

Chapter 2

How to Perform a Neonatal Head Ultrasonography Study

For an informative, diagnostic ultrasonography (US) study of the neonatal brain, a modern, technologically advanced, US unit is essential. Various transducers including vector, curved array, and linear probes capable of scanning at multiple megahertz (MHz) settings should be provided and able to scan at a minimum of 15 MHz in order to reach the optimal tissue quality. Imaging algorithms should be optimized for the preterm (PT) and term (FT) neonatal brains. This “tuning” of the algorithms in cooperation with the manufacturer’s technical representative can dramatically improve resolution, contrast, and detection of pathology and can provide a “high-end” approach for each case.

The study should begin with gray-scale anatomical images accessed through the anterior fontanel (AF) covering the entire brain in coronal (Fig. 2.1) and sagittal (Fig. 2.2) planes. In addition, mastoid fontanel (MF) (Fig. 2.3), posterior fontanel (PF) (Figs. 2.4, 2.5 and 2.6), and suboccipital views through the foramen magnum should be included for a better exploration of the contents of the posterior fossa. Depending on the probe, 3-D data sets may be acquired that allow secondary multiplanar reconstructions which match the more typical CT and MRI imaging planes. Imaging should always take advantage of optimization of all selectable imaging settings including correct depth penetration, gain, number of foci, etc. Moreover, the chosen US probe should have a

footprint that matches the size of the acoustic window, be positioned in the center of the fontanel and maintain good contact with the scalp through the use of appropriate amount of US gel (Daneman et al. 2006; Grant and White 1986; Steggerda et al. 2009; van Wezel-Meijler et al. 2010). Depending on the pathology encountered, more detailed assessment of lesions located along the convexity of the cerebral hemispheres may require additional scanning with higher frequency probes and oblique, off-center probe positioning (Fig. 2.7) (Correa et al. 2004; Di Salvo 2001; Enriquez et al. 2006; Leijser et al. 2006; Steggerda et al. 2009).

In addition to the gray-scale anatomical imaging, the resistive index (RI) of the intracranial vasculature can be sampled using Doppler US along an anterior branch of the circle of Willis, usually one of the anterior cerebral arteries (ACA) (Figs. 2.8 and 2.9). The RI value is calculated as the ratio between the maximal end-diastolic and end-systolic flow velocities (Peak Systolic Velocity-Minimum Diastolic Velocity/Peak Systolic Velocity). For FT neonates, the normal RI is 0.65–0.75, while PT infants have a slightly higher RI value (0.77–0.8) (Fig. 2.10) (Huisman et al. 2010; Zamora et al. 2014). The RI values are best measured at the beginning of the study through the AF without and then with gentle pressure being applied with the transducer. A large variability in the RI values acquired with and without pressure may indicate impaired intracranial autoregulation. Subsequently, the superior sagittal sinus is sampled for patency and flow direction.

To date, there is no internationally adopted standard for optimal timing and frequency of neonatal head US. Each institution uses its own protocol currently (Horsch et al. 2010; Leijser et al. 2006; Nwafor-Anene et al. 2003; Steggerda et al. 2009; van Wezel-Meijler et al. 2010). The frequency of head US examinations should be intensified if there is a sudden deterioration in infant's clinical state: for example, sepsis, necrotizing enterocolitis, episodes of apnea and/or bradycardia, unexplained decrease in hemoglobin level, new onset of neurological symptoms or ventricular dilatation. Scanning is also advised before and after major surgery (van Wezel-Meijler et al. 2010).

Finally, communication between neonatologists/pediatricians taking care of the baby and pediatric radiologists about the symptoms and clinical findings of newborn is essential to best investigate the clinical suspicions, make the correct diagnosis, and avoid misdiagnoses.

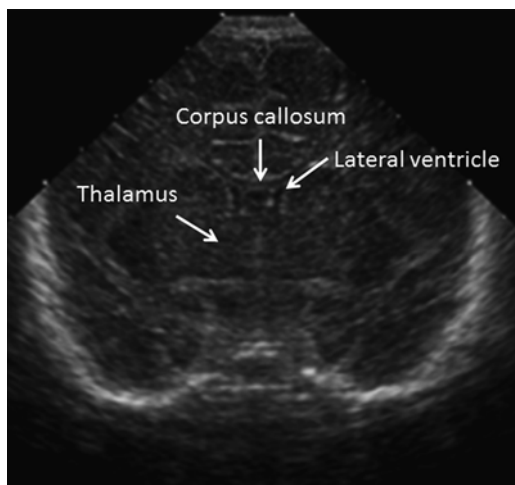


FIG. 2.1. Anterior fontanelle approach: coronal view. This technique is especially important to evaluate the lateral ventricles and choroid plexus. The corpus callosum appears above the cavum septum pellucidum. Caudate nuclei, putamen and globus pallidus, thalami, bilateral temporal lobes, uncus, hippocampi, and Sylvian fissures can be evaluated. The foramen of Monro, brainstem, and posterior fossa structures are also seen.

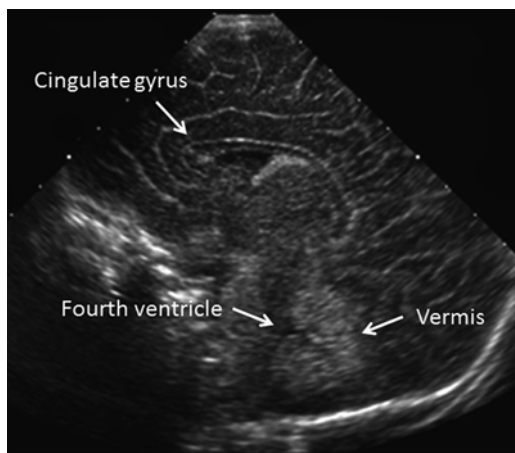


FIG. 2.2. Anterior fontanelle approach: midline sagittal view. The cerebellar vermis appears as an echogenic image in the posterior fossa. The fourth ventricle is placed in front of the vermis, the cisterna magna is placed below the cerebellar vermis and appears hypoechogenic. The corpus callosum is seen as a curve from anterior to posterior, cingulate gyrus appears above and parallel to it.

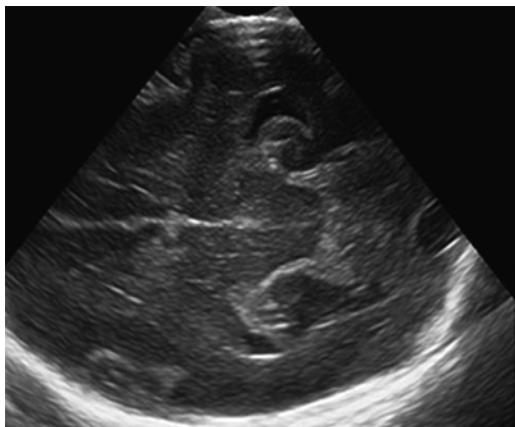


FIG. 2.3. Transmastoid approach: axial image. This technique allows to study the anatomy of the posterior fossa in more detail.

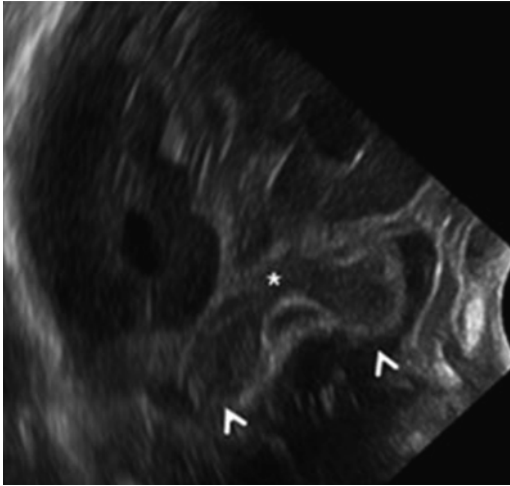


FIG. 2.4. Posterior fontanel approach: coronal image. This technique allows to study the anatomy of the posterior fossa in more detail and shows the craniocervical junction, cerebellar hemispheres (*arrowheads*), and cerebellar vermis (*asterix*) in high detail.

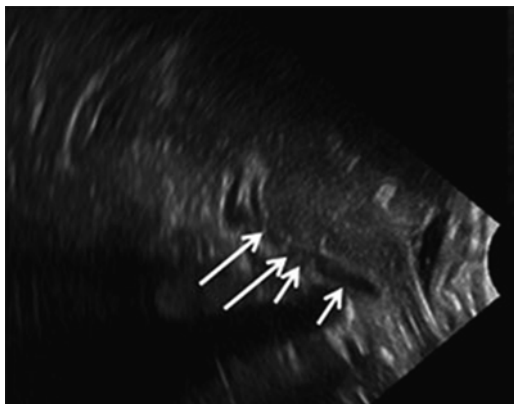


FIG. 2.5. Posterior fontanel approach: sagittal image. This technique allows to study the anatomy of the posterior fossa in more detail and shows the pons (*long arrows*) and remaining brainstem (*short arrows*) in high detail.

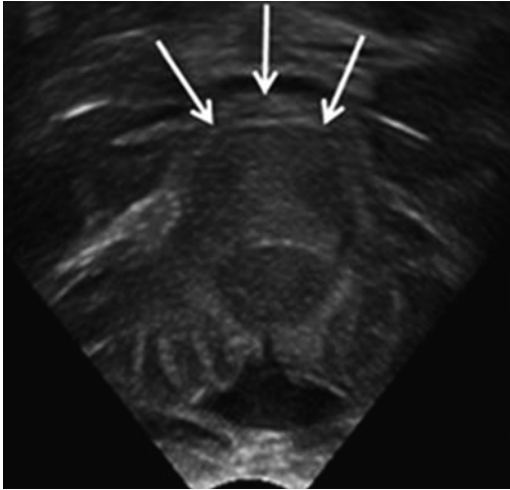


FIG. 2.6. Posterior fontanel approach: axial image. This technique allows to study the anatomy of the posterior fossa in more detail and shows the pons (*long arrows*) in high detail.



FIG. 2.7. High-resolution, high-frequency linear transducers allow to study the anatomy of the brain surface in high detail. This sagittal head ultrasound image has been acquired through the anterior fontanelle. The subarachnoid space is filled with clear, hypoechoic CSF, the pia mater is seen as a hyperechoic thin layer following the contour of the brain gyri, extending into the brain sulci. The cerebral cortex is slightly hypoechoic in contrast to the mildly hyperechoic subcortical white matter. The stripes within the WM represent the acoustic reflections of the intramedullary vessels.

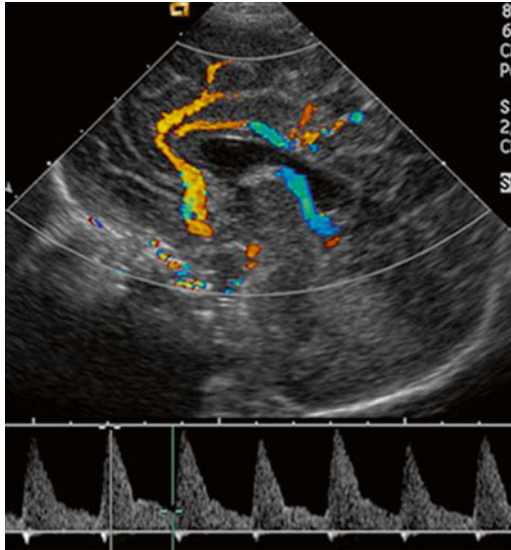


FIG. 2.8. Sagittal color-coded Doppler ultrasound evaluation of the circle of Willis in a normal term infant. *Red* coding indicates flow toward the location of the ultrasound probe, *blue* relates to flow away from the ultrasound probe. In addition, the flow profile over the cardiac cycle is shown with a steep increase of the cerebral blood flow velocity in the systole and a slower, but positive blood flow velocity during diastole.

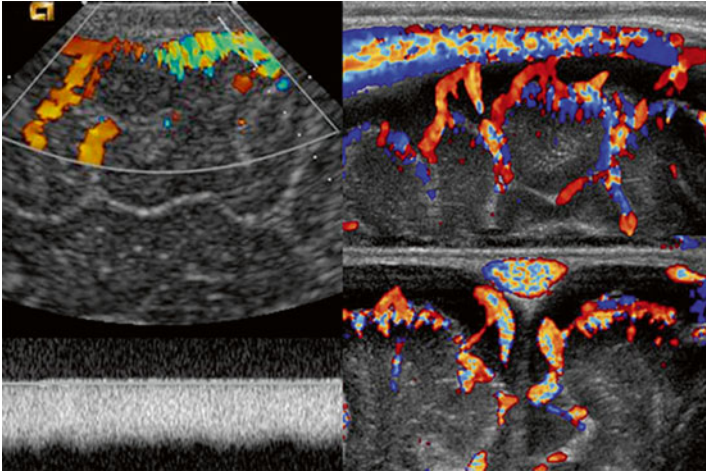


FIG. 2.9. Sagittal and coronal sampling of the superior sagittal sinus including adjacent draining bridging veins. The superior sagittal sinus is lined by the mildly hyperechogenic dura. Multiple veins are noted to cross the subdural space before draining into the superior sagittal sinus. Steady flow with minimal modulation is noted on the flow profile confirming patency of the superior sagittal sinus and normal flow direction.

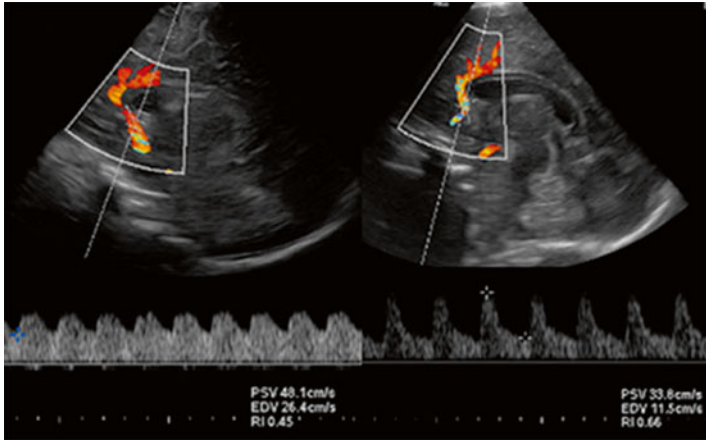


FIG. 2.10. Flow profile sampled from a branch of the anterior circulation through the anterior fontanelle. An elevated end diastolic velocity with resultant lowered RI value of 0.45 is seen in the first neonate with brain edema versus a RI value of 0.66 in the second healthy neonate. A lowered RI value may be seen in a variety of cerebral pathologies including inflammation, hypoxic-ischemic injury which impairs brain autoregulation.

References

- Correa F, Enriquez G, Rossello J, Lucaya J, Piqueras J, Aso C, et al. Posterior fontanelle sonography: an acoustic window into the neonatal brain. *AJNR Am J Neuroradiol*. 2004;25:1274–82.
- Daneman A, Epelman M, Blaser S, Jarrin JR. Imaging of the brain in full-term neonates: does sonography still play a role? *Pediatr Radiol*. 2006;36:636–46.
- Di Salvo DN. A new view of the neonatal brain: clinical utility of supplemental neurologic US imaging windows. *Radiographics*. 2001;21:943–55.
- Enriquez G, Correa F, Aso C, Carreño JC, Gonzalez R, Padilla NF, Vazquez E. Mastoid fontanelle approach for sonographic imaging of the neonatal brain. *Pediatr Radiol*. 2006;36:532–40.
- Grant EG, White EM. Pediatric neurosonography. *J Child Neurol*. 1986;1:319–37.
- Horsch S, Kutz P, Roll C. Late germinal matrix hemorrhage-like lesions in very preterm infants. *J Child Neurol*. 2010;25:809–14. doi:[10.1177/0883073809346849](https://doi.org/10.1177/0883073809346849).
- Huisman TA, Singhi S, Pinto PS. Non-invasive imaging of intracranial pediatric vascular lesions. *Childs Nerv Syst*. 2010;26:1275–95. doi:[10.1007/s00381-010-1203-1](https://doi.org/10.1007/s00381-010-1203-1).
- Leijser LM, de Vries LS, Cowan FM. Using cerebral ultrasound effectively in the newborn infant. *Early Hum Dev*. 2006;82:827–35.
- Nwafor-Anene VN, DeCristofaro JD, Baumgart S. Serial head ultrasound studies in preterm infants: how many normal studies does one infant need to exclude significant abnormalities? *J Perinatol*. 2003;23:104–10.
- Steggerda SJ, Leijser LM, Walther FJ, van Wezel-Meijler G. Neonatal cranial ultrasonography: how to optimize its performance. *Early Hum Dev*. 2009;85:93–9. doi:[10.1016/j.earlhumdev.2008.11.008](https://doi.org/10.1016/j.earlhumdev.2008.11.008).
- van Wezel-Meijler G, Steggerda SJ, Leijser LM. Cranial ultrasonography in neonates: role and limitations. *Semin Perinatol*. 2010;34:28–38. doi:[10.1053/j.semperi.2009.10.002](https://doi.org/10.1053/j.semperi.2009.10.002).
- Zamora C, Tekes A, Alqahtani E, Kalayci OT, Northington F, Huisman TA. Variability of resistive indices in the anterior cerebral artery during fontanel compression in preterm and term neonates measured by transcranial duplex sonography. *J Perinatol*. 2014;34:306–10. doi:[10.1038/jp.2014.11](https://doi.org/10.1038/jp.2014.11).

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