Neonatal Brain Ultrasound

I. Patient Preparation

a. None.

II. Equipment

a. Performed with real-time scanner using a sector or curved linear transducer (C9-4 MHz)
b. Higher frequency transducer (12.5 MHZ) may be helpful to evaluate the subarachnoid and subdural spaces as well as limited views of midline and parasagittal structures.

III. Procedure Protocol

a. Technique
    i. Appropriate Depth, Gain (power), Slope (Time gain curve), and Focal zone settings
    ii. Depth control should be adjusted for each image to ensure that the whole brain is included with optimum magnification, so that the image fills the entire screen
    iii. Focal zone settings should be used to produce a uniform echo pattern in the near and far fields
    iv. Images should be symmetrical about the midline
    v. Anterior fontanelle: closes around 9-15 months, imaging coronal, sagittal/parasagittal, angled coronals
    vi. Posterior fontanelle (if needed): closes at 2-6 months, can provide access to more posterior and inferior portions of the brain (infratentorial evaluation, occipital horns, posterior fossa abnormalities). Image midline then angle to right bring back to midline, then angle to left bring back to midline.
    vii. Mastoid fontanelle (if needed): scan plane parallel to base of skull (along the canthomeatal line) about 1cm posterior and superior to the cavity of the ear cartilage, with baby's head in lateral position if possible, can provide access to posterior fossa structures, coronal and axial planes
    viii. Do not mistake the cavum septum pellucida (completely closed in 80% of infants by 3-6 months of age) for the 3rd ventricle (which is a midline structure located inferior to the cavum septum pellucida)
b. Coronal Images
    i. Minimum of 6 routine coronal images.
    ii. Scanning begins in the anterior portion of the brain using the anterior fontanelle as an acoustic window, then sweeps posterior.

A curved linear or sector transducer is used to obtain the following images:

iii. Coronal Anterior – landmarks (at level of frontal lobes)
    1. Frontal lobes of the cerebral cortex
    2. Anterior cranial fossa
    3. Orbits
    4. Interhemispheric fissure
    5. No ventricles are identified in this plane (if the frontal horns are visible, then plane is too posterior!)

iv. Coronal Anterior – landmarks (at level of frontal horns)
    1. Frontal horns of lateral ventricles (obtain width of frontal horns at this level when applicable). Frontal horns crescent shaped, usually containing CSF, although if normal minimal CSF then bright specular relecors seen.
    2. Genu and anterior body of corpus callosum
    3. Head of caudate nucleus
    4. Cavum septum pellucidi
    5. Temporal lobes of the cerebral cortex
    6. Interhemispheric fissure

v. Coronal Mid – landmarks (at level of brainstem):
    1. Body of lateral ventricles (slight asymmetry between the ventricles is common and not necessarily abnormal)
    2. Third ventricle (located below both lateral ventricles and cavum septum pellucidum, if present)
    3. Cavum septum pellucidi (corpus callosum appears above the cavum)
    4. Thalami
    5. Sylvian fissure
    6. Temporal lobes of cerebral cortex
    7. Brainstem

vi. Coronal Mid – landmarks (at level of quadrigeminal plate cistern, "echogenic star" is landmark)
    1. Body of lateral ventricles
    2. Thalamus
    3. Choroid plexus in floor of lateral ventricles
    4. Choroid plexus of 3rd ventricle (superior point of "star")
    5. Choroidal fissures (superolateral points of "star")
    6. Tentorium cerebelli (inferolateral points of "star")
    7. Cerebellar vermis
    8. Cerebellar hemispheres
    9. Cisterna magna

vii. Coronal Posterior – landmarks (at level of glomus of the choroid plexus of the lateral ventricles)
    1. Trigone (antrum) of lateral ventricles (obtain atrial width at

this level when applicable). A small anechoic CSF gap is often noted between the echogenic glomus of the choroid plexus and the smooth edge lateral ventricles, although a larger degree of CSF gap would be suspicious for pathology.
2. Glomus of choroid plexus
3. Tentorium
4. Cerebellar hemispheres
5. Parietal lobes of cerebral cortex

viii. Coronal Posterior – landmarks (at level of occipital lobes)
1. Occipital lobes of cerebral cortex (should be symmetric and similar in echogenicity).
2. Longitudinal fissure in midline
3. No ventricles present
4. Centrum semiovale

ix. Coronal angled view — to obtain images of extra- axial fluid over convexities of cerebellum
1. Angled view of the subarachnoid/subdural spaces to the left of the foramen of Monroe
2. Angled view of the subarachnoid/subdural spaces to the right of the foramen of Monroe

c. Sagittal Images

i. Minimum of 7 sagittal routine images. Scanning begins midline using the anterior fontanel as an acoustic window and sweeps laterally. A curved linear or sector transducer is used to obtain the following images:

ii. Midline - landmarks:
a. Corpus callosum (to include genu and splenium)
b. Cavum septum pellucidum / vergae when present
c. Third ventricle
d. Fourth ventricle
e. Echogenic cerebellar verrnis
f. Frontal lobe of cerebral cortex
g. Occipital lobe of cerebral cortex

iii. @ 10 degree lateral angle — landmarks (parasagittal at level of caudothalamic groove)
1. Move transducer to the side of the fontanelle opposite the ventricle of interest, the posterior edge of the transducer may be more lateral than the anterior edge.
2. Lateral ventricle (primarily frontal horn and body)
3. Caudate nucleus
4. Thalamus
5. Caudothalmic groove
6. Choroid plexus

iv. @ 20 degree lateral angle — landmarks:
    1. Lateral ventricle (primarily body and occipital horn) (length of occipital horn of lateral ventricle may be taken from this view when applicable)
    2. Choroid plexus
    3. Temporal lobe of cerebral cortex
v. @ 30 degree lateral angle – landmarks (at level of Sylvian fissure)
    1. Parietal lobe of cerebral cortex
    2. Sylvian fissure/lateral sulcus
    3. No ventricle present

d. Axial Images
    i. These views are obtained when fetal positioning and monitoring equipment allow access to various fontanelles.
    ii. Perform Doppler analysis of both MCA's, from a transtemporal approach, taken at a level just anterior and superior to the external auditory meatus, and record a RI. The flow in the ipsilateral MCA, at this level, is identified in a lateral course toward the transducer The flow in the contralateral MCA is identified in a lateral course away from the transducer.
    iii. Obtain view of the posterior fossa using a sector or curved linear transducer from the posterolateral (mastoid) fontanelle. (when possible)
        1. One View obtained in an axial projection with transducer orientation marker towards infant's face
        2. One view obtained in a coronal projection with transducer orientation marker towards the vertex of the infant's head

e. Ventricular Measurements
    i. Width of frontal horn of lateral ventricle, taken from coronal image
    ii. Width of 3rd ventricle, taken from coronal image, when applicable
    iii. Width of trigone (antrium) of lateral ventricle, taken from coronal image (perform this measurement first, if >10 mm, then take other ventriclular measurements listed, if <l0 mm, no other measurements are necessary
    iv. Length of occipital horn of lateral ventricle, taken from sagittal image
    v. Presence of 4th ventricle

f. Doppler Analysis
    i. Perform Doppler analysis, measuring the Resistive Index (RI), on each MCA from a transaxial approach
    ii. If baseline Doppler analysis is normal: RI=75 +/- 10, then repeat Doppler analysis is not necessary, unless follow up examination is ordered within 72 hours of birth.
    iii. Repeat Doppler analysis if baseline RI is abnormal
        1. RI<60 = indicative of acute hypoxemia

2. RI>85 = indicative of late effects of cerebral edema

g. Coronal Images
    i. Frontal Horns of lateral ventricles at level of foramen of Monroe / caudothalmic groove.
h. Sagittal Images
    i. Midline view of cavum septum pellucidi/vergae and corpus callosum
    ii. @ 10 degree lateral angle (parasagittal view) of right and left caudothalmic groove
i. Additional views using high frequency linear array transducer obtained through the anterior fontanelle.
    i. Evaluation of subarachnoid space. If firm transducer pressure is applied to the anterior fontanelle, the superior sagittal sinus may be compressed and the subarachnoid space distorted. Large amounts of coupling gel are advisable to maintain adequate contact, particularly if the infant has a lot of hair.
        1. Subarachnoid space must be assessed in neonates with enlarged head circumference
        2. Localized views (coronal and sagittal) of the superficial three or four centimeters of the brain tissue and the brain surface immediately subjacent to the anterior fontanelle can be taken, using a high frequency linear array. These views allow better assessment of the brain parenchyma, meninges, subarachnoid space (greater than 5 mm is considered enlarged) and extra-axial fluid collection.
        3. The frequency of the transducer should be selected to ensure that the superficial and deep structures are well depicted. This may necessitate using more than 1 frequency setting, a linear transducer, or a standoff pad to aid in imaging of the superior sagittal sinus and superficial central cerebral structures.
    ii. Coronal Images
        1. Frontal horns of lateral ventricles at level of foramen of Monroe / caudothalmic groove.
    iii. Sagittal Images
        1. Midline View of cavum septum pellucidi/vergae and corpus callosum
        2. @ 10 degree lateral angle (parasagittal view) of right and left caudothalmic groove
    iv. Mastoid Fontanelle
        1. Axial images - Landmarks
            a. Cerebellum
            b. Posterior tentorium
            c. Cerebral peduncles

d. Fourth ventricle

j. References
   i. http://www.radiologyassistant.nl/en/440c93be7456f
   ii. http://www.ajronline.org/content/176/4/995.full
   iii. Online Neurosonography Lecture http://www.sonographycme.com/cfm/lectures/lect001003.cfm