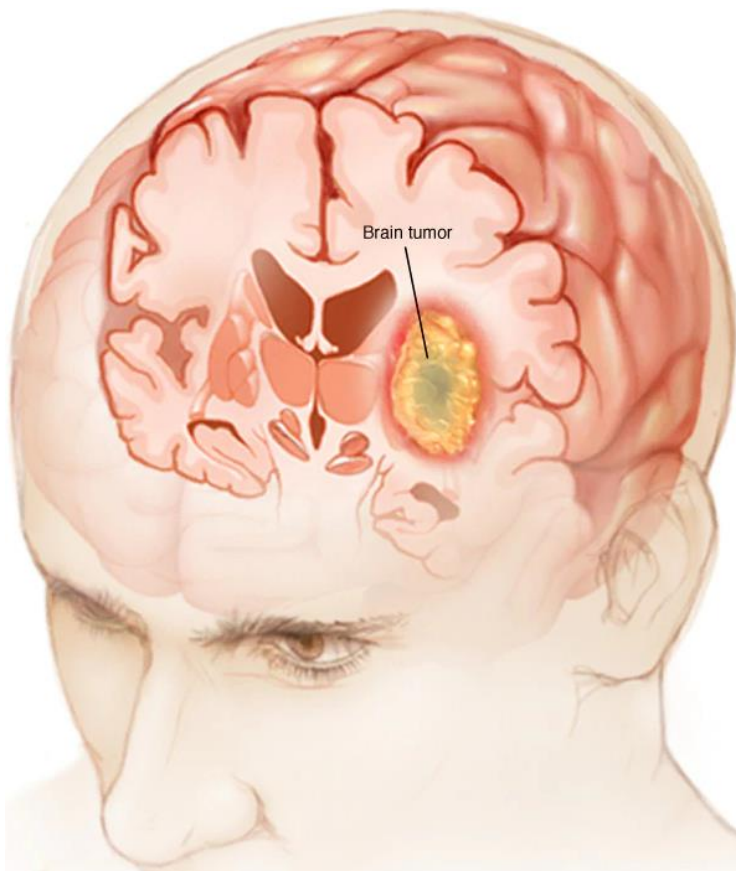


SEMINAR: BRAIN TUMOURS

34484 Pathology of the
nervous system

Neurosurgery



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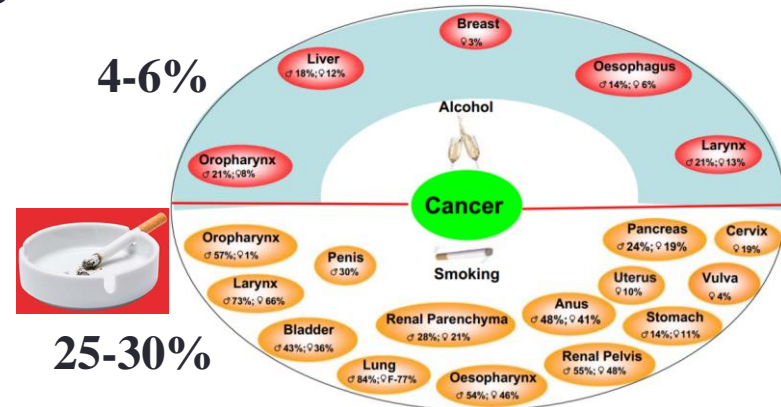
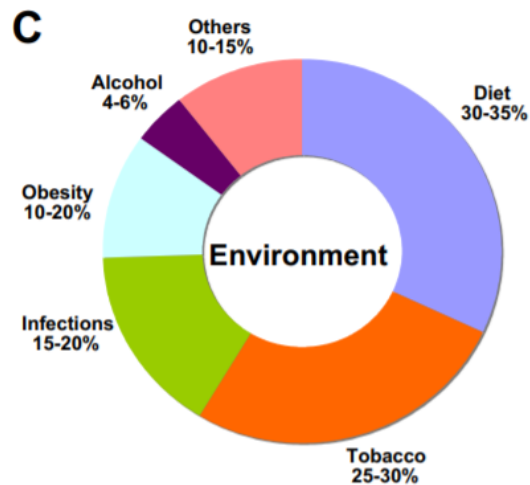
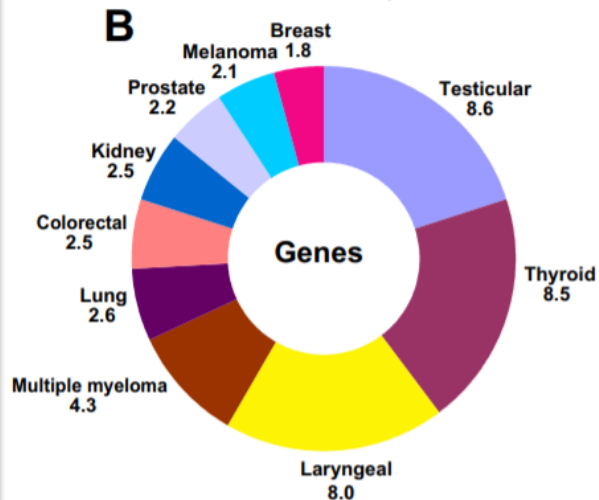
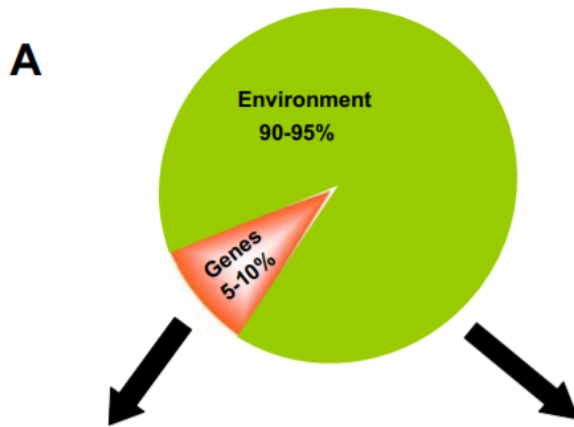
Key concepts

- Cancer
- Brain tumours
- Brain metastases
- Gliomas
- Meningiomas
- Schwannomas
- Pituitary tumours
- Craniopharyngioma
- Primary brain lymphoma
- Meningeal carcinomatosis



Causes of cancer

- Genetic <10%
- Environment >90% = preventable

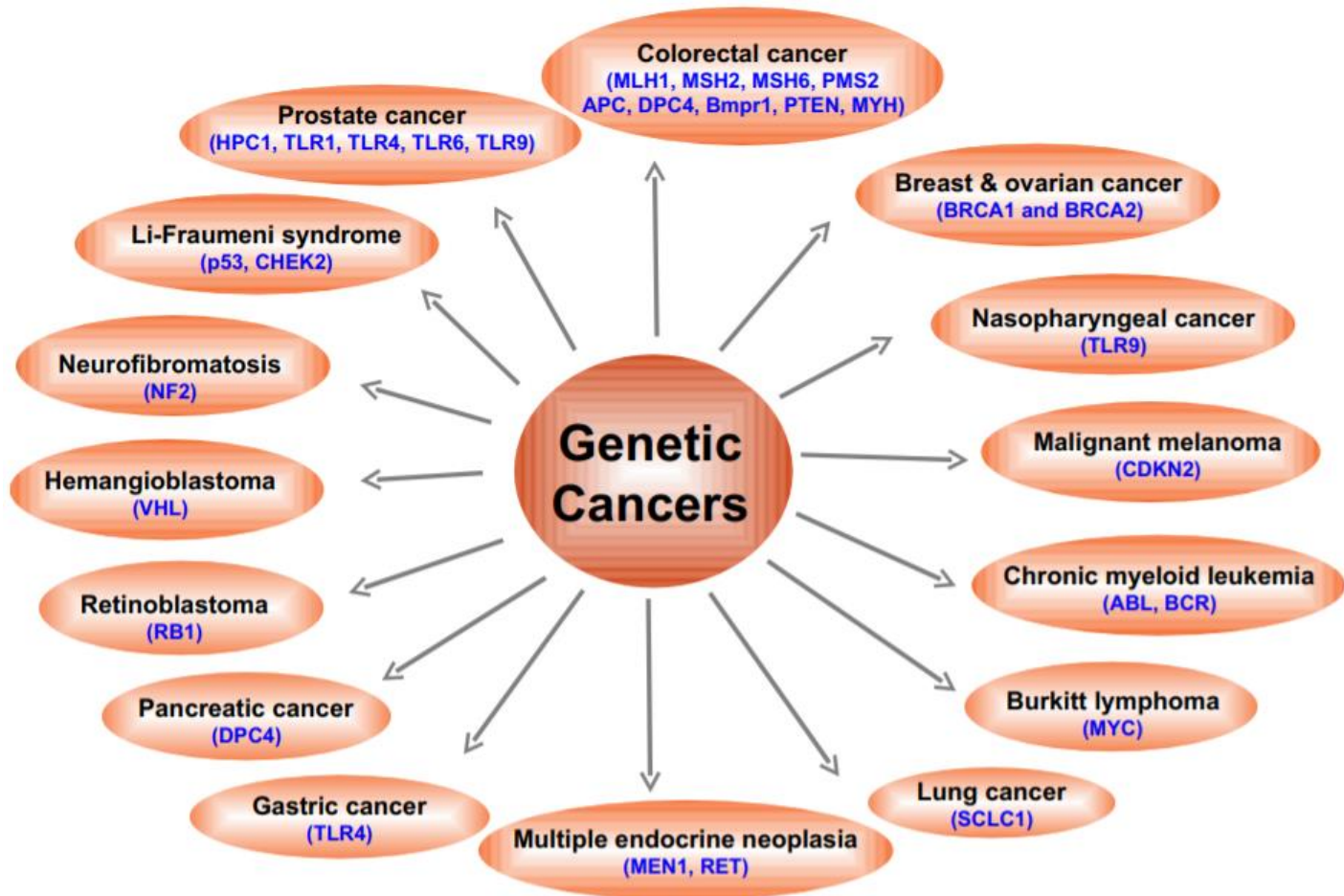


25-30%



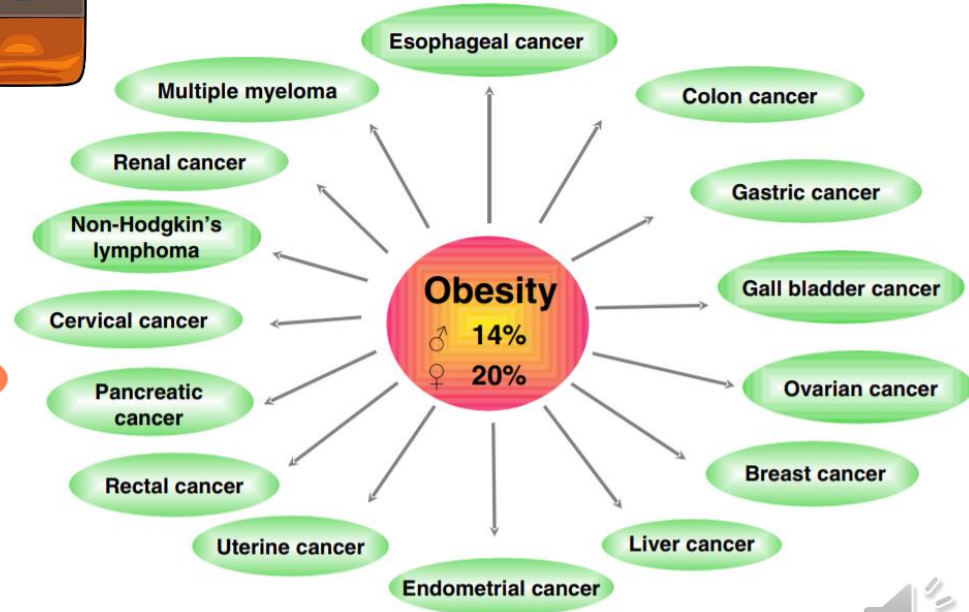
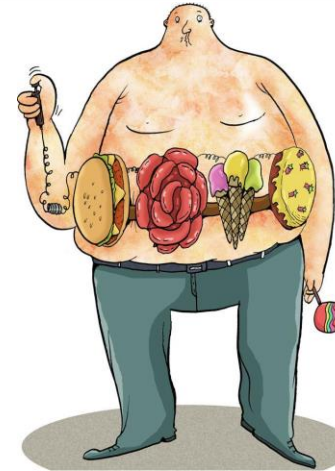
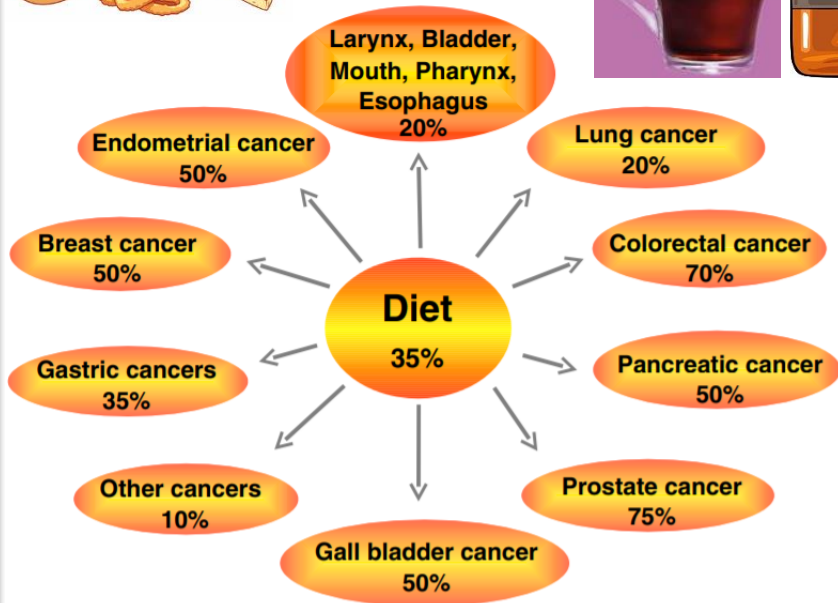
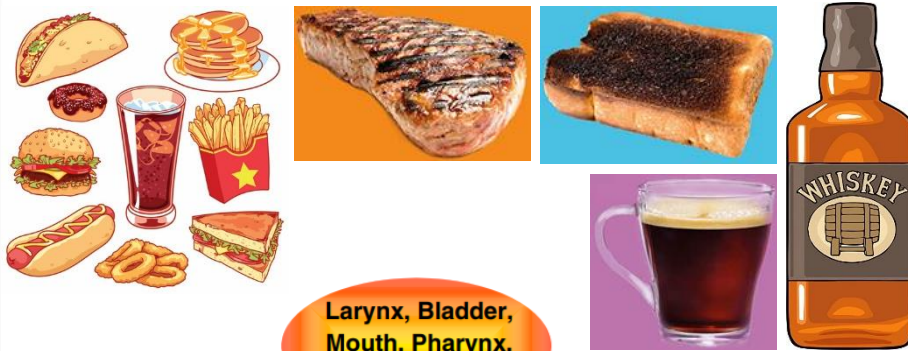
Cancer genetic abnormalities

- Enhanced by environmental chemical compounds



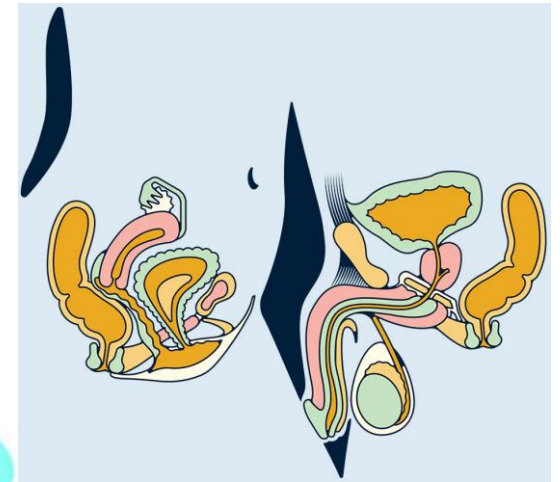
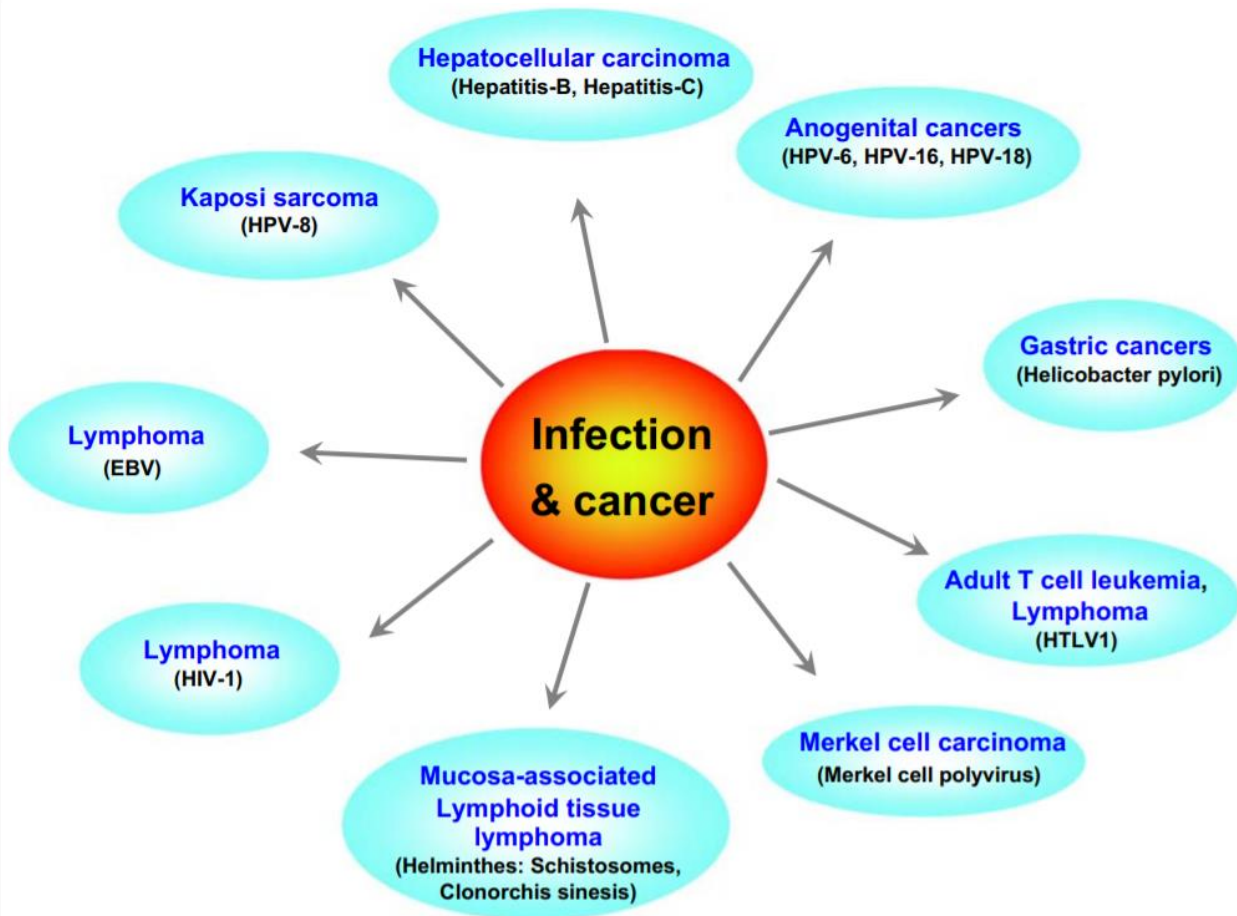
Preventable cancer causes

- Diet 35%
- Obesity 14%♂, 20%♀



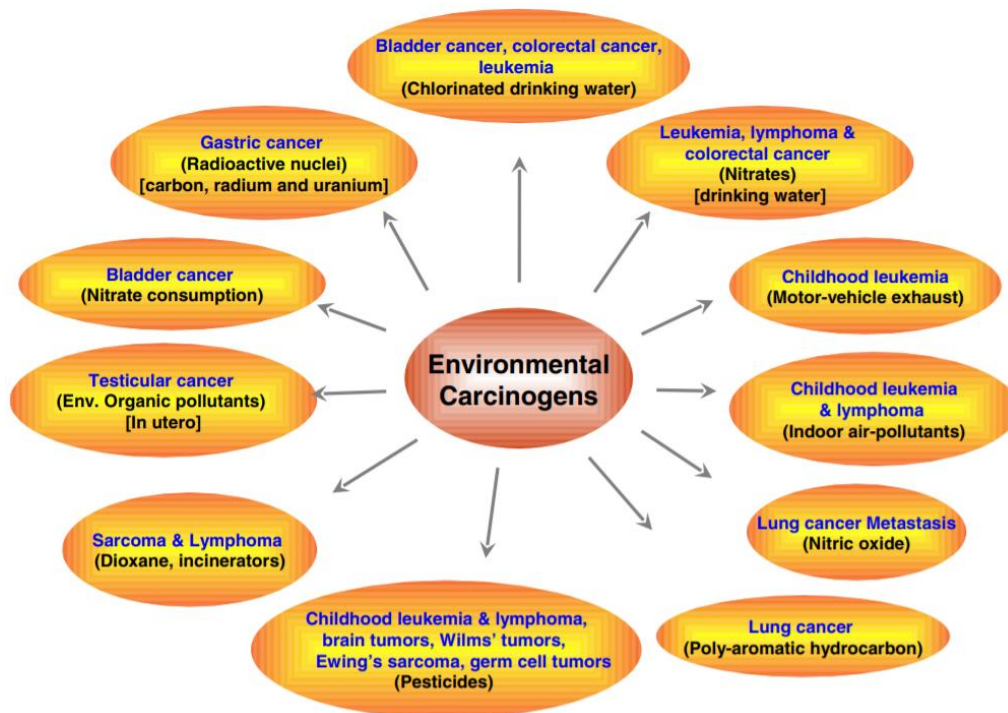
Infection cause of cancer 17.8%

- Many of these infections are transmitted through sex or drug-related activities



Environmental (95%)

- Many related to professional exposure
 - Often relaxed prevention measures (pesticide & herbicide exposure, saw dust, building workers, ...)
- Usually controlled legislation



Electromagnetic waves cause cancer?

- Mobile telephones = no proven relationship
- Electric power stations & high voltage electric lines possible relationship with leukaemia and pineal tumours



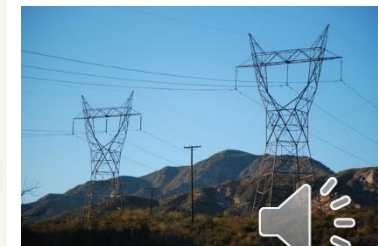
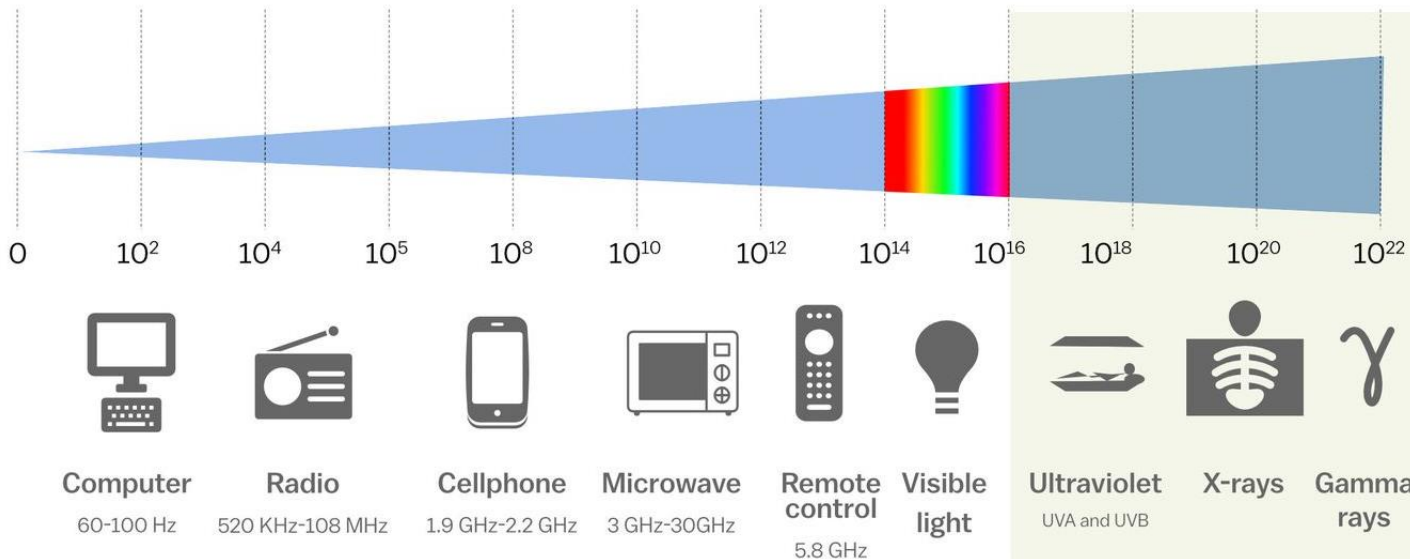
NON-IONIZING RADIATION

Traditionally perceived as harmless due to its lack of potency

IONIZING RADIATION

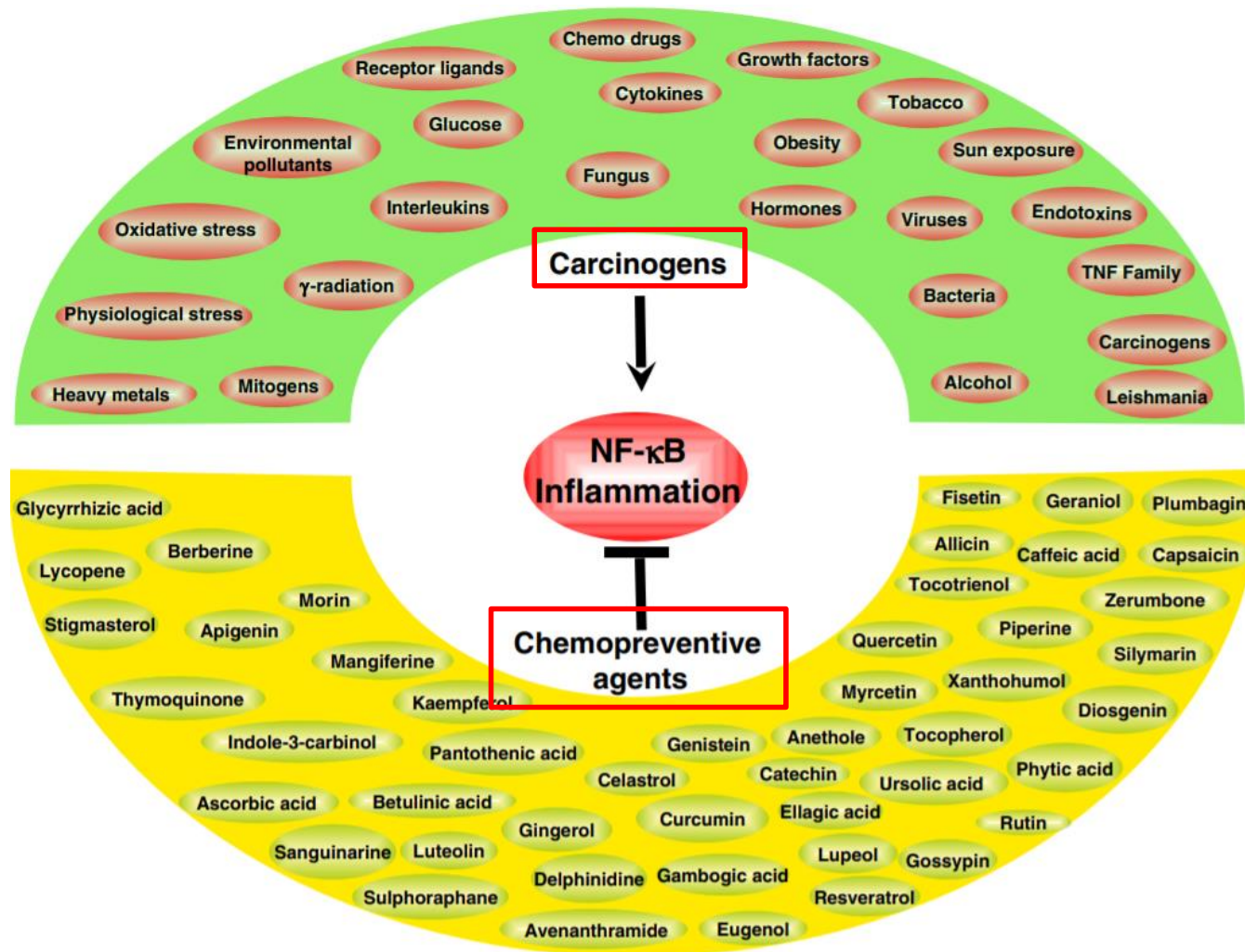
Can cause cellular and/or DNA damage with prolonged exposure

Frequency (Hz)



Can we prevent cancer?

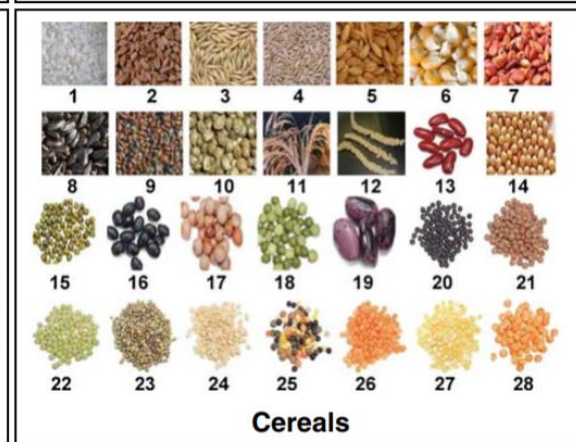
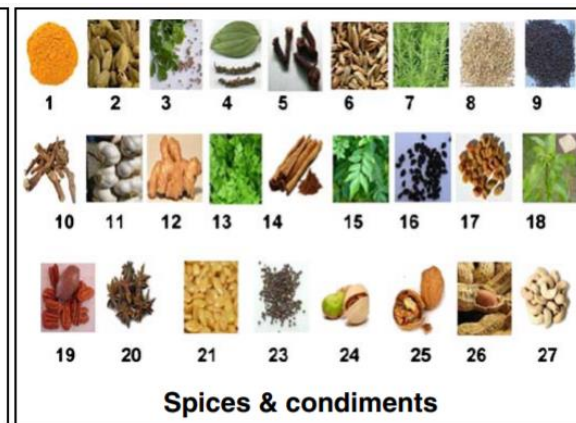
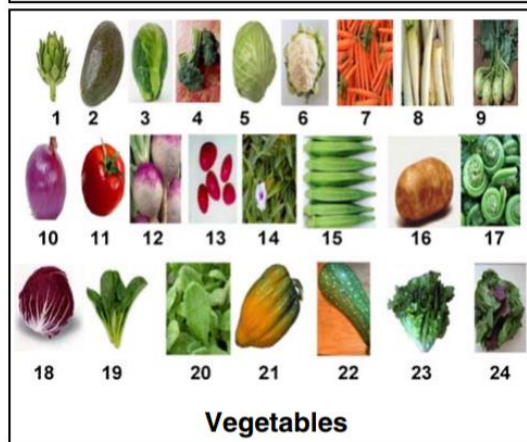
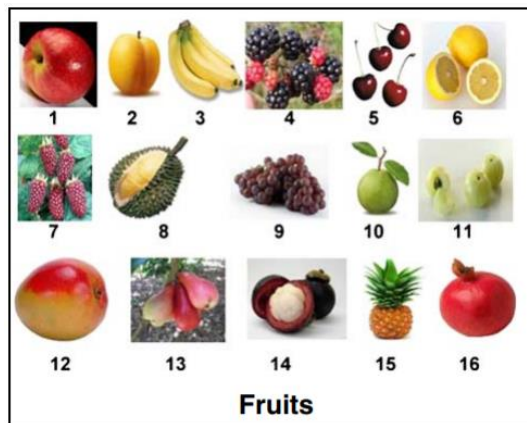
- Our habits change the equilibrium for better or worse



How to prevent cancer?

- Most fruits, spices, vegetables & cereals prevent cancer = adequate diet!

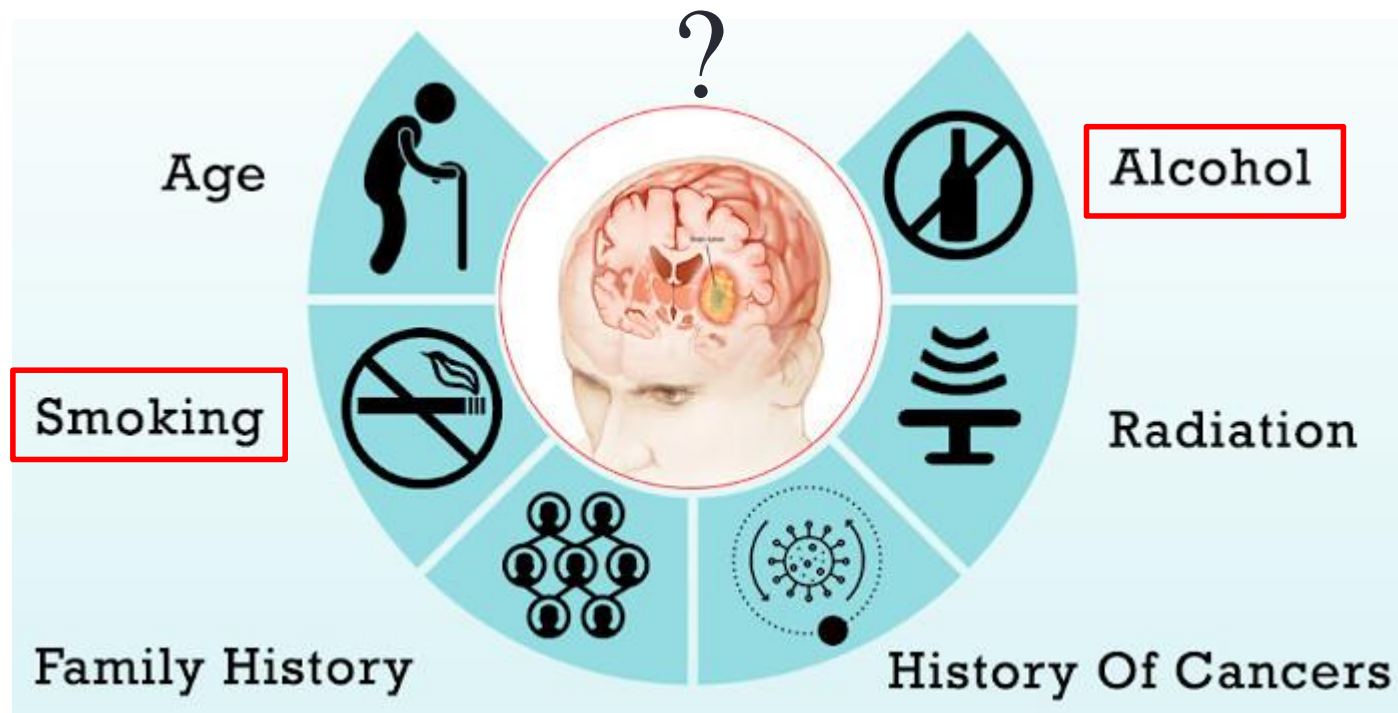
- ↓roasted meat
- ↓fried potatoes
- Cooking by boiling healthier than roasting, frying or microwaving



Fruits, vegetables, spices, condiments and cereals with potential to prevent cancer. Fruits include 1 apple, 2 apricot, 3 banana, 4 blackberry, 5 cherry, 6 citrus fruits, 7 dessert date, 8 durian, 9 grapes, 10 guava, 11 Indian gooseberry, 12 mango, 13 malay apple, 14 mangosteen, 15 pineapple, 16 pomegranate. Vegetables include 1 artichoke, 2 avocado, 3 brussels sprout, 4 broccoli, 5 cabbage, 6 cauliflower, 7 carrot, 8 daikon, 9 kohlrabi, 10 onion, 11 tomato, 12 turnip, 13 ulluco, 14 water cress, 15 okra, 16 potato, 17 fiddle head, 18 radicchio, 19 komatsuna, 20 salt bush, 21 winter squash, 22 zucchini, 23 lettuce, 24 spinach. Spices and condiments include 1 turmeric, 2 cardamom, 3 coriander, 4 black pepper, 5 clove, 6 fennel, 7 rosemary, 8 sesame seed, 9 mustard, 10 liquorice, 11 garlic, 12 ginger, 13 parsley, 14 cinnamon, 15 curry leaves, 16 kalonji, 17 fenugreek, 18 camphor, 19 pecan, 20 star anise, 21 flax seed, 22 black mustard, 23 pistachio, 24 walnut, 25 peanut, 26 cashew nut. Cereals include 1 rice, 2 wheat, 3 oats, 4 rye, 5 barley, 6 maize, 7 jowar, 8 pearl millet, 9 proso millet, 10 foxtail millet, 11 little millet, 12 barnyard millet, 13 kidney bean, 14 soybean, 15 mung bean, 16 black bean, 17 pigeon pea, 18 green pea, 19 scarlet runner bean, 20 black beluga, 21 brown Spanish pardine, 22 green, 23 green (eston), 24 ivory white, 25 multi-coloured blend, 26 petite crimson, 27 petite golden, 28 red chief.

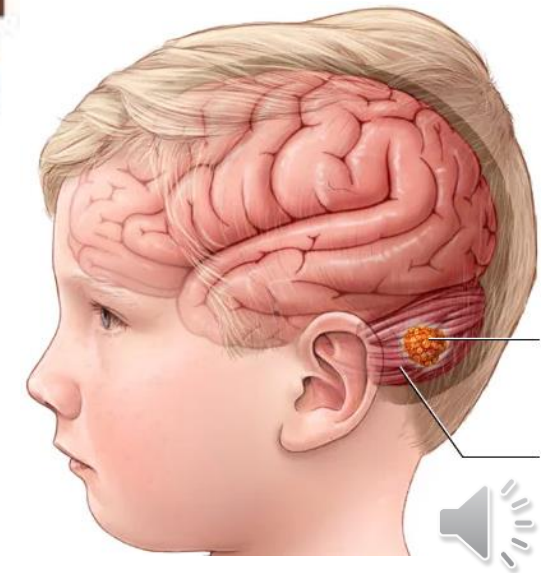
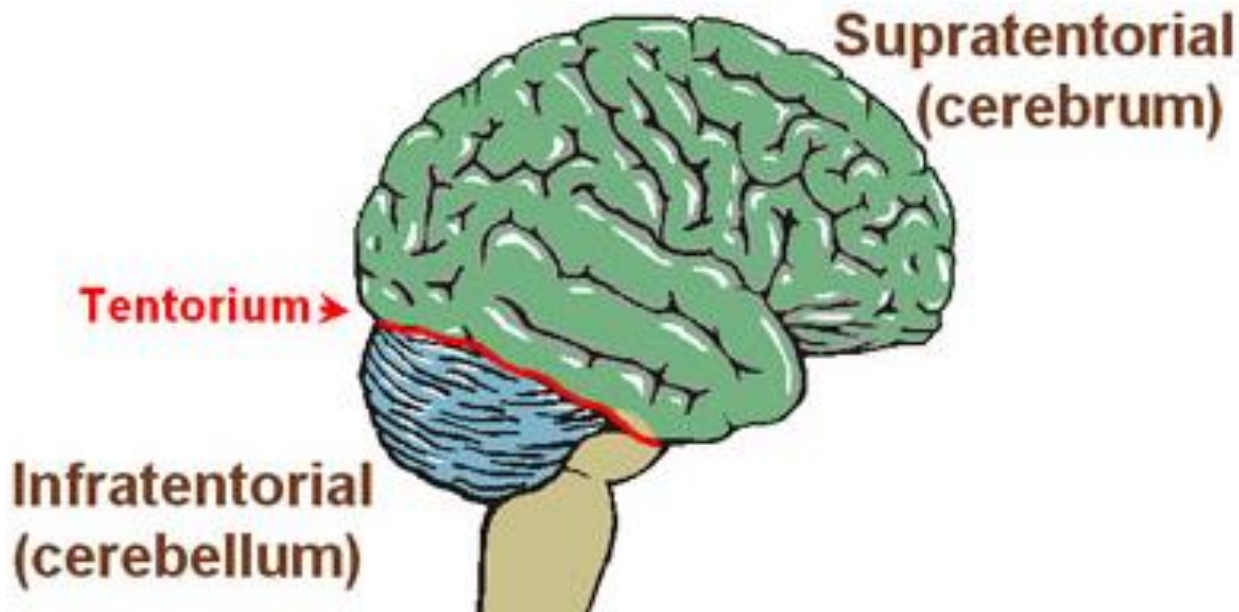
Cause of brain tumours

- Metastases = primary tumour prevention
- Primary brain tumours = some known causes
 - Most carcinogenic agents also act in the brain
 - Which are stopped by the blood brain barrier?



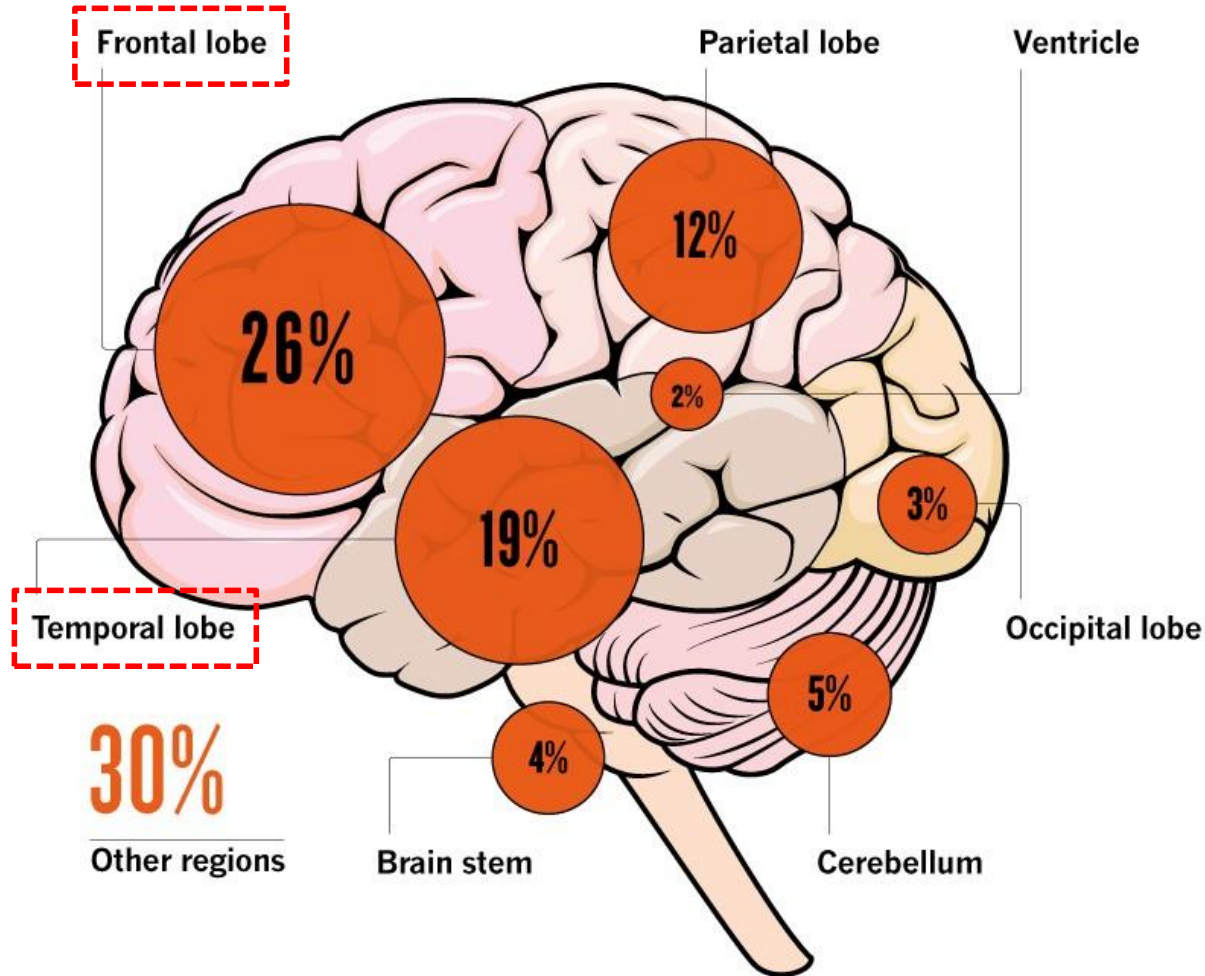
BRAIN TUMOURS: incidence & location

- Incidence: 10-17 / 100,000 inhabitants
- Location
 - Children: posterior fossa
 - 20% childhood malignant tumours
 - Adults: cerebral hemispheres 80%



BRAIN TUMOUR: distribution

- Frontal & temporal lobes mostly affected



CLINICAL PRESENTATION



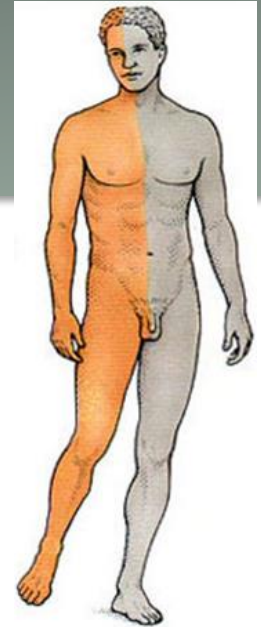
Headache (50%)



Nausea / vomiting (24%)



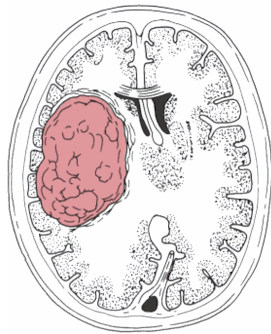
Epileptic seizures (15%)



Neurological deficit (65%)



Depression, personality changes, ... (25%)



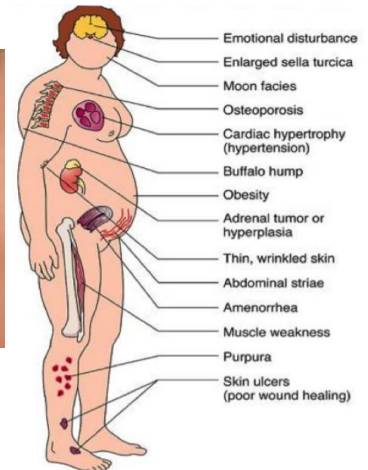
Cerebral haemorrhage (1%)



Vision loss (9%)



Hearing loss (2%)



Hormonal disorders (8%)

BRAIN TUMORS: types

- **Gliomas:**

- Astrocytoma
- Oligodendroglioma
- Ependymoma

- **Neuronal tumours**

- **Poorly differentiated tumours:**

- Medulloblastoma

- **Other parenchymal tumours**

- Primary brain lymphoma
- Germ cell tumour
- Pineal gland tumours

- **Meningioma**

- **Hemangioblastoma**

- **Pituitary tumours**

- **Nerve sheath tumours of the peripheral nervous system:**

- Schwannoma
- Neurofibroma

- **Metastatic tumours**

REMEMBER?



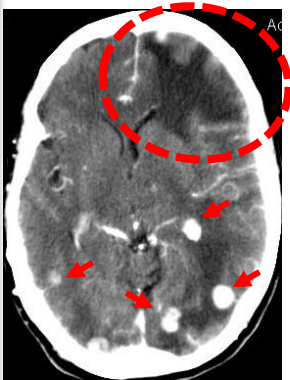
BRAIN TUMOURS: diagnosis

- Clinical features
- Physical examination
 - Neurological examination
 - Weight loss
 - Skin lesions
- Neuroimaging tests
 - CT scan
 - Cerebral
 - Thorax-abdomen-pelvic
 - Brain MRI
 - Spectroscopy
- PET
 - Cerebral
 - Total body

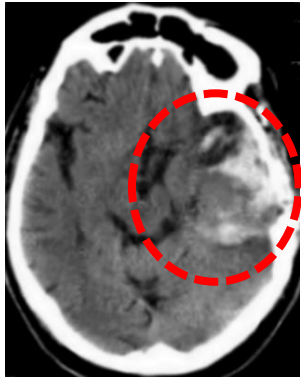


Neuroimaging: CT scan

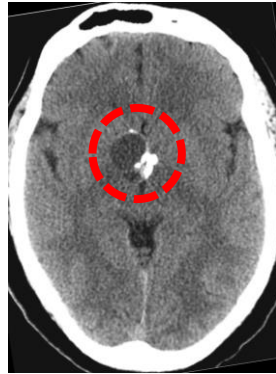
- Diagnoses the tumour not its nature
 - Possible confusion with benign lesions



Metastasis



Glioblastoma



Craniopharyngioma



Oligodendroglioma



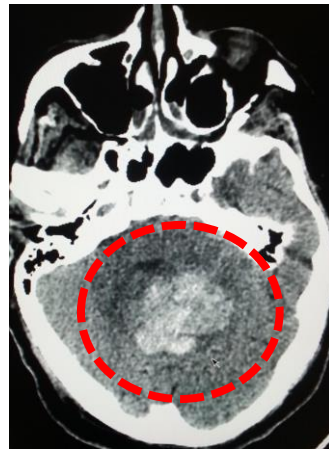
Calcification



Meningioma



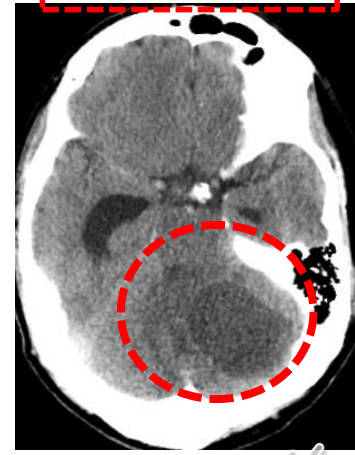
Cystic astrocytoma



Medulloblastoma



Astrocytoma



Metastasis



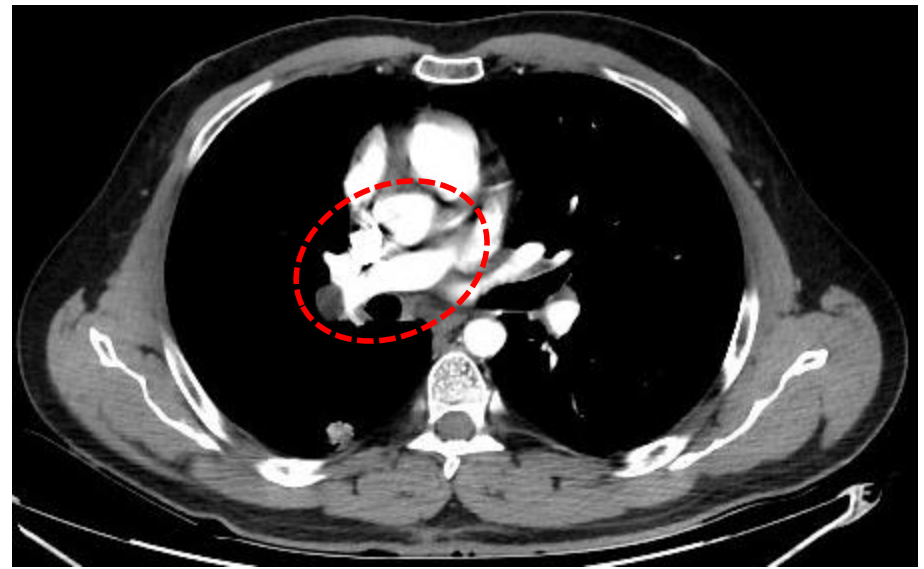
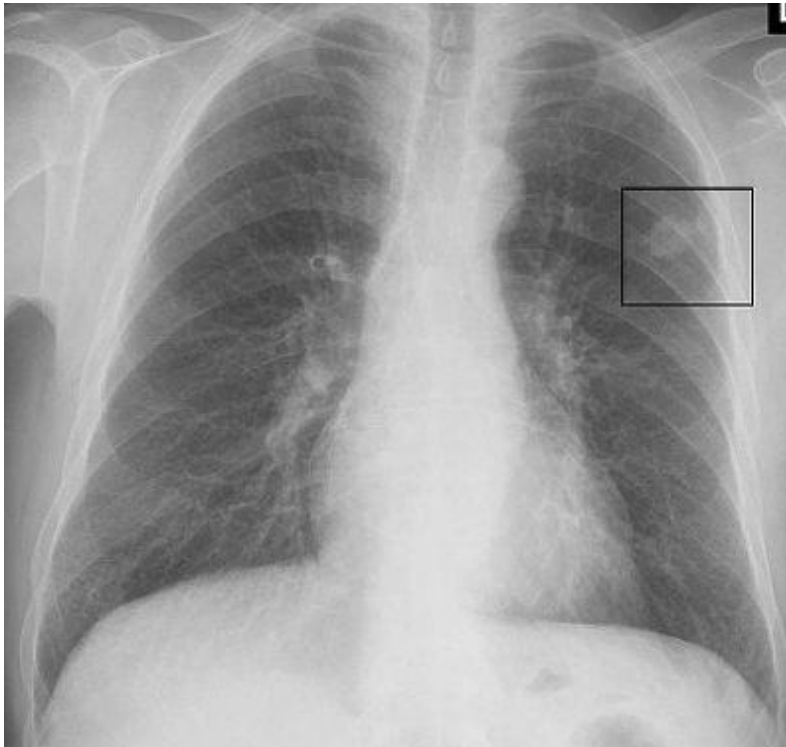
Searching for the primary tumour

- Plain chest x-ray not very useful
- CT thorax-abdomen-pelvis finds most primary tumours
 - Also helps to rule out other metastases
 - Melanomas request clinical inspection of WHOLE body



Chest plain x-ray

- Requested on a regular basis on pre-operative tests
- Poor diagnostic performance
 - Findings MUST be confirmed with CT scan

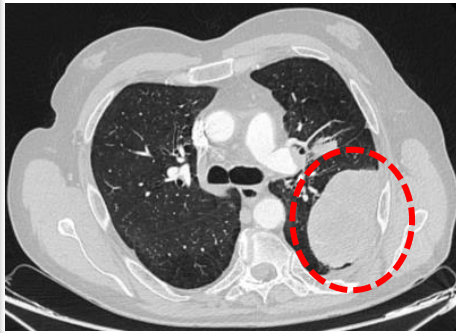


Lung cancer

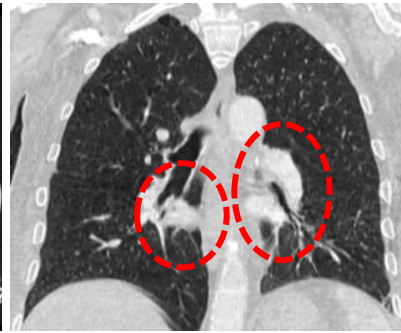


CT thorax-abdomen-pelvis

- Detects most primary tumours & their metastases
- In 15% primary not found = PET scan needed



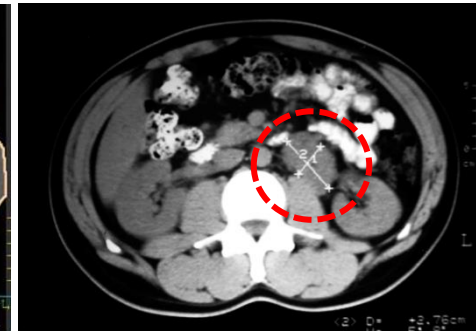
Mesothelioma



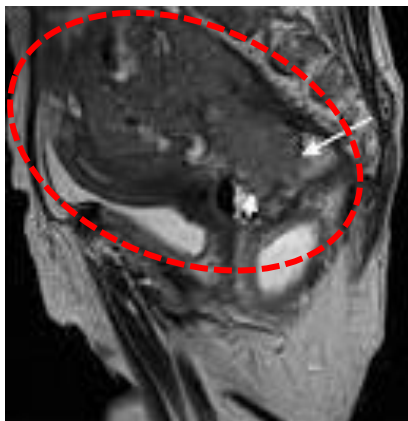
Lung cancer



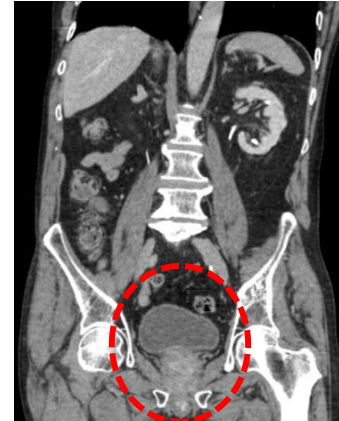
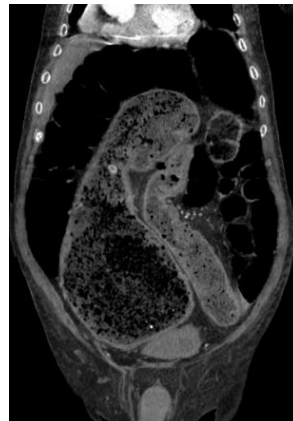
Breast cancer



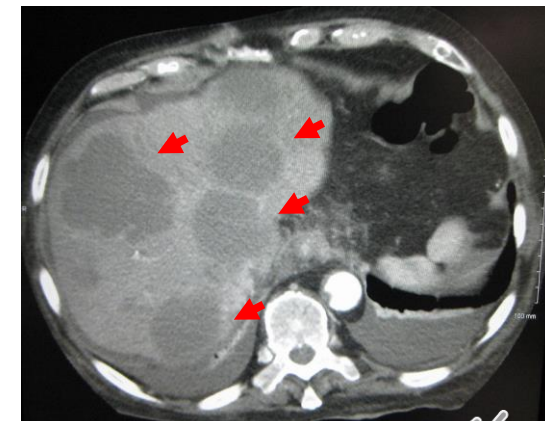
**Retroperitoneal
tumour**



**Rectum neoplasm + intestinal
obstruction**



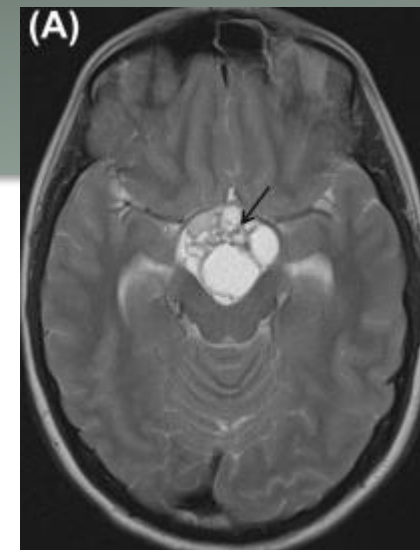
Prostate neoplasm



**Liver metastases from
colon neoplasm**

Neuroimaging: MRI

- Better anatomical detail than CT
- Several different series
 - Each depicts different tumour characteristics
- Shows lesion + edema + infiltration
- Calcifications better seen on CT
- Spectroscopy = biochemical markers
- Tractography
 - Shows if tumour displaces or destroys tracts
 - Helps decide if removal is possible and the path to take
- Eloquent brain area location
 - Essential for surgical planning



MRI



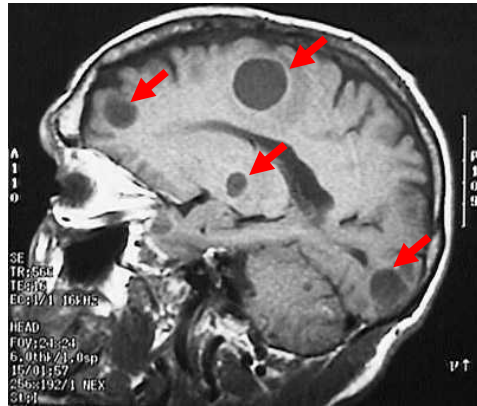
CT scan

MRI: better anatomical detail

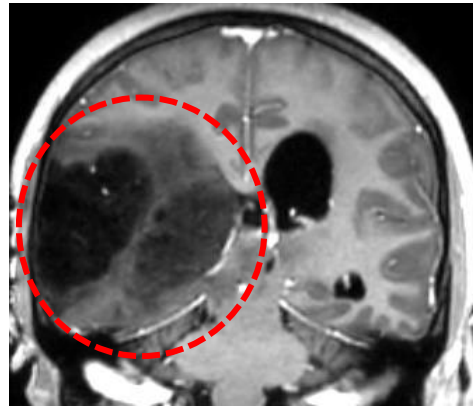
- Helps to identify the tumour type



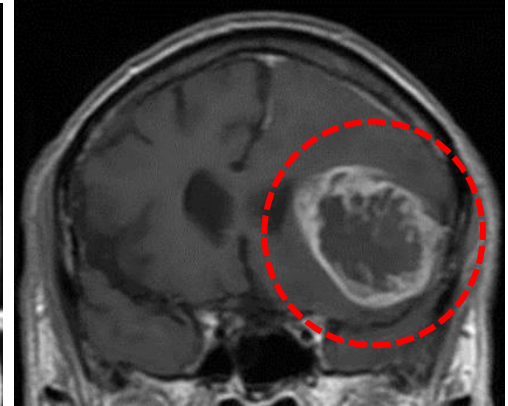
Single metastasis



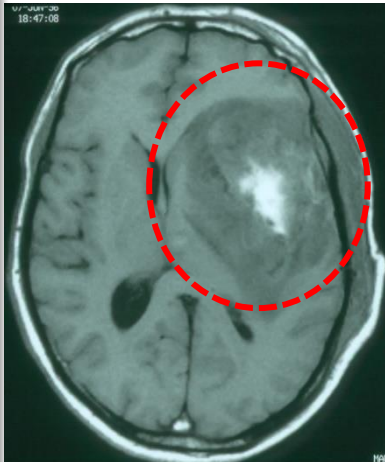
Multiple metastases



Low grade glioma



Glioblastoma



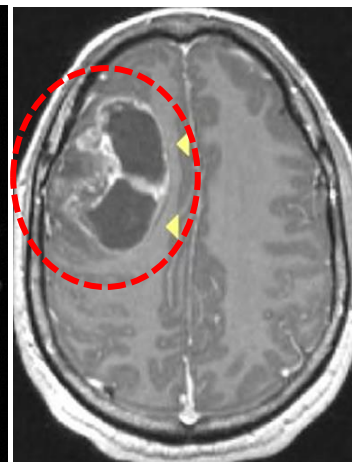
Low grade glioma & malignant evolution



Meningioma



Vestibular schwannoma



Oligodendrolioma

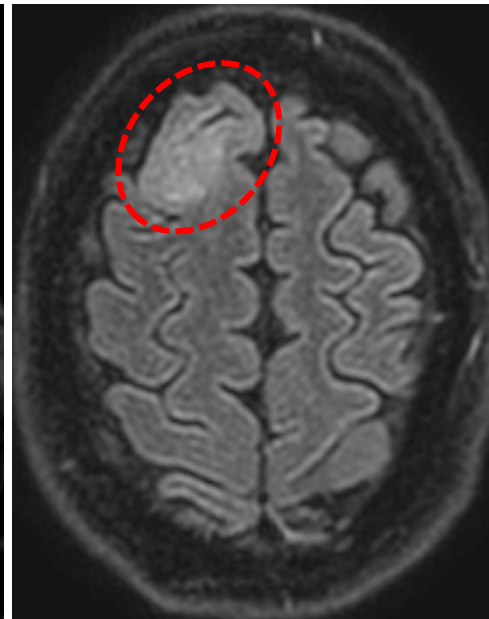
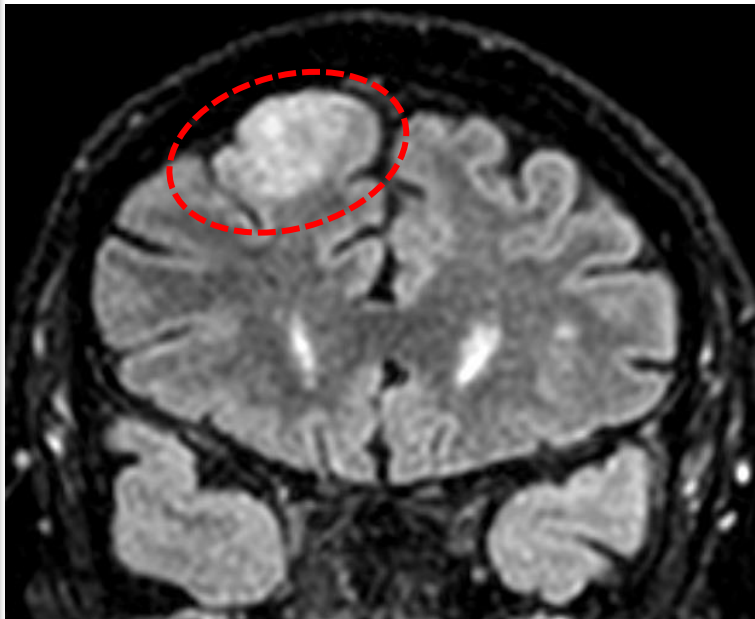
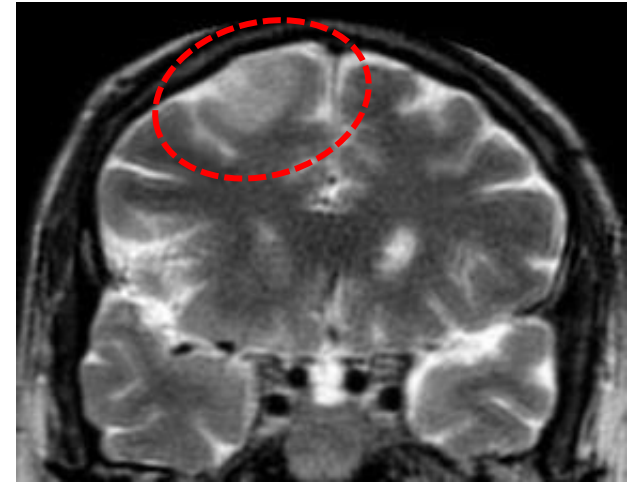


Brain abscess

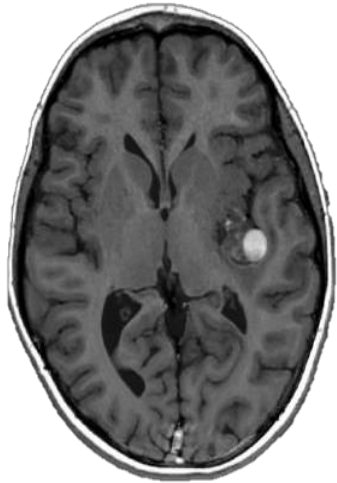


MRI: different series = different tumour characteristics

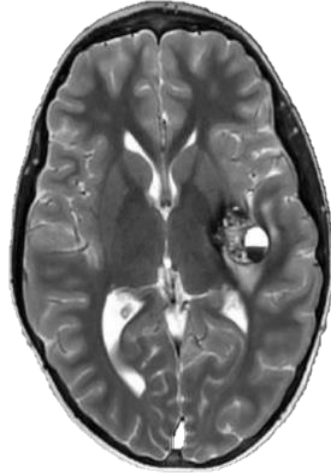
- Helps differentiate between tumour types
- Shows infiltrative patterns
- Allows surgery planning



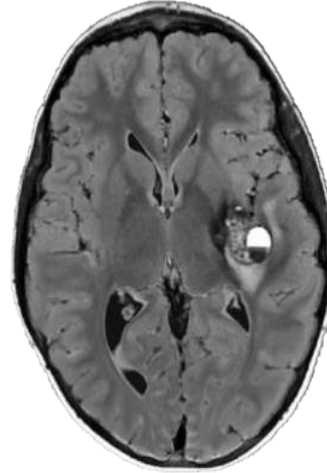
MRI: different series show different tumour characteristics



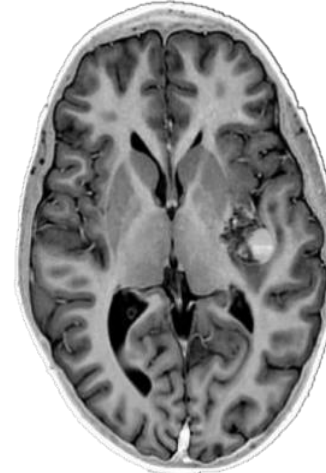
T1w



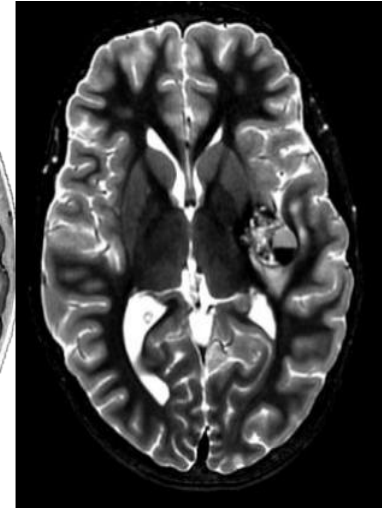
T2w



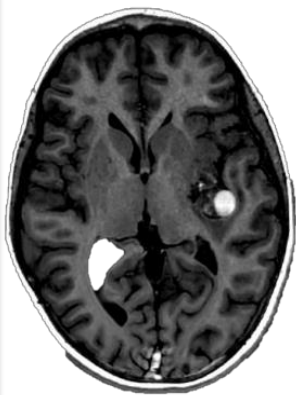
T2 FLAIR*



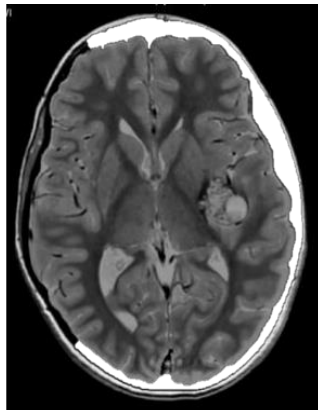
PSIR



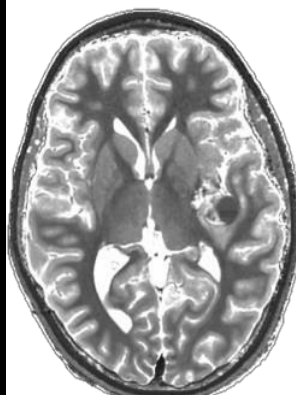
STIR



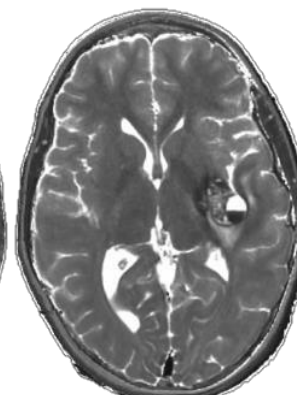
T1 FLAIR



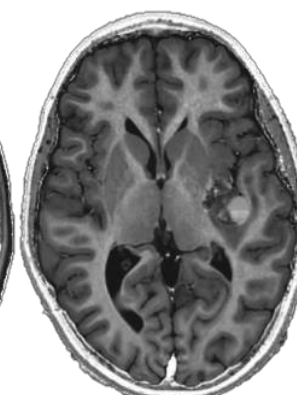
PD



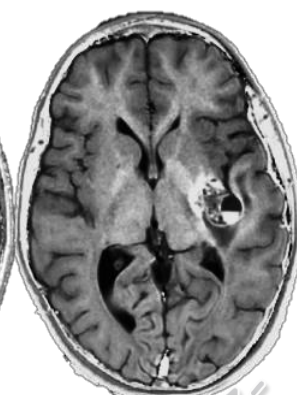
T1



T2



R1=1/T1



R2=1/T2

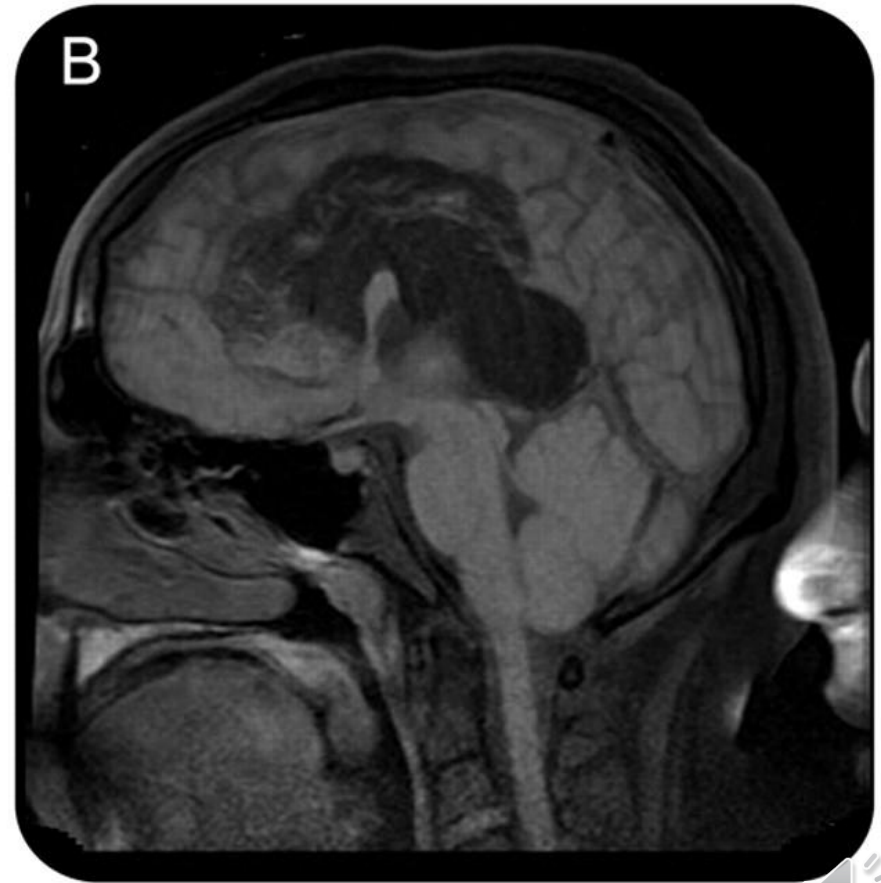


Brain lipoma

- Typical MRI features



Sagittal T1 brain MRI

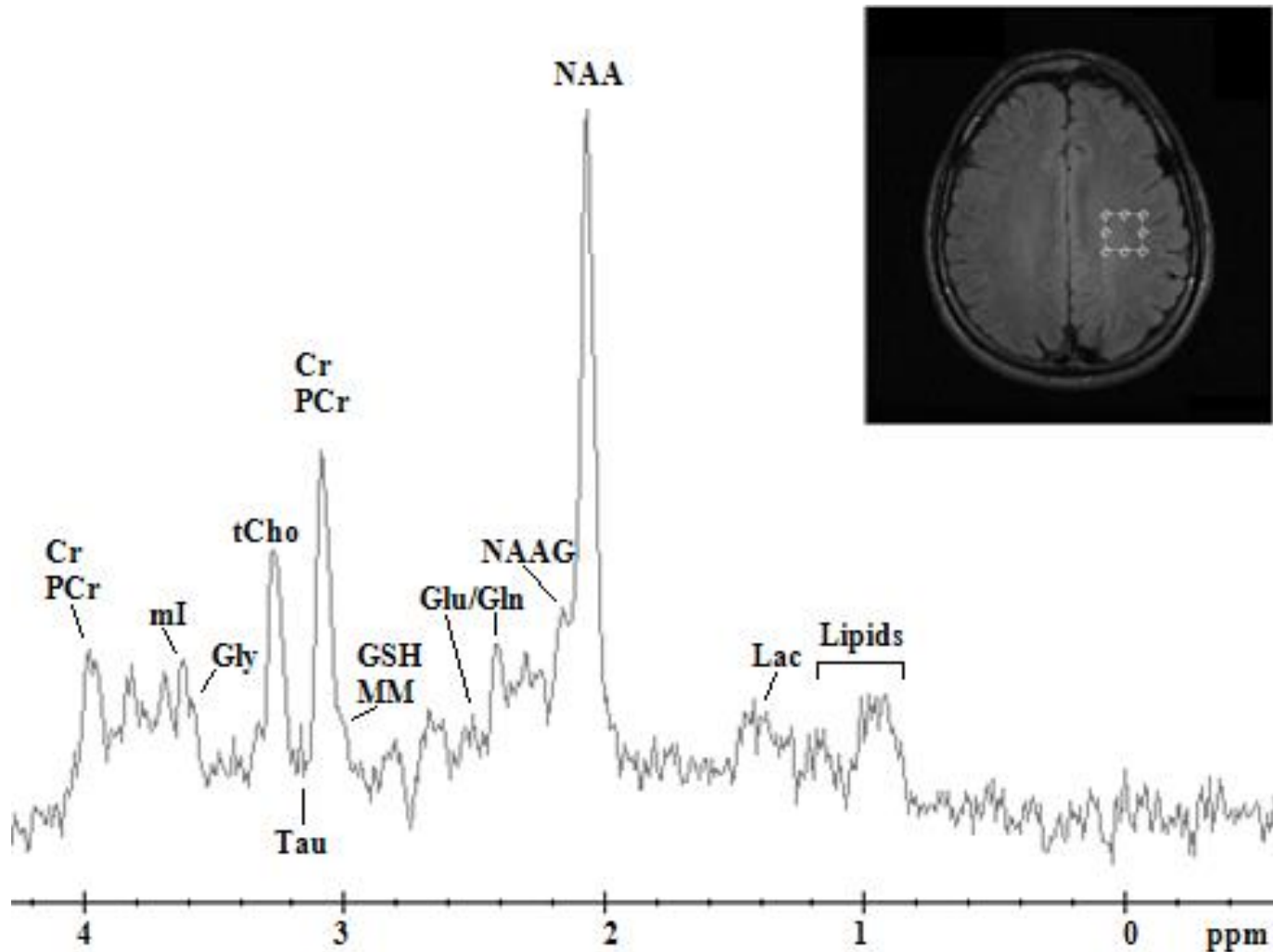


Sagittal fat saturation brain MRI



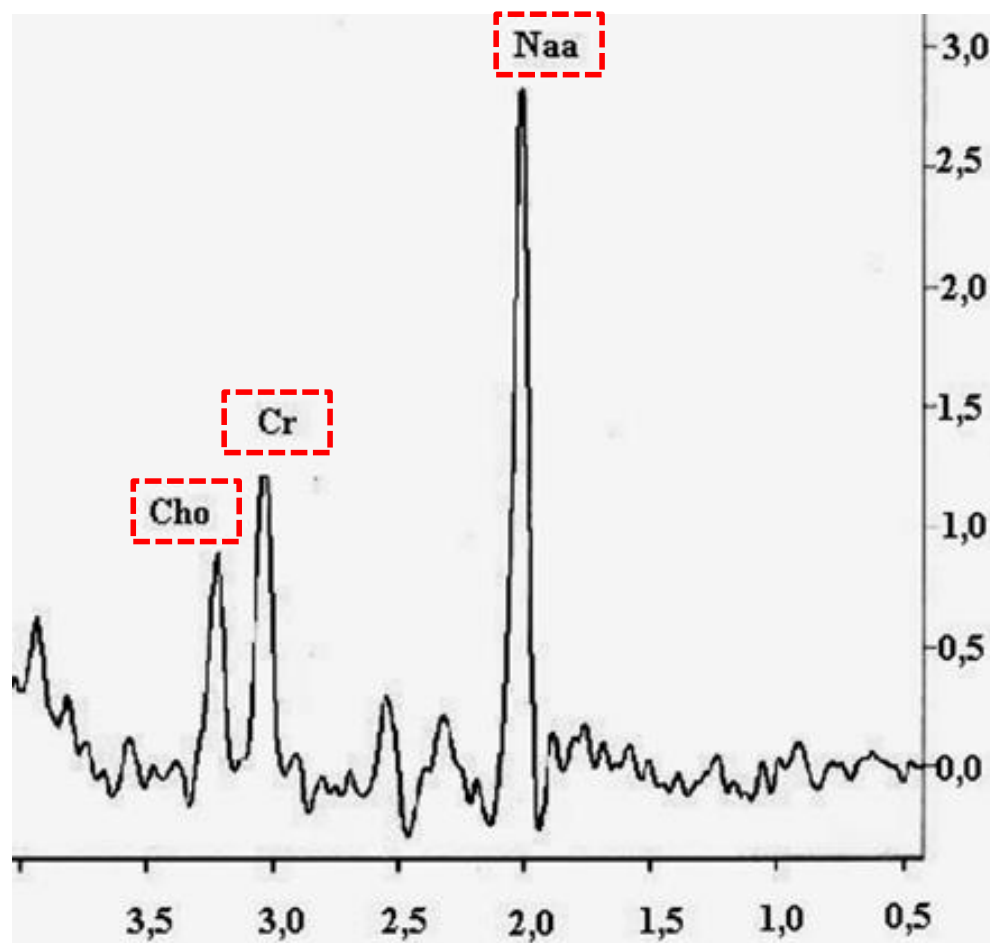
MRI spectroscopy: normal brain

- Analyses the tissular biochemical compounds



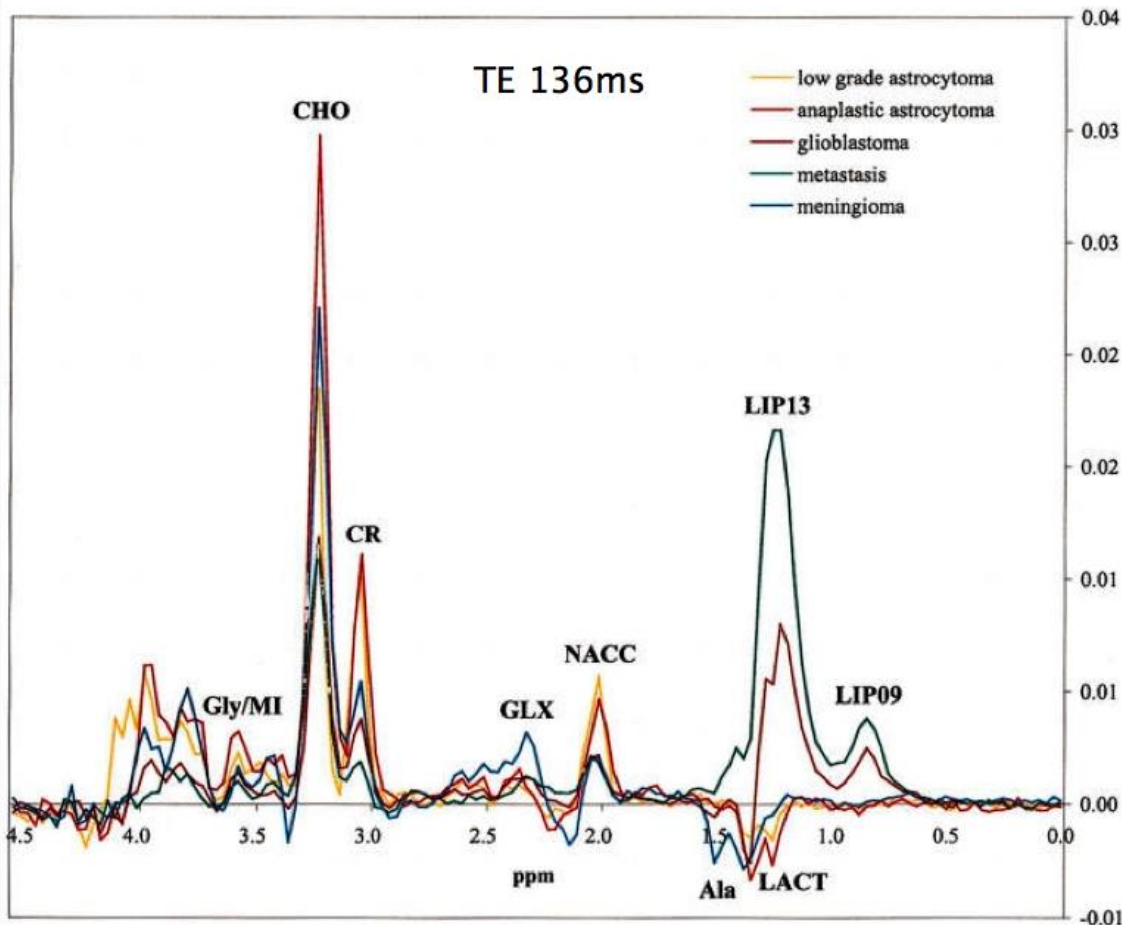
MRI spectroscopy: normal brain

- Most important to remember
 - NAA (N-acetyl-aspartate)
 - Cr (creatinine)
 - Cho (choline)



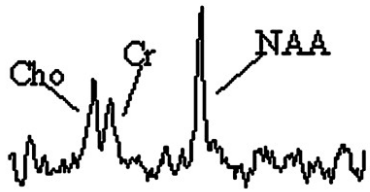
MRI spectroscopy: brain tumours

- Different patterns between different tumours = NON-invasive diagnosis



MRI spectroscopy: brain tumours

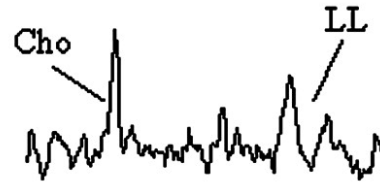
- Brain biopsy may still be necessary



normal brain



melanoma metastasis



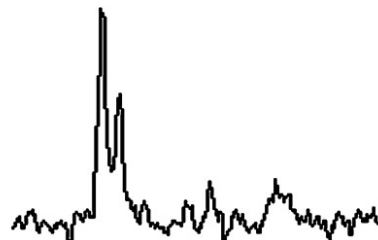
lung metastasis



lung metastasis



grade 2 glioma



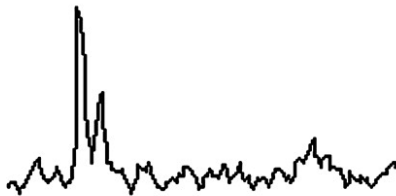
grade 2 glioma



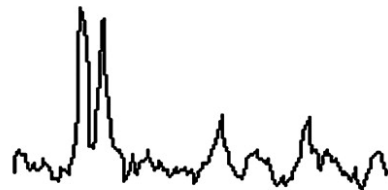
grade 3 glioma



grade 3 glioma



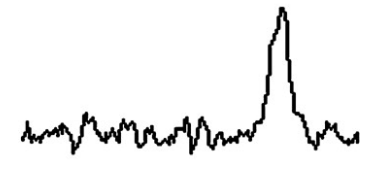
grade 4 glioma



grade 4 glioma



grade 4 glioma

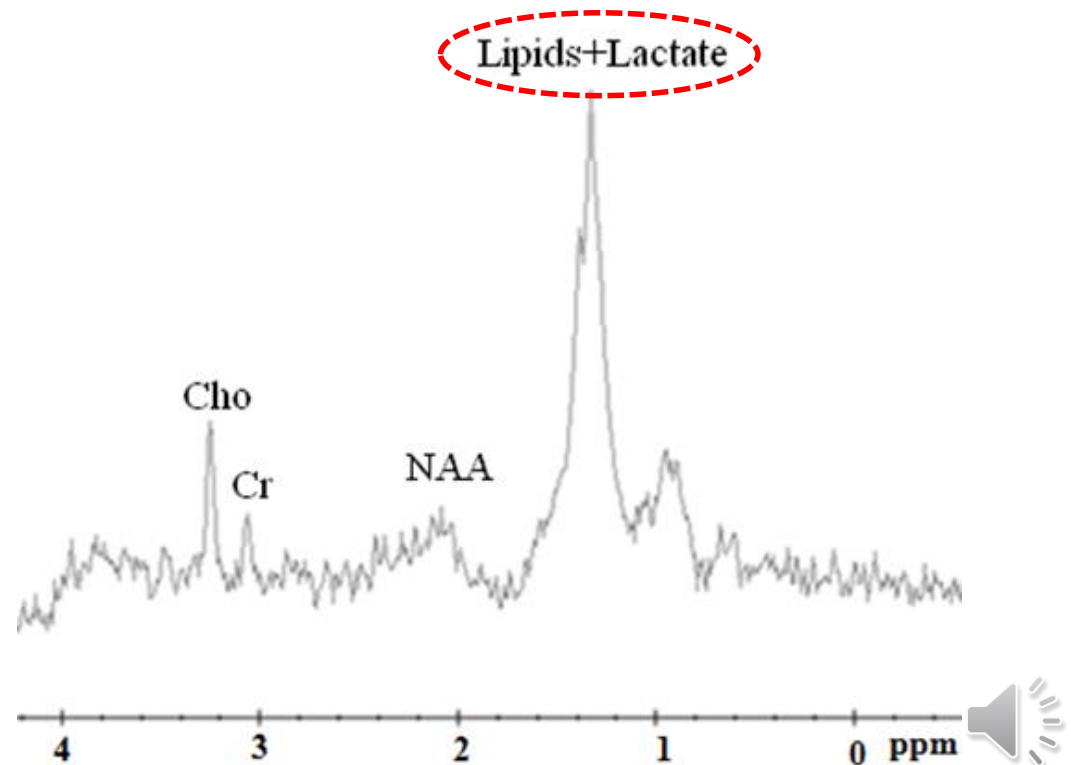


center of grade 4 glioma



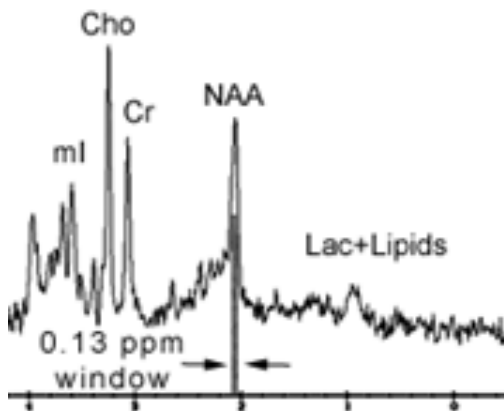
MRI spectroscopy: brain metastases

- Lipids + lactate peak
- Different between different metastases
 - Not enough to decipher primary tumour
 - If primary NOT found in CT thorax-abdomen-pelvis → brain biopsy

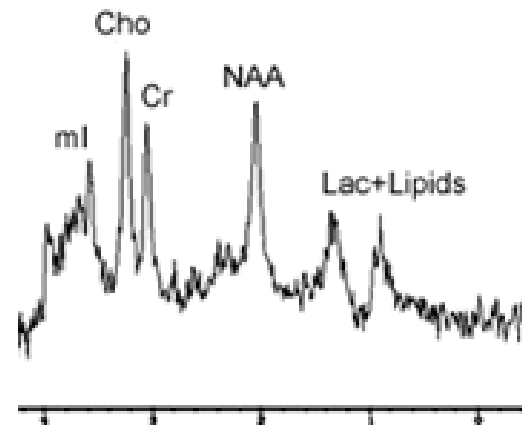


MRI spectroscopy: gliomas

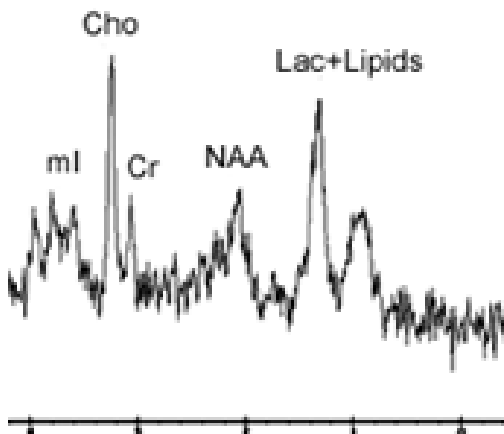
- NAA = cell proliferation
- Lactate + lipids = anaerobic metabolism = malignant



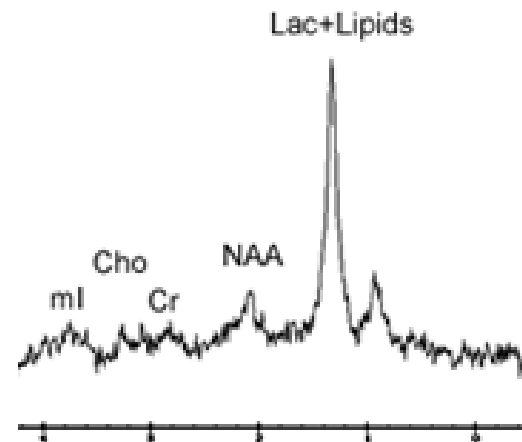
Astrocytoma
grade I



Astrocytoma
grade II



Astrocytoma
grade III

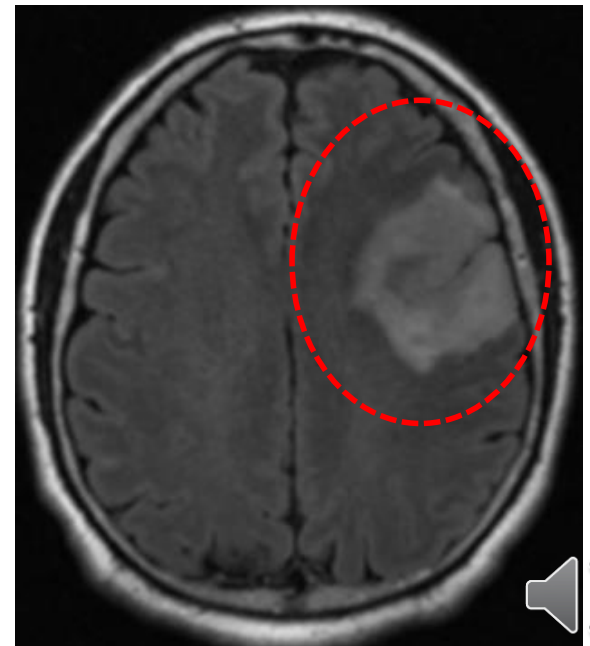
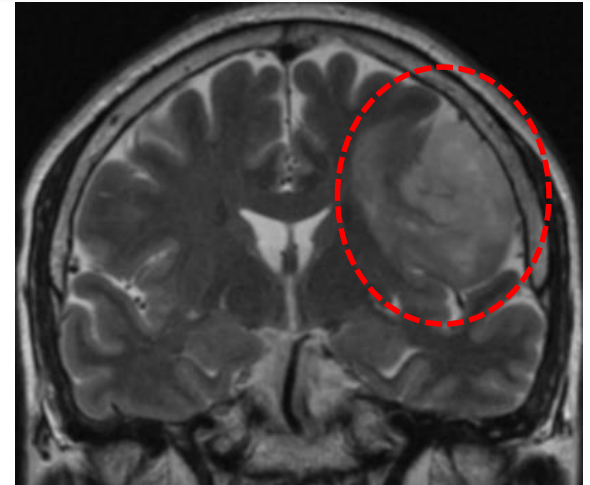
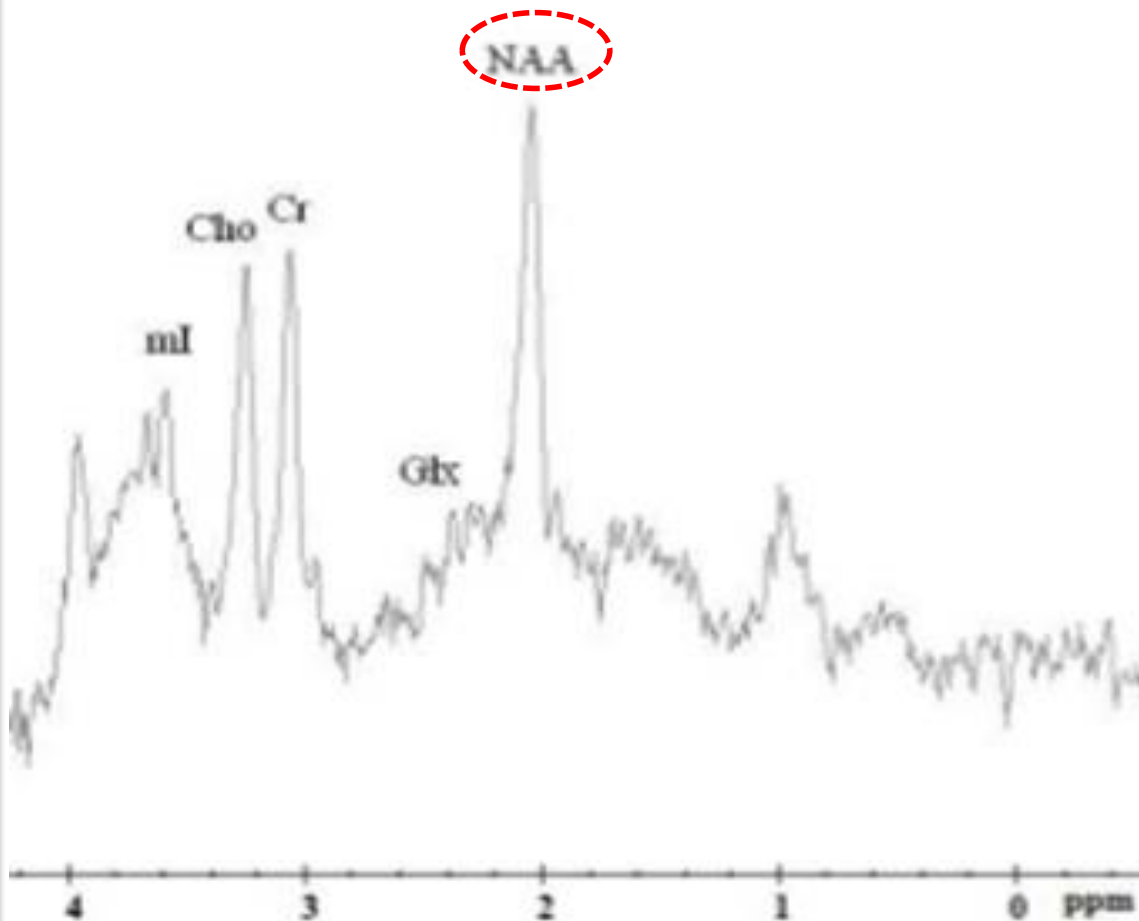


Glioblastoma
multiforme



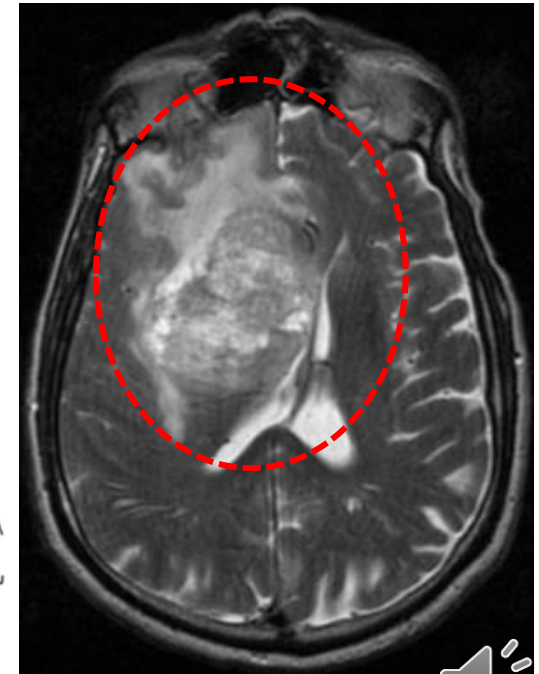
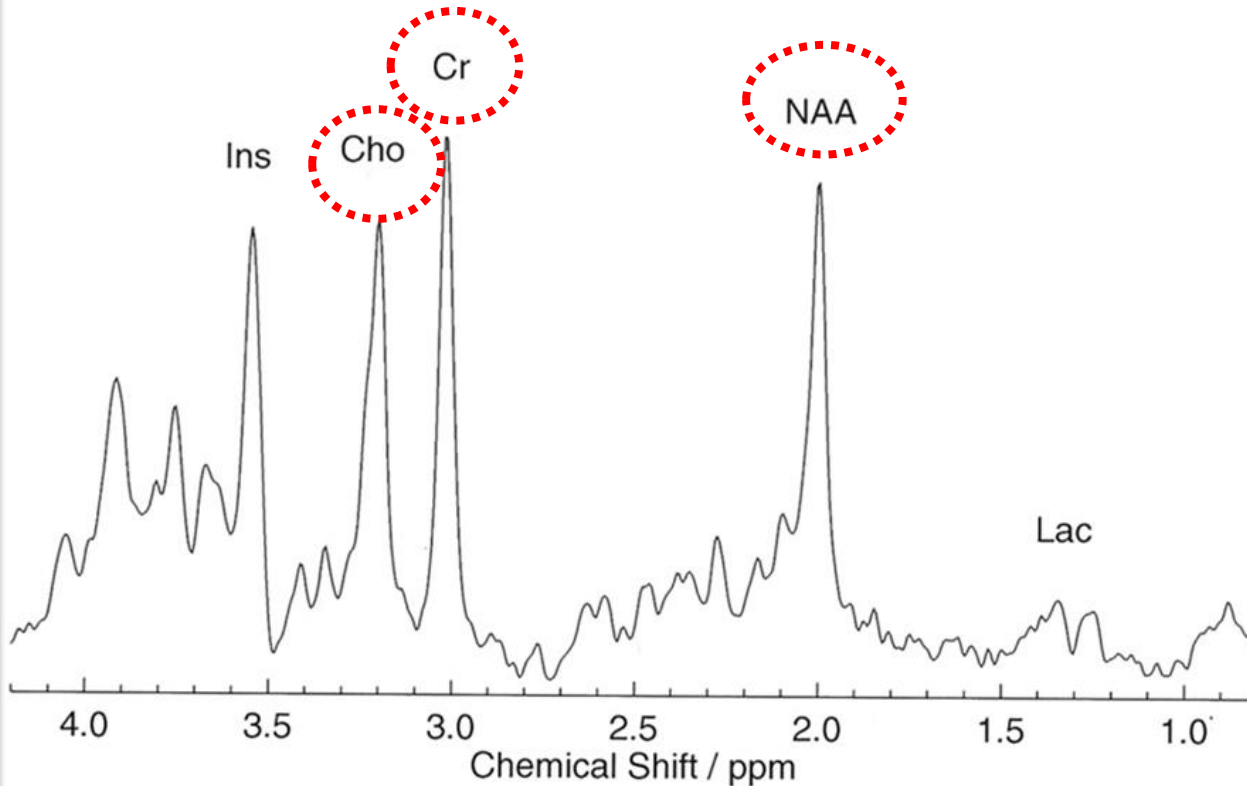
Glioma grade II: N-acetyl-aspartate peak

- NAA increase = cell proliferation



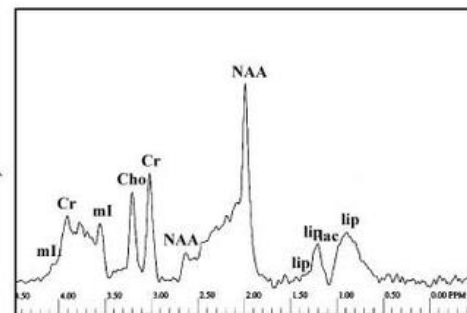
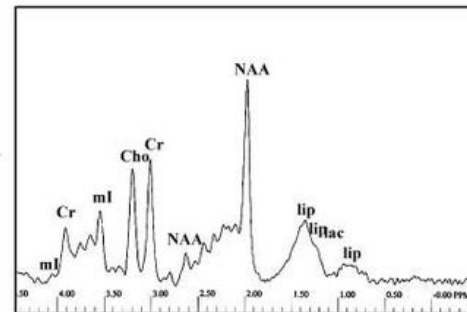
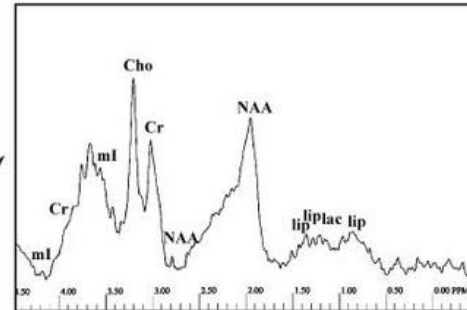
Glioblastoma: choline + creatinine + N-acetyl-aspartate peak

- Cr = index of mitochondrial energy production = malignancy
- Cho = involved in pathways of phospholipid synthesis and degradation = cell membrane



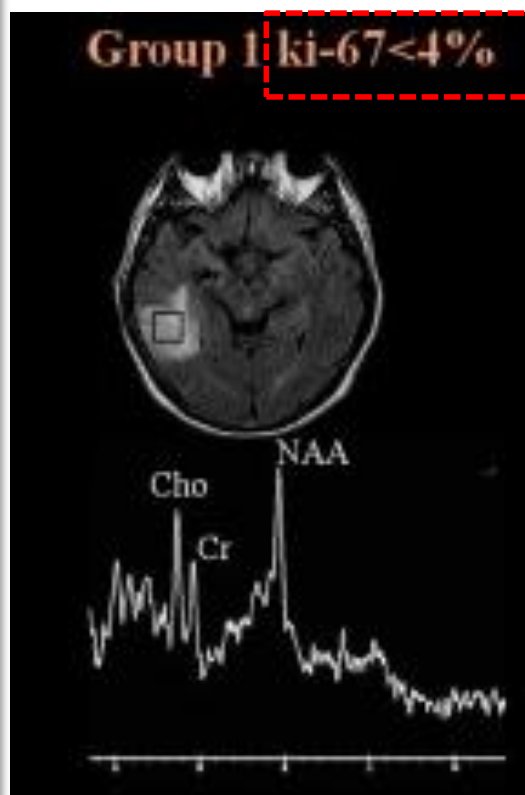
MRI spectroscopy low-grade glioma

- Helps identify infiltration pattern

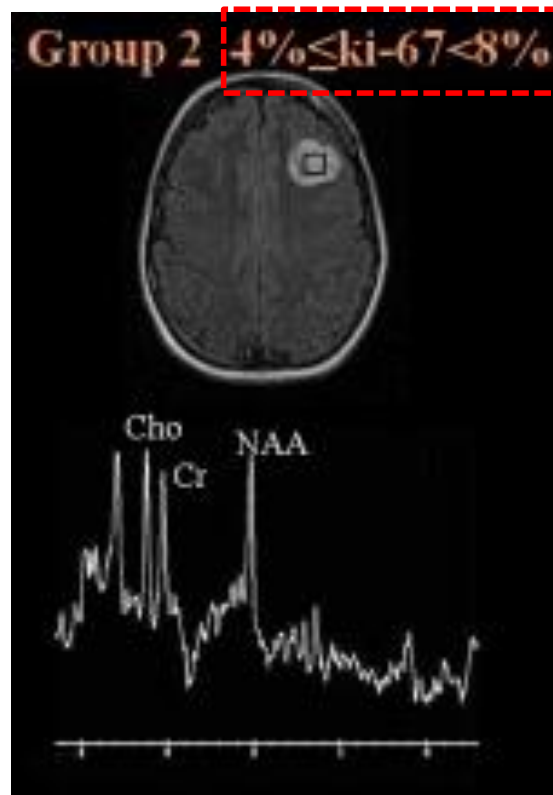


MRI spectroscopy gliomas: malignancy

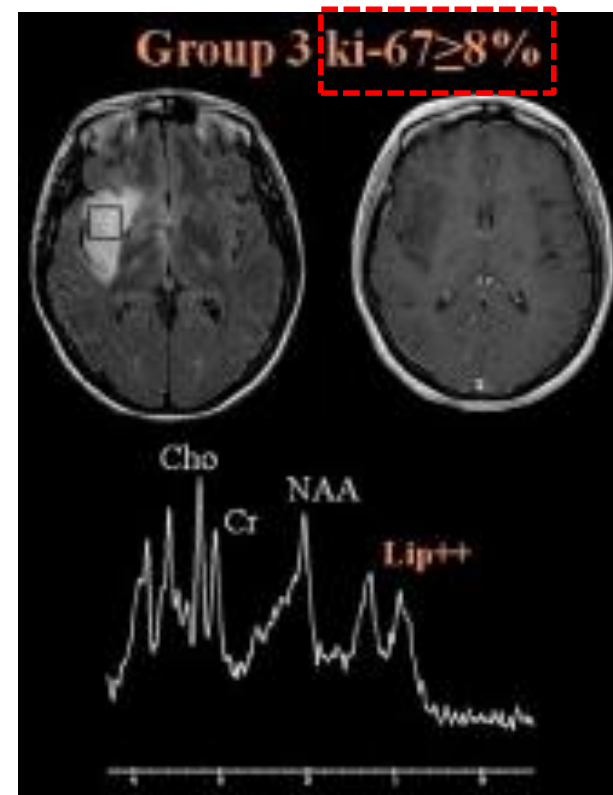
- Does not substitute histological examination!
- Ki-67 protein in cells ↑ increases as they divide
 - ↑↑ cells with Ki-67 = rapid division = malignancy



Absence lipids +
lactate



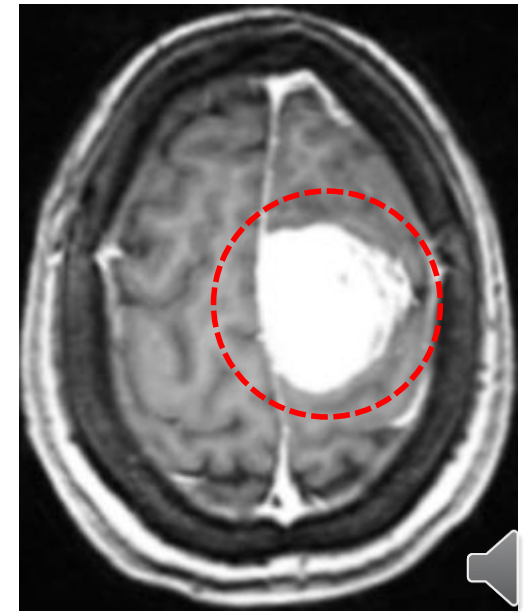
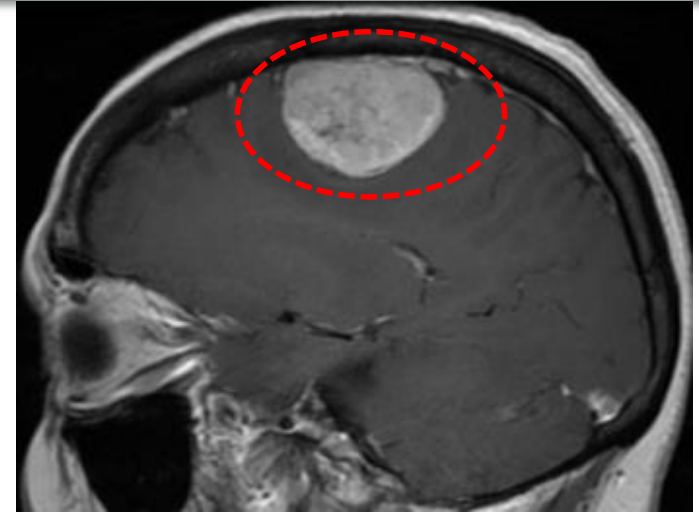
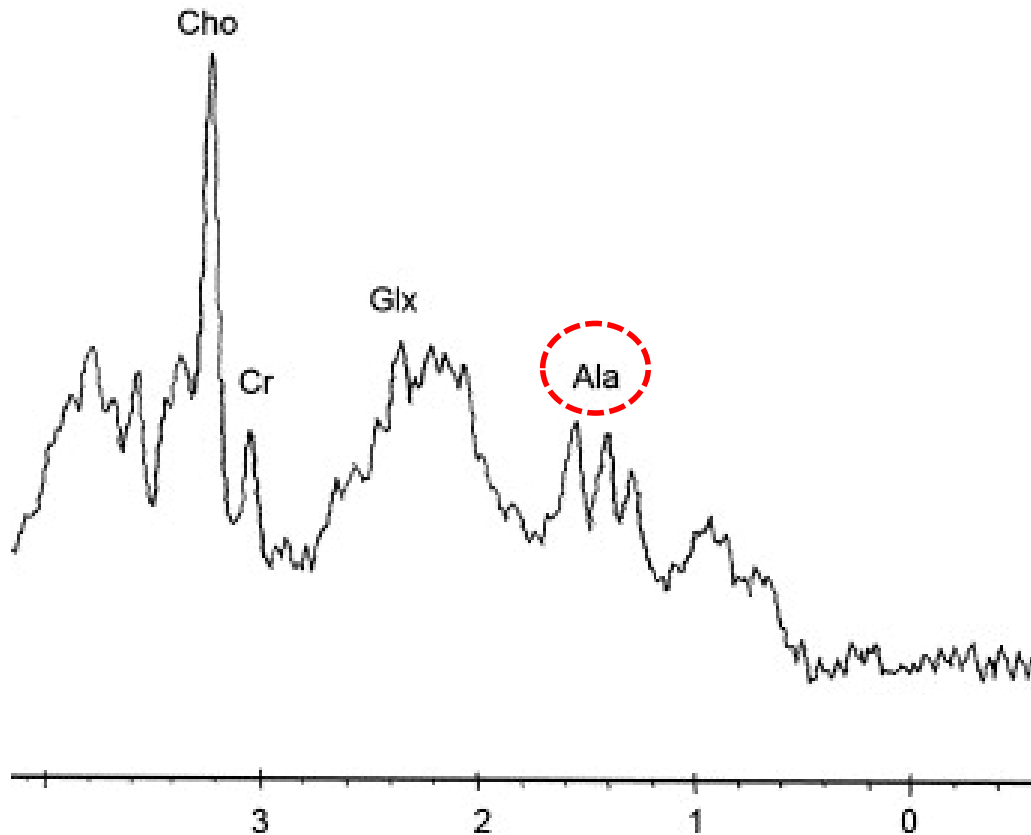
Presence lipids +
absence lactate



Presence lipids +
lactate 

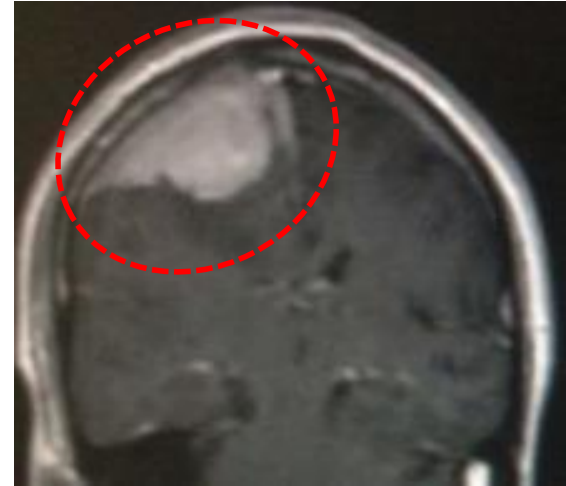
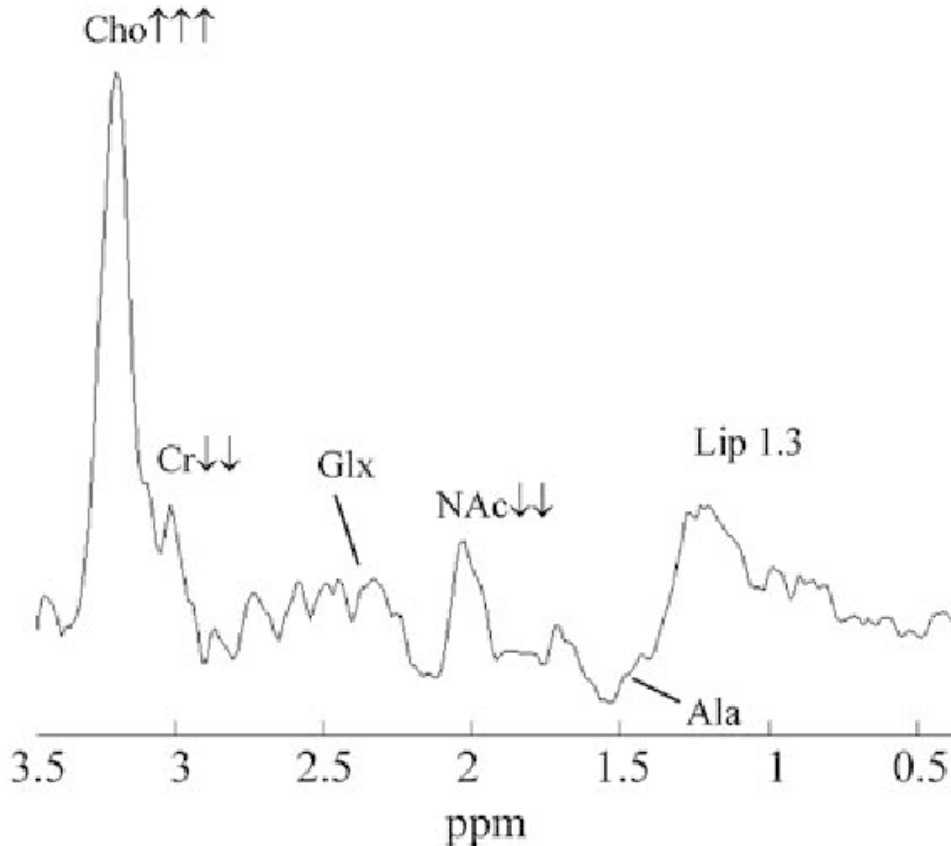
Meningioma: alanine peak

- It is an amino acid



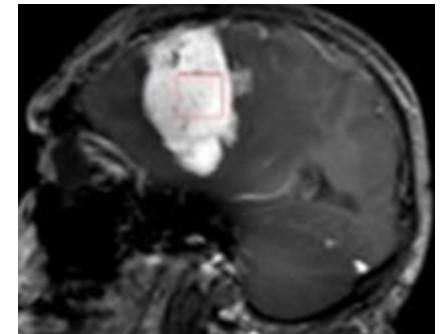
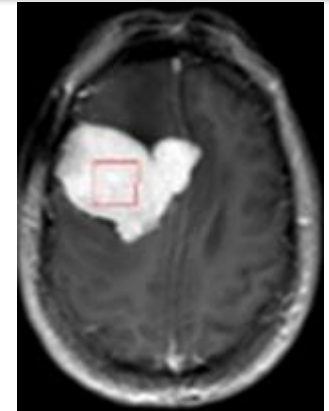
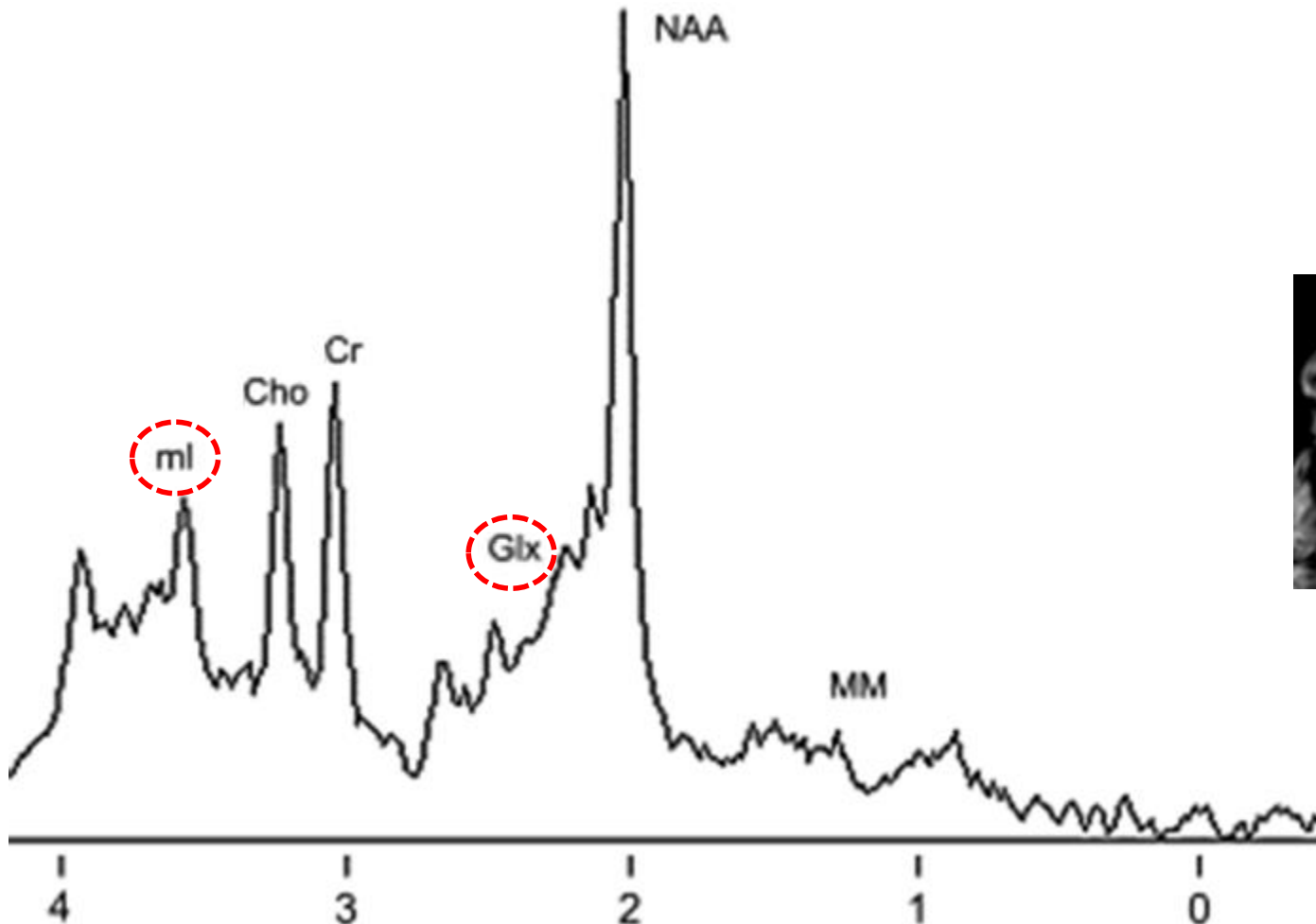
Atypical meningioma

- Other signs of malignancy
 - ↑↑↑ Choline



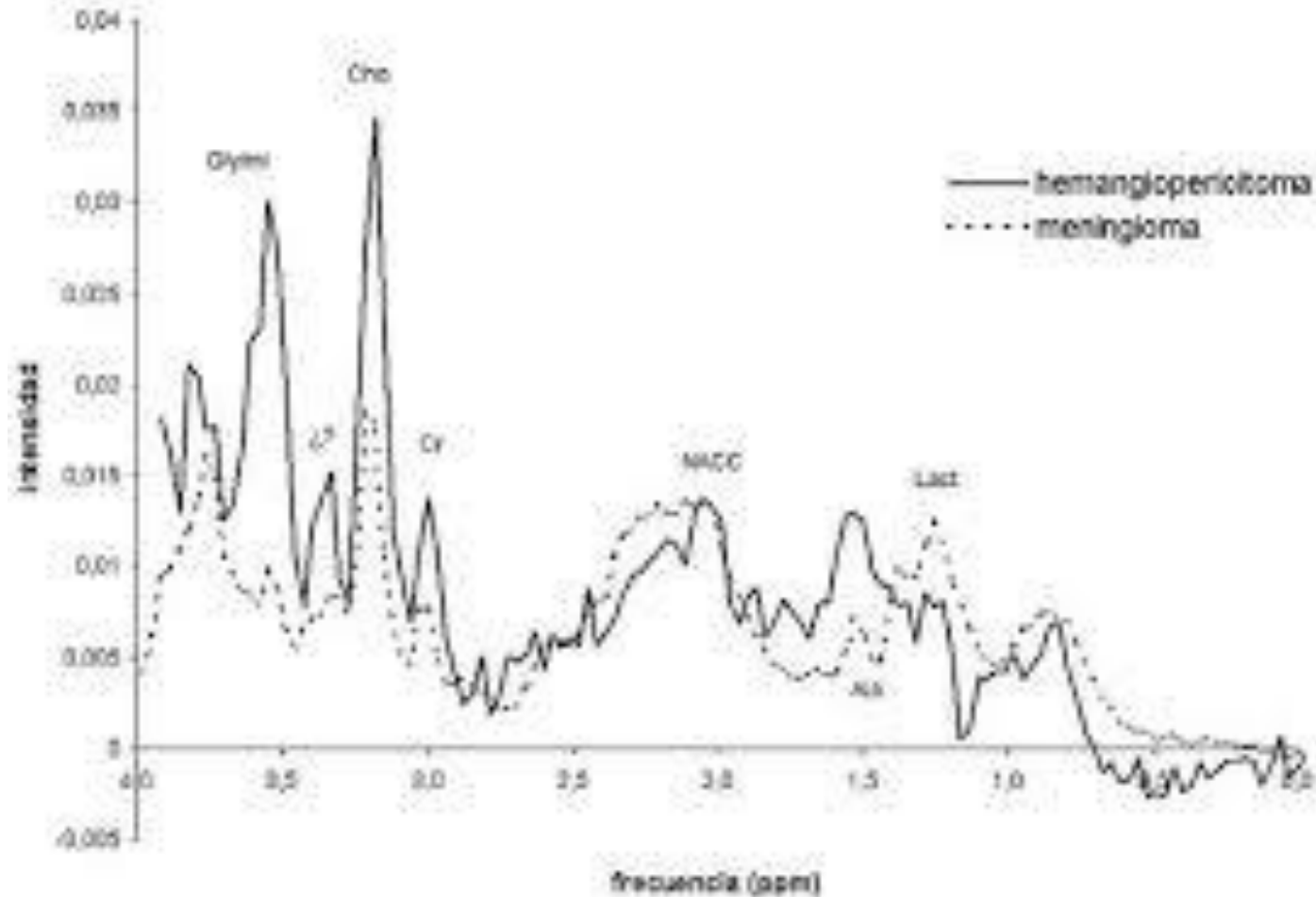
Fibrous solitary tumour: peak myoinositol (ml) & glycine (Glx)

- Known before as hemangiopericytoma



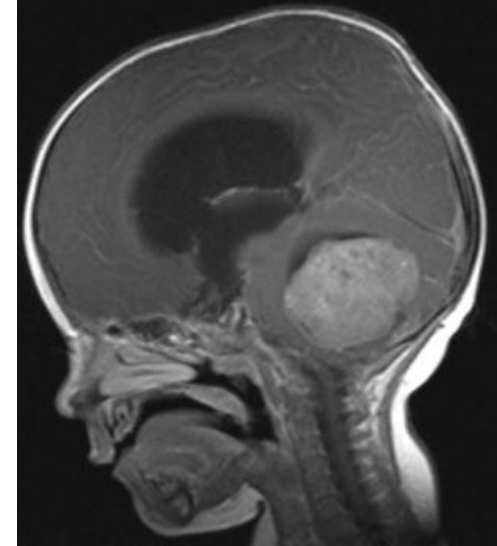
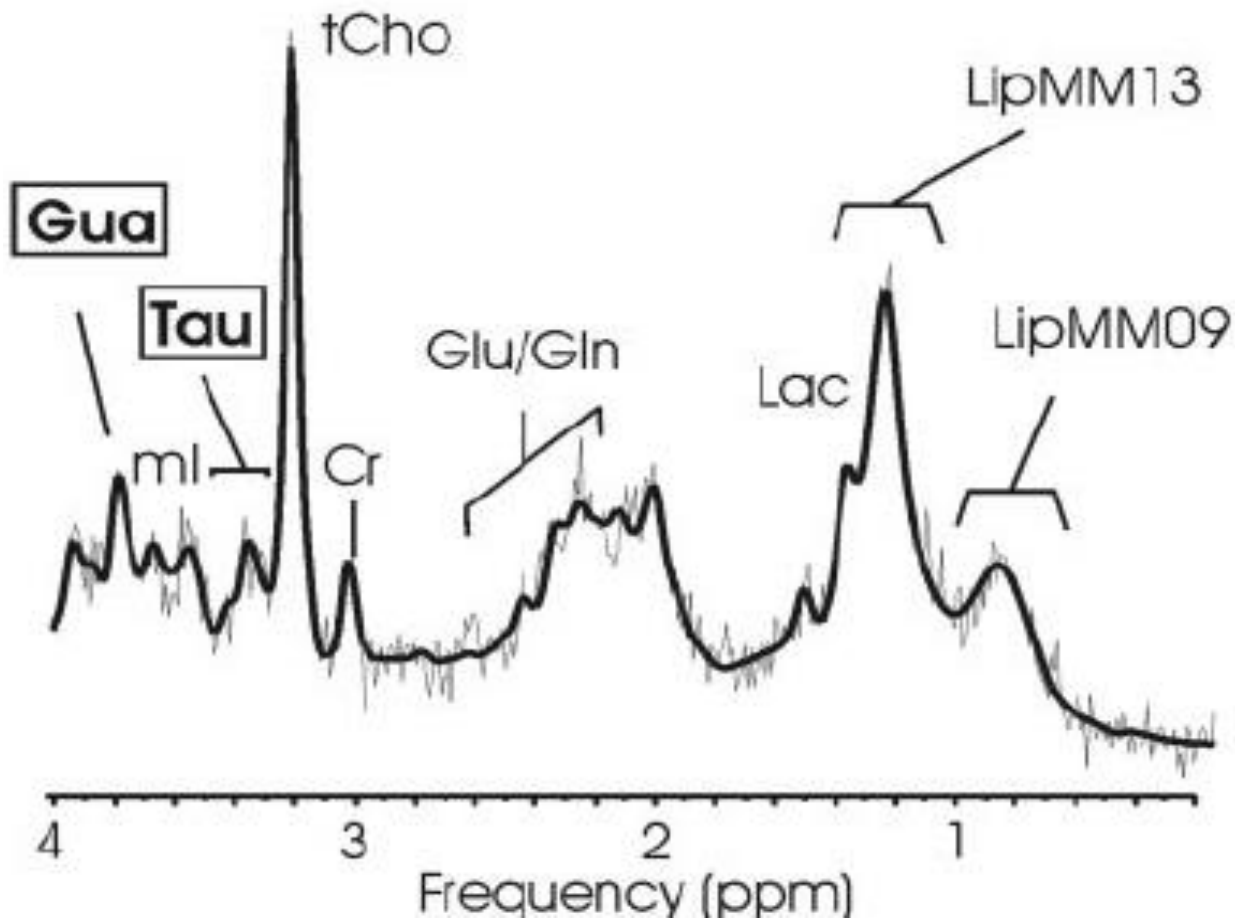
Differential diagnosis meningioma / fibrous solitary tumour

- Not 100% accurate but useful



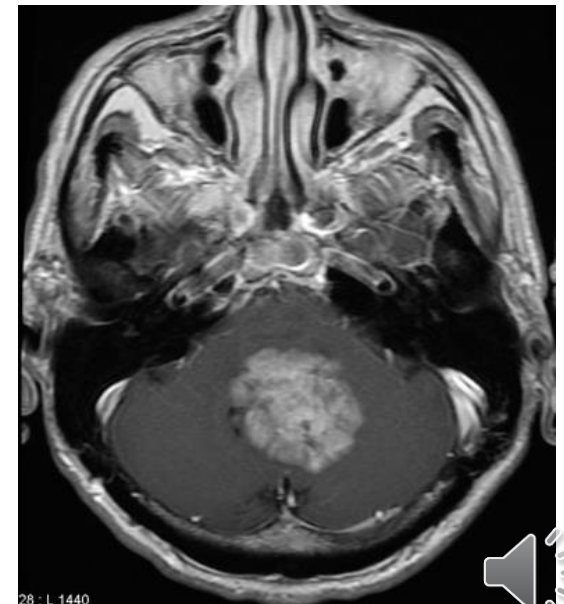
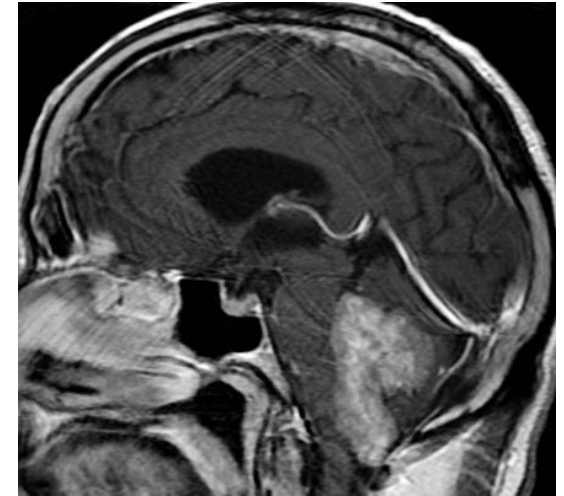
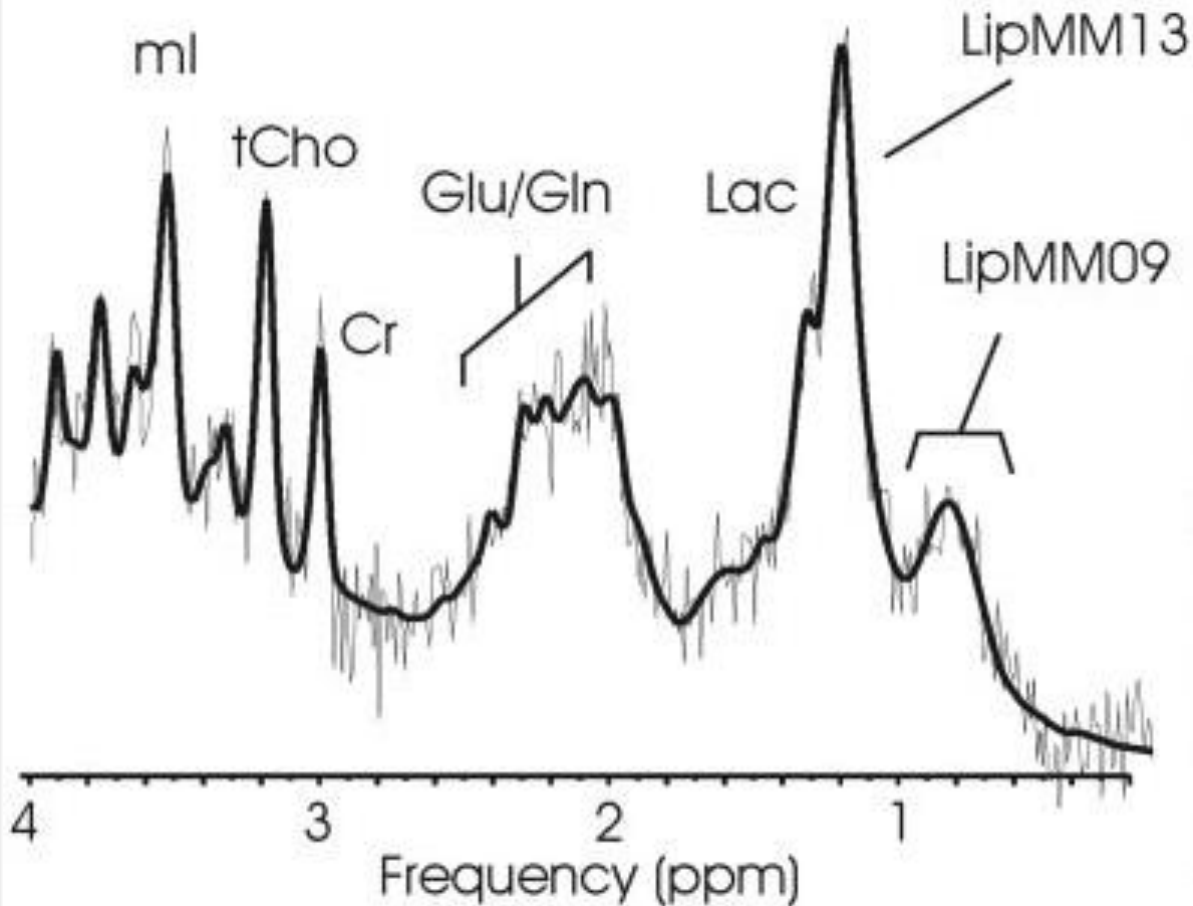
Medulloblastoma

- ↑↑Taurine & Guanine



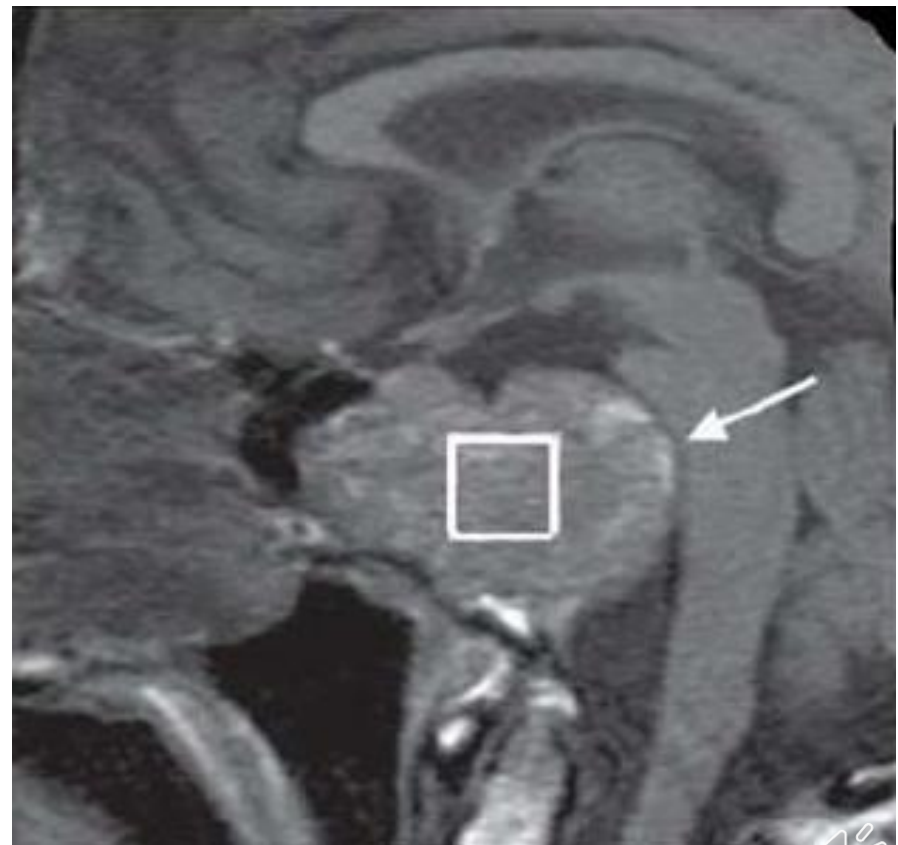
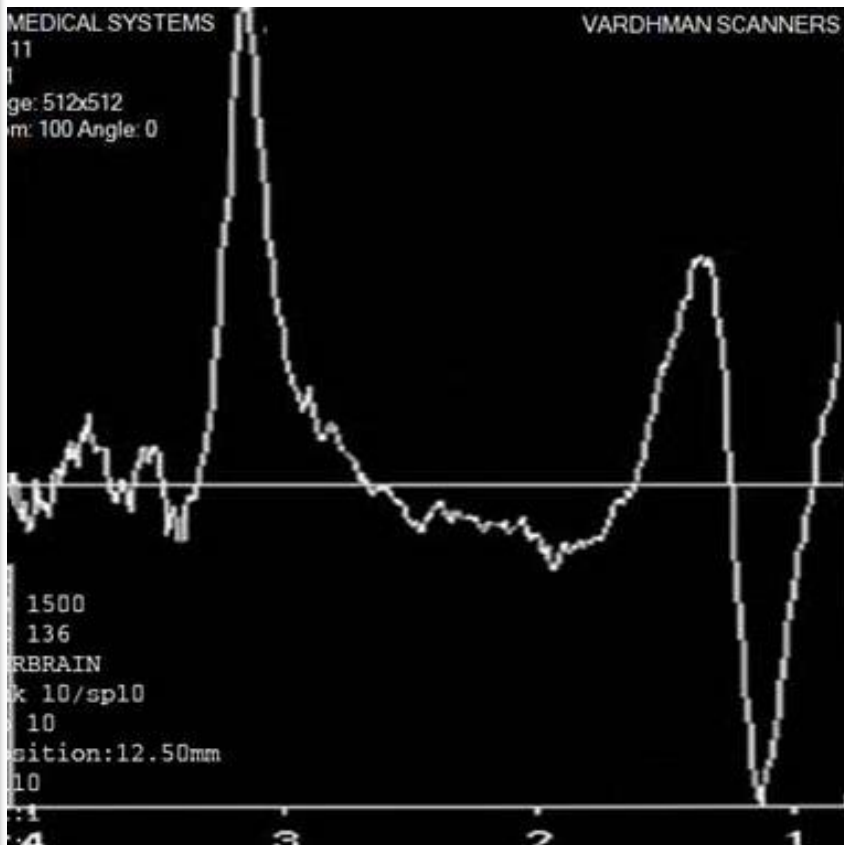
Ependymoma: lipid peak

- ↑ Lipid content (LipMM13 & 09)



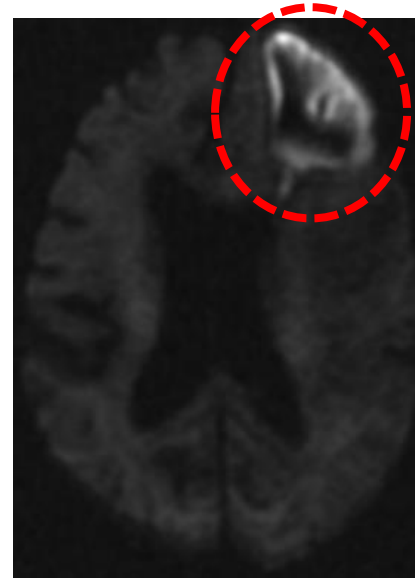
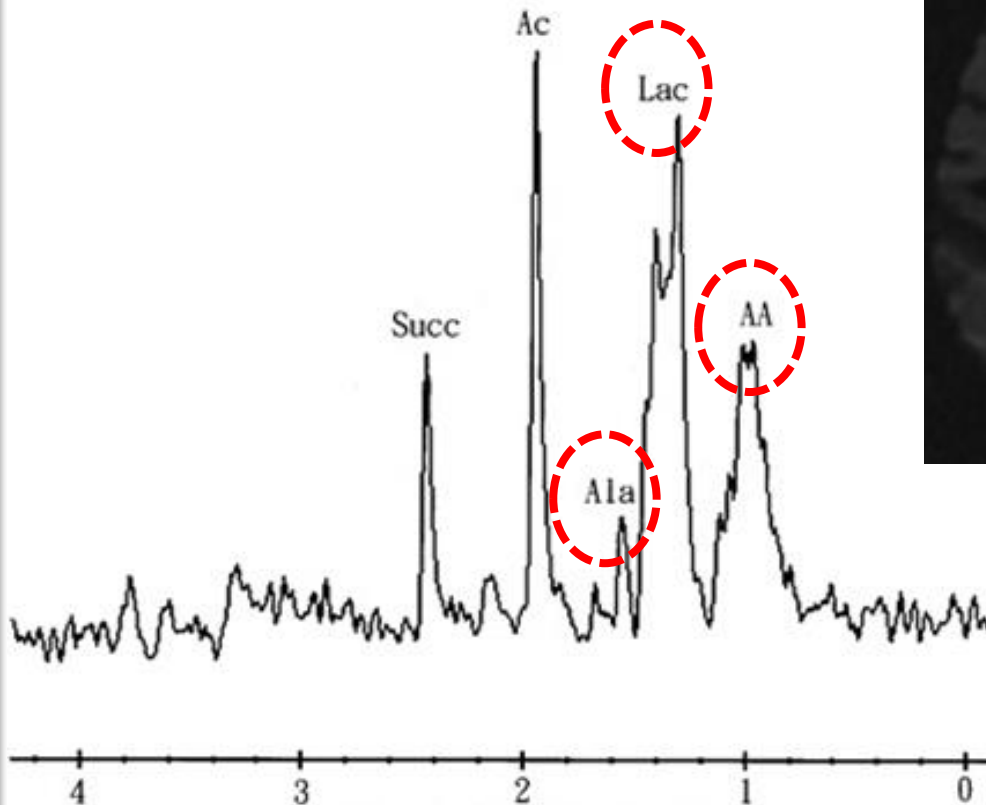
Chordoma

- Significant ↓ NAA & creatinine peaks and ↑↑↑ choline & lipid peaks + moderate ↑ lactate peak



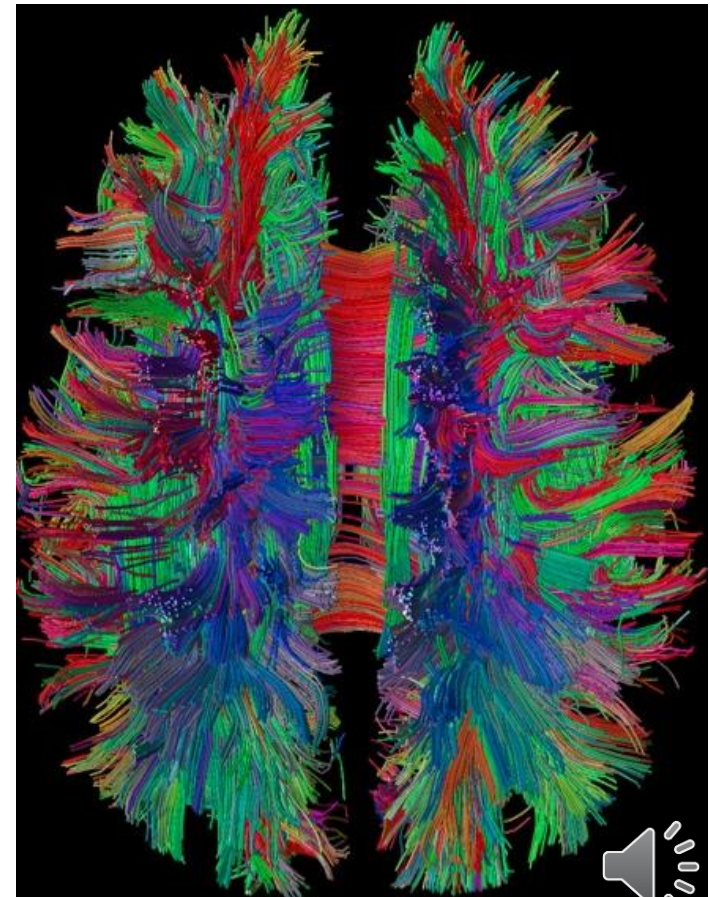
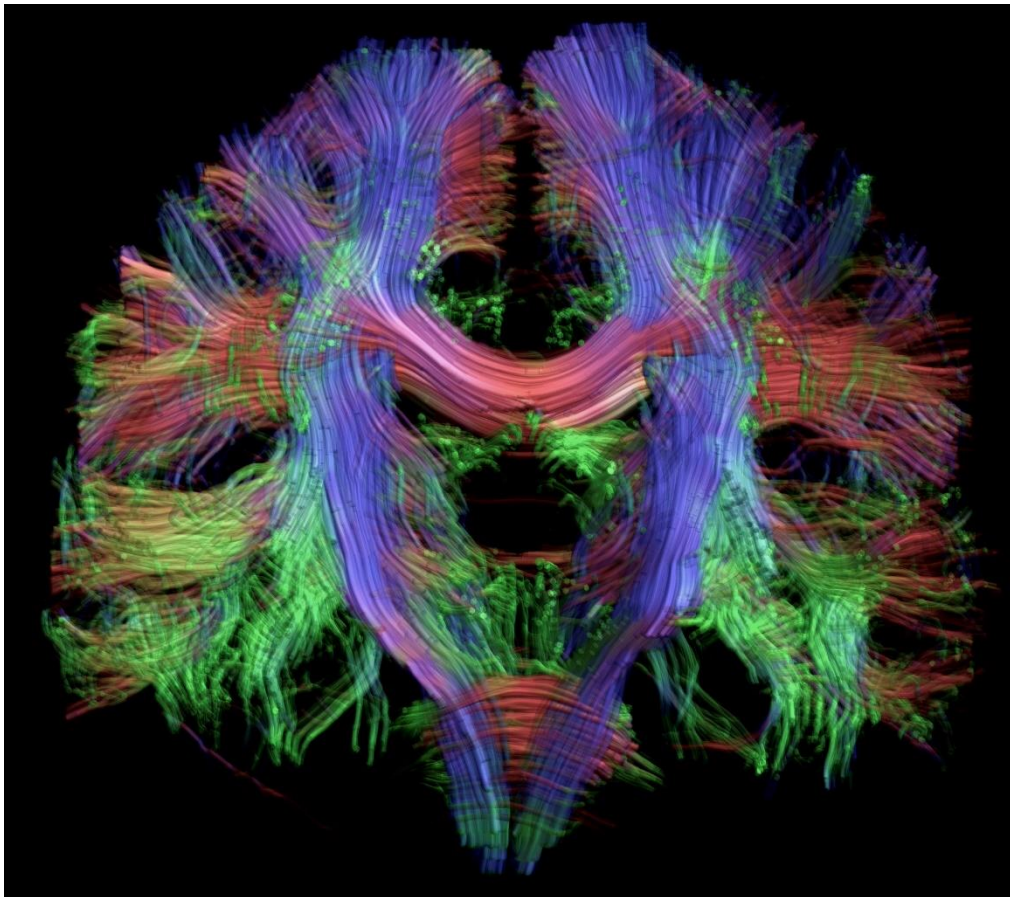
Brain abscess: lactate & amino acid peak

- Reflect anaerobic glycolysis + unusual metabolites



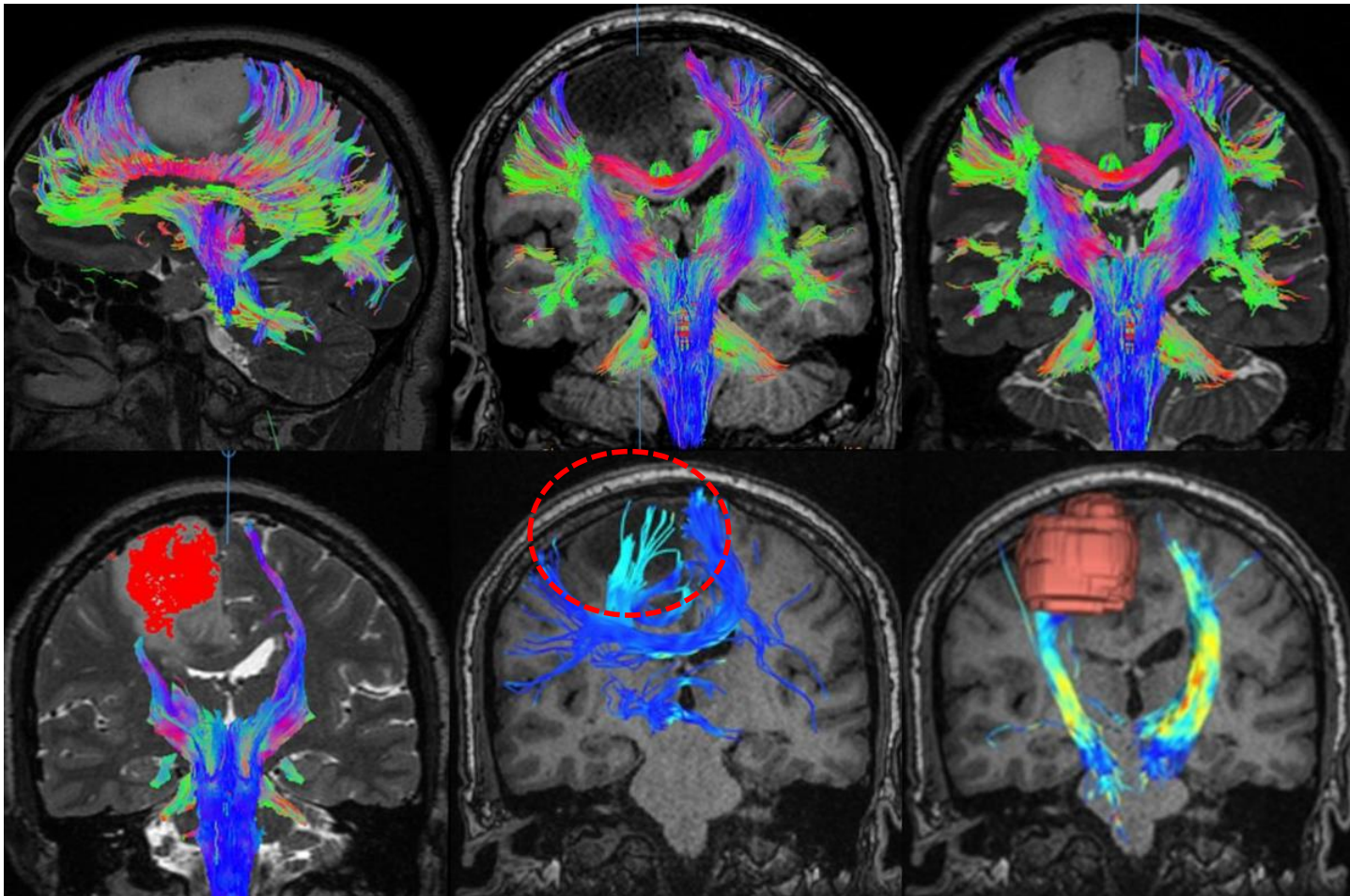
MRI tractography (1)

- Allows pathway identification



MRI tractography (2)

- Allows identification pathways / tumour relationships



Functional MRI: eloquent brain areas

- There are no mute brain areas, there are areas for which WE are still deaf!

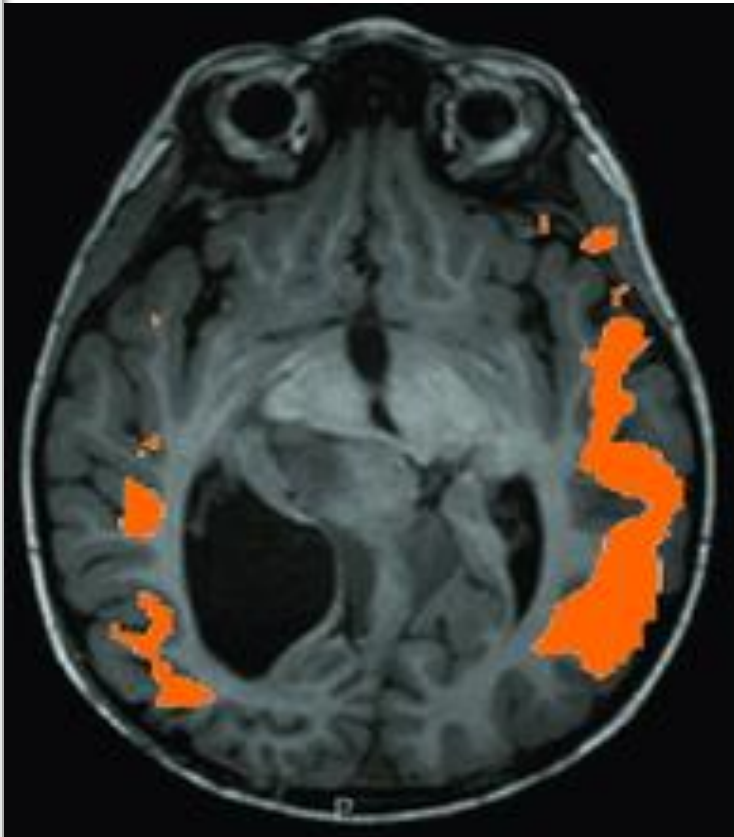


Brain
eloquent areas

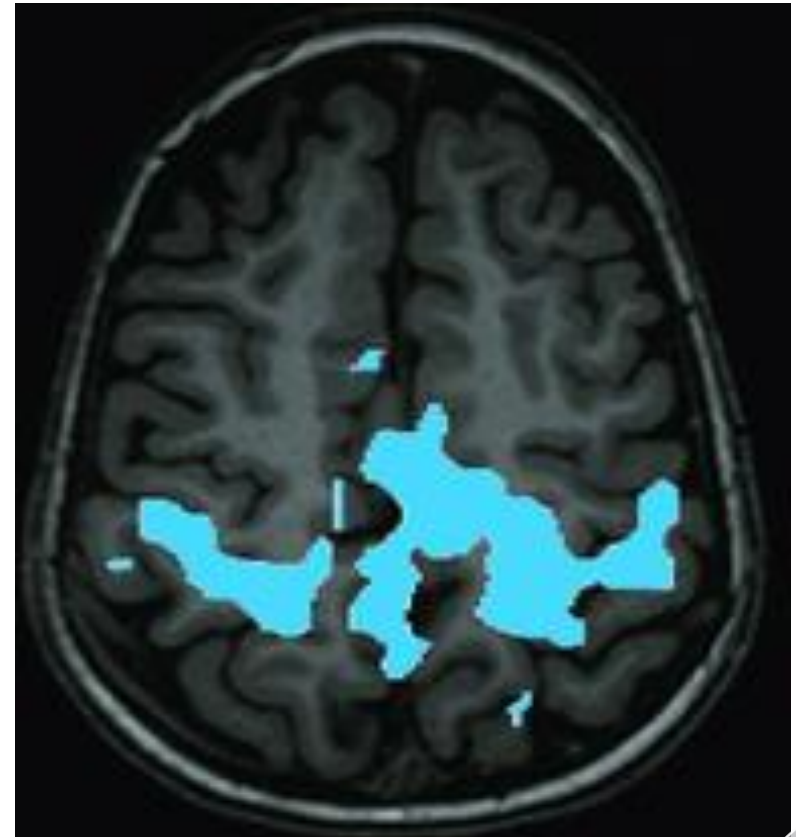


Functional MRI: identification of brain eloquent areas

- No precise anatomical detail = intraoperative neurostimulation essential



Language

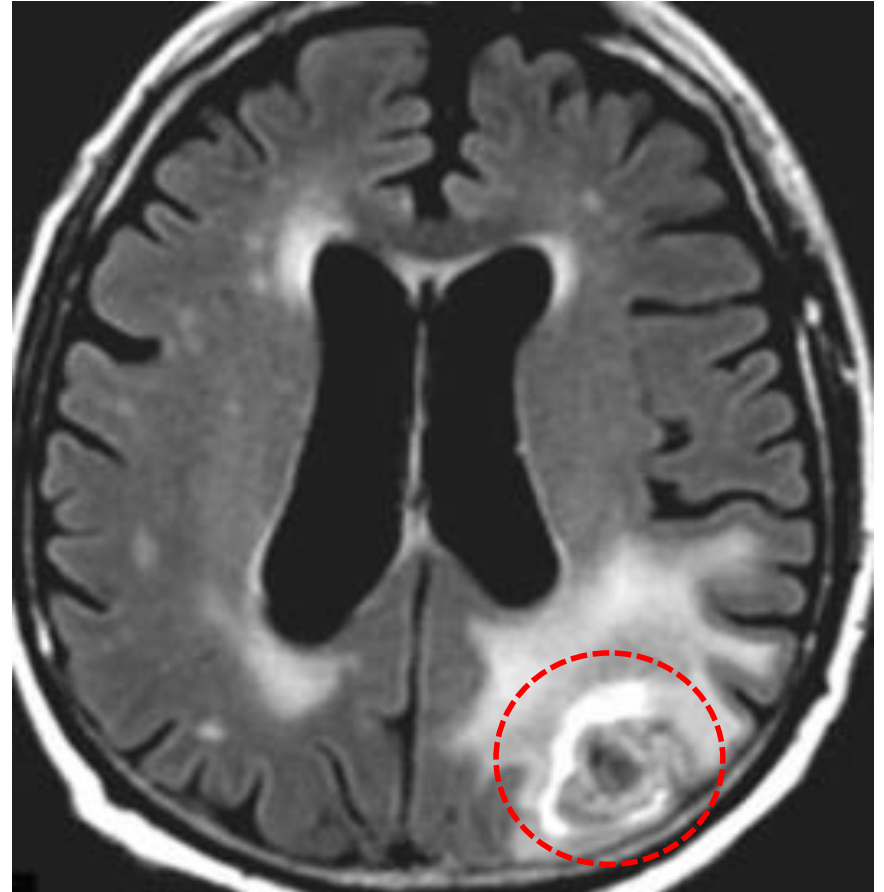
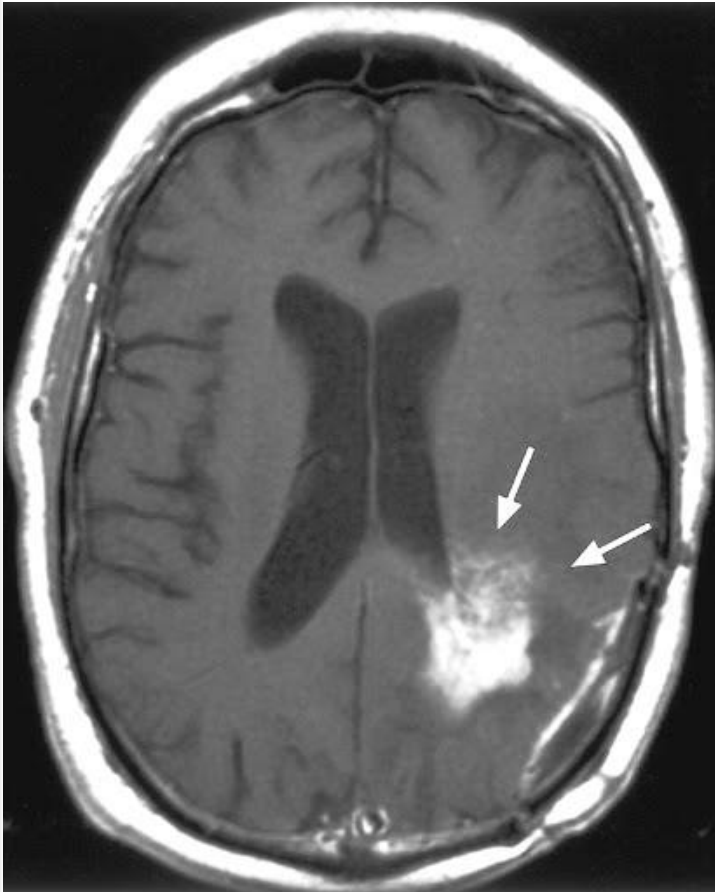


Motor



Positron emission tomography (PET) (1)

- Distinguishes tumour progression versus radionecrosis



MRI images of brain tumour /radionecrosis



Brain PET (2)

• Markers

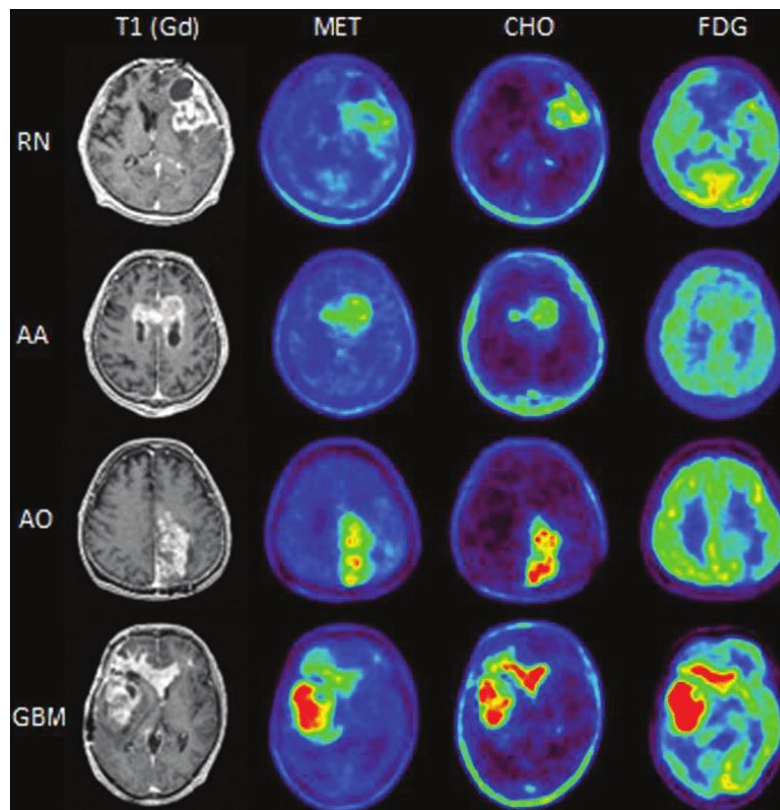
- Methionine (MET) = protein synthesis
- Choline (Cho) = cell membrane synthesis
- Fluorodeoxyglucose (FDG) = glucose consumption

Radionecrosis

Astrocytoma

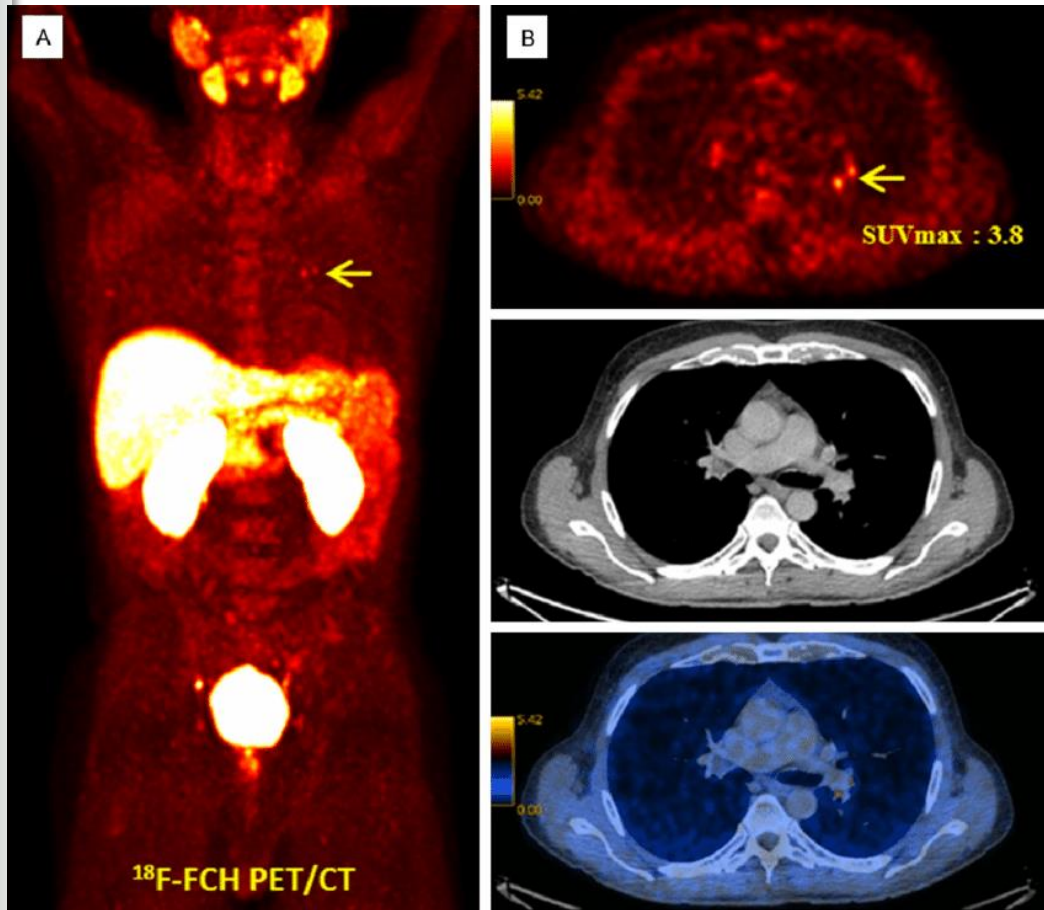
Anaplastic
oligodendroglioma

Glioblastoma

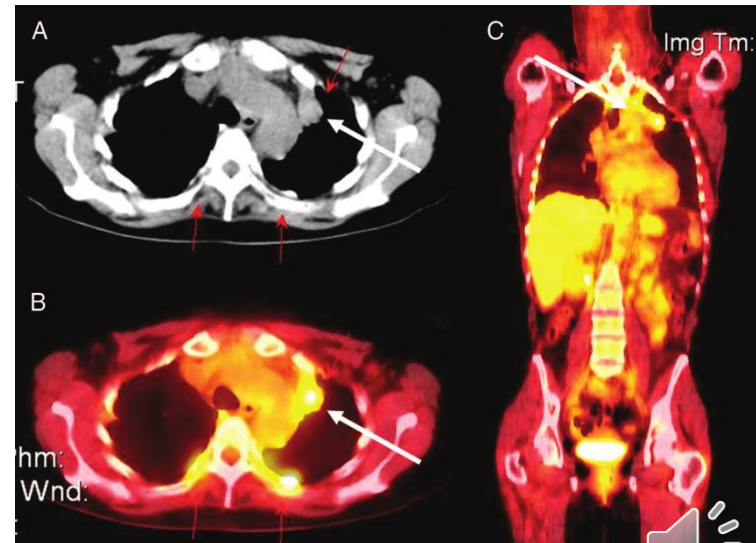
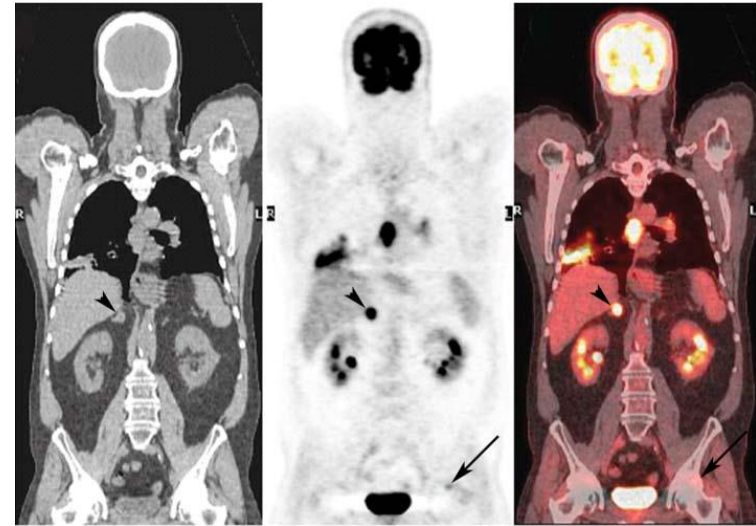


PET body: primary tumours & other metastases

- Little anatomical definition



Primary tumour



Metastases

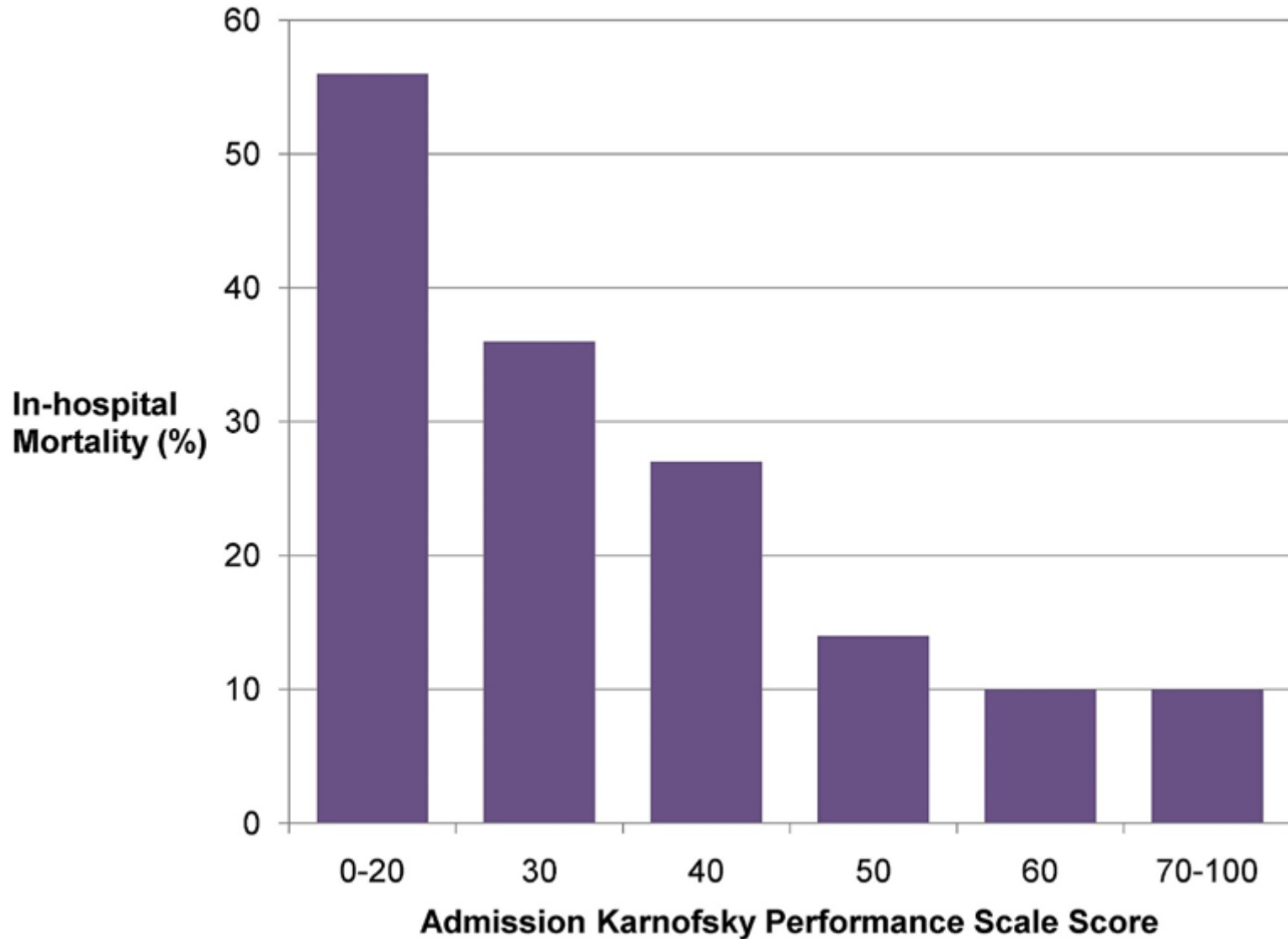
Karnofsky scale & average survival

%	Ambulation	Activity Level Evidence of Disease	Self-Care	Intake	Level of Consciousness	Estimated Median Survival In Days		
						(a)	(b)	(c)
100	Full	Normal <i>No Disease</i>	Full	Normal	Full	N/A	N/A	108
90	Full	Normal <i>Some Disease</i>	Full	Normal	Full			
80	Full	Normal with Effort <i>Some Disease</i>	Full	Normal or Reduced	Full			
70	Reduced	Can't do normal job or work <i>Some Disease</i>	Full	As above	Full	145		
60	Reduced	Can't do hobbies or housework <i>Significant Disease</i>	Occasional Assistance Needed	As above	Full or Confusion	29	4	
50	Mainly sit/lie	Can't do any work <i>Extensive Disease</i>	Considerable Assistance Needed	As above	Full or Confusion	30	11	41
40	Mainly in Bed	As above	Mainly Assistance	As above	Full or Drowsy or Confusion	18	8	
30	Bed Bound	As above	Total Care	Reduced	As above	8	5	
20	Bed Bound	As above	As above	Minimal	As above	4	2	
10	Bed Bound	As above	As above	Mouth Care Only	Drowsy or Coma	1	1	6
0	Death	-	-	-	--			

(a) Survival post-admission to an inpatient palliative unit - all diagnoses (Virik 2002). (b) Days until inpatient death following admission to an acute hospice unit - diagnoses not specified (Anderson 1996). (c) Survival post admission to an inpatient palliative unit - cancer patients only (Morita 1999).

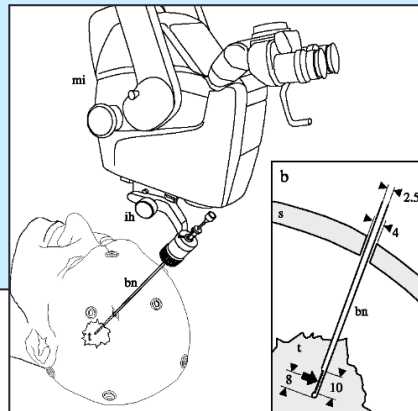
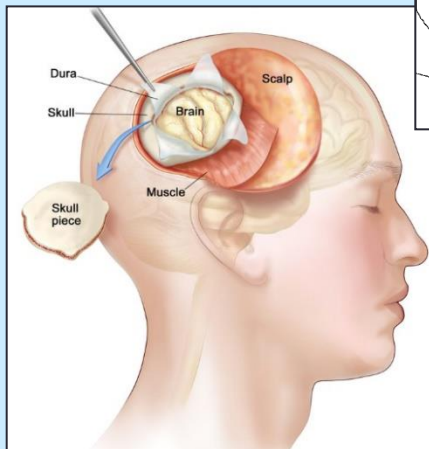


Karnofsky scale & in-hospital mortality



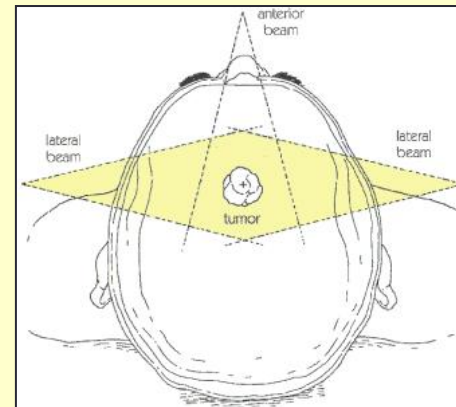
• Surgical

- Stereotactic brain biopsy
- Surgical resection



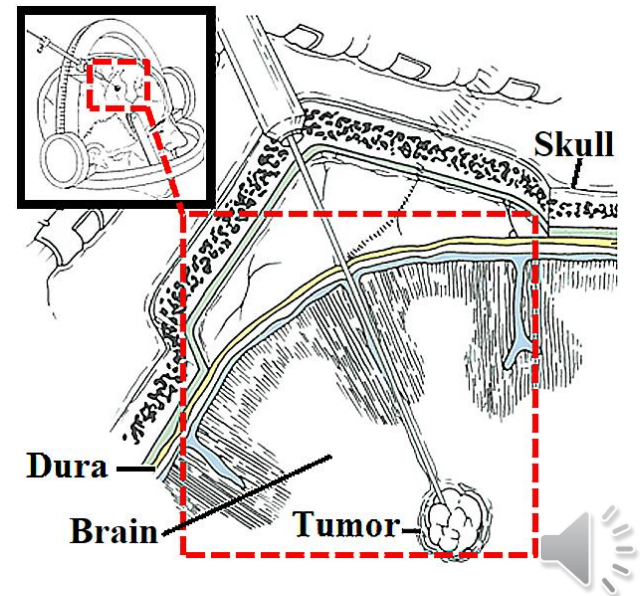
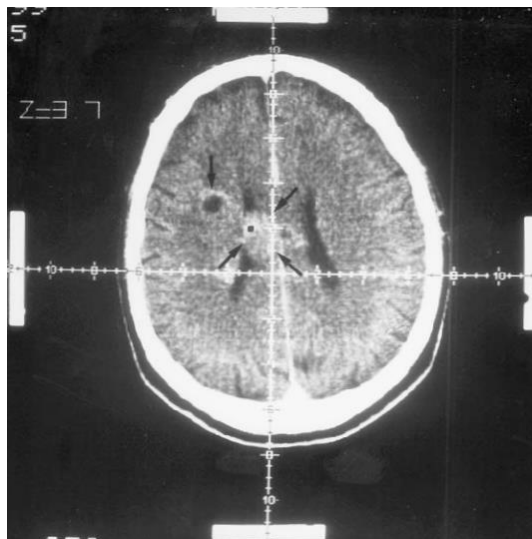
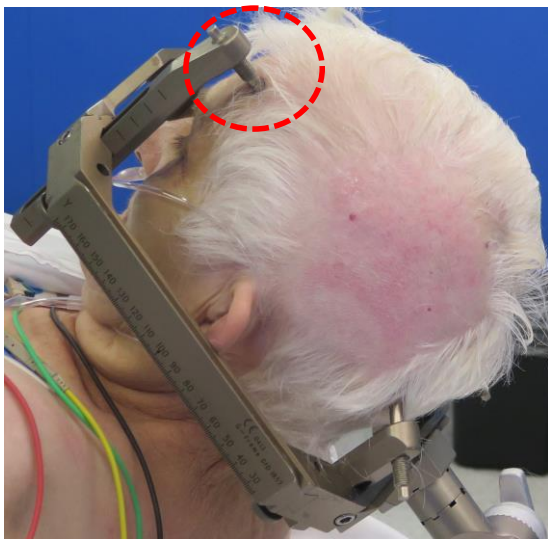
• Adjuvant

- Radiotherapy
- Chemotherapy



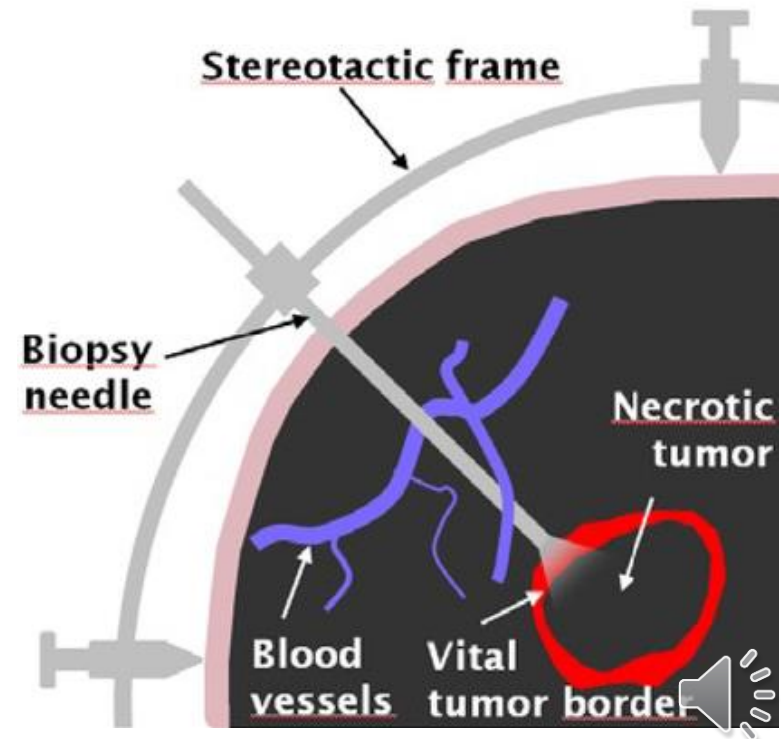
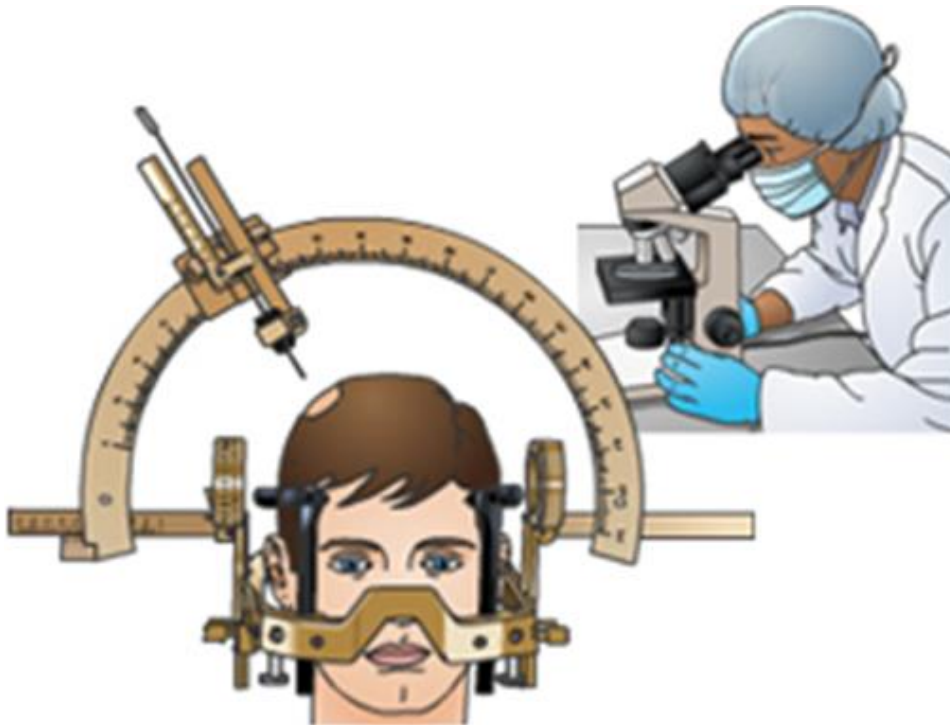
Tumour removal not advisable = stereotaxic brain biopsy for histological confirmation

- Stereotactic frame
 - MUST be fixed to skull with screws = painful
 - Frameless systems available but LESS accurate
- Preop CT scan & MRI needed for coordinate calculation
- A devoted neuropathologist recommended



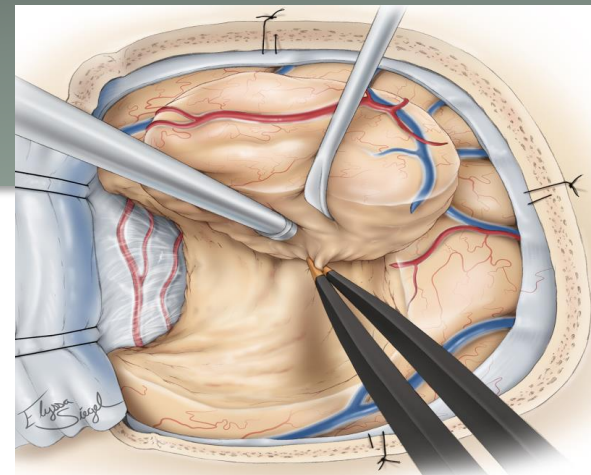
Stereotaxic biopsy

- Small samples
 - Inhomogeneity in tumor cell distribution \Rightarrow possibility of error
 - Especially in gliomas
 - NO molecular nor genetic studies
- Results **DEPENDING ON WHERE BIOPSY IS TAKEN**



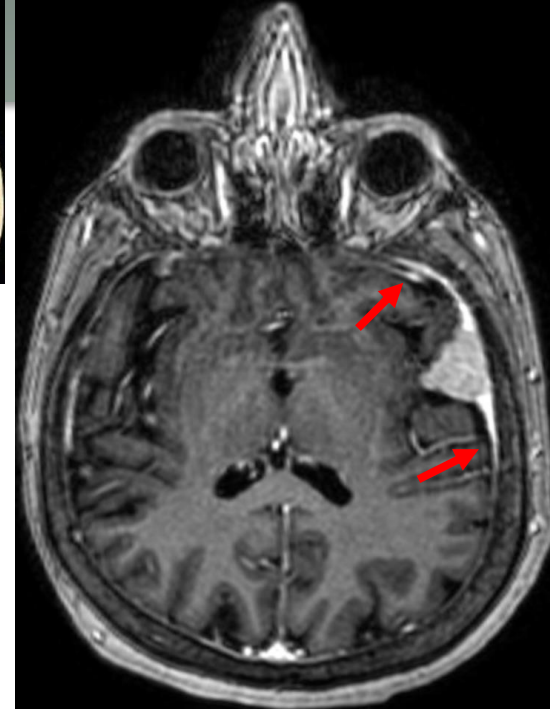
Surgical treatment

- Extent of tumour resection direct relationship with survival
 - Even in malignant gliomas
 - LIMITATION: avoid inducing new neurological deficits
- Complex and expensive equipment required
 - Thorough preoperative preparation with tractography & functional MRI
 - Drug administration to improve intra-operative visualisation of residual tumour
 - Neuronavigation
 - Neurophysiological monitoring
 - Intraoperative MRI

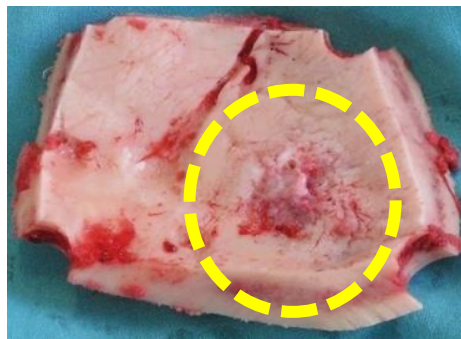
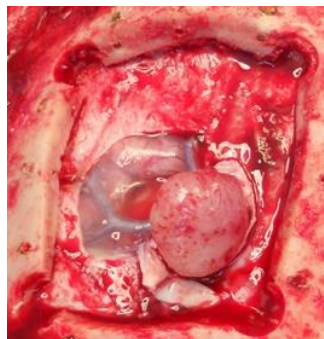
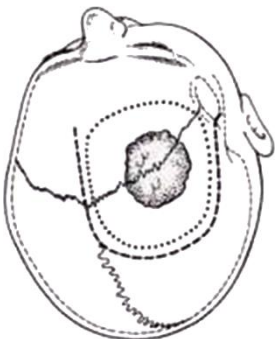


Meningiomas: Simpson grade = recurrence rate

- The dural tail & infiltrated bone are also tumours

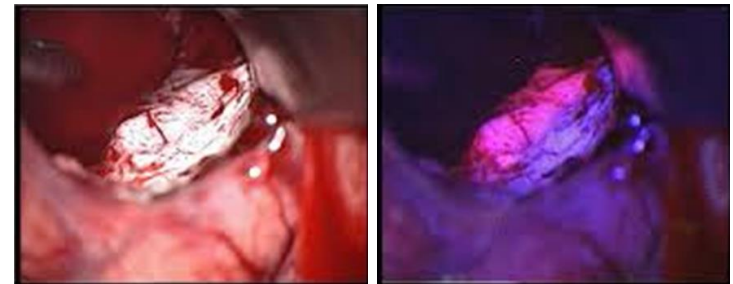
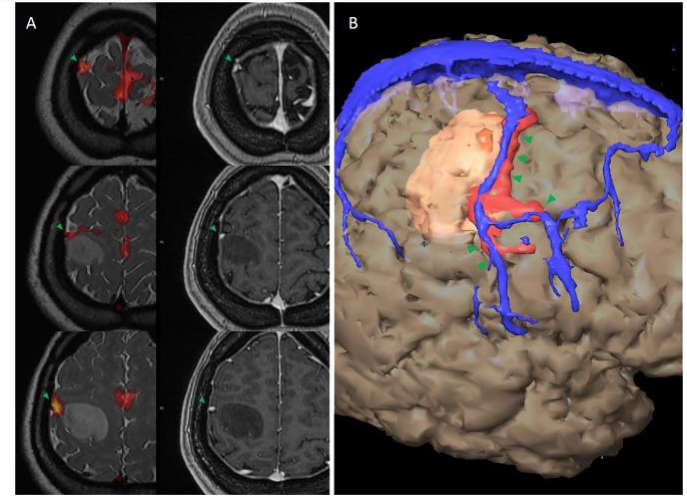


Simpson grade	Definition	10-Year recurrence rate
1	Macroscopic gross-total resection with excision of dura, sinus, and bone.	9%
2	Macroscopic gross-total resection with coagulation of dural attachment.	19%
3	Macroscopic resection without resection or coagulation of dural attachment.	29%
4	Subtotal resection.	40%
5	Biopsy.	Not available



How to improve safely tumour excision?

- Thorough preoperative preparation
- Preop δ -aminolevulinic acid administration
- Neurophysiological monitoring
- Neuronavigation
- Intraoperative tumour identification
- Intraoperative MRI



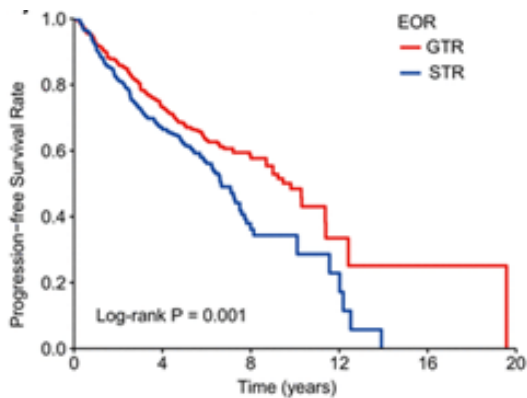
Normal light

BLUE-400

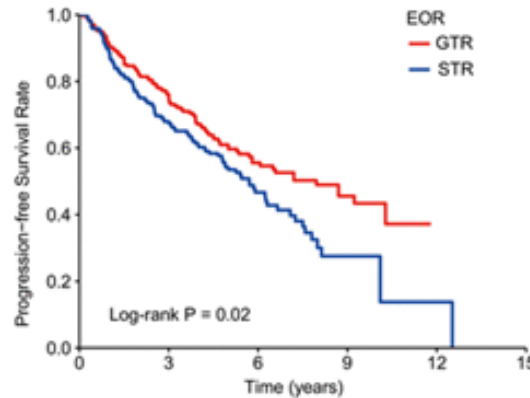


Gliomas: extent of resection & survival

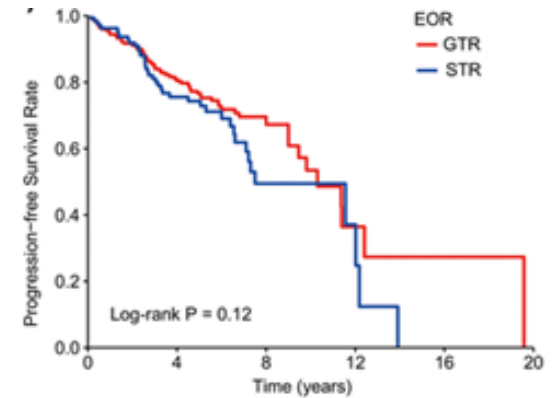
- More radical removal = longer survival



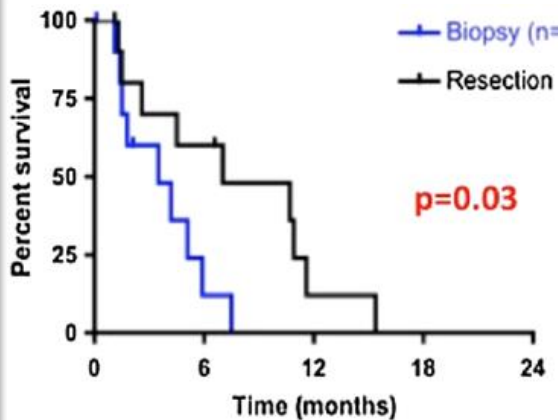
Low grade glioma



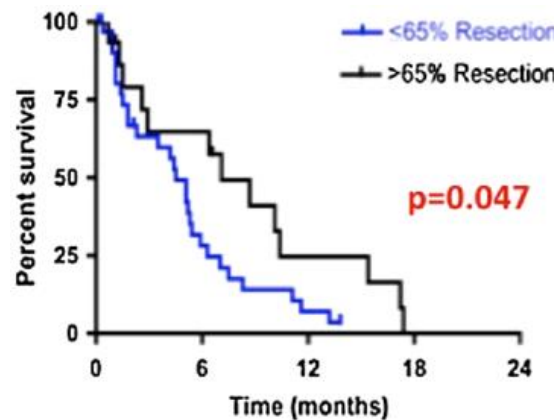
Astrocytoma



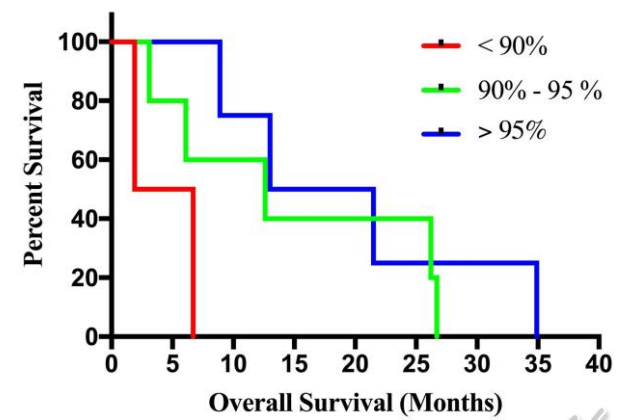
Oligodendroglioma



Glioblastoma



Glioblastoma



Gliosarcoma

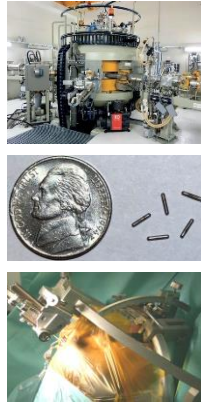


Ionizing radiation treatment: types

- Each has advantages and disadvantages & costs



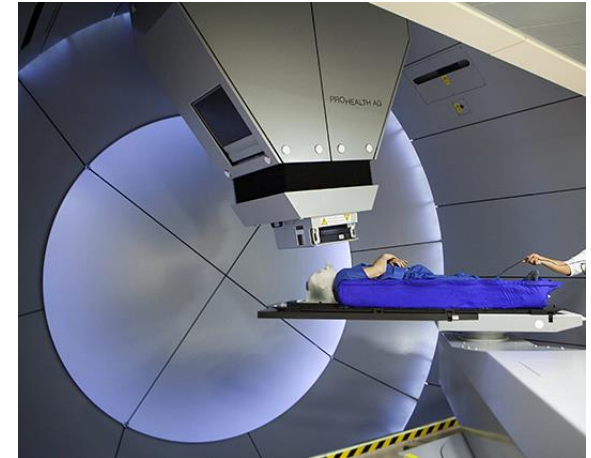
External Beam



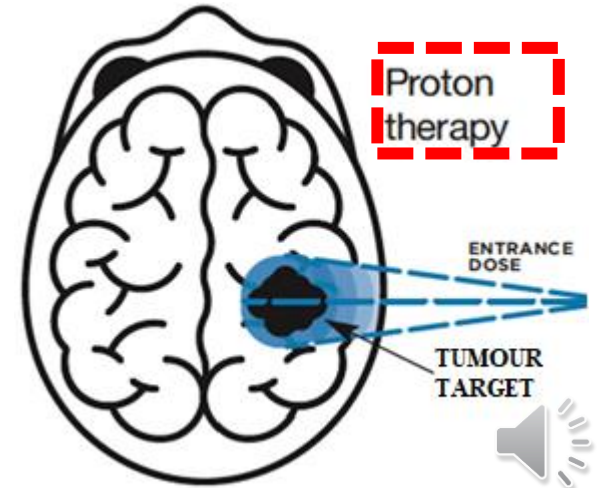
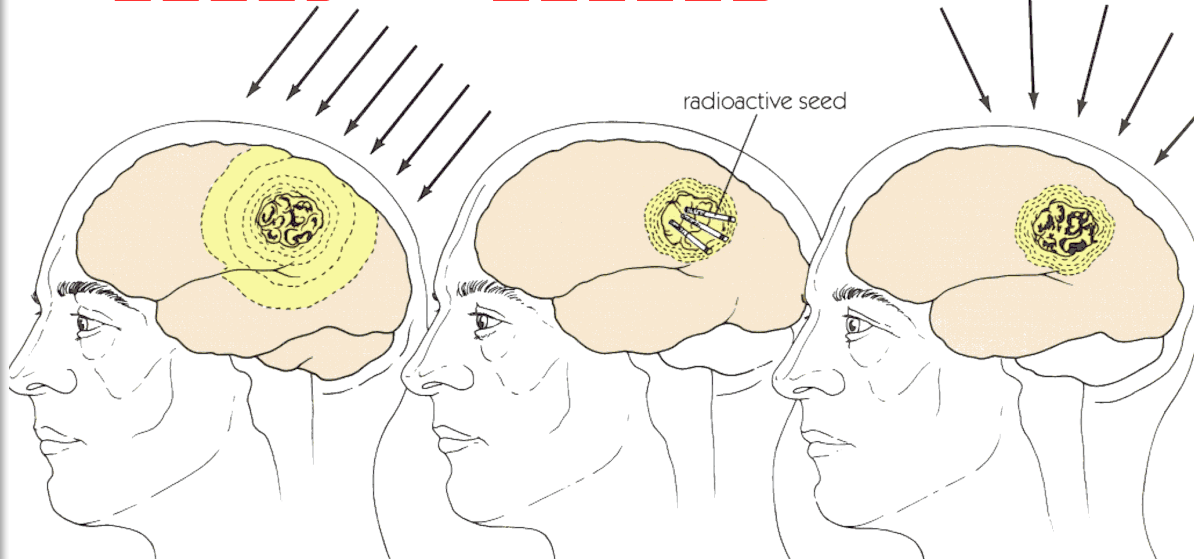
Interstitial Brachytherapy



Radiosurgery

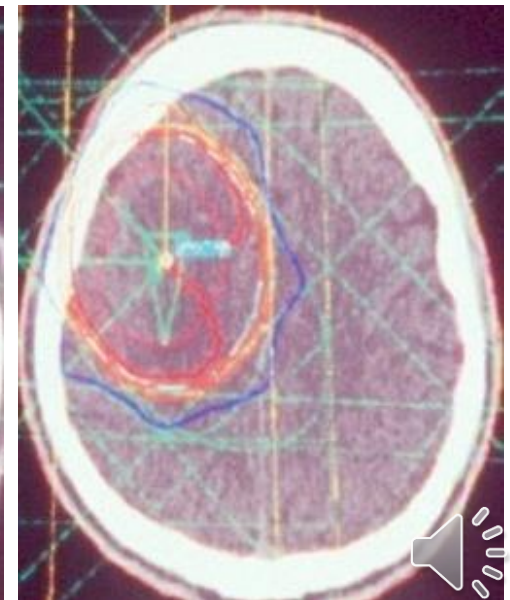
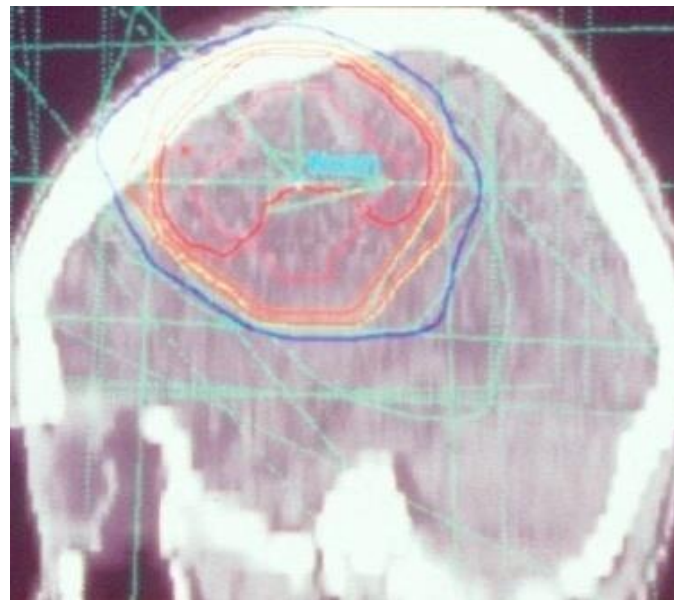
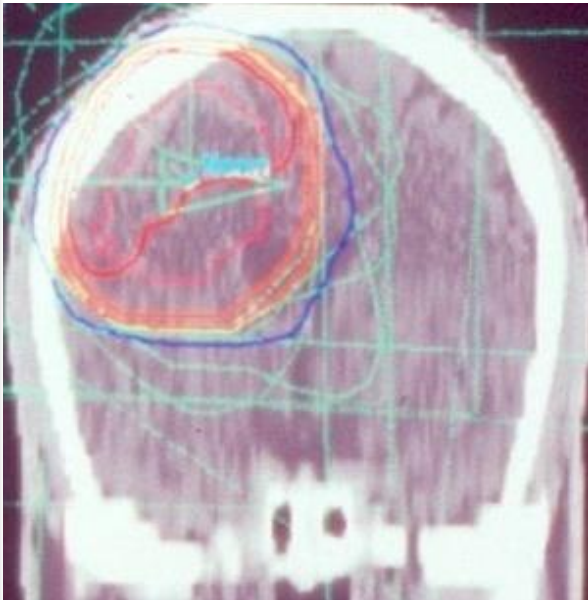
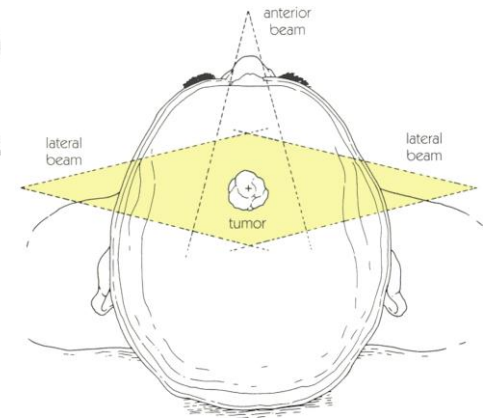
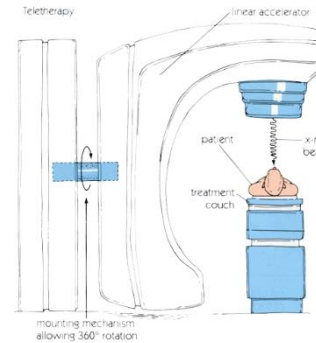


Proton therapy

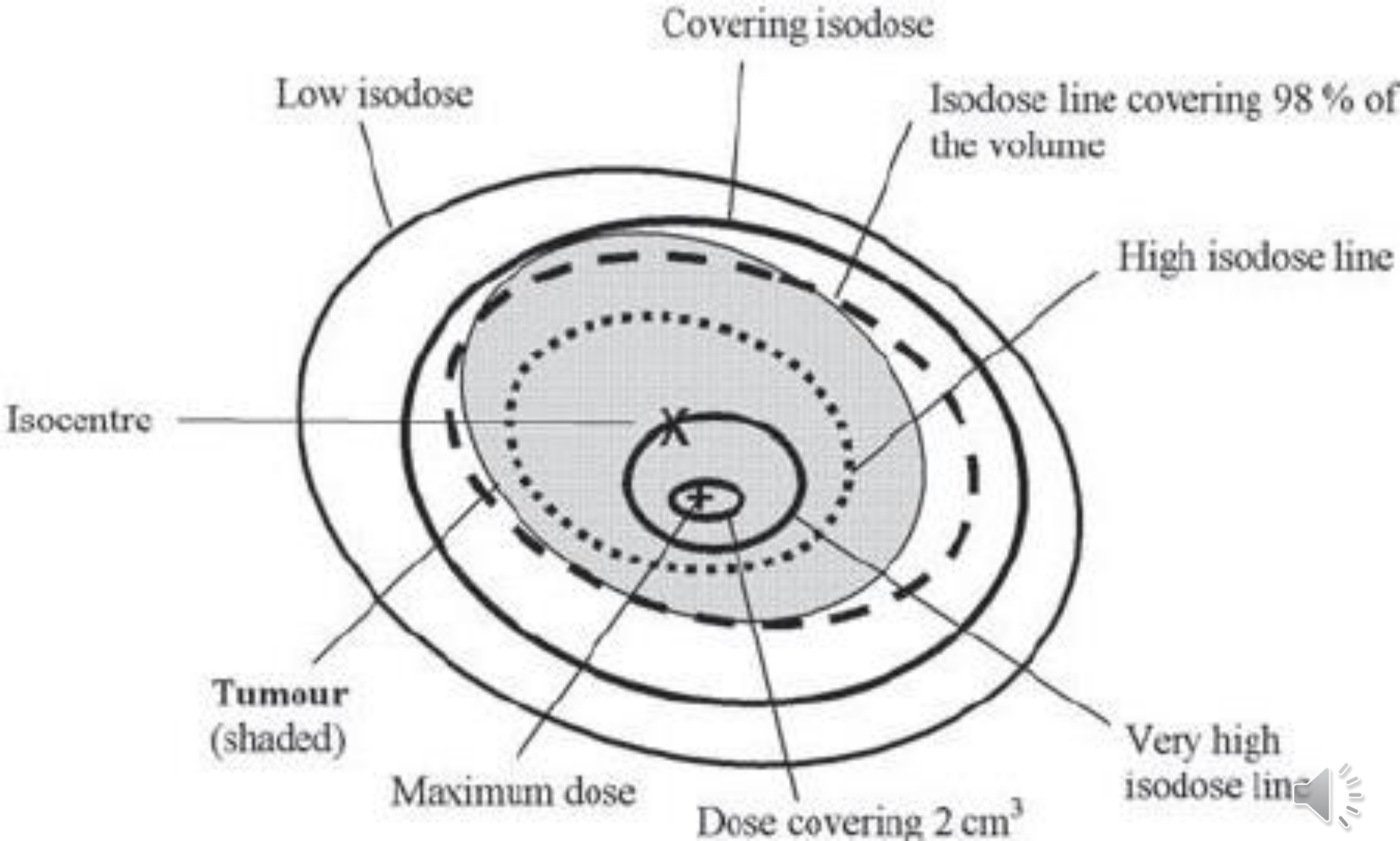


Conventional radiotherapy

- Extensive areas of non-tumoral brain radiated
- Glial & vascular damages = progressive neurological / cognitive deficit in survivors
- Can only be administered once

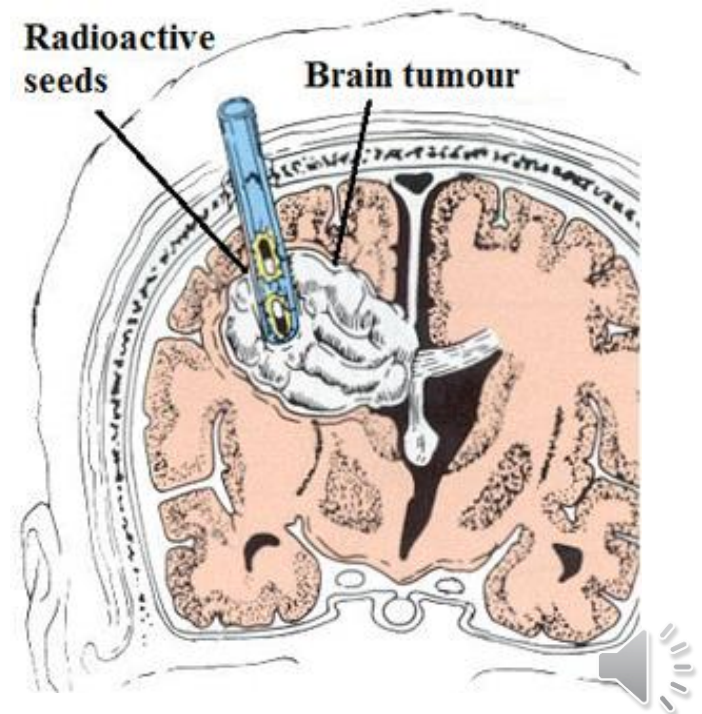
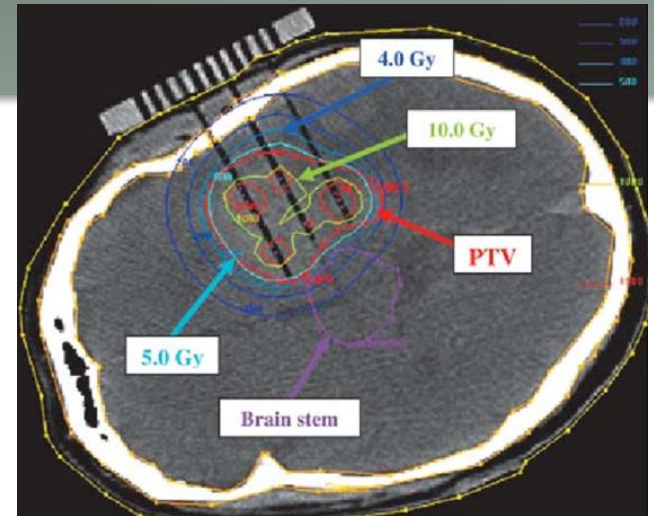


Irregular tumour shape = some areas may be sub-optimally covered



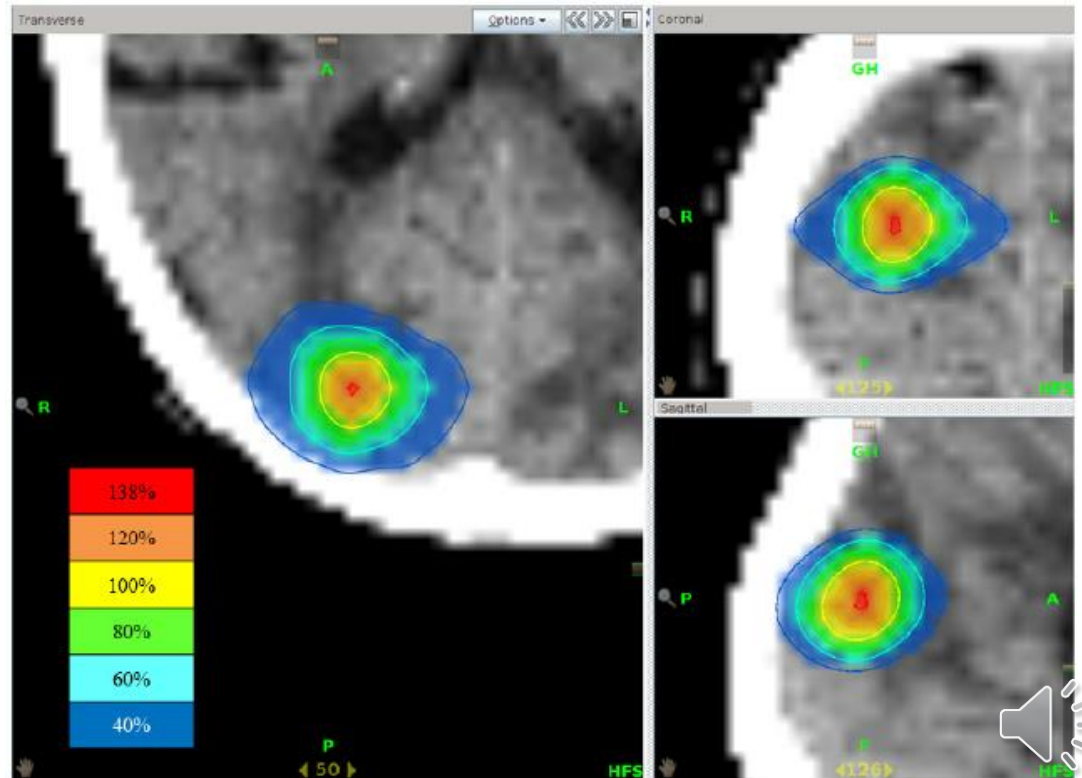
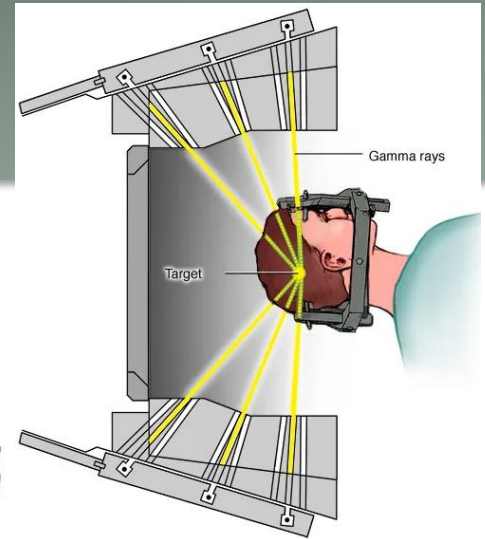
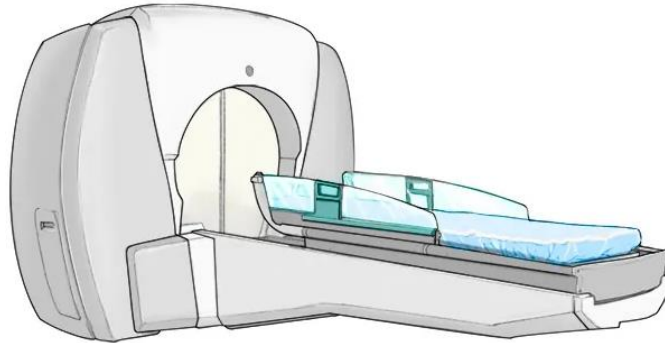
Brachytherapy

- Radioactive seeds inserted surgically inside the tumour
 - Must be flown from Canada
- Stereotactic frame needed
- Seeds **MUST** be removed when radiation dose is administered
- Higher doses possible as nearby brain spared
- Difficult to cover irregular shape tumours
- Can be used after conventional radiotherapy



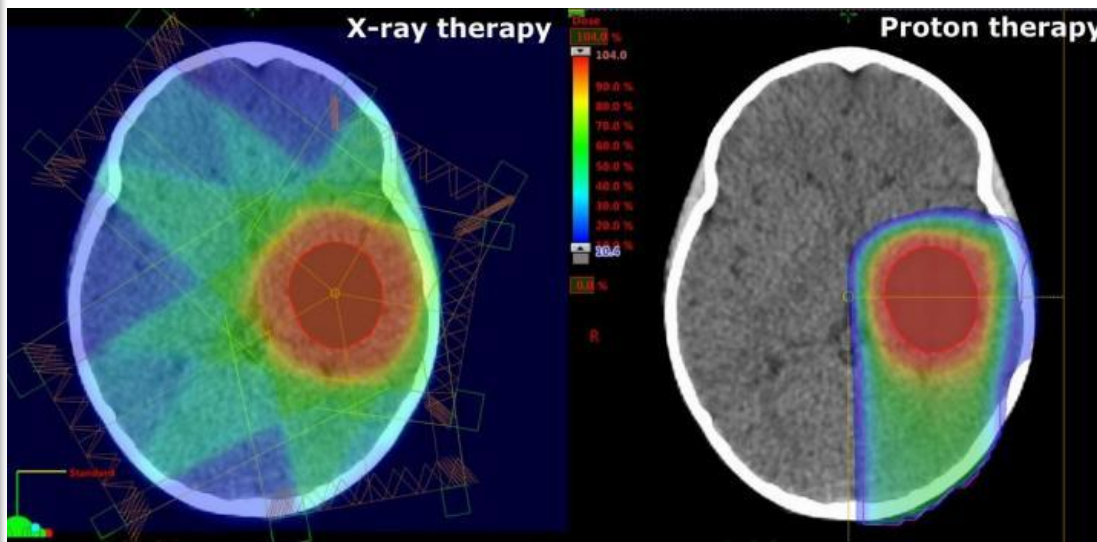
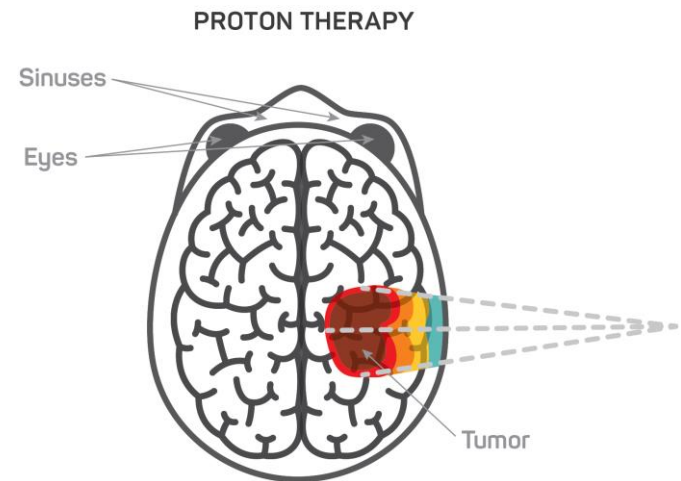
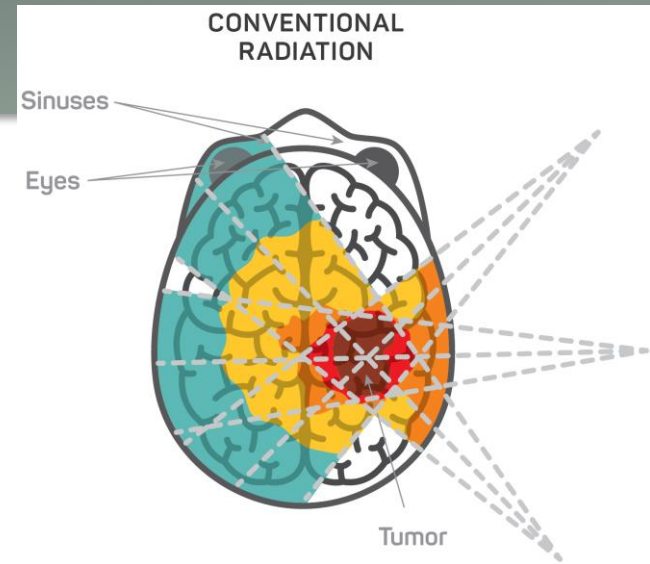
Radiosurgery

- Multiple thin radiation beams converging at target
- Maximal dose to tumour and minimal to brain
- Possible to treat multiple lesions
- Lesion size <3cm in \emptyset
- Particularly useful in metastases



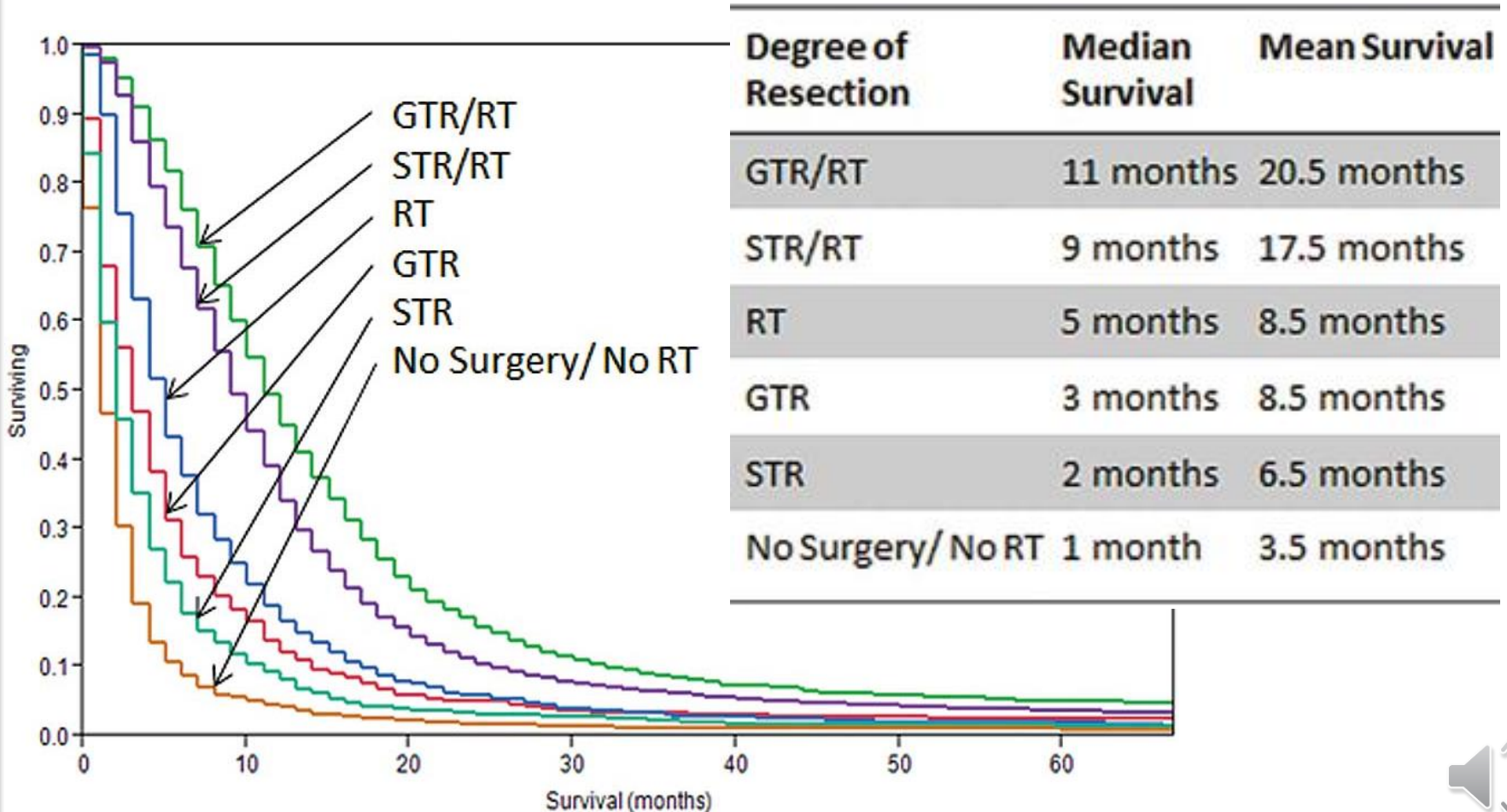
Proton beam

- More precise dose administration
 - Higher effectiveness
 - Less surrounding brain damage
- Very costly equipment



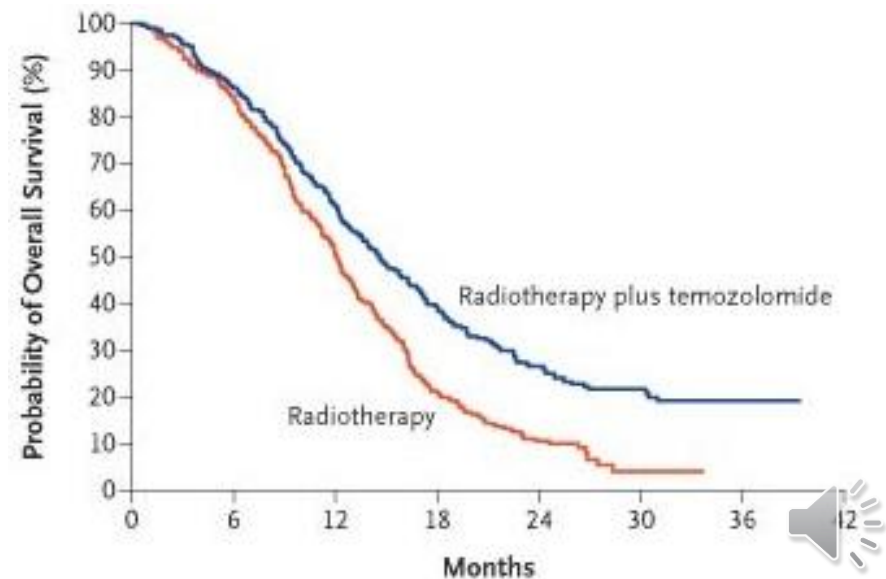
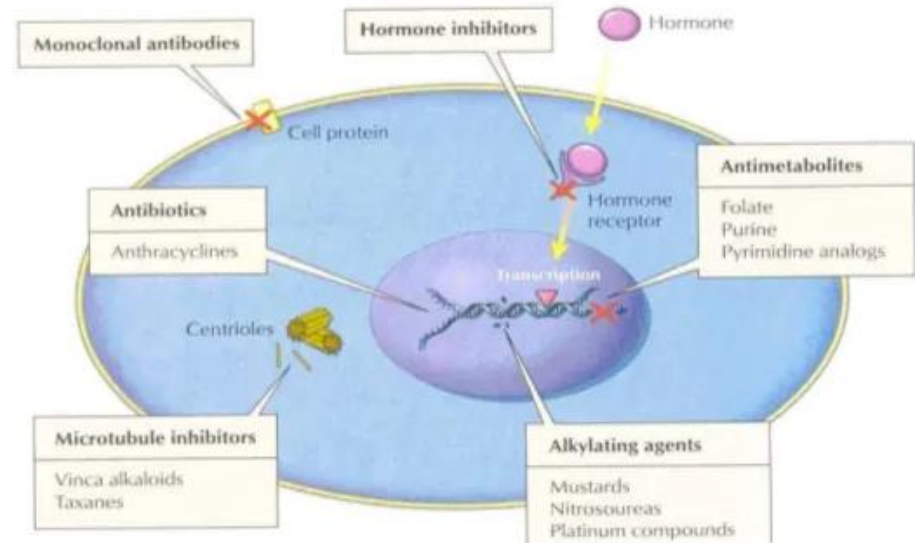
Surgical removal + radiotherapy glioblastoma survival

- Therapeutic combinations = longest survivals in malignant brain tumours



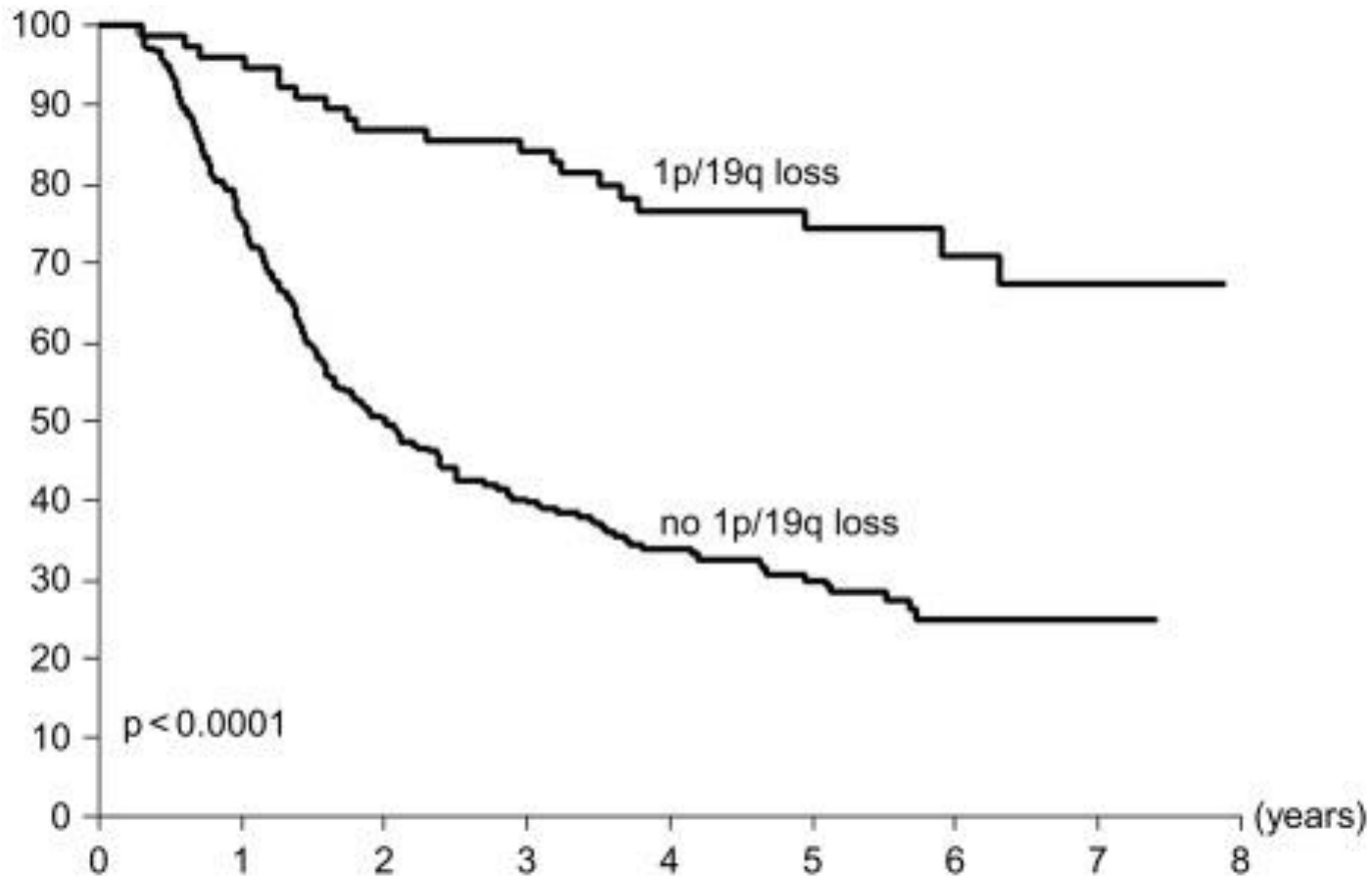
Chemotherapy for brain tumours

- Resistant tumour cells survive → recurrence
- Best combining different action chemotherapeutic agents
- Some enhance radiation therapy effects (Temozolomide)



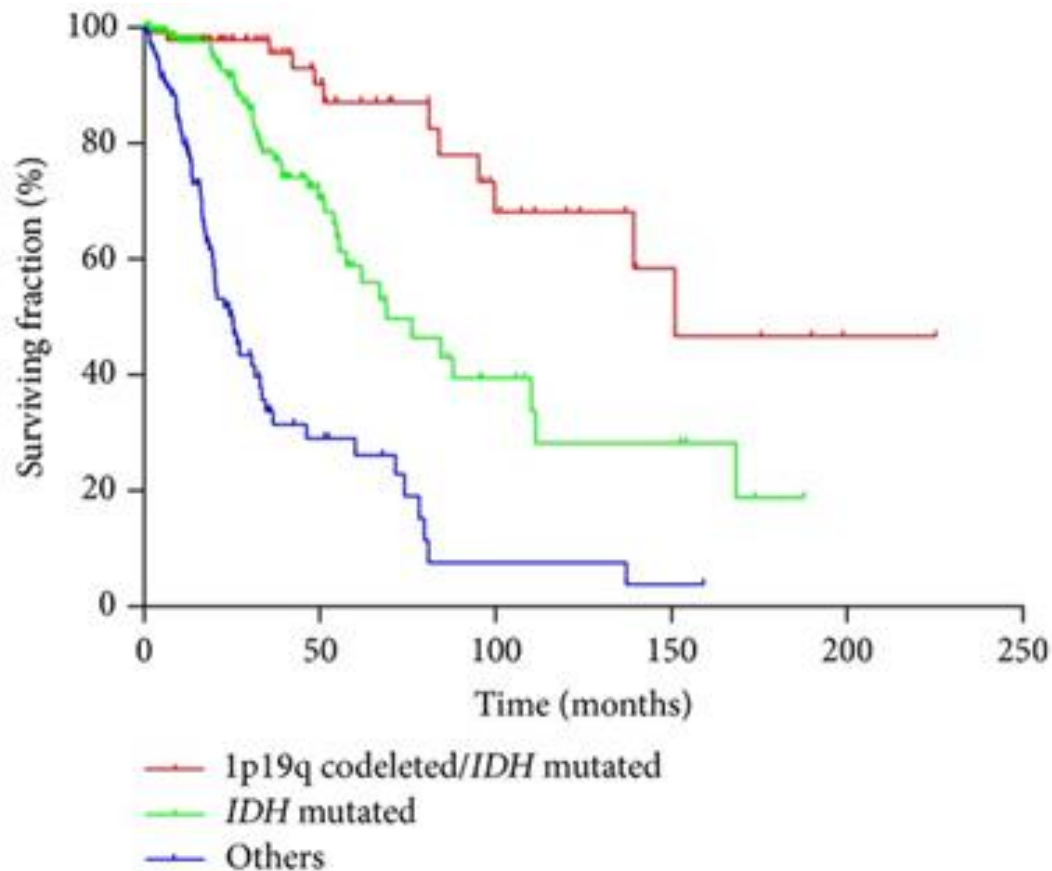
Codeletion 1p 19q prolongs oligodendroglioma survival

- Prolongs survival significantly



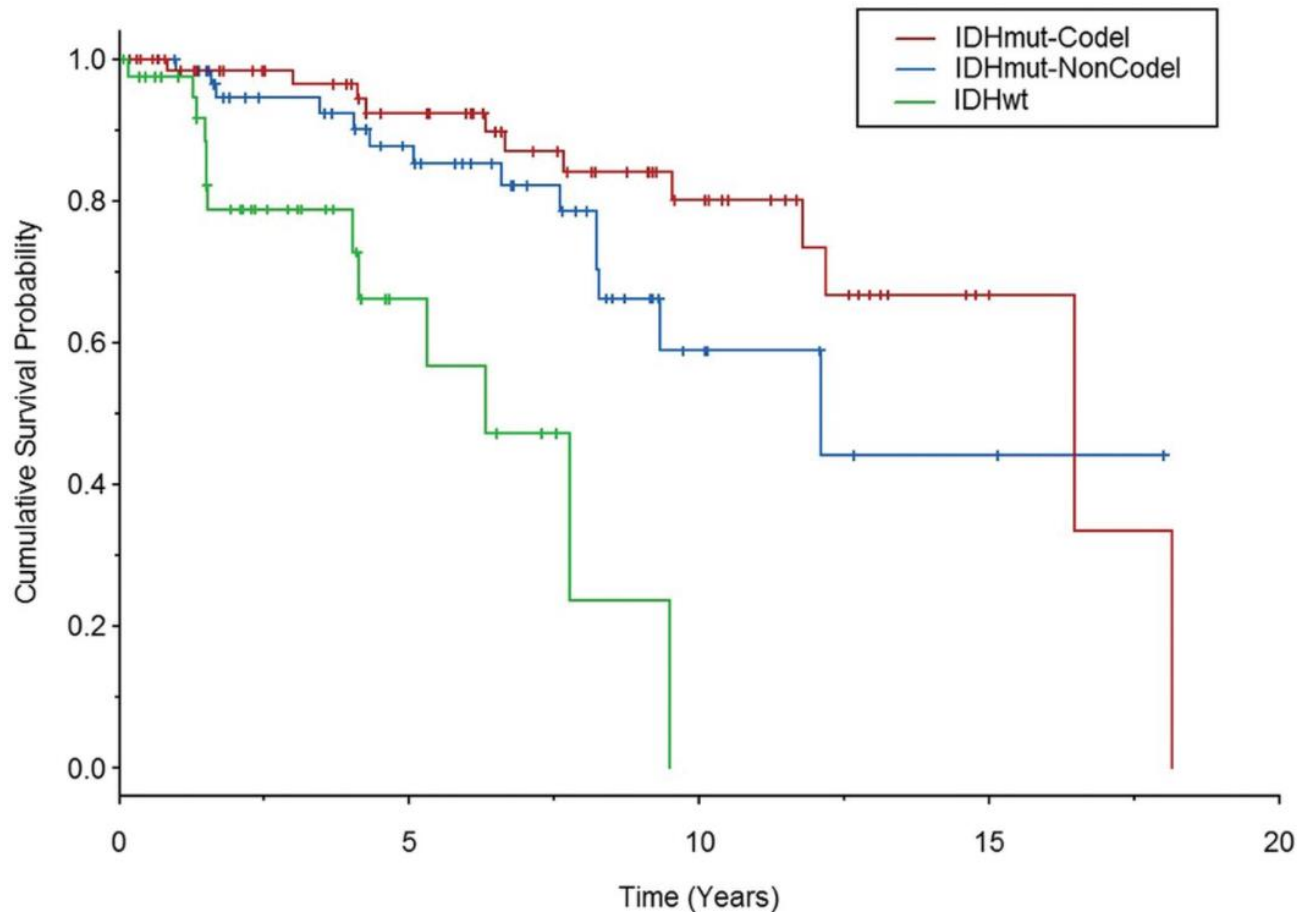
Low grade gliomas: markers and survival rate (1)

- Codeletion 1p 19q versus IDH mutation and others prolong survival most



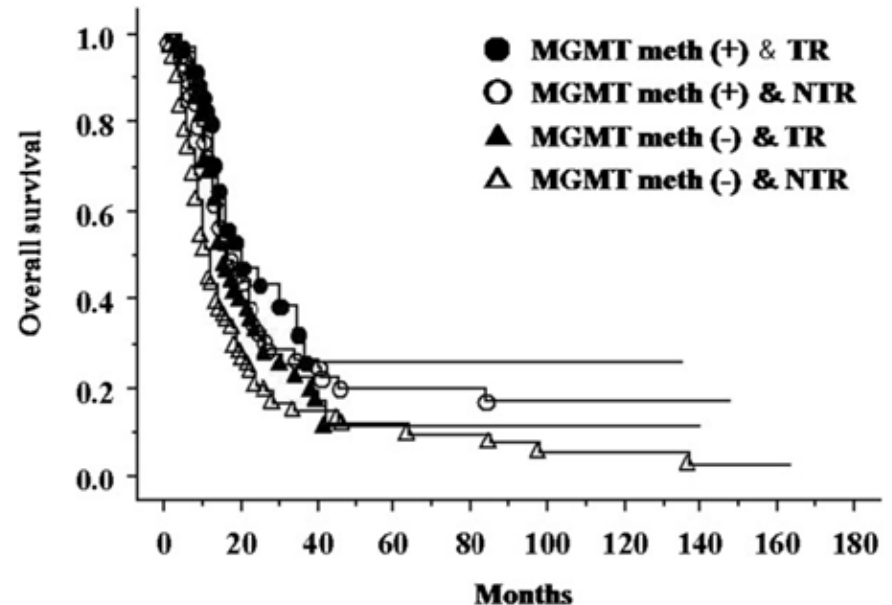
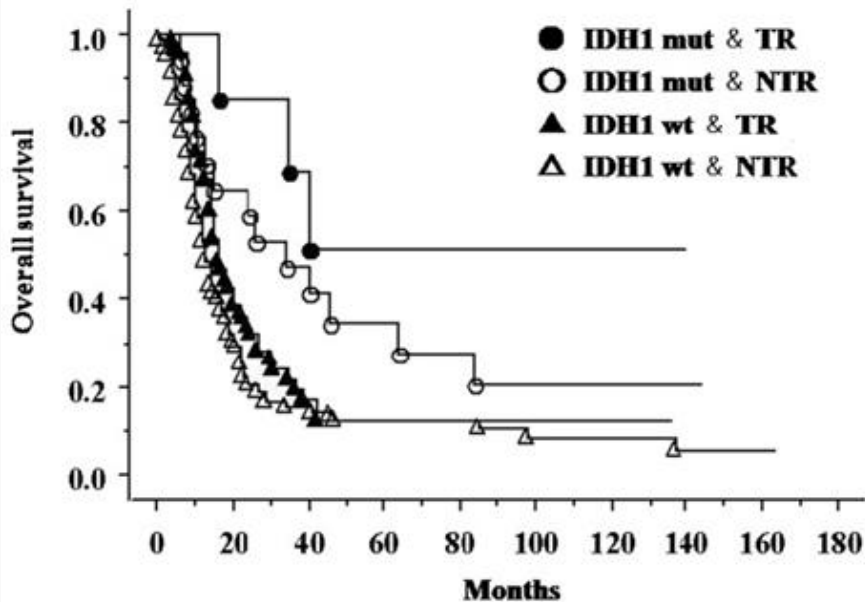
Low-grade gliomas: markers and survival rate (2)

- IDH mutation = longer survival
 - Codeletion 1p 19q = increases survival rate



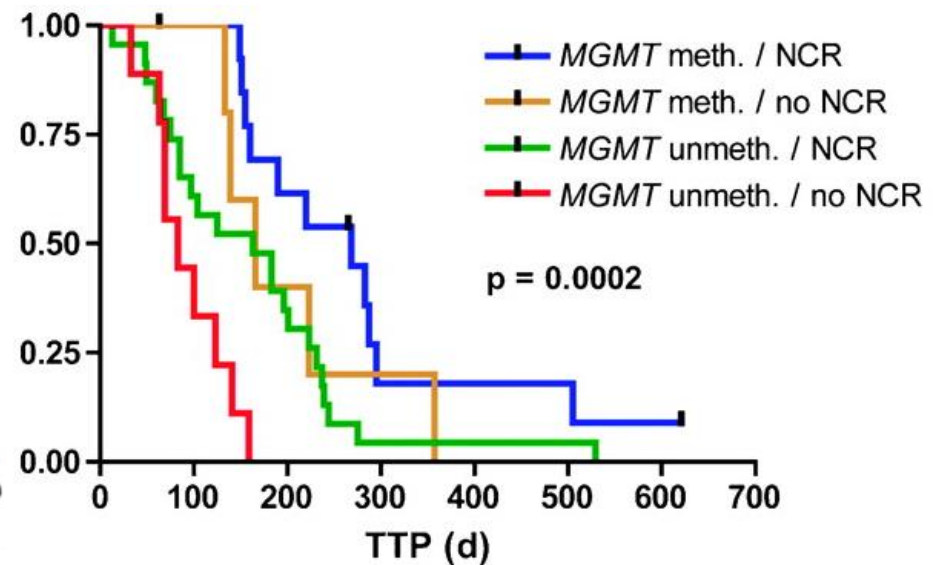
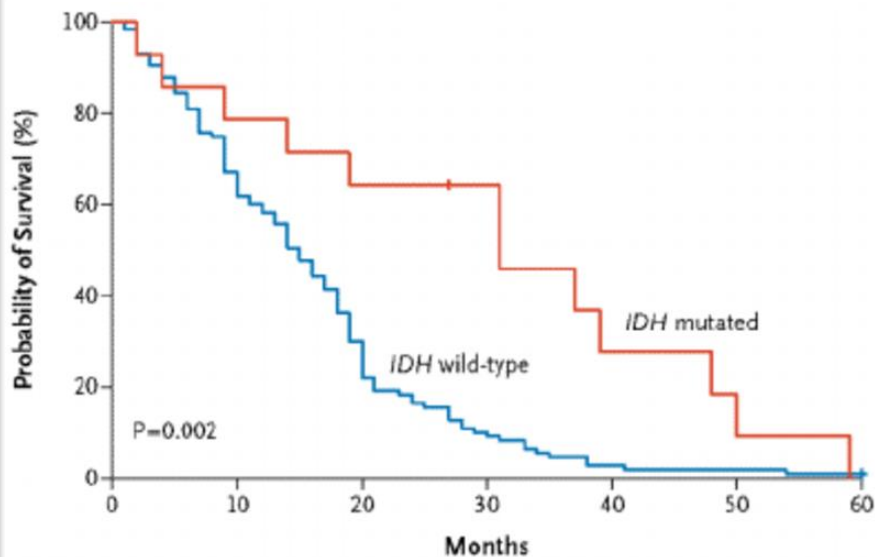
Anaplastic astrocytoma: markers and survival rate

- Total resection with IDH1 mutated & MGMT methylated = longer survival



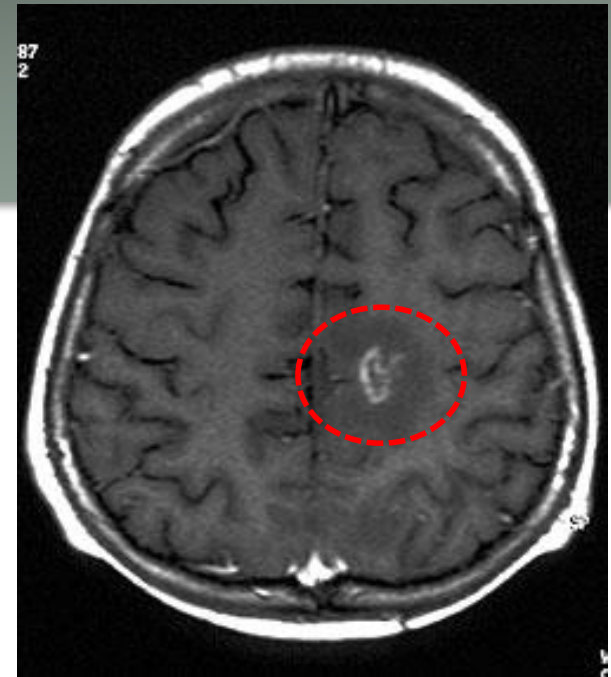
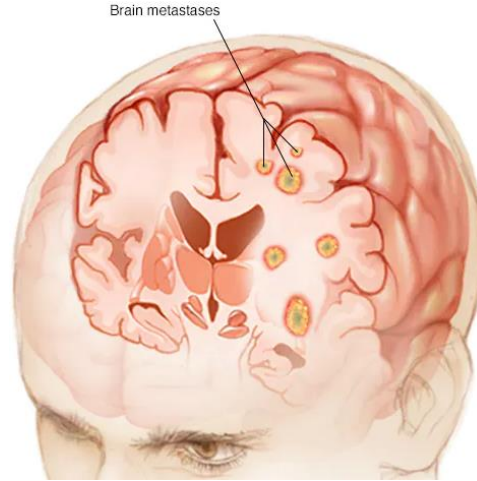
Glioblastoma: markers and survival rate

- Prolonged with IDH mutated and MGMT methylation with near-complete tumour removal (NCR)

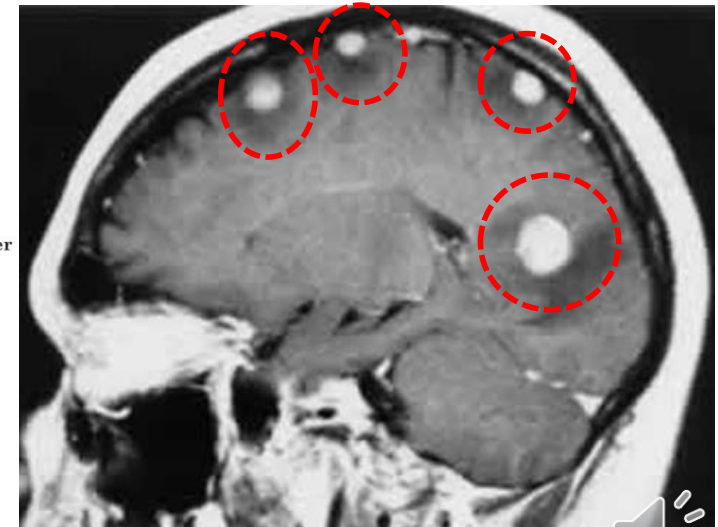
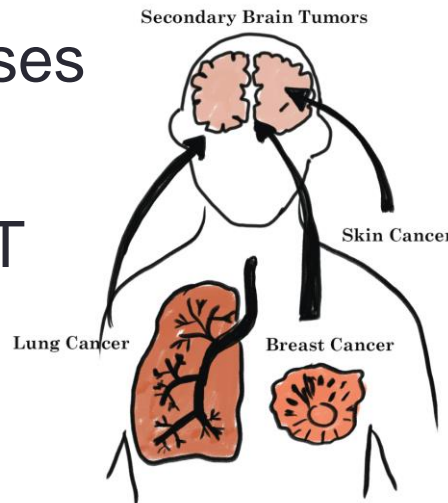


BRAIN METASTASES

- > 50% brain tumours
- 15-30% primary \Rightarrow brain metastases
- 15% metastasis \Rightarrow first symptoms unknown primary
- 70% brain metastases are multiple
- 6% lesions are NOT neoplastic = vital stereotaxic biopsy



30% single

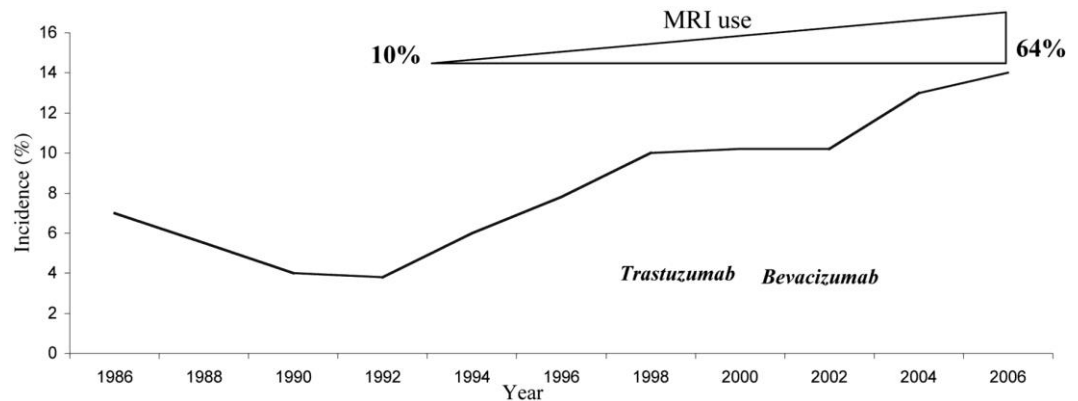


70% multiple



Brain metastases: incidence

- ↑ cancer patient survival
- Improved diagnostic capabilities
 - CT
 - RM
 - Bone scan
 - PET
- Many chemotherapeutic agents ∇ cross blood-brain barrier
- Chemotherapy alters blood-brain barrier



Metastases pathways

• Hematogenous

- Through regular venous/arterial system
- Through Batson's venous plexus

• Lymphatic

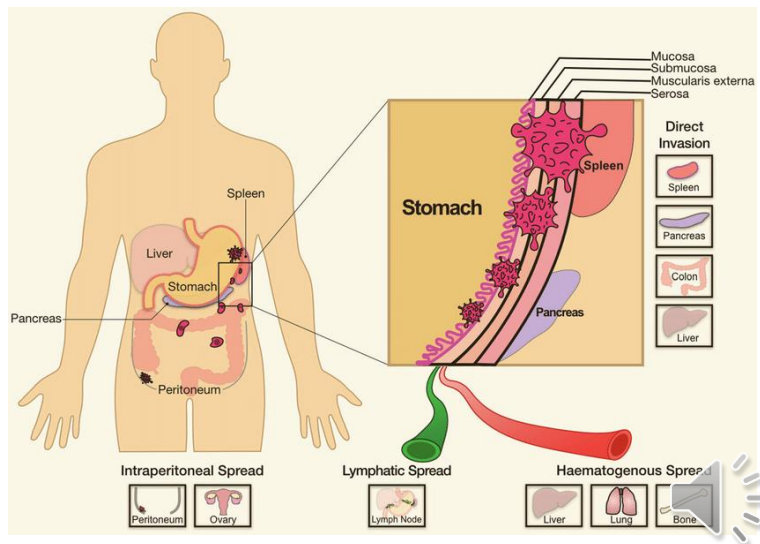
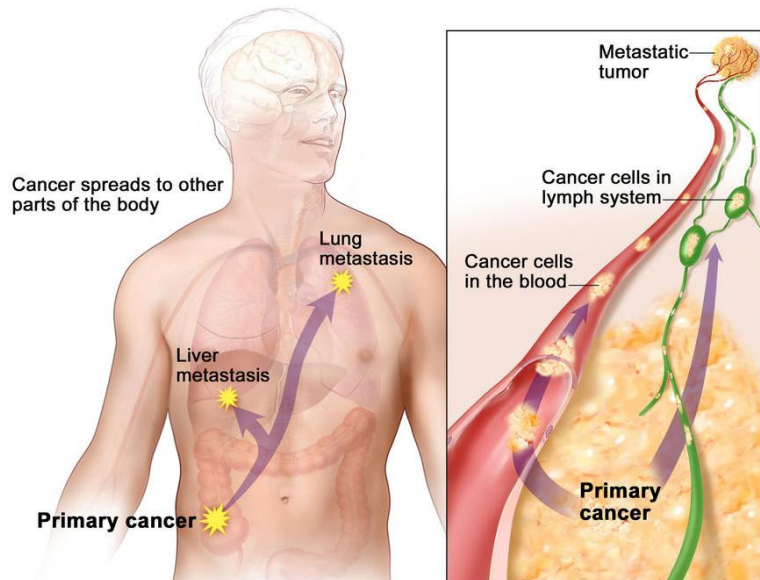
• Transceolomic

- Peritoneal or pleural cavity
- Meningeal carcinomatosis

• Air borne

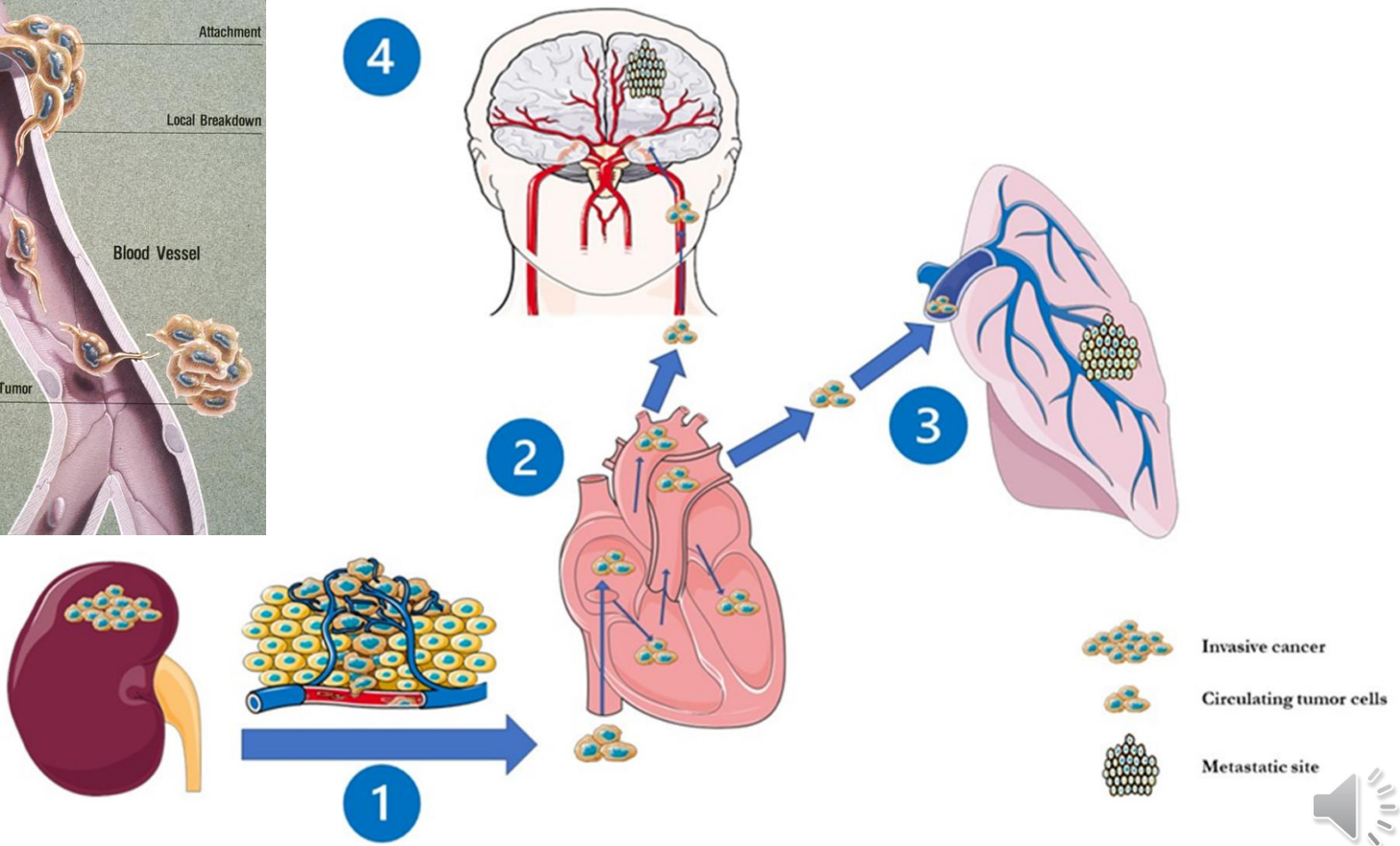
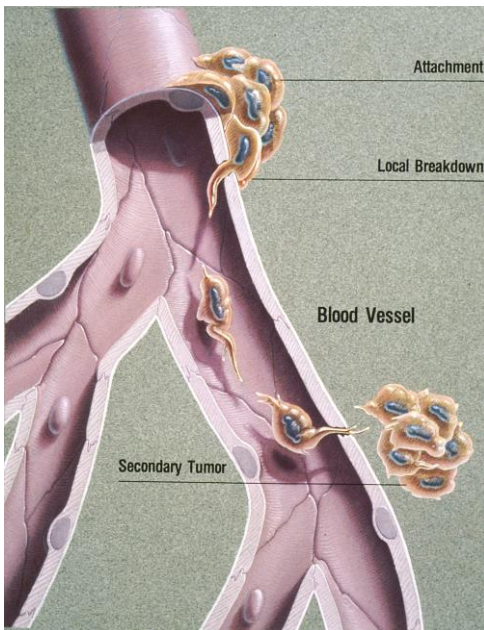
• Pyknotic vesicles

• Retrograde growth through peripheral nerves



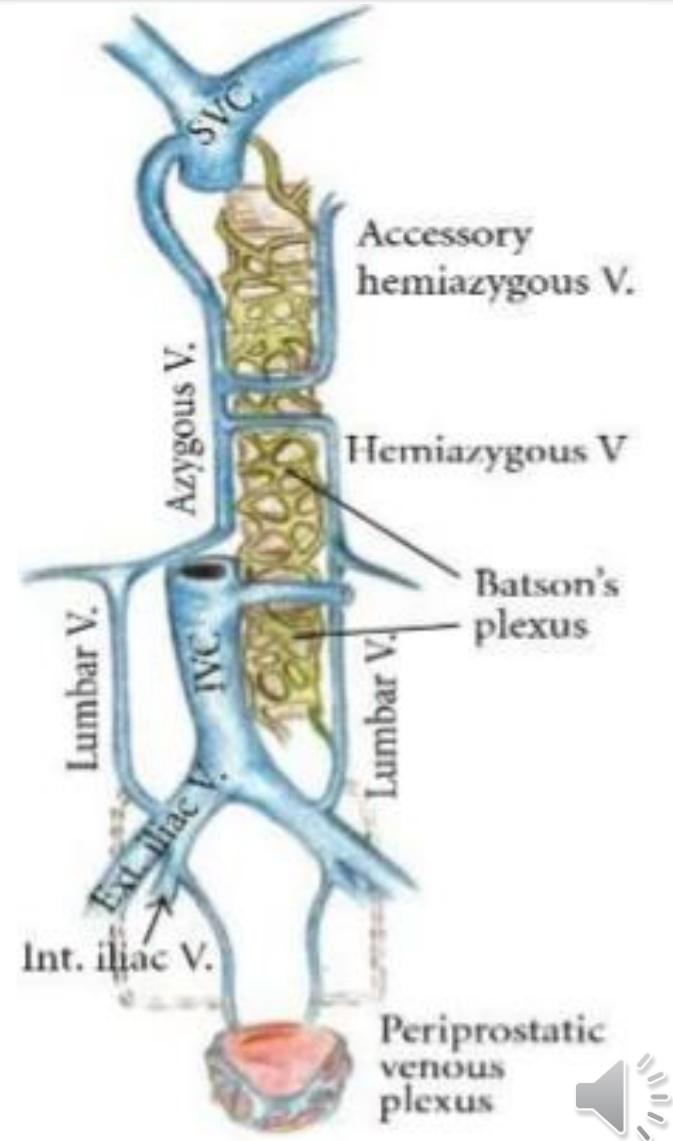
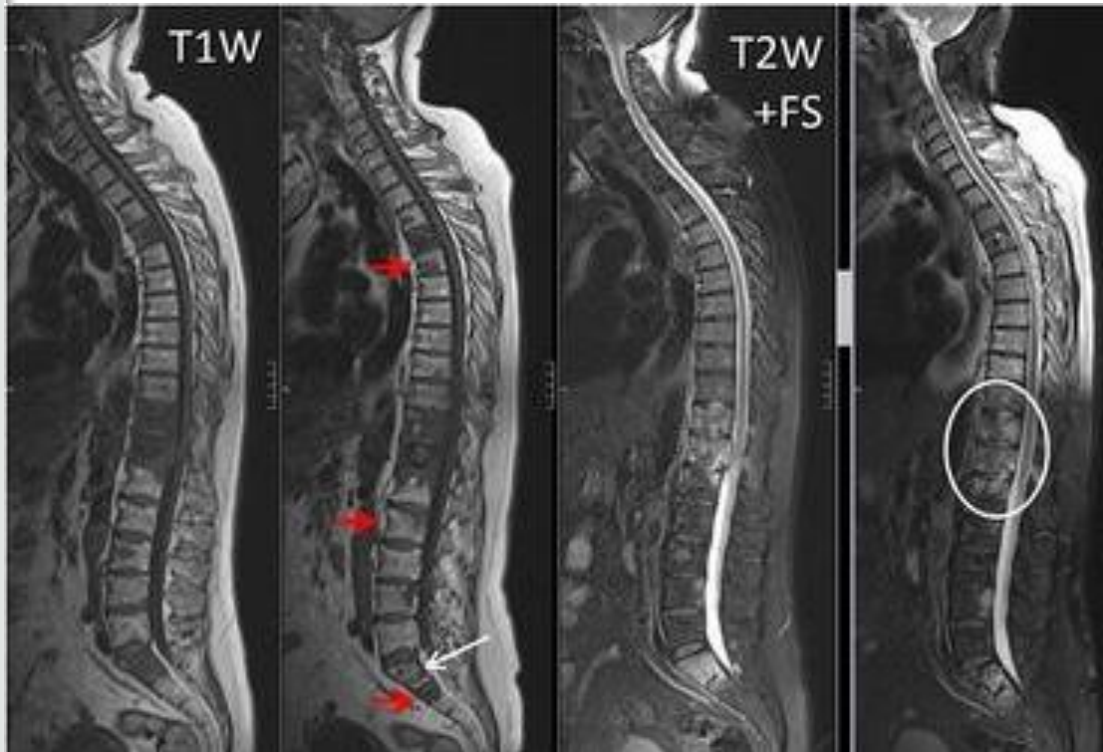
Hematogenous metastases

- The most common pathway

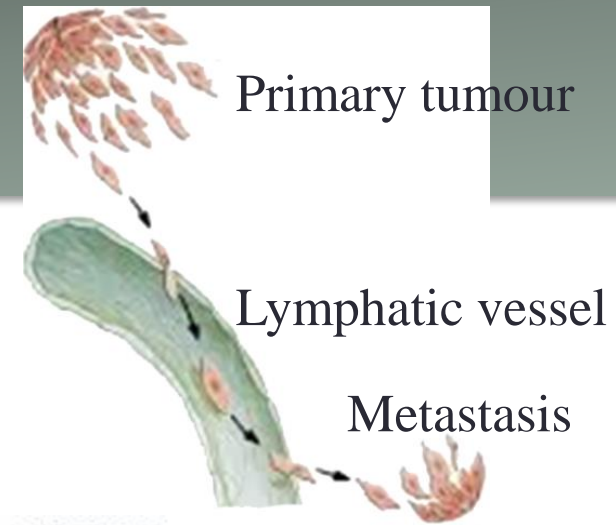


Hematogenous metastases through Batson's venous plexus

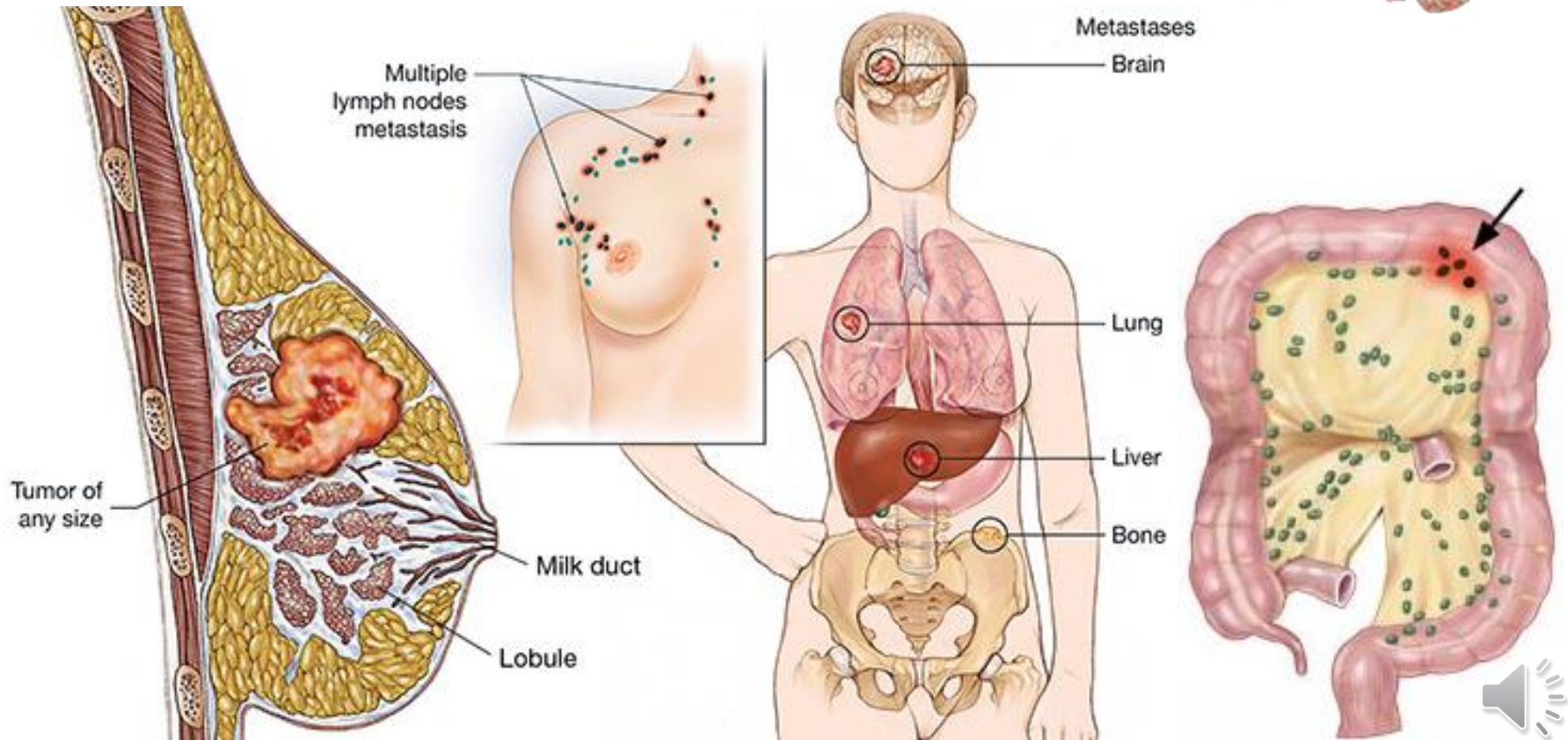
- Uncommon pathway
- Induces spinal metastases
- Typical of prostate cancer



Lymphatic metastases

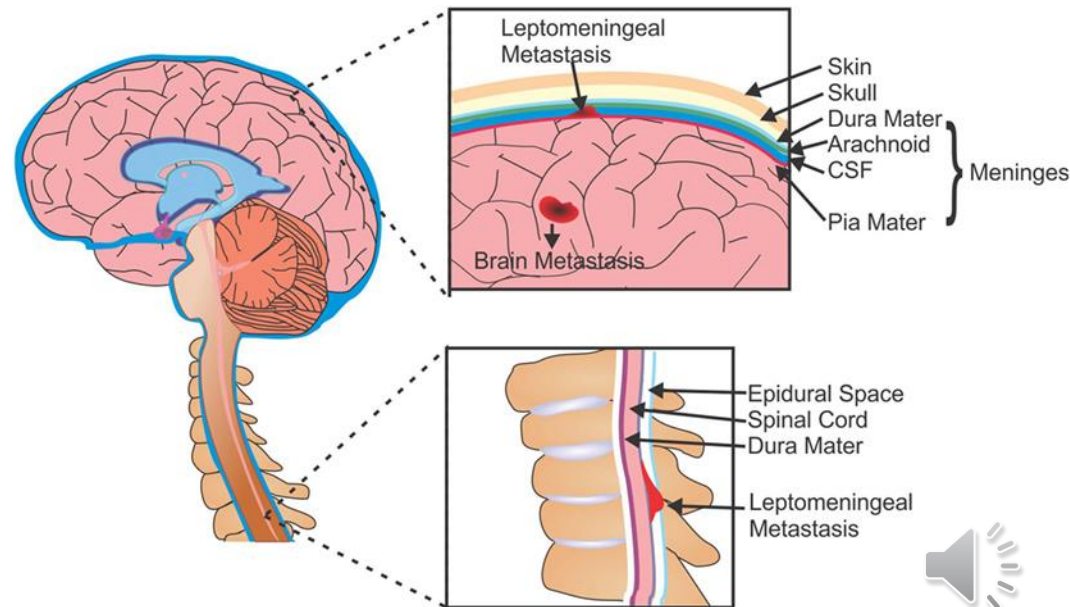
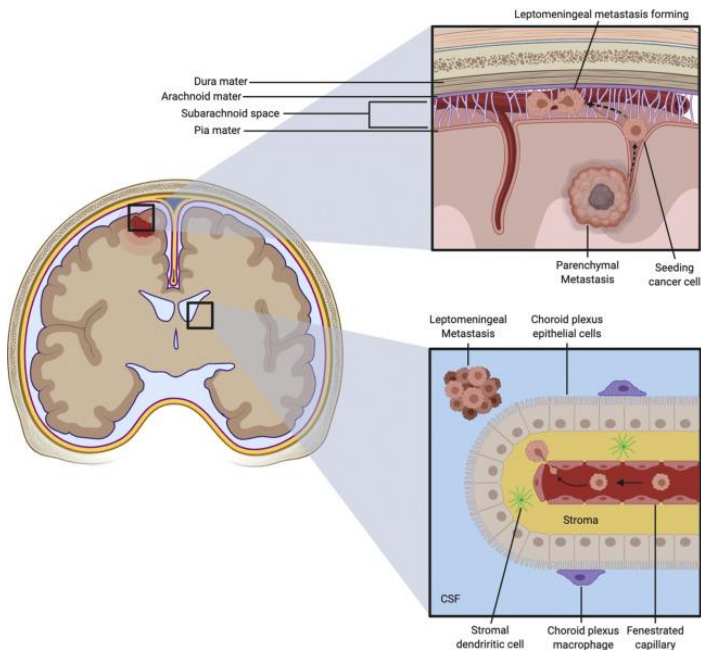
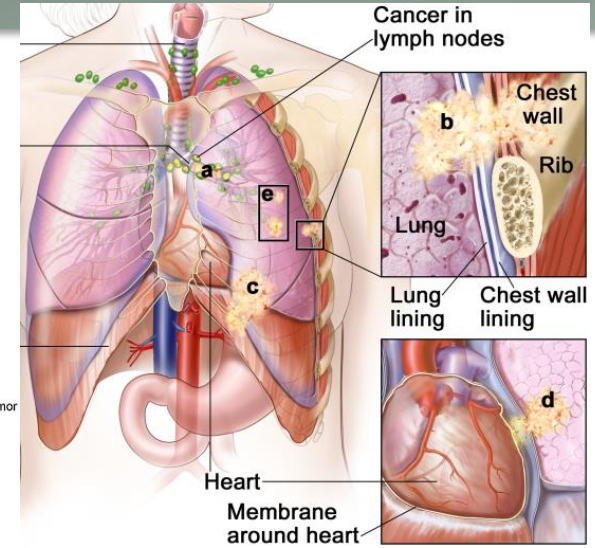
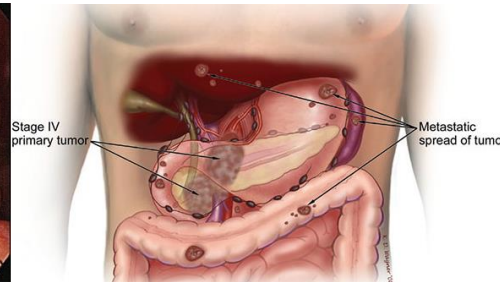
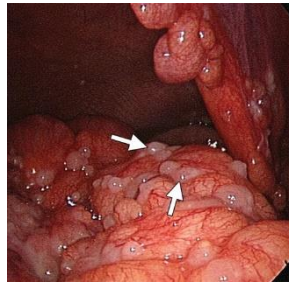
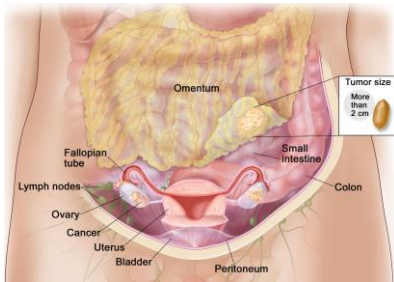


- Rare for brain metastases
- Can be intermediate step before brain metastases



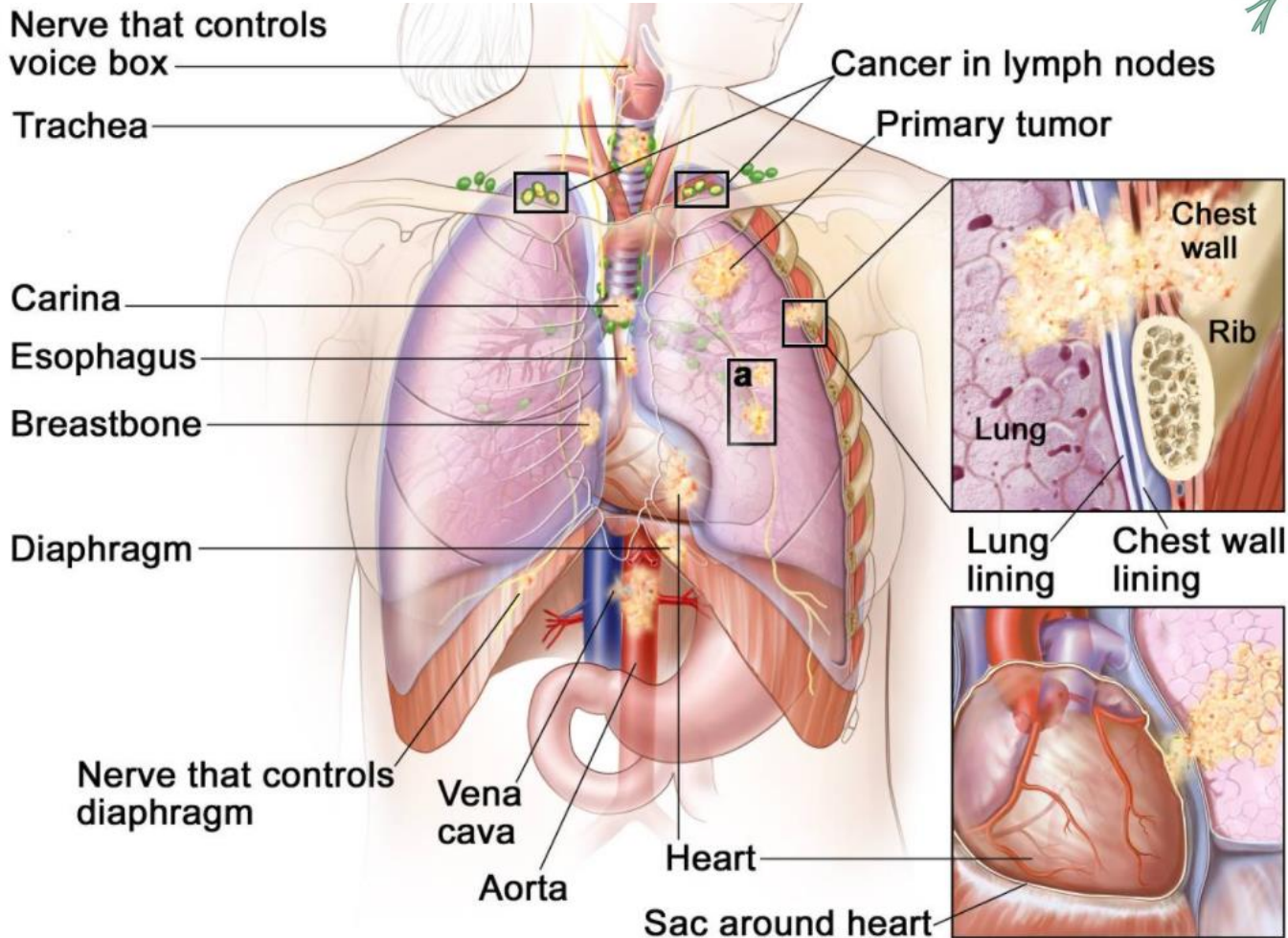
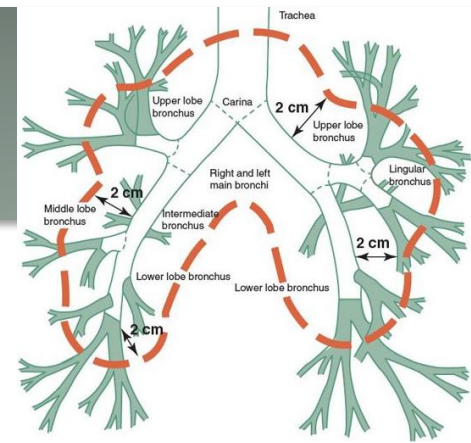
Transceolomic

- Common for some tumours
 - Ovarian cancer



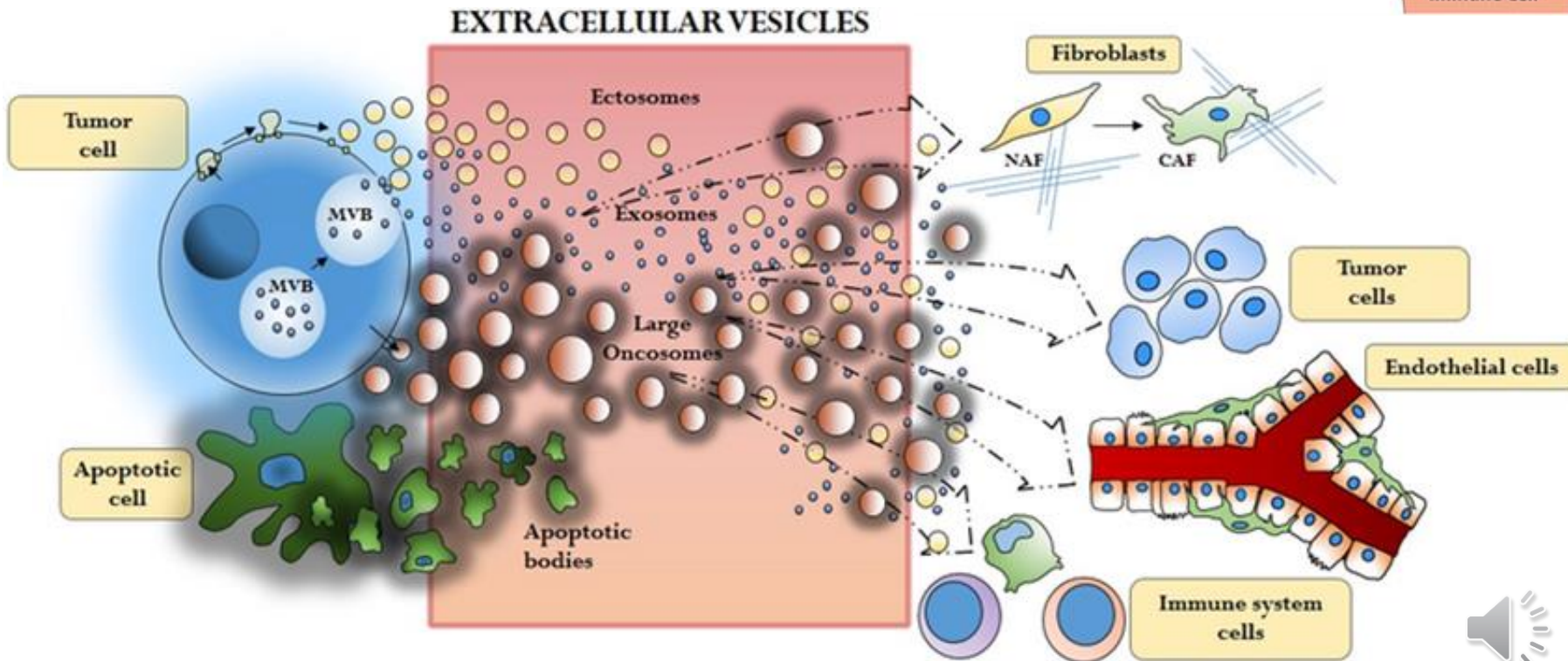
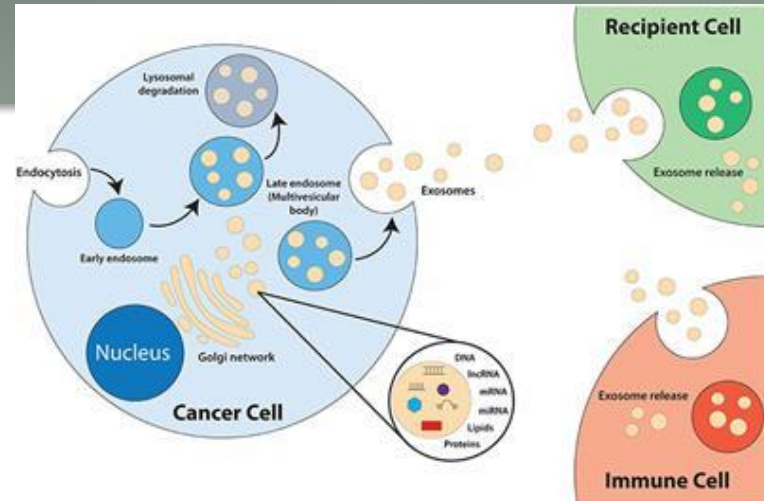
Airborne

- In advanced lung cancer



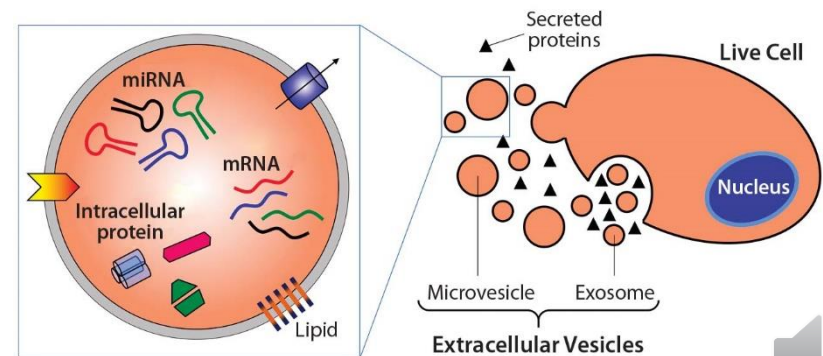
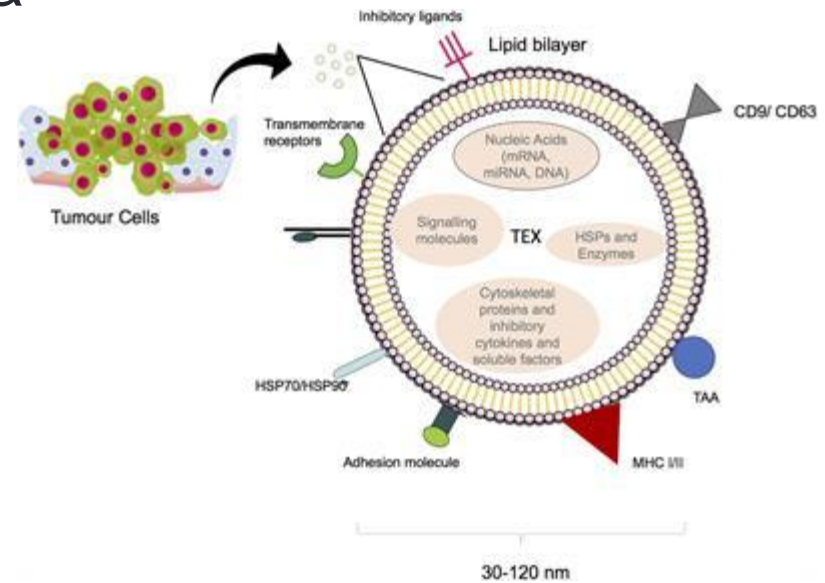
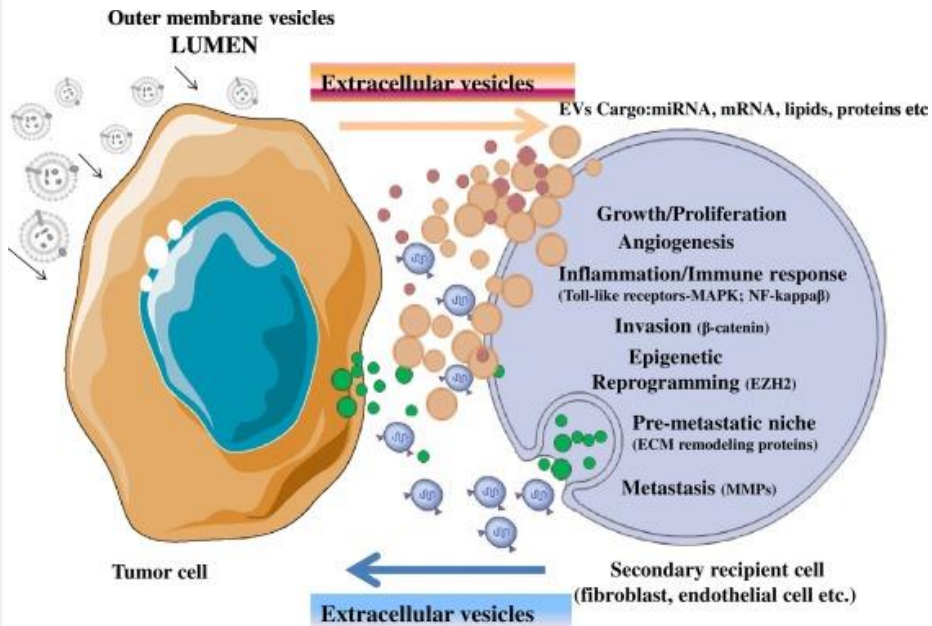
Metastatic spread: pyknotic vesicles

- Tumour DNA in blood and saliva



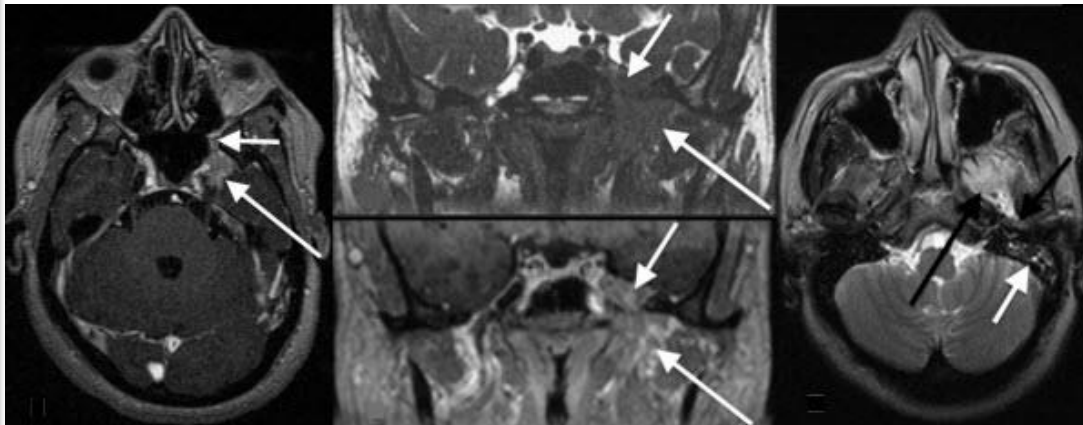
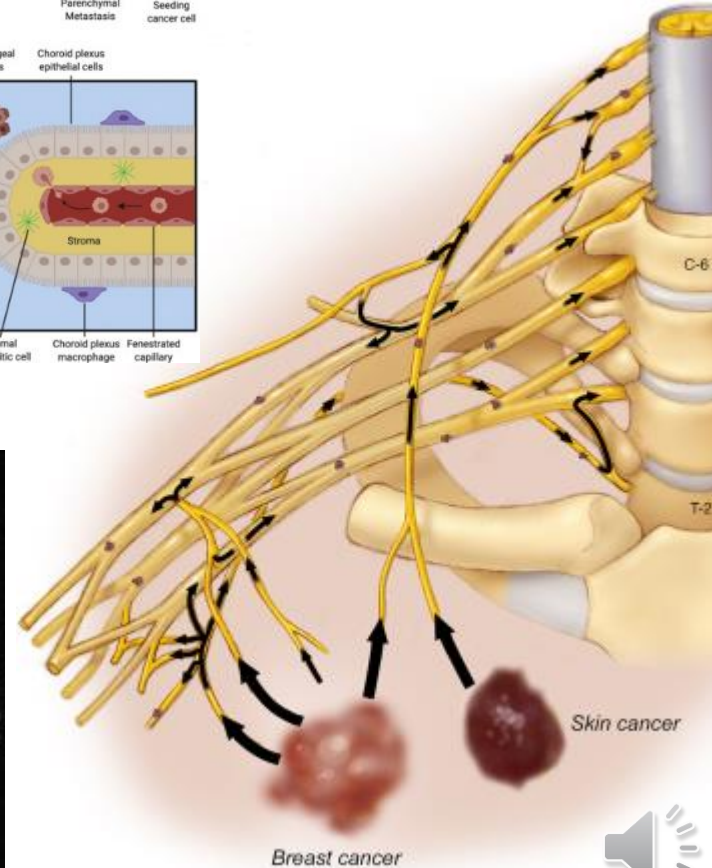
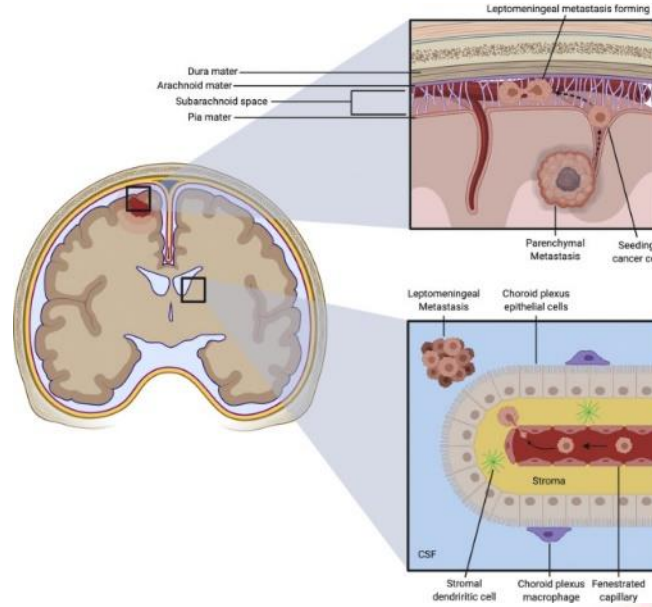
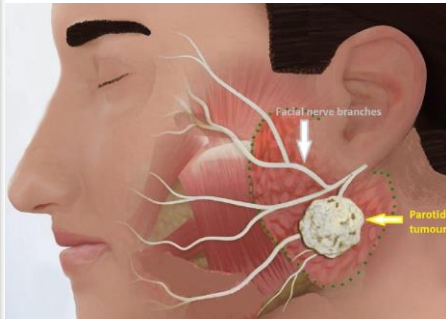
Metastatic spread: pyknotic vesicles

- Tumour DNA in blood and saliva



Metastatic pathways: retrograde growth through peripheral nerves

- Typical of parotid tumours
- Cause meningeal carcinomatosis



Clinical examination oncologic patient (1)

- Thorough examination compulsory



Basal cell tumour



Melanoma



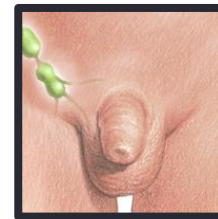
Parotid tumour



Larynx tumour



Upper limb cancer

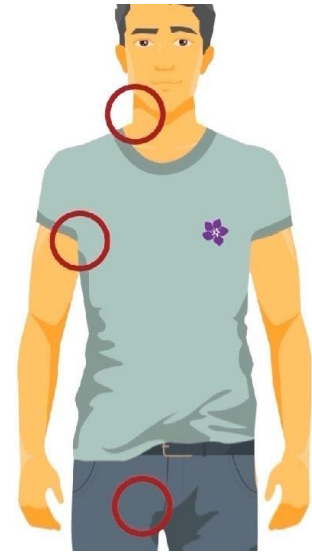


Lower limb cancer



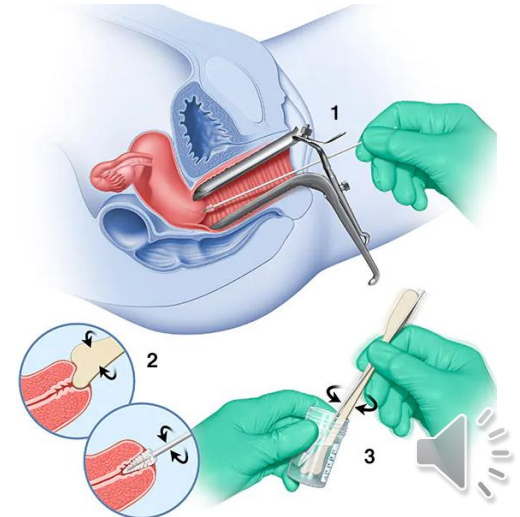
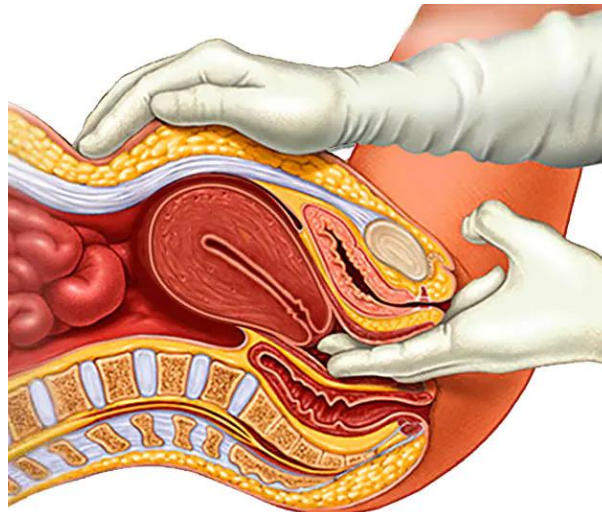
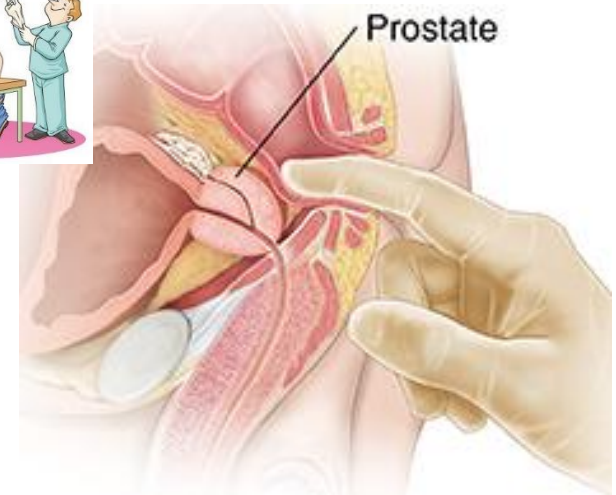
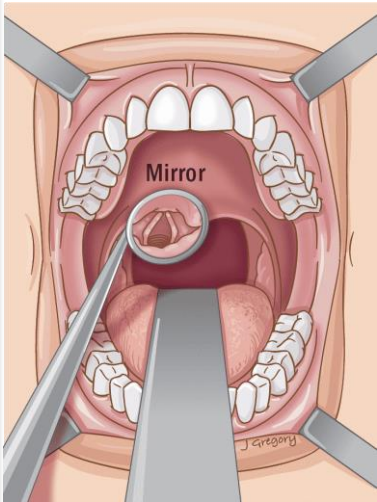
Clinical examination oncologic patient (2)

- ALL lymphatic ganglia chains MUST be examined

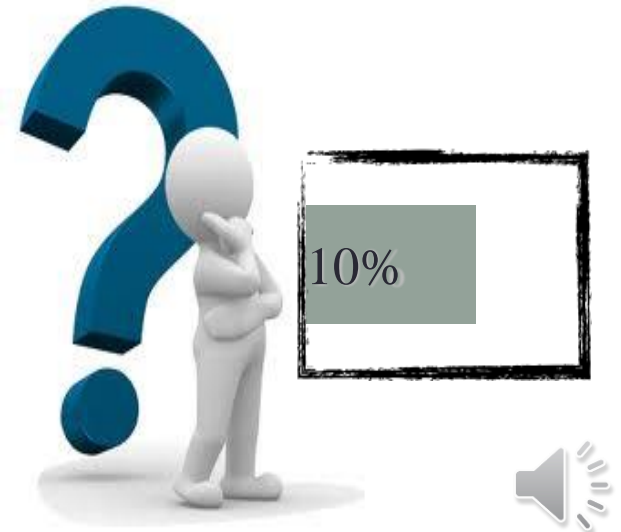
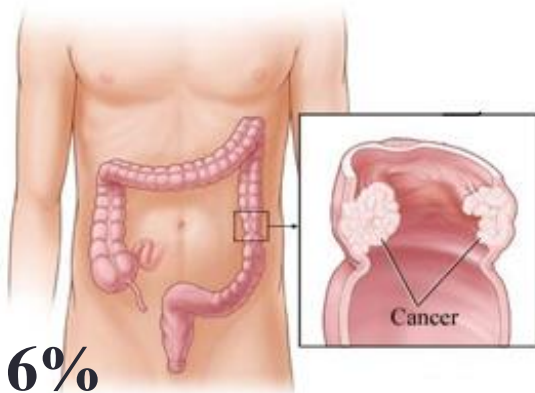
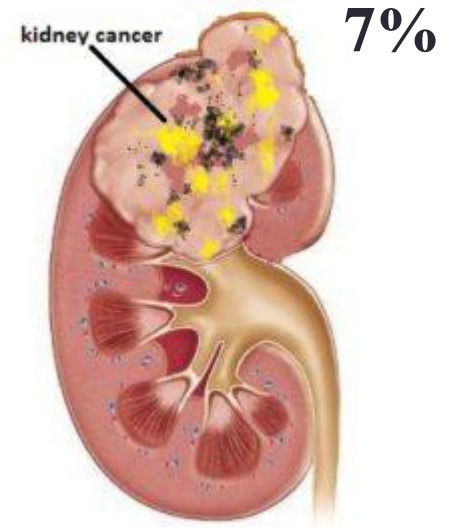
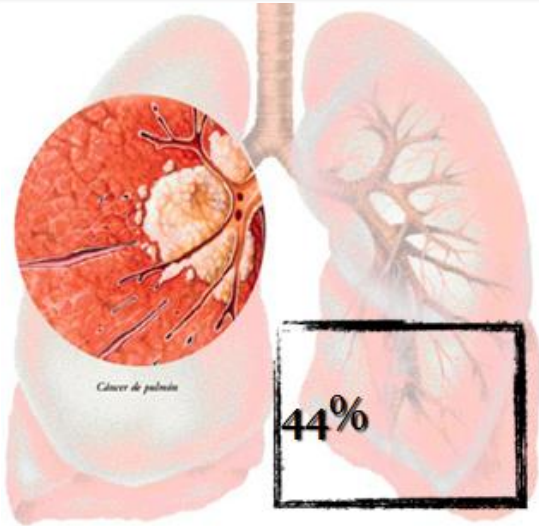


Clinical examination oncologic patient (3)

- ALL tumour sources MUST be ruled out

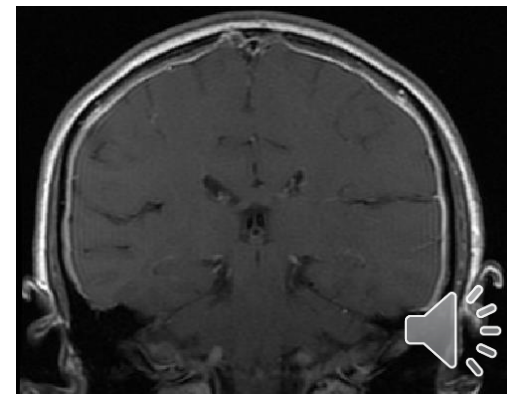
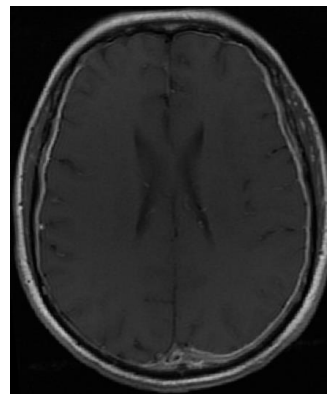
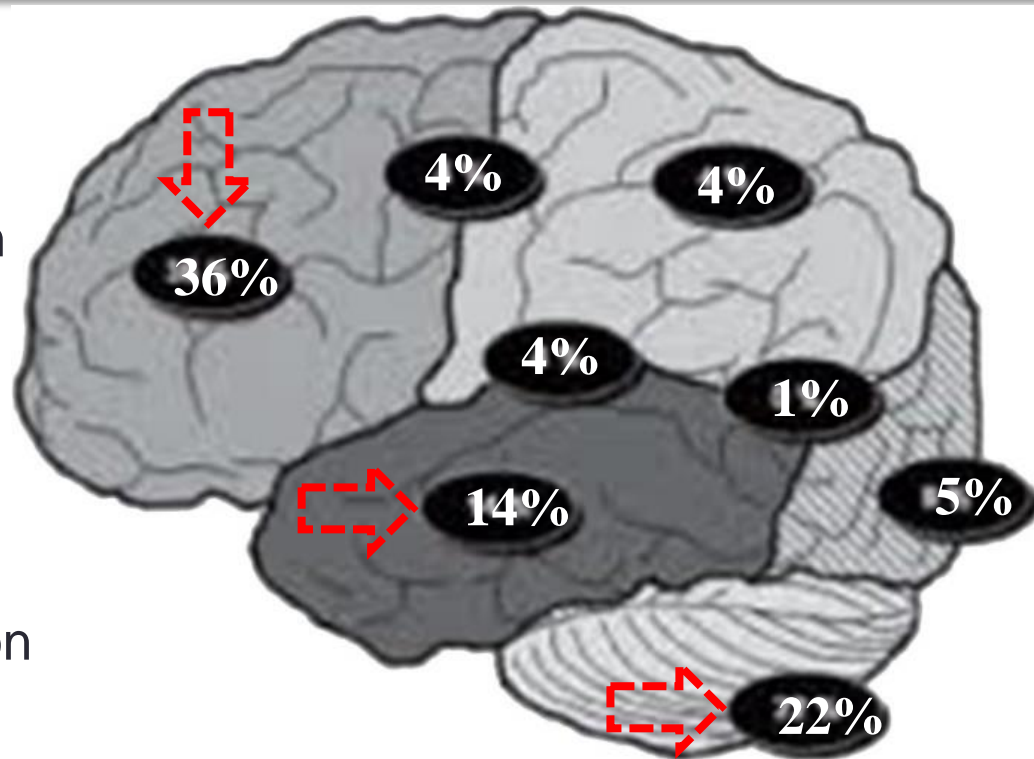


Brain metastases: primary tumour



Brain metastases: location

- Cerebral hemispheres
78%
 - Cortico-subcortical location
 - Mostly frontal / temporal lobes
- Posterior fossa 22%
 - Cerebellum 16%
 - Single posterior fossa lesion in adults = metastasis until proven otherwise
- Meningeal carcinomatosis / Carcinomatous meningitis

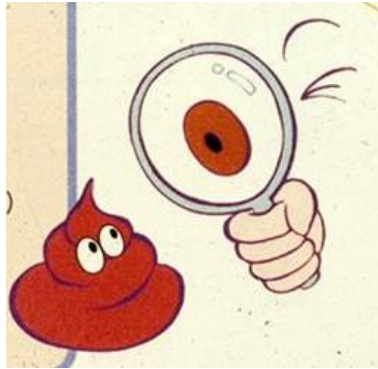


Extension study

- Treatment highly dependent on it



Chest x-ray



Stool analysis



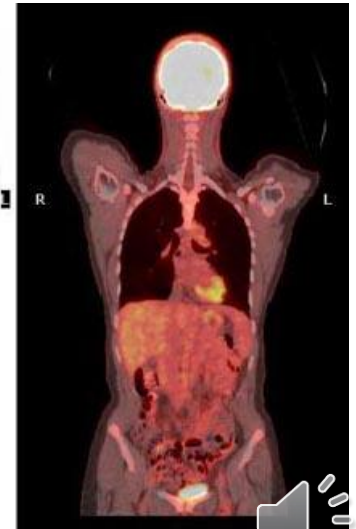
Prostate antigen



Mammography



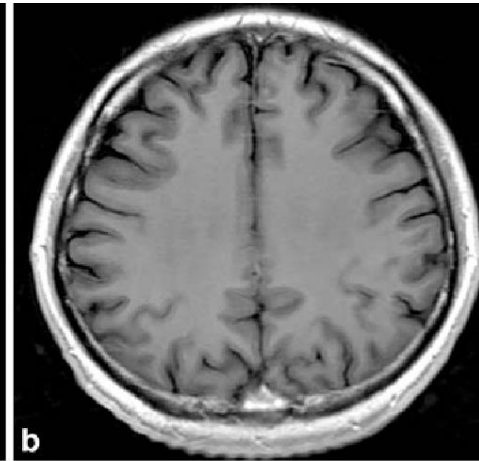
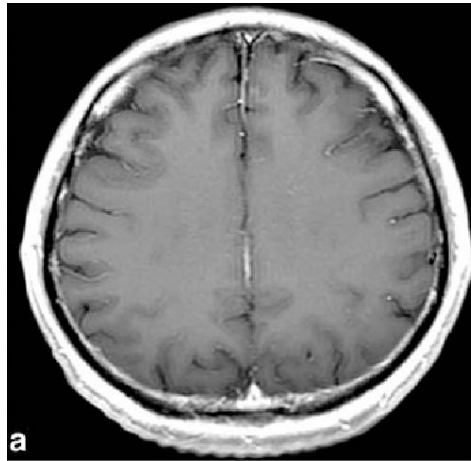
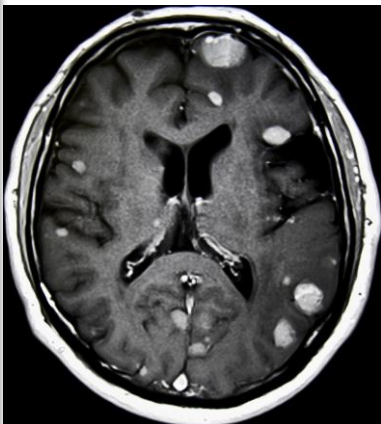
Thorax-abdomen-pelvis CT scan



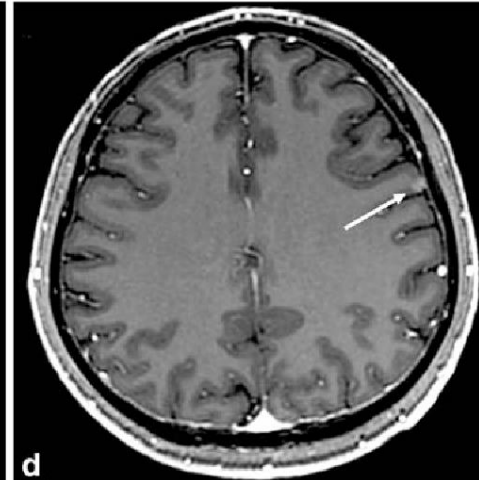
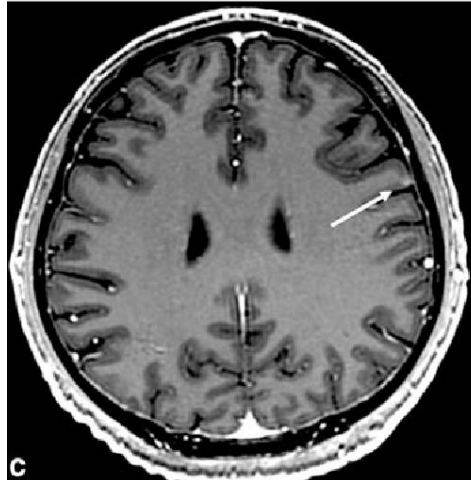
Positron emission tomography (PET)

Single versus multiple metastases

- High field MRI needed to see tiny metastases
 - This will decide treatment & prognosis



1.5 Tesla

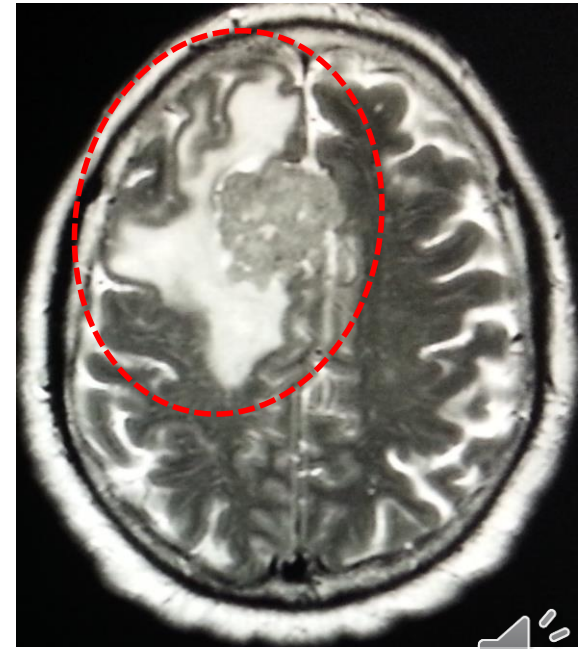


3 Tesla



Brain metastases: medical treatment

- Corticosteroids
 - Dexamethasone 10-20mg i.v. / 6mg / 6h
- H₂ antagonists
- Anticonvulsants

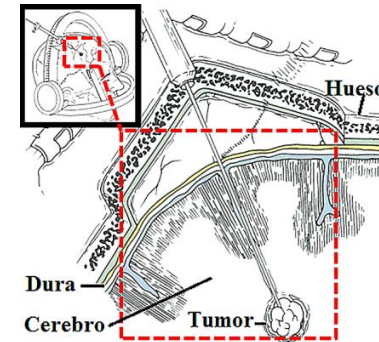


Brain edema around brain metastasis

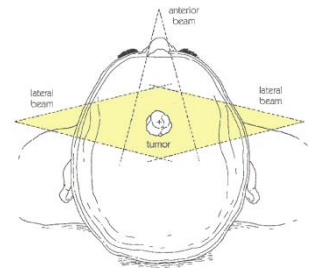


Brain metastases: specific treatment

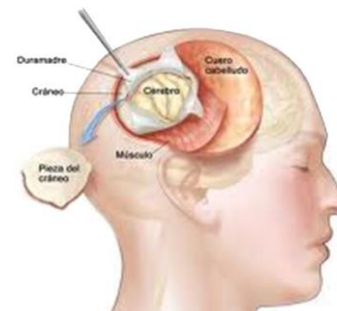
- Unknown primary or diagnosis NOT confirmed = stereotactic biopsy
- Primary NOT controlled = No treatment / palliative whole cranial radiotherapy
- Controlled primary (Karnofsky ≥ 70)
 - Single = surgery + whole cranial radiotherapy
 - Multiple
 - ≤ 3 = radiosurgery \pm whole cranial radiation therapy
 - > 3 = whole cranial radiation therapy



Stereotactic biopsy



Whole cranial radiotherapy



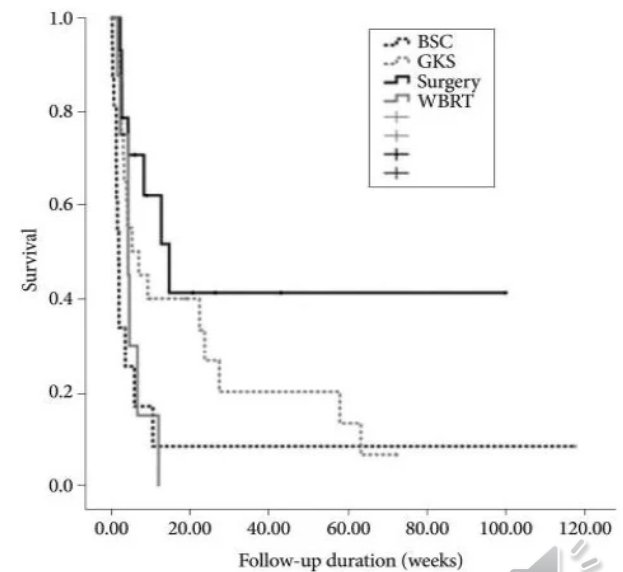
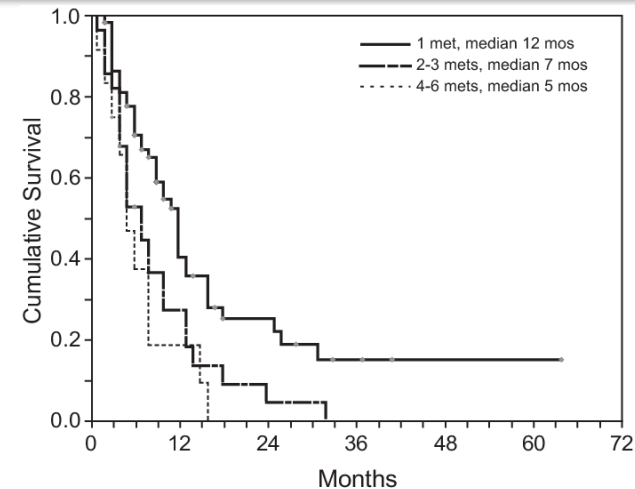
Craniotomy



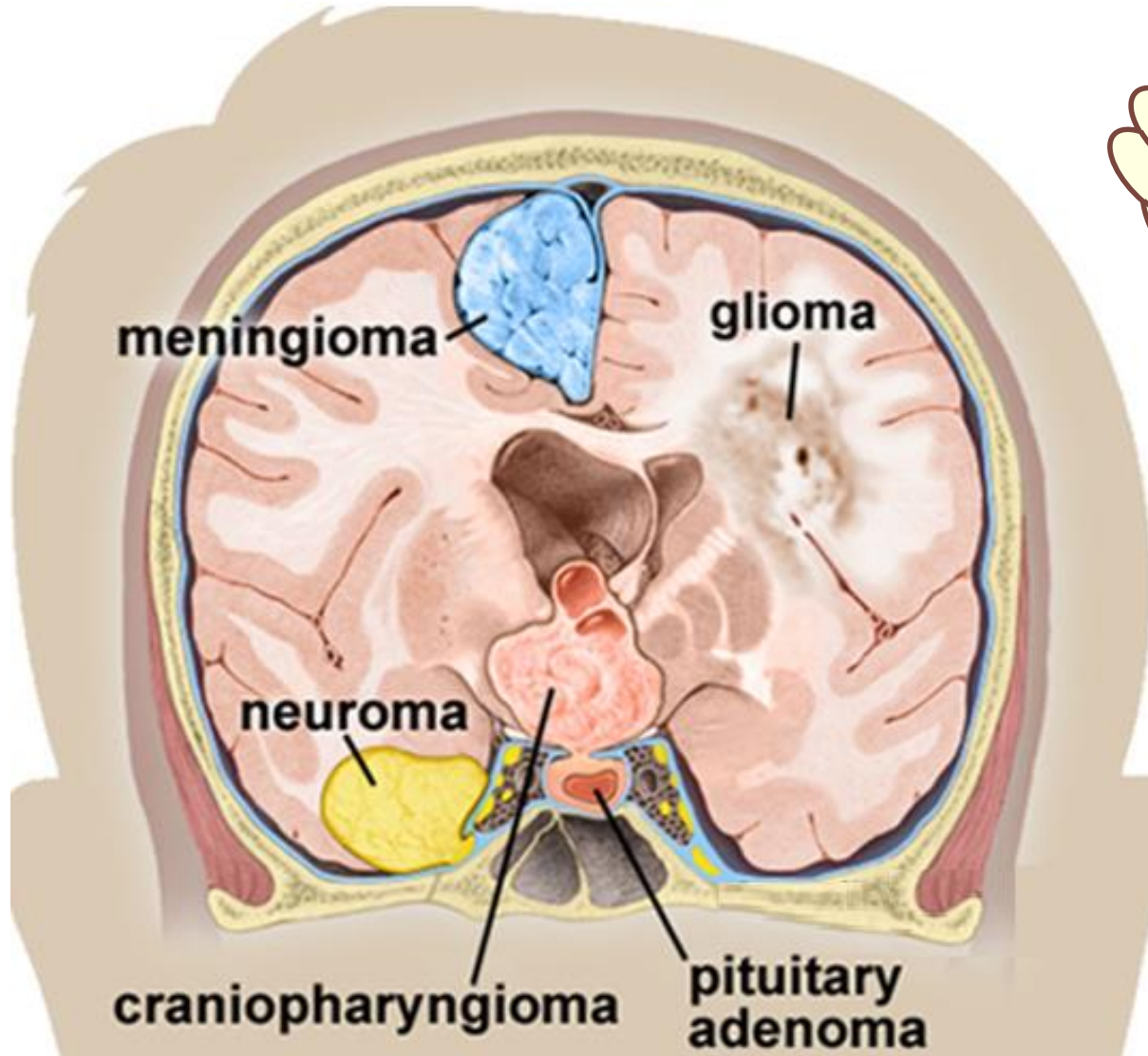
Radiosurgery

Brain metastases: prognosis

- ☠ No treatment ~ 1 month
- ☠ Corticosteroids to control oedema ~ 2 months
- ☠ Whole cranial radiation therapy + corticosteroids ~ 3-6 months
- ☠ Surgery + whole cranial radiotherapy ~ 8-12 months
- ☠ Radiosurgery + whole cranial radiotherapy ~ 12-14 months



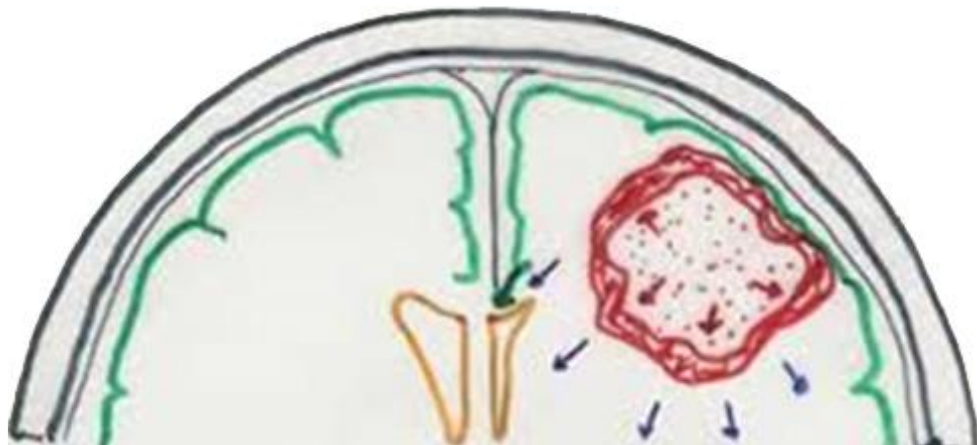
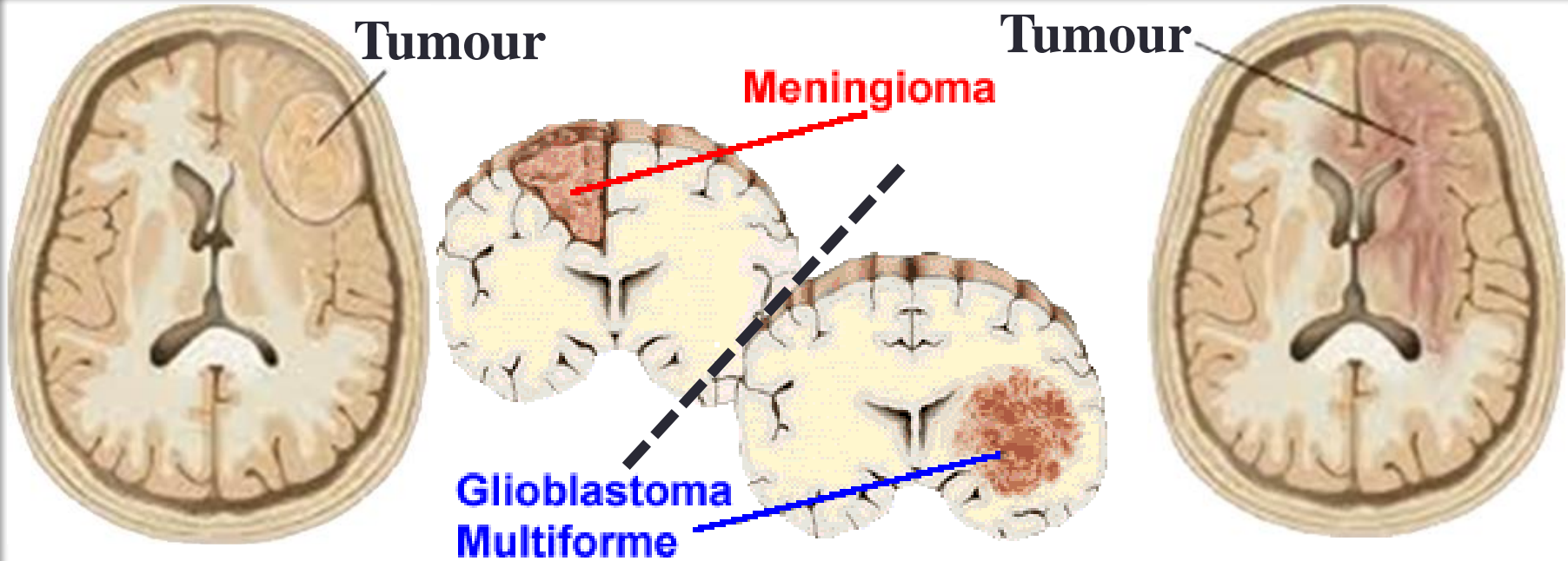
PRIMARY BRAIN TUMOURS



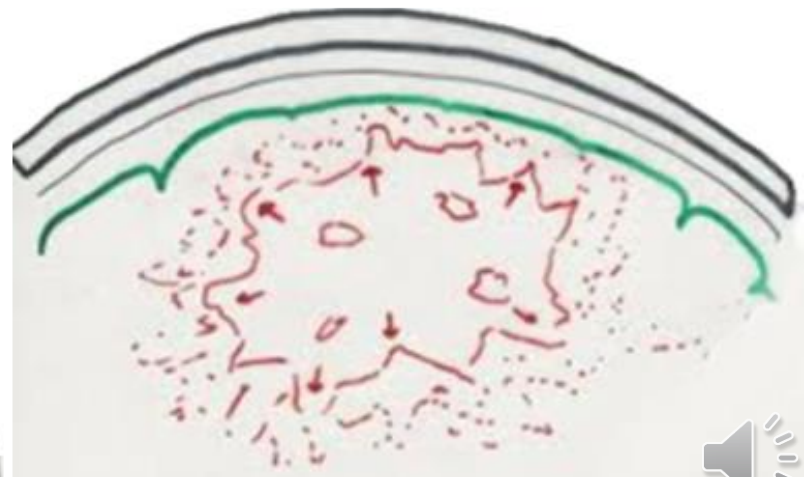
REMEMBER?



Primary brain tumours: growth patterns



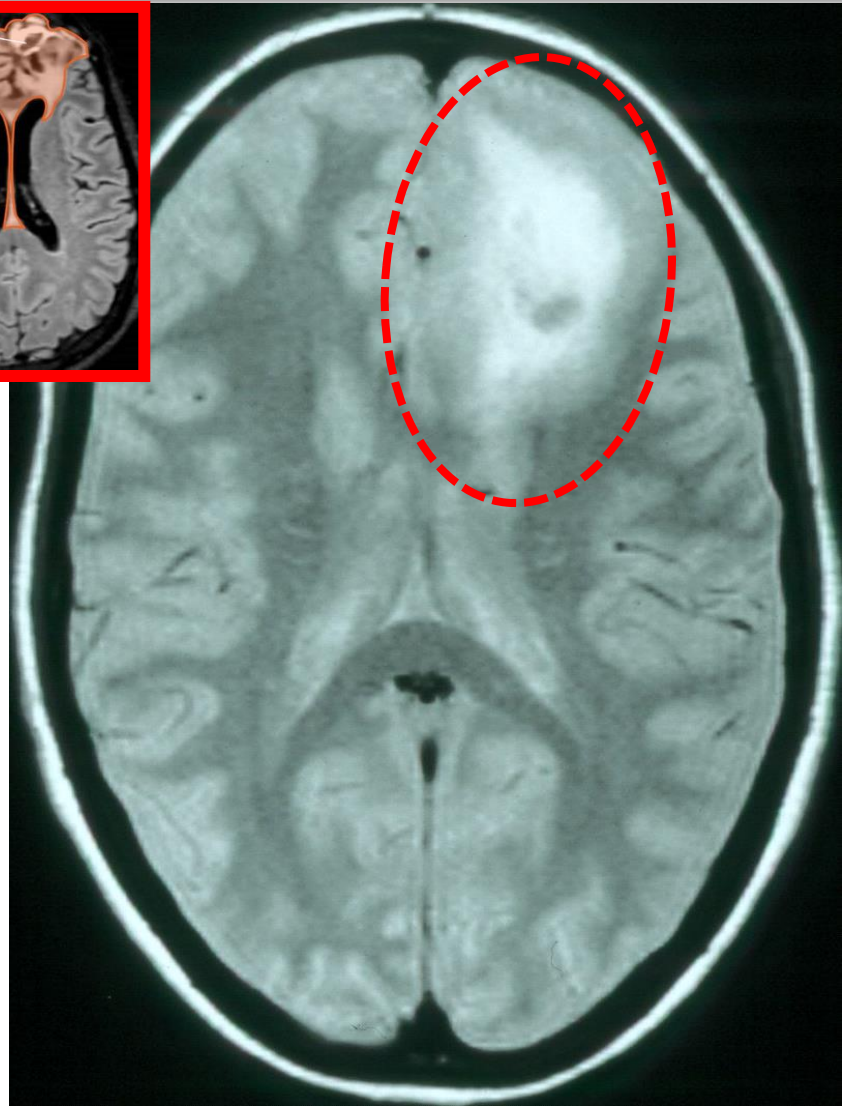
Expansive growth



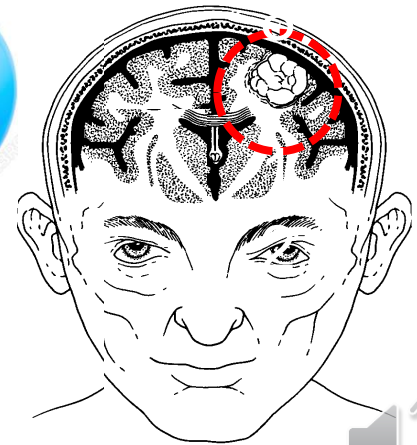
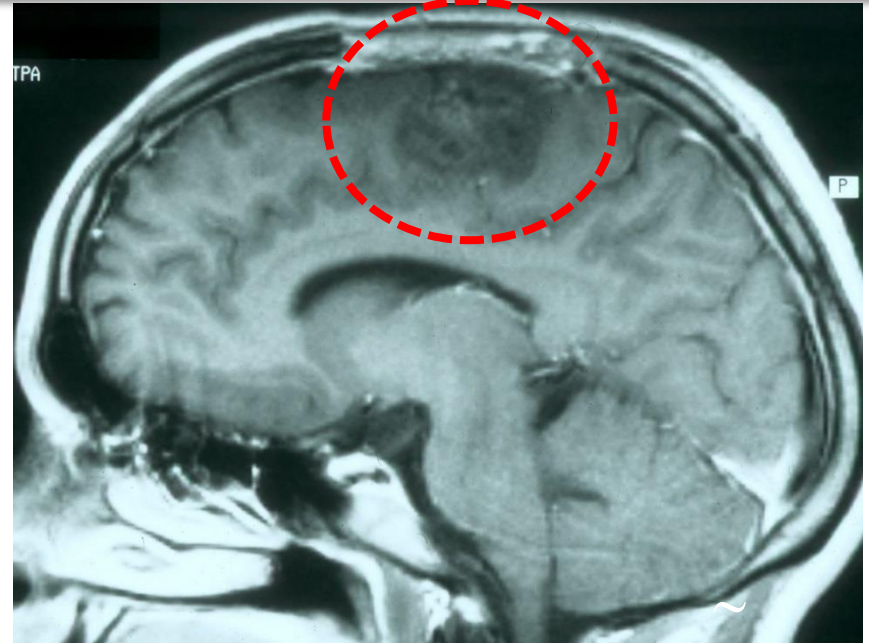
Invasive growth



Primary brain tumours: growth patterns



Invasive growth

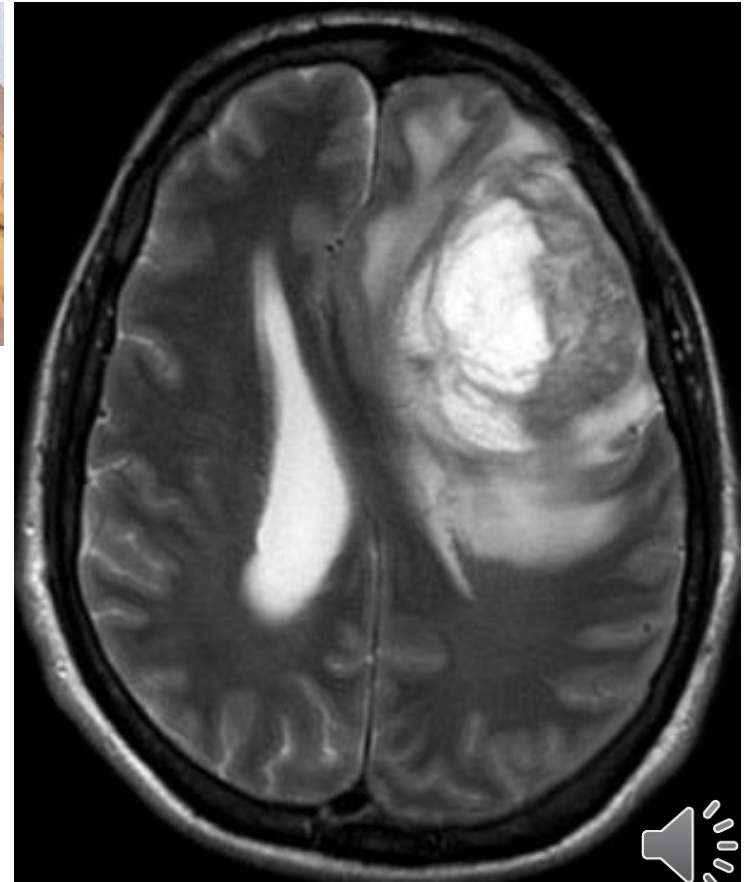
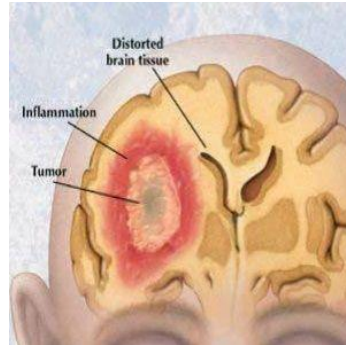
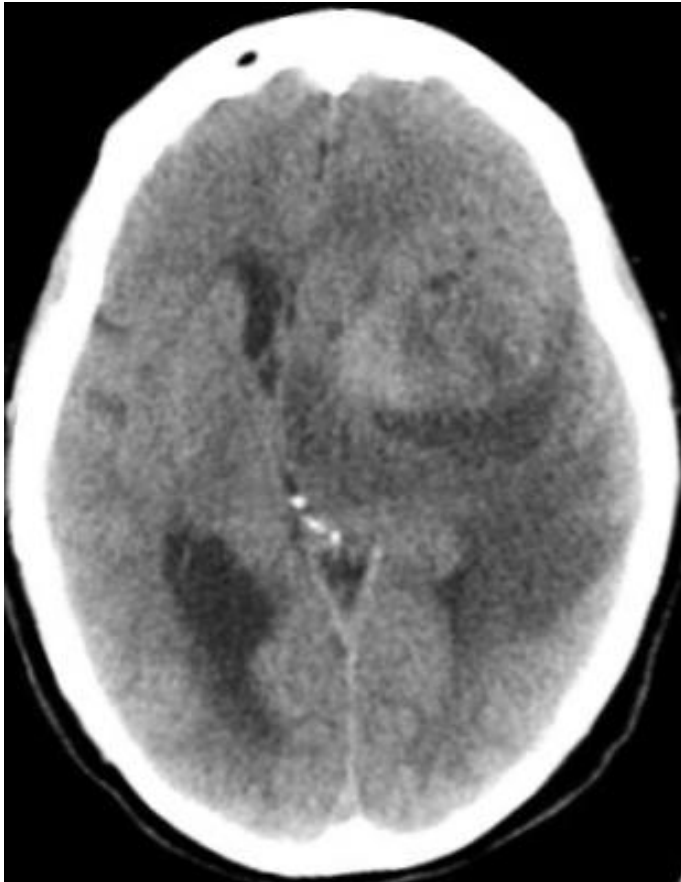


**Expansive
growth**

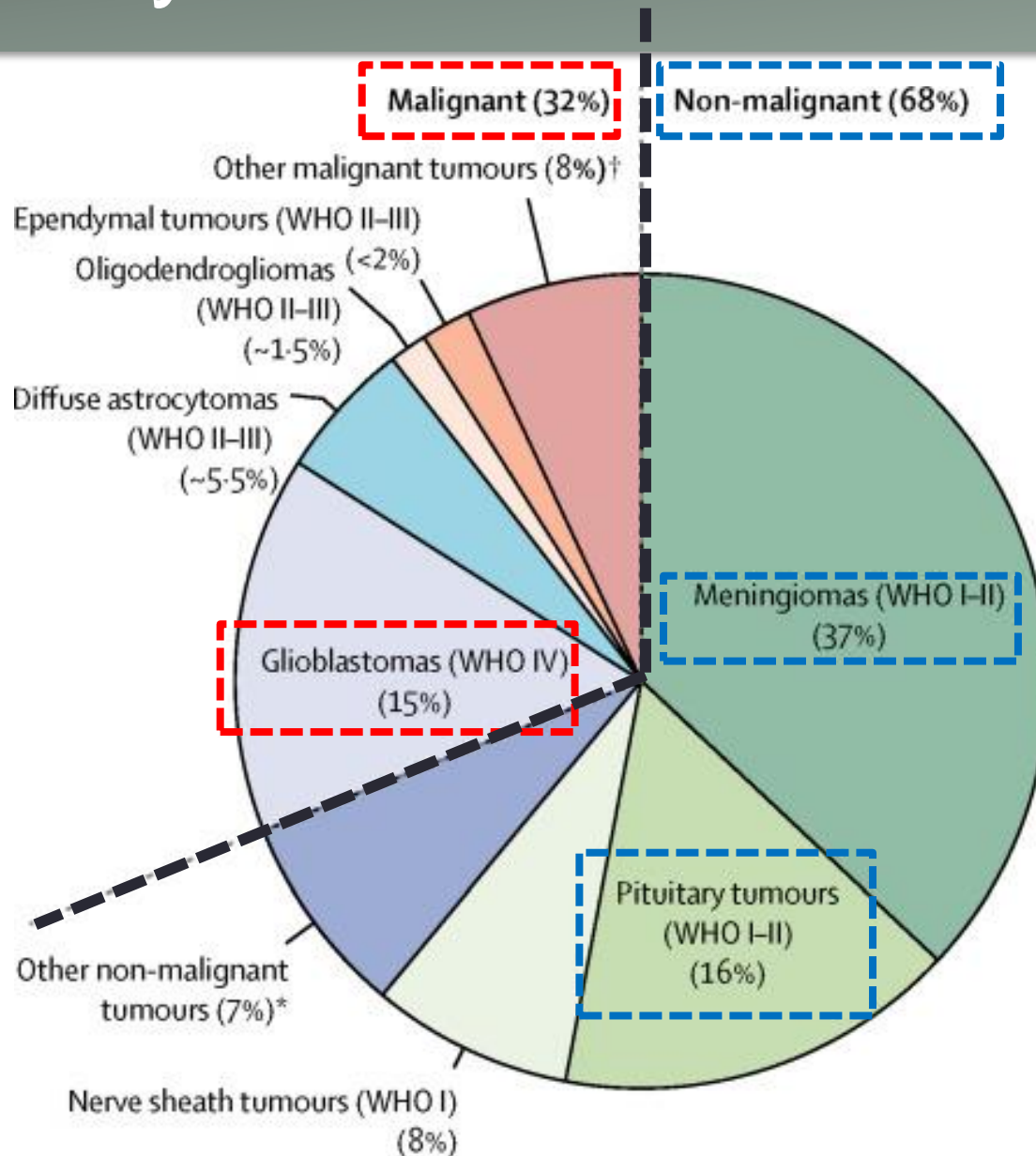


Primary brain tumours: inflammatory reaction

- Worsens the mass effect
- Corticosteroids help control it

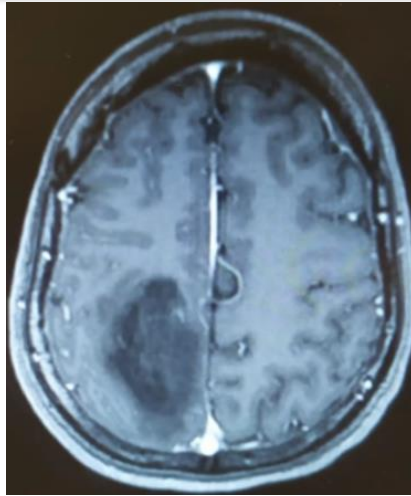


Primary brain tumours: rate

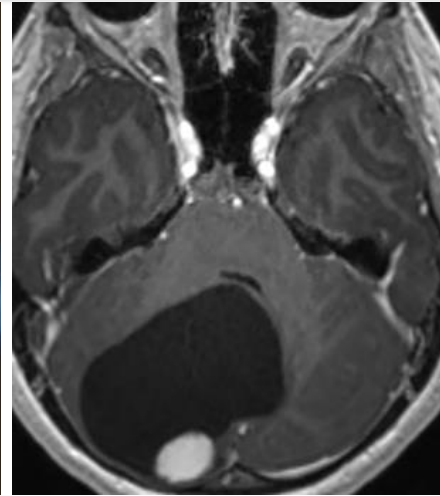


GLIOMAS: most common types

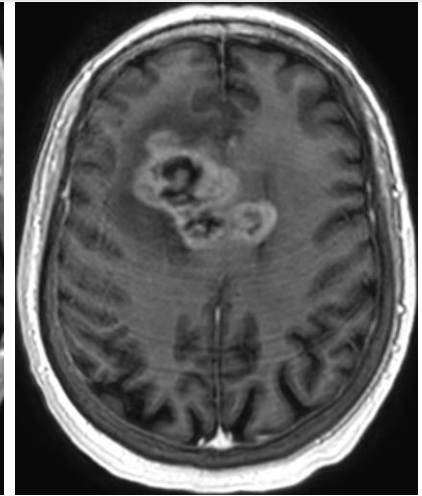
- Low-grade gliomas
- Astrocytoma
- Glioblastoma multiforme
- Oligodendroglioma
- Ependymoma
- Medulloblastoma



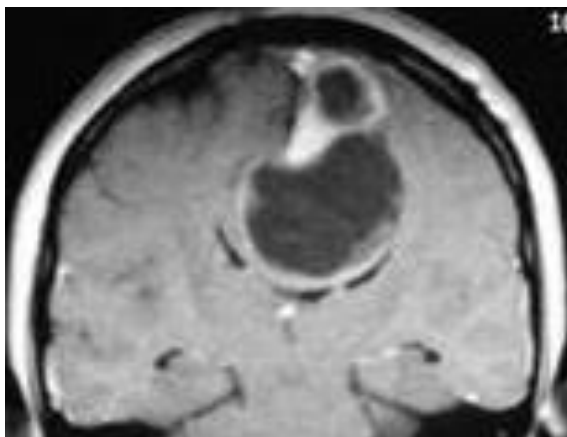
Low grade glioma



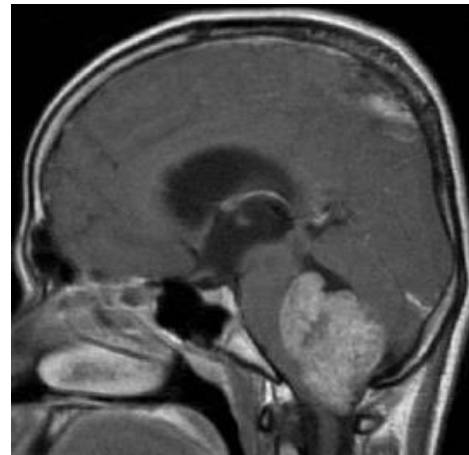
Pilocytic astrocytoma



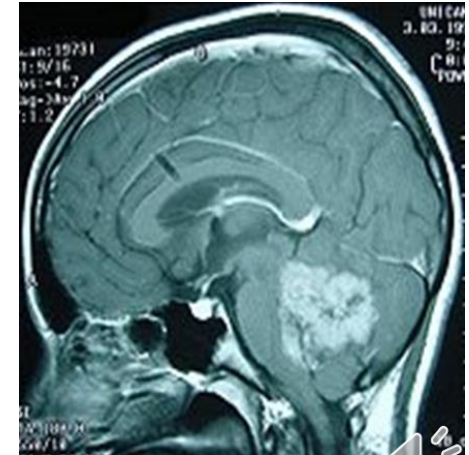
Glioblastoma



Oligodendroglioma

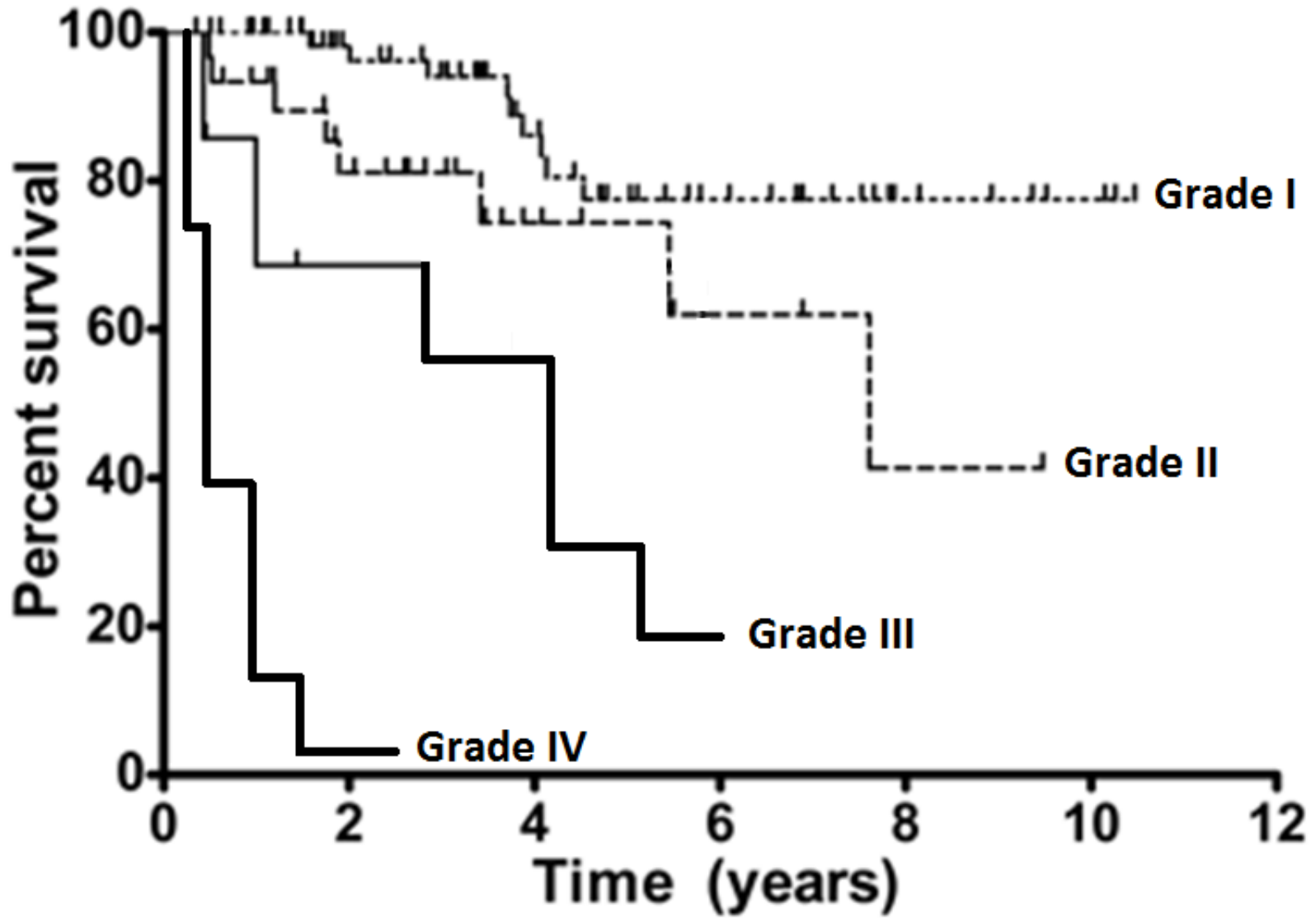


Ependymoma



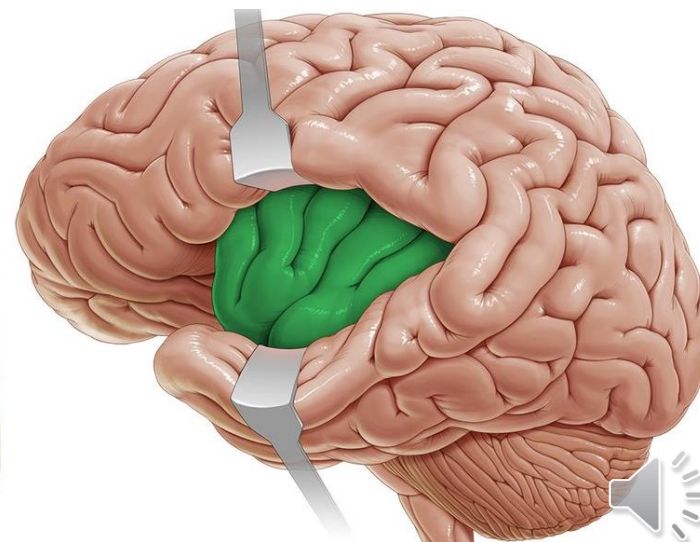
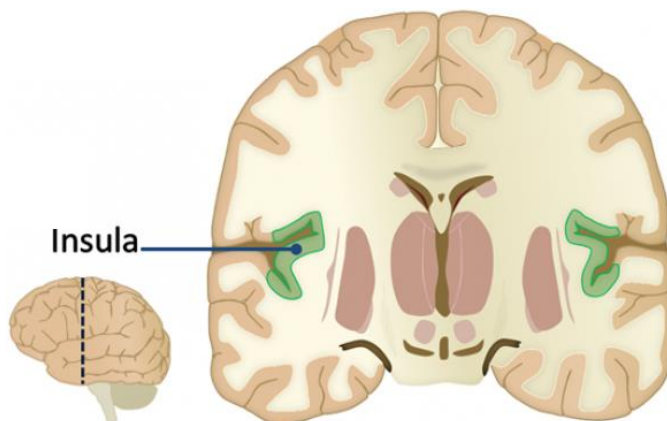
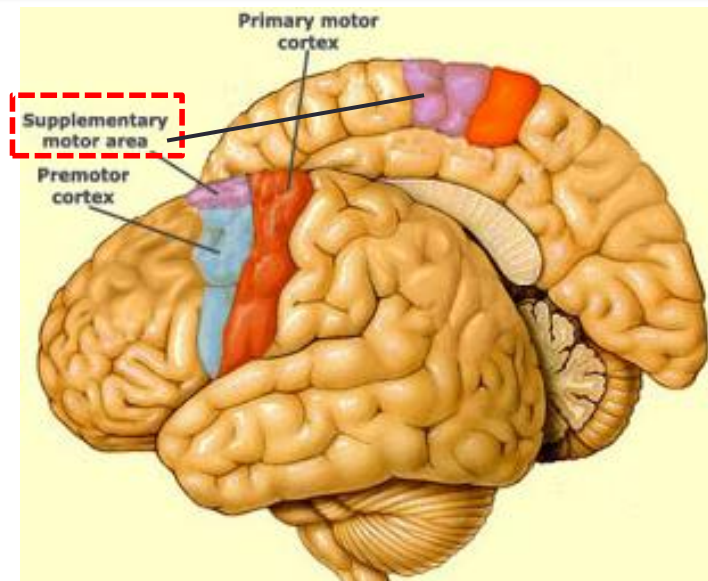
Medulloblastoma

Kaplan-Meier survival curve for gliomas



LOW-GRADE GLIOMAS

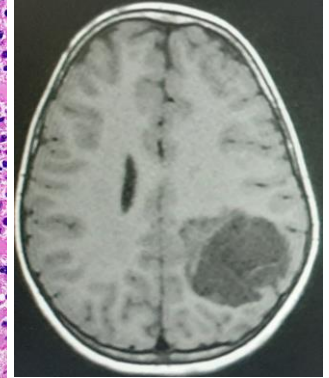
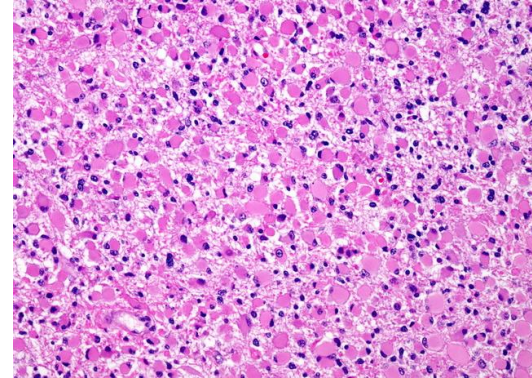
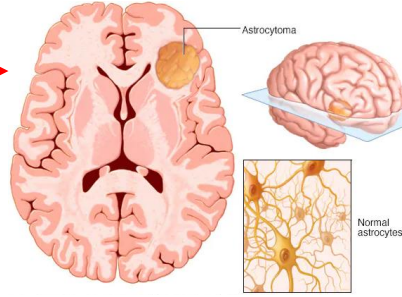
- 15% primary brain tumours
- ↑ Incidence fourth & sixth decades
- Predilection insula + supplementary motor area
- Risk factors
 - Ionizing radiation
 - Hereditary syndromes (Neurofibromatosis, Li-Fraumeni)



Low-grade gliomas: types

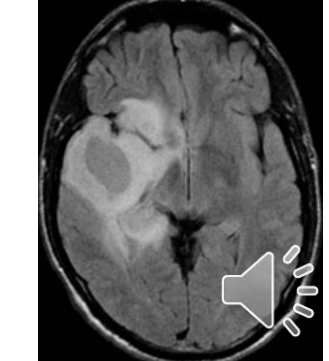
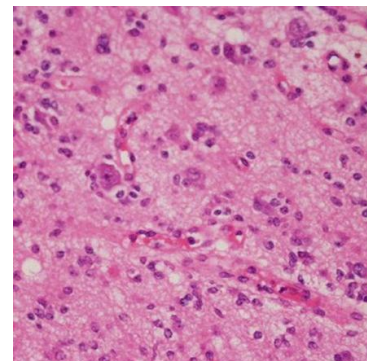
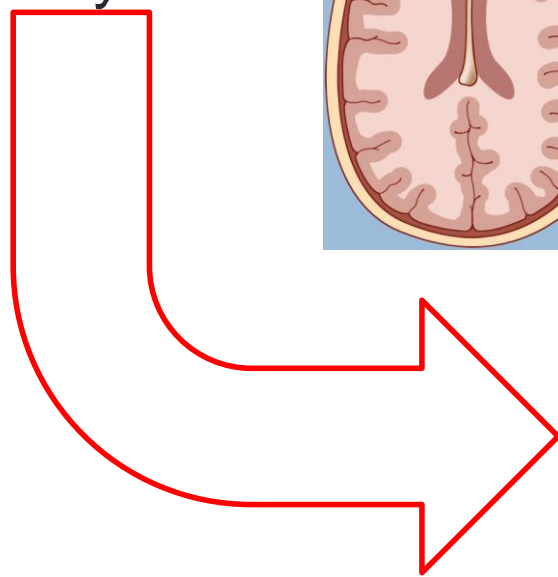
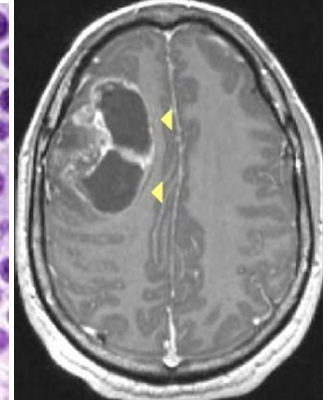
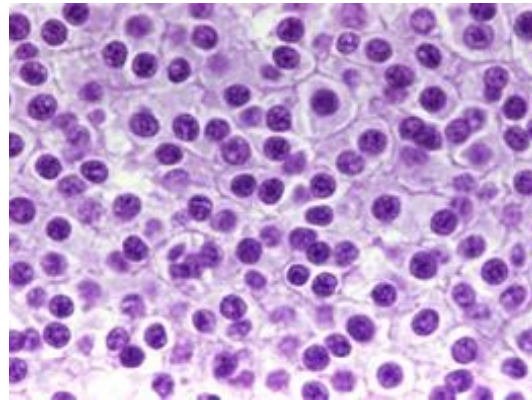
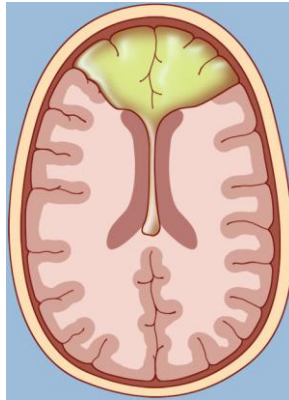
• Astrocytoma →

- Fibrillar
- Gemistocytic
- Protoplasmic



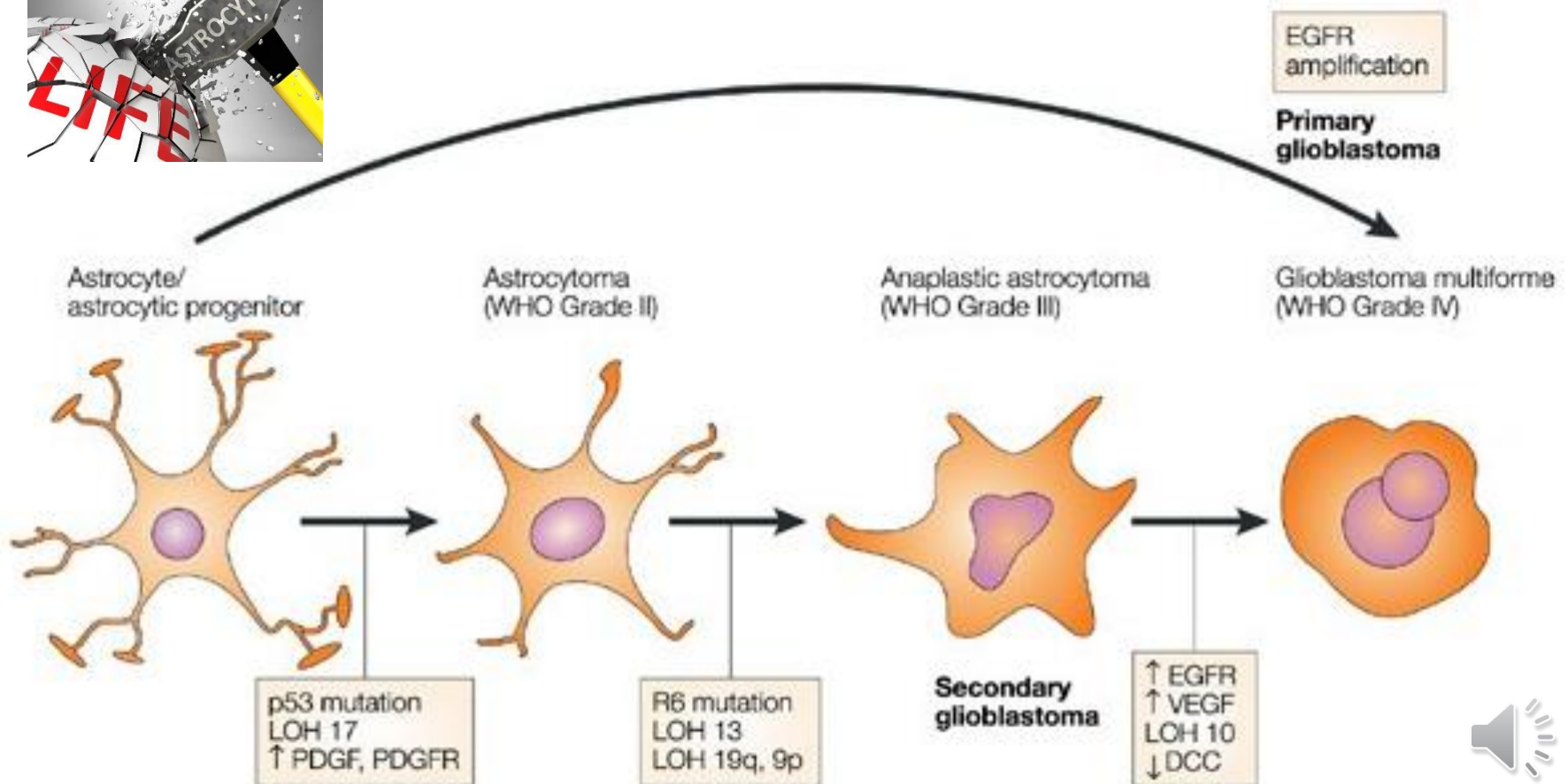
• Oligodendroglioma

• Oligoastrocytoma



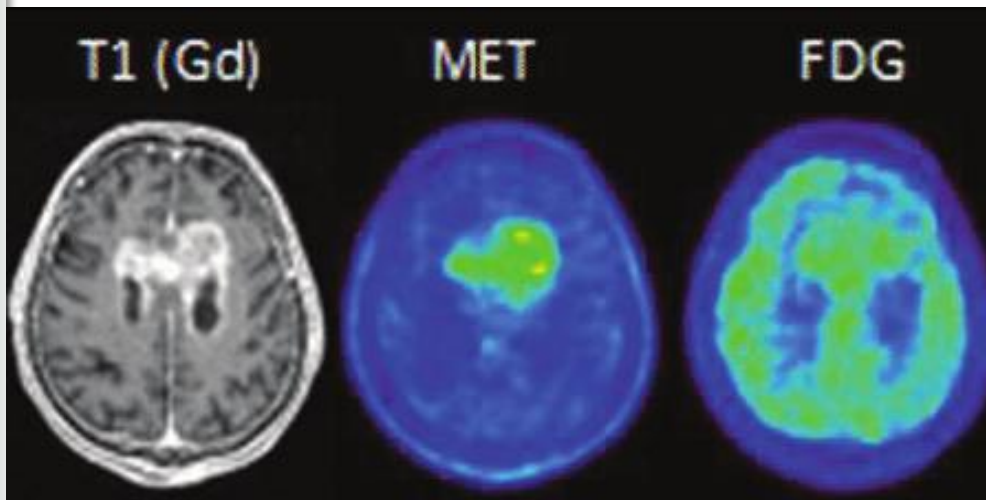
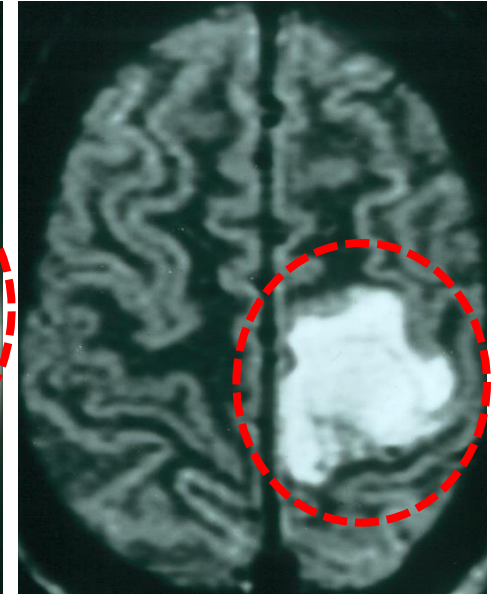
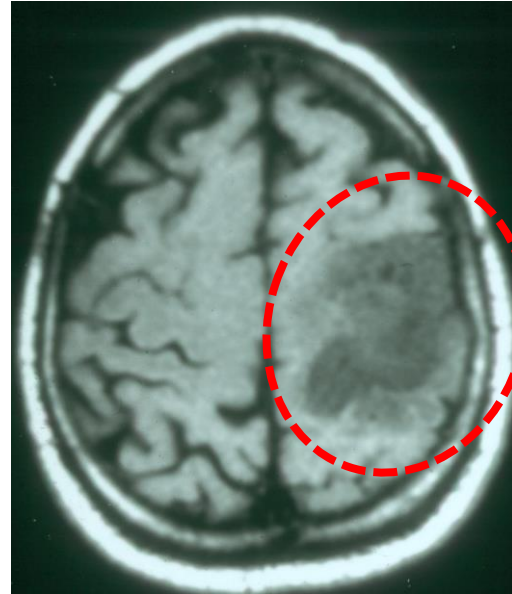
Left untreated low-grade gliomas will become malignant

- Low-grade gliomas are not benign but pre-malignant lesions

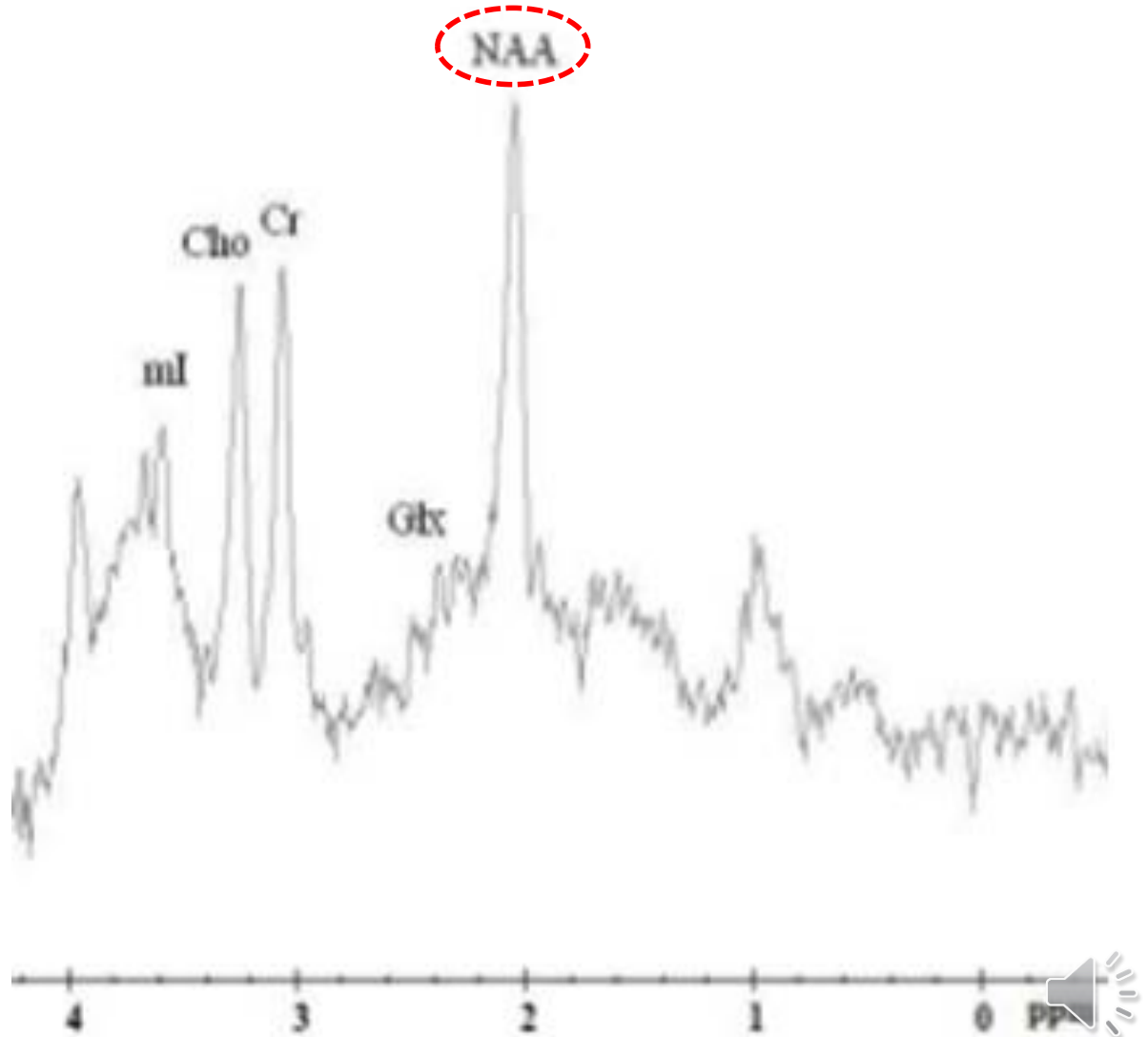
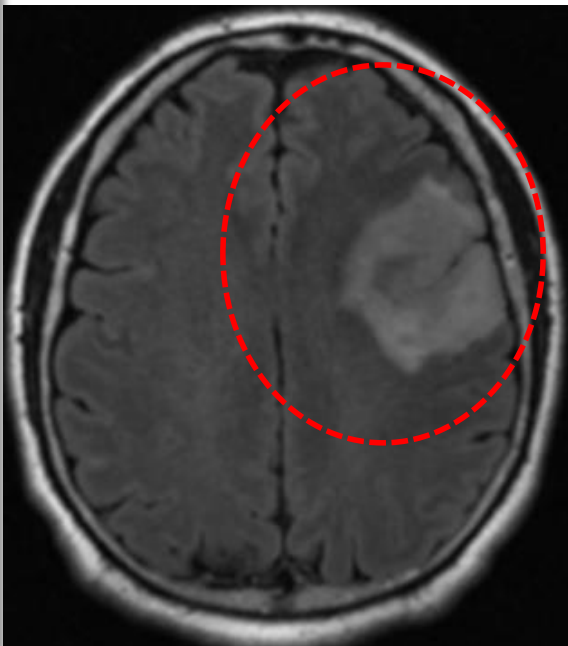
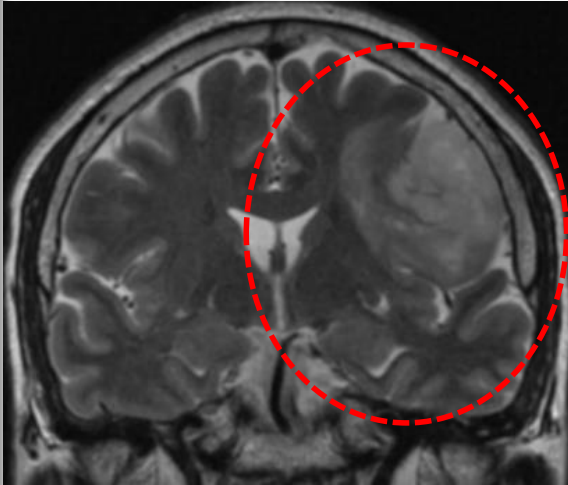


Low-grade gliomas: diagnosis

- MRI
 - Spectroscopy
- PET/SPECT
 - Methionine
 - Fluorodeoxyglucose



Glioma grade II: peak N-acetylaspartate



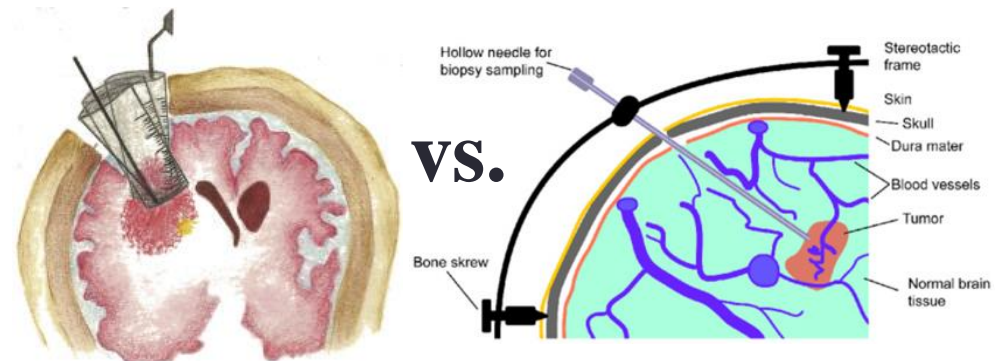
Low-grade glioma treatment: biopsy / resection

- **Craniotomy + resection**

- Get histological diagnosis
- Improve neurological symptoms
- Eliminate mass effect
- Cyto-reduction
 - Delay / reduce possibility of malignancy progression
- Epileptic seizure control
- Lesions in eloquent areas = awake craniotomy

- **Stereotaxic biopsy**

- Diffuse lesions (gliomatosis)
- Location in areas with high risk of post-operative neurological deficits
- Intervention contraindicated for medical reasons

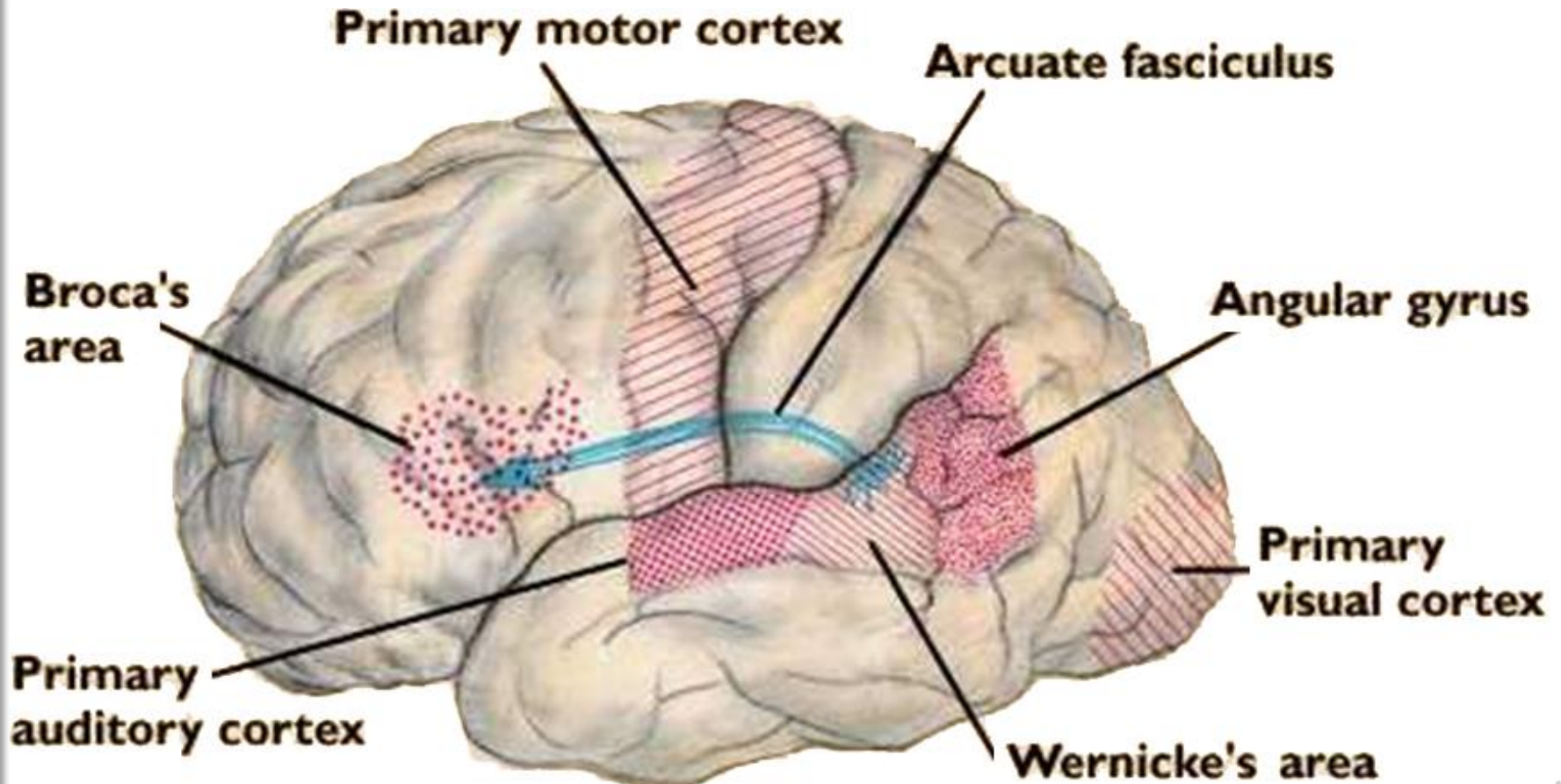


↑↑ removal = better evolution, ↓↓ epileptic seizures ↑↑ time until malignant progression

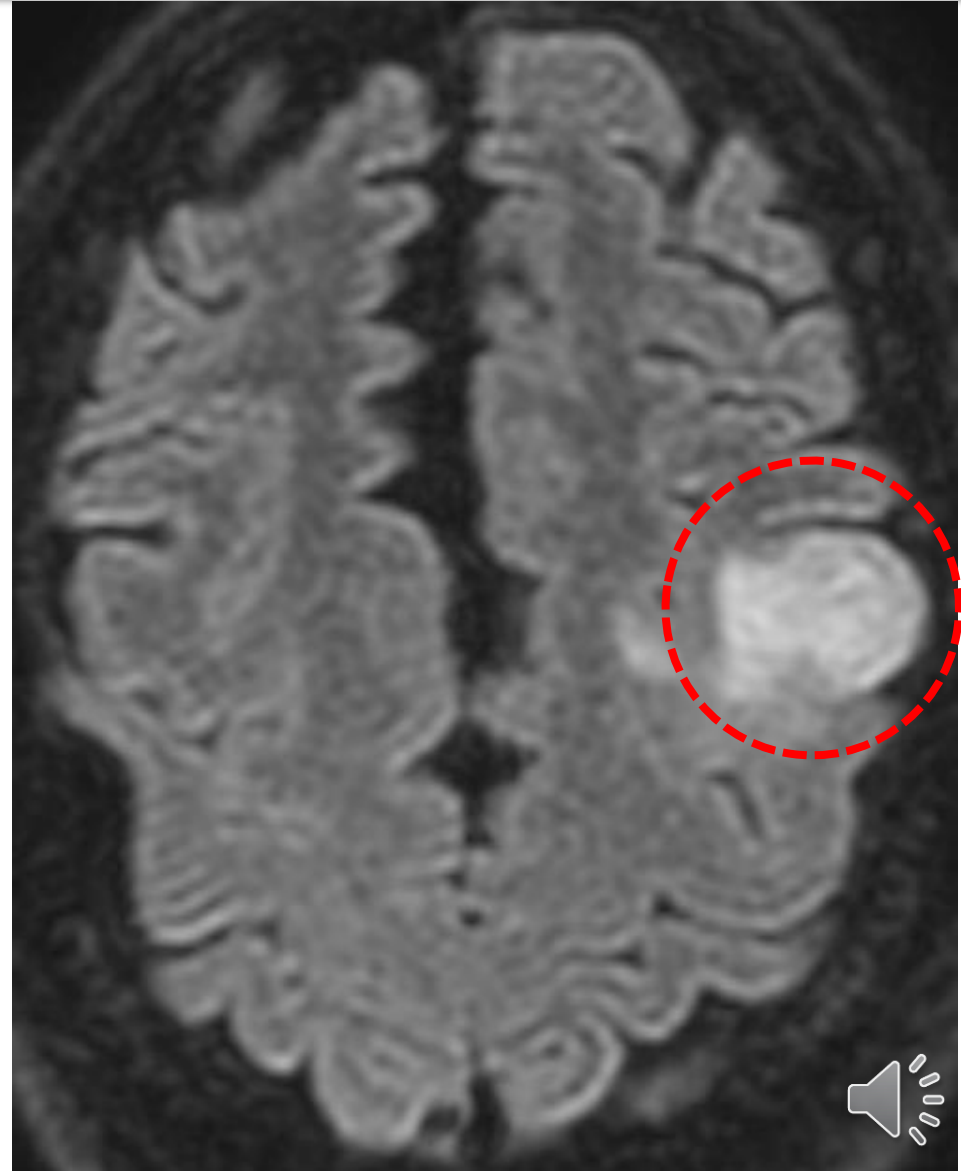
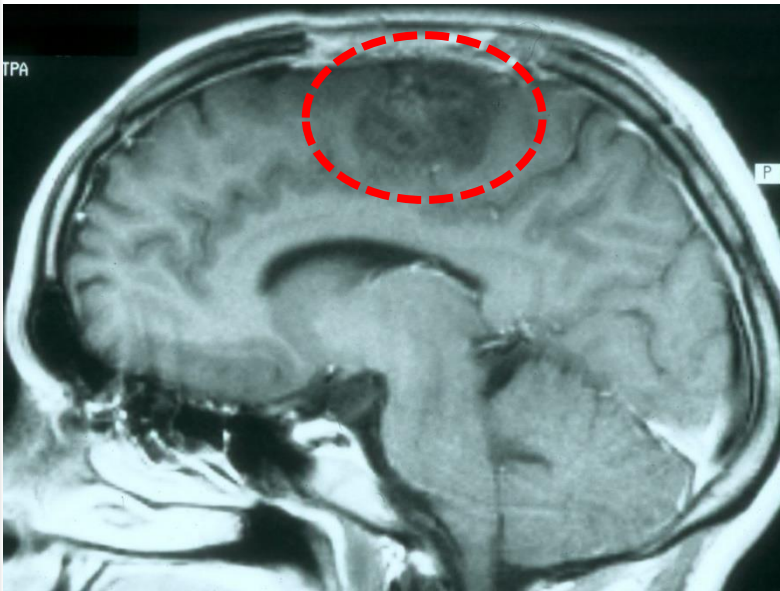
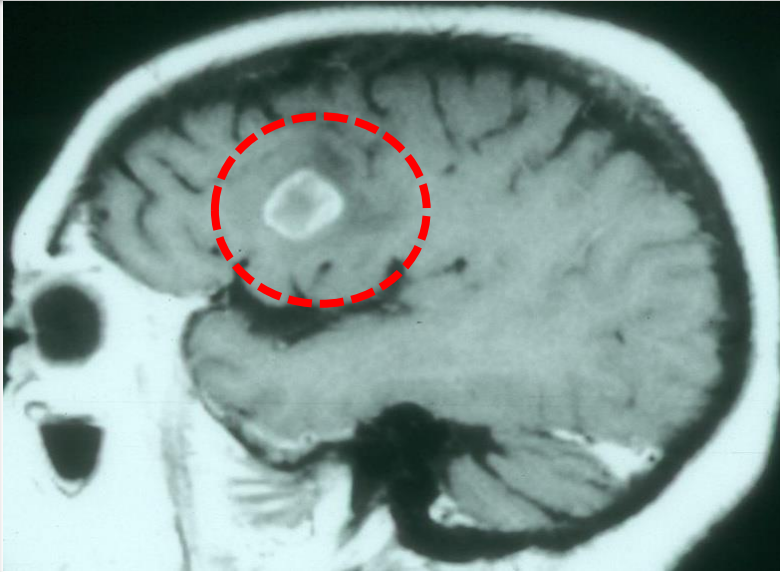


Brain eloquent areas

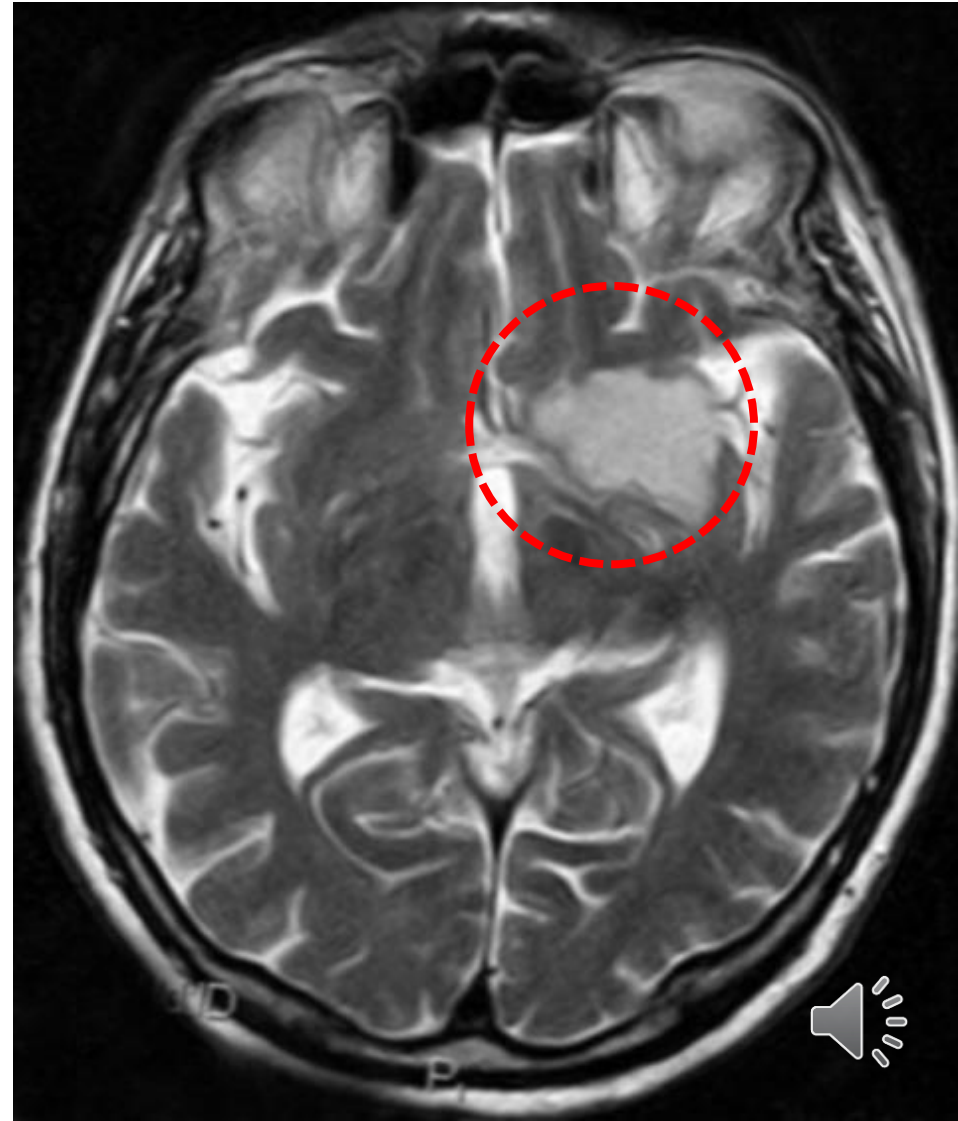
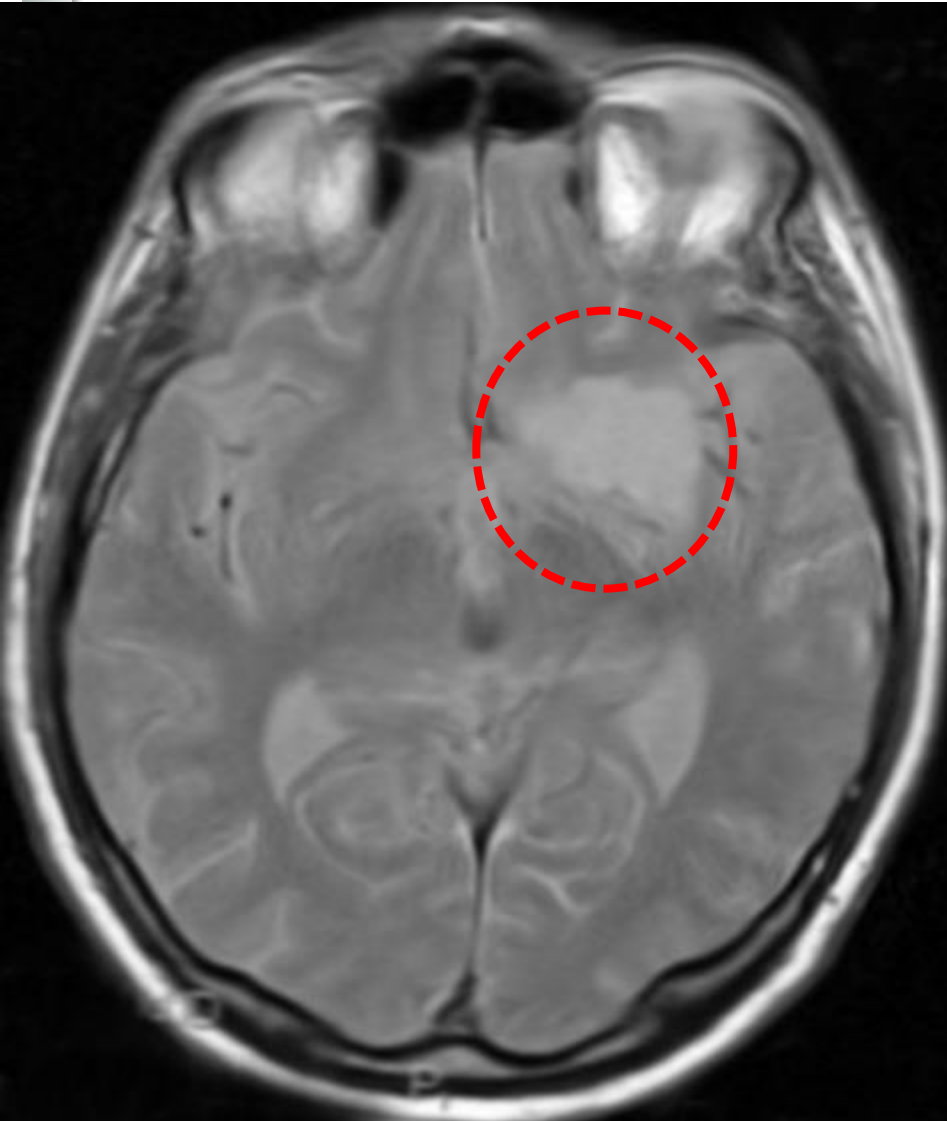
- Their lesion implies very incapacitating sequelae



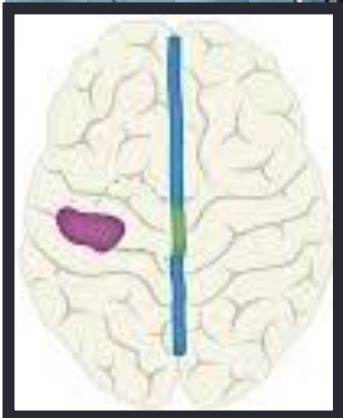
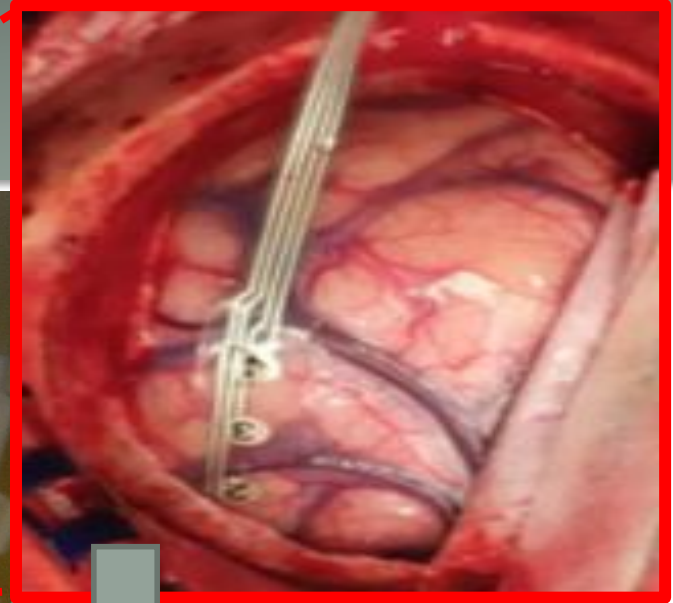
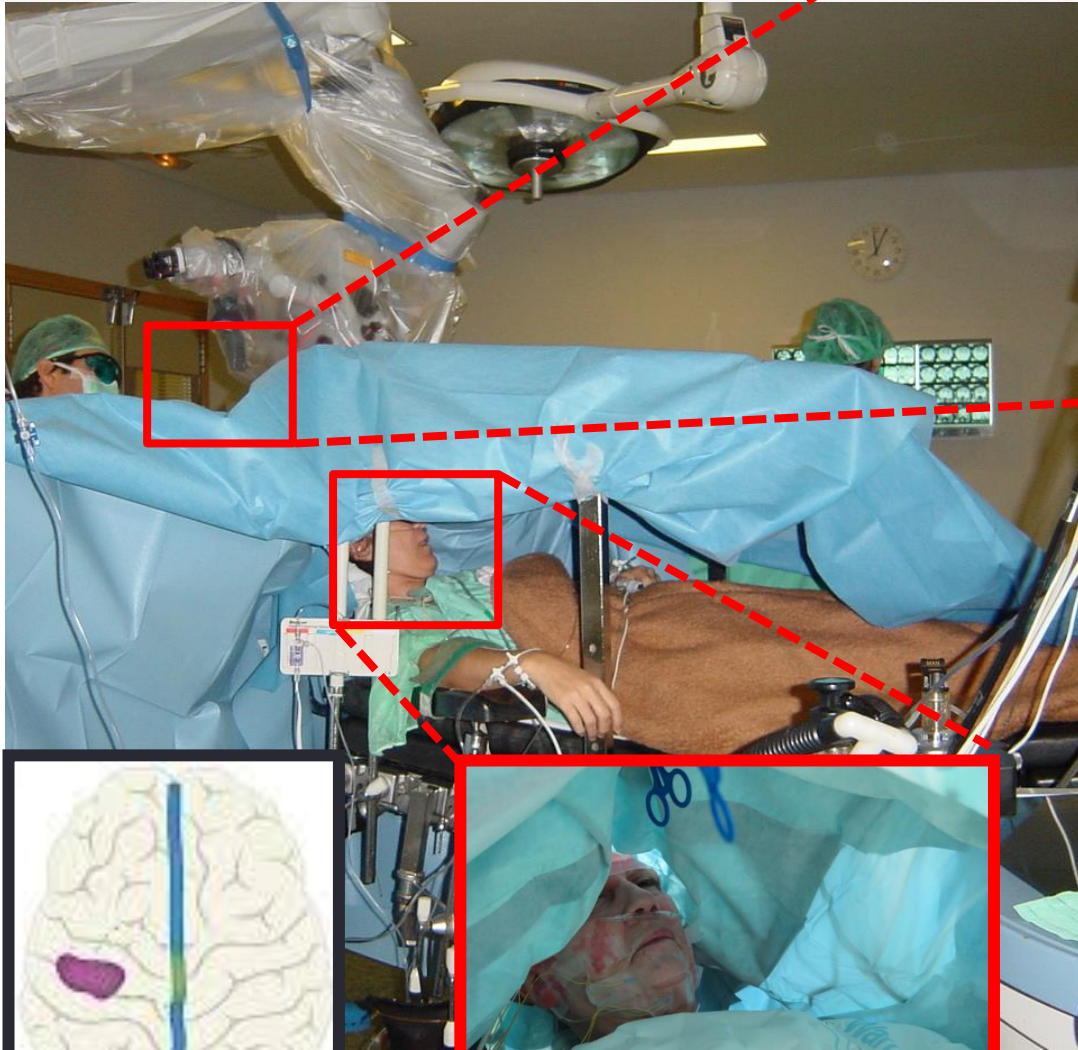
Gliomas in brain eloquent areas



Low-grade glioma in insula



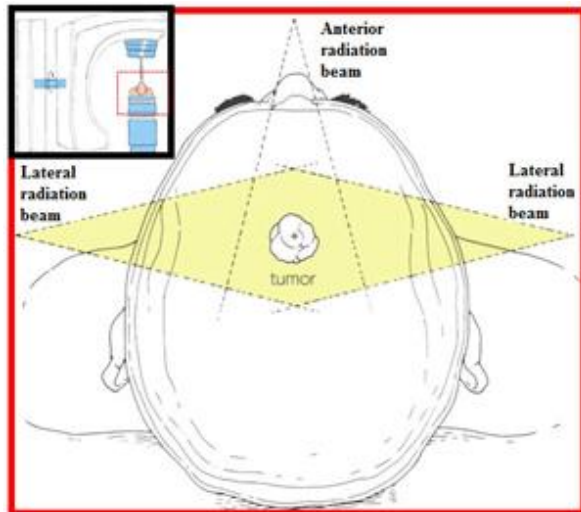
Awake craniotomy



Low-grade gliomas treatment: radiation therapy / chemotherapy

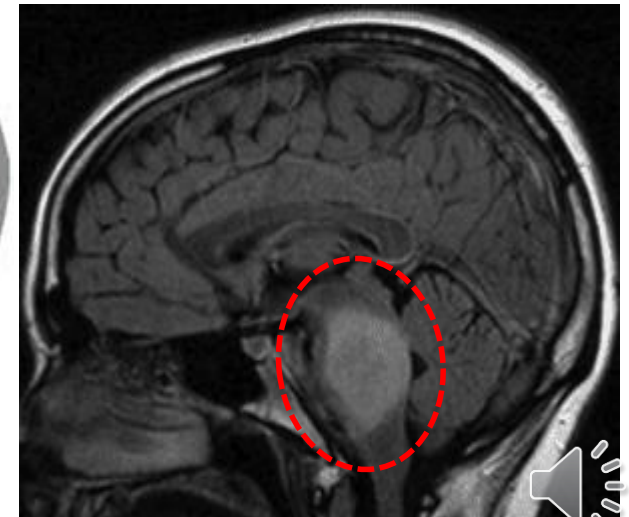
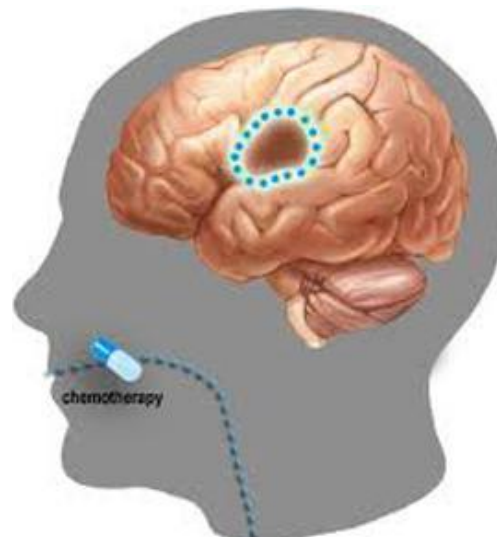
Radiation therapy

- Subtotal removal
- Recurrence



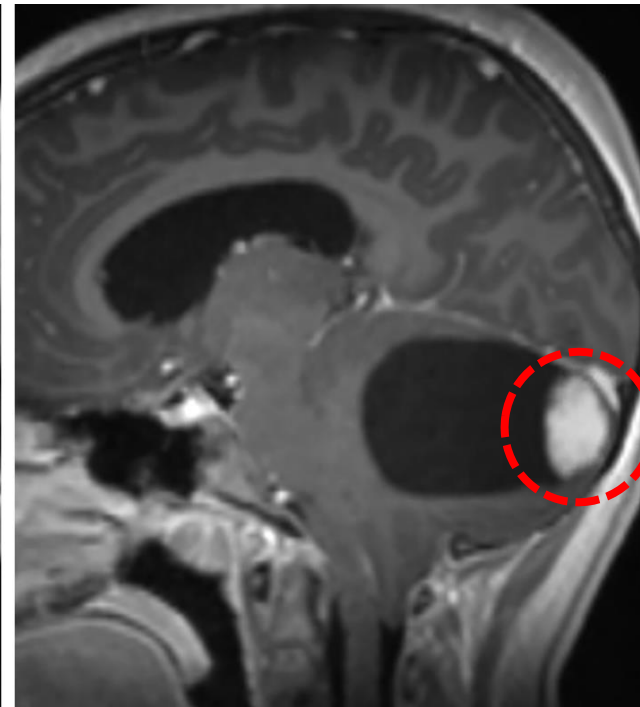
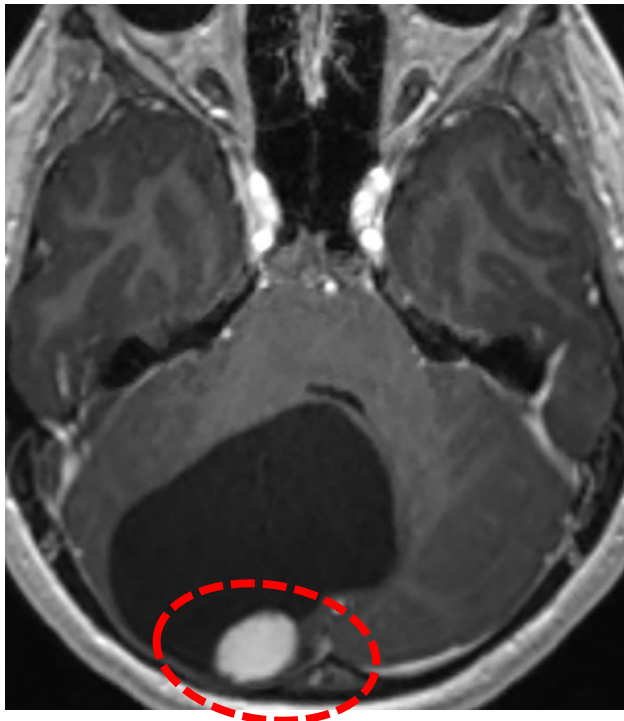
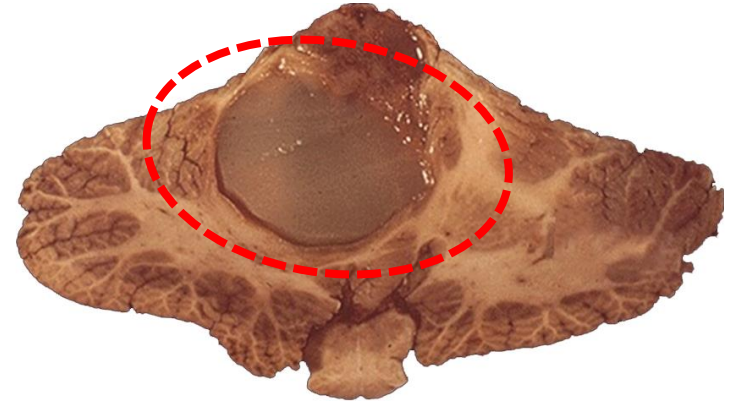
Chemotherapy

- Subtotal removal
- Recurrence
- Astrocytomas /oligoastrocytomas
- Location in brainstem



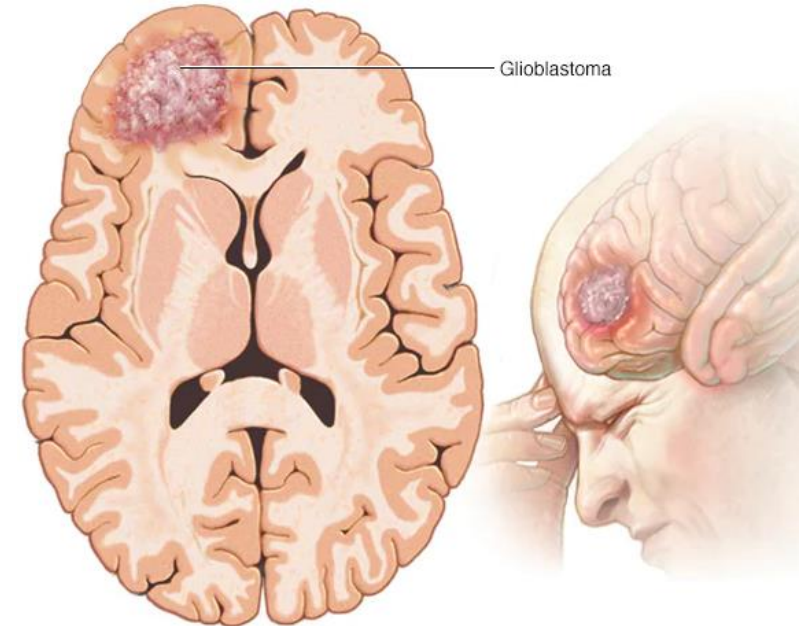
PILOCYTIC ASTROCITOMA

- Children & young adults
- Location: cerebellum > third ventricle > optic nerves
- Cyst with nodule
 - Complete nodule removal = cure



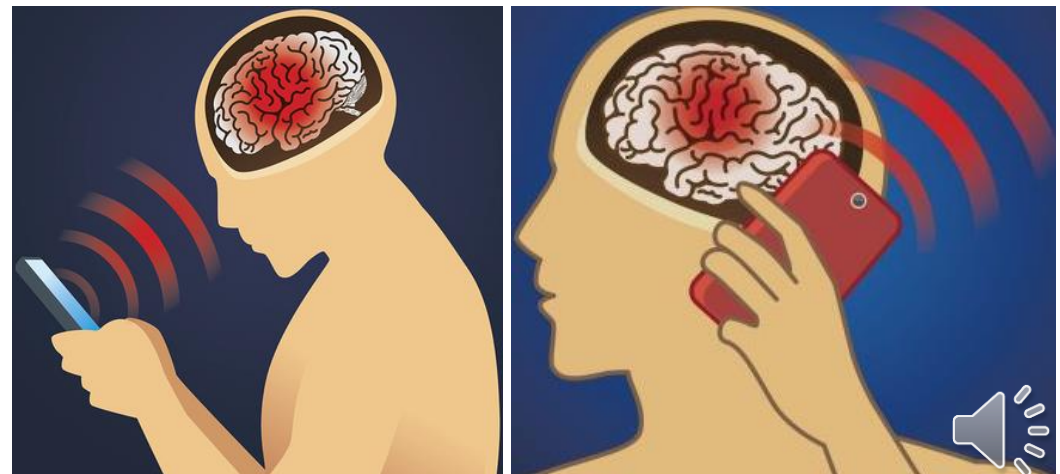
GLIOBLASTOMA MULTIFORME

- Grade IV astrocytoma
- 15% intracranial tumours
- Among primary brain tumours
 - ↑ common (50% of them)
 - ↑ aggressive
- ♂ / ♀ 3: 2
- At any age but incidence ↑ with advanced age



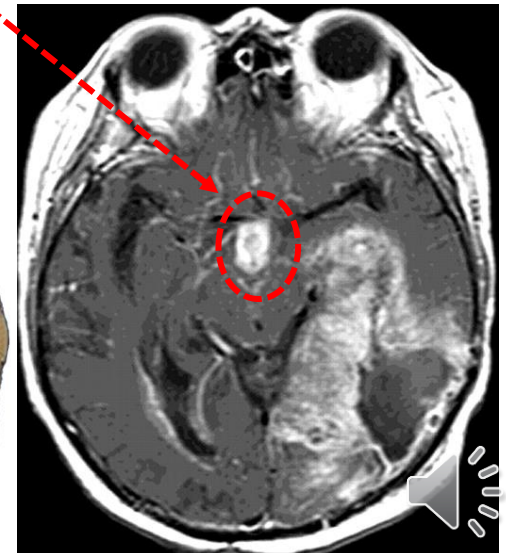
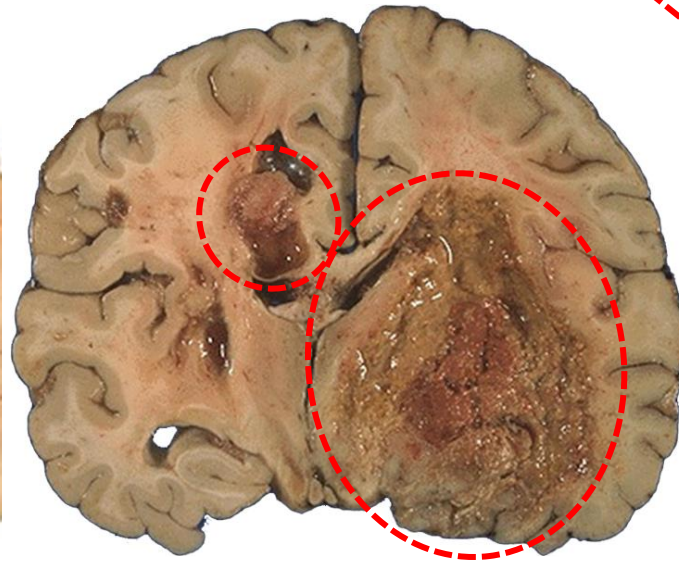
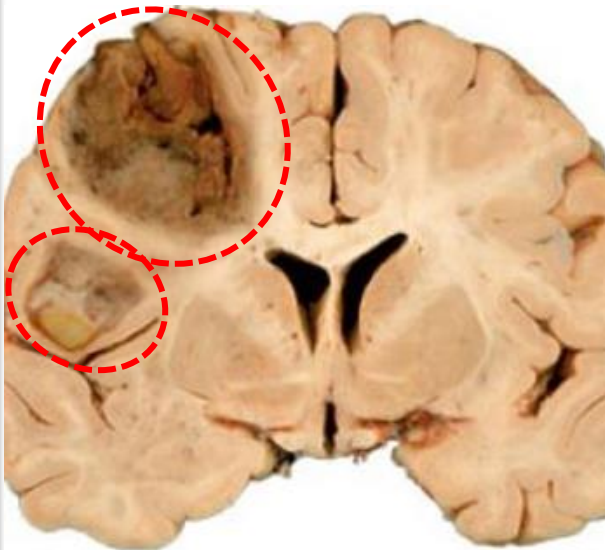
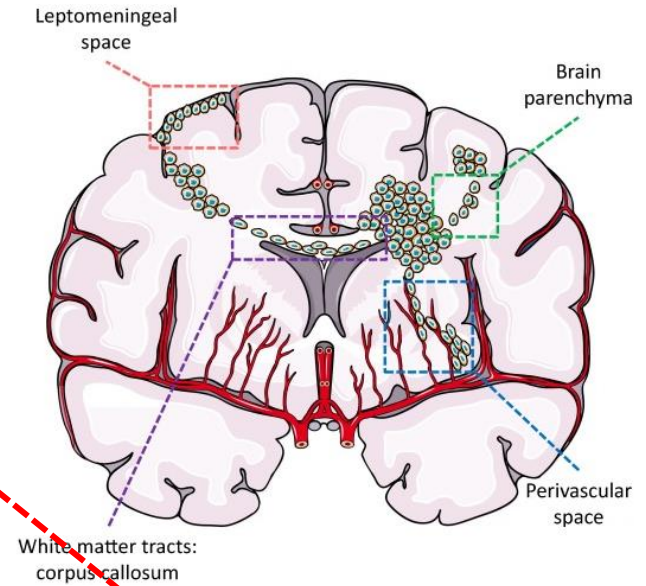
Glioblastoma: etiology

- Unknown cause
- Two development pathways
 - De novo
 - Secondary (from low-grade gliomas)
- Association with genetic diseases
 - Turcot, Gorlin, ...)
 - Ionizing radiation
 - Electromagnetic waves



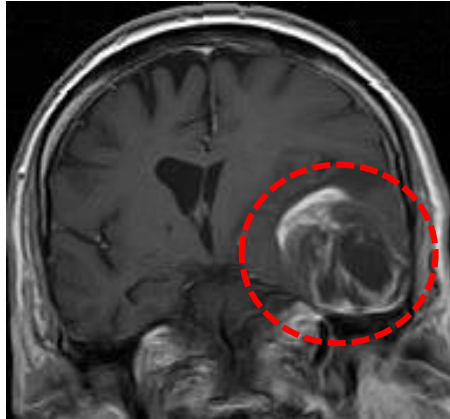
Glioblastoma: infiltrative growth pattern

- Invades nearby brain
- Grows following white matter tracts = contralateral growth
- Meningeal carcinomatosis AFTER surgical removal
- Possible metastases outside brain

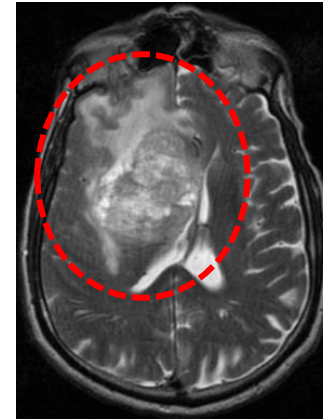


Glioblastoma: MRI

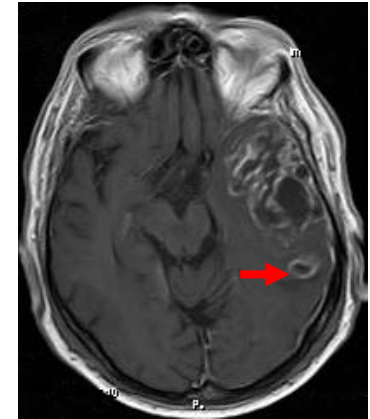
- Ring-like contrast enhancement
- Massive peritumoral oedema
- Invasion of nearby brain
- Distant tumour nodules



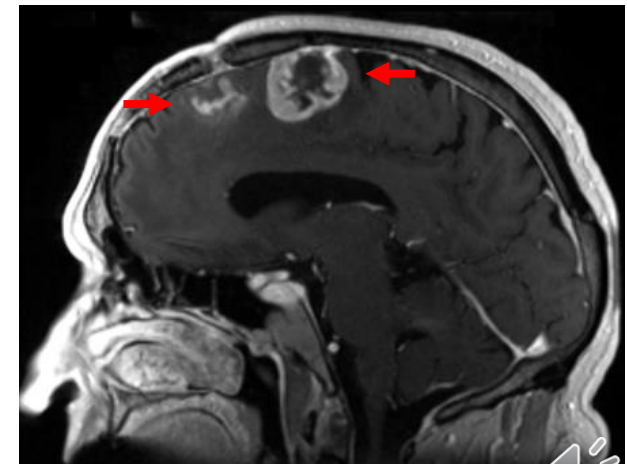
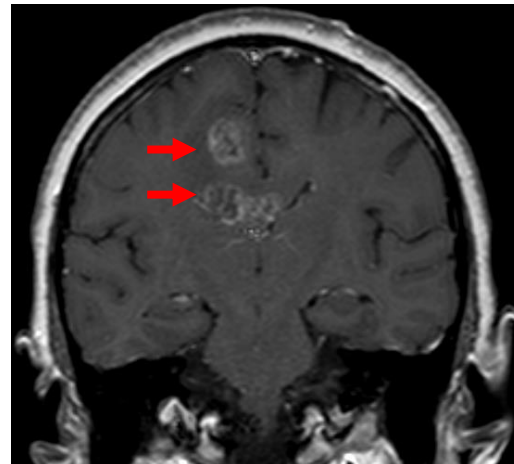
Ring-like contrast enhancement



Massive edema



Infiltration nearby brain

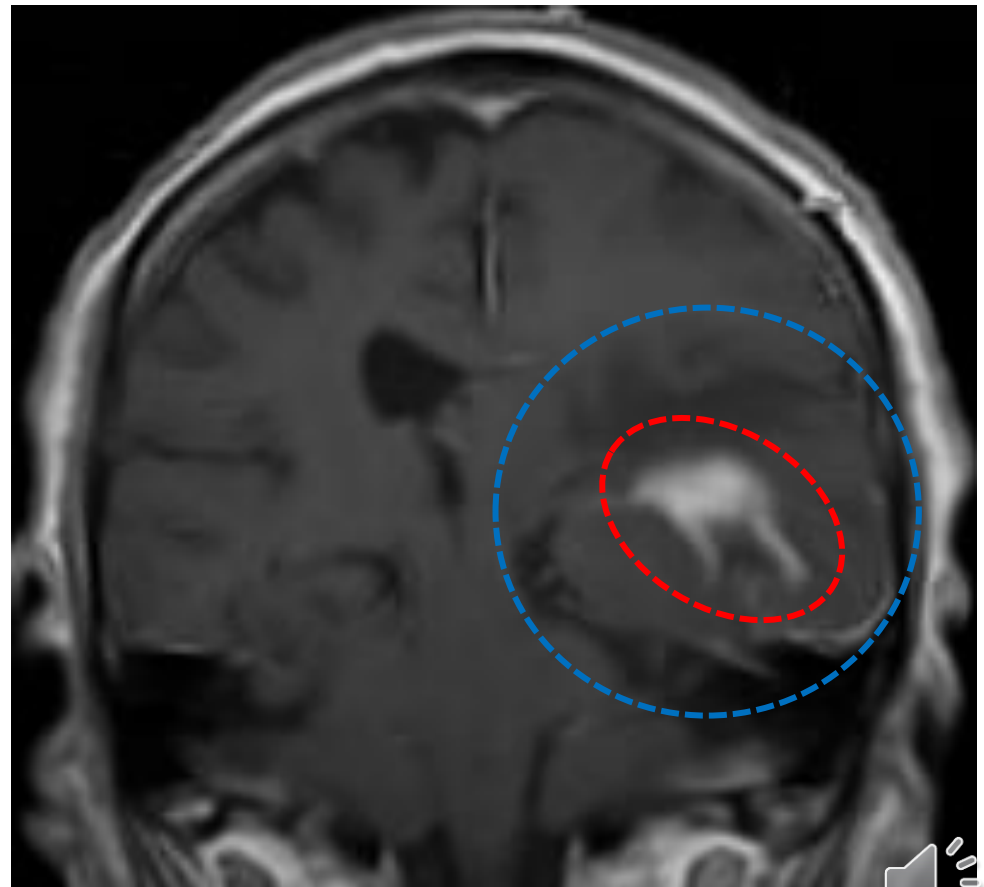
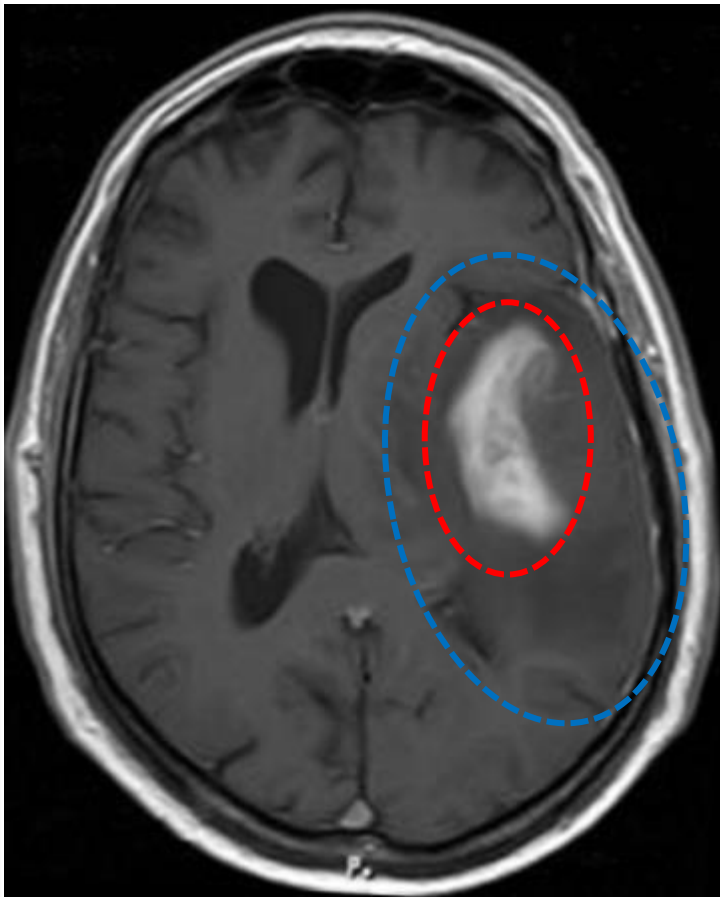


Distant tumour nodules

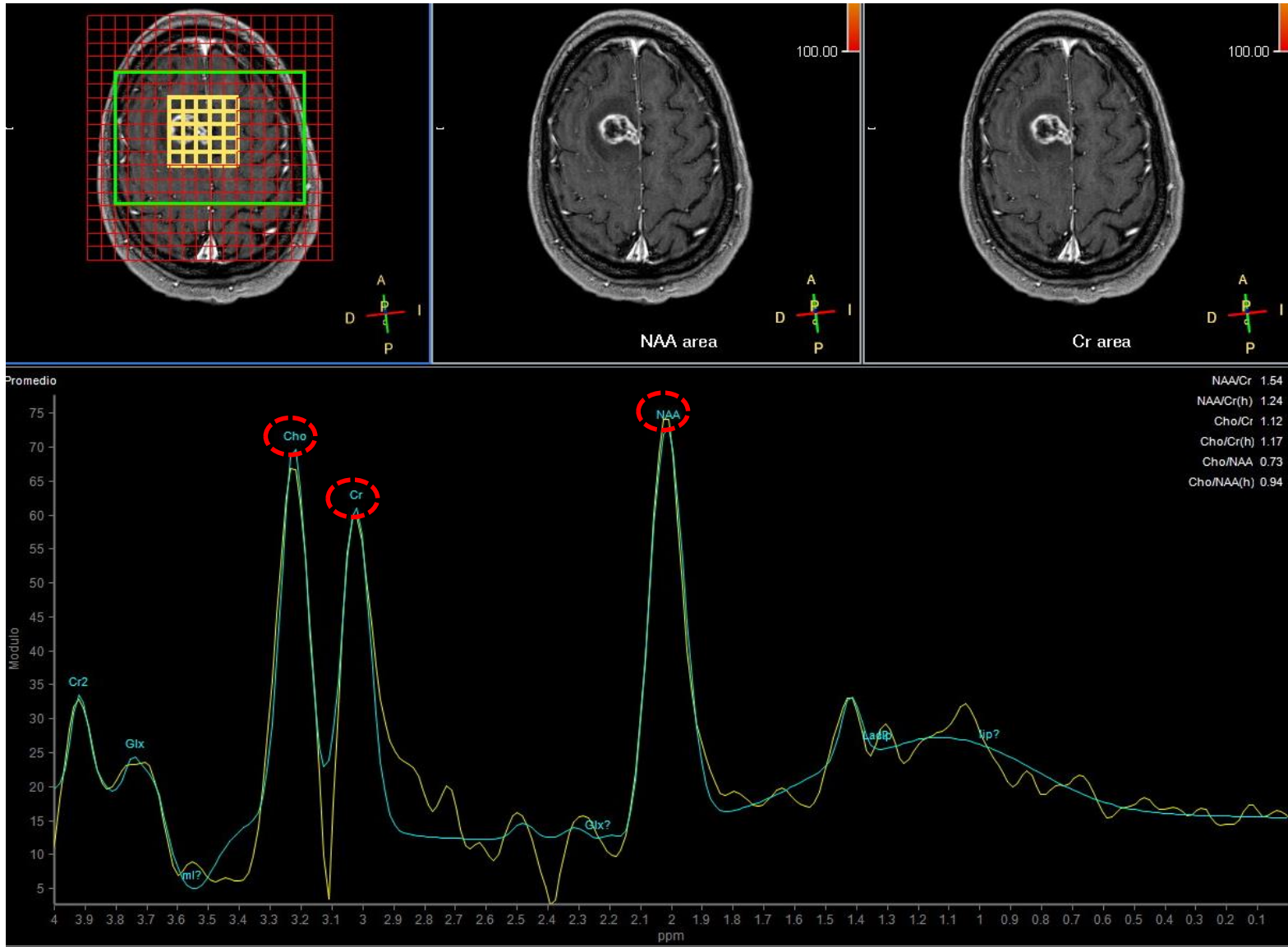


Glioblastoma secondary to low-grade glioma malignant progression

- Remove low-grade gliomas as soon as possible
 - No wait and see attitude

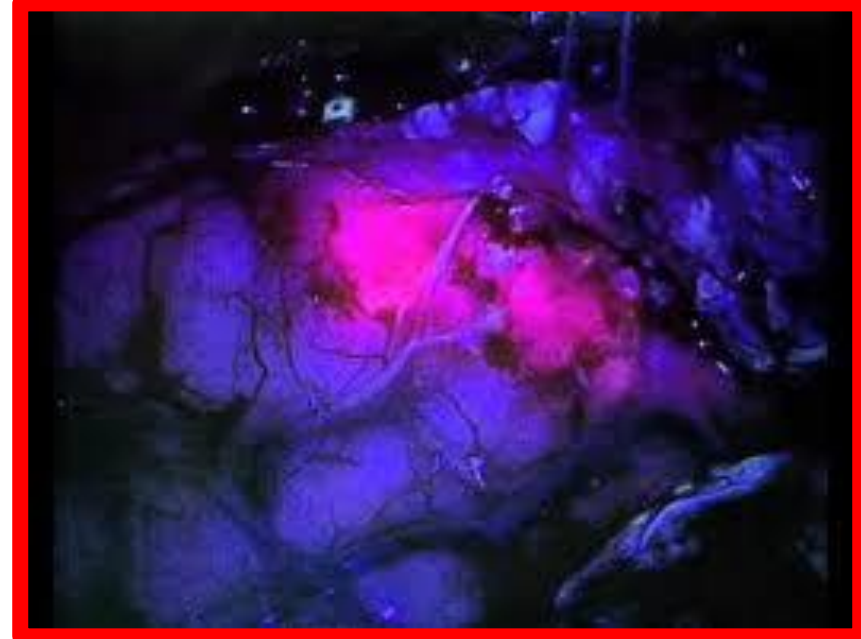


Glioblastoma MRI spectroscopy: peak choline, creatinine and N-acetyl-aspartate



Glioblastoma: treatment

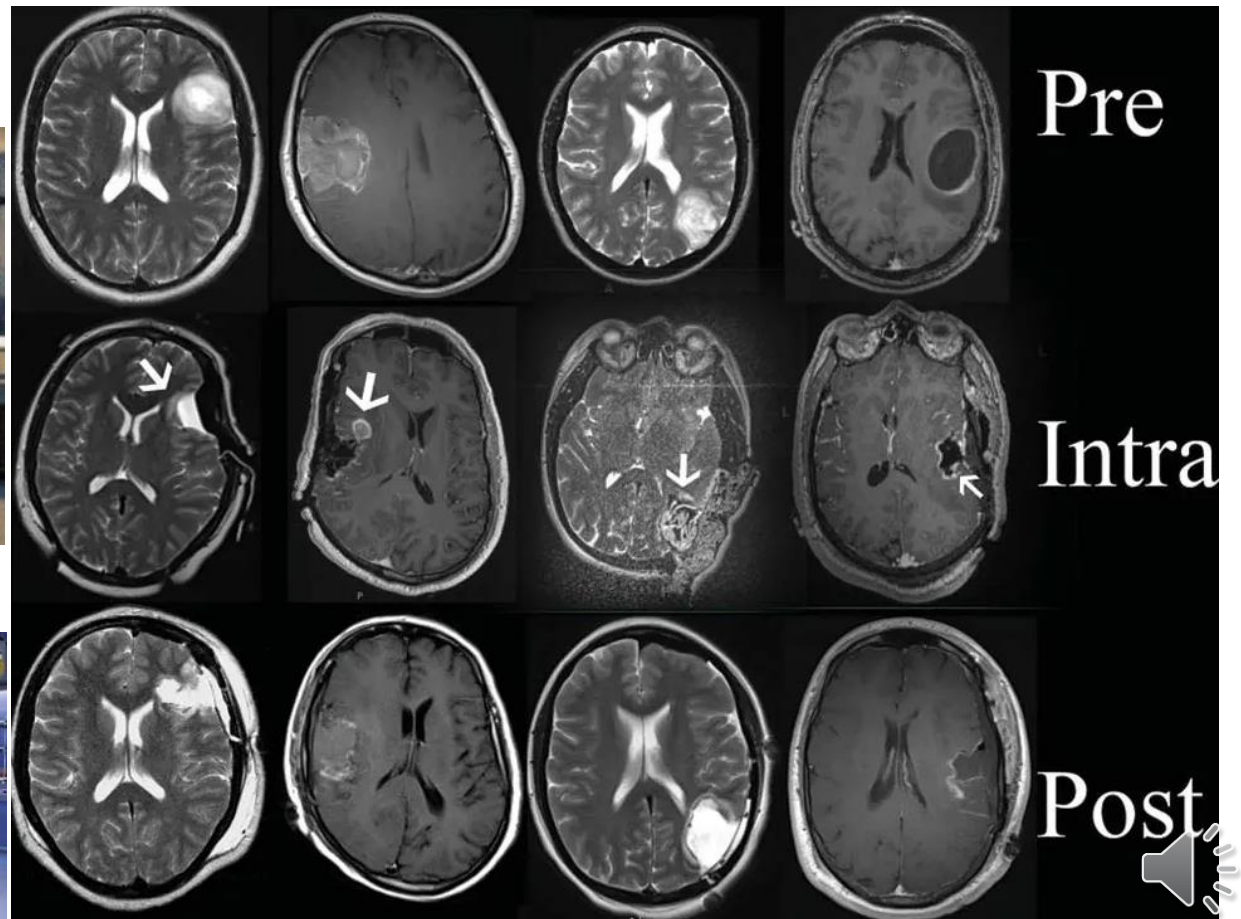
- Resection as radical as possible
 - Preop δ -aminolevulinic acid administration
- Whole cranial radiation therapy
- Chemotherapy
 - BCNU, CCNU
 - Temozolomide
- Average survival 12-14 months
- If excision is NOT possible \Rightarrow histological confirmation by stereotaxic biopsy



Intraoperative glioblastoma image marked with δ -aminolevulinic acid

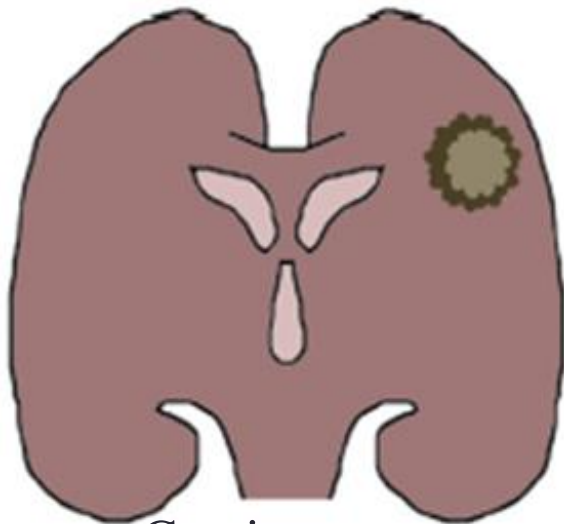
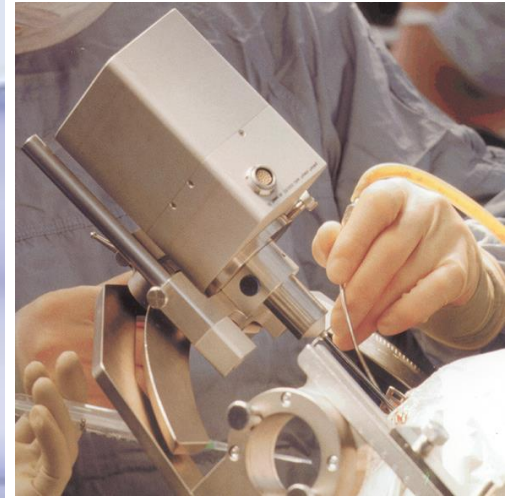
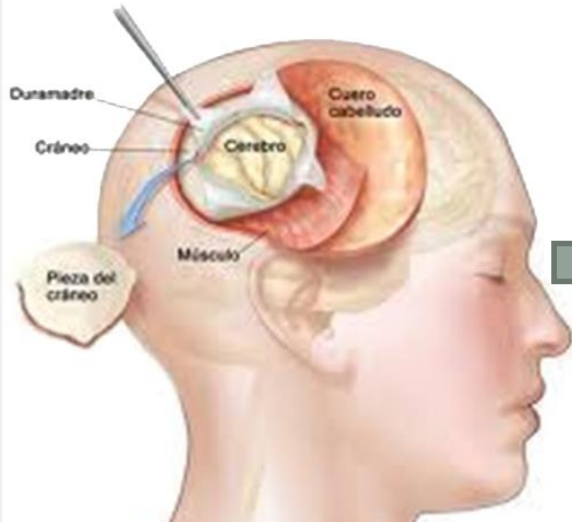
Glioblastoma: intraoperative MRI

- Improves resection
- Improvement in survival still unproved
- Expensive

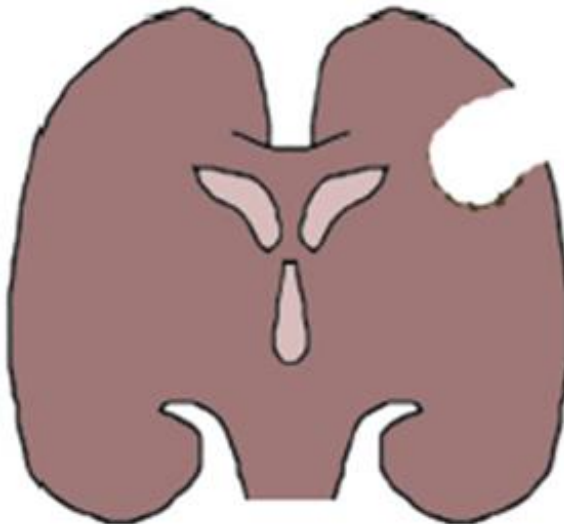


Glioblastoma: intraoperative radiotherapy

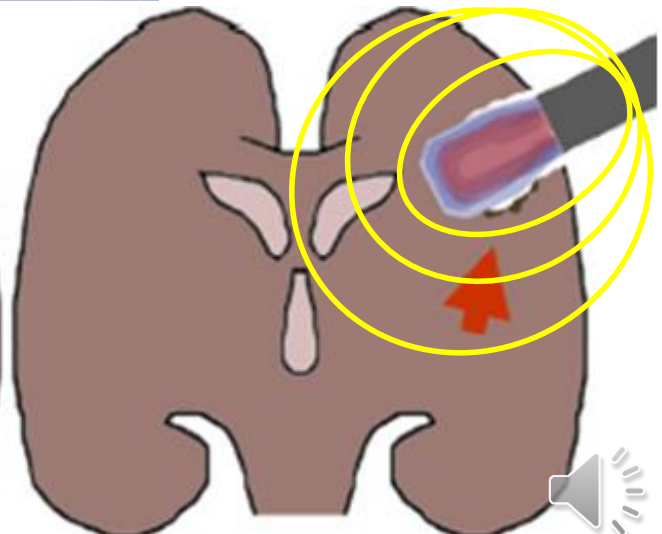
- Indication: recurrent tumour with good patient condition



Craniotomy



Tumour removal

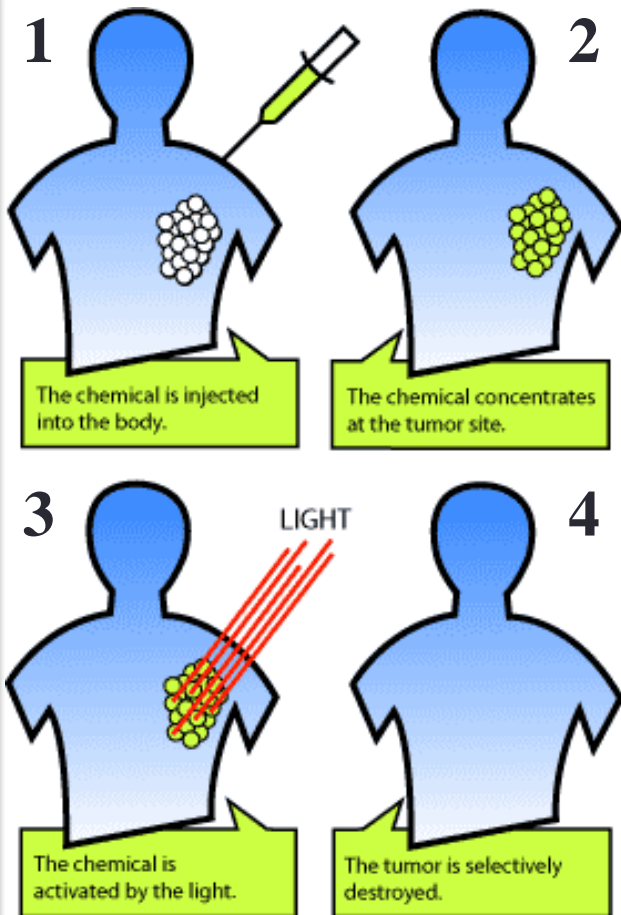


Radiotherapy

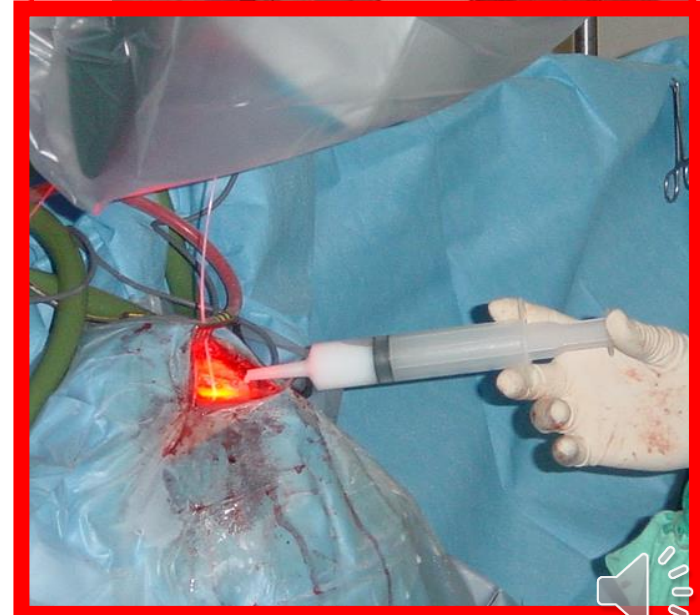
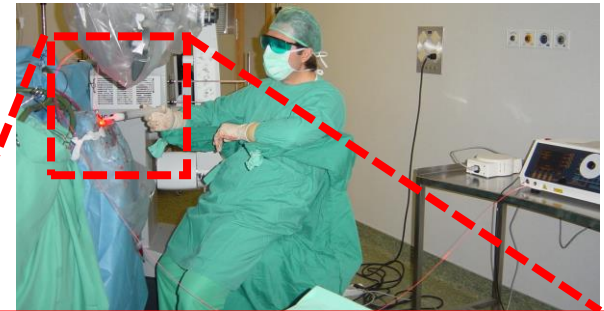
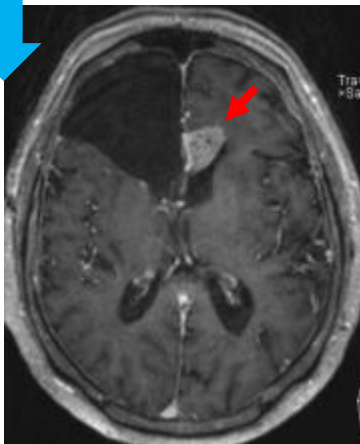


Glioblastoma: photodynamic therapy

- To kill tumour cells invading 6mm of nearby brain
 - 90% recurrences happen 2cm from resection margins



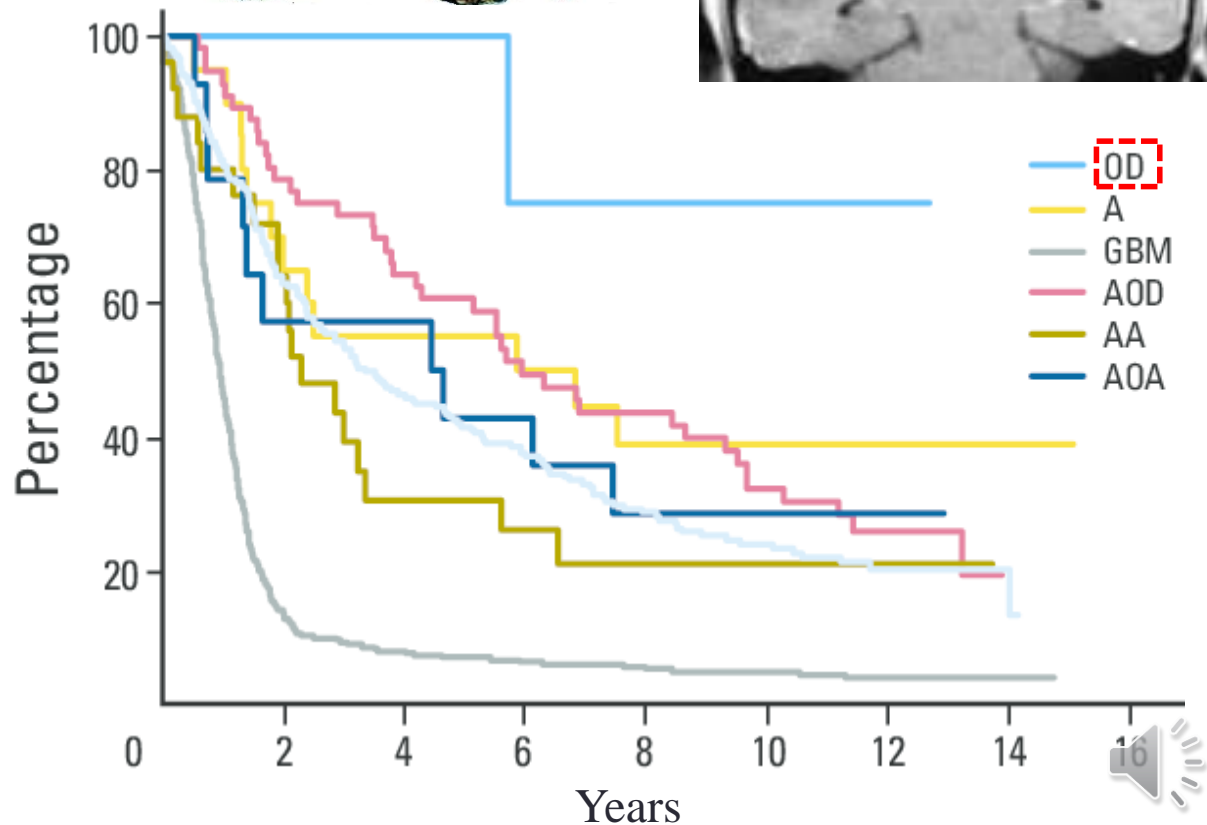
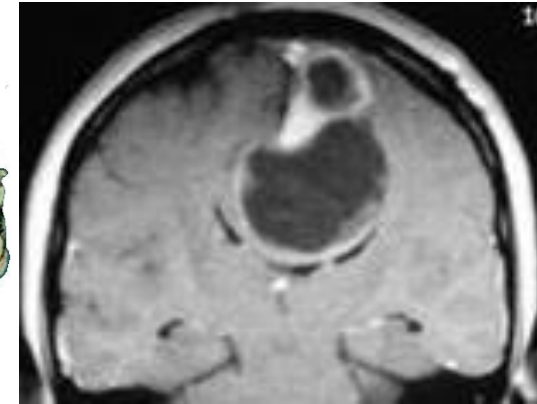
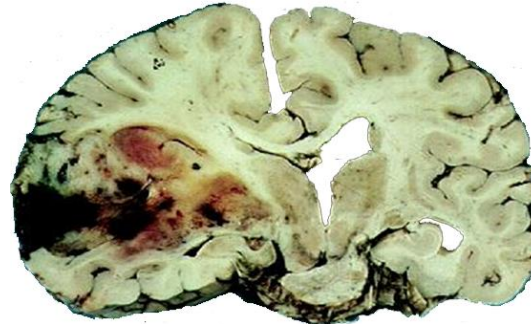
Steps photodynamic therapy



Photodynamic therapy intraop photo

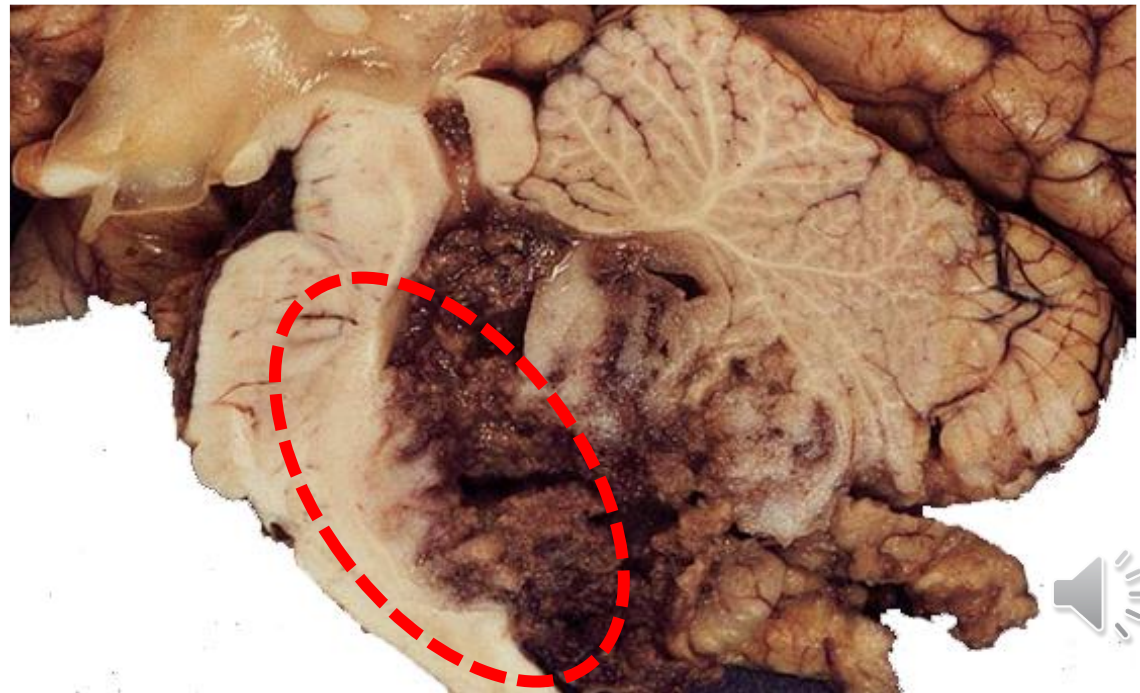
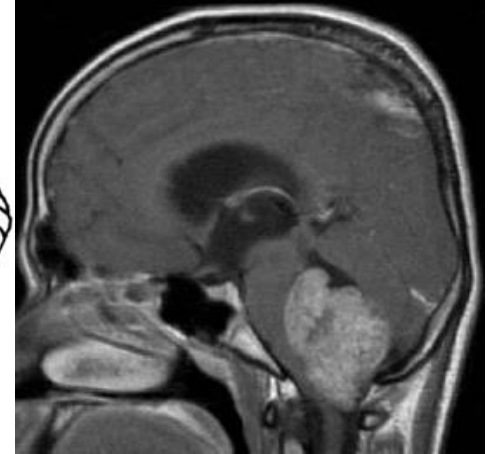
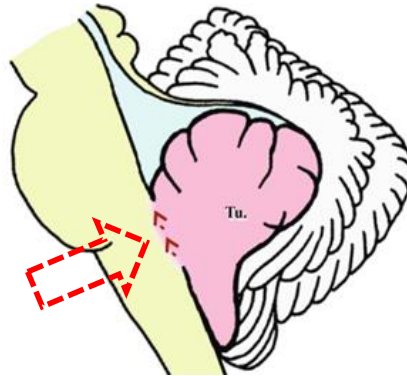
OLIGODENDROGLIOMA

- 3.9% brain tumors
- 4th & 5th decades
- Epileptic seizures common
- Location: cerebral hemispheres
- Better prognosis
 - Good response to chemotherapy (alkylating agents)



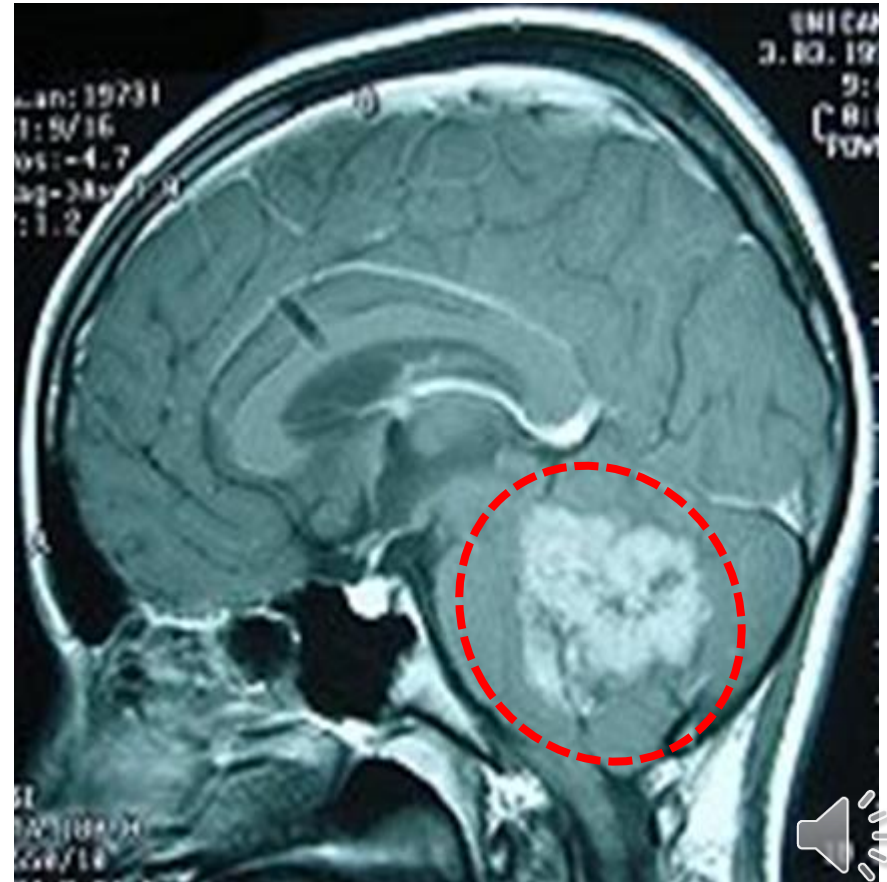
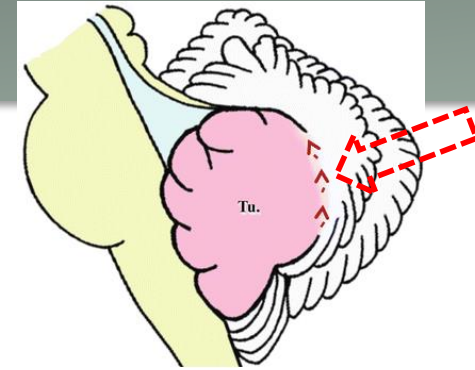
Ependymoma

- Origin: ependyma ventricles & spinal cord
- ↑ Incidence in fourth ventricle = hydrocephalus
 - Invades its floor = cranial nerve deficits
- 3% brain tumours
- Spread through CSF pathways = follow-up MRI brain, cervical, dorsal & lumbar
- Surgical removal + radio + chemotherapy
 - Bad prognosis



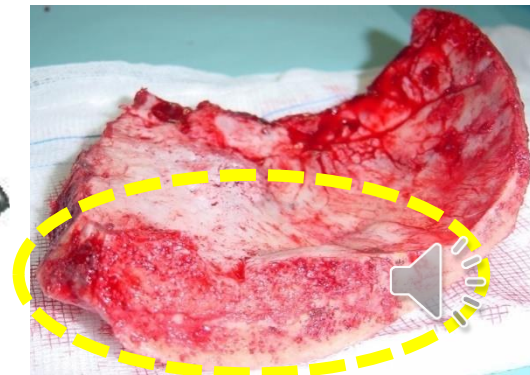
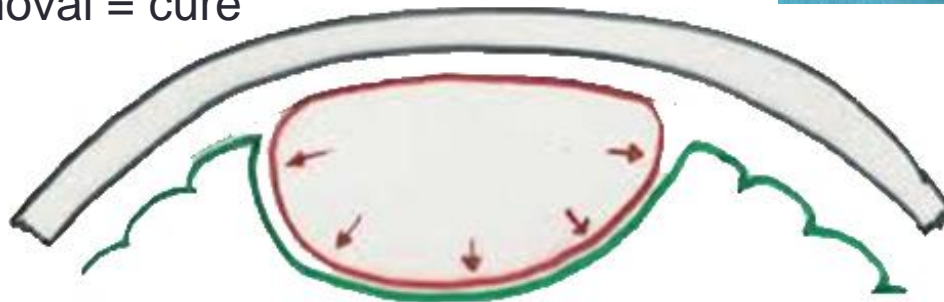
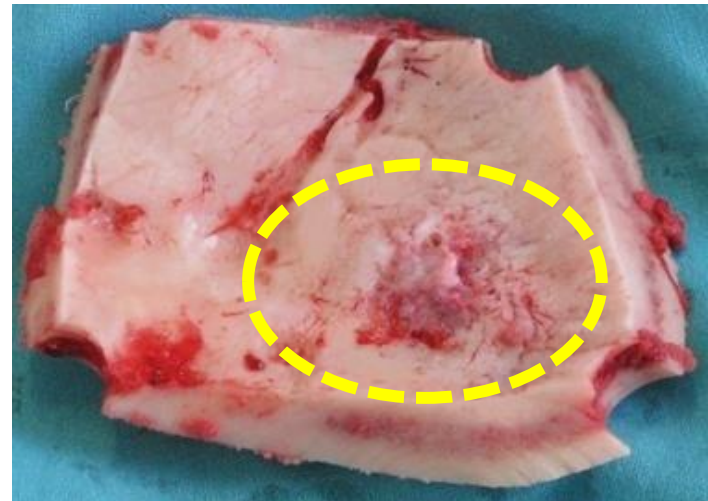
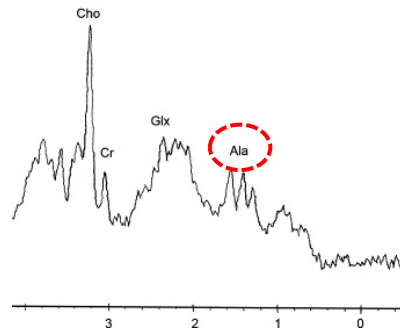
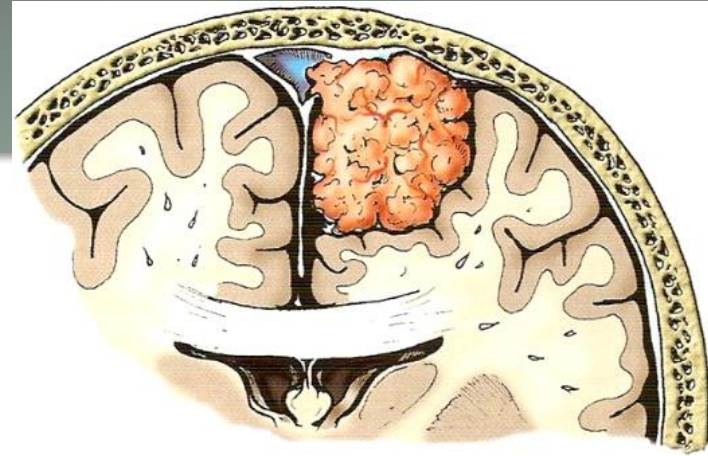
MEDULLOBLASTOMA

- 20% childhood brain tumours
- Location
 - In children: fourth ventricle roof
 - Does not invade floor
 - In adults: cerebellar hemisphere
- Obstructs CSF pathways = hydrocephalus
- Spreads through CSF pathways
 - Horsetail or droplet metastases
- Treatment: radical excision + radio + chemotherapy
 - Bad prognosis



MENINGIOMA

- Origin: arachnoid cells
 - External surface brain & spinal cord and inside ventricles
- 29% primary intracranial tumours
- ↑ frequent ♀, 5th & 6th decades of life
- 95% benign
 - Encapsulated
 - Slow expansive growth
 - Nerve tissue displacement
 - Possible adjacent bone infiltration
- Spectroscopy = alanine peak
- Histologically EMA marker
- Complete removal = cure



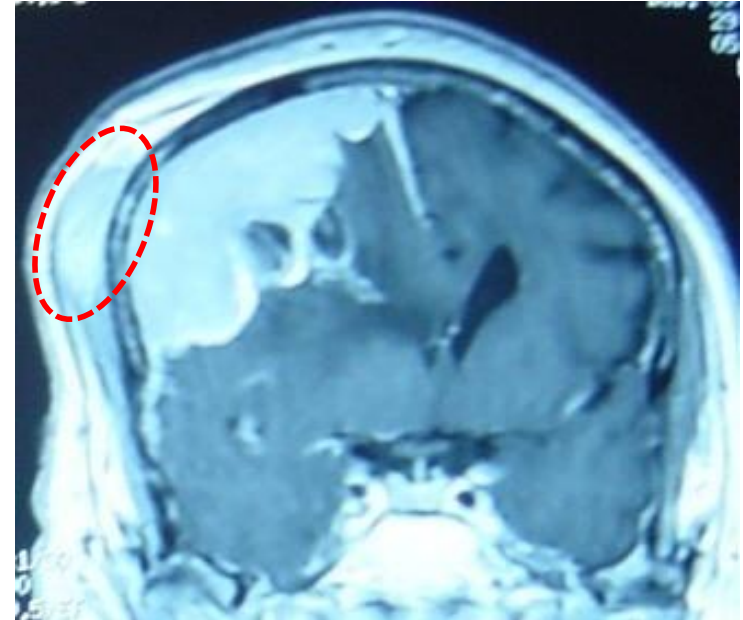
Meningioma: features



Dural tail



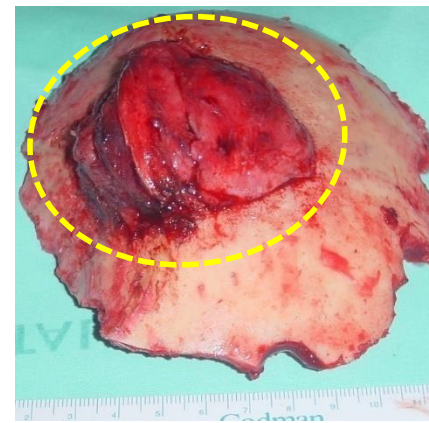
Bone invasion



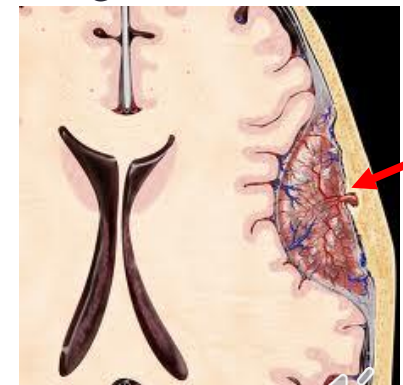
Extracranial growth



Macroscopic aspect



Extracranial growth

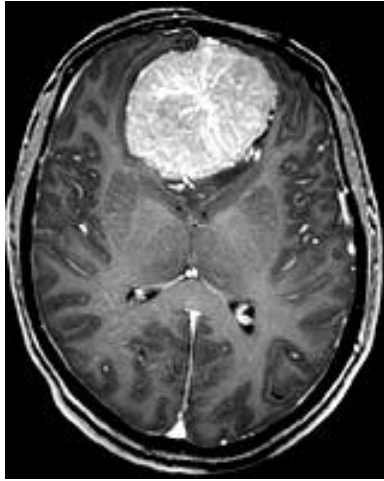


Feeding: meningeal arteries

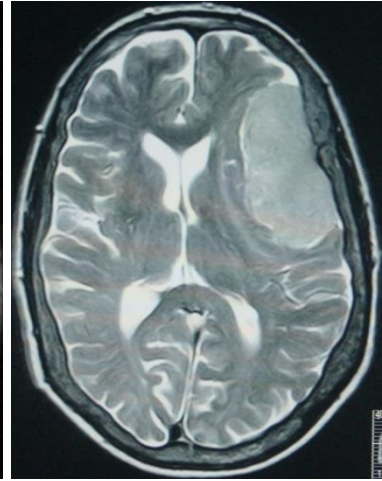
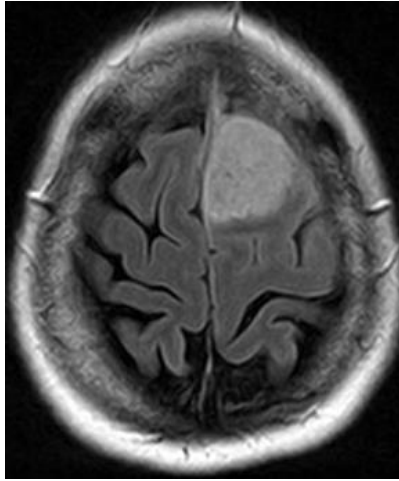
Meningiomas: location



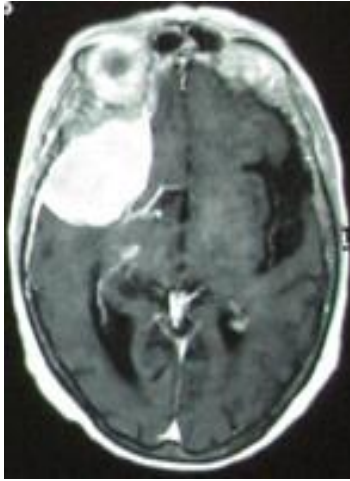
Olfactory groove



Parasagittal



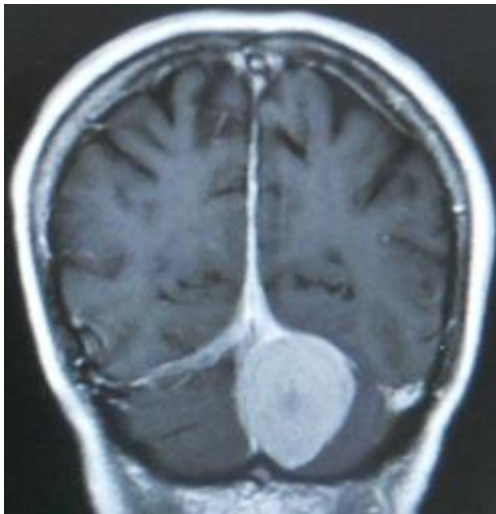
Sphenoid wing



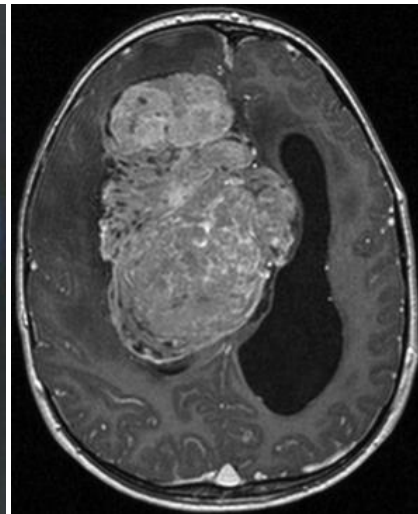
Temporal fossa



Trautman triangle



Torcula



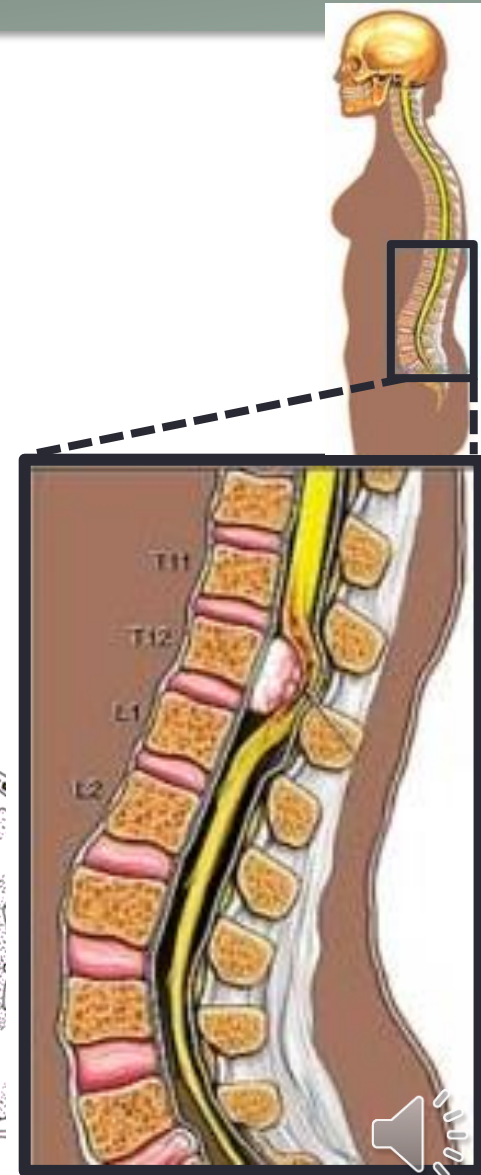
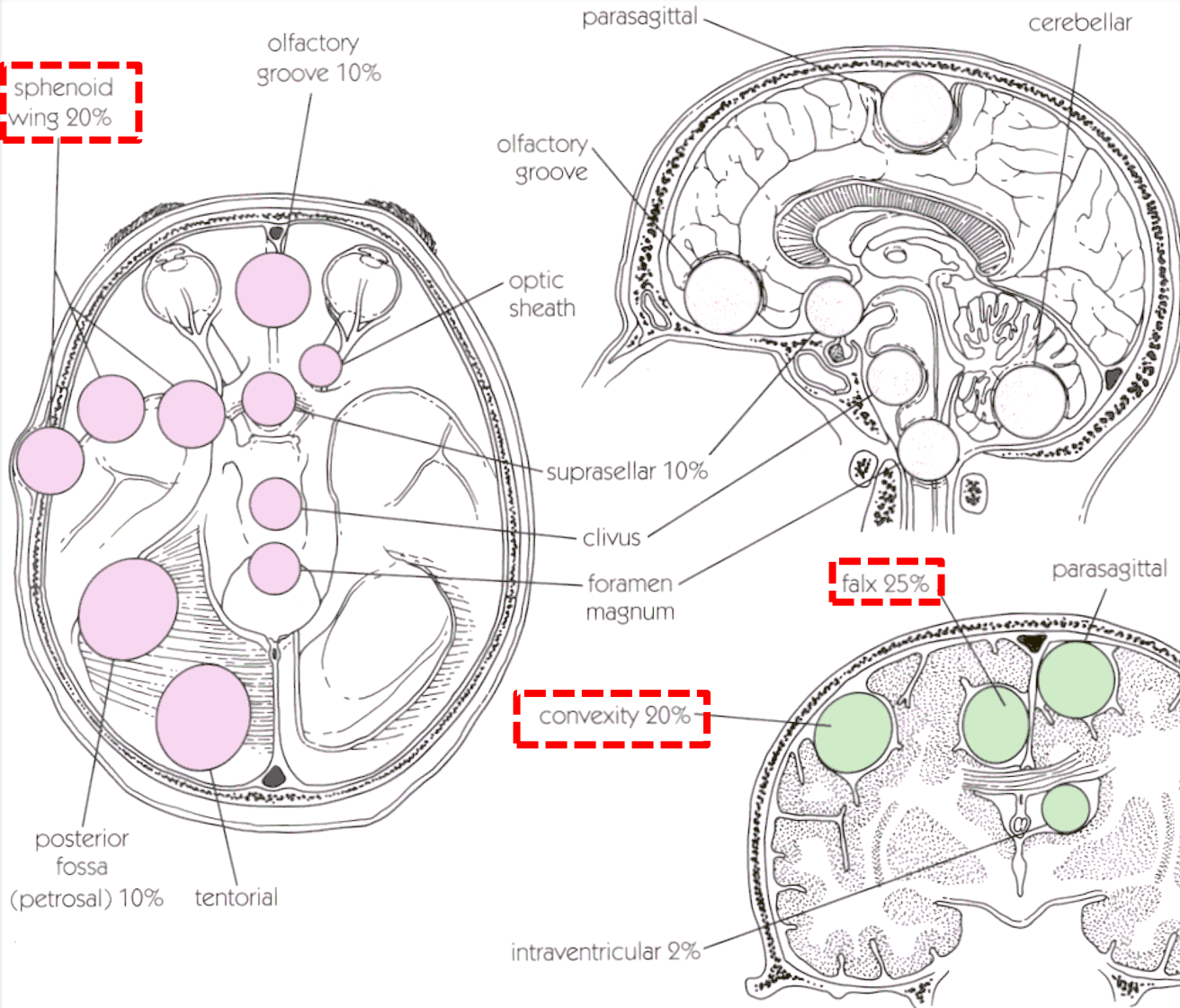
Intraventricular



Spinal canal



MENINGIOMAS: location / incidence



Meningiomas: treatment

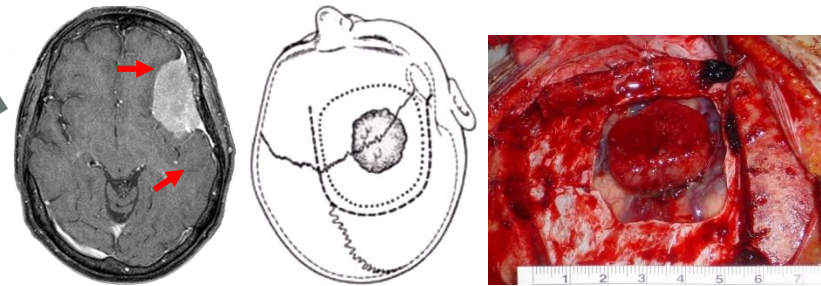
Clinical observation

- Progressive and linear growth (4.94 cm³ / year)
 - ↑ Ø 0.37cm / year
- 23% DO NOT grow

- ✓ Bad general condition
- ✓ Advanced age
- ✓ < 1 cm & asymptomatic
- ✓ Patient refuses to be operated

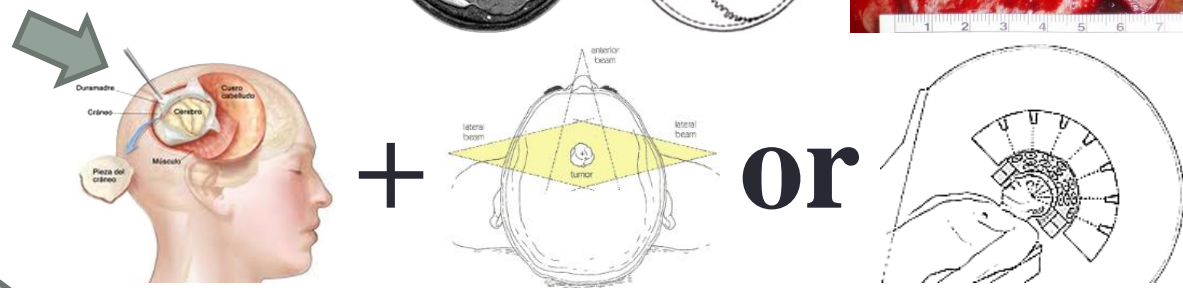
Complete removal (tumour + dura + infiltrated bone)

- 5-year survival 91%
- 5-year recurrence 11-15%



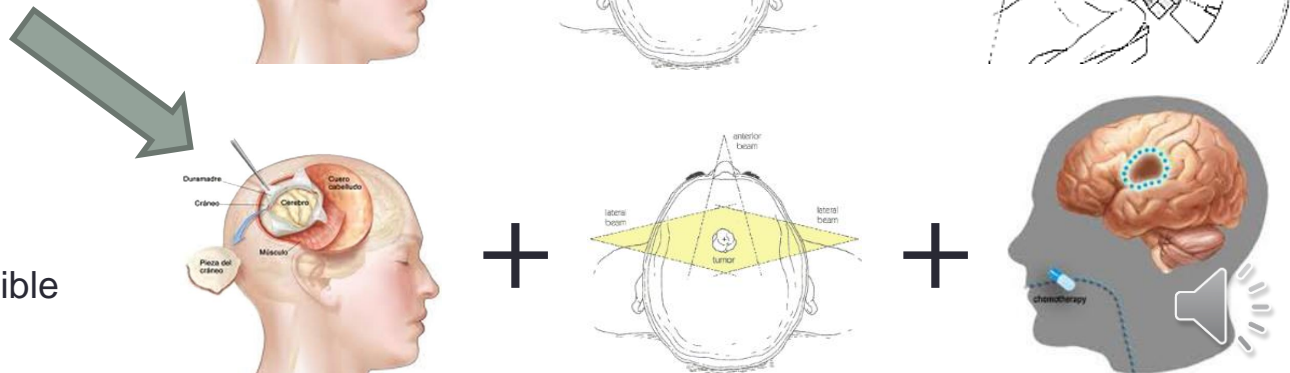
Partial removal = radiation therapy / radiosurgery

- 5-year recurrence 37-85%



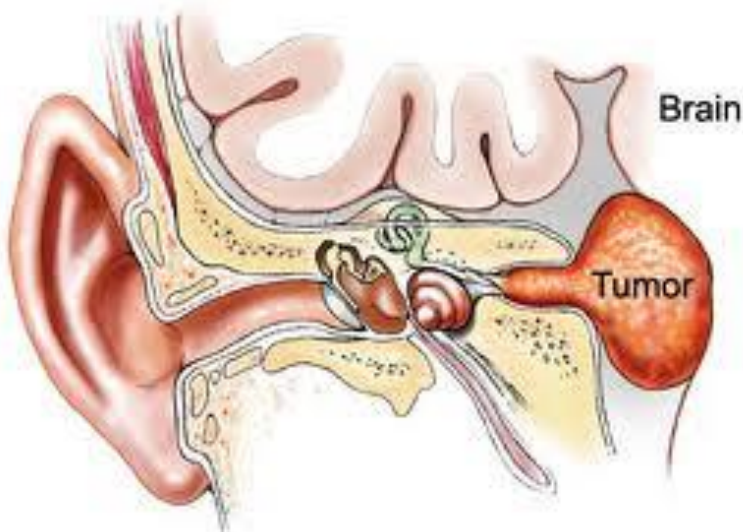
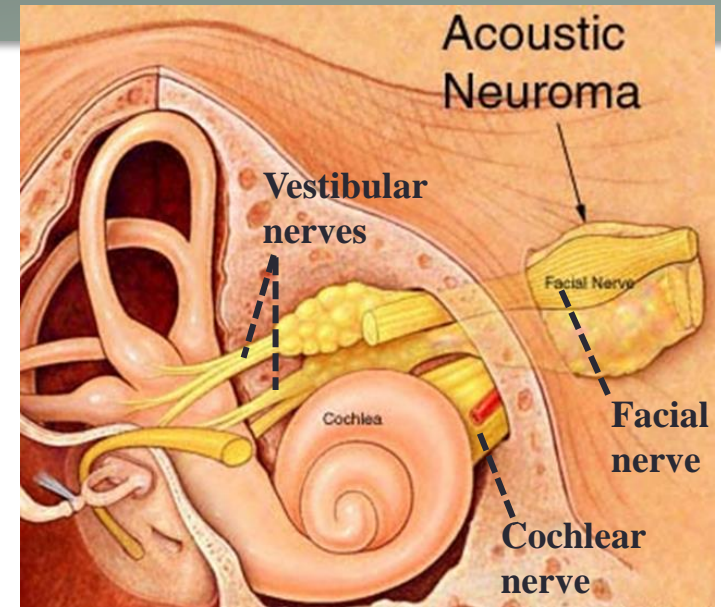
Atypical (malignant) = radical removal + radiotherapy + chemotherapy

- Recurrences common
- Distant metastases possible
- Prognosis bad



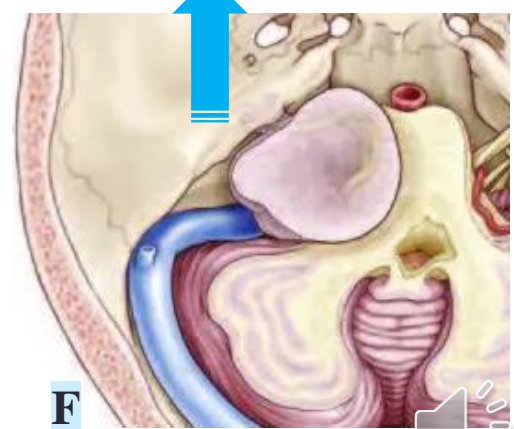
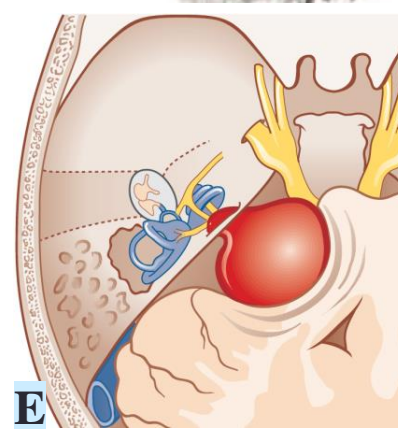
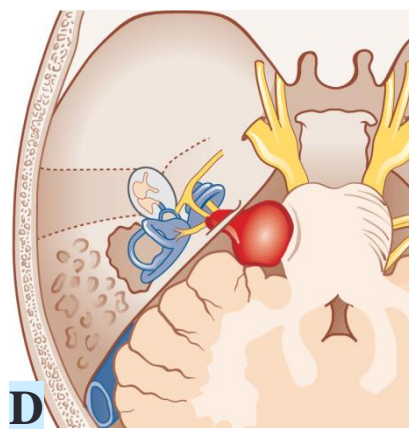
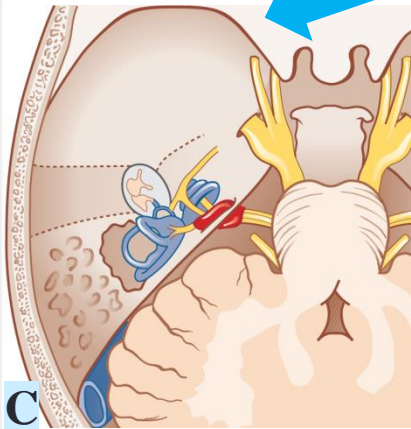
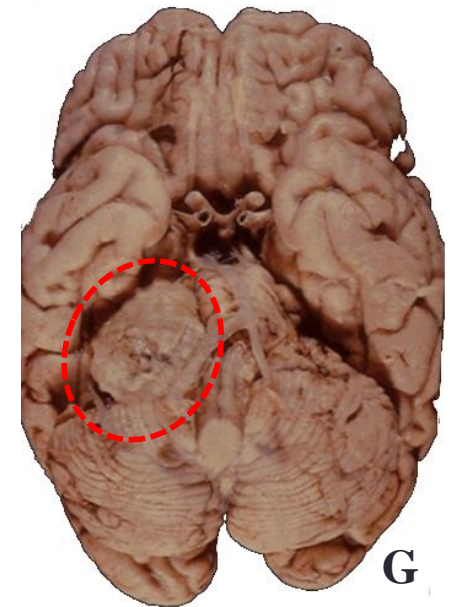
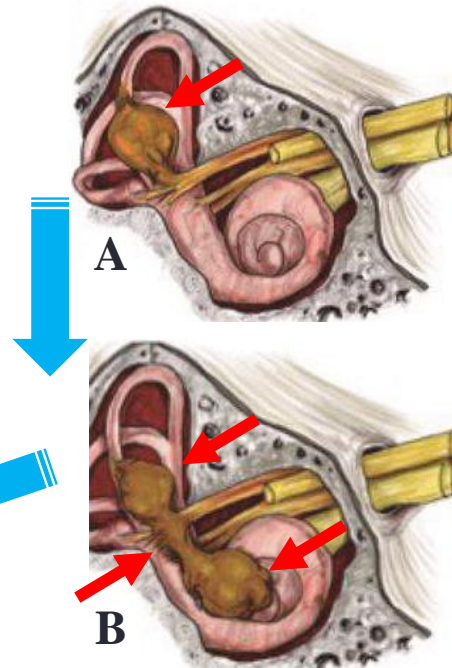
SCHWANNOMA

- 8-10% intracranial tumors
- Origin: Schwann cells
 - Mostly superior vestibular nerve
- Benign
- Neurofibromatosis type II (NF2) \uparrow Incidence
 - Should be ruled out if bilateral Schwannoma at <40 years age



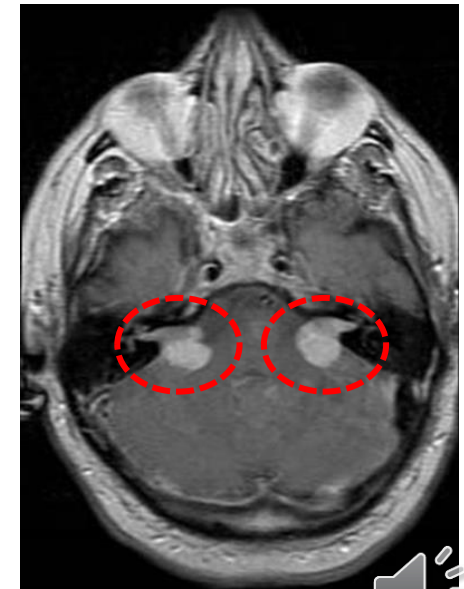
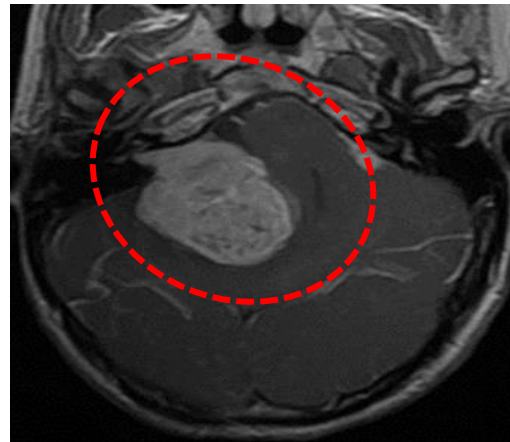
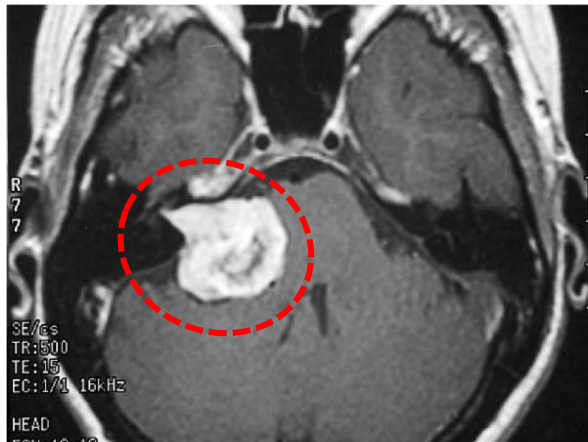
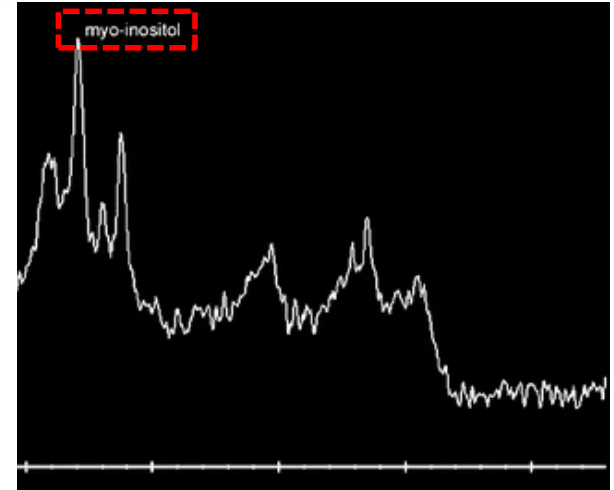
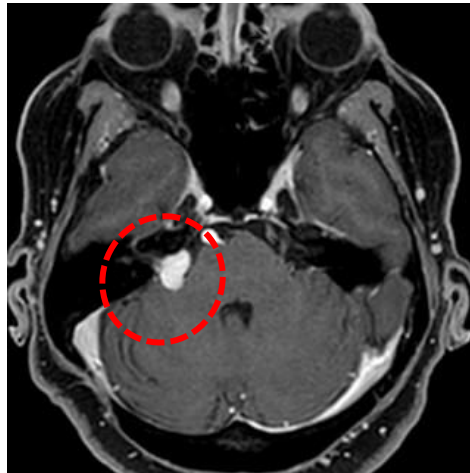
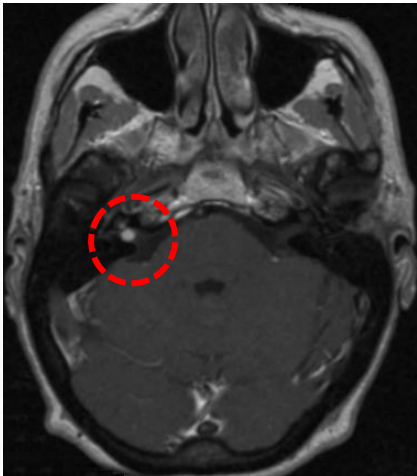
Vestibular schwannoma: clinical features

- Tinnitus 98%
- Sensorineural hearing loss 70%
- Balance disturbances 67%
- Headache 32%
- Facial paresthesia 29%
- Facial paresis 10%
- Diplopia 10%



Vestibular schwannoma: MRI

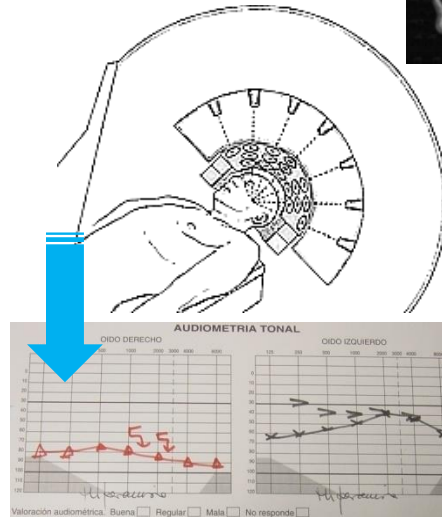
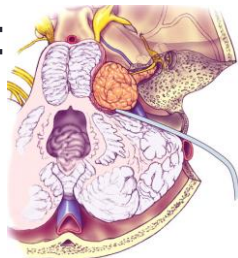
- Typical shape
- Spectroscopy: myo-inositol peak



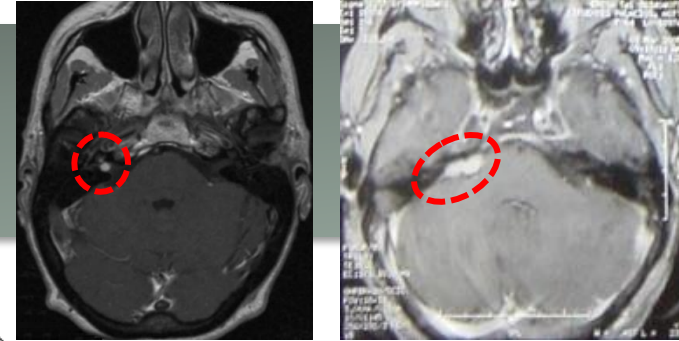
Neurofibromatosis type II

Vestibular schwannoma treatment

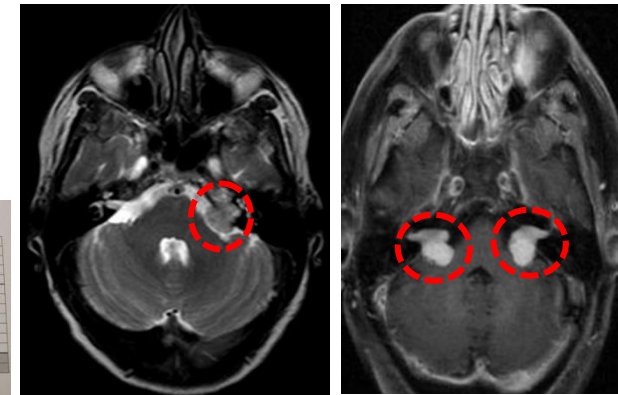
- Tumour < 2 cm, asymptomatic & age > 70 years ⇒ wait and see
 - Follow-up MRI monitor growth
- 2-3 cm or bilateral tumours = radiosurgery
- Tumour > 3 cm = surgery
 - Tumour remnant after surgery = radiosurgery
- Inoperable tumours chemotherapy: Bevacizumab



Progressive hear loss



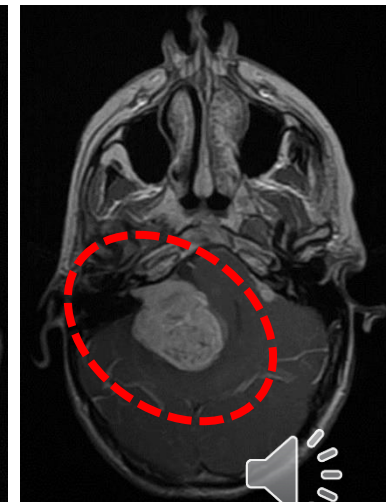
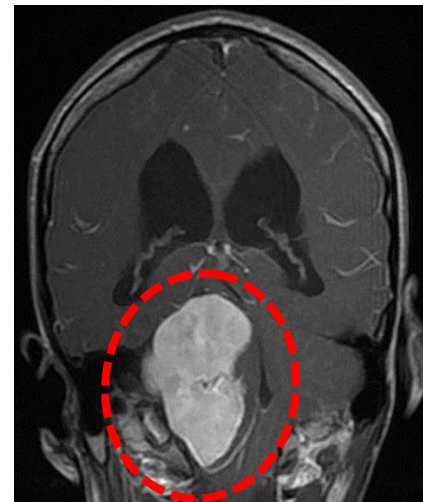
Wait and see



Radiosurgery



Facial paresis post-op



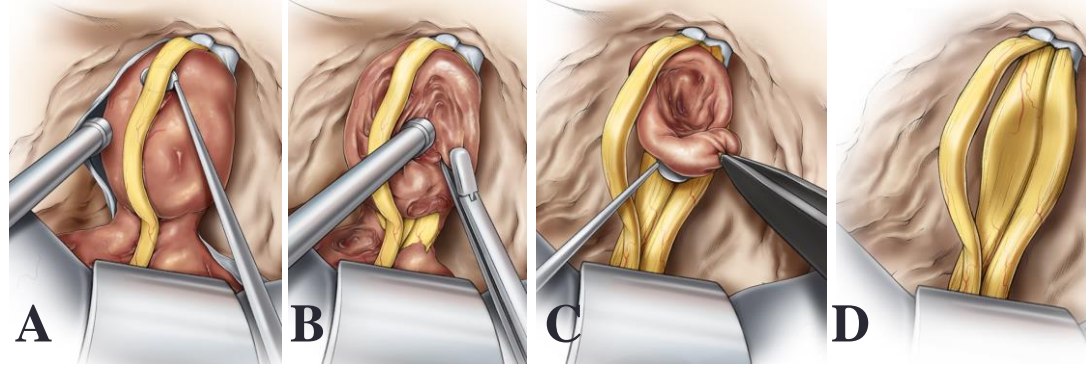
Surgery



Vestibular schwannoma: hearing preservation

• Conditions

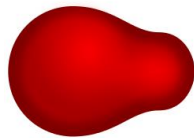
- Serviceable pre-op hearing
- Size > 2 cm
- NOT neurofibromatosis type II = cochlear nerve infiltrated



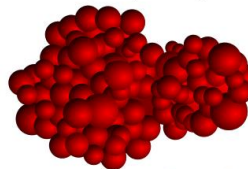
• To allow cochlear implant

- If contralateral tumour grows

Typical Schwannoma
 Single Schwann Cell
 Overgrowth



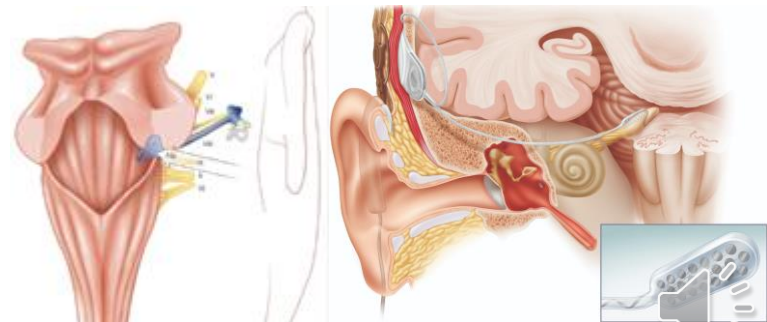
Multi-lobulated Schwannoma
 Multiple Schwann Cells
 Botryoid (Cluster)



Cochlear implant

• Brainstem auditory implant

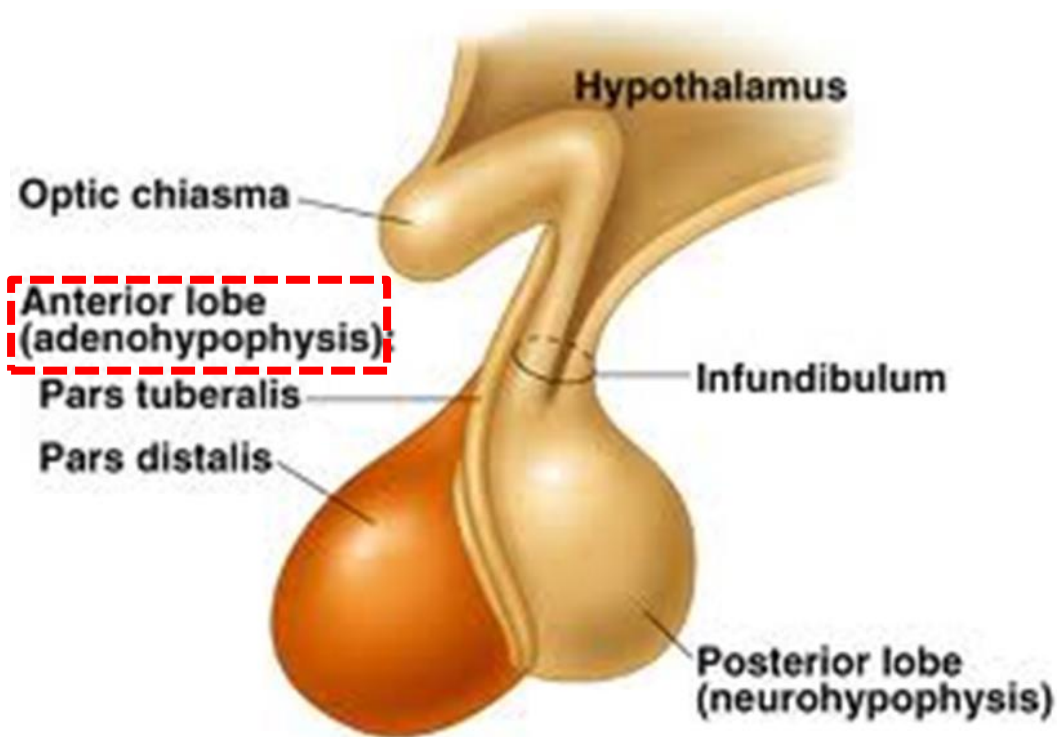
- For neurofibromatosis type II cases



Brainstem auditory implant

PITUITARY TUMOURS

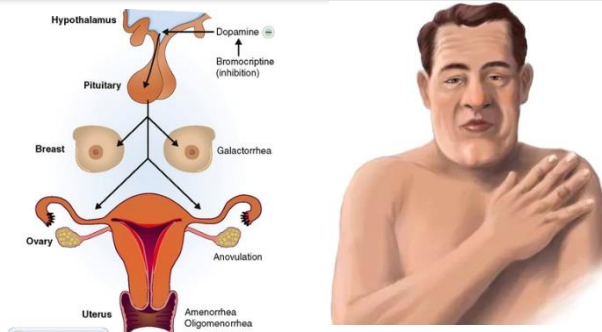
- 10-15% primary brain tumours
- 8.2-14.7 / 100,000 inhabitants
- Incidental finding 25%
- ↑ incidence 3rd-6th decades
- ↑ incidence
 - Women
 - MEN-1
- 95% adenohypophysis



Clinical features

- Hormonal hyperfunction:

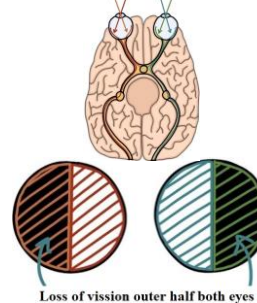
- Amenorrhea and galactorrhea
- Acromegaly / gigantism
- Cushing's disease
- Secondary hyperthyroidism



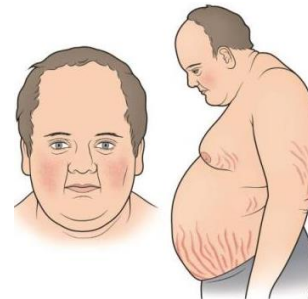
Amenorrhea galactorrhea Acromegaly

- Hypopituitarism

- Addison disease
- Dwarfism in children



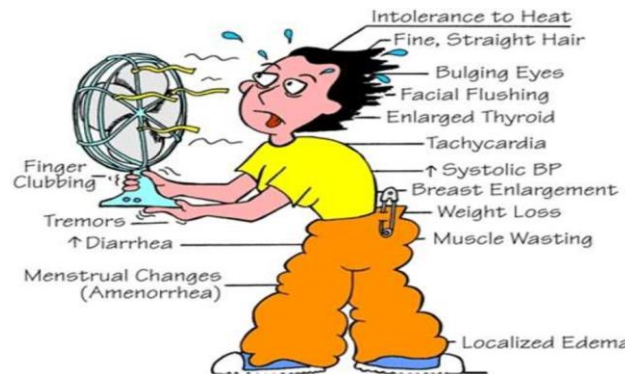
Loss of vision outer half both eyes



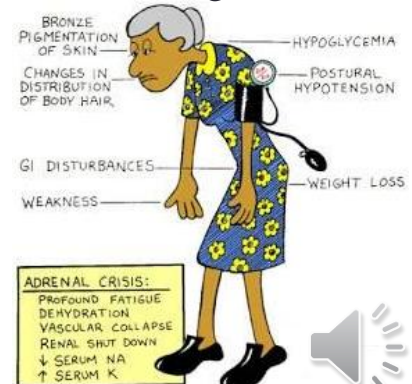
Bi-temporal hemianopia Cushing's disease Dwarfism Gigantism

- Mass effect:

- Headache
- Bi-temporal hemianopia
- Moderate hyperprolactinemia (<150ng / ml)



Hyperthyroidism



Addison's disease

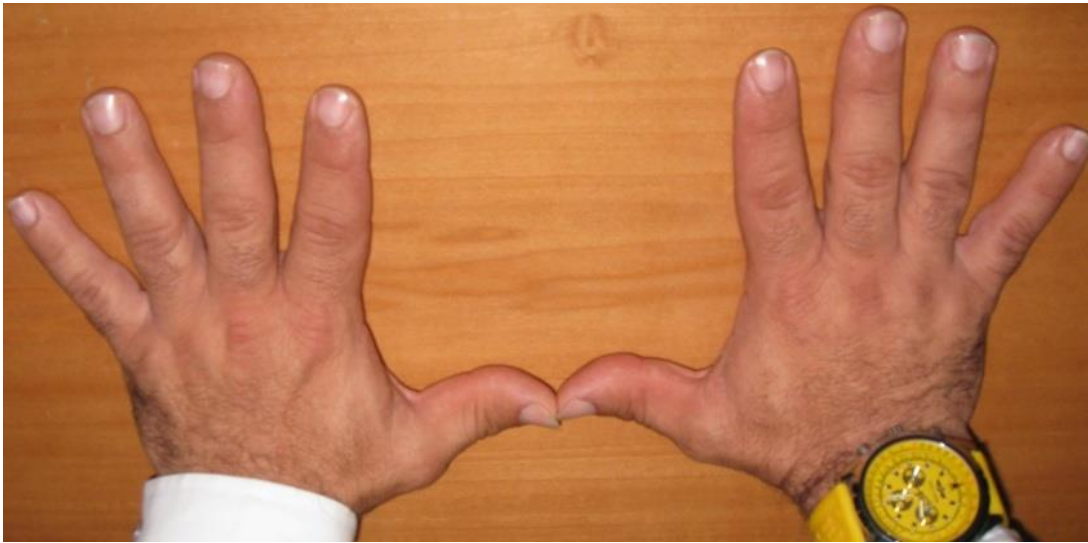
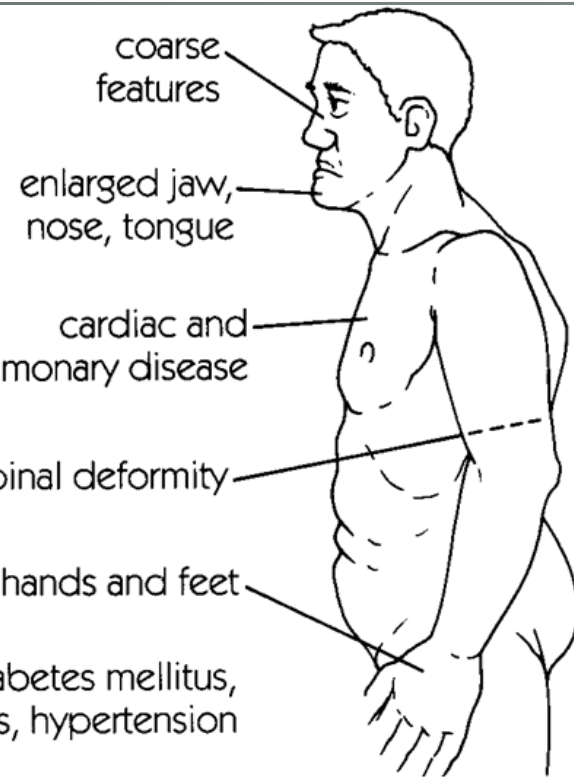
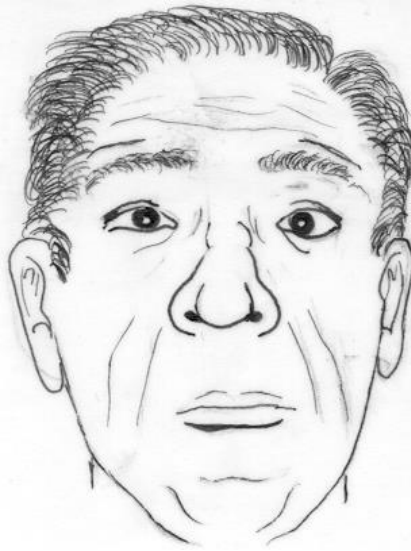
Acromegaly



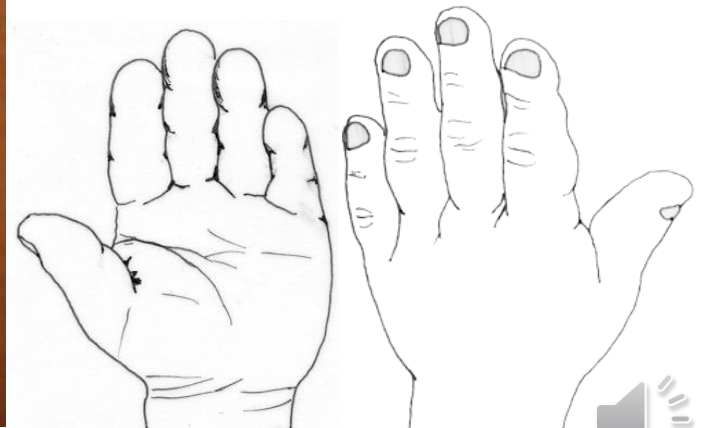
Coarse features



Enlarged tongue



Enlarged hands & feet



Cushing's syndrome



Muscle atrophy



Pendulous abdomen + purple striae



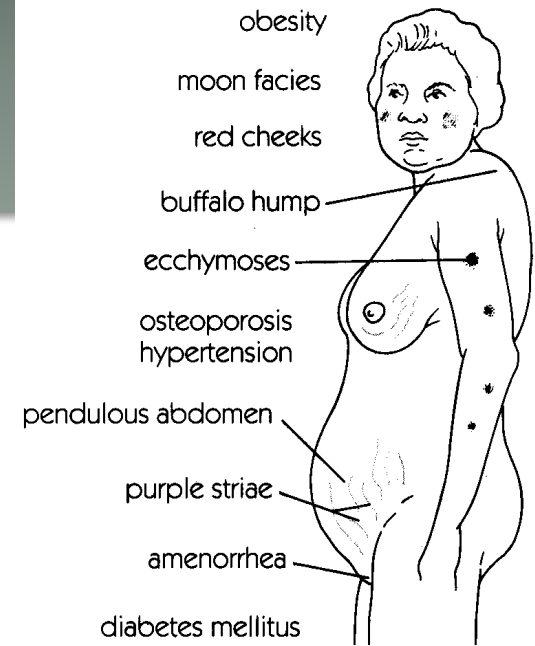
Red cheeks



Moon facies



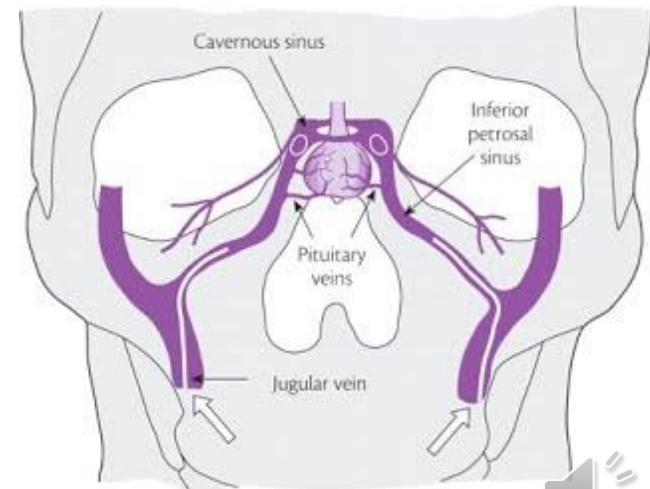
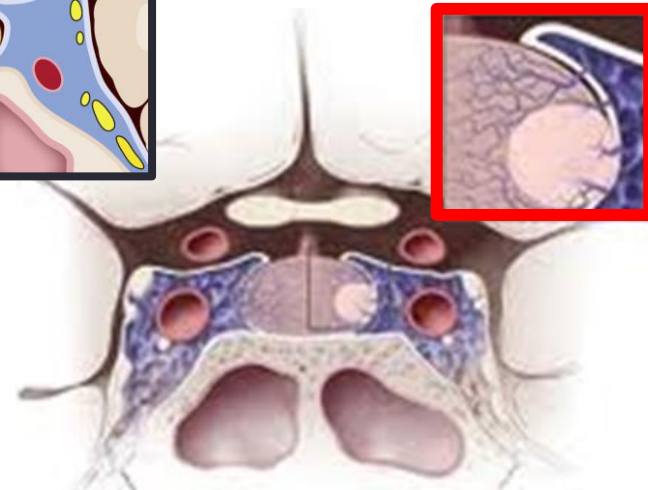
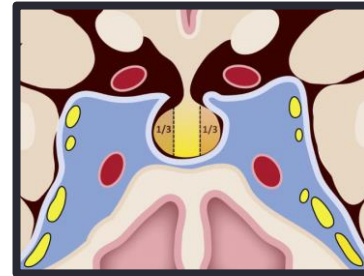
Buffalo hump



Pituitary tumours: diagnosis & treatment

• Types of diagnosis

- Endocrine
 - Baseline hormonal analysis
 - Hormonal dynamic analysis
- Radiological diagnosis (MRI)
 - Tumour size
 - Optic chiasm compression
 - Cavernous sinus invasion
 - Sphenoid sinus involvement
- On the affected side
 - Petrosal sinus catheterization
- Histological



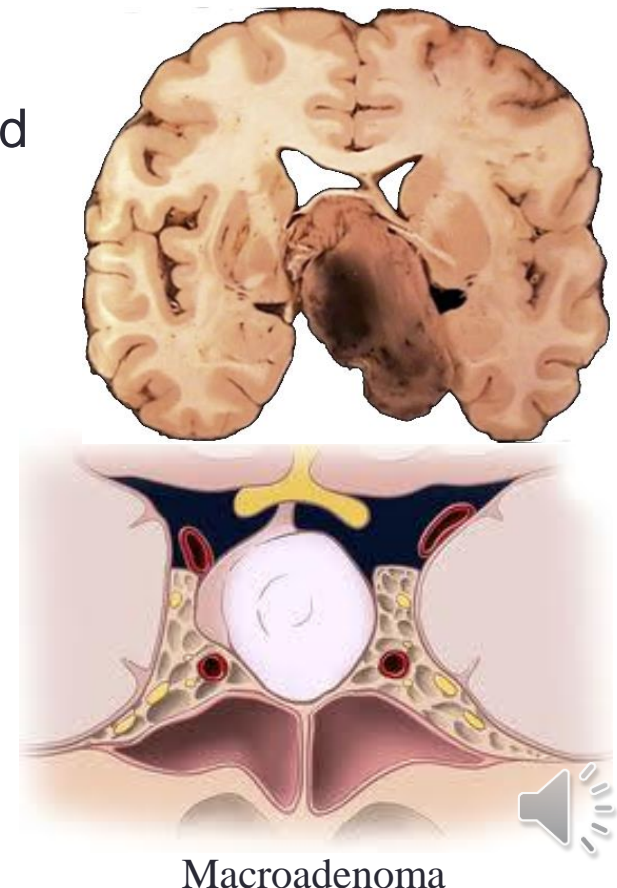
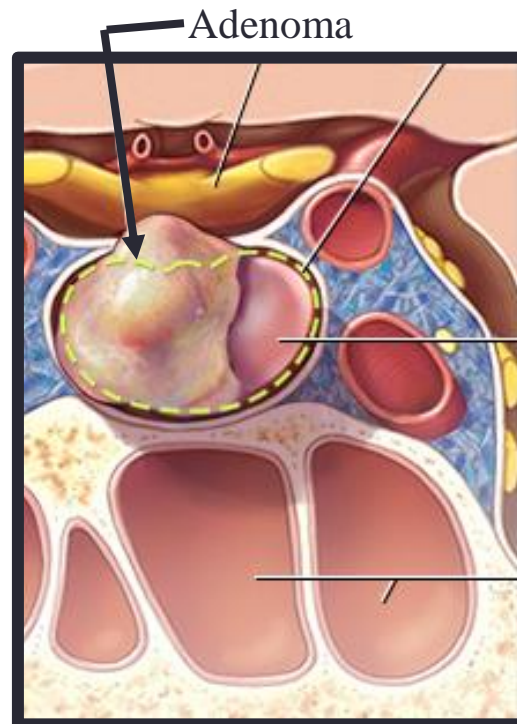
• Types of treatment

- Normalise endocrine function
 - Pituitary insufficiency from tumour / surgery
 - Correct excessive hormonal secretion
- Recover or stop visual deterioration
- Prevent recurrences



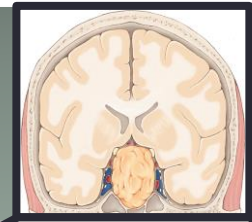
Pituitary tumour according to size

- **Microadenoma** < 1 cm = hemi-hypophysectomy = cure
- Adenoma 1 cm = tumour removal = mild hypopituitarism
- **Macroadenoma** > 1 cm = complete hypopituitarism = full endocrine replacement will be needed
- Invasive adenoma = recurrence to be expected

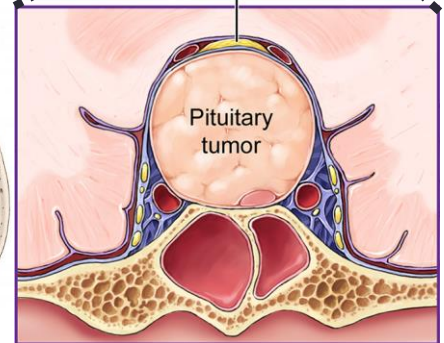
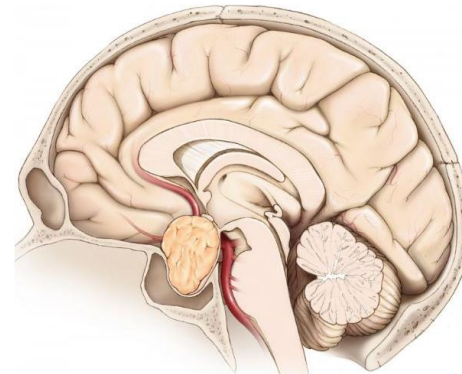


Pituitary tumours: extension

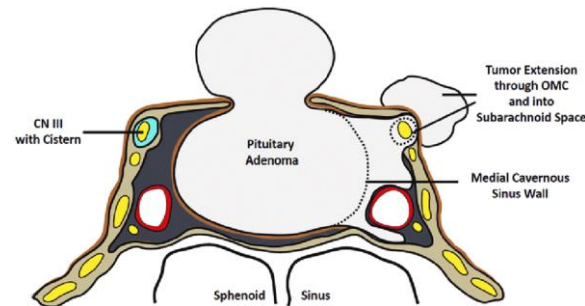
- Chiasm compression = visual loss
- Cavernous sinus invasion = complete tumour removal NOT possible
- Sphenoid sinus involvement = risk CSF leak
- Invasiveness = ↑ chance recurrence



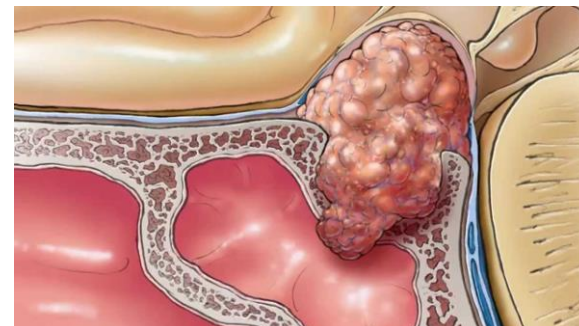
Compressed optic chiasm



Chiasm compression



Cavernous sinus invasion

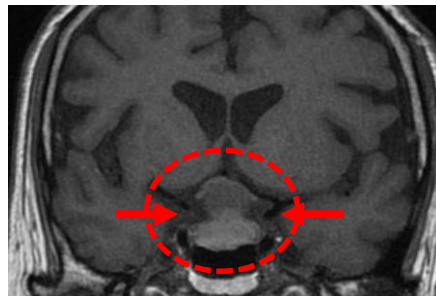
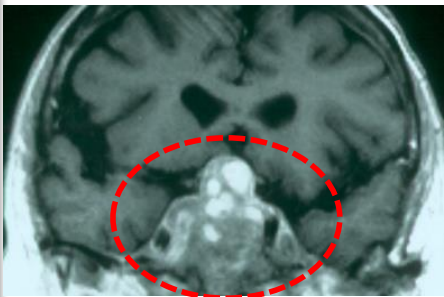
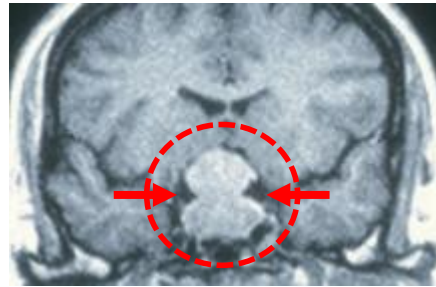
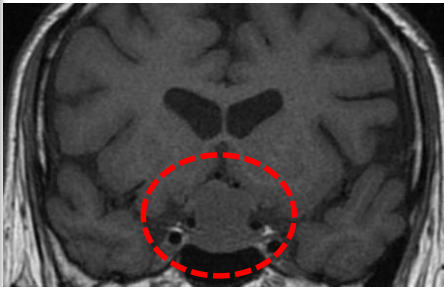
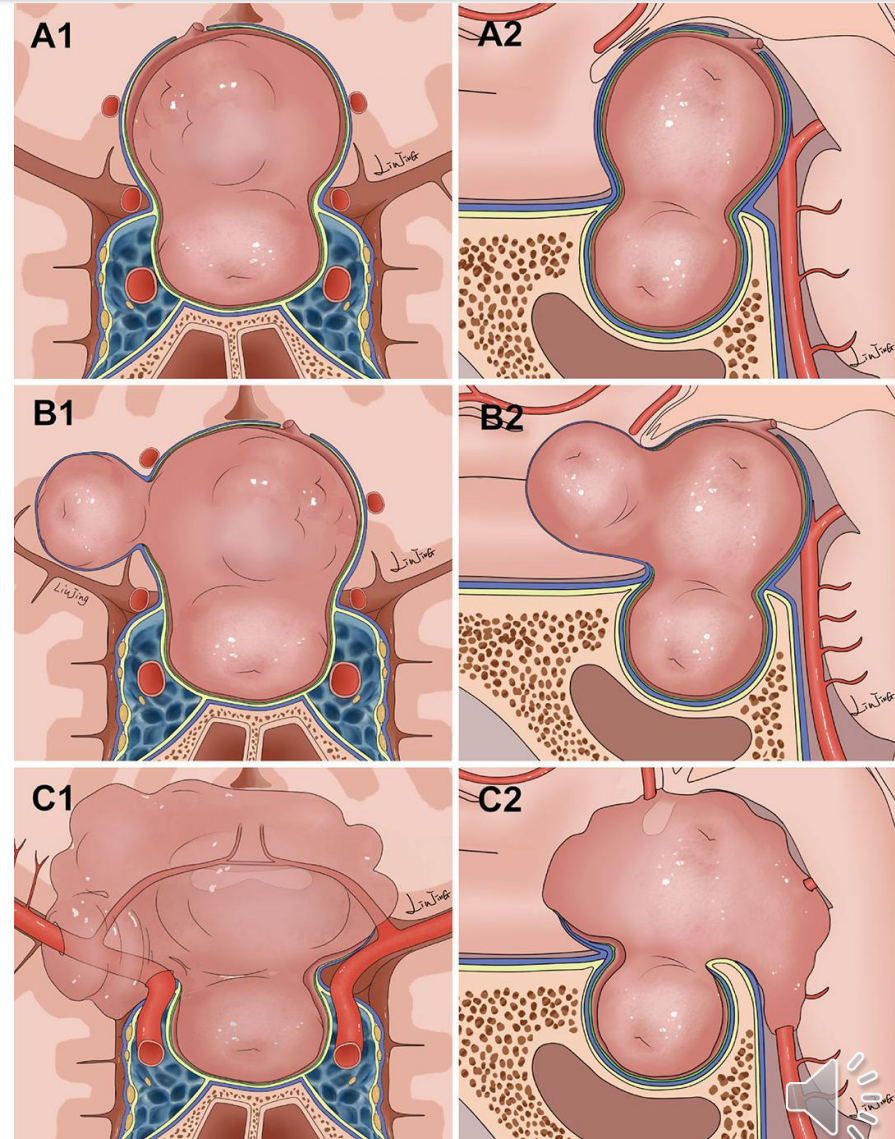
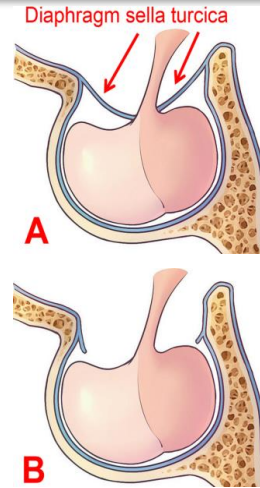


Sphenoid sinus involvement



Suprasellar extension

- The sellar diaphragm may make a waist that prevents transsphenoidal removal

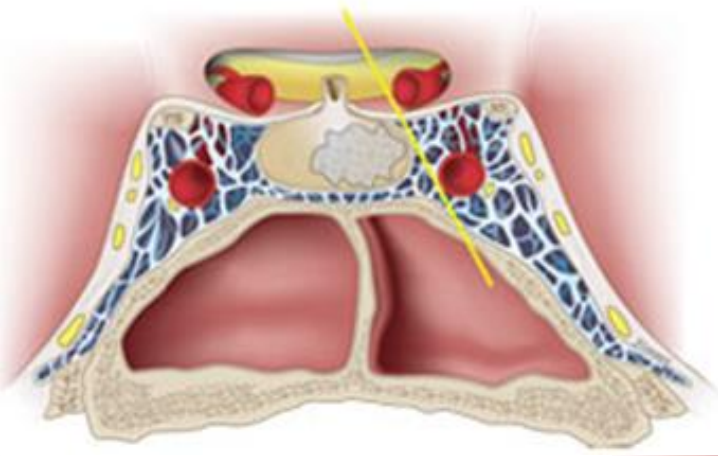


No waist

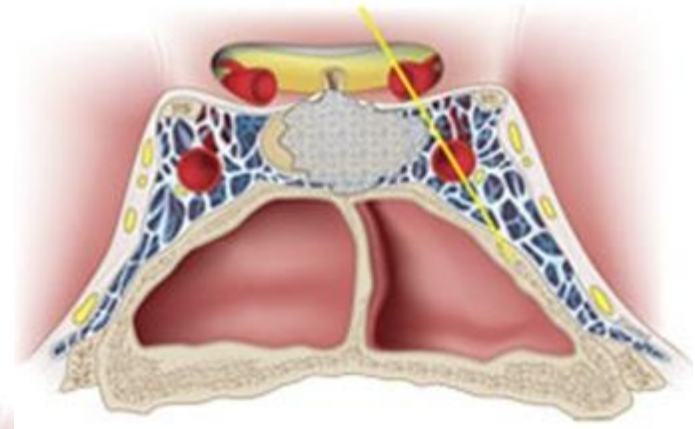
Middle tumour waist

Pituitary tumours: cavernous sinus invasion (Knosp classification)

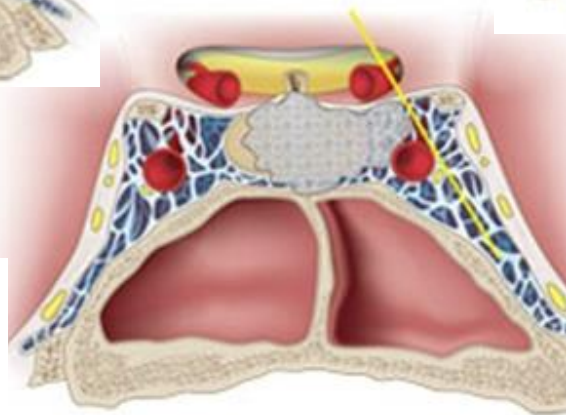
Grade 0



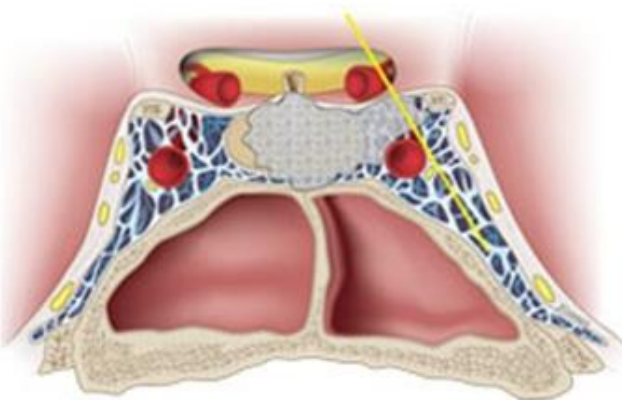
Grade 1



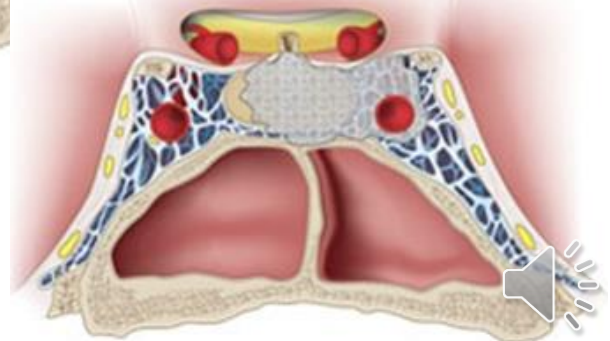
Grade 2



Grade 3

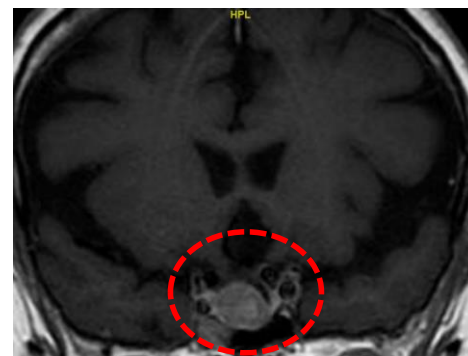
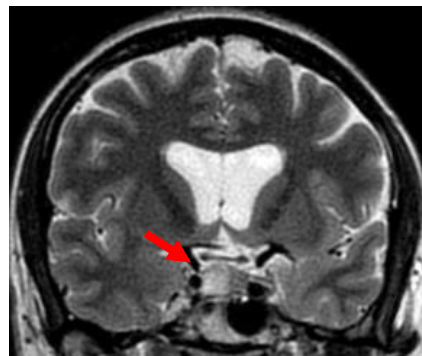


Grade 4



Pituitary tumours: MRI

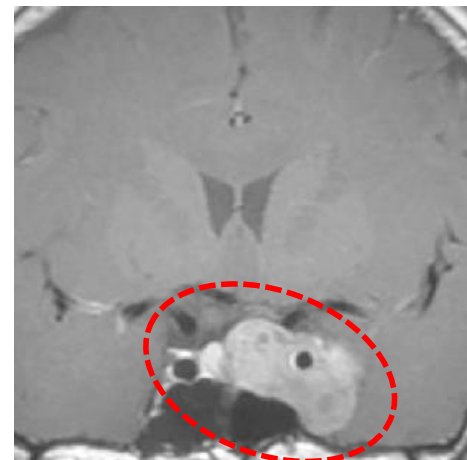
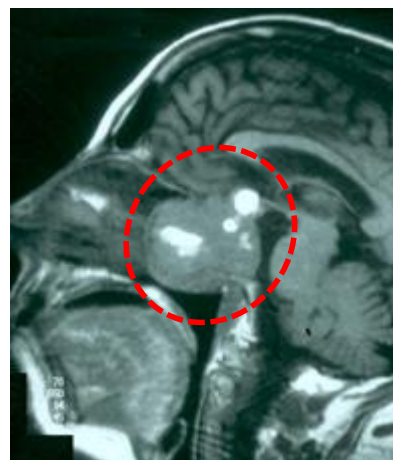
- Will show size, suprasellar extension, cavernous sinus invasion, remaining pituitary gland, haemorrhages & route surgical removal



Microadenoma



Macroadenoma



Suprasellar extension

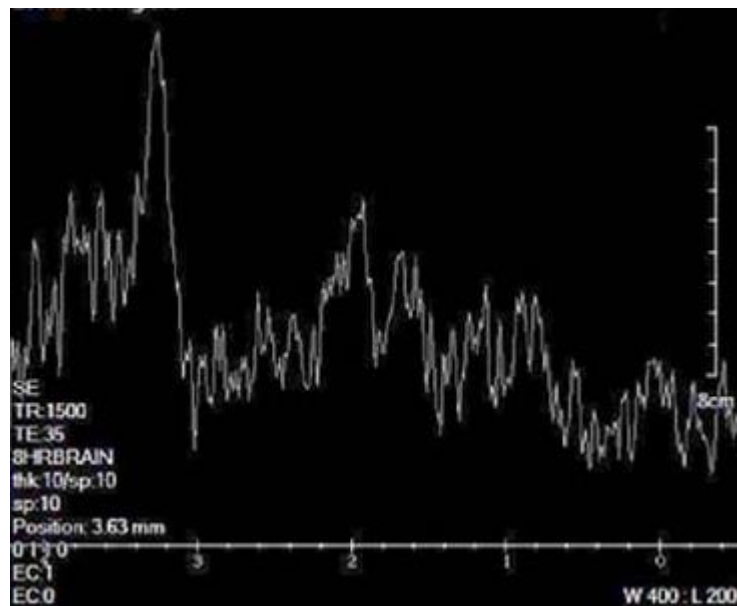
Sphenoid sinus involvement

Cavernous sinus invasion

Pituitary apoplexy

Pituitary tumours: MRS spectroscopy

- Significant reduction NAA & Cr peaks, moderate elevation Cho, and a small lipid and lactate peaks
- Not possible to differentiate between different pituitary tumours
- Helps to rule out craniopharyngioma & chordoma



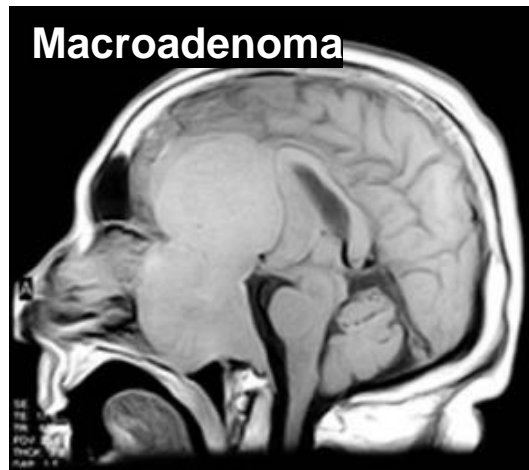
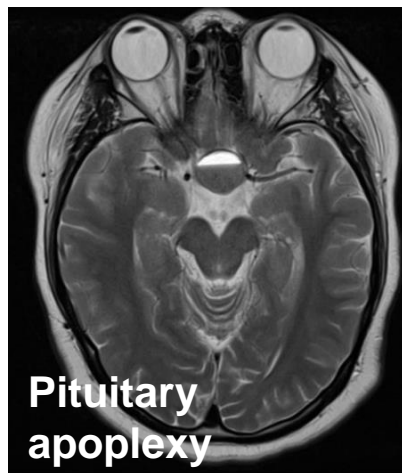
Pituitary tumours: indications surgical treatment

REMEMBER?

- Pituitary apoplexy → URGENT
- Macroadenoma with progressive mass effect
 - Except prolactinoma: Good response to medical treatment
- Hyperfunctioning
 - Acromegaly, Cushing, secondary hyperthyroidism
- Medical treatment failure
- To obtain histological diagnosis (non-functioning)



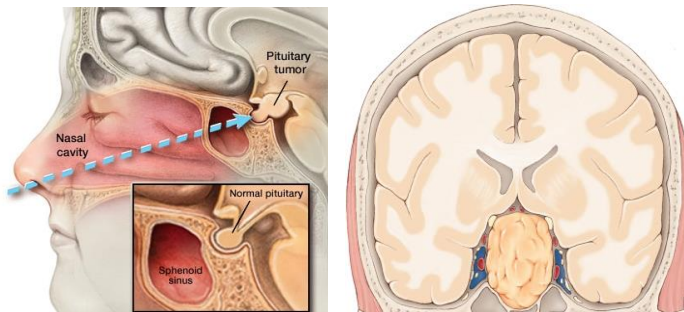
Cushing



Transsphenoidal vs transcranial removal

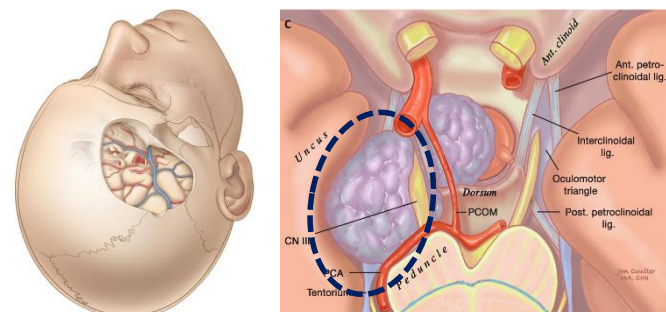
Transsphenoidal

- Microadenomas
 - Hemi-hypophysectomy possible
- Macroadenomas with midline suprasellar growth
- No cavernous sinus invasion
- Better chance vision improvement
- Less aggressive



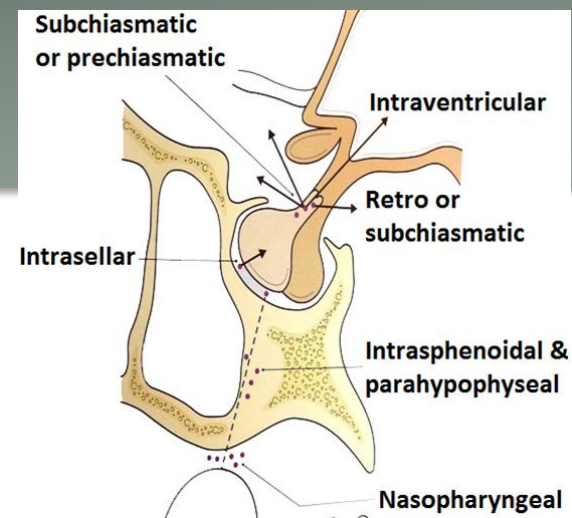
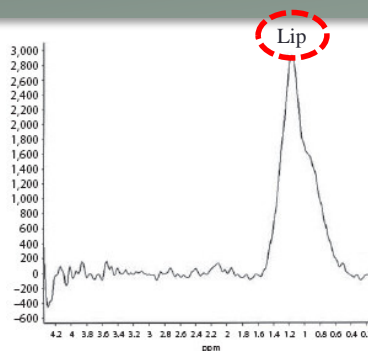
Transcranial

- All tumours, all sizes, all extensions
 - Cavernous sinus invasion
 - Sellar diaphragm waist
- Visual apparatus endangered
- Pituitary function not preserved usually
 - Used for larger tumours
- More aggressive

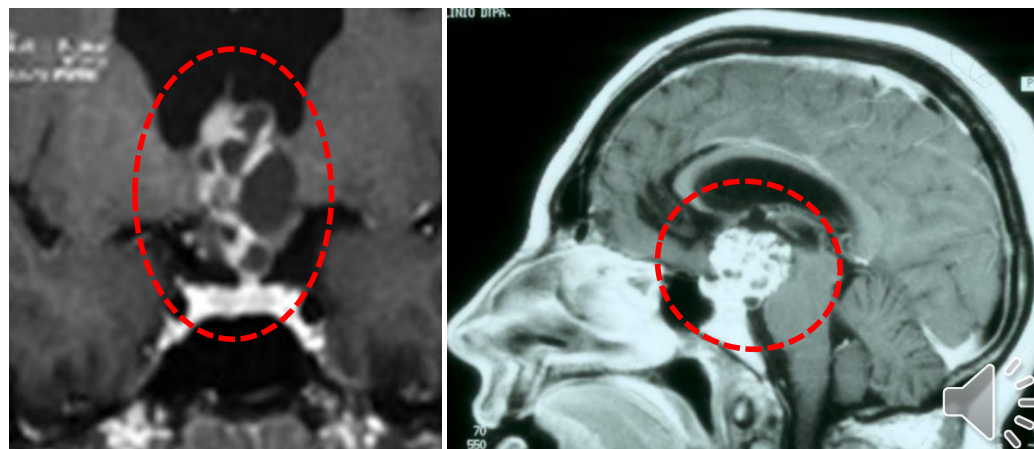


CRANIOPHARYNGIOMA

- Origin: Rathke & craniopharyngeal duct
- 2-4% brain tumours
- Grade I: rarely malignant
- ↑ children and adolescents, ↑ ♂
- Location: sellar & parasellar
 - Suprasellar 75%
- MRI
 - Cystic component with oily content
 - Spectroscopy: lipid peak
 - Calcified wall (seen on CT scan)
- Clinical features
 - Neuroendocrine dysfunction
 - Children = short stature + obesity
 - Visual field loss
 - Hydrocephalus
 - Cognitive disorders
- Treatment: surgical
 - Adjuvant radiotherapy / radiosurgery
 - Hormonal replacement

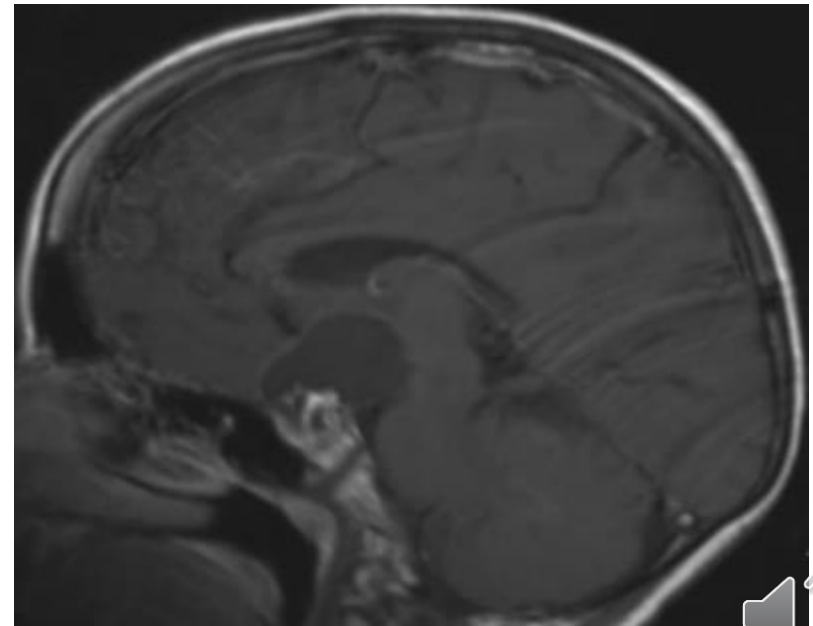
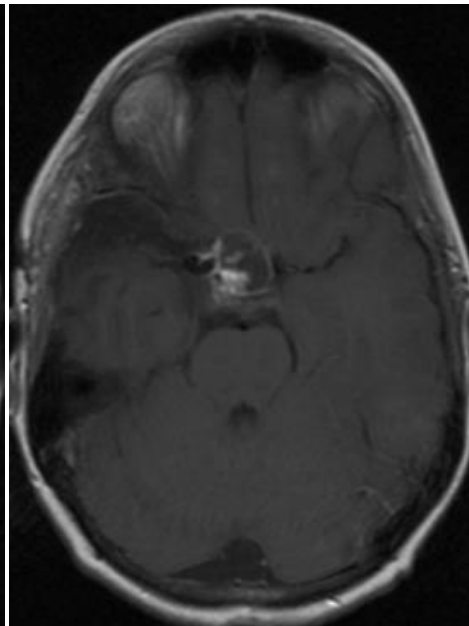
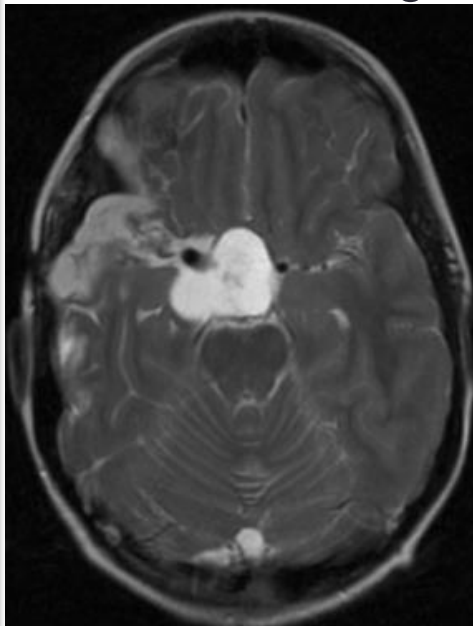
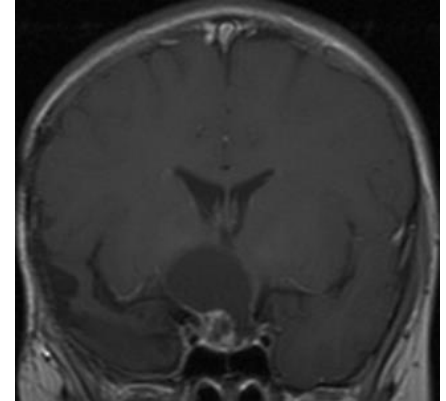
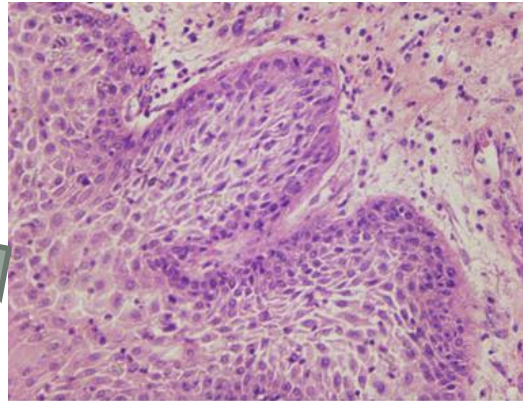


Possibilities of craniopharyngioma location



Craniopharyngioma: MRI

- Cysts common
- Pituitary stalk & third ventricle involvement
 - Invade third ventricle walls
 - Surgical removal = severe endocrinological deficits

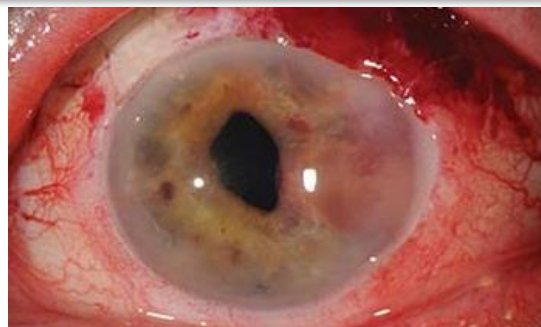


Craniopharyngioma cysts

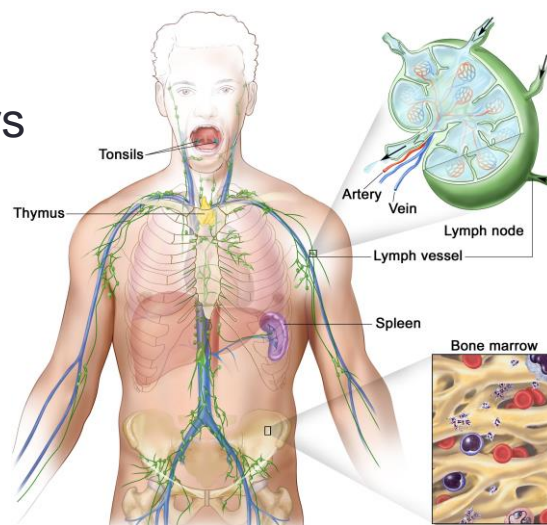
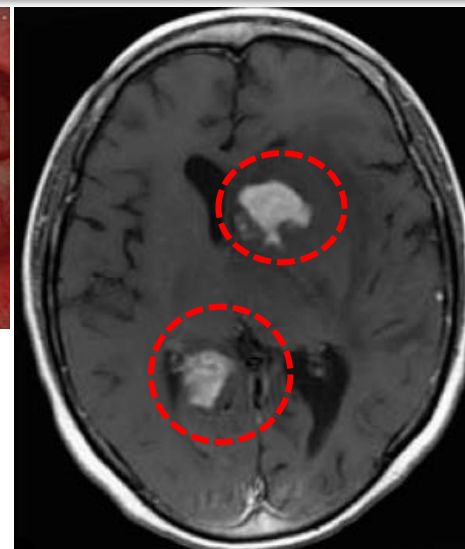


PRIMARY BRAIN LYMPHOMA

- 2% extra-ganglion lymphomas
- 1% intracranial tumours
- ↑ common in immunosuppressed patients & AIDS
- Multiple lesions frequent
- Lymph node & bone marrow involvement common
- Incidence ↑ age, peak 50-70 years
- Clinical features
 - Focal neurological deficit 70%
 - Cognitive changes 43%
 - Epileptic seizures 15-20%
 - Eye involvement 5-20%
- Possible origin by malignant cell progression around nerve roots



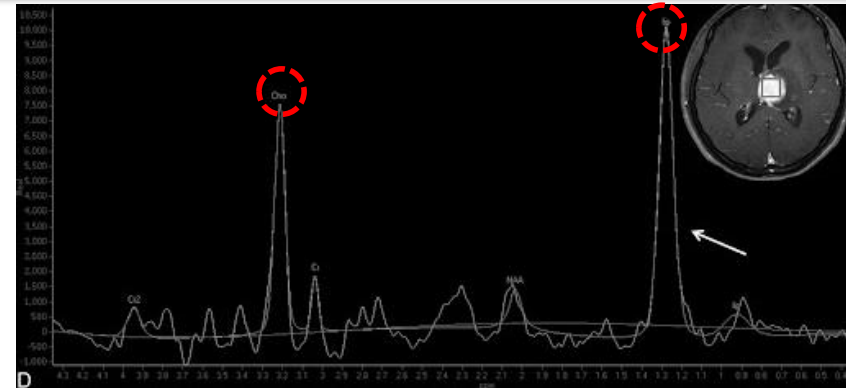
Ocular involvement in cerebral lymphoma



Brain lymphoma: diagnosis & treatment

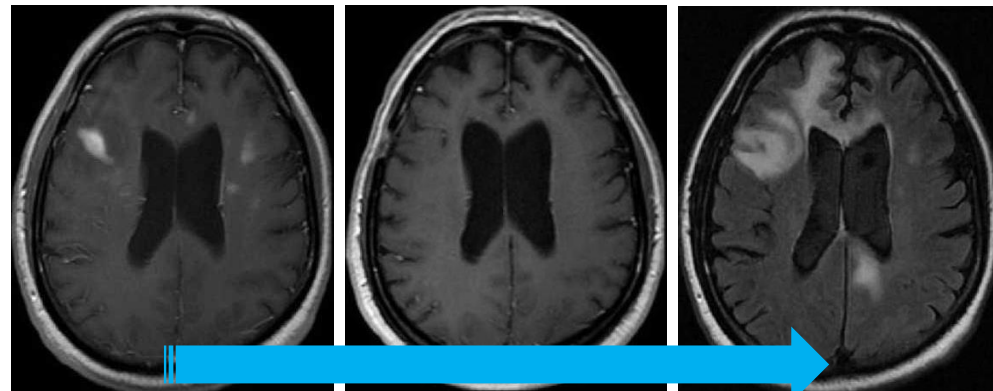
• Diagnosis

- MRI unspecific patterns
 - Spectroscopy \uparrow Cho & $\uparrow\uparrow$ Lip/Lac
- Stereotaxic brain biopsy a MUST
- Bone marrow biopsy to see involvement



• Treatment

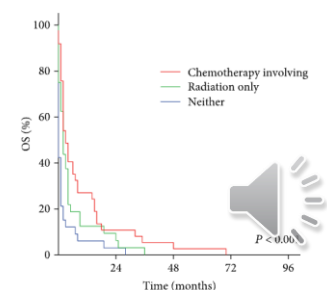
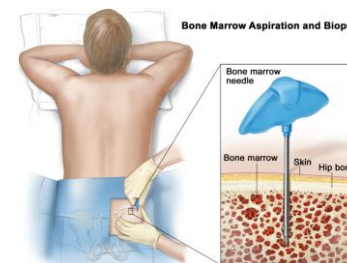
- Corticosteroids = rapid but temporary response
 - Not before biopsy for $\uparrow\uparrow$ false negatives



Effect corticosteroid treatment

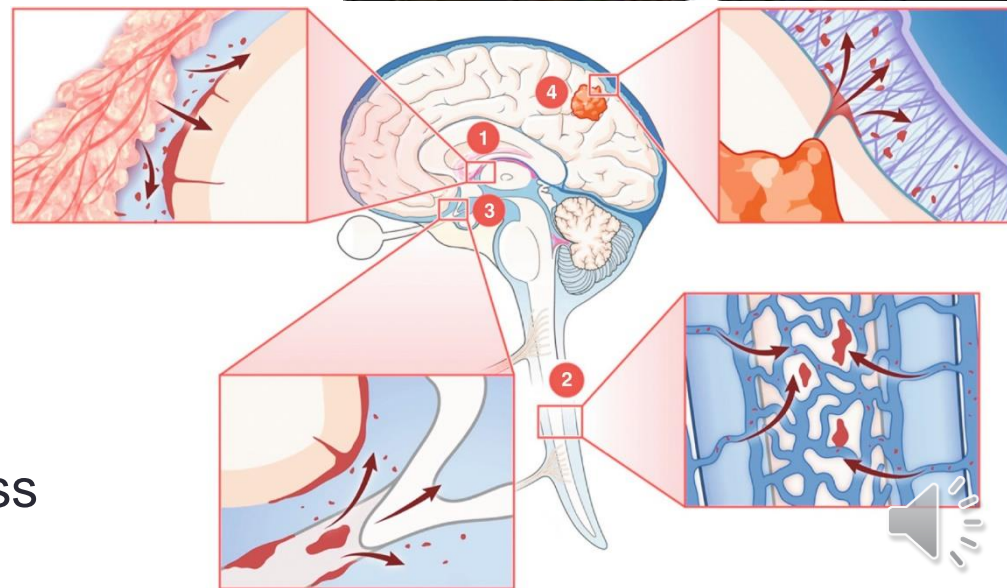
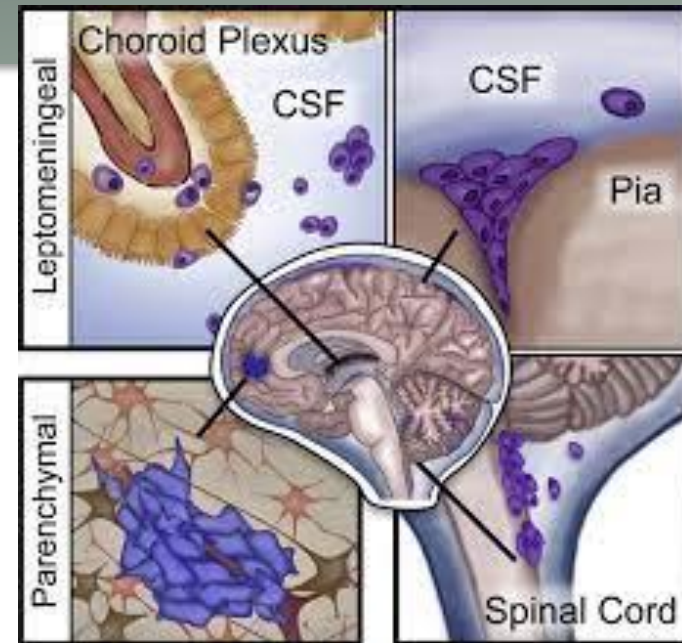
• Survival

- \emptyset treatment 1-3 months
- Surgical removal 1-4 months
- 30-50 grey whole cranial radiation therapy 12-18 months
- Chemotherapy + whole cranial radiotherapy 40-60 months



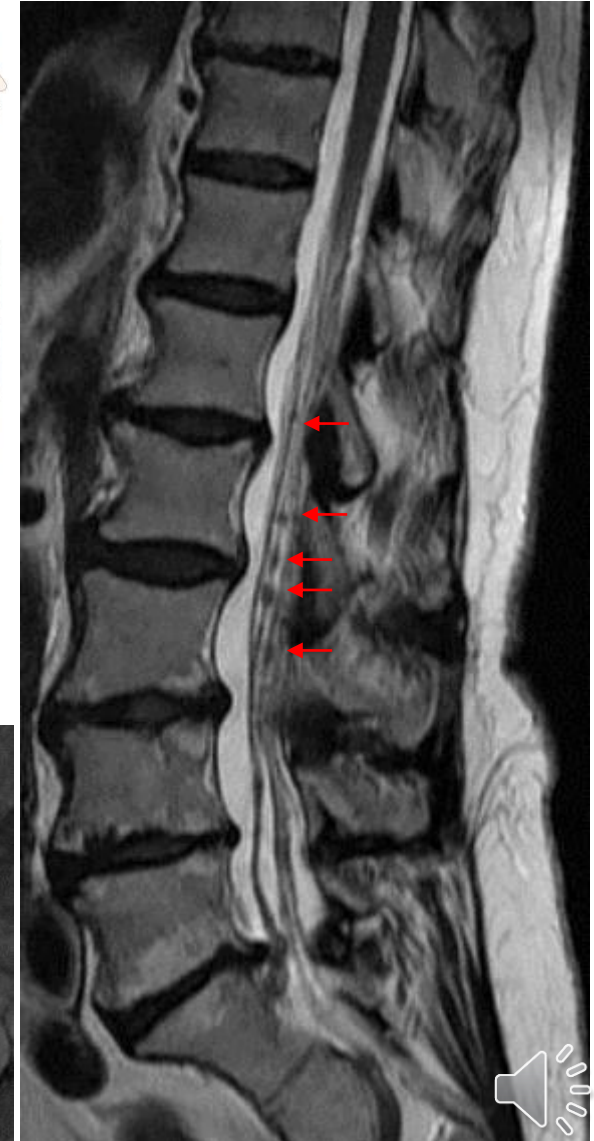
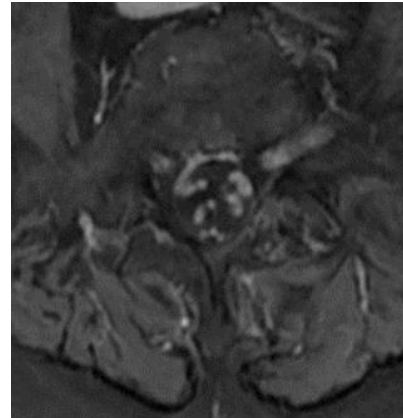
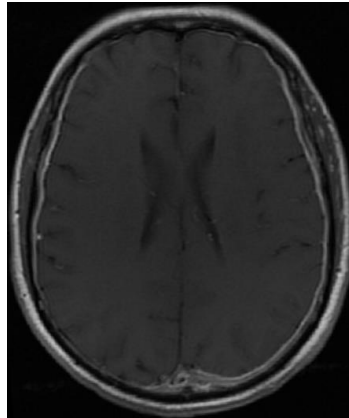
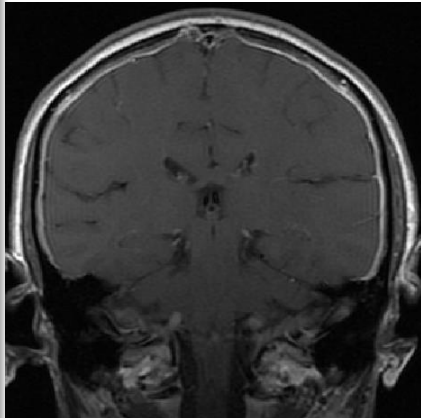
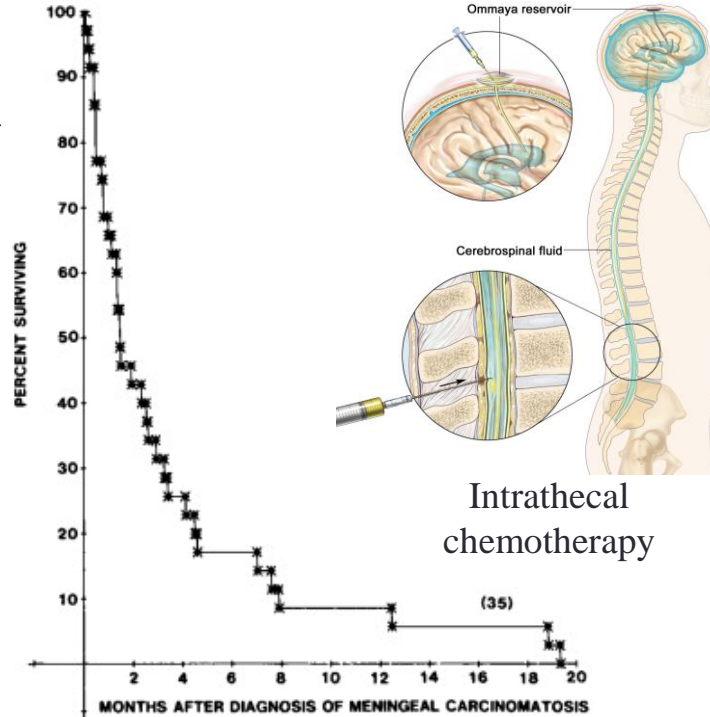
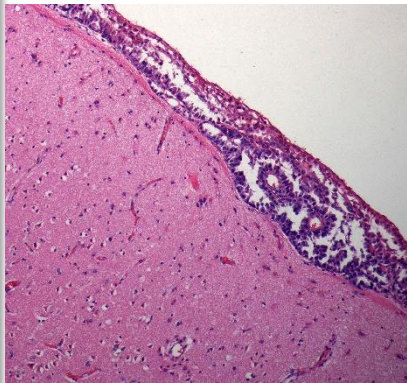
MENINGEAL CARCINOMATOSIS

- Origin: tumour cells lining dura mater
 - Intracranial tumour metastasizing from CSF
 - Ependymoma, medulloblastoma, post-surgery in 14% malignant gliomas
 - Extracranial tumour that grows retrogradely through nerves and nerve roots
 - Parotid gland tumour
- Clinical features
 - Behavioural changes
 - Hydrocephalus
 - Altered level of consciousness



Meningeal carcinomatosis

- Diagnosis = MRI
- Treatment radio & intrathecal chemotherapy
- Dismal prognosis



Questions?



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