Pediatric Neuroradiology
Pre-call Primer
Learning Objectives

After reviewing this series of modules you should be able to:

• **Sutures:**
  – Name pediatric skull sutures and fontanelles.
  – Identify common accessory sutures.
  – Localize pediatric skull sutures and fontanelles.

• **Skull fractures:**
  – Confidently differentiate a suture from a fracture.
  – Identify when a fracture extends through a suture.

• **Bleeds:**
  – Differentiate between epidural, subdural, and subarachnoid bleeds.
  – Discuss the differential considerations of a hypodense region within an extraaxial hemorrhage.
  – List mimics of subarachnoid and subdural bleeds.
Learning Objectives

• Sulci & mass effect
  – Explain the “three shades of gray” approach.
  – Discuss completely effaced sulci.
  – Discuss almost completely effaced sulci.
  – Discuss normal appearing sulci.

• Cisterns:
  – Name the major cisterns.
  – List the contents of the cisterns.
  – Discuss complications of cisternal compression.

• Herniations:
  – Describe major types of brain herniations.
  – Discuss the consequences of brain herniation.
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Pediatric Neuroradiology
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Module 1: Sutures
Relevance

- In the pediatric population, sutures and non-displaced fractures can easily be confused. This can have significant impact on clinical management for victims of abusive head trauma.

- Besides emergency indications, knowledge of pediatric sutures is also important in the accurate diagnosis and treatment monitoring of patients with craniosynostosis.
• Adult fracture signs (fracture edges that are not corticated, fractures are linear compared to normal squiggly sutures) **may not apply in the immature skull**.

• **In children**, a decision of suture versus fracture is frequently based on:
  - Symmetry (favors suture)
  - Knowledge of sutures and accessory sutures
Learning Objectives

After reviewing this module you should be able to:

• Name pediatric skull sutures and fontanelles
• Identify common accessory sutures
• Localize pediatric skull sutures and fontanelles
Large Sutures

- **Coronal** (Corona means crown—think of a tiara)
- **Sagittal** (Sagitta means arrow)
- **Lambdoid** (Lamdoid is a letter from the Greek alphabet with a peculiar shape that matches the configuration of the lambdoid suture).
- **Squamosal** (Squama is Latin for scale and relates to the shape of this part of the temporal bone).
- The remaining sutures are named after the neighboring bones adjacent to them.
- **Metopic and mendosal** sutures also have names that refer to their anatomical location and make them more memorable (metopic=frontal; Mendosal =posterior intraoccipital).
3D Volume Rendered Images

- Head CT imaging in pediatric patients is commonly done for head trauma, and skull fractures or suture diastasis are a common finding.
- 3D volume rendered images can increase detection of fracture and diastasis and are routinely done at our institution. These images require minimal post-processing, and do not increase radiation dose.
- It is prudent to familiarize yourself with creating these images if they are not routinely done at your institution.
Blue dots mark the **coronal suture** as seen from the front (left) and as seen from the top (right).
Yellow lines mark the **coronal suture**
Blue dots mark the **sagittal suture**
as seen from the front (left) and as seen from the top (right).
Yellow lines the **sagittal suture**
On this occipital view we see the **lambdoid suture** (blue dots). There are also accessory sutures on the top of the occipital bone.
Yellow lines mark the **lambdoid suture**.
Here, blue dots mark the **metopic or frontal suture**, seen from the front (left) and from the top (right).
Here, we are looking at the foramen magnum from below and outlined with blue dots is the posterior intraoccipital suture.
Here is the **squamosal suture** with blue dots.
Smaller Sutures

• The smaller sutures are named after the neighboring bones adjacent to them:
  – Spheno-frontal
  – Spheno-parietal
  – Spheno-squamosal
  – Parieto-mastoid
  – Occipito-mastoid
The **squamosal suture** is in dark blue.
The **parieto-mastoid** suture in **red**.
The **occipito-mastoid** suture in **green**.
And the **spheno-temporal** suture in **light blue**.
This is the spheno-frontal suture in blue, 
The spheno-parietal suture in red, 
Again the spheno-temporal suture- this time in green.
Accessory Sutures

Accessory sutures mostly occur in the parietal and occipital bones. These could particularly be confused with fractures.
Accessory Sutures

The Mendosal sutures (red) do not extend across the midline……..

…… unlike the transverse occipital suture (green)

…… and the posterior intraoccipital suture (blue).
Accessory Sutures

The interparietal suture (red) is an accessory suture of the upper part of the occipital bone that wedges between the parietal bones – hence its name!
Accessory parietal suture

Frequently confused with a fracture, especially when asymmetrical! 3D bone renderings (left) and MIP (maximum intensity projections, right) can help in visualizing sutures and fractures.
Accessory parietal suture
Wormian bones

• Wormian bones are intra-sutural bones
• They vary in size and can be found on either side of the skull and are usually an anatomical variation
• Some genetic diseases are associated with Wormian bones, best remembered by the mnemonic **PORKCHOPS**

P - Pyknodysostosis
O - Osteogenesis imperfecta
R - Rickets
K - Kinky hair syndrome
C - Cleidocranial dysostosis
H - Hypothyroidism/hypophosphatasia
O - Otopalatodigital syndrome
P - Primary acroosteolysis/
    pachydermoperiostosis/Progeria
S - Syndrome of Downs
## Suture Closures

<table>
<thead>
<tr>
<th>Structure</th>
<th>Closure</th>
</tr>
</thead>
<tbody>
<tr>
<td>Posterior fontanelle</td>
<td>by 3 mo</td>
</tr>
<tr>
<td>Sphenoidal fontanelle</td>
<td>by 6 mo</td>
</tr>
<tr>
<td>Metopic suture</td>
<td>by 3-9 mo</td>
</tr>
<tr>
<td>Mastoid fontanelle</td>
<td>by 6-18 mo</td>
</tr>
<tr>
<td>Anterior fontanelle</td>
<td>by 1-3 yrs</td>
</tr>
<tr>
<td>Posterior intraoccipital suture</td>
<td>by 1-3 yrs</td>
</tr>
<tr>
<td>Coronal, lambdoid and sagittal sutures</td>
<td>by teenage years</td>
</tr>
</tbody>
</table>

Any suture can persist into adulthood as a developmental variant.
Fontanelles

- As the fontanelles close they form important landmarks of the skull. These landmarks have been given special names.
- When the anterior fontanelle closes this landmark is called the **Bregma**.
- After closure of the posterior fontanelle the landmark is called **Lambda**.
The sphenoid fontanel is anterior and the landmark of the skull after closure is called **Pterion**.

The mastoid fontanelle is posterior and when it closes the landmark is called **Asterion**.
END OF MODULE #1

• Continue to the next slide for references.
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References

- http://carta.anthropogeny.org/moca/topics/age-closure-fontanelles-sutures, last access 07/14/2012
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Module 2: Skull Fractures
Non-displaced skull fractures usually do not require surgical intervention unless associated with large hemorrhages and/or mass effect.

The presence of a skull fracture could indicate an abusive head trauma and is therefore important to detect.

Differentiating non-displaced skull fractures from immature sutures can be very challenging.
Learning Objectives

After reviewing this module you should be able to:

• Confidently differentiate a suture from a fracture
• Identify when a fracture extends through a suture
Quick?

Do you think identifying non-displaced skull fractures in children is easier or more difficult than in adults?

Easier  More difficult
Answer

It is more difficult!!!!

Here is why……..
# Fracture versus Suture signs

<table>
<thead>
<tr>
<th>Adults</th>
<th>Children</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Fracture edges not corticated, suture edges corticated</td>
<td></td>
</tr>
<tr>
<td>• Fracture squiggly, suture linear</td>
<td></td>
</tr>
<tr>
<td>• Fracture asymmetrical, only sagittal suture is midline</td>
<td></td>
</tr>
<tr>
<td>• Overlying scalp hematoma</td>
<td></td>
</tr>
<tr>
<td>• Fracture and immature suture edges <em>both not corticated</em></td>
<td></td>
</tr>
<tr>
<td>• Fracture and immature suture <em>both linear</em></td>
<td></td>
</tr>
<tr>
<td>• Fracture asymmetrical, sagittal and metopic are <em>both midline sutures</em></td>
<td></td>
</tr>
<tr>
<td>• Scalp hematoma can be <em>delayed</em> up to 24 h in infants</td>
<td></td>
</tr>
</tbody>
</table>
Cortication
Corticated right mastoid-occipital suture
Non-corticated right occipital fracture
Immature suture, not corticated

17 day old girl
Left sphenotemporal suture
Pearl

- Trauma can cause suture dehiscence
- So, after differentiating a suture from a fracture, still look for evidence of trauma to that suture
Suture dehiscence

12 year old boy, lambdoid sutures

Traumatic dehiscence right

Normal left
Squiggly vs. Linear
Squiggly mature sutures

3D surface projection

14 year old girl

MIP
Right parietal skull fracture

10 month old girl, right parietal fracture

Skull fracture *(blue arrow)* more linear (but curved course) than sagittal and lambdoid sutures.
Linear immature sutures

3D surface projection

MIP

17 day old girl
Metopic suture

- Do not mistake for fracture
- Closes by 3-9 months
- Can persist into adulthood

8 year old boy
Pearl

- Fractures can be midline
- It is easier to detect a fracture when you know where midline sutures and accessory sutures most commonly occur (see Module #1)
Midline occipital fracture
Symmetry
Asymmetry versus tilted head

- If the patient’s head is tilted, you may not notice the symmetry of a suture
- Scroll to assess findings at comparable imaging levels
Head tilt

Right temporal fracture?
Linear bone lucency is symmetrical considering tilted head.
Scrolling farther down, the lucency is part of the sphenotemporal suture.
Fracture?
Ongoing squiggly maturation

A small bone “finger” (blue arrow) can mimic a fracture is axial plane (dotted line)
END OF MODULE #2

• Continue to the next slide for references.
• Click on the link below to return to the table of contents.
References

• Barkovich AJ, Charles Raybaud. **Pediatric neuroimaging.** Lippincott Williams & Wilkins; Fifth edition (August 1, 2011).
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Module 3: Bleeds
In children just like in adults, it is important to identify in which space a hemorrhage has occurred, as it can be an important **clue to the etiology** of the bleed.

In children, hemorrhages can occur with **abusive** head trauma and should not be missed, even when they are very subtle.
Learning Objectives

After reviewing this module you should be able to:

- Differentiate between epidural, subdural, and subarachnoid bleeds
- Discuss the differential considerations of a hypodense region within an extraaxial hemorrhage
- List mimics of subarachnoid and subdural bleeds
<table>
<thead>
<tr>
<th>Type of extra-axial bleeds</th>
<th>Worst scenario</th>
</tr>
</thead>
<tbody>
<tr>
<td>Subarachnoid</td>
<td>Aneurysm rupture, abusive head trauma</td>
</tr>
<tr>
<td>Subdural</td>
<td>Brain herniation</td>
</tr>
<tr>
<td>Epidural</td>
<td>Brain herniation</td>
</tr>
</tbody>
</table>
# Three Spaces

<table>
<thead>
<tr>
<th>Epidural</th>
<th>Subdural</th>
<th>Subarachnoid</th>
</tr>
</thead>
<tbody>
<tr>
<td>Potential space</td>
<td>Potential space</td>
<td>Physiologic space</td>
</tr>
<tr>
<td>Lentiform bleeds</td>
<td>Crescentic bleeds</td>
<td>Interdigitated with parenchyma from blood in sulci &amp; cisterns</td>
</tr>
<tr>
<td>Mass effect on brain</td>
<td>Mass effect on brain</td>
<td>No mass effect on brain</td>
</tr>
<tr>
<td>Push cortical veins to brain surface</td>
<td>Push cortical veins to brain surface</td>
<td>Cortical veins travel through</td>
</tr>
<tr>
<td>Cross midline</td>
<td>Do not cross midline (with exceptions)</td>
<td>Cross midline</td>
</tr>
<tr>
<td>Do not cross coronal, lambdoid sutures</td>
<td>Cross sutures</td>
<td>Cross sutures</td>
</tr>
</tbody>
</table>
Subdural or subarachnoid?

There is prominence of bilateral frontal extraaxial fluid, right worse than left.
Mass effect?

Yes! The sulci on the right are effaced (blue arrow).

No sulcal effacement on the left.
Vessels pushed?

Can’t see any

There is one..
IV contrast helps!

Vessels pushed into sulci (blue arrows), so there is a subdural effusion/bleed.

A follow-up MRI can help assess for associated brain injury and for determining the age of bleeds.
What are the findings?

8 year old girl, fall
1. Right frontal epidural hematoma (lentiform)  
2. Hypodensity in epidural collection  
3. Sulcal effacement (dotted line)  
4. Effaced right frontal horn  
5. Mild midline shift to left (dotted line)
What are the findings?

4 year old boy, fall
1. Left frontal subdural hematoma (crescentic)
2. Hypodensity within subdural collection
3. Sulcal effacement (dotted line)
4. Effaced left lateral ventricle (dotted line)
5. Midline shift to right (dotted line)
A mixture of densities in an extraaxial collection can indicate:

- Hyperacute (ongoing) hemorrhage
- Acute admixtures of CSF and blood
- Clot retraction
- New (acute) on top of old (chronic) blood
What are the findings?

13 day old boy, abusive head trauma
1. Subarachnoid hemorrhages (short arrows)
2. Frontal and temporal loss of gray-white differentiation (dotted lines)
3. Mass effect on suprasellar cistern (long arrows)
Does this patient have subarachnoid blood?

1 year old boy
Answer

• Probably no.
• There is global effacement of sulci, cisterns, ventricles.
• Severe cerebral edema can compress vessels and mimic hemorrhage in cisterns and sulci – so called “pseudo-subarachnoid hemorrhage sign”
Does this newborn have subdural hemorrhages?
Answer

- Likely not.
- Postnatal dehydration (hemo-concentration) likely accounts for this homogeneous and extensive hyperdensity throughout the major venous sinuses.
Is there a subdural?
Yes. This patient has subdural hemorrhage (arrow).

**PEARLS:**

- Dura should be paper thin, not “cardboard” thick.
- Any asymmetrical thickening or nodular hyperdensity along the dura can be a sign of subdural hemorrhage in the setting of trauma.
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Module 4: Sulci & Mass Effect
Relevance

- Evaluation of the CSF spaces can reveal subtle evidence of mass effect.
- Mass effect can cause **significant morbidity and mortality** if undetected and untreated.
Learning Objectives

After reviewing this module you should be able to:

• Explain the “three shades of gray” approach
• Discuss completely effaced sulci
• Discuss almost completely effaced sulci
• Discuss normal appearing sulci
Three Shades of Gray

- Identifying “Three Shades of Gray” can help in identifying sulcal effacement.
Three Shades of Gray

Normal 3 shades:

- Light - gray matter
- Medium - white matter
- Dark - CSF
Three Shades of Gray

Shunted patient. Normal baseline shown below.
On follow-up there is an imbalance of three shades of gray, mostly loss of the darkest shade (CSF).

Follow-up: Sulcal effacement.
Three scenarios of sulci:

- Completely effaced (two shades of gray)
- Some sulci seen (mostly two shades)
- Looks normal (normal three shades)
Interpretation: “Completely effaced”

• This is abnormal
• It may be hard to determine why sulci are abnormal
• There could be a severe acute event, such as cerebral swelling, diffuse edema (from anoxia, electrolyte derangement, metabolic disorders) meningitis/encephalitis, etc..
• ….or something more “benign”, such as craniosynostosis resulting in restricted skull growth- the growing brain displaces CSF
Interpretation: Some sulci (“hints of sulci”), basilar cisterns, & ventricles are normal.

Conclusions:
“Probably normal” or
“No definite findings of brain swelling”

Can add:
“Please correlate with physical exam”
(e.g. level of consciousness)

Rationale:
Patients with brain swelling are likely symptomatic for it.
Interpretation: “Sulci look normal”

Probably there is no cerebral swelling unless on prior study sulci were even more prominent.
# Interpretation summary

<table>
<thead>
<tr>
<th>Condition</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Completely effaced</td>
<td>Abnormal. Look for other signs and/or an explanation of edema and/or mass effect.</td>
</tr>
<tr>
<td>Some hints of sulci are seen</td>
<td>Could be normal but cannot definitely exclude global mass effect in the absence of a baseline imaging study.</td>
</tr>
<tr>
<td>Looks normal</td>
<td>Likely normal. Probably no global mass effect/brain swelling.</td>
</tr>
</tbody>
</table>
Pearl: Cerebral swelling

Acute swelling is not easy to determine in children

- The ventricles and sulci are usually small in children (much smaller than in older adults)
- The grey – white contrast (demarcation) in normal children can be accentuated, normal or decreased!
To properly assess for the presence and the severity of cerebral swelling, you need to particularly evaluate:

- Sulci
- Lateral ventricles
- Basal cisterns
- 4th ventricle
Below: Diffuse cerebral swelling (same patient as above), impending herniation (arrows: 4th ventricle blunted, perimesencephalic cistern effaced, sulci effaced)
Normal

Diffuse swelling, impending herniation
Craniosynostosis

- Craniosynostosis can have imaging findings that closely resemble cerebral edema, however the differentiation is important due to different treatments.

  – The diagnosis of craniosynostosis relies on noting that there are prematurely fused sutures as seen on the next page.
Premature fusion of the sutures causes effaced sulci in craniosynostosis.

Diffuse swelling in cerebral edema.
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Module 5: Cisterns
Relevance

- The cisterns of the brain give important information about mass effect.
- They are tricky to evaluate because they are small spaces.

Pearl:
Small changes in small spaces can indicate BIG problems......
Learning Objectives

After reviewing this module you should be able to:

- Name the major cisterns
- List the contents of the cisterns
- Discuss complications of cisternal compression
What are the cisterns you should know?

- Cerebromedullary (Cisterna Magna)
- Prepontine
- Cerebellopontine
  - Chiasmatic
  - Interpeduncular
- Crural
- Ambient
- Quadrigeminal

Suprasellar cistern
Perimesencephalic cistern
Are there even more cisterns?

- Medullary c.
- Chiasmatic c.
- Crural c.
- Carotid c.
- Sylvian c.
- Supracerebellar c.
- Pericallosal c.
- Retrothalamic c.
- Lamina terminalis c.
Combos

Some cistern names refer to a combination of several cisterns

1. Basal cisterns:
premedullary, prepontine, interpeduncular, chiasmatic, CP angle, crural, carotid, sylvian

2. Perimesencephalic cistern:
interpeduncular, crural, ambient, quadrigeminal

3. Suprasellar cistern
interpeduncular, chiasmatic
Cisternal compression

- **Arteries** can become occluded and cause infarction in the territory they supply
- **Veins** can become compressed and cause congestion/venous infarctions
- **Nerves** can become compressed and cause palsy
Below: Diffuse cerebral swelling (same patient as above), impending herniation
(arrows: 4th ventricle blunted, perimesencephalic cistern effaced, sulci effaced)
Cerebromedullary (Cisterna magna)

<table>
<thead>
<tr>
<th>Boundaries</th>
<th>Contents</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Largest of the subarachnoid cisterns</td>
<td>• Vertebral artery</td>
</tr>
<tr>
<td>• Lies between the cerebellum and the medulla</td>
<td>• Postero-inferior cerebellar artery (PICA)</td>
</tr>
<tr>
<td>• Receives CSF from the fourth ventricle via the median foramen of Magendie and the paired lateral foramina of Luschka</td>
<td>• Cranial nerves nine (IX), ten (X), eleven (XI) and twelve (XII)</td>
</tr>
<tr>
<td></td>
<td>• Choroid plexus</td>
</tr>
</tbody>
</table>
### Prepontine

<table>
<thead>
<tr>
<th>Boundaries</th>
<th>Contents</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Surrounds the ventral aspect of the pons</td>
<td>• Basilar artery</td>
</tr>
<tr>
<td>• Anterior boundary are clivus and occipital bones</td>
<td>• Origin of the anteroinferior cerebellar artery (AICA)</td>
</tr>
<tr>
<td></td>
<td>• Origin of the superior cerebellar arteries</td>
</tr>
<tr>
<td></td>
<td>• Cranial nerve six (VI)</td>
</tr>
</tbody>
</table>

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# Cerebellopontine

<table>
<thead>
<tr>
<th>Boundaries</th>
<th>Contents</th>
</tr>
</thead>
<tbody>
<tr>
<td>• In the lateral angle between the cerebellum</td>
<td>• Cranial nerves five (V),</td>
</tr>
<tr>
<td>and the pons</td>
<td>seven (VII) and eight (VIII)</td>
</tr>
<tr>
<td></td>
<td>• Anteroinferior cerebellar artery</td>
</tr>
<tr>
<td></td>
<td>(AICA)</td>
</tr>
<tr>
<td></td>
<td>• Petrosal vein</td>
</tr>
</tbody>
</table>
Cerebellopontine angle cistern
## Chiasmatic

<table>
<thead>
<tr>
<th><strong>Boundaries</strong></th>
<th><strong>Contents</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td>Ventral to the optic chiasm</td>
<td>• Anterior aspect of the optic chiasm and optic (II) nerves</td>
</tr>
<tr>
<td></td>
<td>• Hypophyseal stalk</td>
</tr>
<tr>
<td></td>
<td>• Origin of the anterior cerebral arteries</td>
</tr>
</tbody>
</table>
# Interpeduncular

<table>
<thead>
<tr>
<th>Boundaries</th>
<th>Contents</th>
</tr>
</thead>
<tbody>
<tr>
<td>Situated between the two cerebral peduncles</td>
<td>Bifurcation of the basilar artery</td>
</tr>
<tr>
<td></td>
<td>Peduncular segments of the PICA</td>
</tr>
<tr>
<td></td>
<td>Peduncular segments of the superior cerebellar arteries</td>
</tr>
<tr>
<td></td>
<td>Perforating branches of the PICA</td>
</tr>
<tr>
<td></td>
<td>Posterior communicating arteries (PCoA)</td>
</tr>
<tr>
<td></td>
<td>Cranial nerve three (III)</td>
</tr>
</tbody>
</table>
Interpeduncular cistern
# Ambient cistern

<table>
<thead>
<tr>
<th>Boundaries</th>
<th>Contents</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Medial to the temporal lobes</td>
<td>• Cranial nerve four (IV)</td>
</tr>
<tr>
<td>• Dorsolateral to midbrain</td>
<td>• Basal vein of Rosenthal</td>
</tr>
<tr>
<td>• Connects to crural cisterns</td>
<td></td>
</tr>
<tr>
<td>• Has supra- and infratentorial compartments</td>
<td></td>
</tr>
</tbody>
</table>
Cisterna ambiens

CT image for localization
### Quadrigeminal

<table>
<thead>
<tr>
<th>Boundaries</th>
<th>Contents</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Dorsal to the midbrain</td>
<td>• Vein of Galen</td>
</tr>
<tr>
<td></td>
<td>• Posterior pericallosal arteries</td>
</tr>
<tr>
<td></td>
<td>• Third portion of the superior cerebellar arteries</td>
</tr>
<tr>
<td></td>
<td>• Perforating branches of the posterior cerebral and superior cerebellar arteries</td>
</tr>
<tr>
<td></td>
<td>• Third portion of the posterior cerebral arteries</td>
</tr>
</tbody>
</table>
Quadrigeminal cistern
END OF MODULE #5

• Click next slide for references
• Click on the link below to open the next module
References

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Module 6: Herniation
Relevance

• Herniation can be lethal.
• Understanding and describing herniations requires knowledge of cisterns.
• We can help clinicians understand what is going on by describing the type of herniation as accurately as possible.
Learning Objectives

After reviewing this module you should be able to:

• Describe major types of brain herniations
• Discuss the consequences of brain herniation
Major herniation types

1. Subfalcine
2. Lateral transtentorial (uncal)
3. Central transtentorial, descending
4. Tonsillar
5. Central transtentorial, ascending
6. External
# Subfalcine herniation

- Most common type of herniation

## Causes:
- Unilateral frontal, parietal, or temporal lobe lesion
- Unilateral brain edema
- Unilateral extraaxial collection

## Complications:
- Anterior cerebral artery compression
- Internal cerebral veins compression

## Imaging signs:
- Anterior falx tilts away from the mass effect
- Posterior falx is more resistant to displacement
- Ipsilateral ventricle compressed
- Contralateral ventricle obstructed
Subfalcine herniation

Posttraumatic right epidural hematoma

Anterior falx bowed to the left (black arrow)

Midline shifted to left (blue arrows)

Posterior falx not affected (red arrow)
Subfalcine herniation

Ipsilateral ventricle compressed (blue arrow)
Contralateral ventricle obstructed (black arrows)
Uncal herniation

- Is an anterior lateral transtentorial herniation.
- Best-known type of transtentorial herniation

**Causes:**
- Unilateral, expanding supratentorial lesion, especially in the middle cranial fossa

**Complications:**
- Ipsilateral 3rd nerve palsy (blown pupil)
- Contralateral cerebral peduncle (contralateral hemiparesis, can cause false lesion localization clinically)

**Imaging signs:**
- Uncus is displaced over the free edge of the tentorium
- Midbrain is displaced
- Opposite cerebral peduncle is squeezed against the contralateral tentorial edge
- Contralateral perimesencephalic cistern is compressed; ipsilateral perimesencephalic cistern is preserved
Uncus

Amygdala- located in the temporal lobe; involved in memory, emotion, and fear.

The amygdala is just beneath the surface of the front, medial part of the temporal lobe where it causes the bulge on the surface called the **uncus**.
Uncal herniation

Uncus is displaced medially over the free edge of the tentorium (blue arrow)

Midbrain is displaced to the contralateral side, effacing the contralateral ambient cistern (red arrow)
Uncal herniation

Ipsilateral perimesencephalic cistern is visualized (blue arrow)

Contralateral cerebral peduncle is squeezed against the contralateral tentorial edge (red arrows)
Central transtentorial herniation, descending

**Causes:**
- Mass effect in the frontal, parietal, and occipital lobes

**Complications:**
- Third nerve palsy
- Posterior cerebral artery compression
- Anterior choroidal artery compression
- Duret’s brainstem hemorrhage
- Aqueductal obstruction

**Imaging signs:**
- Obliterated basal cisterns
- Downward displacement of the diencephalon
- Downward displacement of the medial temporal lobes
- Hydrocephalus from aqueduct obstruction
- Compressed 4th ventricle

• Caudal descent of brain tissue through the tentorial incisura
Central transtentorial herniation, descending

2 y.o. girl, on ECMO< fixed an dilated pupils

Effaced basal cisterns

Downward displacement of the diencephalon (red arrow)
Tonsillar herniation

Causes:
- Most commonly caused by a posterior fossa mass
- Supratentorial mass that causes downward transtentorial herniation

Complications:
- Damage cardiac and respiratory centers of the brainstem (death)
- Occlusion of the posterior inferior cerebellar arteries (infarction)

Imaging signs:
- Tonsils below the foramen magnum
- Anterior brainstem displacement
- Loss of CSF surrounding the brainstem

• Caudal descent of cerebellar tonsils through foramen magnum
Tonsillar herniation

4 yo boy, baseline

Patent cisterna magna
Patent foramina of Luschka
Beam hardening artifact

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Tonsillar herniation

Same 4 yo boy, 2 years later, status epilepticus

- Effaced premedullary cistern
- Effaced foramina of Luschka
- Beam hardening artifact
- Effaced cisterna magna
# Central transtentorial herniation, ascending

- Cranial ascent of cerebellar tonsils through the incisura

## Causes:
- Posterior fossa lesion with mass effect
- Trapped fourth ventricle

## Complications:
- Venous compression vein of Galen and basal vein of Rosenthal
- Aqueduct of sylvius compression (hydrocephalus)

## Imaging signs:
- Effacement of the superior cerebellar cistern
- Superior displacement of the superior vermis through the incisura
- Compression of the midbrain
- Forward displacement of the pons against the clivus
- Compression of fourth ventricle (except in trapped fourth ventricle)
Incisura

- Midline opening of the tentorium
13 y.o. girl, baseline

Preserved pre-pontine cistern

Preserved supra-cerebellar cistern

Tentorium

Table of Contents
Central transtentorial herniation, ascending

13 y.o. girl with left posterior fossa tumor

- Effaced pre-pontine cistern
- Compressed 4th ventricle
- Superior displacement of the superior vermis through the incisura
- Effaced supra-cerebellar cistern
External herniation

Causes:
- Trauma
- Surgery

Imaging signs:
- Brain outside the skull margins

Brain tissue protruding through the skull
Also known as “fungus cerebri”
3 y.o. boy, non-accidental trauma + edema, right frontal craniectomy
END OF MODULE #6

- Click next slide for references
- Click on the link below to open the next module
References