NEONATAL BRAIN ULTRASOUND EXAMINATION

POLICY: Neonatal brain ultrasound or neurosonography will be performed with an order from a physician or other qualified clinical practitioner. The examination will be supervised and interpreted by a radiologist or other licensed practitioner who is qualified by reason of training to understand the normal anatomy and pathophysiology of the neonatal brain, and integration of ultrasound with other imaging techniques to optimize the probability of detecting disease.

PURPOSE: To assess the anatomy of the neonatal brain and document normal and abnormal structures therein.

INDICATIONS: Neonatal and infant neurosonography is indicated for patients with signs and/or laboratory evidence of disease involving the neonatal brain. Such indications include, but are not limited to: bulging fontanel, decrease in blood pressure and/or hematocrit, abnormal level of consciousness, weakness, lethargy and macrocephaly. Neonatal head ultrasound may include, but is not limited to, evaluation for: hemorrhage or parenchymal abnormalities, hydrocephalus, hypoxic ischemic encephalopathy, craniosynostosis, congenital or acquired brain infections and suspected congenital malformations. Screening ultrasound of the neonatal head is indicated for preterm infants at risk for hemorrhage or parenchymal abnormalities (<32 weeks). Screening may also be indicated prior to surgical procedures. Neurosonography is also used to survey and monitor progression or resolution of previously demonstrated intracranial disease, including prenatal abnormalities.

PATIENT PREPARATION: There is no special preparation for this examination. However, the quality of neonatal head ultrasound decreases with age of the infant. The two primary sonographic windows for acquiring ultrasound images of the brain are the anterior and posterior fontanels. The posterior fontanel closes at 2-3 months of age and the anterior fontanel closes at 9-18 months of age. Diagnostic quality of neurosonographic imaging decreases as these fontanels get progressively smaller and eventually close altogether.

PROCEDURE: Neonatal brain ultrasound will be performed with the patient in a supine position. Sonographer’s hands should be washed and gloved when handling neonates and performing the ultrasound examination. As a precaution to minimize the possibility of disease transmission, the transducer should be cleaned with a disinfectant wipe before the ultrasound examination and single-dose sterile ultrasound gel should be used. If possible, gel should be warmed prior to use (eg: wrapped in a warm towel). The highest frequency transducer(s) that will allow adequate penetration and field of view should be used in order to optimally visualize brain anatomy. The sonographer should be careful to apply minimal pressure to the fontanel (only enough to maintain contact). The neonatal brain should be imaged in its entirety (e.g. coronal and sagittal
views) via the anterior fontanel. Additional views may be obtained through the posterior fontanel, mastoid fontanel and/or sphenoidal/temporal fontanel. A high frequency linear transducer should be used when imaging peripheral brain structures. Minimal required images are based on the ACR-AIUM-SPR-SRU Practice Parameter for the Performance of Neurosonography in Neonates and Infants (Revised 2014). The order of imaging will be as follows (minimal number of images in parenthesis):

ANTERIOR FONTANAL APPROACH

- Coronal (6 images, 1 cine)
- Sagittal (12 images, 2 cines)

CORONAL
- Coronal images should be oriented so that the right side of the brain is displayed on the left side of the ultrasound image. The brain should be surveyed completely with an anterior to posterior sweep. Images should be labeled coronal brain ant-post obtained sequentially in an anterior to posterior fashion. Additional images may be required to fully document the findings.

- Minimal stored images should include:
  - One coronal view of the frontal lobes anterior to the frontal horns of the lateral ventricles with orbits visualized deep to the skull base.
  - One coronal view of the frontal horns of the lateral ventricles. An attempt should be made to also demonstrate the following: interhemispheric fissure, basal ganglia (caudate nuclei, putamina, globi pallidi) and temporal lobes.
  - Two coronal views of the bodies of the lateral ventricles. An attempt should be made to also demonstrate the following: interhemispheric fissure, cingulate sulcus, corpus callosum, cavum septum pellucidum or septum pellucidum, foramina of Monroe, third ventricle, choroid plexus (with fornix) in the roof of the third ventricle into the lateral ventricles, thalami, caudate nuclei, sylvian fissures, aqueduct of Sylvius, fourth ventricle, temporal horns of the lateral ventricles, midbrain (mesencephalon), pons and medulla.
  - One coronal view of the trigone of the lateral ventricle with the echogenic glomi of the choroid plexuses. An attempt should be made to also demonstrate the following: splenium of the corpus callosum, quadrigeminal plate/cistern, occipital horns of the lateral ventricles, cerebellum (vermis and hemispheres) and cisterna magna.
  - One coronal view posterior to the occipital horns of the lateral ventricles, demonstrating periventricular blush (parietal and occipital lobes) and the posterior interhemispheric fissure.
  - One coronal cine sweep from far anterior to far posterior.
  - Two high-resolution, coronal views of the subarachnoid space and interhemispheric fissure; one view should include color Doppler, optimized to identify vessels coursing through the subarachnoid space.
SAGITTAL

- Sagittal images should be oriented so that the anterior aspect of the brain is displayed on the left side of the ultrasound image. The brain should be surveyed completely with a left to right sweep. Images of the left brain should be obtained sequentially from left lateral to midline and labeled \textit{sagittal brain Lt-ML}. Subsequently, images of the right brain should be obtained sequentially from midline to right lateral and labeled \textit{sagittal brain ML-Rt}. Additional images may be required to fully document the findings.

- Minimal stored images should include:

  \textit{(sagittal brain Lt-ML)}
  - One left parasagittal view to demonstrate the insula and sylvian fissure.
  - One left parasagittal view in the periventricular region to demonstrate periventricular blush (deep white matter of the frontal, parietal and occipital lobes).
  - Two left parasagittal views of the lateral ventricle demonstrating the caudothalamic groove (caudate nucleus and thalamus).
  - One or more additional left parasagittal view(s) of the lateral ventricle, to include all other parts of the lateral ventricle. An attempt should be made to also demonstrate the following: choroid plexus, cerebellar hemisphere and periventricular region (frontal, parietal and occipital lobes).
  - One or more midline sagittal view(s) of the corpus callosum. An attempt should be made to also demonstrate the following: cingulate sulcus, cavum septum pellucidum or septum pellucidum, cavum vergae (if present), third and fourth ventricles, aqueduct of Sylvius; midbrain (mesencephalon), pons, medulla, quadrigeminal plate/cistern, cerebellar vermis, cisterna magna; and sulci (if present).
  - One sagittal cine sweep of the left brain from left lateral to midline.

\textit{(sagittal brain ML-Rt)}
  - One additional midline sagittal view.
  - Two right parasagittal views of the lateral ventricle demonstrating the caudothalamic groove (caudate nucleus and thalamus).
  - One or more additional right parasagittal view(s) of the lateral ventricle, to include all other parts of the lateral ventricle. An attempt should be made to also demonstrate the following: choroid plexus, cerebellar hemisphere and periventricular region (frontal, parietal and occipital lobes).
  - One right parasagittal view in the periventricular region to demonstrate periventricular blush (deep white matter of the frontal, parietal and occipital lobes).
  - One right parasagittal view to demonstrate the insula and sylvian fissure.
  - One sagittal cine sweep of the right brain from midline to right lateral.

\textbf{PATHOLOGIC CONDITIONS}: When pathologic processes are detected during the
course of the examination, extra images are necessary to characterize the abnormality. One or more cine clips should be obtained of any detected pathology. The following is a description of commonly encountered abnormalities, or conditions that should be considered during the examination and the minimum additional stored images expected for each circumstance. The list is not intended to be comprehensive, and sonographers are expected to apply their knowledge of pathophysiology to provide clear images of the abnormalities they encounter. Various sonographic windows may be necessary to optimally view different pathologic conditions. Such sonographic windows might include the posterior fontanel, mastoid fontanel and/or temporal window (sphenoidal fontanel).

Periventricular Leukomalacia (PVL) is a disease of the white matter of the brain that affects the periventricular zones and normally results in cavitation and periventricular cyst formation. Most commonly affects preterm (<33wks) and low birth weight infants (<1500g). PVL occurs as a result of hypoxic-ischemic lesions causing impaired perfusion of the periventricular region of the cortex. Progression of PVL can be monitored using neurosonography. On ultrasound, the periventricular region is normally seen as slightly hyperechoic (periventricular blush), but less echogenic than the nearby choroid plexus. Initial findings consist of areas of increased periventricular echogenicity. This is especially suspicious if the finding is unilateral. On subsequent scan, disease may progress to the development of cysts (this finding is the most predictive sonographic marker for cerebral palsy).

- Grade 1: area of increased echogenicity persists >7 days
- Grade 2: development of small periventricular cysts
- Grade 3: development into extensive periventricular cysts, occipital and fronto-parietal
- Grade 4: in deep white matter developing into extensive subcortical cysts (seen mostly in full term neonates)

Germinal Matrix Hemorrhage (GMH) occurs in the germinal matrix which is densely vascular and present at the caudothalamic groove until 35-36 weeks gestation. Therefore the risk of hemorrhage is markedly reduced in infant older than 36 weeks. Infants at greatest risk for GMH are less than 32 weeks gestation, and the risk increases with extent of prematurity. 90% of hemorrhages are identified within four days of birth. In addition to prematurity, risk factors include low birthweight, cyanotic congenital heart disease, prolonged labor and multiple gestation pregnancy. Many infants with GMH have a vague or asymptomatic presentation. Those with grade III and IV bleeds may present with respiratory depression, abnormal posturing, seizures and bulging fontanels. By ultrasound, GMH appears as echogenic region(s) close to the caudothalamic groove, extending along the floor of the lateral ventricle. This must be differentiated from the normal echogenic choroid plexus within the posterior body of the lateral ventricles which should not extend further anterior than the caudothalamic groove. Therefore, echogenicity anterior to the groove represents hemorrhage. Prognosis is good for grade I and II hemorrhages, but poor for grades III and IV. Grade IV bleeds have a 90% mortality rate.
References:


Website: http://www.acr.org/~media/02fa18ced7c4c42a6cb761c92bd50d8.pdf