BRAIN TUMORS

LECTURE OUTLINE

- Introduction
- Epidemiology and risk factors
- Classification
- Clinical manifestations
- Common brain tumors
- Investigations and management

INTRODUCTION

- Brain tumors are a diverse group of intracranial neoplasms.
- They can be divided into primary or secondary (metastatic).
- They can also be divided into benign or malignant.
- Brain tumors can be deadly, significantly impact quality of life.

EPIDEMIOLOGY

- • The incidence of brain tumors varies between countries ranging between 5-18/100,000.
- • Almost 15% of the cases will affect the child age group.
- • Most cases of brain tumors are benign.
- • Secondary brain tumors are more common than primary.

RISK FACTORS

- • Genetic predisposition (LiFraumeni, VHL, NF)
- • Exposure to radiation
- • Certain types of viral infections (CMV, EBV)
- • Immunosuppression
- • Racial and ethnic differences
- • Trauma (meningioma)

CLASSIFICATION

- 1) Tumors of neuroepithelial tissue:

A. Astrocytic tumors
B. Oligodendroglial tumors
C. Oligoastrocytic tumors
D. Ependymal tumors
E. Choroid plexus tumors
F. Neuronal and mixed neuronal-glial tumors
G. Tumors of the pineal region
H. Embryonal tumors
I. Others neuroepithelial tumors.

CLASSIFICATION

- 2) Tumors of cranial nerves (Schwanoma, Neurofibroma, Perineuroma)
- 3) Meningeal tumors (Meningioma)
- 4) Lymphomas and hematopoietic neoplasms (Malignant lymphoma and plasmacytoma)
- 5) Germ cell tumors (Germinoma, Teratoma)
- 6) Tumors of sellar region (Craniopharyngioma)
- 7) Metastatic tumors (Lung, Breast, Colon, Kidney)

CLINICAL MANIFESTATIONS

- Most of the time, brain tumors follow a course dependent on their nature (Benign vs. Malignant, Low-grade vs. High grade).
- Patients with brain tumors may present with generalized and/or focal signs and symptoms or they may be asymptomatic.
- These symptoms vary according to the size and location of the tumor.
- Absence of symptoms is more common with low-grade tumors and small lesions without surrounding edema.

CLINICAL MANIFESTATIONS

1) Headaches:

- Headache is a common manifestation of brain tumors and a presenting symptom in up to half of patients.
- Conversely, brain tumors are an uncommon cause of headaches
- Headaches associated with brain tumors are usually dull and constant, symptom severity tends to progress over time.
- Worse in the AM and made worse with straining or coughing.

CLINICAL MANIFESTATIONS

2) Seizures:

- New onset seizures are another common manifestation of primary and metastatic brain tumors.
- Low-grade tumors are more likely to cause seizures than high-grade tumors.
- The clinical manifestations of focal seizures depend upon tumor location (Frontal vs Occipital vs Temporal).
- Focal-onset seizures in any location can evolve into bilateral tonic-clonic seizures.
- Both primary and metastatic brain tumors can cause status epilepticus.

CLINICAL MANIFESTATIONS

3) Symptoms of raised ICP:

- Increased ICP can arise either from a large mass or from restriction of cerebrospinal fluid (CSF) outflow causing hydrocephalus.
- Symptoms may be subtle or consist of the classic triad of headache, nausea, and papilledema.
- A significant rise in ICP can temporarily decrease cerebral perfusion, leading to loss of consciousness.

CLINICAL MANIFESTATIONS

4) Focal deficits:

- Muscle weakness
- Cortical sensory deficits
- Visual spatial dysfunction
- Cognitive dysfunction
- Aphasia

METASTATIC TUMORS

- Most common intra-cranial tumor in adults (~50% of all brain tumors).
- 80% are hemispheric, often at grey-white matter junction or temporal-parietal-occipital lobe junction.
- Most common cancers that metastasize to the CNS include lung (mc), breast, colon, melanoma, kidneys, testicles.
- They commonly spread through the hematogenous route.
- In general, brain metastases are associated with poor prognosis.

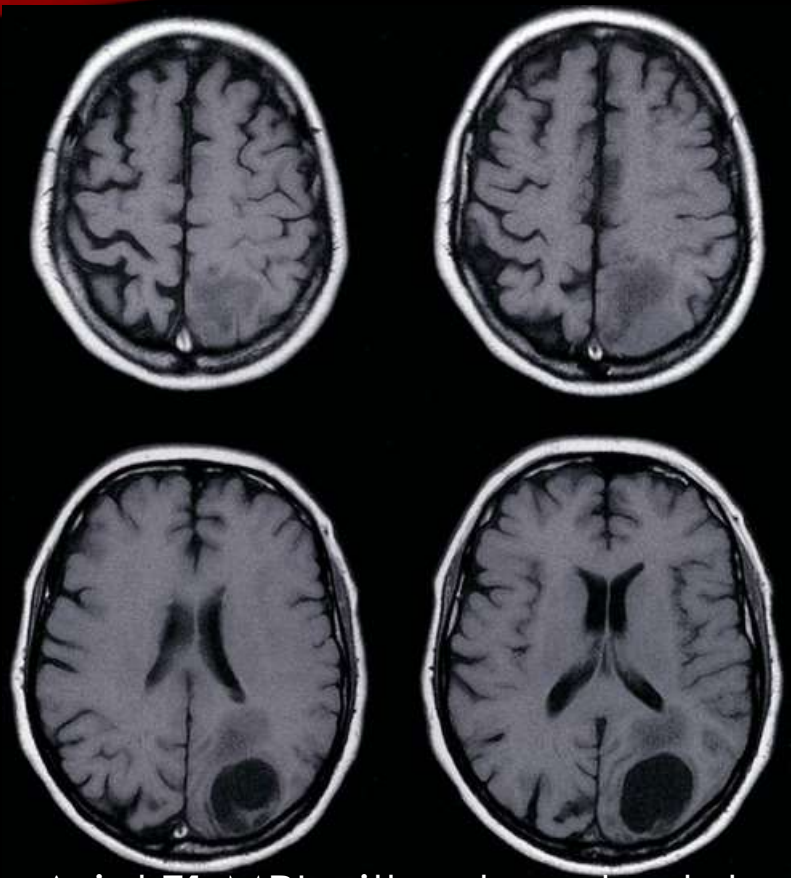
METASTATIC TUMORS

- Investigations:

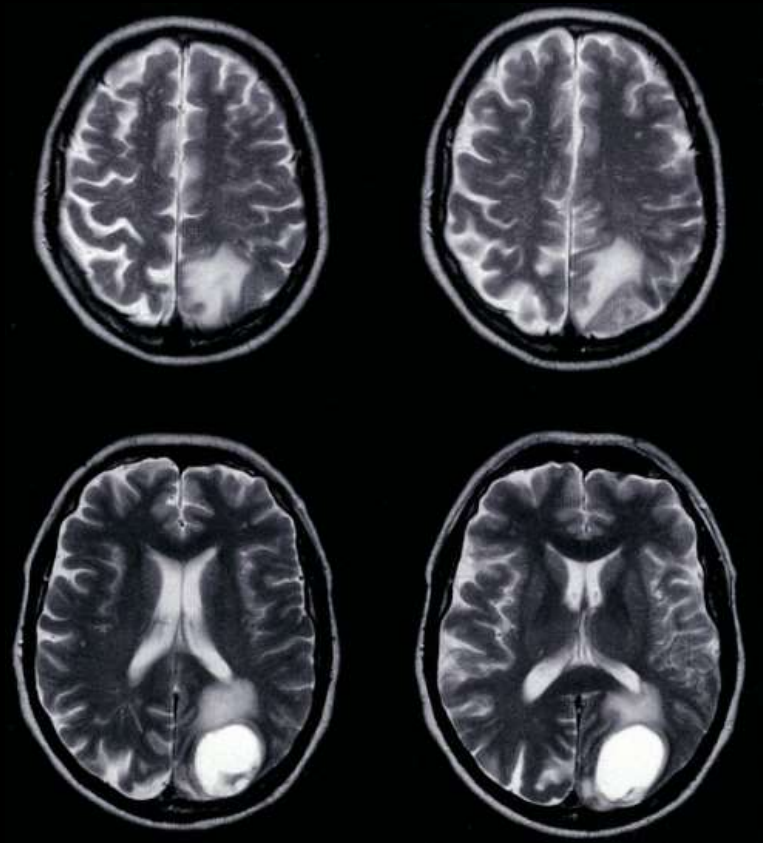
- Full metastatic workup (CXR, CT chest/abdo, abdominal U/S, PET scan, mammograms) To identify the primary tumor*.
- CT with contrast (round, multiple, well-circumscribed, ring enhancing lesions, with surrounding edema).
- Contrast (Gadolinium) -enhanced MRI more sensitive, especially for posterior fossa.

* Consider brain biopsy in unusual cases or if no primary tumor identified.

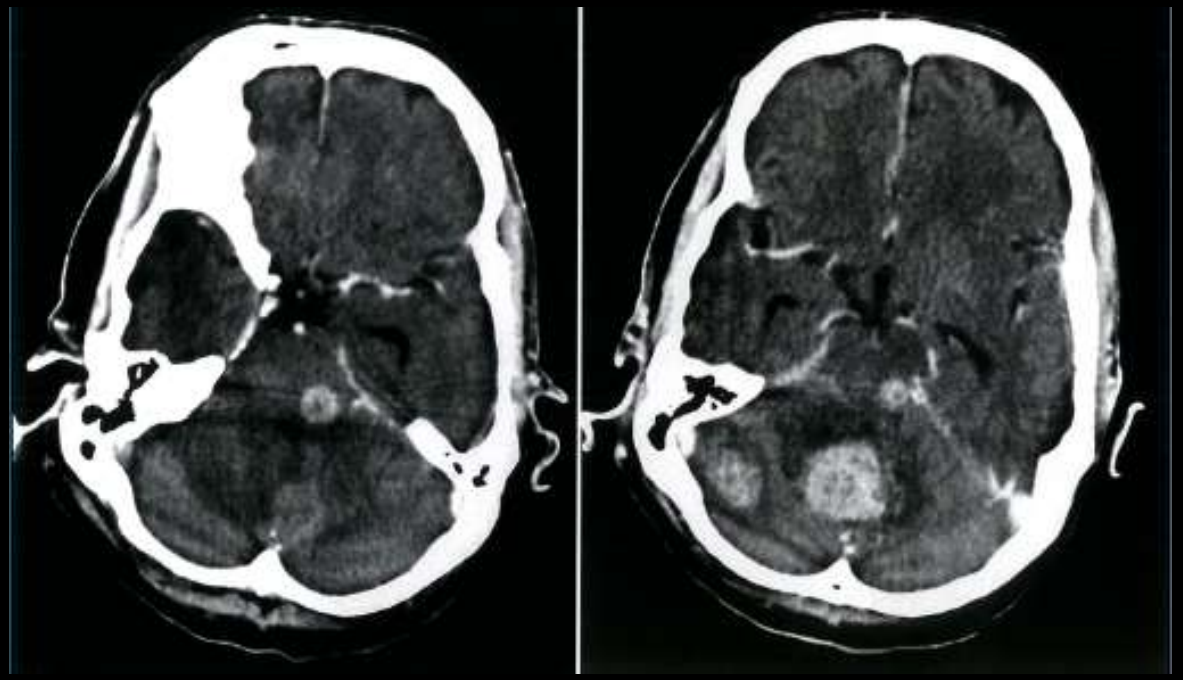
CEREBRAL METASTASIS IN LUNG CARCINOMA



Axial T1 MRI without contrast showing A solitary, well-circumscribed, predominantly hypointense mass in the left occipital lobe is accompanied by perifocal edema.



Axial T2 MRI without contrast showing A solitary, well-circumscribed, predominantly hyperintense mass in the left occipital lobe is accompanied by perifocal edema.



Axial CT with contrast showing cerebellar and brainstem lesions that show intense contrast enhancement in a lung cancer patient.

METASTATIC TUMORS

- Management:

- Medical treatment: steroid (eg dexamethasone) to reduce tumor edema and ICP, AEDs (eg phenytoin), chemotherapy.

- Radiation therapy (emerging evidence supports avoidance of whole brain radiation and use of focal radiation to spare cognitive functions).

- Surgical resection in carefully selected patients.

- Prognosis:

- vary based on primary tumor.

PRIMARY BRAIN TUMORS

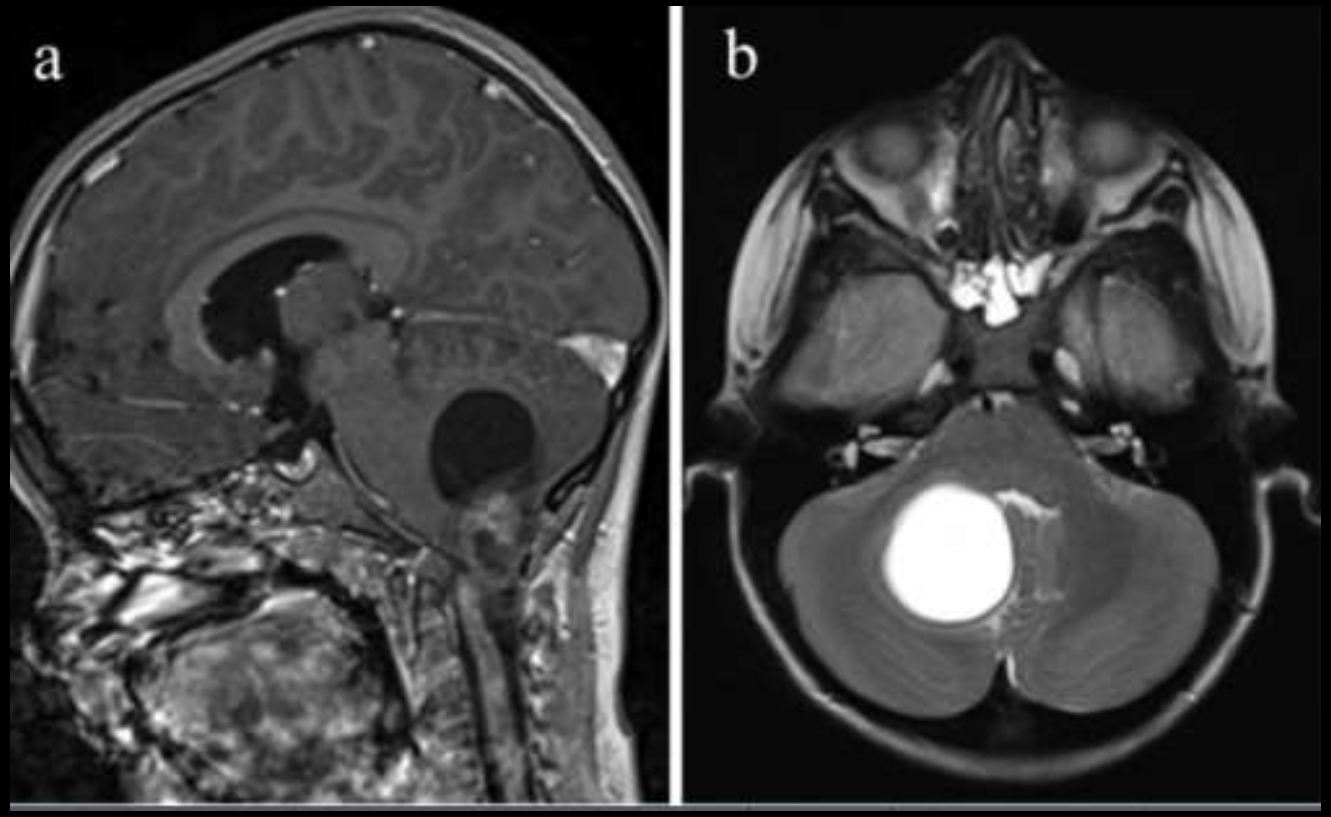
1. ASTROCYTOMA

- The most common primary intra-axial brain tumor, this tumor is derived from astrocytes (a type of glial cells).
- Astrocytoma's vary in terms of malignancy, from low grade to high grade.
- People can develop astrocytoma's at any age. The low-grade type is more often found in children or young adults, while the high-grade type is more prevalent in adults.

GRADE 1 PILOCYTIC ASTROCYTOMA

- They are considered benign tumors, occurring mostly in children.
- Often associated with NF1.
- They usually present as cystic lesions in the cerebellum (ie infratentorial).
- They could occur in young adults in areas like the brain stem
- Prognosis: favorable
- Survival rate >10 years, cure if total resection.

GRADE 1 PILOCYTIC ASTROCYTOMA



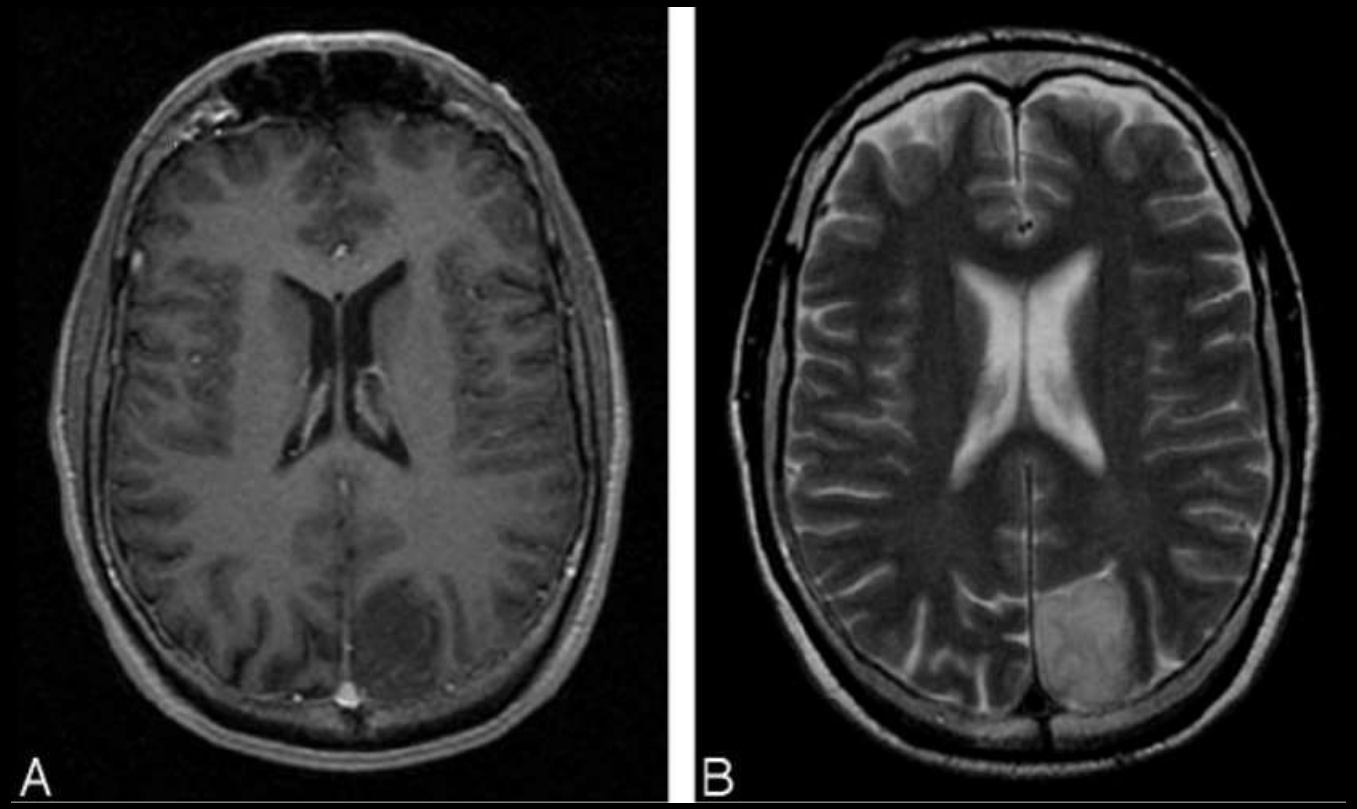
MRI head (a: T1-weighted; with contrast; sagittal plane; b: T2-weighted; axial plane) of a child
A large lesion in the right cerebellar hemisphere displaces the vermis to the left of midline (T1 hypointense and T2 hyperintense) and a heterogeneously enhancing solid nodular component (green overlay).

Cerebellar pilocytic astrocytoma frequently manifests as a large cystic lesion with an enhancing mural nodule.

GRADE 2 DIFFUSE FIBRILLARY ASTROCYTOMA

- They are slowly growing infiltrative tumors.
- They look like brain tissue with no apparent margin or capsule.
- Arises both in adults and children (cerebellum).
- Most commonly found in the frontal and temporal lobes.
- Incurable, survival approximately 5 years.

GRADE 2 DIFFUSE FIBRILLARY ASTROCYTOMA

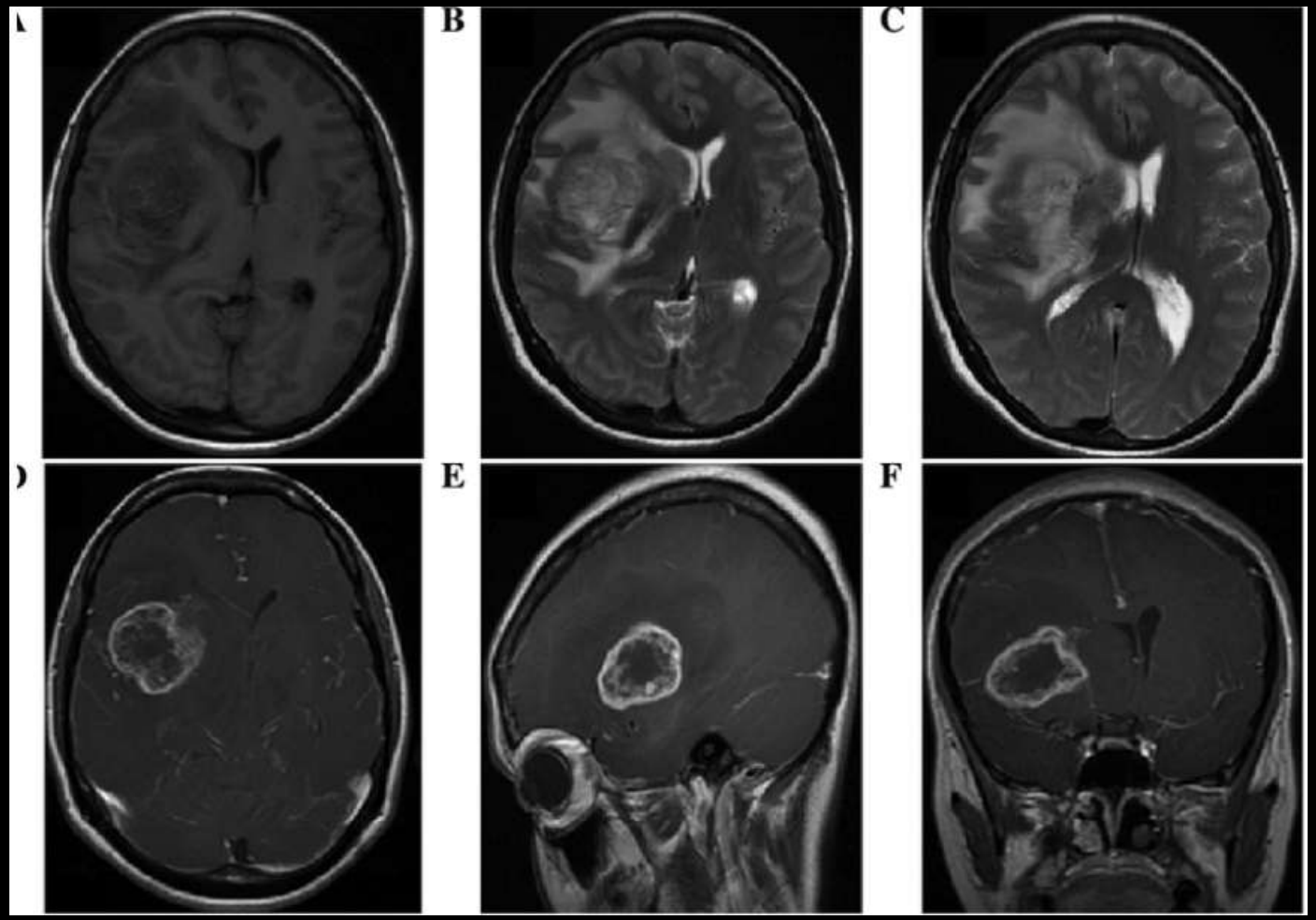


- A: contrast-enhanced T1-weighted image showing a nonenhancing mass in the left parietal lobe.
- B: The mass has relatively homogeneous increased signal intensity in the T2-weighted image.

GRADE 3 ANAPLASTIC ASTROCYTOMA

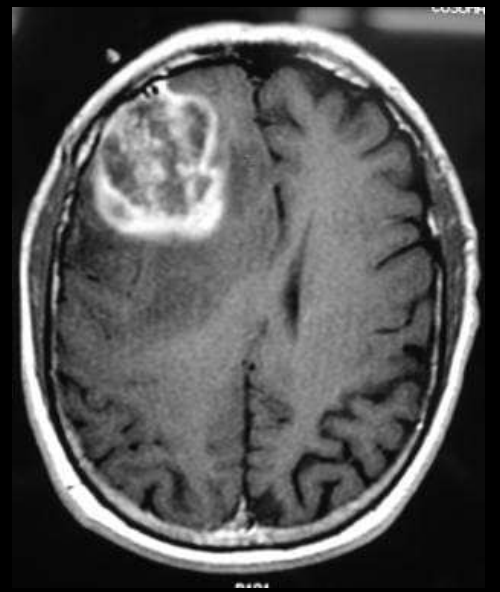
- These tumors are infiltrative with rapid growth
- They are highly vascular tumors with areas of necrosis and high mitotic figures.
- Incurable, survival 1.5-2 years.

GRADE 3 ANAPLASTIC ASTROCYTOMA



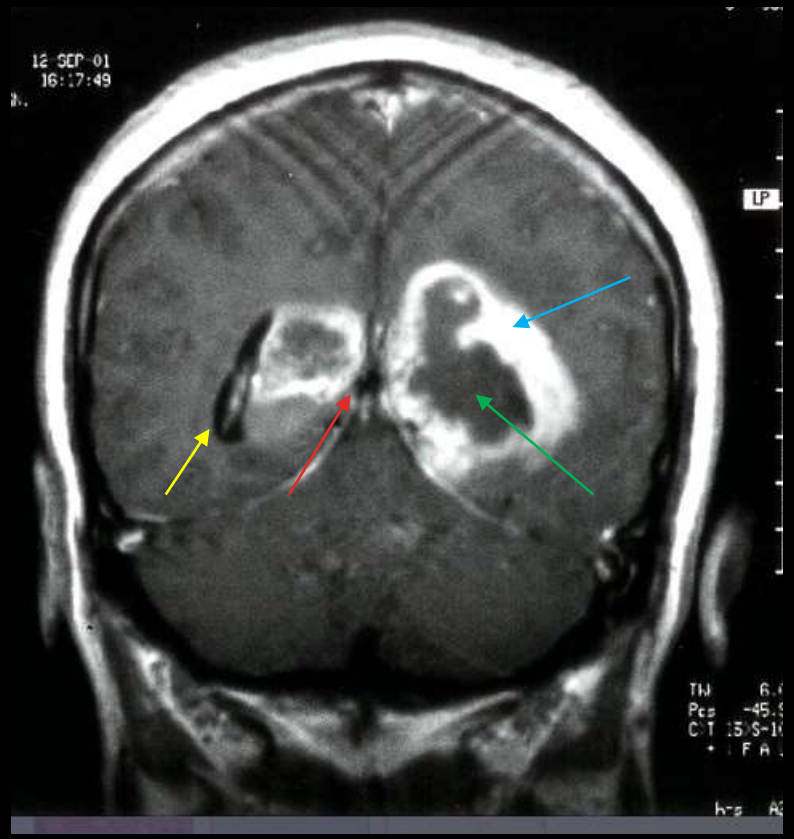
- (A) T1-weighted (B and C) T2-weighted and (D) postcontrast T1-weighted axial as well as post-contrast T2-weighted (E) sagittal and (F) coronal images revealed an ill-defined insular mass in the right hemisphere.

GRADE 4 GLIOBLASTOMA



- The most malignant type of astrocytoma
- The most common malignant primary brain tumor
- Rapid growth, abrupt symptom onset, and short disease course (death within weeks)
- They have necrotic areas with new vessel formation and areas of hemorrhage may be seen occasionally.
- Incurable, survival 12 months, 10% at 2 years

GRADE 4 GLIOBLASTOMA



-They are located mostly in the white matter of cerebral hemispheres and they tend to cross corpus collosum showing butterfly appearance(due to their rapid growth and ability to invade brain tissue).
-GFAP positive
-on imaging : irregular shape / non-homogenous mass

*GFAP: glial fibrillary acidic protein

- Coronal T1 MRI with contrast:

bihemisphere garland-like contrast enhancement. There is peripheral contrast agent enhancement (blue) with central necrosis (green). The third ventricle (red) is centrally located. The tumor is displacing the lateral ventricle (yellow).

Diagnosis: bilateral glioblastoma (butterfly glioma).

MANAGEMENT

- Corticosteroids to decrease brain edema.
- Anti-epileptic drugs to control seizures.
- Surgical excision of the tumor with or without chemo/radiotherapy.

Classification of astrocytomas

Grade	Type	Description	Epidemiology	Location	Prognosis
I	Pilocytic astrocytoma	• Slow growing, localized tumors • Often associated with neurofibromatosis type I	• Predominantly in children and young adults (< 20 years)	• Cerebellum (most common) • Cerebral hemispheres (supratentorial)	• Favorable; long-term survival • Completely curable with complete surgical resection • Median survival: > 10 years
II	Diffuse astrocytoma	• Slow growing, low-grade tumor that has the potential to progress to higher-grade tumors	• Peak age: 20–40 years of age	• Cerebral hemisphere	• Incurable • Median survival: 2–12 years
III	Anaplastic astrocytoma [22][23]	• A slow-growing, infiltrative tumor that arises from glial cells in the CNS	• Peak age: 30–50 years of age		• Incurable • Median survival between 18 months and 10 years
IV	Glioblastoma multiforme (GBM) [24][25][26]	• Malignant tumor with rapid growth, abrupt symptom onset, and short disease course (death within weeks)	• Peak age: 60–70 years of age • Most common malignant primary brain tumor	• Cerebral white matter • Possibly bilateral: butterfly glioma	• Incurable • Median survival of 15 months

2. MEDULLOBLASTOMA

- Highly malignant primary brain tumor in children.

- Occurs in cerebellum often in midline (1.truncal ataxia if it involves cerebellar vermis: inability to sit upright / stand without support, 2.cerebellar defects: broad-based gait).

- More common in males.

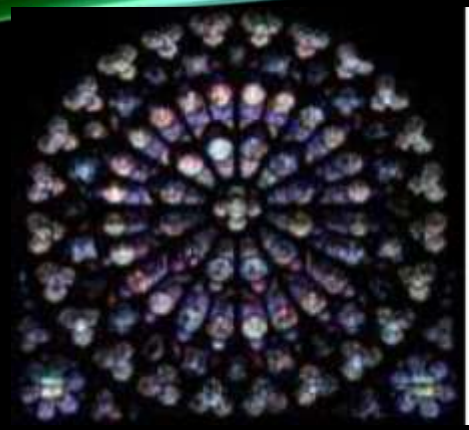
- Can compress 4th ventricle → causing non-communicating hydrocephalus causing headache and papilledema.
- Can spread to CSF:

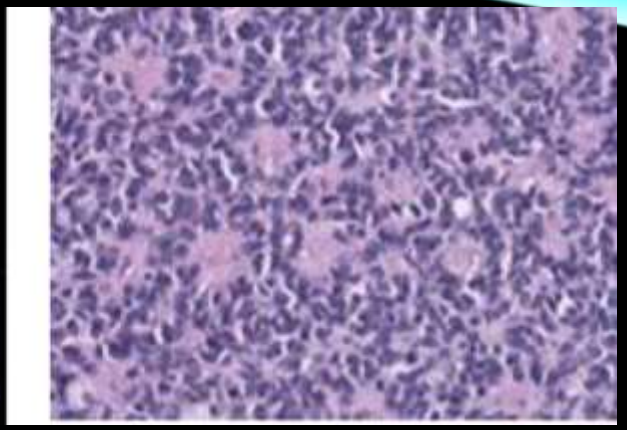
-Nodules in dura of spinal cord: "Drop metastasis".

-Tend to occur in lower spinal cord, cauda equina.

-Back pain, focal neuro lesions can occur.

- Associated with Turcot syndrome (FAP that is associated with gliomas of Lynch syndrome)





•Diagnosis:

Imaging: intraparenchymal contrast-enhancing mass (CT: iso/hyperdense, MRI T1 hypointense, T2:isointense)

Histology: Homer-Wrights Rosettes. (small round blue cells surrounding a central neutrophil)

• Treatment:

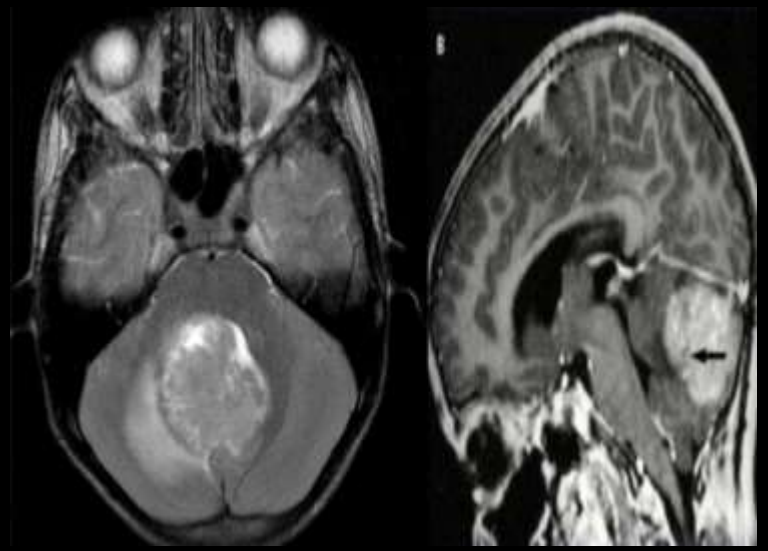
Surgical resection, complementary Radiotherapy for the neuroaxis, and chemotherapy when recurred.

• Prognosis:

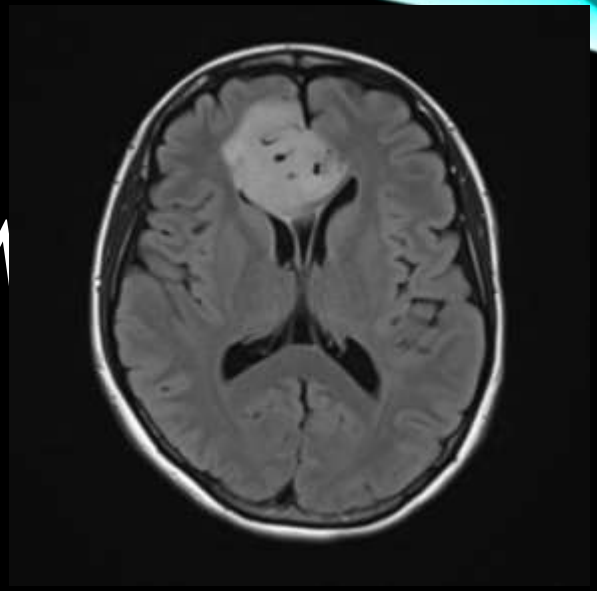
50%-60% survival at 5 years.

75% children survive to adulthood.

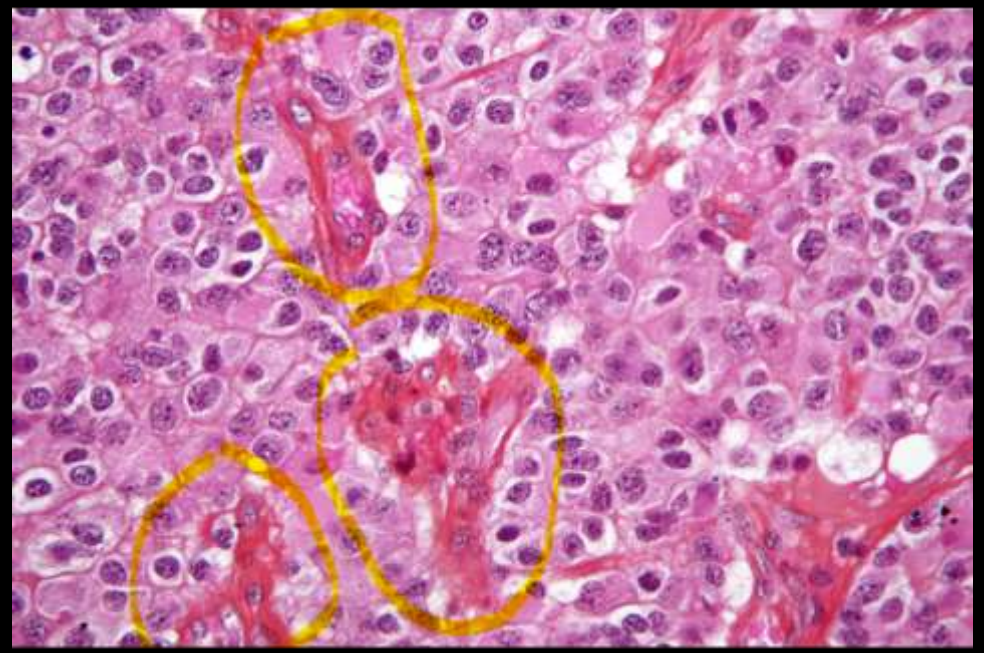
Many with complications of treatment.



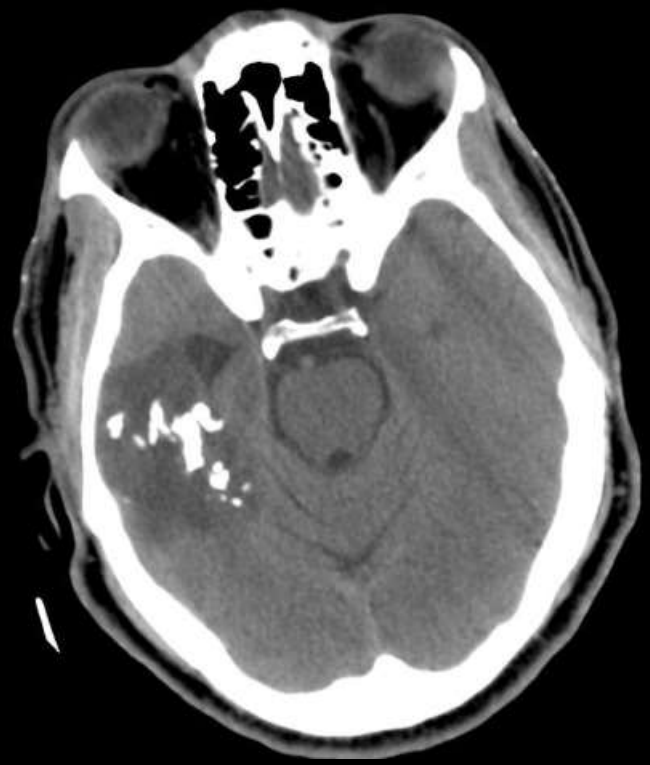
3. OLIGODENDROGLIOM



- Tumor that arises from oligodendrocytes.
- Relatively rare, and slow growing tumor most often found in the frontal lobes.
- Median age is 40-50
- Due to being found in the frontal lobe it is often associated with seizures, focal neurological deficits, and personality changes.
- On imaging it appears as an intra-parenchymal tumor with calcifications, masses involving the cortex or subcortical white matter. (CT: hypodense, T1:hypointense, T2:hyperintense)
- Biopsy: fried egg cells (cells with a clear cytoplasm and round nucleus),chicken-wire pattern of capillary anastomses
- Treated by resection and adjuvant radiotherapy and chemo therapy.
- Recurrence: nearly 100%
- 5-year survival rate 50-60%



Fried egg cells



- Non contrast CT:

hypodense lesion with multiple intralesional hyperdense calcifications is visible in the temporal lobe

4. MENINGIOMA

- Most common benign primary intracranial tumor in adults, arising from arachnoid membrane (thus can arise in any part of the CNS covered by the meninges).
- Mostly idiopathic. Also due to ionizing radiation.
- NF2 is associated with the development of multiple meningiomas.
- This tumor is often calcified, may cause hyperostosis of adjacent bone (detectable on imaging)
- Many are asymptomatic and can be an incidental finding. (if it developed symptoms, it would be the general symptoms of CNS tumors (eg seizure,..)).
- It has a female predominance and has been tied to hormonal disturbances and to trauma.

MENINGIOMA

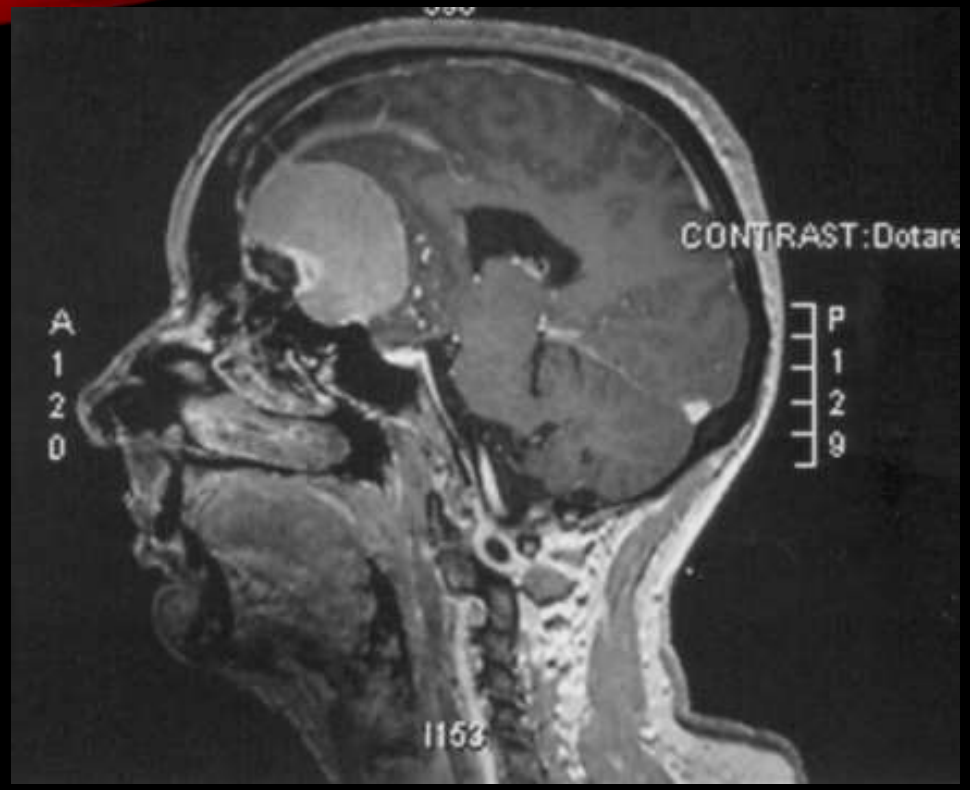
- Investigations:

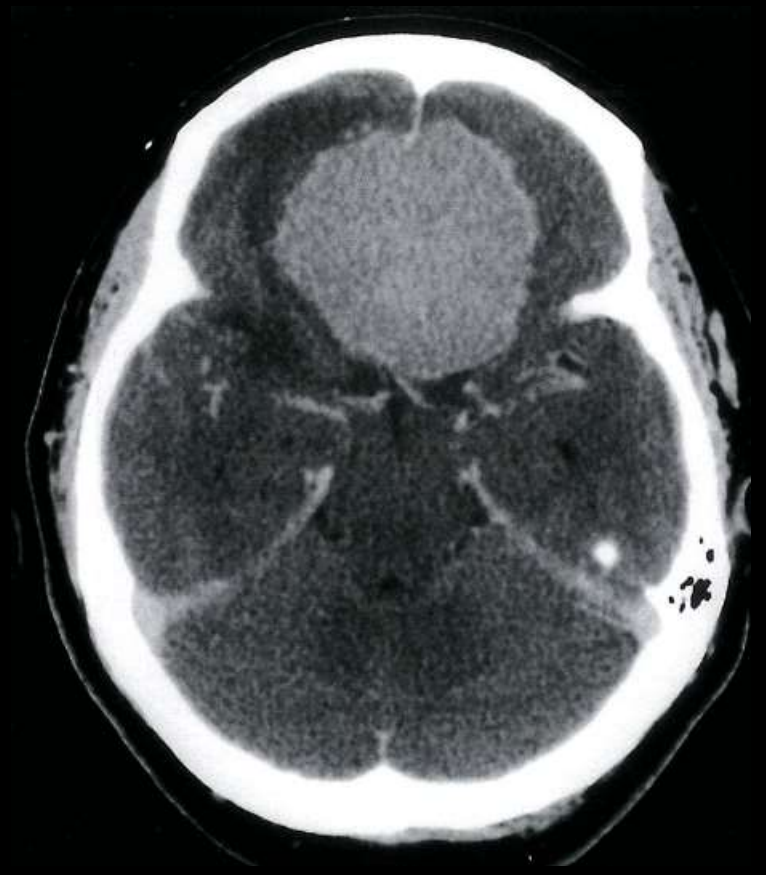
- CT scan with contrast (Hyperdense, homogenous lesion, with dural borders).

- Imaging modality of choice: MRI

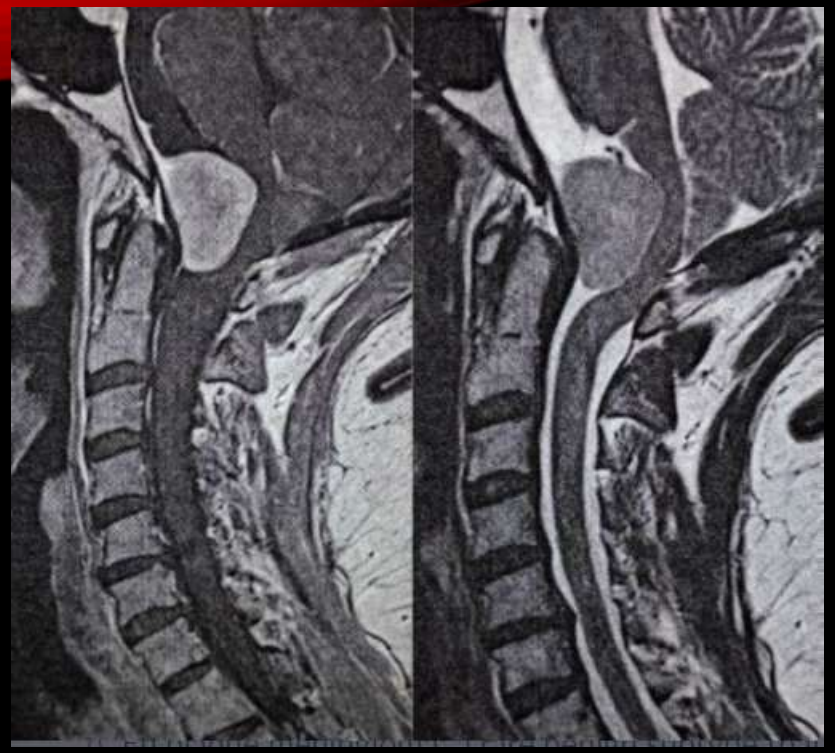
- MRI with contrast (MRI will show an isointense lesion on the T1 weighted sequence, which enhances well with gadolinium).

- Both CT and MRI will show the vasogenic edema which accompany meningioma's.





- Olfactory groove meningioma on (left) T1 MRI with contrast (right) axial CT with contrast

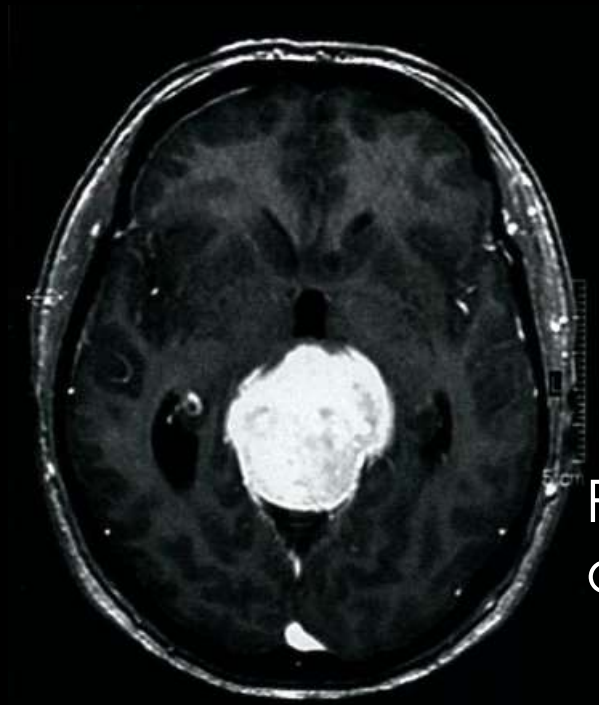


- Foramen magnum meningioma

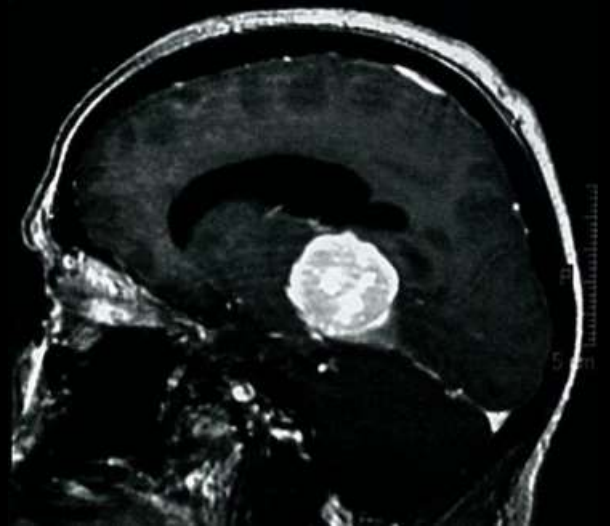
MRI:

Left: T1 with contrast

Right: T2



Pineal region meningioma on T1 with contrast



MENINGIOMA

- Management:
- - Conservative management (asymptomatic and/or non-progressive on CT/MRI).
- - Surgery resection (curative if complete resection and indicated when symptomatic and/or documented growth on serial CT/MRI).
- - Endovascular embolization for highly vascularized, likely bloody, tumors to facilitate surgery.
- - Radiation therapy (in case of inoperable tumors, postop, as an adjuvant, and in small tumors).

5. VESTIBULAR SCHWANOMA

- Also known as **acoustic neuroma**, slow growing, benign, posterior fossa tumor that arises from Schwann cells.
- Arises from vestibular nerve of CN VIII in internal auditory canal, expanding into bony canal and cerebello-pontine angle (CPA).
- Characterized by **unilateral** progressive hearing loss, tinnitus, disequilibrium/unsteady gait, and dizziness (compression of CN VIII).
- Late symptoms: due to pressure of adjacent structures (CN V & VII involvement)
- If the tumor was bilateral, it is diagnostic of NF2.

VESTIBULAR SCHWANOMA

- Investigations:

- **MRI with contrast** (gadolinium or T2 FIESTA sequence (>98% sensitive/specific)).

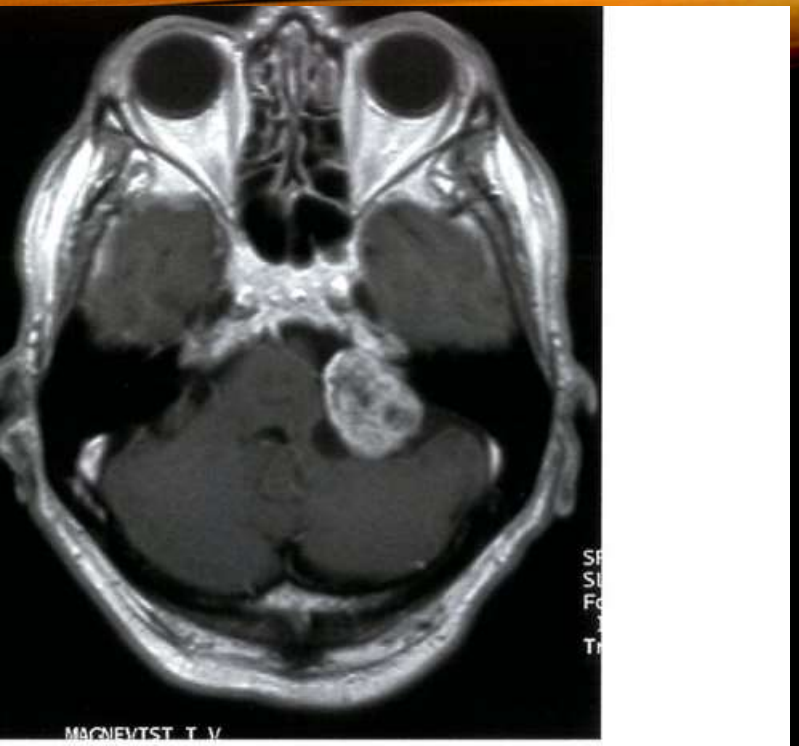
- CT with contrast as a second choice.

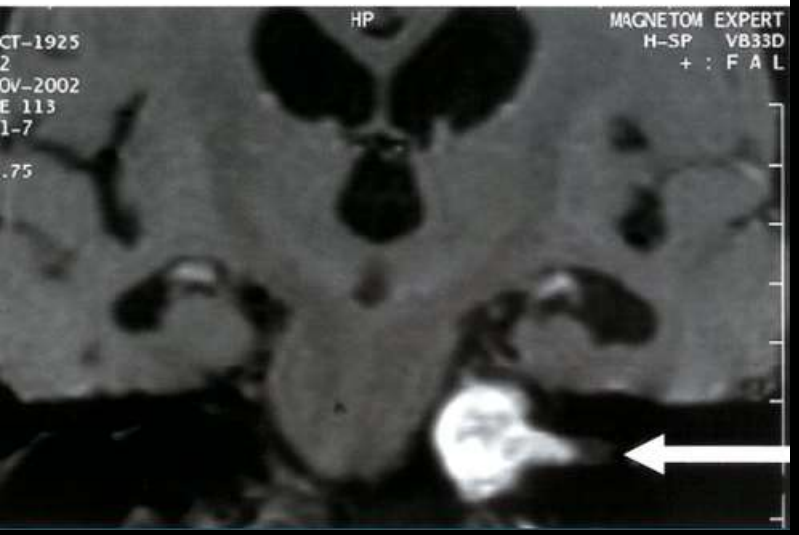
-CN testing:

CN VIII: Pure tone audiometry test, Weber & Rinne tests.

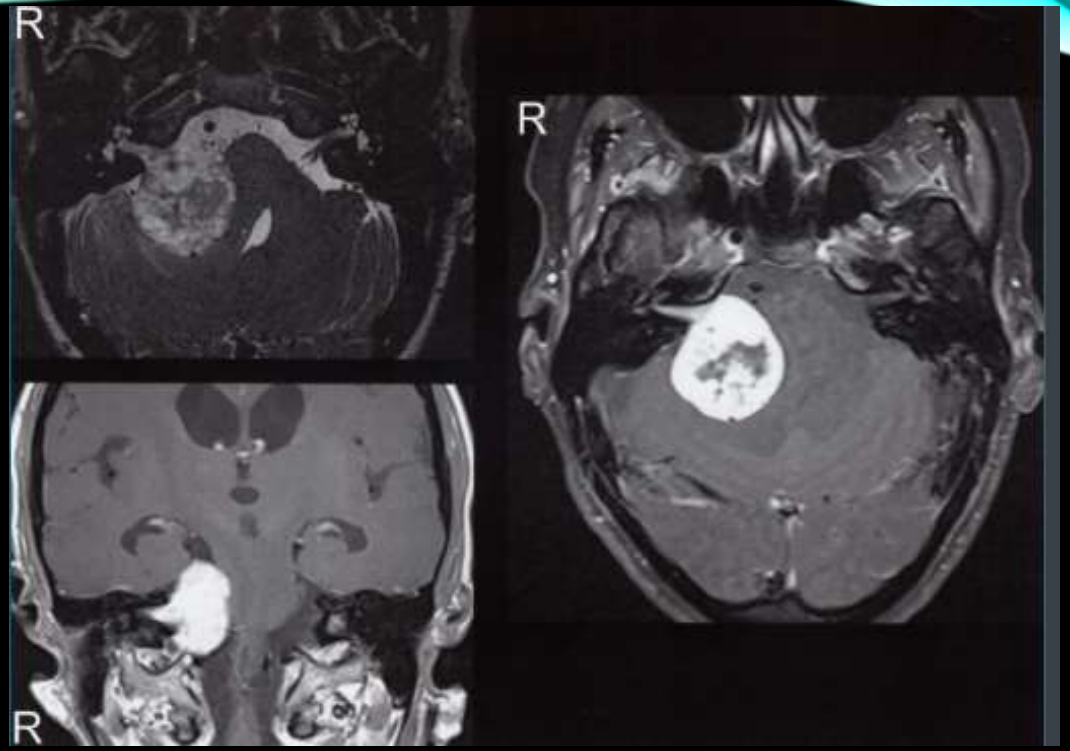
CN V: ipsilateral decreased corneal reflex.

CN VII: ipsilateral facial twitching or weakness.





- T1-weighted axial cranial MRI
- In the first image, a hyperintense lesion in the cerebellopontine angle is visible. In the second image, ingrowth into the internal auditory meatus can be seen



Cranial MRI
Upper left: T2-weighted image (axial view)
Lower left and right: T1 with contrast (axial and coronal views)

A tumor is visible on the right side between the brainstem and the cerebellum. There is strong contrast enhancement within the lesion and it has a hypointense center, suggesting necrosis.

VESTIBULAR SCHWANOMA

- Management:

- Monitoring through serial imaging (CT/MRI) and audiometry if tumor is small, hearing is still preserved.

- Surgical excision of the tumor.

- Radiation therapy.

- They have a good prognosis.

6. PITUITARY ADENOMA

- Pituitary adenomas are benign tumors of the pituitary gland. Most are located in the anterior lobe (front portion) of the gland.
- Pituitary adenomas are classified by their size (Macro vs. Micro) and whether or not they secrete hormones (Functional vs. Non-functional).
- Excessive hormone secretion can lead to Cushing syndrome, acromegaly, hyperprolactinemia
- May produce their manifestations by compression of adjacent structures like the optic chiasm, leading to bitemporal hemianopia.
- In some cases these tumors may undergo hemorrhage or necrosis (pituitary apoplexy) leading to pituitary insufficiency.

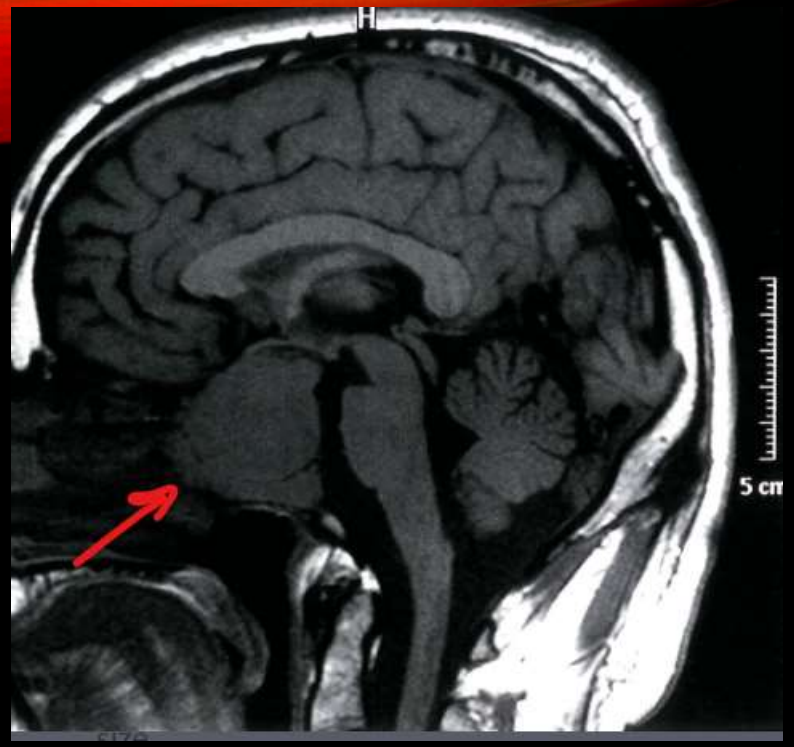
PITUITARY ADENOMA

- Investigations:

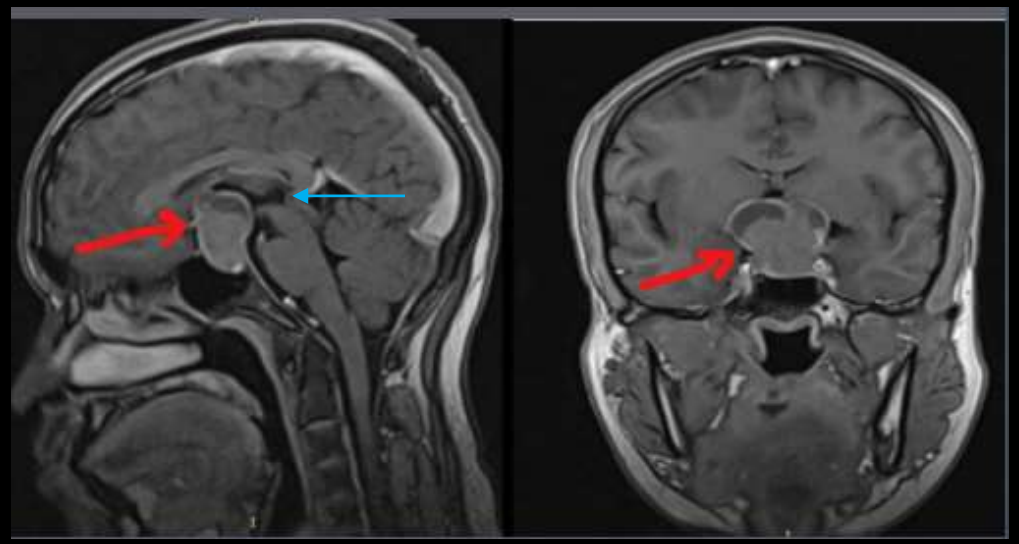
- MRI with and without contrast.

- Endocrine tests (prolactin level, TSH, cortisol, FSH/LH, IGF-1), electrolytes, urine electrolytes, and osmolarity.

- Visual Field testing.



- MRI T1 without contrast sagittal plane
- Pituitary macroadenoma.



- MRI T1 sagittal and coronal planes, with contrast
- Sellar mass with suprasellar extension compressing the third ventricle (blue)

PITUITARY ADENOMA

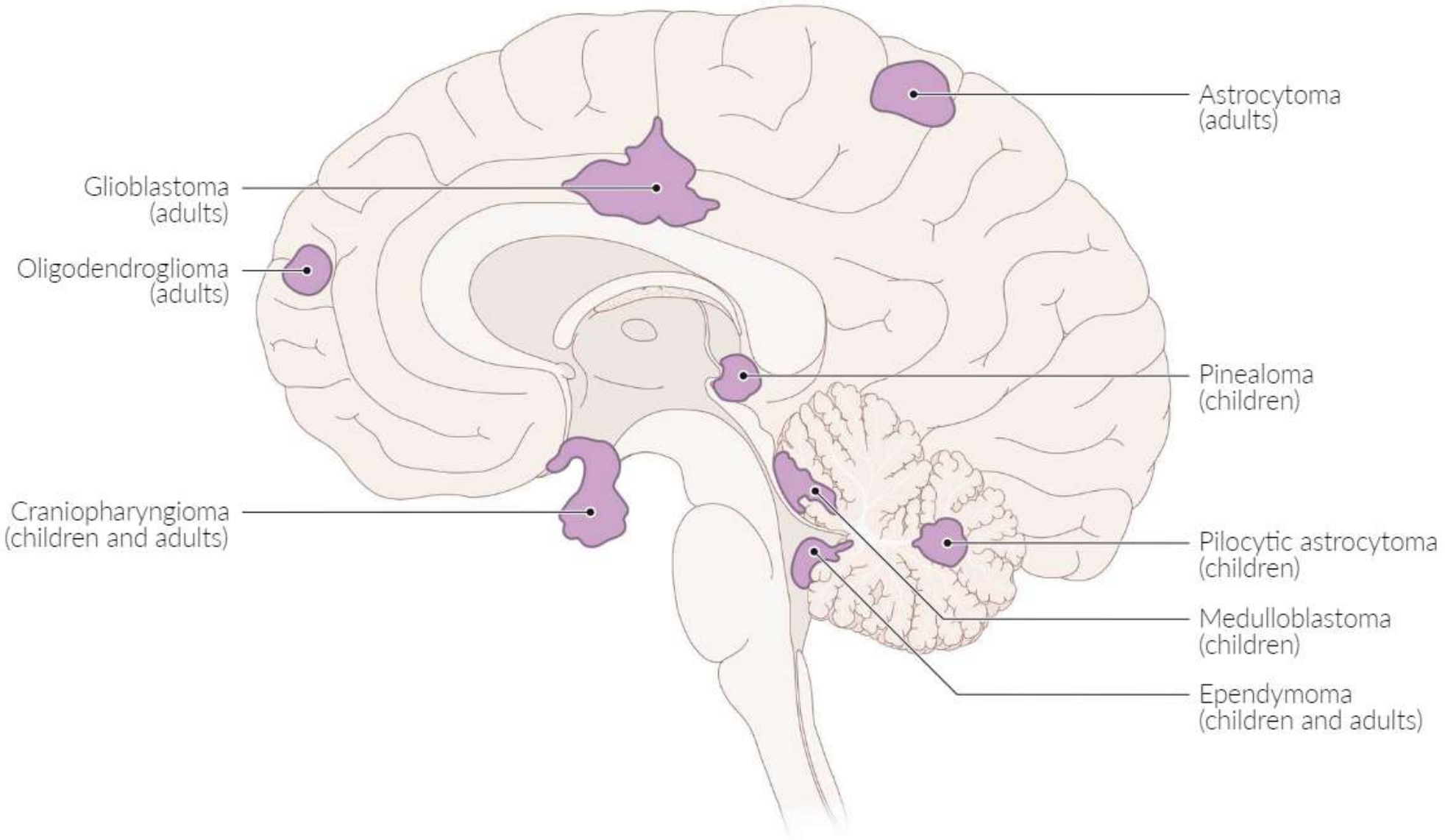
- Management:

- In microadenomas and secreting adenomas an attempt should be made to treat prolactinomas by medications before resorting to surgery.

- In case of severe visual manifestations, or after failure of medical treatment transphenoidal or transethmoidal, surgery is indicated.

- Post op endocrine replacement therapy.

Initial treatment of pituitary adenomas [7][8][9]	
Tumor type	First-line treatment
Prolactinomas (symptomatic or macroadenomas)	Pharmacotherapy
Secretory adenomas (except prolactinomas)	Surgery
Symptomatic nonsecretory adenomas	
Asymptomatic microprolactinomas	Observation
Asymptomatic nonsecretory adenomas	


Astrocytoma
(adults)
Glioblastoma
(adults)
Oligodendroglioma
(adults)
Pinealoma
(children)
Craniopharyngioma
(children and adults)
Pilocytic astrocytoma
(children)
Medulloblastoma
(children)
Ependymoma
(children and adults)

THANK YOU