NEURORADIOLOGY

Reem Hasweh, MD
• Radiology overview
• Anatomy
• Hydrocephalus
• Hemorrhage
• Brain Calcifications
• Cerebral sinuses thrombosis
• Ischemia
• Neoplasms
• Skull Vault fractures
• Spine related disease
• Radiology overview
• Anatomy
• Hydrocephalus
• Hemorrhage
• Brain Calcifications
• Cerebral sinuses thrombosis
• Ischemia
• Neoplasms
• Skull Vault fractures
• Spine related disease
Radiology overview: Radiograph

Imaging modalities:
• Radiograph
• Ultrasound (US)
• Computed tomography (CT)
• Magnetic resonance imaging (MRI)
Radiology overview: Radiograph

Radiograph utilizes ionizing radiation
No Significant role in neuroimaging

Advantages:
• Rapid
• Cheap
• Detect skull fractures and sinuses disease
• Evaluate spine bony structures

Disadvantage
• Inability to evaluate the brain and spinal cord
• Not able to detect skull and spinous small fractures
Radiology overview: Radiograph

How finding are described on a radiograph?

• Radiolucent (Air, fat)
• Radio-opaque (bone)

What are the views?

• Frontal
• Lateral
• Additional views (Oblique for spine and open mouth for sinuses)
Radiology overview: Radiograph

Frontal radiograph of the skull
Radiology overview: Radiograph

Lateral radiograph of the skull
Radiology overview: Radiograph

Frontal and lateral cervical spine radiograph
Radiology overview: Radiograph

Frontal and lateral thoracic spine radiograph
Radiology overview: Radiograph

Frontal and lateral lumbar spine radiograph
Radiology overview: Ultrasound

It has a role in brain and spine imaging in pediatric age group (Infants) not adults.

It plays a role in neck imaging to evaluate the thyroid, cervical lymph nodes, and masses.

How findings are described in ultrasound?

• Hyperechoic=echogenic (Fat)
• Hypoechoic
• Isoechoic
• Non echoic (Fluid)
Radiology overview: Ultrasound
Radiology overview: CT

• CT is a diagnostic imaging procedure that uses x-rays (ionizing radiation) to build cross-sectional images ("slices") of the body.

• CT depends on the density of the tissue passed by the x-ray beam, can be measured from the calculation of the attenuation coefficient.
Radiology overview: CT
Radiology overview: CT
Scout image: From vertex to skull base
Radiology overview: CT

• How findings are described in CT?
  • Hypodense (Low attenuation)
  • Hyperdense (High attenuation)
  • Isodense

CT density

<table>
<thead>
<tr>
<th>Structure/Tissue</th>
<th>Hounsfield units</th>
</tr>
</thead>
<tbody>
<tr>
<td>Air</td>
<td>-1000 to -600</td>
</tr>
<tr>
<td>Fat</td>
<td>-100 to -60</td>
</tr>
<tr>
<td>Water</td>
<td>0</td>
</tr>
<tr>
<td>CSF</td>
<td>+8 to 18</td>
</tr>
<tr>
<td>White matter</td>
<td>+30 to 41</td>
</tr>
<tr>
<td>Gray matter</td>
<td>+37 to 41</td>
</tr>
<tr>
<td>Acute blood</td>
<td>+50 to 100</td>
</tr>
<tr>
<td>Calcification</td>
<td>+140 to 200</td>
</tr>
<tr>
<td>Bone</td>
<td>+600 to 2000</td>
</tr>
</tbody>
</table>
Radiology overview: CT

What are the projections (planes)?

• Coronal
• Sagittal
• Axial

• These images are taken once then images are reconstructed by the machine to produce 3 or more different planes.
  • Window can be changed to soft tissue, bone, and lung window
Radiology overview: CT

Advantages:
• Quick (takes seconds)
• Price is less than MRI but still more expensive than radiograph and ultrasound
• Good resolution
• Best for bone and calcified lesions

Disadvantages:
• Utilizes ionizing radiation
• Not good for posterior fossa and white matter disease
## Radiology overview: CT

<table>
<thead>
<tr>
<th>What appears hyperdense (bright) on CT?</th>
<th>What appears hypodense on CT (dark)?</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Acute blood</td>
<td>• Fluid</td>
</tr>
<tr>
<td>• Calcification</td>
<td>• CSF</td>
</tr>
<tr>
<td>• High grade tumors</td>
<td>• Air</td>
</tr>
<tr>
<td>• Contrast</td>
<td>• Fat</td>
</tr>
<tr>
<td>• Bone</td>
<td>• Chronic blood</td>
</tr>
<tr>
<td>• Metal foreign body</td>
<td>• White matter darker than grey matter</td>
</tr>
</tbody>
</table>
Radiology overview: CT

Hyperdense things on CT

- Ocular lens
- Bone
- Contrast (dye)
- Calcifications
- Acute blood
- Metal (bullets w/ streak artifact)
Radiology overview: CT

Hypodense things on CT

fat
air
CSF (water)
Radiology overview: CT
Radiology overview: CT
Axial head
Radiology overview: CT
Axial CT brain and bone window
Radiology overview: CT
Sagittal head
Radiology overview: CT
Coronal head
Radiology overview: CT
Cervical spine sagittal bone window
Radiology overview: CT
Coronal CT spine with bone window
Radiology overview: CT
Axial CT spine with bone window
Radiology overview: MRI

MRI is an imaging modality that does not use ionizing radiation to create useful diagnostic images. MRI scanner consists of a large, powerful magnet in which the patient lies.

Advantages:
• Superior soft tissue contrast
• Multiplanar imaging (Axial, Coronal, and sagittal)
• No ionization radiation

Disadvantages:
• Images take longer time (minutes to an hour)
• Expensive
• Not safe for patients with metal implants or foreign bodies
Radiology overview: MRI
Radiology overview: MRI

MR has advantage of multi planar imaging
Radiology overview: MRI
Axial brain
Radiology overview: MRI
Sagittal brain
Radiology overview: MRI
Coronal brain
Radiology overview: MRI
Axial spine
Radiology overview: MRI
Sagittal spine
Radiology overview: MRI
Coronal spine
Radiology overview: MRI

Sequences used in MRI:
• T1 (with or without contrast)
• T2
• FLAIR
• Fat Sat
• Gradient echo
• Diffusion weighted images/ ADC map
• Flow sensitive sequences (MR angiography, MR venography)
Radiology overview: MRI

How findings are described in MRI (signal intensity)?

• Hypointense (low signal)
• Hyperintense (High signal)
• Isointense

<table>
<thead>
<tr>
<th>MR signal</th>
<th>High signal (bright)</th>
<th>Low signal (dark)</th>
</tr>
</thead>
<tbody>
<tr>
<td>T1</td>
<td>Fat, melanin, blood</td>
<td>Iron</td>
</tr>
<tr>
<td></td>
<td>(methemoglobin)</td>
<td>Water</td>
</tr>
<tr>
<td></td>
<td>Proteinaceous fluid</td>
<td>Air</td>
</tr>
<tr>
<td></td>
<td>Paramagnetic substances</td>
<td>Bone, collagen</td>
</tr>
<tr>
<td></td>
<td>(manganese, copper)</td>
<td>Most tumors</td>
</tr>
<tr>
<td></td>
<td>Chelated gadolinium contrast</td>
<td></td>
</tr>
<tr>
<td>T2</td>
<td>Water</td>
<td>Air</td>
</tr>
<tr>
<td></td>
<td>Edema</td>
<td>Bone</td>
</tr>
<tr>
<td></td>
<td>Fat</td>
<td>Chronic blood/hemosiderin</td>
</tr>
<tr>
<td></td>
<td>Blood</td>
<td>Acute blood (intracellular</td>
</tr>
<tr>
<td></td>
<td>Most tumors</td>
<td>deoxyhemoglobin)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Early subacute blood</td>
</tr>
<tr>
<td></td>
<td></td>
<td>(methemoglobin)</td>
</tr>
</tbody>
</table>
Radiology overview: MRI

Signal intensity

• Fluid (Bright on T2 and dark on T1)
• Fat (Bright on T1 and T2)
• Bone (Dark on T1 and T2)
• Blood (Depends on the stage of bleeding)
• Soft tissue (Variables depending on the content)
Radiology overview: MRI

Brain sequences:

- **T1**: Scalp (hyperintense), skull vault (Hypointense), Grey matter (Hypointense), white matter(iso-hyperintense), CSF (Hypointense)

- **T2**: Scalp (hyperintense), skull vault (Hypointense), Grey matter (Iso-hypo intense), white matter(hypointense), CSF (Hyperintense)

- **FLAIR**: Scalp (hyperintense), skull vault (Hypointense), Grey matter (Iso-hypo intense), white matter(hypointense), CSF (Hypointense)

- **Diffusion weighted images (DWI) and ADC**: Acute infarction, subacute blood, abscess, high grade tumors, epidermoid, post ictal state (High signal on DWI and low signal on ADC)

- **Gradient echo sequences and susceptibility sequence**: Blood and calcifications (dark)

- **Contrast enhanced sequence**: lesion with contrast enhanced homogenously or heterogeneously.
Radiology overview: MRI
Radiology overview: MRI

T1 follows anatomy, grey is grey and white is white
Radiology overview: MRI

T2

T2 is opposite to T1
FLAIR is similar to T2 but CSF is dark
Radiology overview: MRI
DWI and ADC (Restricted diffusion and hypointense signal on ADC map),
dx: Acute bi-occipital and left thalamic infarction
Radiology overview: MRI
MRI with contrast

Meningioma before and after contrast

Shown here is a meningioma. While in this case, the mass is well seen even prior to contrast, it still is isodense to brain. Often, a mass cannot be well seen until it enhances with gad. This gives clues as to the type of mass. Meningiomas tend to be uniformly brightly enhancing though they are benign tumors.
Radiology overview

Mention the **body part**, **study**, **side** (Right/left), **plane** (axial/coronal/sagittal), **Signal intensity/attenuation** (Hypo/hyper/iso intense or dense), **sequence** (T1,T2, FLAIR if MRI ) and **contrast** if given
• Radiology overview
• **Anatomy**
• Hydrocephalus
• Hemorrhage
• Brain Calcifications
• Cerebral sinuses thrombosis
• Ischemia
• Neoplasms
• Skull Vault fractures
• Spine related disease
Anatomy

Head
• **Scalp**
• **Calvarium** Outer/inner tables and diploic space filled with fatty marrow
• **Brain**
• **Sinuses**

Spine
• **Cervical**
• **Thoracic**
• **Lumbar**
ANATOMY OF THE HEAD

Head

• Scalp
• **Calvarium** Outer/inner tables and diploic space filled with fatty marrow

• Brain
• Sinuses
Anatomy

Calvarium

Lateral view
Anatomy

Calvarium

Normal Skull of the Newborn

- Frontal bones
- Metopic suture
- Anterior fontanelle
- Coronal suture
- Sagittal suture
- Parietal bones
- Posterior fontanelle
- Occipital bone
- Lambdoid suture
Anatomy
Anatomy
Ventricles (CSF flow)
Normal Brain anatomy

- Eye
- Optic nerve
- Sphenoid bone
- Temporal lobe
- Sella turcica (contains pituitary gland)
- Petrous bone
- Mastoid air cells
- Pons
- 4th ventricle
- Cerebellum
Normal Brain Anatomy

- Frontal lobe
- Interhemispheric fissure
- Sylvian fissure
- Middle cerebral artery
- Temporal lobe
- Lateral ventricle (temporal horn)
- Suprasellar cistern
- Perimesencephalic cistern
- Midbrain
- Quadrigeminal plate cistern
- Cerebellum (vermis)
- Occipital lobe
Anatomy

CT brain

Normal Brain Anatomy

- Frontal lobe
- Lateral ventricle (frontal horn)
- Caudate nucleus (head)
- Sylvian fissure
- Insula (cortex)
- Lentiform nucleus
- Internal capsule (post. limb)
- Thalamus
- Pineal gland (calcified)
- Choroid plexus (calcified)
- Occipital lobe
Anatomy
Anatomy

Third ventricle
The third ventricle is located centrally. The lateral ventricles communicate with the third ventricle via small holes (foramina of Monro).
Anatomy

let's review another head CT to check the anatomy of the brain
First of six axial CECT images of cerebral hemispheres from inferior to superior shows interhemispheric fissure containing falx cerebri. Sylvian (lateral) fissure is seen separating frontal & temporal lobes.
This image shows frontal & temporal lobes & basal ganglia. Anterior limb of internal capsule separates caudate head from lentiform nucleus (putamen & globus pallidus). Posterior limb contains corticospinal tract & separates thalamus from lentiform nucleus.
More superior image shows parts of basal ganglia including caudate, putamen & globus pallidus. Anterior limb, genu & posterior limb of internal capsule are seen. Internal capsule is major projection fiber to & from cerebral cortex & it fans out to form the corona radiata. Thalamus borders third ventricle & is separated from basal ganglia by internal capsule.
Image more superior shows thalamus & internal cerebral veins at level of lateral ventricles. Falx cerebri is present within interhemispheric (great longitudinal) fissure. Occipital lobe is present posteriorly, just above tentorium cerebelli & contains primary visual cortex.
The corona radiata (centrum semiovale) is comprised of radial projection fibers from cortex to brainstem. Corona radiata is continuous with internal capsule inferiorly. Occipital lobe is not seen on this and higher scans.
Image at cerebral vertex shows central sulcus separating frontal from parietal lobes. Primary motor cortex is within frontal lobe precentral gyrus while primary somatosensory cortex is within parietal postcentral gyrus. Specific sulci & gyri are better resolved on MR imaging, although sylvian fissure & central sulcus are reliably found on CT imaging.
Anatomy

MRI Brain
Anatomy
MRI Brain
Anatomy

MRI Brain
Anatomy

MRI Brain
Anatomy
MRI Brain
Anatomy
MRI Brainstem Sagittal

Brain Stem..

Three parts from superior to inferior:
1 midbrain
2 pons
3 medulla oblongata

Connects cerebral hemispheres with spinal cord, and indirectly to cerebellum
ANATOMY

• let's review another brain MRI to check the anatomy of the brain
First of nine axial T1 MR images through cerebral hemispheres from inferior to superior shows inferior aspect of hemispheres. Occipital lobe is partially seen, superior to the sloping tentorium cerebelli. Uncus forms medial border of temporal lobe, merges posteriorly with parahippocampal gyrus.
Basal aspect of frontal lobes is formed by orbital gyri. Olfactory bulb/tract lies in/below olfactory sulcus. Hippocampus lies posterior & inferior to amygdala. Parahippocampal gyrus is separated from medial occipitotemporal (lingual or fusiform) gyrus by collateral sulcus.
Axial image at level of midbrain shows sylvian fissure separating frontal & temporal lobes. Insula lies deep to sylvian fissure covered by surrounding frontal, temporal & parietal operculae. Calcarine sulcus is surrounded by primary motor cortex in posterior occipital lobe.
More superior image at level of inferior basal ganglia shows anterior limb of internal capsule separating caudate head from lentiform nucleus. Anterior commissure is a major commissural fiber which is seen anterior to fornix in lamina terminales in anterior third ventricle. Anterior commissure connects anterior perforated substance & olfactory tracts anteriorly & temporal lobe, amygdala & stria terminales posteriorly.
This image shows basal ganglia & thalamus. Globus pallidus is hyperintense relative to putamen. Parietooccipital sulcus separates parietal & occipital lobes. Hippocampal tail is seen wrapping around midbrain & thalamus. External capsule lies between putamen & claustrum. Extreme capsule lies between claustrum & insula.
Image through superior basal ganglia shows supramarginal gyrus & angular gyrus of parietal lobe.
More superior image shows top of caudate nucleus body as it wraps around lateral ventricle. Parietooccipital sulcus on medial aspect of hemispheres separates parietal & occipital lobes.
Cerebral hemispheres are separated by interhemispheric (longitudinal) fissure which contains falx cerebri. Central sulcus separates frontal & parietal lobes. Corona radiata (centrum semiovale) is formed by fibers from all cortical areas in internal capsule fanning out into superior hemispheres.
Image more superior shows falx cerebri within interhemispheric fissure. Falx cerebri is a dural fold which contains superior sagittal sinus. Central sulcus separates frontal & parietal lobes & is typically identified on MR imaging. Often, the "hand knob" representing hand motor area of precentral gyrus can be identified.
Anatomy
Paranasal sinuses
Anatomy
Paranasal sinuses CT (coronal image)
Anatomy
Paranasal sinuses CT (coronal image)
Anatomy
Paranasal sinuses CT(sagittal image)
ANATOMY OF THE SPINE

Spine

• Cervical
• Thoracic
• Lumbar
Anatomy
Sagittal spine
Anatomy
Sagittal cervical spine
Anatomy
Sagittal thoracic spine
Anatomy
Sagittal lumbar spine
Anatomy
Axial spine CT
Anatomy
Sagittal spine MRI
Anatomy
Sagittal cervical spine MRI
Anatomy
Sagittal thoracic spine MRI
Anatomy
Sagittal lumbar spine MRI
• Radiology overview
• Anatomy
• Hydrocephalus
• Hemorrhage
• Brain Calcifications
• Cerebral sinuses thrombosis
• Ischemia
• Neoplasms
• Skull Vault fractures
• Spine related disease
Hydrocephalus

- Hydrocephalus (HC) means increase in the volume of CSF and thus of the cerebral ventricles (ventriculomegaly).

- **communicating** (i.e. CSF can exit the ventricular system)
  1. Subarachnoid hemorrhage
  2. Meningitis
  3. Meningeal Carcinomatosis
  4. Overproduction of CSF (Choroid plexus papilloma)

- **Non communicating**, due to masses obstructing
  1. Foramen of Monro
  2. Cerebral aqueduct
  3. 4\textsuperscript{TH} ventricle

Hydrocephalus ex vacuo (ventricles are enlarged due to loss of adjacent brain parenchyma ..... This is not true hydrocephalus
Hydrocephalus
Hydrocephalus
Hydrocephalus
Communicating HC

- communicating (i.e. CSF can exit the ventricular system)
  1. Subarachnoid hemorrhage
  2. Meningitis
  3. Meningeal Carcinomatosis
  4. Overproduction of CSF (Choroid plexus papilloma)
Hydrocephalus
Communicating HC (overproduction of CSF): Axial T1 C+ MR shows classic findings of a lobular, intensely enhancing choroid plexus tumor with associated hydrocephalus.
Hydrocephalus
Non communicating

- Non communicating, due to masses obstructing
  1. Foramen of Monro (e.g. Colloid cyst)
  2. Cerebral aqueduct (e.g. tectal plate glioma, pineal tumors).
  3. 4th ventricle
Hydrocephalus
Sites of obstruction non communicating hydrocephalus
Hydrocephalus
Non communicating

• Non communicating, due to masses obstructing
  1. Foramen of Monro (e.g. Colloid cyst)
  2. Cerebral aqueduct (e.g. tectal plate glioma, pineal tumors).
  3. 4\textsuperscript{TH} ventricle
Hydrocephalus

CT brain shows a hyperdense lesion (colloid cyst) at foramen of Monro (Obstructive HC)
Hydrocephalus
Non communicating

- **Non communicating**, due to masses obstructing
  1. Foramen of Monro (e.g. Colloid cyst)
  2. Cerebral aqueduct (e.g. tectal plate glioma, pineal tumors).
  3. 4\textsuperscript{TH} ventricle (e.g. medulloblastoma, ependymoma, subependymoma)
Hydrocephalus

CT brain shows a mass at 4th ventricle (Obstructive HC)
Hydrocephalus
Ventricular enlargement in elderly

Axial FLAIR MR shows mild ventricular enlargement (white curved arrow) in proportion to the mild sulcal enlargement (white open arrow) in an elderly patient with expected atrophy. Note the lack of significant white matter disease.
Hydrocephalus

Brain atrophy in an elderly with ex vaco ventricular dilatation
• Radiology overview
• Anatomy
• Hydrocephalus
• **Hemorrhage**
• Brain calcifications
• Cerebral sinuses thrombosis
• Ischemia
• Neoplasms
• Skull Vault fractures
• Spine related disease
Hemorrhage

• is a collective term encompassing many different conditions characterized by the extravascular accumulation of blood within different intracranial spaces
Hemorrhage

How does hemorrhage appear on CT?
• Acute (0-3 days)..... Hyperdense
• Subacute (3-10 days or up to 1 month)...... Isodense
• Chronic > 1 month....... Hypodense
Hemorrhage

How does hemorrhage appear on MRI? Depends on sequence and age of the blood

**T1WI**
- **Hyperacute** (< 24 hours): Isointense to mildly hypointense
- **Acute** (~ 1-3 days): Isointense to mildly hypointense
- **Early subacute** (~ 3-7 days): ↑ signal periphery, isointense center
- **Late subacute/early chronic** (~ 1-2 weeks/4 weeks): Diffuse ↑ signal
- **Late chronic** (> 1 month): Iso- to hypointense

**T2WI**
- **Hyperacute**: Hyperintense, may have subtle hypointense rim, hyperintense peripheral edema
- **Acute**: Markedly hypointense, increased edema
- **Early subacute**: ↓ hypointensity, ↑ edema
- **Late subacute/early chronic**: Progressive central signal increase, peripheral hypointensity
- **Late chronic**: Hypointense rim or cleft, no edema

**FLAIR**
- Same as on T2WI

**Gradient echo**: hypointense
Hemorrhage

• **intra-axial hemorrhage**
  • [intracerebral hemorrhage](#)
    • [basal ganglia hemorrhage](#)
    • [lobar hemorrhage](#)
    • [pontine hemorrhage](#)
    • [cerebellar hemorrhage](#)

• **extra-axial hemorrhage**
  • [extradural hemorrhage (EDH)](#)
  • [subdural hemorrhage (SDH)](#)
  • [subarachnoid hemorrhage (SAH)](#)

• Intraventricular hemorrhage
Hemorrhage

• intra-axial hemorrhage
  • intracerebral hemorrhage
    • basal ganglia hemorrhage
    • lobar hemorrhage
    • pontine hemorrhage
    • cerebellar hemorrhage
**Hemorrhage**: intra-axial hemorrhage

Intra parenchymal Causes:
- Trauma
- Hypertensive
- Hemorrhagic transformation of an infarct
- Hemorrhagic venous infarct

Could be surrounding by edema
- Edema appears hypodense on CT
- Edema appears hypointense on T1 and hyperintense on T2
Hemorrhage: Intra axial hemorrhage

- **Hypertensive intracerebral hemorrhages** are common. In fact, [hypertension](#) is the most common cause of [intracerebral hemorrhages](#). They can be conveniently divided according to their typical locations which include, in order of frequency:
  - [basal ganglia hemorrhage](#) (especially the putamen)
  - [thalamic hemorrhage](#)
  - [pontine hemorrhage](#)
  - [cerebellar hemorrhage](#)
Hemorrhage
Intraparenchymal hemorrhage

Intra-axial hemorrhage

Putamenal  Pontine  Parenchymal
Hemorrhage
Intraparenchymal hemorrhage
Hemorrhage
Intraparenchymal hemorrhage
Hemorrhage
Left frontoparietal intraparenchymal hemorrhage
Hemorrhage: Intra axial hemorrhage
Right frontal intraparenchymal hemorrhage
Hypertensive intracerebral hemorrhage (Pons)
Hypertensive intracerebral hemorrhage (Basal ganglia)
Hypertensive intracerebral hemorrhage (cerebellum)
Hypertensive intracerebral hemorrhage (Thalamus)
Hemorrhage

• extra-axial hemorrhage
  • extradural hemorrhage (EDH)
  • subdural hemorrhage (SDH)
  • subarachnoid hemorrhage (SAH)
Hemorrhage
Hemorrhage: Extra axial hemorrhage

Subdural vs. Epidural Hematoma

SDH

EDH
Hemorrhage: Extra axial hemorrhage
Hemorrhage: Extra axial hemorrhage

Subdural vs. Epidural

Note the crescentic shape

Note the lenticular shape
Hemorrhage: Extra axial hemorrhage

Epidural hematoma

Subdural hematoma
Hemorrhage: Extra axial hemorrhage
Epidural hematoma (Extradural)

• A collection of blood that forms between the inner surface of the skull and outer layer of the dura
• History of trauma
• Usually the source of bleeding is a tear involving middle meningeal artery
• Crosses falx but not sutures
Hemorrhage: Extra axial hemorrhage

Epidural hemorrhage

Coronal graphic illustrates swirling acute hemorrhage from a laceration of the middle meningeal artery by an overlying skull fracture. The epidural hematoma displaces the dura inward as it expands.
Hemorrhage: Extra axial hemorrhage

Epidural hemorrhage

Axial NECT scan in a 47-year-old man with head trauma shows a classic biconvex (lentiform) uniformly hyperdense epidural hematoma (EDH) (white solid arrow) in the right middle fossa. Bone CT (not shown) disclosed a nondisplaced skull fracture underlying the hematoma.
Hemorrhage: Extra axial hemorrhage

Epidural hemorrhage

Axial NECT shows a left anterior middle fossa epidural hematoma in the left temporal lobe (white solid arrow).
Hemorrhage: Extra axial hemorrhage

Epidural hemorrhage

Axial T2WI MR demonstrates linear hypointense dura (white solid arrow) interposed between an epidural hematoma and the underlying brain. This distinguishes epidural hematoma from subdural hematoma.
Hemorrhage: Extra axial hemorrhage
Epidural hematoma with bony fracture and scalp swelling
Hemorrhage: Extra axial hemorrhage
Epidural hematoma (Right frontoparietal) with midline shift to the left and effacement of right cortical sulci
Hemorrhage: Extra axial hemorrhage
Epidural hematoma (Right frontal) with scalp swelling
Hemorrhage: Extra axial hemorrhage
Epidural hematoma (Bifrontal)
Hemorrhage: Extra axial hemorrhage
Epidural hematoma (Left temporal)
Hemorrhage
Epidural hematoma

What dose hypodense foci within hematoma indicate?

- Active bleeding *(Swirl sign)*
- Clotting
- Air (in case of overlying fractures or communicating with sinuses)
Hemorrhage: Extra axial hemorrhage

Epidural hemorrhage

Axial NECT shows a hyperdense, biconvex epidural hematoma with compression of the brain. Note the internal hypodense "swirl" sign (black solid arrow), which implies active bleeding with an unretracted, semiliquid clot.
Hemorrhage: Extra axial hemorrhage

Epidural hemorrhage

Axial NECT shows a large, biconvex, hyperdense epidural hematoma that contains air from a frontal sinus fracture. Note the "swirl" sign (black solid arrow). A significant midline shift and pneumocephalus are present.
Hemorrhage: Extra axial hemorrhage

Subdural hemorrhage

- collection of blood accumulating in the subdural space, the potential space between the dura and arachnoid mater of the meninges around the brain
- Not always associated with trauma
- Occurs in child abuse (non accidental injury) and in old age patients
- Usually the source of bleeding is venous
- Does cross sutures
- Seen along falx and tentorium cerebelli
Hemorrhage: Extra axial hemorrhage

Subdural hemorrhage

Graphic shows acute subdural hematoma (aSDH) (white curved arrow) compressing the left hemisphere and lateral ventricle, resulting in midline shift. Coexisting cortical contusions (black solid arrow) and axonal injuries (black curved arrow) are common in aSDHs.
Hemorrhage: Extra axial hemorrhage
Subdural hemorrhage

Axial NECT in a 58-year-old woman with head trauma shows a classic aSDH (white curved arrow) extending over the left convexity and compressing the underlying subarachnoid space (white open arrow). The subtle hypodense foci (black solid arrow) within the hyperdense aSDH represent unclotted blood and risk for rapid hematoma expansion.
Hemorrhage: Extra axial hemorrhage

Subdural hemorrhage

Axial NECT shows a crescentic, homogeneously hyperdense extraaxial collection (white solid arrow) with compression and displacement of the underlying brain, findings typical of aSDH.
Hemorrhage: Extra axial
Left frontal subdural hematoma
Hemorrhage
Subdural hematoma, acute
Hemorrhage
Subdural hematoma, subacute
Hemorrhage
Subdural hematoma, subacute
Hemorrhage
Subdural hematoma, chronic left frontoparietal
Hemorrhage
Subdural hematoma, chronic right frontoparietal hematoma
Hemorrhage
Subdural hematoma, acute on chronic bilateral frontoparietal
Hemorrhage
Subdural hematoma
Hemorrhage
Subdural hematoma, Right and left frontoparietal hematomas of all ages
Hemorrhage
Subdural hematoma WITH midline shift
Hemorrhage: Extra axial
Subarachnoid hemorrhage

• Type of extra-axial intracranial hemorrhage and denotes the presence of blood within the subarachnoid space

• Due to
  • Trauma
  • Ruptured aneurysm
  • vasculitis
Hemorrhage
Hemorrhage

Subarachnoid Haemorrhage
Computed Tomography Findings

Subarachnoid Haemorrhage
The hyperdense signal (i.e., light grey) in the subarachnoid space is due to the presence of blood.

Original image by James Heitman, MD / CC BY-SA 3.0

Normal
This is the normal isodense signal (i.e., dark grey) of cerebrospinal fluid in the subarachnoid space.

Original image by Mikael Häggström / CC0 BY-SA 1.0
Hemorrhage: Extra axial
Subarachnoid hemorrhage

Axial NECT scan shows the typical curvilinear configuration of SAH (white solid arrow) in the sulci of the right temporal lobe.
Hemorrhage
Diffuse subarachnoid hemorrhage
Hemorrhage
Subarachnoid: Focal right posterior frontal
Hemorrhage
Subarachnoid: Focal right temporal
Hemorrhage
Focal right frontoparietal subarachnoid hemorrhage

FLAIR is a good sequence to check for acute subarachnoid hemorrhage
Hemorrhage
Bilateral posterior parietal subarachnoid hemorrhage (More obvious on FLAIR)
Hemorrhage: Extra axial
Subarachnoid hemorrhage

Axial FLAIR MR shows sulcal hyperintensity (white solid arrow), indicative of SAH.
Hemorrhage
Right subarachnoid and left subdural parietal hematoma
Hemorrhage: Intraventricular
Hemorrhage: Intraventricular
Lateral and third Intraventricular hemorrhage
Hemorrhage: Intraventricular
MRI shows left Intraventricular hemorrhage
Hemorrhage
Left basal ganglia hemorrhage with extension into the left lateral ventricle
Gradient echo sequence

Blood appears hypointense on gradient echo sequence
Time for a break
• Radiology overview
• Anatomy
• Hydrocephalus
• Hemorrhage
• Brain calcifications
• Cerebral sinuses thrombosis
• Ischemia
• Neoplasms
• Skull Vault fractures
• Spine related disease
Intracranial calcifications

- **Normal intracranial calcifications** can be defined as all age-related physiologic and neurodegenerative calcifications that are unaccompanied by any evidence of disease and have no demonstrable pathological cause.
Intracranial calcifications

- Normal variation (Falx, dentate nuclei, basal ganglia, choroid plexus, and pineal gland, hippocampus)
- Congenital infection (TORCH)
- Tumors
- Metabolic (Hyperparathyroid, Fahr)
- Previous insult (Healed infection, infarct, hemorrhage)
- Vascular malformation (Arteriovenous malformation, Sturge Weber syndrome)
- Radiation
- Arterial calcifications
Intracranial calcifications
Falx calcifications
Intracranial calcifications

Basal ganglia
Intracranial calcifications
Infections: Neurocysticercosis
Intracranial calcifications
Sturge weber syndrome
Intracranial calcifications
Dentate nuclei
Intracranial calcifications
Arterial calcifications
**Intracranial calcifications**

Axial NECT shows calcification in the supraclinoid internal carotid arteries (black solid arrow), a common location for intracranial atherosclerosis.
Intracranial calcifications
TORCH

CT head demonstrates hydrocephalus, periventricular calcifications, and cortical abnormalities, suggestive of TORCH infection
Intracranial calcifications

**Calcifications**

**Intra-axial tumors:**
- Astrocytomas (20%)
- Oligodendrogliomas (90%)
- Metastases
- Ependymoma (50%)
- Choroid plexus papilloma (25%)
- Ganglioglioma (40%)

**Extra-axial tumors:**
- Meningiomas (25%)
- Craniopharyngeomas (90%)
- Chordomas
- Chondrosarcomas
Tumors with calcifications (Meningioma)

Head CT (bone window) shows calcified mass in the right middle cranial fossa, represents meningioma
Tumors with calcifications (Craniopharyngioma)
Tumors with calcifications (Oligodendroglioma)
• Radiology overview
• Anatomy
• Hydrocephalus
• Hemorrhage
• Brain Calcifications
• Cerebral sinuses thrombosis
• Ischemia
• Neoplasms
• Skull Vault fractures
• Spine related disease
Cerebral sinuses thrombosis

- occlusion of venous channels in the cranial cavity, including dural venous sinus thrombosis, cortical vein thrombosis and deep cerebral vein thrombosis.

Imaging findings:

- CT without contrast: Dense Sinuses
- CT venogram with contrast (CTV): Empty delta sign
- MRI without contrast: loss of normal flow void
- MR venogram with contrast: No contrast filling within the venous sinus
Dural sinuses
Dural sinuses
Dural sinuses thrombosis

Sagittal graphic shows thrombosis of the superior sagittal sinus (white solid arrow) and straight sinus (white open arrow). Inset in the upper left reveals a thrombus in the superior sagittal sinus in cross section ("empty delta" sign) (white curved arrow) seen on contrast-enhanced imaging.
Dural sinuses thrombosis

Axial source image from a CTV in the same patient shows the dura around the superior axial sinus enhances (white solid arrow), but its clot-filled lumen (white open arrow) does not ("empty delta" sign).
Dural sinuses thrombosis

Axial CT venogram in the same patient shows nonenhancing thrombus (black solid arrow) filling the entire SSS. The dural walls of the SSS enhance (white open arrow).
Cerebral sinuses thrombosis

Sinus dense
Cerebral sinuses thrombosis

Right transverse sinus thromosis, Dense sinus
Cerebral sinuses thrombosis
Superior sagittal sinus thrombosis, No contrast within the sinus
Cerebral sinuses thrombosis
Left transverse sinus thrombosis, no contrast within the sinus
Empty delta sign in sinus thrombosis
"PowerPoint slides are like children: No matter how ugly they are, you’ll think they’re beautiful if they’re yours.”

Scott Adams
The Joy of Work
• Radiology overview
• Anatomy
• Hydrocephalus
• Hemorrhage
• Brain Calcifications
• Cerebral sinuses thrombosis
• Ischemia
• Neoplasms
• Skull Vault fractures
• Spine related disease
Brain Ischemia

• Infarction (Due to Ischemia or hemorrhage)

Ischemia: Sudden cessation of adequate amounts of blood reaching parts of the brain. Ischemic strokes can be divided according to territory affected or mechanism.

First study to be done to a patient in ER with history of hyper acute stroke is non contrast CT (To exclude hemorrhage as a cause of stroke)
Gold standard after CT is DWI to detect hyperacute stroke if not detected on the initial CT
Brain Ischemia

• Ischemia is divided according to vascular territory:
  
• Anterior circulation (Anterior cerebral artery infarct and middle cerebral artery infarct, and lacunar infarct)

• Posterior circulation (Posterior cerebral artery infarct, brainstem infarct, and cerebellar infarct)
Brain Ischemia

Vascular territory in the brain
Brain Ischemia

Stages of brain ischemia:

• early hyperacute: 0 to 6 hours
• late hyperacute: 6 to 24 hours
• acute: 24 hours to 1 week
• subacute: 1 to 3 weeks
• chronic: more 3 weeks
Brain Ischemia

Ischemia results in cytotoxic edema
Cerebral edema

❖ **Focal**

- **Cytotoxic cerebral edema** refers to a type of cerebral edema, most commonly seen in cerebral ischemia, in which extracellular water passes into cells, resulting in their swelling. Cellular swelling is the primary reason for increased restricted diffusion on MRI.

- **Vasogenic cerebral edema** refers to a type of cerebral edema in which the blood brain barriers disrupted. It is an extracellular edema which mainly affects the white matter via leakage of fluid from capillaries.

- It is most frequently seen around brain tumors (both primary and secondary) and cerebral abscesses, though some vasogenic edema may be seen around maturing contusions and hemorrhage.

❖ **Diffuse**
Brain edema

Cytotoxic Edema
- Cellular swelling
- Gray-white margin lost

Vasogenic Edema
- Leaky capillaries
- Gray matter is spared
Brain Ischemia
CT

• **Immediate** (0-6hr): Dense vessel Sign
• **Early** hyperacute (6-24hr): Loss of grey-white matter differentiation, cortical hypodensity with associated parenchymal swelling with resultant gyral effacement, loss of insular ribbon sign
• **Acute** (1d-1w): With time the hypoattenuation and swelling become more marked resulting in a significant mass effect.
• **Subacute** (1-3): the swelling starts to subside and small amounts of cortical petechial hemorrhages develop
• **Chronic**: Volume loss, gliosis, cortical calcifications
Brain ischemia

Axial NECT shows increased density in the left middle cerebral artery (cyan open arrow) related to a "dense MCA sign" in a patient with acute right sided symptoms. The density is related to acute thrombus within the vessel.
Brain ischemia

Axial NECT shows increased density related to a "dot sign" in a distal left middle cerebral artery (MCA) branch (cyan solid arrow) representing acute thrombus. Hypodensity related to early infarct is seen in the adjacent brain parenchyma.
Brain Ischemia

CT: Dense left MCA sign
Brain Ischemia

CT: Dense Vessel sign
Brain Ischemia

CT: Dense Vessel sign
Brain Ischemia

CT: Loss of grey-white matter differentiation
Brain Ischemia

• The **loss of the insular ribbon sign** refers to a loss of definition of the gray-white interface in the lateral margin of the insular cortex ("insular ribbon") and is considered an early CT sign of **MCA infarction**.
Brain Ischemia

“Loss of Insular Ribbon” Sign
Brain Ischemia

CT: Acute right ACA

Ct brain demonstrates hypodensity in the medial right frontal lobe in the territory of right ACA with loss of grey white matter junction.
Brain Ischemia

CT: Acute left ACA

CT brain demonstrates hypodensity in the left frontal lobe in the territory of left ACA with loss of grey white matter differentiation and sulcal effacement.
Brain Ischemia
CT: Acute right ACA
Brain Ischemia
CT: Acute left MCA
Brain Ischemia

CT: Acute right MCA
Brain Ischemia
CT: Acute left PCA infarct
Brain Ischemia
CT: chronic right MCA
Brain Ischemia

DWI (Diffusion restriction)

Diffusion restriction (Hperintense signal) on DWI in the territory of left MCA
Brain Ischemia
Bilateral occipital and left thalamic infarct
Brain Ischemia
Right MCA infarct

Diffusion restriction (hyperintense signal) on DWI in the territory of right MCA
Brain Ischemia
DWI: Lacunar infarct < 1.5 cm

Diffusion restriction (hyperintense signal) on DWI in the right thalamus
Brain Ischemia

DWI: Acute midbrain infarct

Diffusion restriction (hyperintense signal) on DWI
Brain Ischemia
Acute pons infarction

Diffusion restriction (Hperintense signal) on DWI
Brain Ischemia

MRI of Acute Stroke

T2

T1-non

T1-gad
Brain Ischemia
T2 and FLAIR
Remember to comment on presence of dense vessel sign, grey-white matter interface, sulcal effacement, density of the area, presence of midline shift or hydrocephalus, territorial involvement and the side!!!!!!!!!
Brain CT in elderly

Age related cerebral atrophy and white matter hypoattenuation of chronic small vessel ischemic disease. This is a relatively normal appearance for a patient of this age.
Vasogenic edema

- It is most frequently seen around brain tumors (both primary and secondary) and cerebral abscesses.
Vasogenic edema around metastases
Vasogenic edema around abscess
Diffuse cerebral edema

Diffuse brain swelling due to:

• Post trauma
• Acute medical illness
• Hypertensive emergency
• Anoxic brain injury
• Drug overdose
Diffuse cerebral edema

Radiological findings:
• Diffuse hypodense supratentorial brain
• Loss grey white matter junction
• Effacement of sulci
• Effacement of basal cistern
• Small size ventricles
• Pseudo subarachnoid sign
• Dense cerebellum
Diffuse cerebral edema
Pseudosubarachnoid hemorrhage
Diffuse cerebral edema
Dense cerebellar sign
Causes of restriction on DWI image (high signal)

- **Acute ischemia**
  - Abscess
  - Cytotoxic cerebral edema
  - Epidermoid cyst
  - Subacute hemorrhage
  - Active demyelinating disease.
- High grade tumor (lymphoma, GBM, Medullobloastoma)
- Post ictal state
• Radiology overview
• Anatomy
• Hydrocephalus
• Hemorrhage
• Brain Calcifications
• Cerebral sinuses thrombosis
• Ischemia
• Neoplasms
• Skull Vault fractures
• Spine related disease
Brain neoplasms

Localization

- Intra or extra axial tumor?
  - **Intra-axial** tumor = tumor locates **within** brain parenchyma
  - **Extra-axial** tumor = tumor locates **outside** the brain parenchyma, such as Skull, CSF cisterns and ventricles.
Brain neoplasms

Classification
• Diffuse astrocytic and oligodendroglial tumors
• Choroid plexus tumors
• Neuronal and mixed neuronal-glial tumors
• Pineal region
• Embryonal tumors
• Germ cell tumors
• Lymphomas
• Tumors of cranial and paraspinal nerves
• Ependymal tumors
• Tumors of the sellar region
Important tumors to know:

- Meningioma
- Glioblastoma multiforme (GBM)
- Lymphoma
- Craniopharyngioma
- Choroid plexus papilloma
- Oligodendroglioma
Brain neoplasms: Meningioma

- **Meningiomas** are extra axial tumors and represent the most common tumor of the meninges. They are a non-glial neoplasm that originates from the meningocytes or arachnoid cap cells of the meninges.

**Radiological findings:**
- **CT:**
  - non-contrast CT 60% slightly hyperdense to normal brain, the rest are more isodense
  - 20-30% have some calcification
  - post-contrast CT 72% brightly and homogeneously contrast enhance, few with enhancing dural tail

- **MRI:**
  T1/T2: Isointense
  Contrast MRI: Intense enhancement, few with enhancing dural tail
Brain neoplasms: Meningioma

Axial T1 C+ MR shows the mass (white solid arrow) enhances strongly and uniformly.
Brain neoplasms: Meningioma

Coronal T1 C+ MR shows the enhancing mass (white solid arrow) with slightly more intensely enhancing dural tail (white open arrow). A WHO grade I meningioma was removed at surgery. The dural tail was not involved by tumor.
Brain neoplasms: Meningioma

CT shows calcified left frontal lesion
Brain neoplasms: Meningioma
Brain neoplasms: Glioblastoma multiforme (GBM)

- GBM is the most common adult primary intracranial neoplasm, poor prognosis.

Radiological findings:

- **CT**
  - irregular thick margins: iso- to slightly hyperattenuating (*high cellularity*)
  - irregular hypodense center representing necrosis
  - marked mass effect with surrounding vasogenic edema
  - hemorrhage is occasionally seen
  - intense irregular, heterogeneous enhancement of the margins is almost always present

- **MRI**
  - DWI: The solid portion is hyperintense (Diffusion restriction)
  - **T1**
    - hypo to isointense mass within white matter, central heterogeneous signal (necrosis, intratumoral hemorrhage)
  - **T1 C+ (Gd)**
    - enhancement is variable but is almost always present. typically *peripheral* and irregular with nodular components, usually surrounds necrosis
  - **T2/FLAIR**
    - Hyperintense, surrounded by vasogenic edema
Axial T1WI C+ FS MR in a 60-year-old man with acute onset of seizures shows a heterogeneously enhancing occipital lobe mass with central necrosis and extension across the splenium of the corpus callosum (white curved arrow), characteristic of GBM. The frontal and temporal lobes are the most common locations for GBM.
Brain neoplasms: Glioblastoma multiforme (GBM)

Axial T1 C+ FS MR in the same patient shows a thick enhancing rind of tumor that surrounds the necrotic tumor core, characteristic of GBM. Other lesions including lymphoma and demyelination may also involve the corpus callosum.
Axial FLAIR MR shows a heterogeneously hyperintense mass (white open arrow) crossing the corpus callosum genu with signal abnormality extending into the frontal lobe subcortical white matter (white solid arrow). Viable tumor cells may extend beyond the area of MR signal abnormality.
Brain neoplasms: Glioblastoma multiforme (GBM)

Differential diagnosis of midline lesion with irregular ring enhancement:
• GBM
• Lymphoma POST treatment
Brain neoplasms: Glioblastoma multiforme (GBM)
Brain neoplasms: Lymphoma

- **Primary CNS lymphomas (PCNSL)** are relatively uncommon tumors, accounting for 2.5% of all brain tumors.

- **Radiological findings:**
  - **CT:**
    - most lesions are hyperattenuating (dense) (70%)
    - shows enhancement (complete before treatment and ring post treatment and in HIV patients)
  - **MRI:**
    - T1: Isointense
    - T2: Isointense with surrounding edema which appears hyperintense
    - Contrast MRI: shows enhancement (complete before treatment and ring post treatment and in HIV patients)
    - DWI: high signal due to high cellularity
Brain neoplasms: Lymphoma
Brain neoplasms: Craniopharyngioma

- **Craniopharyngiomas** are relatively benign neoplasms that typically arise in the sellar/suprasellar region.

- **Age:**
  - Between the ages of 5-15 years, consisting almost exclusively of the adamantinomatous subtype.
  - A second, smaller peak occurs in adults aged over 40 years old, consisting of both papillary and adamantinomatous subtypes.
Brain neoplasms: Craniopharyngioma

• Radiological finding:
  ✤ Adamantinomatous craniopharyngiomas (Pediatric type) typically have a lobulated contour as a result of usually being multiple cystic lesions with calcifications in 90% of cases

  ✤ Papillary craniopharyngiomas (Adult type) tend to be more spherical in outline and usually lack the prominent cystic component; most are either solid or contain a few smaller cysts. Calcification is uncommon or even rare in the papillary subtype
Brain neoplasms: Craniopharyngioma
Brain neoplasms: Choroid plexus papilloma

- **Choroid plexus papillomas** are an uncommon, benign neuroepithelial intraventricular tumor which can occur in both the pediatric (more common) and adult population.

- Location:
  - adults: most often (70%) occur in the **fourth ventricle**
  - children: most often occur in the **lateral ventricles**, with a predilection for the trigone

Radiological findings:
CT: The tumors are usually well-defined lobulated masses, either iso- or somewhat hyperdense compared to the adjacent brain. There is associated hydrocephalus
MRI:
T1: Isointense
T2: Hyperintense
Contrast: Homogenous enhancement
**Brain neoplasms: Choroid plexus papilloma**

CT with contrast shows enhancing lesion in the left trigone
Brain neoplasms: Oligodendrogliaoma

• intracranial tumors that account for 5-25% of all gliomas and 5-10% of all primary intracranial neoplasms.

• On imaging, oligodendroglialomas commonly present as masses involving the cortex or subcortical white matter
  ❖ low attenuation on CT
  ❖ hypointense compared to grey matter on T1 and hyperintense compared to grey matter on T2-weighted MRI images.

• The attenuation or signal can be eventually heterogeneous due to calcification, cystic degeneration and hemorrhage
Brain neoplasms: Oligodendroglioma
Ring enhancing lesions
Miscellaneous lesions
Dermoid with calcifications
Arachnoid cyst
• Radiology overview
• Anatomy
• Hydrocephalus
• Hemorrhage
• Brain Calcifications
• Cerebral sinuses thrombosis
• Ischemia
• Neoplasms
• Skull Vault fractures
• Spine related disease
Skull fractures

• anatomically
  • base of skull
  • skull vault

• associated with overlying wound
  • open (compound)
  • closed

• degree of displacement
  • undisplaced
  • depressed (5-10 mm)

• number of fracture lines/fragments
  • linear
  • comminuted
Skull fractures
depressed
Skull Vault fractures:
comminuted and depressed
Skull fractures
Skull Vault fractures
Skull Vault fractures
Depressed fracture with pneumocephalus and overlying soft tissue swelling
Pneumocephalus
Pneumocephalus
• Radiology overview
• Anatomy
• Hydrocephalus
• Hemorrhage
• Brain Calcifications
• Cerebral sinuses thrombosis
• Ischemia
• Neoplasms
• Skull Vault fractures
• Spine related disease
Spine related disease

Checklist:
• the alignment of the spine
• Height of the vertebral bodies and discs.
• Signal of the bone and disc
• Presence of intraspinal masses

Spine related disease
• Disc herniation/prolpase
• Infection (Spondylodiscitis)
• Intraspinal lesions
• Trauma
Spine related disease: Disc disease

• Normally the disc is hyperintense on T2 with degeneration there will be decrease height of the disc with decrease T2 signal

• Disc herniation refers to the displacement of disc material beyond the normal confines of the disc <25%
  ❖ Prolapse
  ❖ Extrusion

• Disc bulge refers to the displacement of disc material beyond the normal confines of the disc >25%
Spine related disease: Disc degeneration with bulge
Spine related disease: Disc degeneration with herniation
Spine related disease: Disc degeneration with herniation
Spine related disease: Infection (Spondylodiscitis)

Enhancing vertebral body endplates with irregular disc
Spine related disease: Intraspinal lesions

• **Neoplasms of the spinal canal** encompass a range of tumors which arise from or involve the spinal cord, theca, and spinal nerves.

• Classification:
  - Intradural
    • Intramedullary
    • Extramedullary
  - Extradural
Spine related disease: Intraspinal lesions

**Spinal cord (intramedullary)**
- spinal ependymoma (most common spinal cord tumor in adults)
- spinal astrocytoma (most common spinal cord tumor in children)
- spinal pilocytic astrocytoma
- spinal hemangioblastoma
- spinal cord metastasis
- spinal leptomeningeal metastases (these can mimic exophytic tumors)
- spinal primitive neuroectodermal tumors
- spinal lymphoma/leukemia
- spinal ganglioglioma
Spine related disease: Intraspinal lesions

**Intradural extramedullary**

- **spinal meningioma**
- **spinal nerve sheath tumors**
  - **spinal schwannoma**
  - **spinal neurofibroma**
- **spinal leptomeningeal metastases**
Spine related disease: Intraspinal lesions

Extramedullary

- Vertebral body tumors
- Vertebral body infection
- Disc prolapse
Spine related disease: Intraspinal lesions

- Intramedullary
  - Child with eccentric mass within thoracic cord?
    - Astrocytoma
  - Adult with central mass with hypointense hemosiderin cap?
    - Ependymoma
  - Vascular lesion of C/T spine with edema?
    - Hemangioblastoma
  - Child with long segment tumor with bony remodeling?
    - Ganglioglioma or gangliocytoma (rare)

- Intradural-Extradural
  - Posterior thoracic mass with ca++ and dural tail?
    - Meningioma
  - Mass with enhancement but low centrally (target sign), with hemorrhage and fat?
    - Schwannoma
  - Mass with enhancement but low centrally (target sign), "without" hemorrhage and fat?
    - Neurofibroma
  - Enhancing cauda equina or filum terminale mass with hemorrhage?
    - Myxopapillary ependymoma

- Extradural
  - Child with calcified, enhancing mass?
    - Neural crest tumor
  - Adult with calcified mass with bony destruction?
    - Chordoma
Spine related disease: Intraspinal tumor

Ependymoma in the spine of an adult patient
Spine related disease: Trauma

Anterior translation of C5 over C6
Spine related disease: Trauma

Vertebral body fracture
The End