Coronal

Normal anatomy

Sagittal

Normal anatomy

Posterior fossa

Normal anatomy

Hemorrhage

- Choroid and acute hemorrhage are similar in echogenicity
- It is therefore important to know the normal location of the choroid plexus to differentiate from adjacent hemorrhage
Hemorrhage

- Choroid plexus
  - Lies on the floor of the bodies of lateral ventricles
  - Hugs the basal ganglia at the atria
  - Dips into roof of third ventricle at the foramina of Monro
  - Is absent from frontal horns; occipital horns

Germinal matrix

- Anterior horn
- Germinal matrix
- Head of caudate
- Posterior horn
- Tentorial incisure
- Recess of third ventricle
- Third ventricle
- Third ventricle
- Basal vein
- Basal ganglia
- Basal vein
- Basal ganglia

Germinal matrix hemorrhage

Grade I: Confined to the Germinal Matrix

Grade II: Extending into the ventricles insufficient to dilate ventricles

Grade III: Extending into the ventricles sufficient to dilate ventricles

Grade IV: Extending into the ventricles Periventricular hemorrhagic infarction
Germinal matrix hemorrhage
- Sequelae of germinal matrix hemorrhage
  - Hydrocephalus

Choroid plexus hemorrhage
- Similar to underlying choroid
  - Location
  - choroid thickness
  - contour
    - May need CT or MR to differentiate

Posterior fossa hemorrhage
- Very premature infants
- Hemorrhagic diathesis: ECMO
  - FINDINGS:
    - Amorphous echogenicity
    - Loss of normal posterior fossa anatomy
    - Echogenicity in cerebellar hemispheres
    - Mass effect

Posterior fossa hemorrhage
- 25 week, 690 gram premature infant
Posterior fossa hemorrhage

Term infant on ECMO

Parenchymal hemorrhage

- Hemorrhagic diathesis
- ECMO

Ischemia

- Periventricular Leukomalacia
- Hypoxic / Ischemic Lesion
- Territorial Infarction
- Premature
- Edema
- Gray / white differentiation

Periventricular leukomalacia

- Ischemia
  - Watershed zone of penetrating cortical vessels and periventricular branches
  - White matter
  - Oligodendrocyte progenitors
  - Pre-oligodendrocytes
  - Subplate neurons
- Typically symmetric
- Parieto-occipital
- Frontoparietal

Microangiograph of development of cerebral vasculature

Takahama & Tanaka

Periventricular leukomalacia

ACUTE
Hypoxic – ischemic injury

Doppler Examination

Normal arterial waveform: forward diastolic flow
RI: 75 ± 10

Necrosis – apoptosis continuum

• Oxidative stress & excitotoxicity
• Downstream intracellular signaling
• Inflammation and repair

Ischemia
- Decrease of ATP
  - Failure of ATP sodium/potassium pump
  - Membrane depolarization
- Release of vasoactive neuropeptides
  - GLUTAMATE
- Loss of autoregulation
- Increased diastolic flow
**Territorial infarction**

- Often asymptomatic
  - Symptoms nonspecific
    - Seizures
    - Hypotonia
- Left middle cerebral artery territory most frequently affected
  - Edema localized to vascular territory

**Territorial infarction**

- Territorial edema
  - Loss of gray/white differentiation
  - Definition of cortical/sulcal interfaces
    - Variable
  - Extends to skull surface
  - Mass effect
  - Increased echogenicity
    - Not indicative of hemorrhage

**Territorial infarction**

- Bland
- Hemorrhagic

**Territorial infarction**

- Acute
- Chronic

**TORCH INFECTION**

- Toxoplasmosis
- Rubella
- CMV
- Herpes
Congenital infection

- Calcifications
  - Periventricular
  - Parenchymal
- Atrophy
- Migration anomalies
  - CMV
- Lenticulostriate vasculopathy

Lenticulostriate Vasculopathy

- What is it?
  - Basophilic and cellular infiltrate
  - Medium-sized arteries
  - Basal ganglia
  - Not calcified
  - Not visible on CT

CMV with Lissencephaly

Lenticulostriate Vasculopathy

Initial Description

- TORCH
  - CMV
  - Rubella
  - Syphilis
- Trisomy 13
- Asphyxia

Expanded Associations

- Trisomy 21
- Toxoplasmosis
- Prenatal EtOH, cocaine
- Multiple pregnancy
- Cyanotic congenital heart disease
- Unknown
- Largely normal if dissociated from underlying conditions
**Congenital Anomalies**

- Agenesis of corpus callosum
- Migration anomalies
- Schizencephaly
- Holoprosencephaly
- Hydranencephaly
- Arnold Chiari Malformation
- Dandy Walker
- Vein of Galen aneurysm

**Genetic of Corpus Callosum**

- 12 - 20 week of gestation
- Lamina terminalis at rostral end of prosencephalon provides bridge for decussating fibers
- Growth is anterior to posterior
- Rotates and defines the cingulate gyri

**Corpus Callosum**

- Complete agenesis
- Partial agenesis
Agenesis of Corpus Callosum

- Cingulate gyri do not invert, laterally displaced
  - Separated frontal horns
  - Parallel lateral ventricles
- Hemispheres are permitted to separate
  - Widening of interhemispheric fissure
- Cingulate sulcus does not form
  - Gyri radiate from third ventricle

Agenesis of Corpus Callosum

- Undecussated axons (Bundles of Probst) appose the roofs of the lateral ventricles
- Leaves of septum pellucidum: deviated, attenuated or absent
- Roof of third ventricle is permitted to rise to a variable degree between lateral ventricles
- Dilatation of occipital horns (colpocephaly)
- Limbic system: hippocampal, cingulate gyral malformations
Agenesis of Corpus Callosum

Associations
- Chromosomal abnormalities
  - Trisomy 8, 13, 18
- Aicardi syndrome
  - X-linked (male lethality)
  - Infantile spasms, agenesis, eye, vertebral anomalies, arachnoid cysts
- Migration anomalies
  - Pachygyria, polymicrogyria, lissencephaly, heterotopia

Migration anomalies

- Neuronal migration complete by 20 – 24 weeks gestation
- Gyrification development
  - Most rapid 26 – 28 weeks
  - Continues post-term

Migration anomalies

Lissencephaly
- Thin outer neuronal layer, cell-sparsely dispersed layer
- Disorganized inner mantle
- Smooth brain

- Pachygyria
  - Better organized, smaller cell-sparse layer
  - Broad gyri, fewer in number

- Polymicrogyria
  - 4-6 layer, abnormally laminated cortex
  - Neuronal organization
  - Small gyri, increased in number

- Gray matter heterotopia
  - Extracortical ectopic neurons

Migration anomalies

Pachygyria
- Broad, few gyri
- Agenesis of corpus callosum

Migration anomalies

Polymicrogyria
- Thin, numerous gyri
- Agenesis of corpus callosum
Migration anomalies
Subependymal heterotopia

Wavy contour of lateral ventricles
Agenesis of corpus callosum

Schizencephaly
- Clefts lined by gray matter
- Pia - ependymal continuity
- Closed - lip
- Open - lip
- Bilateral: 80%
- Prognosis dependent on extent
- Etiology unknown
  - Familial
  - In utero injury

Schizencephaly

Holoprosencephaly
- Failure of cleavage of prosencephalon
  - 5th - 6th week gestation
- Spectrum
  - Alobar → Semilobar → Lobar
- 1/250 spontaneous abortions
- ~1/10,000 live births
- 1.4:1 male:female
- Trisomy
  - 13, 18

Holoprosencephaly
- Alobar
  - Monoventricle: overlying dysplastic cortex
    - Posterior membrane: dorsal cyst
    - Olfactory bulbs absent
- Semilobar
  - Posterior fissure
    - Olfactory bulbs absent or hypoplastic
- Lobar
  - Anterior falx present but hypoplastic
    - Septum pellucidum is absent
    - Olfactory bulbs absent, hypoplastic, or normal

Holoprosencephaly
- Cyclopia
- Ethmocephaly
- Cephalocephaly
- Hypotelorism
- Median Cleft

Spectrum
- More severe facial anomalies correlate with more severe forms of holoprosencephaly
- Severe holoprosencephaly may be seen with less severe facial anomalies: 30%
Holoprosencephaly

Alobar Holoprosencephaly

Semilobar Holoprosencephaly

Hydranencephaly

- Destruction or resorption of most of cerebral mantle
- Vascular event
  - CMV
  - Toxoplasmosis

Arnold-Chiari Malformation

- Small posterior fossa
  - Inferior displacement of 4th ventricle, medulla, cerebellum
  - Elongation and thinning of medulla and pons
- Colpocephaly
- Beaking of quadrigeminal plate
- Beaking of floor of frontal horns: “batwing”
  - Prominent head of caudate
- 3rd ventricular enlargement
  - Large pineal recess
- Large massa intermedia
- Abnormalities of corpus callosum
- Stenogyria

Arnold-Chiari Malformation

Arnold-Chiari Malformation
**Arnold-Chiari Malformation**

- Agenesis or hypoplasia of vermis
  - Continuity between 4th ventricle and cisterna magna
  - Obstruction to CSF flow at the foramina of Luschka and Magendie
  - Hydrocephalus

**Dandy Walker**

- Agenesis or hypoplasia of vermis
  - Continuity between 4th ventricle and cisterna magna
  - Obstruction to CSF flow at the foramina of Luschka and Magendie
  - Hydrocephalus

**Vein of Galen Aneurysm**

- Arteriovenous malformation
  - Aneurysmal dilatation of draining vein
- Steal phenomenon
  - Hypoperfusion of parenchyma
  - Ischemic changes

**Vein of Galen Aneurysm**

- Arteriovenous malformation
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Vein of Galen Aneurysm

Medieval Anatomy Class

Thank you for your attention