Neurosonography: State of the art

Lisa H Lowe, MD, FAAP
Professor and Academic Chair, University MO-Kansas City
Pediatric Radiologist, Children’s Mercy Hospitals and Clinics
Learning objectives

After this talk, the listener should be able to:

Describe modern screening head US

Update their own practice protocols

Perform modern head US with Doppler
Outline - Discuss

Modern head US technique:

- Anatomy
  - Anterior fontanel
  - Posterior fontanels
  - Screening Doppler & RI’s
  - Linear

- Normal variants/pitfalls
- Compare normal vs pathology
Screening head US

- **Old way**: Gray scale only

- **Modern way**: Doppler screening
  - Arterial & Venous
  - Resistive index
- Posterior fontanels
- **Linear 12 - 4 mHz**: Cortex and basal ganglia
RULES OF NORMAL ANATOMY:

**White matter should look like white matter**

**Gray Matter should look like gray matter**
RULES OF NORMAL ANATOMY:

1. Normal is symmetric, but symmetric is NOT always normal

2. US can screen anatomy, vessel patency & resistance
Normal Anatomy

Modern basics..
Screening coronal US: 3 parts

Via anterior fontanel:

1. Gray scale
2. Doppler
   - Color
   - Spectral
3. Linear
6-8 Coronal gray scale views

1. Frontal lobes:
   - Orbital Cones
   - Inter-hemispheric fissure
Gray scale coronal

2. Frontal horns:
   - Corpus callosum
   - Cavum septum pellucidum
   - Subarachnoid space
3. Thalami:
- Thalamus
- Foramen of Monro
- Third ventricle
- Caudate nucleus
- Midbrain (M)
4. **Body lateral ventricles:**

- Lateral ventricles
- 4\(^{th}\) ventricle
- Cerebral peduncle (CP)
- Sylvian fissure (SF)
5. Cisterna magna:
- Cisterna magna
- Cerebellum (CB)
- Quadrigeminal plate cistern (Q)
- Lateral ventricles
Gray scale coronal

5. Cisterna magna:
- Dancing ‘lady’
- Always has a clean dress – NO spots!

Spot on the lady’s dress!
Gray scale coronal

6. Choroid plexus:

**Rule:** White matter always < echogenic than choroid plexus
Gray scale coronal: Cortex

**Rule: 3 layers**
- Pia - echogenic
- Gray matter - hypo
- White matter - hyper
7. Occipital lobes:

- Occipital lobes
- Interhemispheric fissure
1. Midline Sagittal:
- Cavum septum pellucidum
- Corpus callosum
- Massa intermedia (MI)
- 3rd ventricle
- Aqueduct
- 4th ventricle
- Vermis (V)
Gray scale sagittal

2. Right CT groove:
   - Caudate-thalamic groove
   - Thalamus
Gray scale sagittal

3. Right lat vent:
- Entire lateral ventricle
- Choroid plexus
- Temporal lobe
- Occipital lobe
- Thalamus
- Caudate
Gray scale sagittal

4. Right Sylvian fissure:
   - Sylvian fissure

Note echogenicity of pia, cortex and white matter
5. Left CT groove:
- Caudate (C)
- Thalamus (T)
Gray scale sagittal

6. Left ventricle:
- Entire ventricle
- Choroid
- Temporal lobe
- Occipital lobe
- Caudate
- Thalamus
Gray scale sagittal

7. Left Sylvian fissure:
   - Temporal lobe
Standard sagittal views

**Posterior fossa:**
- Cisterna magna
- Cerebellum (C)
- Midbrain

![Image with annotations](image)
Posterior fossa views

**Cerebellum:**

- Cisterna magna
- Side ways dancing lady

- 3rd
- Cisterna magna
Posterior fossa views

**Posterior fossa:**
- Rotate 90 degrees

![Diagram of the posterior fossa with labeled structures: Cisterna magna, Dancing lady, and 3rd.]
Screening Doppler US

Doppler MCA RI’s

Anterior fontanel -
1. Coronal arterial -
   - RI (Normal) 0.60 - 0.90
2. Sagittal venous -
   - Sagittal sinus
   - Vein of Galen

RI – 0.79
Anatomy: Screening Doppler

- Normal RI’s: highest in premies & decrease up to age 2
- RI’s NOT accurate in cardiac disease

**General approximation:**
- Premie - 0.8 (+/- 0.05)
- Term - 0.7 (+/- 0.05)
- 1 year - 0.6 (+/- 0.05)
- 2+ years - 0.5 (+/- 0.05)

0.6-0.9 ballpark all infants
Screening Doppler: Arterial

MCA or ICA RI’s

Rt ICA

Lt MCA

RI=0.71
Screening Doppler: Transtemporal (TCD)

**Circle of Willis:**
- ICAs harder to see
- Closed anterior fontanel
  - Sickle cell
  - post-hemorrhage vasospasm
Screening Doppler: Venous

Via anterior fontanel, Sagittal plane
- Vein of Galen
- Sagittal sinus

Sup Sag Sinus

VOG
Screening Doppler: Venous

Via posterior fontanel
- Transverse sinus

Transv sinus

Midbrain

Cerebellum
Screening Doppler: Power

Normal

Hyperemia – Hypoxic injury
Screening linear:

- Layers of cortex
  - Pia
  - Cortex/gray matter
  - White matter

- Subarachnoid
  - Many vessels
  - Symmetric
Normal Variants

Vs.

Pathology
Normal Variants: Immature Sulcation

>24 weeks, Sylvian fissure is present.

Occipitoparietal fissure seen at 24 weeks.
Term Sulcation

Cingulate gyrus forms at 28 weeks

Sulcal branching occurs > 30 weeks
Abnormal: Lack of sulcation

- No cingulate gyrus
- Agenesis Corpus Callosum

Choroid plexus
Normal Variants: Cavum Septum Pellucidum

- Fluid between leaves of septum pellucidum

Cavum Septum Pellucidum closes by 3-6 months
Normal Cisterna Magna

Cavum septum pellucidum

Normal cisterna magna 7 mm

3rd

V

Choroid plexus

Normal Cisterna Magna: 3-8 mm sagittal
Mega Cisterna Magna vs. Arachnoid cyst

- MCM < 8mm
- Arachnoid cyst - mass effect
  - ? Significance
  - ? Retrocerebellar cyst
- DDx: Dandy Walker malformation
Normal Variants: Asymmetric Ventricles

20-40% infants

Lateral ventricles - smaller as infant matures

Normal = <10 mm transverse
Abnormal: Ventriculomegaly

- Vents > 10mm
- Colpocephaly
- Ddx: Chiari 2, PVL or Agenesis Corpus Callosum

• Agenesis corpus callosum
Normal Variants: Choroid Plexus Variants

- Bulbous glomus
- Echoes anterior to caudothalamic groove = germinal matrix hemorrhage

Abnormal: Germinal matrix hemorrhage
Normal Variants: Choroid Plexus Cysts

- Isolated variant 1% pregnancies
- Round, < 1 cm
- ? chromosomal aneuploidy if > 2 cm, multiple, and/or bilateral
Normal Variants: Connatal cysts

• **Synonyms:** subfrontal or frontal horn cysts

• **Bilateral,** symmetric, **multiple,** "string of pearls"
Periventricular cysts summary

• A = Periventricular leukomalacia
  • Abnormal

• B = Connatal cysts
  • Normal

• C = Subependymal cysts
  • Abnormal

Image courtesy of radiology resident artist, Reza Zinati, MD
Normal Variants: Subependymal Cysts

• Congenital (germinolytic) vs acquired (posthemorrhagic)

• Congenital (germinolytic) - ? cause hypoxia, hemorrhagic, infection, genetic, metabolic
Normal Variants: Hyperechoic Pseudolesions

Rotation of the transducer 90 degrees to lesion resolves, thus normal.
Abnormal: Periventricular WM

- WM = echogenic
- 90 degrees – still echogenic
- 3 wk follow up
Normal Variants: Periventricular Halo

Periventricular white matter - normally hyperechoic

Normal echogenicity < adjacent choroid plexus

Asymmetric or heterogeneous WM - abnormal
Abnormal: Asymmetric white matter

- Infant on ECMO

- 24 hr f/u
- Blood
Normal Variants: Lenticulostriate Vasculopathy

Nonspecific association with TORCH infections, chromosomal abnormalities, malformations, and hypoxic ischemic states

Unilateral or bilateral; Branching, linear or punctate echogenicity
Conclusions:

Age of “radiation awareness”, high quality US is more important than ever

US technology has advanced greatly

Radiologists must use updated US techniques
Thanks for your attention

http://www.umkcradres.org/education/peds/neuro/index.htm