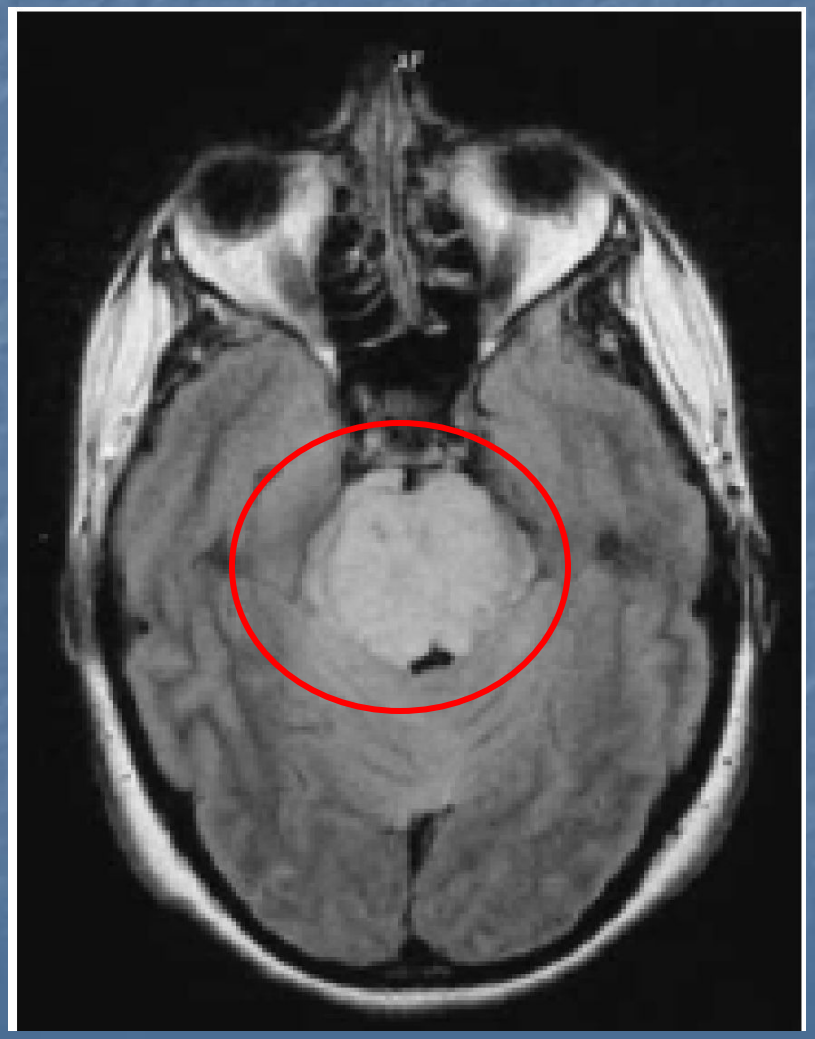
- Imaging:
  - Plain x-ray may show an enlarged sella turcica;
  - CT scan will detect only large adenomas; it will show a large hyper- or isodense lesion;
  - MRI is the imaging of choice;
    - Microadenomas (lesions <1 cm) will be seen as a low intensity lesions on T1;
    - Gadolinium will enhance the normal gland that is adjacent to adenoma
    - Macroadenomas will appear as isointense on T1 and will enhance uniformly with gadolinium



BRAINSTEM GLIOMAS

- Epi
  - Male=Female
  - Account for 10-20% on all CNS tumors
  - More common in children (account for 20% of all intracranial neoplasms under the age 15);
  - In children, median age at diagnosis is 5-9 years of age.
- Facts
  - NF-1 is the only known risk factor
  - Mostly benign (but range from benign to very aggressive);
  - Long term survival for low-grade gliomas is near 100%.
- Location
  - In peds, 80% arise in pons, with 20% arise in medula, midbrain, and cervicomedulary junction;
- Presentation
  - Most patients with low-grade brainstem gliomas have a long history of minor signs and symptoms;
  - May present with neck pain or torticollis;
  - Medulary tumors may present with cranial nerve palsies, dysphagia, nasal speech and apnea, n/v, ataxia,or weakness;
  - May cause “locked-in” syndrome

BRAINSTEM GLIOMAS



- Imaging
  - MRI is the method of choice to image those tumors (brainstem glioma appears isodense on CR and can be missed);
  - Appear isointense or hypointense on T1 images, hyperintense on T2, and inhance uniformly and brightly with IV contrast;

4th ventricle

- In adults tumors in the 4th ventricle are uncommon.
- Metastases, followed by hemangioblastomas, choroid plexus papillomas and dermoid and epidermoid cysts.

Metastatic tumors

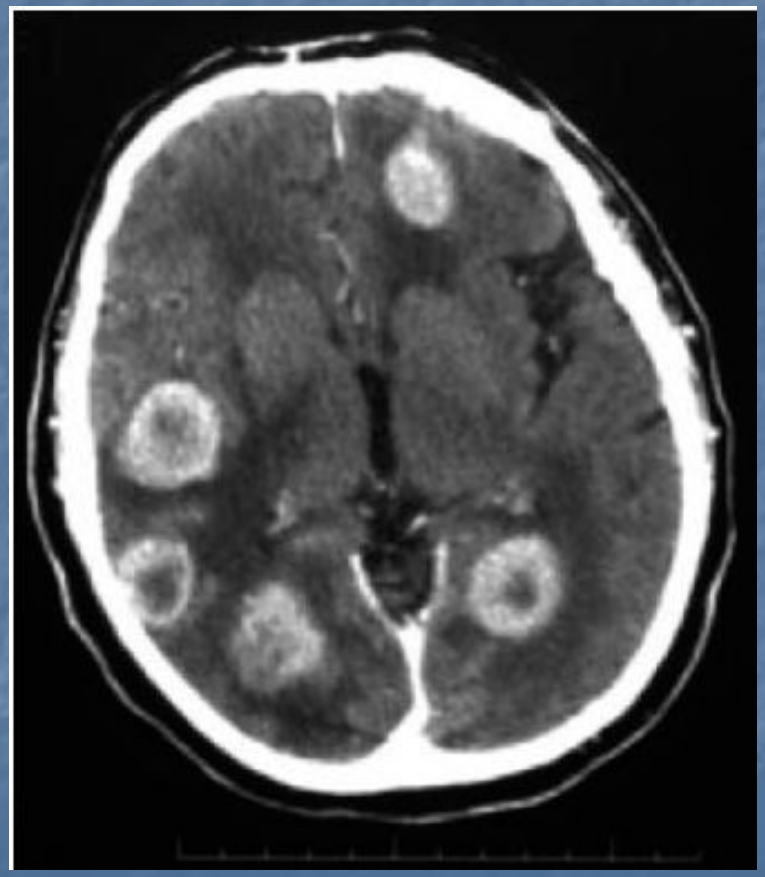
- Parenchymal meta – most common masses in the in supratentorial and infratentorial spaces (more supra)
- 50% solitary, 50% multiple, 20% 2 lesions
- Origin – lung, (50%), breast (15%) melanoma(11%), kidney, GIT
- Cystic meta- ovary, breast, GIT

Hemorrhagic meta

- Breast
- Choriocarcinoma
- lung
- Melanoma
- RCC
- Thyroid
- retinoblastoma

Secondary tumors-MTS

- Lung cancer (NSCCa)
- Breast cancer
- Melanoma
- Kidney
- Thyroid



Carcinomatous Meningitis

(Meningeal Carcinomatosis)

Dissemination of tumor cells throughout the meninges and ventricles.

5 percent of cases of adenocarcinoma of breast, lung, and gastrointestinal tract; melanoma; childhood leukemia; and systemic lymphoma.

Manifestations:
Polyradiculopathies (particularly of the cauda equina), multiple cranial nerve palsies, and a confusional state.

Treatment
Radiation therapy to the symptomatic areas (cranium, posterior fossa, or spine),
Intraventricular/intratecal methotrexate

Multiple brain tumors can be seen in phacomatoses:

- Neurofibromatosis II: meningiomas, ependymomas, optic nerve gliomas, choroid plexus papillomas
- Tuberous Sclerosis: subependymal tubers, intraventricular giant cell astrocytomas, ependymomas
- von Hippel Lindau: hemangioblastomas