

Neuroradiology Brain

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Basic brain lesions

- Trauma
- Stroke
- Tumor
- Metabolic & degenerative diseases
- Infections
- Congenital anomalies

Head trauma

- Primary damage
 - Basic impact during injury
 - Contusions
 - Hematomas (parenchymal, epidural, subdural, subarachnoid)
 - Axonal and vascular damage
- Secondary damage
 - Late sequelae of injury
 - Increased intracranial pressure
 - Cerebral edema,
 - Infection,
 - Trauma,
 - Postoperative hypoxia and infarction

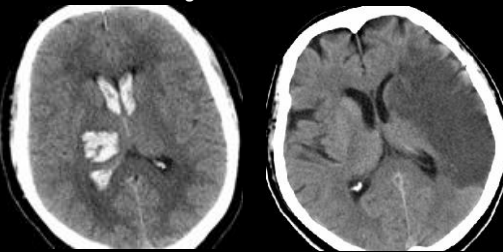
Head trauma- CT

- Probable positive CT
 - Vomiting, severe headache
 - Seizure
 - Patients over age 60
 - Alcohol or drug intoxication
 - Whiplash injury
 - Coagulation disorders
- Probable negative CT
 - Some anatomic regions
 - Infratemporal region
 - Subfrontal region
 - Posterior fossa
 - Diffuse axonal / vascular injury

Head trauma- CT

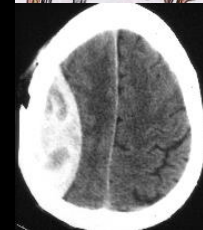
White = Hemorrhage

Black = Infarct



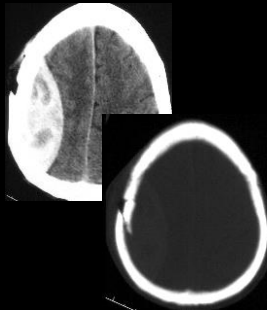
Epidural hematoma

- Bleeding into the space between the dura and internal tabula of skull
- Rupture of a/v MM due to T bone fracture
- No fx in children due to elasticity of the skull



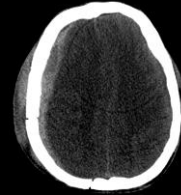
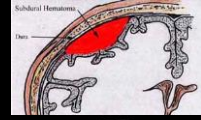
Epidural hematoma

- Convex shape is typical
- In the acute stage of low-density areas (swirl sign)
- Do not cross the sutures
- In chronic stage its density drops and can become concave



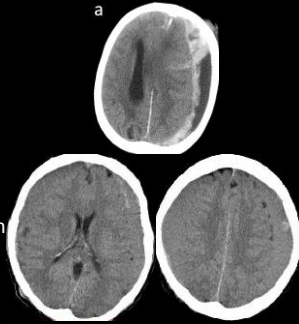
Subdural hematoma

- Bleeding into the space between the dura and pia / arachnoid membrane
- Traumatic rupture subdural bridging veins
- Accompanied brain damage increase the mortality upto 50%

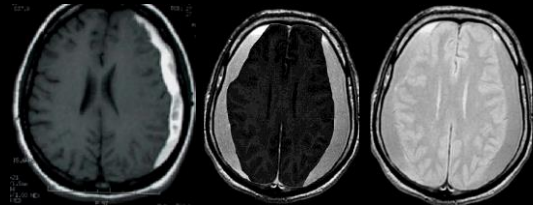


Subdural hematoma

- CT findings
 - Concave in shape
 - Hyperdense
 - Can cross the sutures
 - "swirl" sign
- Bilateral isodense subdural hematomas can be easily missed on CT

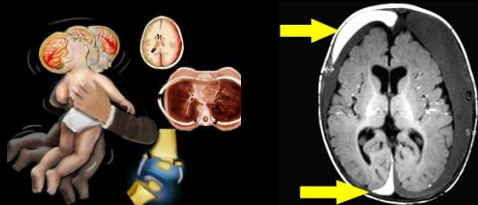


Subdural hematoma



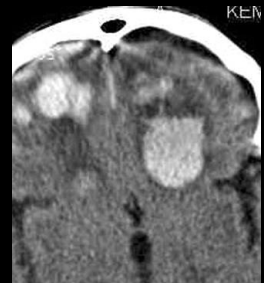
Subdural hematoma

- Changing phases of the SDH in a baby / child could be evidence of the "battered child / child abuse"

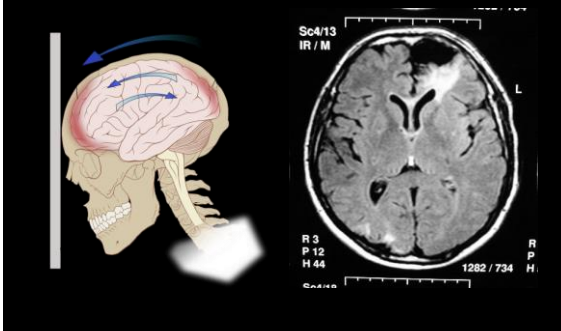


Hemorrhagic contusion

- Parenchymal damage leading to hemorrhage
- Generally in the cortex but may extend to white matter
- It can be drained into subdural or subarachnoid spaces
- Peripheral edema

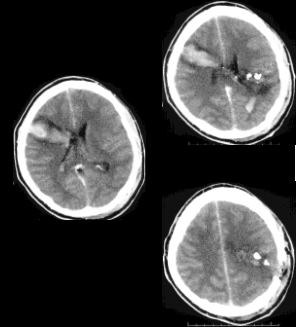


Coup & Contrecoup injury



Penetrating injuries

- CT findings
 - Bone damage
 - Metallic foreign bodies, fragments
 - Bleeding (EDH, SDH, SAH)
 - Hemorrhagic tract
 - Air
 - Vascular injury (ischemia, infarction, rupture, dissection ..)

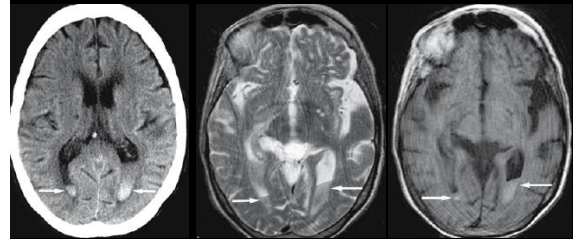


Subarachnoid hemorrhage

- Bleeding into the space between the arachnoid and pia
- 50% -70% as a result of aneurysm rupture
- Other reasons
 - Trauma
 - Hemorrhagic tumor
 - AVM
 - Bleeding diathesis
- May be focal or diffuse

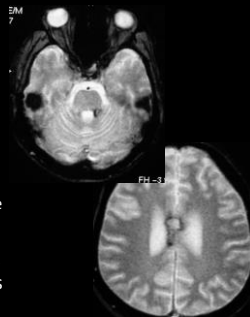


Intraventricular hemorrhage



Diffuse axonal injury

- Commonly seen in
 - Gray / white matter junction
 - Corpus callosum (most commonly splenium)
 - Brainstem (poor prognosis)
 - The internal capsule
 - Superior cerebellar peduncle
- CT is not sensitive
 - The majority of the lesions are not hemorrhagic
- T2-weighted gradient echo sequences (or susceptibility-weighted sequences, such as SWI) are the most sensitive methods

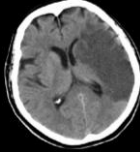


Stroke

- Stroke is a sudden deterioration in brain function due to disruption in arterial supply
- A sudden decrease in the nutrient medium providing cell viability
- Cell death (infarction) is a more complex event and occurs due to amount of ischemia
- It occurs in about 20 min when cerebral blood flow ≤ 20 ml/100 g brain/min.

Types of stroke

- Ischemic (80%)
 - Thromboembolism (AS / cardiac)
 - Global hypoxic injury
 - Vasculitis
 - Hypercoagulation
- Hemorrhagic (20%)
 - Hypertension
 - Aneurysm / AVM
 - Trauma



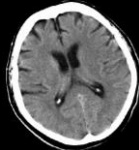
Goal of imaging

- Exclude hemorrhage
- Differentiate between irreversibly affected brain tissue and reversibly impaired tissue (dead tissue versus tissue at risk)
- Identify stenosis or occlusion of major extra- and intracranial arteries



CT findings

- Looks normal during first 24 h
- Hypodens brain tissue
- Decrease in GM/WM interface
- Dense MCA sign
- Insular ribbon sign
- Loss of sulcal effacement



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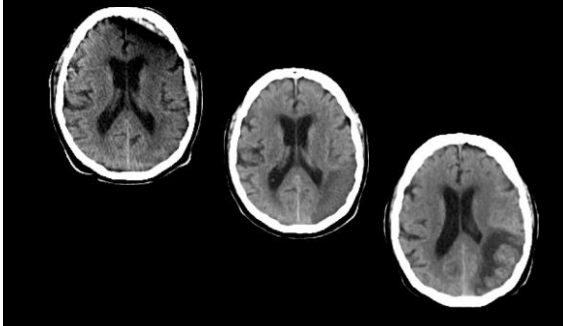


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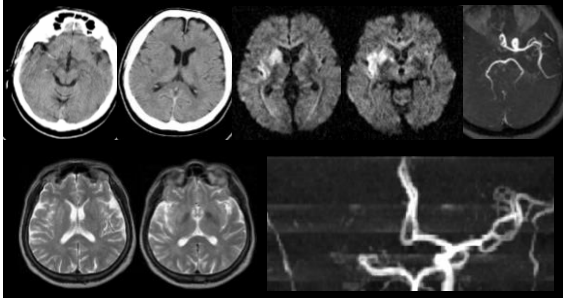
Hemorrhagic transformation



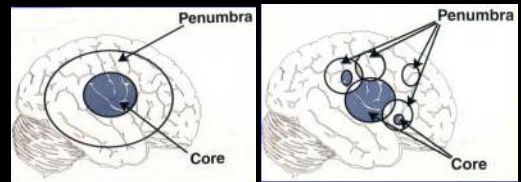
CT perfusion



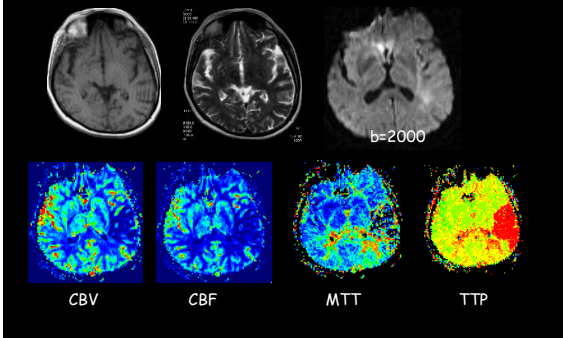
Acute infarction



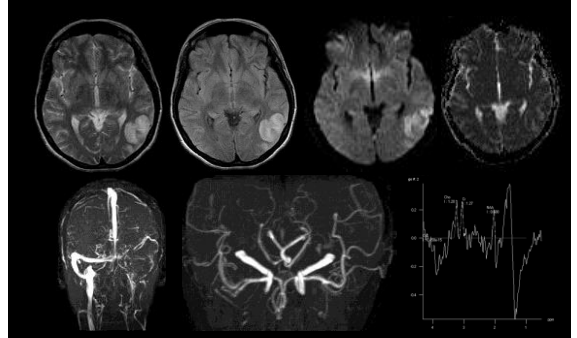
Simple / Complex Penumbra



DWI PWI mismatch



Venous infarction

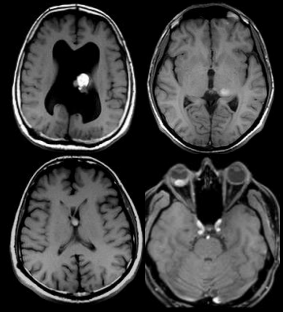


Brain tumors

- To determine the lesion
- To reveal location, propagation and interaction of the lesion
- Make the differential diagnosis
- To guide interventional procedures
- To guide treatment planning
- Evaluate the response to treatment
- Patient's age, sex, and clinic
- Number of lesions
- Location (intra / extra-axial)
- Location within neuroaxis (GM, WM, PV, BS)
- T1 and T2 signal intensity
- Existence, degree, type of opacification
- Hemorrhage, calcification, necrosis
- DWI, DTI, PWI and MRS findings

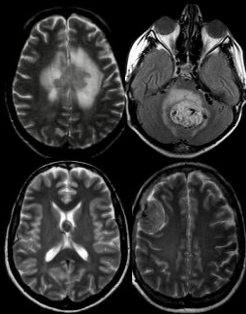
T1 hyperintensity

- Paramagnetic effect
 - Late subacute hemorrhage (methb)
 - Melanin / free radicals
 - Fe, Mn, Cu ions
- Non-paramagnetic effect
 - Increased protein content
 - Oil
 - Flow related enhancement



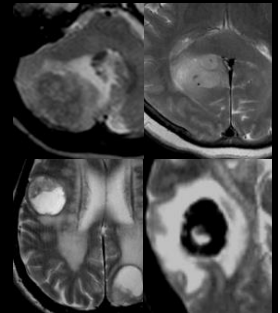
T2 hypointensity

- Paramagnetic effect
 - Dystrophic calcification
 - Fe deposition
 - Hemosiderin / deohb / intracellular methb
 - Melanin / free radical
 - Increased protein content
- Fibrocollagenous tissue
- Increased nucleus / cytoplasm ratio
- Signal void due to blood flow



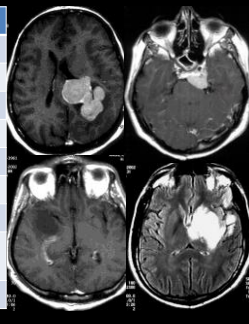
T2 hypointensity

- Increased nucleus / cytoplasm ratio
 - Undifferentiated round cell tumor
 - Medulloblastoma
 - Pineoblastoma
 - Neuroblastoma
 - Lymphoma
 - Mucinous adenoca. metastasis
 - Amelanotic melanoma
 - High-grade glioma



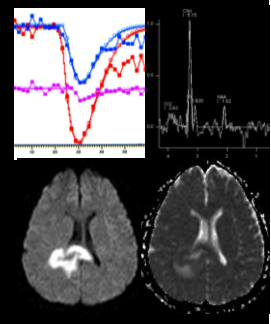
Benign / Malign

Findings	Benign	Malign
Contour	Well defined	Ill defined
Structure	Homogeneous	Heterogeneous
Contrast	-/+	+
Edema	-/+	+ /++ /+++
Mass effect	-/+	+ /++ /+++
Necrosis	-	+
Bleeding	-	+
Border	Thin regular	Thick irregular
Calcification	-/+	-/+



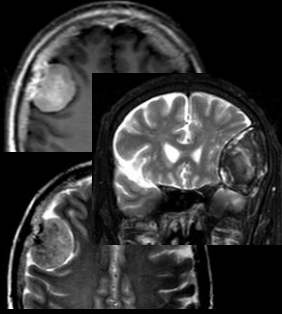
By increased malignancy

- ADC ↓
- rCBV ↑
- Permiability ↑
- Cho/Cr ↑, NAA/Cr ↓
- Laktat appears
- ml (Grade II tumor)



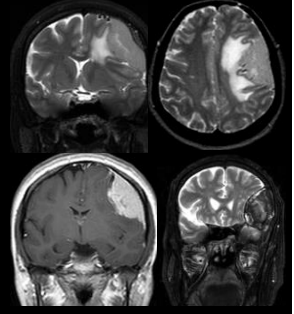
Extra-axial location

- Existence of CSF cleft, vascular structures or dura between the mass and the brain
- Presence of GM between the mass and WM



Extra-axial location

- Suggestive findings
 - Peripheral settlement
 - Dural based lesion
 - Changes in the adjacent bone
 - Opacification in the adjacent meninges

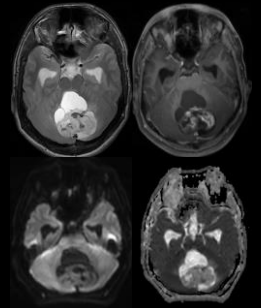


WHO 2007 classification

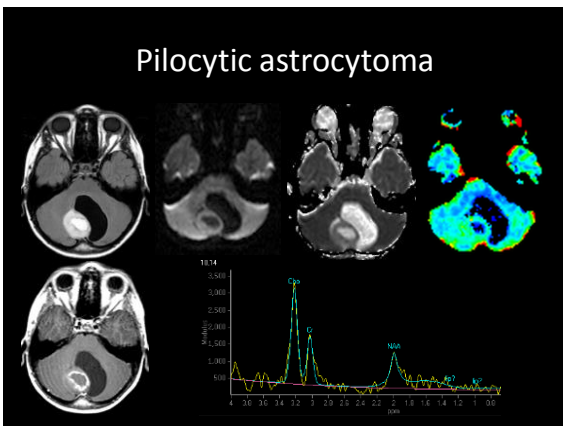
- Neuroepithelial tumors
 - Astrocytic tumors
 - Oligodendroglial tumors
 - Oligoastrocytic tumors
 - Ependymal tumors
 - Choroid plexus tumors
 - Other epithelial tumors
 - Neuronal & mixed neuronal-glia tumors
 - Pineal region tumors
 - Embryonic tumors
- Tumors of the meninges
 - Meningothelial cell tumors
 - Primary melanocytic lesions
 - Mesenchymal tumors
 - Other tumors,
- Lymphoma and hematopoietic tumors
- Germ cell tumors
- Peripheral nerve tumors
- Sellar region tumors
- Metastatic tumors

Pilocytic astrocytoma

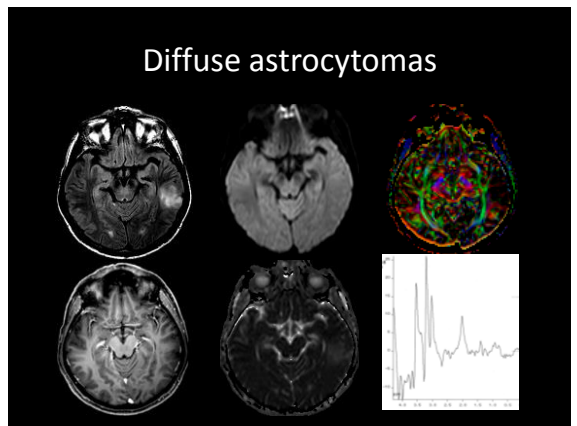
- 90-98% of juvenile
- 2-10% of adults
- Cerebellar (<10 years)
- Hypothalamic-chiasmatic (> 12 years)
- Hemispheric (> 20 years)
- Well-circumscribed, lobular
- Solid / cystic
- Edema and calc. (-)
- MRS like advanced tumors



Pilocytic astrocytoma

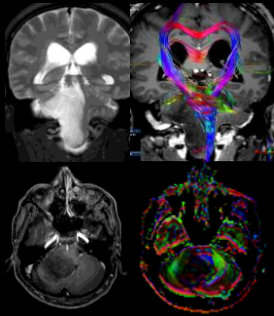


Diffuse astrocytomas



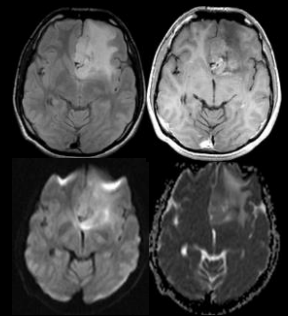
Brain stem glioma

- Constitutes 10 to 15% of pediatric tumors
- Most of stage II & fibrillary type
- Diffuse enlargement of the brain stem
- T2W hyperintense
- C (-), bleeding
- C (+) anaplasia?



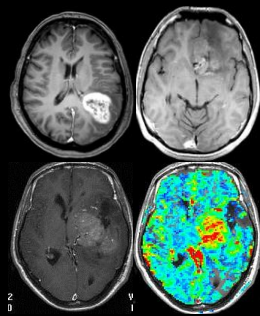
Anaplastic astrocytoma

- 10% of brain tumor
- 75% developed from LGGT
- 40-50 years
- White matter
- Infiltrating
- Poor prognosis
 - 5 years 20%
 - 2-3 year all



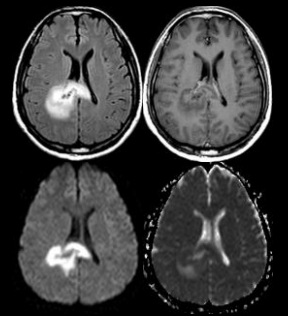
Anaplastic astrocytoma

- 50-70% C (+)
 - Focal / patchy
 - Nodular
 - Annular
 - Infiltrating
- MRS and PWI
 - Biopsy guidance
- DTI
 - Infiltration



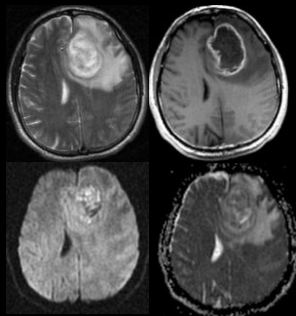
Glioblastoma

- 15-20% of brain tumors
- 65-75% astrocytoma
 - 95% primary
 - 5% secondary
- White matter (F, T, P), bihemispheric (CC) involvement
- Synchronous-metachronous
 - Multifocal
 - Multicentric

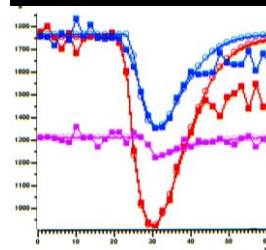


Glioblastom

- 5% 5-year survival
- <1 year all
- "Brain to brain"
- Infiltrating
- Tumoral edema
- Cyst / necrosis often
- Thick irregular C (+)
- Often bleeds
- Calcification is rare

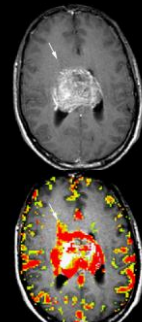


Glioblastom



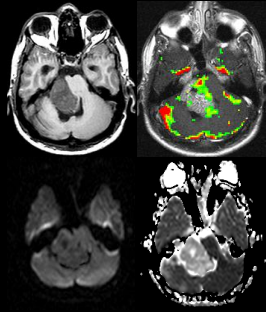
rCBV₁= 6,58
rCBV_{PT}= 2,21

Balakbasi N, et al. AJNR 2005 ;26:2187-2199



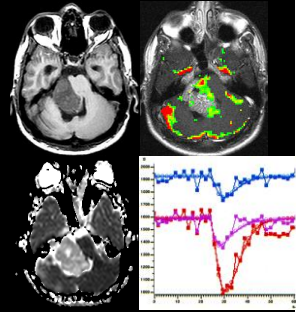
Ependimom

- 10% of pediatric ICT
- 60-70% of infratentorial
 - 4th ventricle
- 30-40% supratentorial
 - Hemisphere > Ventricular
- Dual peak
 - 1-5 years
 - 20-30 years
- Hydrocephalus



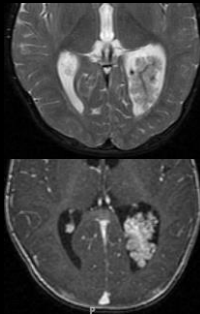
Ependimom

- Extension into foramen and cistern
- Periventricular infiltration
- Heterogeneity
- Punctate calcification (50%)
- Partially cystic
- Bleeding (10%)
- C(+)
- DWI: normal / restricted
- PWI: Increased rCBV
- Subarachnoid seeding 5%



Choroid plexus papilloma

- 75% <2 years
- 85% <5 years
- Adult
 - 4th and lateral ventricles
- Child
 - Trigon >> 3rd ventricle
- 25% calcification
- Intratumoral hemorrhage
- Vascular signal void
- Homogeneous C (+)



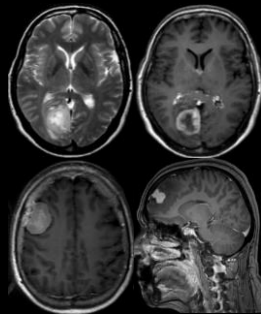
Vestibular schwannoma

- Cystic degeneration > bleeding > necrosis
- Intens (Antoni A) and loose (Antoni B) areas
- 80% of IAC involvement
- Small section (cone) in IAC, large portions (ice cream)
- CSF space
- T1 hypo / isointense, T2 hyperintense, intens C +

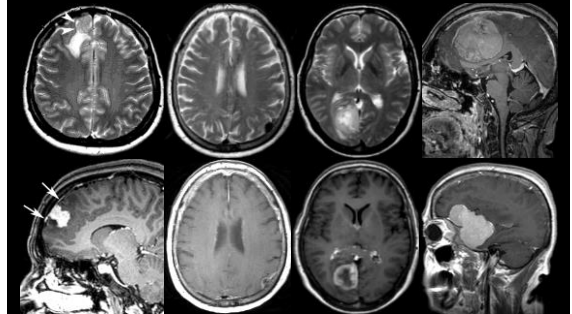


Meningioma

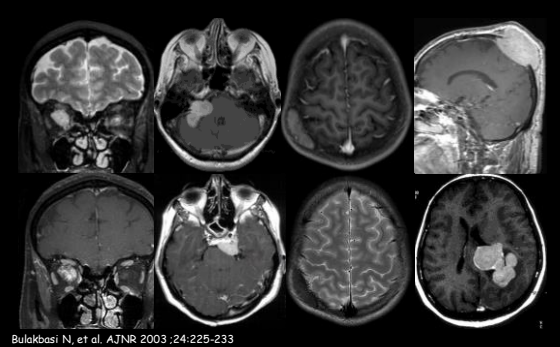
- 90% supratentorial
- 10% infratentorial
- Well demarcated
- Homogeneous internal structure
- Homogeneous C +
- Edema ±
- Mass effect +
- Necrosis ±
- Tail sign



Meningioma



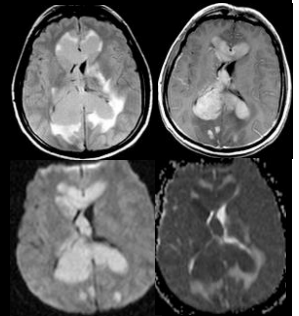
Meningioma



Bulakbasi N, et al. AJNR 2003;24:225-233

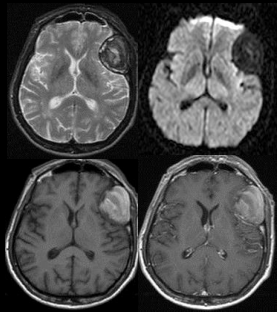
CNS Lymphoma

- Most non-Hodgkin's
- 2/3 solitary
- 1/3 multiple
- Periventricular WM / BG
- Irregular contour
- Intens C (+)
- Restricts diffusion

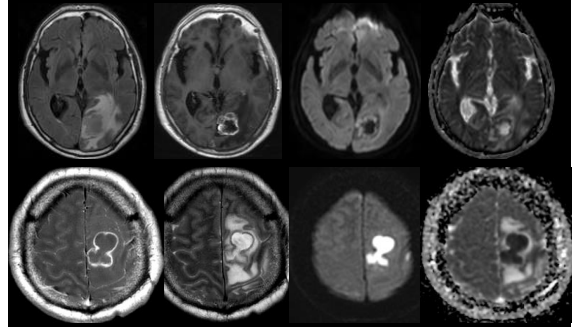


Metastasis

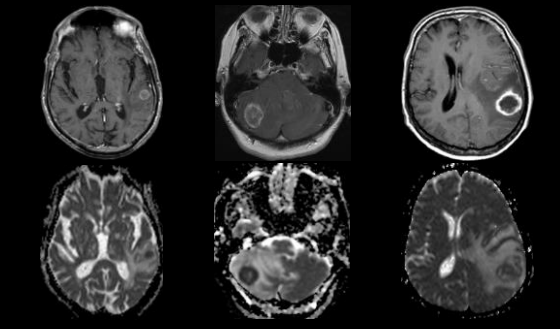
- Well-circumscribed, round
- Solid / annular C +
- Peripheral edema
- Number
 - 50% of solitary
 - 2 lesions 20%
 - 30% > 2 lesions
- Location
 - Bone
 - Dural / leptomeningeal
 - Parenchymal



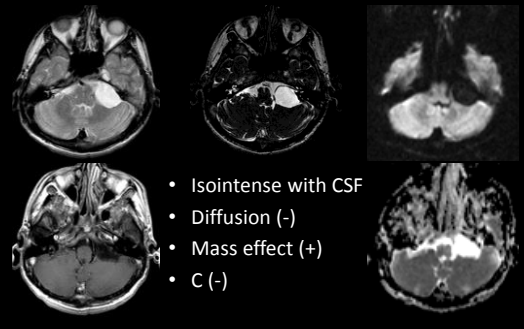
Metastasis v.s. Abscess



Metastasis

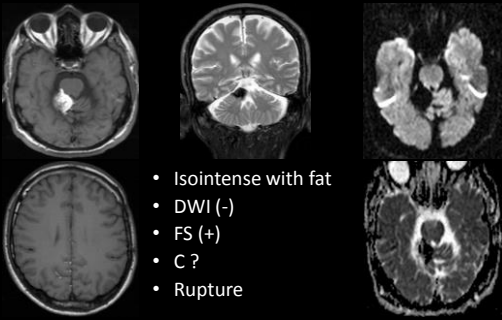


Arachnoid cyst



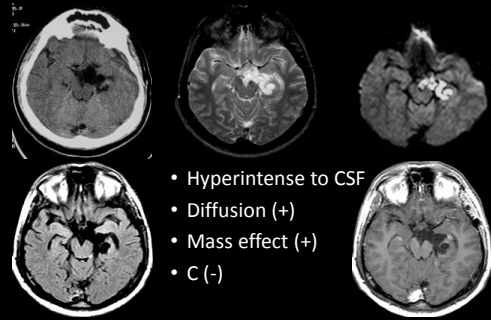
- Isointense with CSF
- Diffusion (-)
- Mass effect (+)
- C (-)

Dermoid



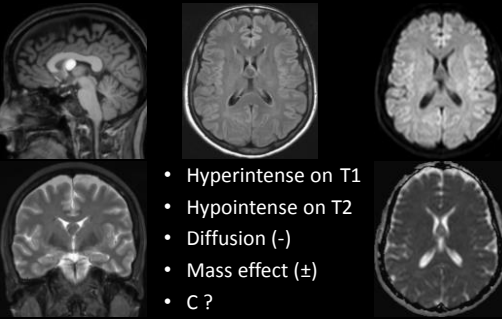
- Isointense with fat
- DWI (-)
- FS (+)
- C ?
- Rupture

Epidermoid



- Hyperintense to CSF
- Diffusion (+)
- Mass effect (+)
- C (-)

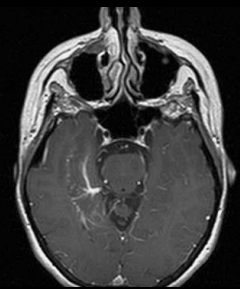
Colloid cyst



- Hyperintense on T1
- Hypointense on T2
- Diffusion (-)
- Mass effect (±)
- C ?

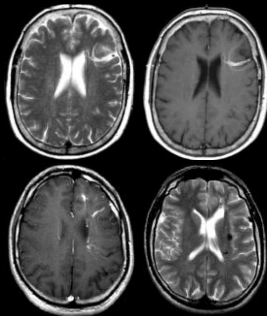
Developmental venous anomaly

- Most common cause of malformation (60%)
- Frontal > parietal = cerebellum
- GVA ≠ venous angioma
- Angioma is a pathological lesion with high risk of bleeding
- Non-pathological, embryological variant of venous drainage



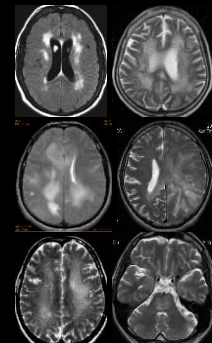
Developmental venous anomaly

- Medusa's head
 - Dilated medullary veins
 - Stellate, tubular vessels converge on collector vein
- Concomitant lesion
 - Cavernoma



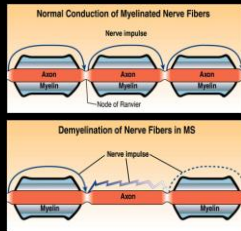
White matter diseases

- Demyelinating disorders:
 - Dysfunction of oligodendrocytes
 - Mostly congenital and metabolic
- Demyelinating diseases:
 - Destruction of myelin
 - Multiple sclerosis and secondary demyelination



Multiple sclerosis

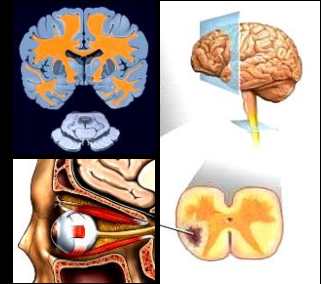
- F>M (2:1)
- 70% 20-40, % 10 > 50
- Etiology
 - Autoimmune, viral, genetic, environmental, vascular
- Variants
 - Classic shape (Charcot type)
 - Acute (Marburg type)
 - Neuromyelitis optica (Devic's disease)
 - Concentric sclerosis (Baló disease)
 - Diffuse cerebral sclerosis (Schilder's type)



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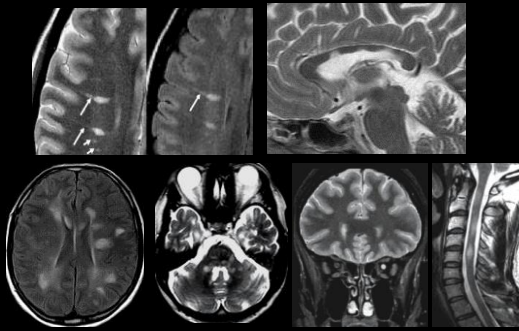
Multiple sclerosis

- Involves
 - Brain
 - Spinal cord
 - Optic nerve
 - Vascular system



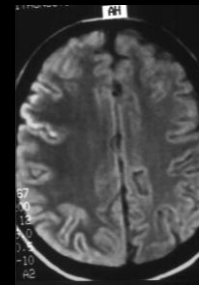
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Multiple sclerosis



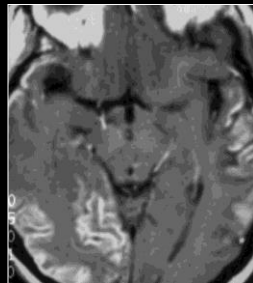
Meningitis

- Early phase
 - Normal / minimal hydrocephalus
 - Hyperintensity in sulcus and cisterns due to the inflammatory exudate
- Early and late phase:
 - Meningeal enhancement
 - Dural
 - Pia-arachnoidal



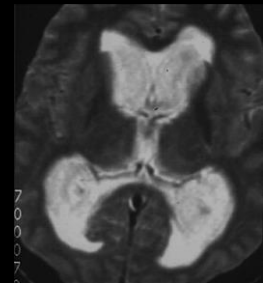
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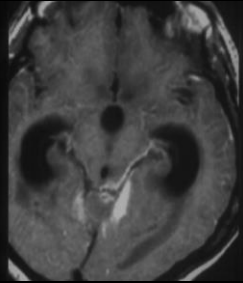
Complications of meningitis

- Hydrocephalus
- Ventriculitis / ependimit
- Subdural effusion
- Empyem
- Cerebritis / abscess
- Cerebral infarction
- Dural sinus / cortical vein thrombosis
- Venous infarction



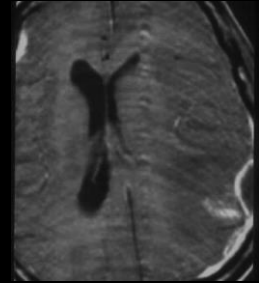
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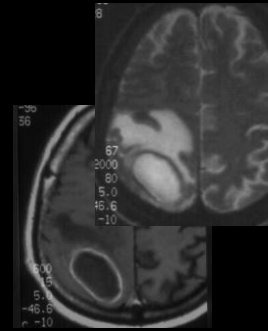
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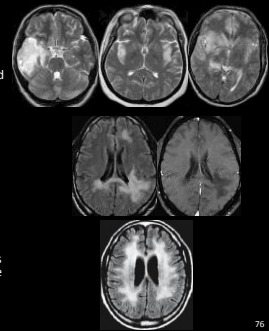
Abscess

- Stages
 - early serebritis
 - late serebritis
 - Early capsule formation
 - Late capsule formation
- Location
 - Corticomedullary junction (the most common)
 - Frontal & parietal lobes (more often)
 - Less than 15% in the posterior fossa
 - Multiple abscesses rare



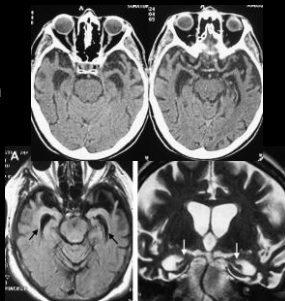
Viral encephalitis

- HSV
 - The most common cause of fatal sporadic encephalitis.
 - Hyperintensity in the temporal and inferior frontal lobes
 - Late period: gyral enhancement and hemorrhage
- PML
 - In immunodeficiency (AIDS, transplantation)
 - Papova viruses (JC virus)
 - bilaterally asymmetric T2-hyperintense lesions
 - Contrast (-), mass effect (-)
- HIV encephalitis
 - Diffuse hyperintense on T2 images and generalized atrophy and white matter changes



Alzheimer's disease

- Hippocampal and entorhinal cortex atrophy correlated with clinical findings
- Temporal lobe atrophy
 - Hypometabolism
 - CBV ↓
 - ADC ↑
 - NAA ↓, myo-inositol ↑



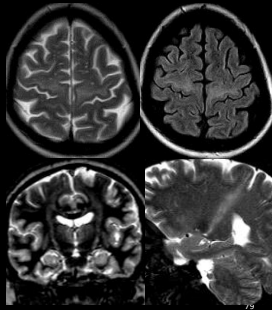
Parkinson's disease

- Loss of dopaminergic neurons in the substantia nigra pars compacta
- Neuroradiology: ddx
 - Multisystem atrophy
 - Secondary parkinsonism (vascular, hydrocephalus, tm)
- Reduction in the thickness of pars compacta (4 mm ↓)



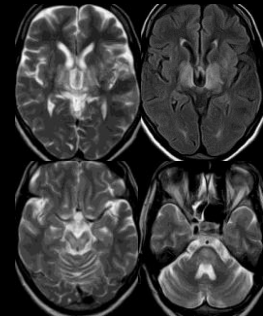
Amyotrophic lateral sclerosis

- The most common cause of degenerative motor disease
- Involves corticospinal tract and keeps 2nd motor neurons
- Death in 3-5 years
- T2 hyperintensity along the corticospinal tract
- Hypointense band in the prefrontal cortex



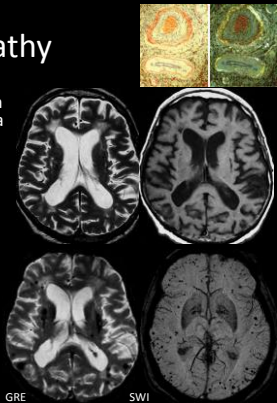
Wilson's disease

- Hepatolenticular degeneration
- Affects brain, liver, cornea, bone and kidney
- Spongiform degeneration
 - Putamen, caudate nucleus, thalamus, pontine mesencephalon, dentate nucleus

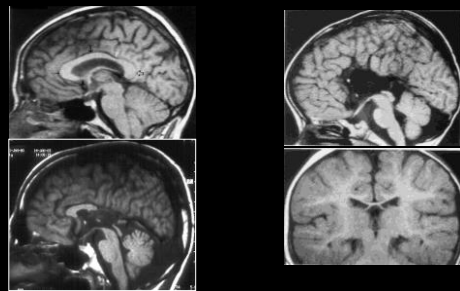


Amyloid angiopathy

- Beta-amyloid accumulation in the media and adventitia of vascular structure
- Involves cerebral cortex + leptomeninges
- Hemorrhagic episodes (40%)
- 60 A ↑ the most common cause of spontaneous hemorrhage
- CT / MRI haemorrhage different periods → multifocal T2 * GRE hypointensity



Anomalies of corpus callosum



Chiari I malformation and syringomyelia in spinal cord

