



BRAIN TUMORS

Dr. Mahmoud Abdallat
Neurosurgery Department



INTRODUCTION

- **Intracranial tumors can be divided into**

- primary brain tumors vs. Metastasis
- intra-axial(parenchymal) vs. extra-axial
- supratentorial vs. infratentorial
- adult vs. pediatric

- **can be divided into**

- benign: non invasive, but can be devastating due to mass effect in fixed volume of skull (e.g. most meningiomas, WHO Grade I)
- Malignant: implies rapid growth, invasiveness, possibly drop-metastases to spinal cord from a primary CNS tumour (rare)



Epidemiology

Table 8. Tumour Location: Etiology and Clinical Feature

	Supratentorial	Infratentorial (Posterior Fossa)
Epidemiology		
Age <15 yr Incidence: 2-5/100,000/yr 60% infratentorial	Astrocytoma (all grades) (50%) Craniopharyngioma (2-5%) Others: pineal region tumours, choroid plexus tumours, ganglioglioma, DNET	Medulloblastoma (15-20%) Cerebellar astrocytoma (15%) Ependymoma (9%) Brainstem astrocytoma
Age >15 yr 80% supratentorial	High grade astrocytoma (12-15%, e.g. GBM) Metastasis (15-30%, includes infratentorial) Meningioma (15-20%) Low grade astrocytoma (8%) Pituitary adenoma (5-8%) Oligodendroglioma (5%) Other: colloid cyst, CNS lymphoma, dermoid/epidermoid cysts	Metastasis Acoustic neuroma (schwannoma) (5-10%) Hemangioblastoma (2%) Meningioma

Clinical Feature

Shared Features (from elevated ICP)

H/A: usually worse in AM and made worse with straining, coughing

N/V

Papilledema

Diplopia - CN VI palsy

Distinguishing Features

Seizure: commonly the first symptom

Progressive neurological deficits (70%)

Frontal lobe: hemiparesis, dysphasia, personality changes, cognitive changes

Temporal lobe: auditory/olfactory hallucinations, memory deficits, contralateral superior quadrantanopsia

Mental Status Change: depression, apathy, confusion, lethargy

"Tumour TIA" (transient ischemic attack) stroke like symptoms caused by

- occlusion of vessel by tumour cells
- hemorrhage
- 2^o to "steal phenomenon" - blood is shunted from ischemic regions to non-ischemic regions

Endocrine disturbance - with pituitary tumours ([see Endocrinology, E20](#))

Brainstem involvement: cranial nerve deficits and long tract signs

N/V: compression on vagal nucleus/area postrema

Diplopia: direct compression CN VI

Vertigo

Nystagmus

Truncal ataxia + titubation: cerebellar vermis lesions

Limb ataxia, dysmetria, intention tremor: cerebellar hemisphere lesions

Obstructive hydrocephalus more common than supratentorial lesions



Etiology and pathogenesis

- As any neoplastic process in the body .
there must be :
Induction , promotion and progression
- Carcinogenesis process on molecular
level
 - oncogene
 - tumor suppressor gene



Risk Factors

1. no genetic predisposition except in certain inherited syndromes
 1. **NF1** : optic nerve glioma , peripheral neurofibroma
 2. **NF2** :bilateral acoustic neuroma , multiple meningioma
 3. **Tuberous sclerosis** : subependymal glioma
 4. **Li-fraumeni disease:** glioma , ependymoma and medulloblastoma
 5. **Von hippel lindau disease:** hemangioma and hemangioblastoma



Risk Factors

2. radiation of head
3. immunosuppression
4. viral infection
5. Chemicals as anthracen and nitrosurea
6. Head trauma



WHO Classification

- In 2007 , the WHO Classification of CNS tumours was based solely on histology; an update was made in 2016 which bases the classification on a combination of histology (phenotype) and molecular genetics (genotype) for “integrated” diagnoses
- Last update published 2021 (5th update) introduces major changes that advance the role of molecular diagnostics in CNS tumor classification



Classification

- WHO classification depend on cell of origin

- **neuroepithelia tumors**
 - **glial cells**
 - astrocytoma
 - oligodendroglioma
 - ependymoma
 - choroids plexus tumors
 - **neurons**
 - ganglioglioma
 - gangliocytoma
 - neuroblastoma
 - **pineal tumors**
 - **medulloblastoma**
- nerve **sheath tumors** : shwanomma , neurofibroma
- meningeal tumors : meningioma
- microglial cells : primary CNS lymphoma
- pituitary tumors
- germ cell tumors :
 - germinoma
 - teratoma
- TUMOR LIKE MALFORMATION
 - Craniopharyngioma
 - Dermoid and epidermoid tumors
 - Colloid cyst
- Metastasis and extension from regional tumors .



Clinical presentation

- Gradual vs acute onset

1. **headache**

result of :

- increase in ICP
- invasion or compression of pain sensitive
- secondary to vision difficulties



Clinical presentation

2. other features of **increased ICP**
3. **lateralizing** features of brain shift and herniation
4. **epilepsy**
new onset epilepsy in adult specially above age of 30 should warn the physician for possibility of tumor . because this occur in 30% of patients with tumors



Clinical presentation

5. **subtle changes in personality and behavior**
6. **progressive neurological deficit**
depend on site



Clinical presentation

- signs and symptoms are divided according to tentorium cerebelli



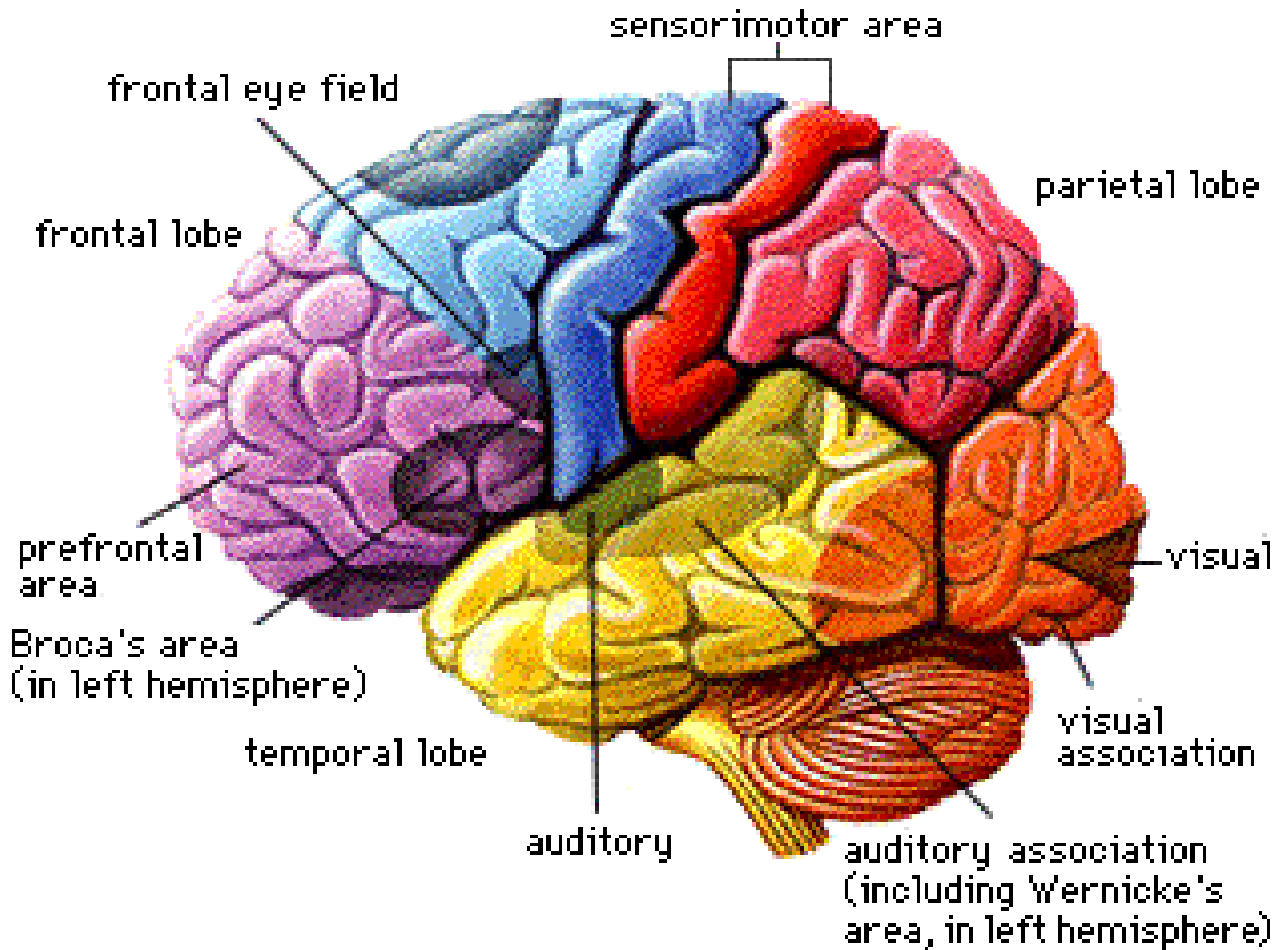
Supratentorial

- **frontal lobe**
- **parietal lobe**
- **temporal lobe**
- **occipital lobe**
- **hypothalamus and pituitary**
- **cranial nerves I II , cavernous sinus cranial nerves**



Infratentorial

- increased ICP and hydrocephalus
- cerebellum signs
- brain stem signs : cranial nerve palsy III – XII . alternation in consciousness , long tract signs





Investigation

- Aim is :
 - to diagnose presence of brain tumor .
 - To find the source if you suspect the tumor to be a mets



Investigation

- **Skull X-RAY**

- **calcification** : Oligodendroglioma , meningioma
craniopharyngioma and ependymoma
- **hyperostosis** of skull
- **bone destruction** : mets , chordoma ,
craniopharyngioma
- **erosion** of sella tursica
- **signs of ICP**
- **midline shift** of pineal gland if calcified



Investigation

- **brain CT**

- site , mass effect , bone destruction , enhancement , multiplicity
- **enhanced tumors**
 - high grade gliomas
 - meningioma
 - mets
 - acoustic neuroma
 - large pituitary tumors



Investigation

- **MRI** : Goldstandard
- **Angiography or MRA**
- **PET scan**
- **CSF cytology** : remember the contraindications



Investigation

- **Biopsy :**
 - needle biopsy thru burr hole ,
 - or stereo tactic biopsy image guided o
 - or at time of treatment
- **Tumor markers**



Differential diagnosis

- vascular : hematoma , aneurysm AVM
- infection : abscess , tuberculoma ,
hydatid cyst
- arachnoid cyst , dermoid and
epidermoid cyst



Treatment

- **medical therapy**

- medical treatment doesn't affect tumor it self
- this used only to reduce edema surrounding the tumor
- **steroid** are used specially with mets , meningioma and GBM

*for
vasogenic
edema*



Surgical Treatment

- aim of surgery (we aim for total resection but when not possible subtotal resection to ↓ the space occupying then)
- to take a biopsy
- removal of tumor either completely or partially (cytoreduction) (sth else)
- to treat complication as hydrocephalus
- Surgical removal is recommended for most types of brain tumors



Surgical Treatment

- craniotomy
- craniectomy
- trans-sphenoidal
- trans-oral



Radiotherapy

- differentiate between *radiation therapy* and *radiosurgery*.
- Conventional radiotherapy used as **adjuvant** therapy
- most radiosensitive are germinoma and medulloblastoma

{ FRAME device for navigation MRI
Stereotactic Radiotherapy (localized radiotherapy)
(tumor only)



Radiotherapy

- **complication :**
 - increase edema
 - demylenation
 - radionecrosis
 - affect cognitive functions
 - may induce other kind of tumors as meningioma



Chemotherapy

- problems facing conventional chemotherapy
 - presence of intact BBB.
 - small proportion of cells in active growth

Examples:

1. Alkylating agents i.e. temozolomide (GBM)
2. Combination of drugs: Procarbazine, lomustine and vincristine (PCV)



New Treatment

- hyperthermia treatment
- immunotherapy : LAK
- gene therapy



Posterior Fossa Tumors

- May need shunting or EVD prior to definitive surgery .
- risk are :
 - possible peritoneal seeding
 - prolonged hospitalization
 - risk of shunt complications



GLIOMA

- Tumors that arise from cells derived from neuroectoderm , the glial cells
- Most common brain tumors **52%**
- Four different types



Astrocytoma

- tumor that arise from astrocyte
- function in
 - support neurons
 - absorb neurotransmitter
 - release neuroactive molecules
 - aid in formation of BBB



Astrocytoma

- most common primary tumors of brain , 45%
- peak age : 40 – 60 years
- astrocytoma ranges in aggressiveness
- site : equal incidence in frontal , temporal parietal and thalamic . less common in occipital



Astrocytoma

- multiple classification systems
- WHO :
 - **Grade 1** : pilocytic astrocytoma
 - **Grade 2** : diffuse astrocytoma
 - **Grade 3** : anaplastic astrocytoma
 - **Grade 4** : glioblastoma multiforme

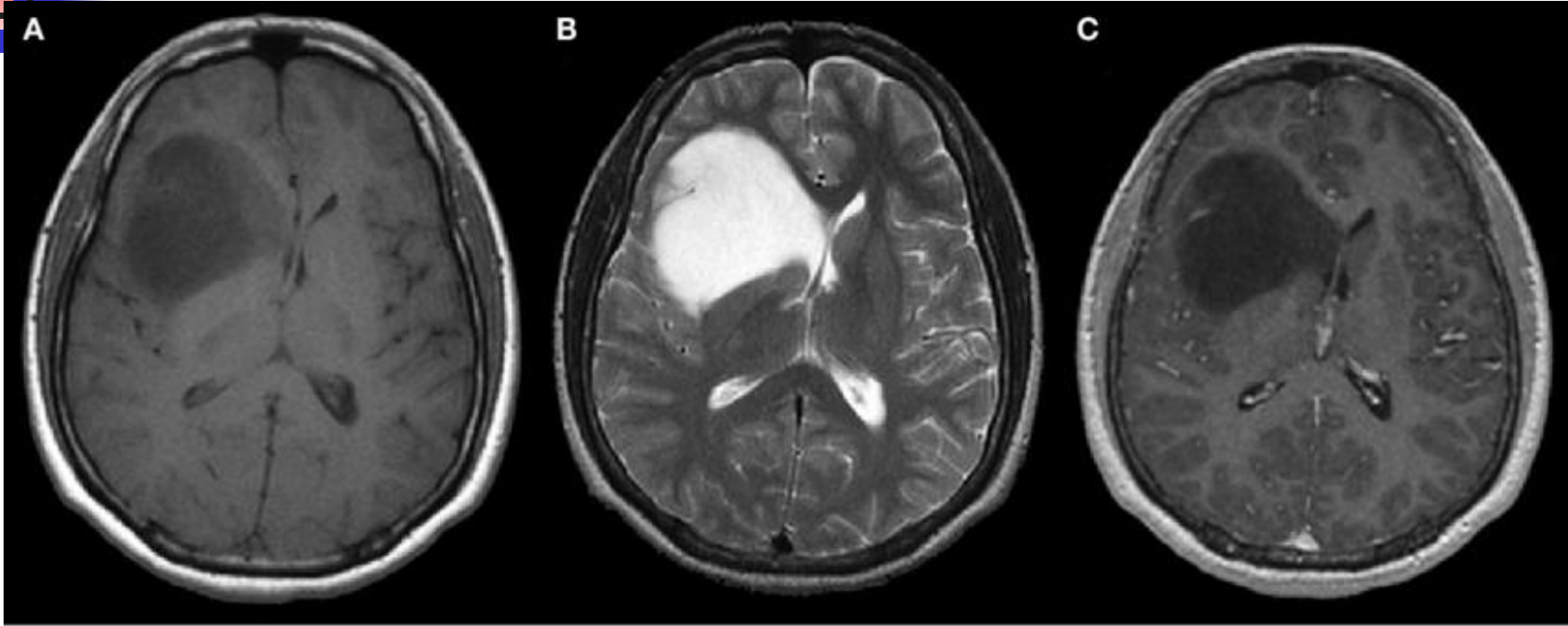
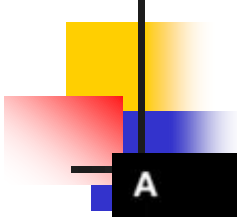


Low grade

- **Site :** *no enhancement (intact BBB)*
 - In adults usually in cerebral hemispheres
 - In children : in cerebellum
- **Macroscopic features :**
 - Not capsulated , no distinct margins
 - Relatively Avascular
 - Firm fibrous consistency
 - 15% show fine calcium deposit
 - Occasionally may invade diffusely

- **Microscopically:**

WHO Grade 1 and 2: well-differentiated and demonstrate hypercellular glia with nuclear atypia and rare mitotic activity

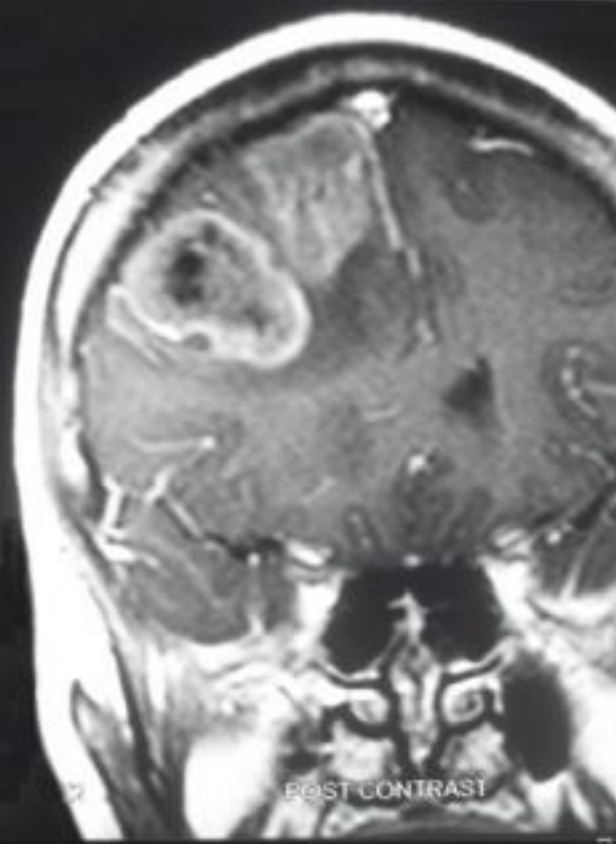
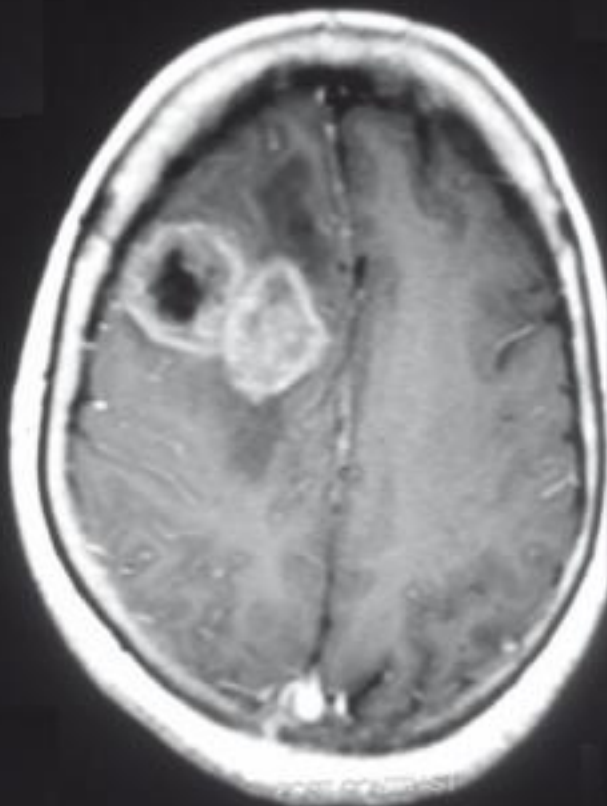
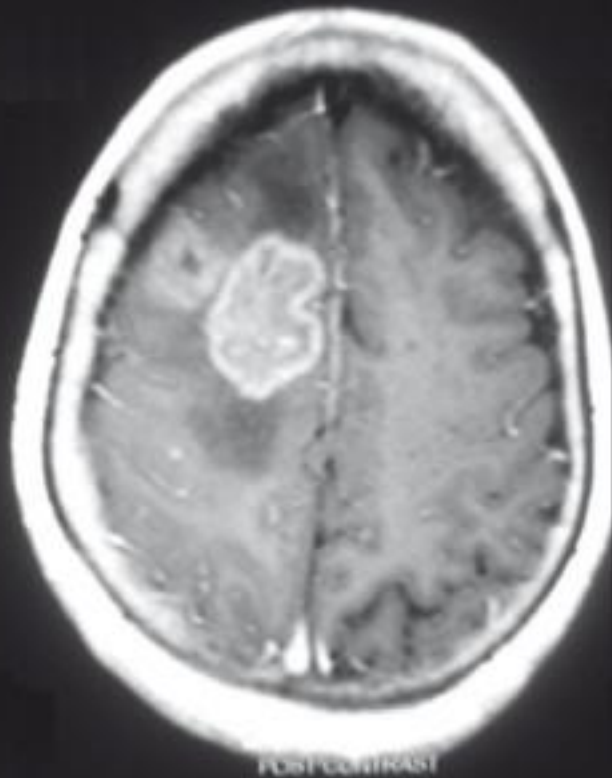






High grade

- **Site :**
 - cerebral hemisphere
- **Macroscopic features:**
 - Highly vascular margin ,necrosis
 - Butterfly glioma
- **Microscopic features**
 - Grade 3
 - Grade 4
- Rapidly growing and widely infiltrating





Clinical features

- Duration and progression of symptoms will depend on the grade
 1. epilepsy
 2. feature if increase ICP
 3. focal neurological deficit



investigations

- **CT**

- **Low grade :**

- small hypodense mass
- little surrounding edema
- no enhancement
- calcification may present

- **high grade**

- large mass
- marked edema
- enhance in non uniform manner ,





investigations

- MRI
- More sensitive than CT specially :
 - posterior fossa , brain stem and skull base tumor and for small tumor mass
 - usually both low and high appear decrease t1 signal increase t2 signal
- Angiograph → *vascularity of the tumor*
- Skull X-RAY (*hemangioma / embolization*)



Astrocytoma

- spread :
 - systemic : rare
 - CSF seeding : 10 -25% of high grades
 - tracing thru white matter



Management

- surgical :
aim is to
 - take biopsy
 - decrease tumor size
 - reduce tumor mass prior to adjuvant therapy
- radiotherapy
as adjuvant therapy
- other therapy :
chemotherapy , immunotherapy ,
hyperthermia



Prognosis

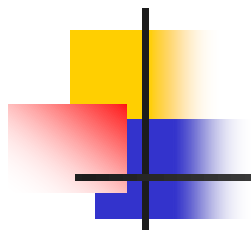
- at present there is no satisfactory treatment for grade 3 and 4
 - surgery alone is 17 weeks
 - adjuvant radiotherapy is 37 weeks

- low grades is approximately 8 years .

*nothing
dies
within*

*6 months
surgery year*

*surgery & others
2-5 years*



	Typical CT/MRI Findings	Survival
I – Pilocytic astrocytoma	± mass effect, ± enhancement	>10 yr, cure if gross total resection
II – Low grade/diffuse*	Mass effect, no enhancement	5 yr
III – Anaplastic*	Complex enhancement	1.5-2 yr
IV – Glioblastoma multiforme (GBM)	Necrosis (ring enhancement)	12 mo, 10% at 2 yr

*IDH mutant WHO Gr II/III tumours have a better overall prognosis than IDH wild-type; following IDH stratification, the chromosomal 1p/19q codeletion has prognostic value in IDH mutated grade II–III gliomas after adjustment for tumour proliferation, age, and adjuvant treatment



Oligodendroglioma

- Origin
- 5% of all gliomas
- peak age : maximal incidence in 5th decade
- site : supratentorial
- Presented as range
- most are well differentiated
- 40 % are mixed glioma with astrocytoma or ependymoma



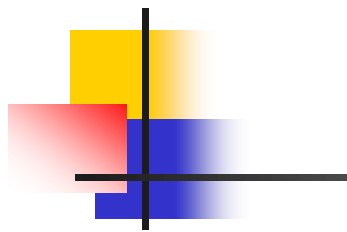
Clinical features

- as astrocytoma



Investigations

- CT
- MRI
 - Calcification in 90%
 - Enhancement in 50%
 - Well demarcated edges





Treatment

- Standard treatment is aggressive resection followed by radiotherapy
- Prognosis : 5 year survival is 30 – 50%.



Ependymoma

- Origin
- 5% of all glioma
- Age : most are in children and adolescents
- Site :
 - 30% of cases are supratentorial , mainly in adults
 - 70% are infratentorial , mainly in children



classification

- **non-anaplastic tumors :**
 - **papillary** : occur in 2 patterns (rosette and psudorosette
 - **myxopapillary**
 - **subependymoma** : usually heavily calcified, may be found incidentally at autopsy or present clinically
- **anaplastic**
- anaplastic and pappillary are most common symptomatic ependymoma



clinically

- supratentorial :
 - presented with increased ICP
 - focal neurological deficit
- infratentorial :
 - increased ICP due to hydrocephalus
 - ataxia due to cerebellum involvement



Investigation

- **CT**

- **MRI**

- Tumor arise in ventricle and enhance
- calcification in 90% specially supratentorial

- Spread by:

- seeding thru CSF
- systemic spread is rare



Treatment

- Surgical resection
- Radiation of whole neuroaxis
 - Second most radio sensitive tumor after medulloblastoma
- Prognosis : 5 years survival 20 -50%
Adults and supratentorial tumors have better prognosis



Medulloblastoma

All are
grade 4

- Peak age is 5 years
- It is most common midline posterior fossa tumor
- All are highly malignant
- Spread by
 - CSF seeding
 - hematogenous spread

most

common

in
child
age
group

(Some
say
pilocytic)



Medulloblastoma

- **CT**

- Isodense midline lesion compressing 4th ventricle , with strong enhancement

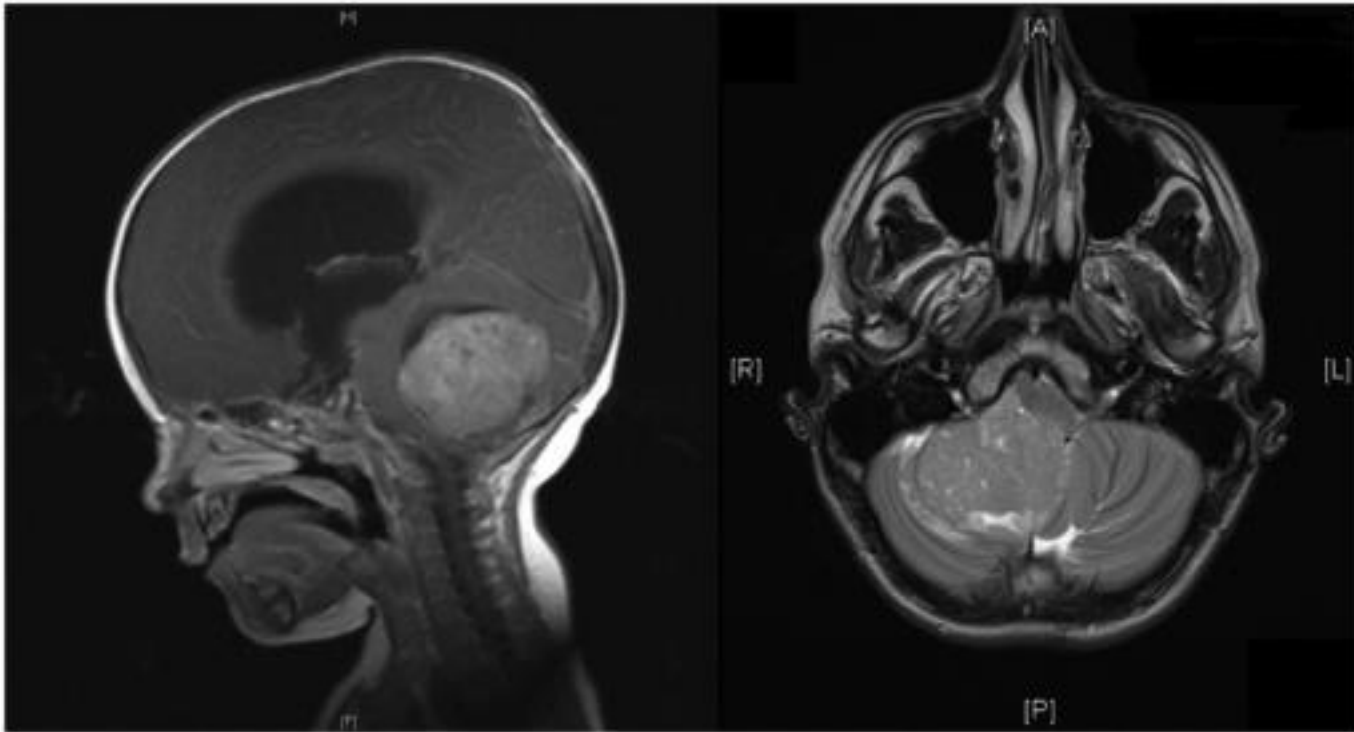
- **MRI**



Treatment

- Treat hydrocephalus
- Surgery
- Neuraxis radiation

- Prognosis
 - 5 years survival is 40 – 60 %



↓ consciousness due to ↑ ICP due to hydrocephalus



Meningioma

- Tumor arise from arachnoids layer of meninges
- Most common benign brain tumors , 15% of all tumors
- Occur at any age , peak in middle age
- More in females



Etiology

- Possible risk factors
 - head trauma
 - Low levels of radiation
 - Nf2
 - Sex hormones are important



Meningioma

- **Site :**

- Most common is parasagittal region
- Less frequently from convexity
 - sphenoidal wing
 - Olfactory groove
 - suprasellar

- **Classification**

Depend on position of origin rather than histology



Histological types

(doesn't matter)

- syncytial or meningiotheliomatous
- transitional type
- fibroblastic
- angiomatous
- malignant infrequent

*Grade 1-2 benign
Grade 3 malignant
] matters*



Clinically

- **parasagittal tumors**
 - patient present with epilepsy , contralateral lower limb paresis
 - may present with ICP in bilateral tumors
 - urinary incontinence especially if bilateral
 - if arise from posterior falx : hemianopia
- **convexity tumors**
 - ICP
- **Sphenoid ridge**
 - May compress optic nerve
 - May cause ICP
 - **foster kennedy syndrome** : contralesional papilledema and optic atrophy in the other



Clinically

- **Olfactory groove**

- Anosmia initially unilateral
- Increased ICP
- Foster Kennedy

- **Suprasellar**

- Bitemporal hemianopia but without endocrine disturbances

- **Ventricular tumors**

- Increased ICP



Investigations

- **CT**

- Hyperdense
- Enhance uniformly
- Hyperostosis of cranial vault

- **MRI**

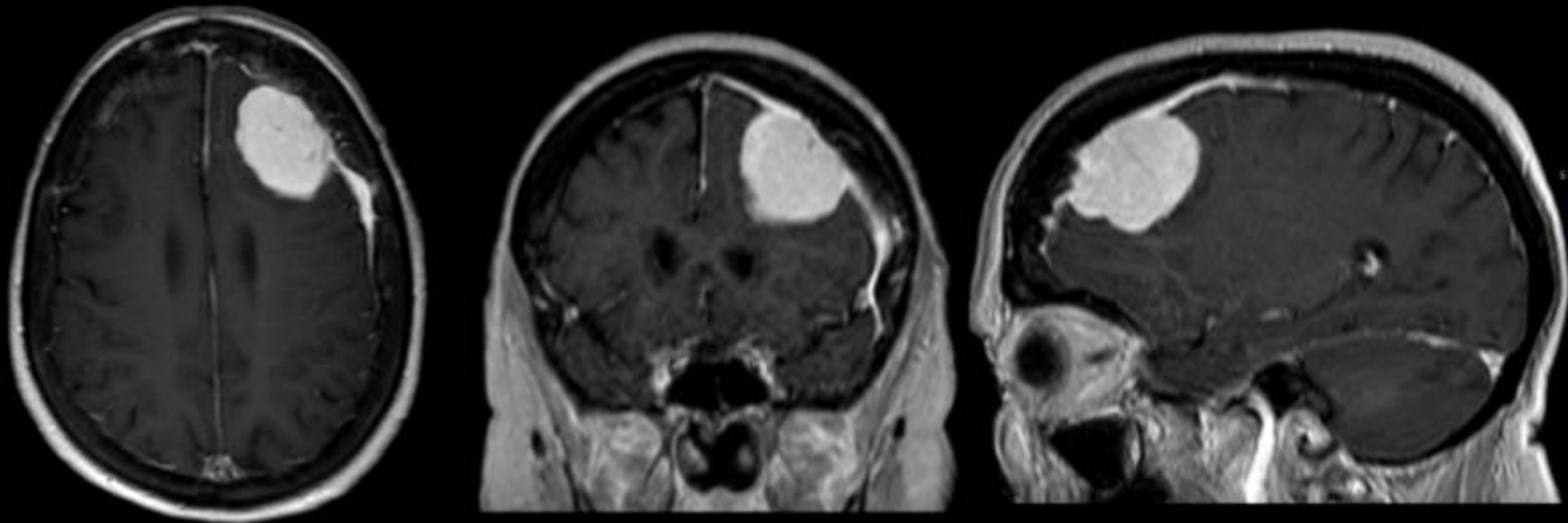
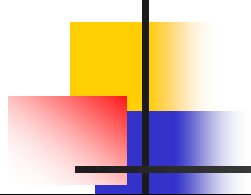
- Isointense in t1



Treatment

- Total surgical excision
- Radiation may be used to treat residual tumors

- Risk of recurrence
 - Most common source tumor invaded dural sinus and not removed by surgery
 - And in malignant variant



homogenous
insradial
convexity



Pituitary adenoma:

- Primarily from anterior pituitary, 3rd - 4th decades, M=F, associated with MEN-1 syndrome
- Incidence in autopsy studies approximately 20%



classification

- *likely functional* microadenoma <1 cm; *likely mass effect / non functional* macroadenoma ≥1 cm
- endocrine active (functional/secretory) vs. inactive (non-functional)
- most common functional: prolactinomas, adrenocorticotrophic, growth-hormone (GH) producing
- differential diagnosis: parasellar tumours (e.g. craniopharyngioma, tuberculum sellae meningioma), carotid aneurysm

→ All micro except prolactinoma

→ all surgical except prolactinoma.

↳ most common prolactinoma.



Clinical Features

- mass effects
- H/A
- Bitemporal hemianopsia (compression of optic chiasm) ; hydrocephalus (3rd ventricle compression)
- Invasive adenomas: CNIII,IV,V1,V2,VI palsy (cavernous sinus compression) ; proptosis and chemosis
- (cavernous sinus occlusion)



- Endocrine effects:

- hyperprolactinemia (prolactinoma): infertility, amenorrhea, galactorrhea, decreased libido.

- ACTH production: Cushing's disease, hyperpigmentation

- GH production: acromegaly/gigantism

- panhypopituitarism: due to compression of pituitary (hypothyroidism, hypoadrenalism, hypogonadism)

- DI – rare, except in apoplexy



presents with the subarachnoid hemorrhage symptoms

- Pituitary apoplexy (sudden expansion of mass due to hemorrhage or necrosis)
- abrupt onset H/A, visual disturbances, ophthalmoplegia, reduced mental status, panhypopituitarism and DI
- CSF rhinorrhea and seizures (rare)
- signs and symptoms of SAH (rare)

likely already adenoma & complicated with hemorrhage



Investigations

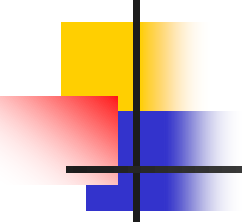
- formal visual fields , CN testing
- endocrine tests (prolactin level , TSH , 8 AM cortisol , fasting glucose , FSH/LH , IGF-1) , electrolytes , urine electrolytes, and osmolarity
- imaging (MRI with and without contrast)

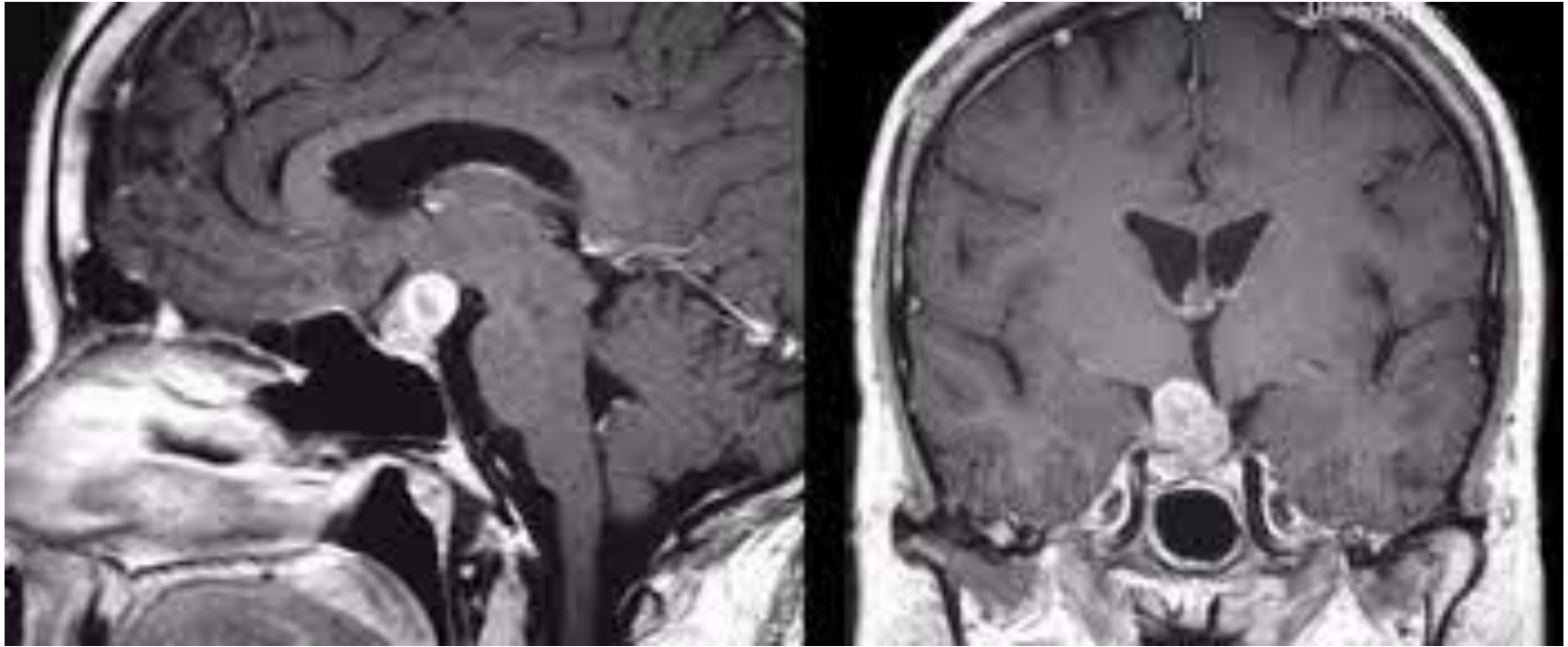


Treatment

- **medical**

- for apoplexy: rapid corticosteroid administration \pm surgical decompression
- for prolactinoma: dopamine agonists (e.g. bromocriptine)
- for Cushing's: serotonin antagonist (cyproheptadine), inhibition of cortisol production (ketoconazole)
- for acromegaly: somatostatin analogue (octreotide) \pm bromocriptine
- endocrine replacement therapy

- 
-
- surgical
 - endoscopic trans-sphenoidal, trans-ethmoidal, and less commonly trans-cranial approaches (i.e. for significant suprasellar extension)





Vestibular Schwannoma (Acoustic Neuroma)

- slow-growing (60% show no growth over 1 yr; average rate for growing tumors 1-2 mm/yr), benign posterior fossa tumour (8-10% of tumours)
 - arises from vestibular nerve of CNVIII in internal auditory canal , expanding into bony canal and cerebello-pontine angle (CPA)
- if bilateral ,diagnostic of NF2
- epidemiology : 1.5/100,000 ; all age groups affected , peaks at 4th-6th decades



Clinical Features

- Early clinical triad: (tumour < 2cm) unilateral progressive hearing loss 98% , tinnitus , and disequilibrium (compression of CN VIII)
- Later clinical features:
 - tumour usually > 2 cm: otalgia, facial numbness + weakness, changes to taste (due to CN V and VII compression, respectively)
 - tumour usually > 4 cm: ataxia, H/A, N/V, diplopia, cerebellar signs (due to brainstem compression; ± obstructive hydrocephalus)



Investigations

- MRI with gadolinium or T2 FIESTA sequence (>98% sensitive/specific) ; CT with contrast 2nd choice
- audiogram , brain stem auditory evoked potentials , caloric tests.

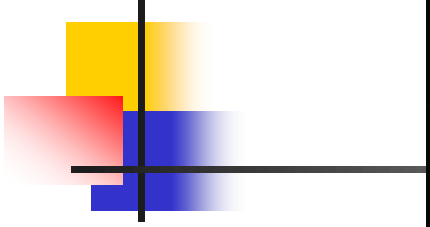
→ baseline to assess improvement



Treatment

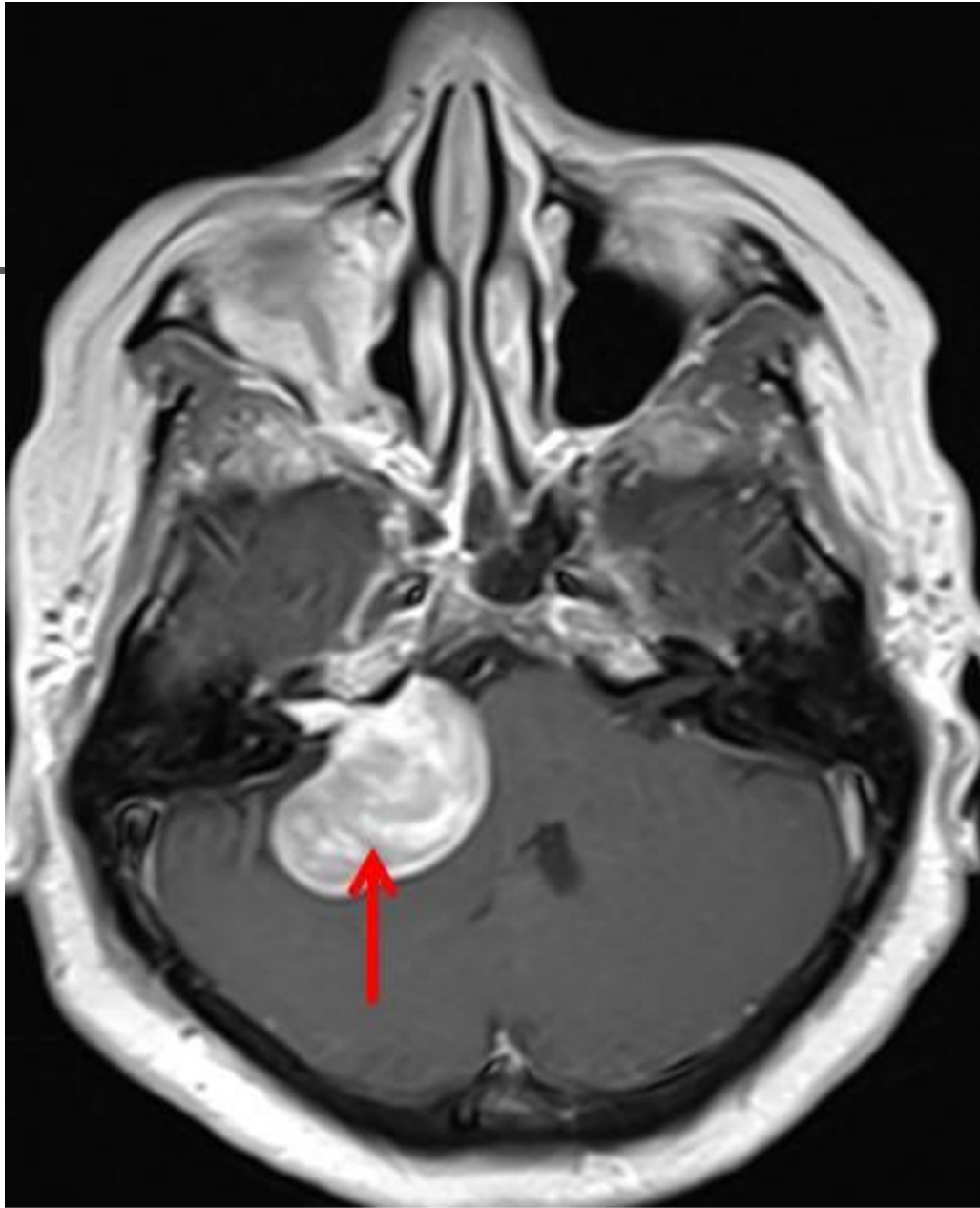
- expectant : serial imaging (CT/MRI q6mo) and audiometry if tumor is small , hearing is still preserved, high perioperative risk, or elderly patient
- radiation: Stereotactic Radiosurgery (Gamma Knife) SRS or XRT
- surgery: if lesion > 3cm , brain stem compression , edema , hydrocephalus
- Curable if complete resection (almost always possible)
- Operative complications: CSF leak , meningitis , required shunt ; CNV, VII, VIII dysfunction
- (proportional to tumour size; only significant CNVIII disability if bilateral)
- Implications for testing of family members of NF2 mutation carrier

*if small
Cranial
to
access)*



CPA

Surgery



- 
-
- Questions??