AIUM Practice Parameter for the Performance of Neurosonography in Neonates and Infants

Introduction

The American Institute of Ultrasound in Medicine (AIUM) is a multidisciplinary association dedicated to advancing the safe and effective use of ultrasound in medicine through professional and public education, research, development of clinical practice parameters, and accreditation of practices performing ultrasound examinations.

The *AIUM Practice Parameter for the Performance of Neurosonography in Neonates and Infants* was developed (or revised) by the American Institute of Ultrasound in Medicine (AIUM) in collaboration with other organizations whose members use ultrasound for performing this examination(s) (see "Acknowledgments"). Recommendations for personnel requirements, the request for the examination, documentation, quality assurance, and safety may vary among the organizations and may be addressed by each separately.

For the purpose of this practice parameter, infants are defined primarily as those in whom the anterior fontanelle remains open and this parameter is intended to provide the medical ultrasound community with recommendations for the performance and recording of high-quality ultrasound examinations. The parameter reflects what the AIUM considers the appropriate criteria for this type of ultrasound examination but is not intended to establish a legal standard of care. Examinations performed in this specialty area are expected to follow the parameter with recognition that deviations may occur depending on the clinical situation.

Indications

Indications for neurosonography in preterm or term neonates and infants include but are not limited to evaluations for the following entities:

- Abnormal increase in head circumference.
- Hemorrhage or parenchymal abnormalities in preterm and term infants.[1–7]
- Ventriculomegaly (hydrocephalus).[1–5]
- Vascular abnormalities.[2–5,8–10]

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- Suspected hypoxic ischemic injury (hypoxic ischemic encephalopathy).[2–5,11–15]
- Patients on hypothermia, extracorporeal membrane oxygenation, and other support machines.[16]
- Congenital malformations.[2–5]
- Signs or symptoms of a central nervous system disorder (eg, seizures, facial malformations, macrocephaly, microcephaly, and intrauterine growth restriction).[2–5,17]
- Congenital or acquired brain infection.[2–5]
- Suspected or known head trauma.[2–5,18,19]
- Craniosynostosis.[20,21]
- Follow-up or surveillance of previously documented abnormalities, including prenatal abnormalities.[2–5]
- Screening before surgery.

There are no contraindications to neurosonography.

Qualifications and Responsibilities of Personnel

Physicians interpreting or performing this type of ultrasound examination should meet the specified AIUM Training Guidelines in accordance with AIUM accreditation policies.

Sonographers performing the ultrasound examination should be appropriately credentialed in the specialty area in accordance with AIUM accreditation policies.

Physicians not personally performing the examination must provide supervision, as defined by the Centers for Medicare and Medicaid Services Code of Federal Regulations 42 CFR §410.32.

Request for the Examination

The written or electronic request for an ultrasound examination must originate from a physician or other appropriately licensed health care provider or under the provider's direction. The clinical information provided should allow for the performance and interpretation of the appropriate ultrasound examination and should be consistent with relevant legal and local health care facility requirements.

Specification of the Examination

(See also section VII, "Equipment Specifications")

Standard Imaging Examination of the Neonate and Infant[2–5,22]

Any prior imaging should be reviewed before the ultrasound evaluation if available.

The coronal view, by convention, should have the patient's right side on the left side of the image.

Representative coronal views should be obtained by sweeping through the entire brain, from anterior to posterior, using the anterior fontanelle as a sonic window. Coronal views should include the following, sequentially:

- Frontal lobes anterior to the frontal horns of the lateral ventricles with orbits visualized deep to the skull base.
- Frontal horns or bodies of lateral ventricles and interhemispheric fissure.
- Include lateral ventricles at the level of the foramina of Monro (outlining the course of the choroid plexus from the lateral into the third ventricle), interhemispheric fissure, cingulate sulcus (if developed), corpus callosum, septum pellucidum or cavum septi pellucidi, caudate nuclei, putamina, globi pallidi, and Sylvian fissures.
- Lateral ventricles slightly posterior to the foramina of Monro, the point at which the lateral and third ventricles communicate. Include the pons and medulla, thalami, and choroid plexus in the roof of the third ventricle and in the caudothalamic grooves.
- Level of the quadrigeminal plate cistern and cerebellum. Include the cerebellar vermis and cisterna magna.
- Echogenic glomi of choroid plexuses at the posterior aspect of the lateral ventricles at level of trigones. Include the splenium of the corpus callosum at divergence of the lateral ventricle and periventricular white matter lateral to the posterior horns of lateral ventricles.
- Posterior to occipital horns. Include parietal and occipital lobes and the posterior interhemispheric fissure.
- Extra-axial fluid spaces: use high-frequency linear transducers to obtain a coronal magnification view

of the extra-axial fluid space, including peripheral brain structures (superior sagittal sinus at the level of frontal horns; measure the sinocortical distance, craniocortical distance, and width of the interhemispheric fissure)[23]. A color Doppler evaluation of the bridging veins may be performed on this view to help differentiate between subarachnoid hemorrhage and subdural hemorrhage.

The transducer may be tilted from side to side to image as much of the superficial peripheral surfaces of the cerebral hemispheres as possible. The appropriate frequency of the transducer should be selected to ensure that the superficial and deep structures are well depicted. In some larger term or older infants, more than 1 transducer frequency may be needed for optimal evaluation of the supratentorial and infratentorial structures. High-frequency linear transducers may be used for additional detail of abnormalities as needed.

The sagittal view, by convention, should place the anterior aspect of the brain on the left side of the image. The right side, left side, and midline should be clearly annotated. Sequential representative sagittal views are obtained with appropriate degrees of left and right transducer angulation because the frontal horns are somewhat more medial than are the bodies of the lateral ventricles. For the midline view, the transducer should be held in a straight sagittal plane parallel to the midline of the brain. These views should include the following:

- Right and left parasagittal views to show the insula.
- Right and left parasagittal views to show the Sylvian fissure.
- Right parasagittal view to image the deep white matter (periventricular regions).
- Right and left parasagittal views of lateral ventricles, including the caudothalamic groove.
- Right and left parasagittal views of lateral ventricles, showing the choroid plexus.
- Additional parasagittal views to include all parts of lateral ventricles.
- Midline sagittal views to include the corpus callosum, cavum septi pellucidi, and cavum vergae, if present, third and fourth ventricles, aqueduct of Sylvius, brain stem, cerebellar vermis, cisterna magna, and sulci, if present. The branches of the anterior cerebral artery (pericallosal artery and callosomarginal artery) may be visualized as needed.
- Midline anterior cerebral artery pulsed Doppler assessment of the resistive index, as needed,[24] especially for infants with suspected hypoxic ischemic encephalopathy.
- Superior sagittal sinus with color Doppler imaging, as needed.

The mastoid view is primarily used to visualize the cerebellum and may be obtained from both the right and left mastoid fontanelles as needed.

Additional views, if necessary, may be taken through the posterior fontanelle, any open suture, burr hole, craniotomy defect, or thin areas of the temporal and parietal bones.[25] The transtemporal approach may also be used to visualize the circle of Willis and its major branches. The foramen magnum approach may be used to evaluate the brain stem and upper cervical spine, particularly in infants with known or suspected Chiari 1 or 2 malformations.

For patients with ventricular shunt tubes, additional views should be obtained when a shunt tube and its tip are not visualized on routine scans.

When clinically indicated, spectral, color, and/or power Doppler imaging may be useful to evaluate vascular structures through a fontanelle or a transcranial approach. Color or power Doppler imaging may be useful in cases of suspected sinus venous thrombosis.[26,27] Spectral Doppler imaging may be useful in patients with hydrocephalus and hypoxic ischemic brain injury.[27]

When there is concern for craniosynostosis, additional imaging may be performed with a high-resolution linear transducer held perpendicular to the expected course of the coronal, sagittal, lambdoid, and metopic sutures.[21]

Video clips may be obtained for better demonstration of questionable abnormalities, as needed.[28]

Documentation

Accurate and complete documentation is essential for high-quality patient care. Written reports and ultrasound images/video clips that contain diagnostic information should be obtained and archived,

with recommendations for follow-up studies if clinically applicable, in accordance with the *AIUM Practice Parameter for Documentation of an Ultrasound Examination*.

Equipment Specifications

Neurosonographic examinations should be conducted with sector or curved and/or linear transducers that can fit within and image through the anterior fontanelle with the appropriate settings determined by the depth of penetrability.[2–5] Linear transducers are useful in evaluating superficial structures, such as the skull or scalp. If the anterior fontanel is not available, imaging may be performed through available sutural openings or by using a transcranial approach via the thinner squamosal portion of the temporal bone. This approach may require a lower-frequency transducer to penetrate through the bone. The transducer should be adjusted to operate at the highest clinically appropriate frequency, realizing that there is a trade-off between resolution and beam penetration. Higher frequencies are used in premature neonates, term neonates, and young infants, and lower frequencies are used in older infants.

The Doppler power output should be as low as reasonably achievable (ALARA) to answer the diagnostic question.

Quality and Safety

Policies and procedures related to quality assurance and improvement, safety, infection control, and equipment performance monitoring should be developed and implemented in accordance with the *AIUM Standards and Guidelines for the Accreditation of Ultrasound Practices*.

ALARA Principle

The potential benefits and risks of each examination should be considered. The ALARA principle should be observed for factors that affect the acoustic output and by considering the transducer dwell time and total scanning time. Further details on ALARA may be found in the current AIUM publication *Medical Ultrasound Safety*.

Infection Control

Transducer preparation, cleaning, and disinfection should follow manufacturer's recommendations and be consistent with the AIUM Guidelines for Cleaning and Preparing External- and Internal-Use Ultrasound Transducers Between Patients, Safe Handling, and Use of Ultrasound Coupling Gel.

Equipment Performance Monitoring

Monitoring protocols for equipment performance should be developed and implemented in accordance with the *AIUM Standards and Guidelines for the Accreditation of Ultrasound Practices*.

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