

Ultrasound examination of the neonatal brain

Guideline for the performance and reporting of neonatal and preterm brain ultrasound examination, by the Finnish Perinatology Society and the Paediatric Radiology Club.

1. Indications

- Routine follow-up of the preterm (ga<32 wk, birth weight <1500g) neonate: performed at 1-3 days, 7 days and 28 days of life, also when indicated by the clinical condition of the baby and before discharge from the hospital
- Screening for anomalies: syndromes, other anomalies
- Suspicion of congenital infection: e.g. SGA and anomalous features, microcephaly
- Seizures or otherwise unwell newborn
- Neurological abnormality or suspicion of intracranial abnormality
- Follow-up of known abnormality
- Ruling out intracranial abnormality before interventions such as medication (e.g. anticoagulant therapy) or operation

NOTICE. Ultrasound should not be used as the only modality for trauma imaging, because even significant intracranial traumatic changes may not be detected with ultrasound.

2. Equipment

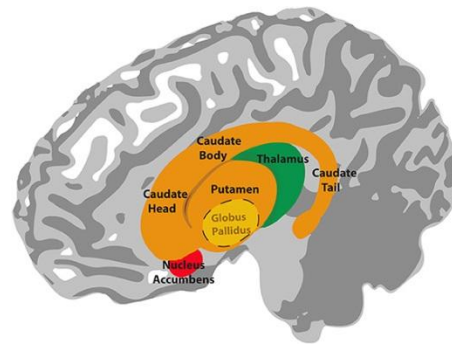
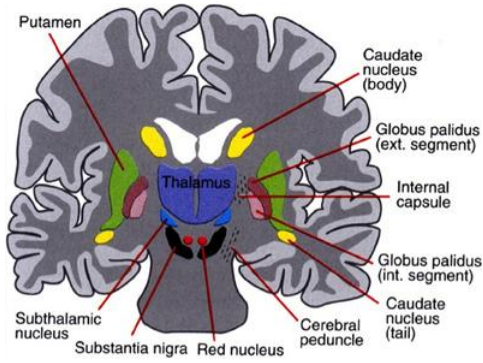
- The transducer should be suitable for imaging through the fontanelles
 - preterm neonates: 8-10 MHz
 - term neonates / older or larger infants: 6-9 MHz
- Linear transducer at least as an additional probe (e.g. sinus sagittalis, subarachnoidal space)

3. Training

- Training should be either part of the specialization training (radiology, neonatology) or given by a specialist performing brain ultrasound examinations regularly (course or hospital training). In addition to practical training consisting of a minimum of 25 examinations (40 if possible) performed under guidance, the training should include literature to provide a basis for theoretical understanding of the most common pathological findings.

4. Performing and reporting the examination

- The examination is performed through the anterior fontanelle. Either the posterior or mastoid fontanelle may also be used to detect changes in the posterior fossa particularly in preterm neonates.
- At least the following images should be stored (in coronal images the patient seen from the front (=patient's right on the left)), in parasagittal images posterior on the right, side markings in all images) (Appendix 3):



Through the anterior fontanelle

coronal:

anterior to the frontal horns

through the frontal horns and Sylvian fissure

3. ventricle and thalamus

posterior horns – *plexuses included*

posterior to plexus – *posterior parenchyma*

ventricular measurements (VI, AHW) at the level of foramen Monro

sagittal:

midline structures – 3. ventricle, *cavum septum pellucidum*, 4. ventricle

ventricle – *caudothalamic groove*

ventricle– *frontal- and posterior horns*

lateral to the ventricle – *deep white matter*

Through the mastoid fontanelle:

axial and coronal images

the posterior fossa

-Images of all pathological findings in two planes

4a. Doppler

Color Doppler imaging can be used to assess the symmetry of vascularization and also the venous flow at least in the sagittal sinus. Doppler measurements may have significance in the assessment of issues associated with asphyxia and prematurity, thus measurement of the resistance-index (RI) of anterior cerebral and/or pericallosal arteries is recommended during the first days of life.

4b. Intracerebral-/Intraventricular hemorrhage ICH/IVH

A modified Papile classification is recommended:

Grade I

- subependymal hemorrhage

Grade II

- hemorrhage seen in the ventricle, no ventricular dilatation

Grade III

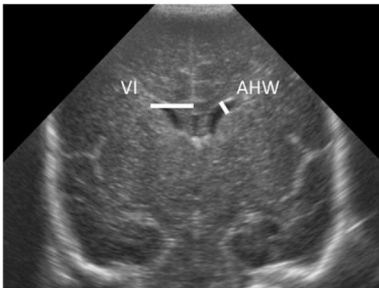
- hemorrhage seen in the ventricle, ventricular dilatation

Grade IV

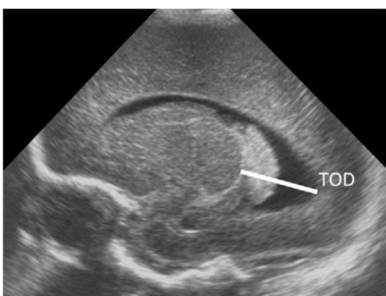
- Gr I, II tai III hemorrhage, with hemorrhagic infarctation in the periventricular parenchyma

4c. Measurement of the lateral ventricles

- Both anterior horn width (AHW) and the measurement recommended by Levene (Levene ventricular index, VI) should be measured routinely in the coronal plane. In the case of Gr II-IV ICH also the thalamo-occipital distance measured in the parasagittal plane (TOD) can be used.



Levene index, VI (mm): distance from the falx to the lateral border of the ventricle on the level of the third ventricle.
Anterior horn width, AHW (mm): oblique width of the anterior horn.



Thalamo-occipital distance, TOD (mm): measured from the posterior border of thalamus to the posterior border of the lateral ventricle.

-AHW 4mm and TOD 24mm may be used for screening purposes at all ages, because they are less affected by the the gestational age.

- Reference values according to Brouwer et al 2012 (Appendix 1)(Brouwer, de Vries et al: New reference values for the neonatal cerebral ventricles; Radiology; Volume 262: Number 1—January 2012)

Levene index			
Gestational age (weeks)	mean (mm)	-2 SD (mm)	+2SD (mm)
25	8	7	10
30	9.5	8	11.5
35	10.5	9	12.5
40	11.5	10	14

AHW	mean (mm)	-2 SD (mm)	+2 SD (mm)
	1.1	0.1	2.9

TOD			
Gestational age (weeks)	mean (mm)	-2 SD (mm)	+2 SD (mm)
25	15	12	19
30	15.5	12	20
35	16	12.5	21
40	15.5	12	20

- The shape of the ventricles should also be reported. Angular shape of the posterior horns may be associated with loss of white matter and the ballooning effect with beginning hydrocephalus.

- slight (AHW ad 1mm) widening of the lateral ventricles may occasionally be detected in full term neonates during the first days of life (re-opening effect).

4d. Periventricular leucomalacia (PVL)

MRI is the method of choice to detect hypoxic-ischemic lesions. The cystic changes of PVL Gr III-IV are reliably detected using US, but particularly the slight changes in echogenicity associated with Gr I PVL are not reliably detected and Gr II changes may be detected only for a short period of time. The cystic form of PVL is much less common.

PVL Gr I

- Must be separated from the normal periventricular echogenicity, "blush"/"flaring"
- Echogenicity normalizes in 2-3 wk

PVL Gr II

- Follow-up scanning shows small (fronto-parietal/occipital) periventricular cysts, which may disappear before term

PVL Gr III-IV

- Periventricular echogenicity evolves into large cystic areas
- Gr IV: also subcortical cysts

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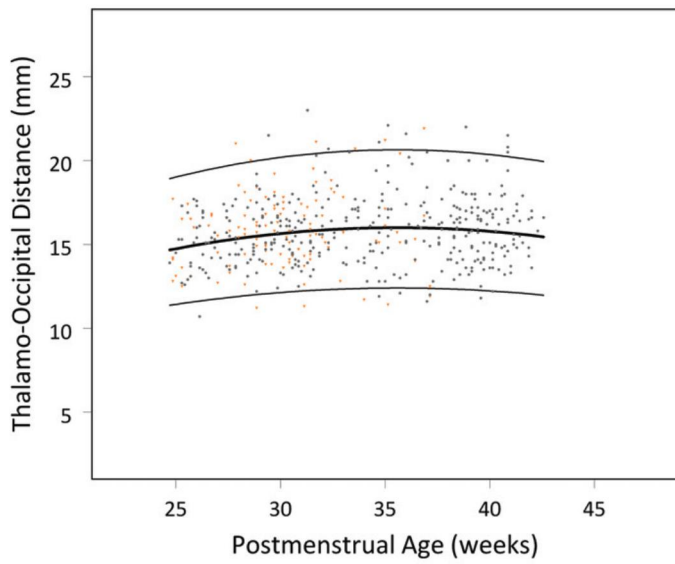
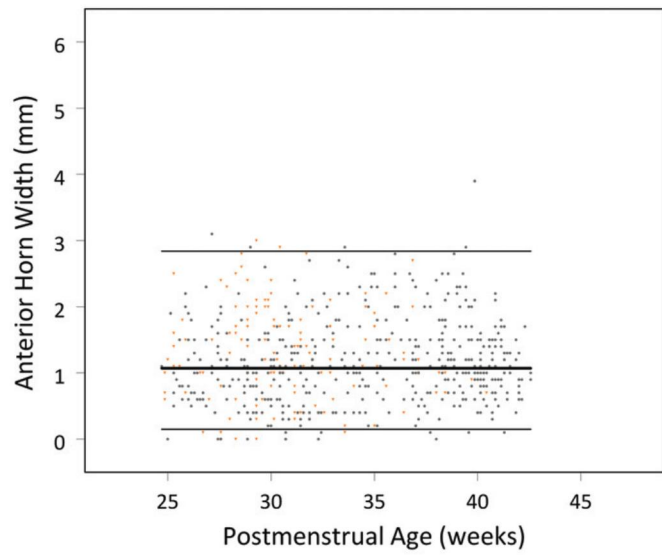
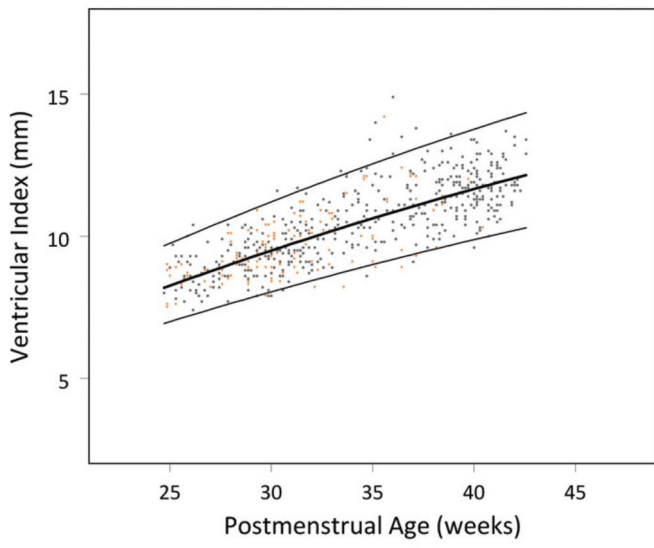
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Approved by:

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Pediatric radiologist

Appendix 1, Brouwer et al 2012 reference curves:



Appendix 2, Short summary

Summary of ICH/IVH grading

Modified Papile grading:

Gradus I

- subependymal hemorrhage

Gradus II

- hemorrhage in the ventricles, no ventricular dilatation

Gradus III

- hemorrhage in the ventricles and ventricular dilatation

Gradus IV

- Gr I, II tai III , with hemorrhagic infarction of the parencyma

- routinely recommended measurements: anterior horn width (AHW) and Levene index (VI) in coronal plane. In Gr II-IV ICH also the thalamo-occipital distance in sagittal plane (TOD) can be used.

- ADW 4mm and TOD 24mm can be used for screening purposes, because they are less affected by the the gestational age.

- Reference values according to Bouwers et al 2012

Levene index VI			
Gestational age wk	mean mm	-2 SD mm	+2SD mm
25	8	7	10
30	9,5	8	11,5
35	10,5	9	12,5
40	11,5	10	14

AHW	mean mm	-2 SD mm	+2 SD mm
	1,1	0,1	2,9

TOD			
Gestational age wk	mean mm	-2 SD mm	+2SD mm
25	15	12	19
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Appendix 3,

