Neonatal Intensive Care Unit Clinical Guideline

Cranial Ultrasound (US)

Background

Cranial US is an important neonatal bedside investigation, and we anticipate that all junior doctors in Paediatric training, clinical fellows and nurse practitioners will develop their skills in acquisition and interpretation of scans. Serial imaging is an important part of surveillance of "well" preterm babies, as well as a critical tool in the sick /at risk infant. US is good at detecting IVH and ventricular dilation, is reasonably good for large anatomical abnormalities and for severe white matter changes such as cystic PVL. However we increasingly also use MRI scans to confirm/delineate/investigate babies with particular risk factors.

IVH is most common in the premature population and usually occurs within the first 2 weeks of life. A third of infants had echodensities as early as 1 hours after birth, around half of GMH or IVH in the first 6-8 hours after birth. Most IVHs are evident by the day 3 but they can develop any time within the first 2 weeks of life. (Sauve, R, 2001). The incidence of IVH decreases with increasing gestational age, and is rare beyond 34 weeks gestation because of involution of the vascular germinal matrix. Many infants are asymptomatic and these haemorrhages are found on surveillance sonography. In term babies at risk of long term neurological problems, such as those with HIE, severe hypoglycaemia or meningitis, cranial US is used to define anatomy and particularly to look for evidence of white matter and basal ganglia changes. Rare pathologies, such as newborn stroke, may also be picked up on cranial US.

The first scan is part of the admission process and **should be done as soon as possible**, preferably within 4 hours of birth.

Aetiology/Risk Factors for IVH

General pathogenic factors may include antepartum, intrapartum and neonatal conditions:

Antepartum	Intrapartum	Neonatal
Prematurity	Low umbilical artery pH	RDS
Lack of antenatal corticosteroids	Delivery outside a tertiary unit	PDA
Maternal pre-eclampsia	Delivery mode (C-section is protective)	Pneumothorax
Antepartum haemorrhage	Low 1 minute APGAR	Sepsis
Chorioamnionitis	Bruising at delivery	Resp-CVS instability

Indications for Routine Cranial Ultrasound – at risk babies

- Premature infants (≤34/40 gestation at birth**)** – to look for intracranial bleeds or development of PVL
- Neurological abnormalities (e.g. seizures) – to look for structural lesions or intracranial blood
- Antenatally detected abnormalities (e.g. ventriculomegaly, arachnoid cysts) – to monitor change
- HIE – to look for midline shift, cerebral oedema and basal ganglia and white matter changes.
- Other congenital abnormalities – to look for associated structural lesions.
- Congenital or acquired CNS infection – to look for calcification, ventriculitis or abscesses.
- Coagulopathy or thrombocytopenia – to look for intracranial blood or midline shift.
- Maternal cocaine use – to look for evidence of stroke.
- IUGR
- Infants with hypoglycaemia (symptomatic or severe hypoglycaemia (<1.0mmol/L)) – to look for midline abnormalities. You can find the hypoglycaemia guideline here.

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Scanning Frequency

Timing of Scan	≤30 weeks at birth	31-34 weeks at birth	HIE/Abnormal Neurology	Ventricular Dilatation
Admission	✓	✓	✓	✓
Day 1	✓		optional	
Day 3-4	✓	✓	✓	✓**
Day 6-7	✓	✓	optional	✓**
Day 14	✓	✓*	✓*	Twice weekly if enlarging. Ensure plan documented on ward round sheet
Inpatient	1-2 weekly*			
Term (≥35/40) Corrected	✓	✓		
Other	Further scans may be requested by the attending consultant			

* If still inpatient, discuss on ward round.
** If ventricular dilation present on first scan

Any scans with IVH or babies whose routine measurements of OFC increase across centile lines should have further scans to monitor for ventricular dilatation. The frequency of these scans will be determined based on the severity of the IVH and any indication of the development of ventricular dilatation.

Machine Settings

All images should have:

- two patient identity marks
- date, time and hospital
- which side is which labelled on each image
- the patient looking to the left in the sagittal plane
- the patient left brain on the right side in the coronal plane.

Use the smaller 12S probe, and it should default to the correct single setting. Make sure you enter the baby's details accurately. You may need to adjust the size (to fill the screen).

Images

A standard set of views is taken to assist with consistent visualisation of structures and in the interpretation of possible abnormalities. The ultrasound takes a "slice" through the structure, resulting in a 2D image of a 3D structure. It is therefore important to understand the relationship of the anatomy to the image provided. Images below detail the standard set of images taken. The accompanying images are from a 30 week infant with normal appearing anatomy.

Images are taken through the anterior fontanelle. It is rare to use other views e.g. posterior fontanelle or temporal bone views.

In the coronal plane, a series of images are taken through the frontal lobes, more posteriorly through the ventricles and thalami, then along the plane of the choroid plexus, then superior to that.
The sagittal images are initially taken in the midline, with images then taken on both sides at the level of the lateral ventricles then periventricular areas. For the purposes of conserving space on this page, the left sagittal images have been omitted.

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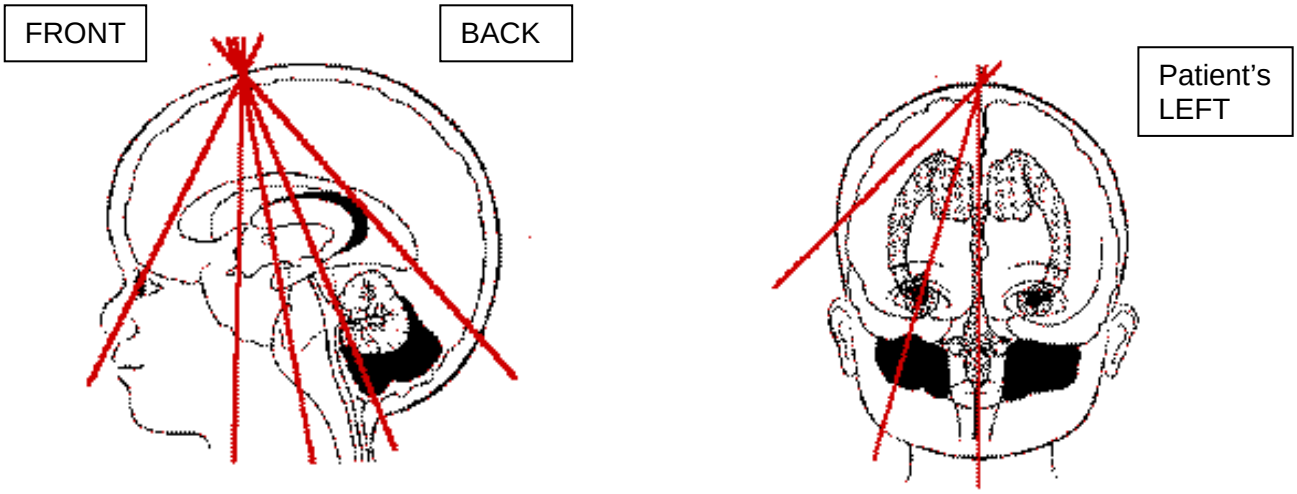

At St. Peter's, our views are always taken as marked above.

Coronal Views

Frontal Lobes

The transducer obtains an image through the frontal lobes. The orbital ridge forms the inferior boundary of this image.

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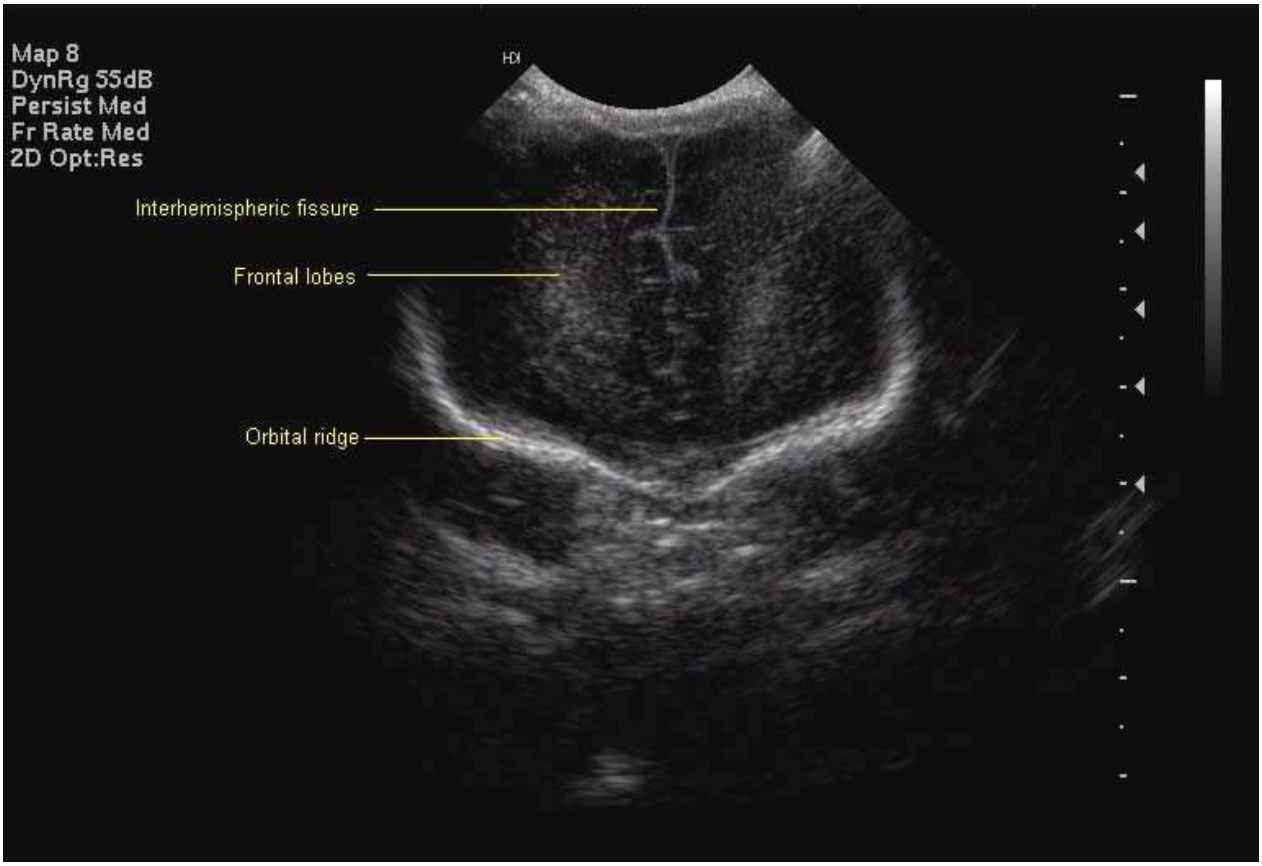

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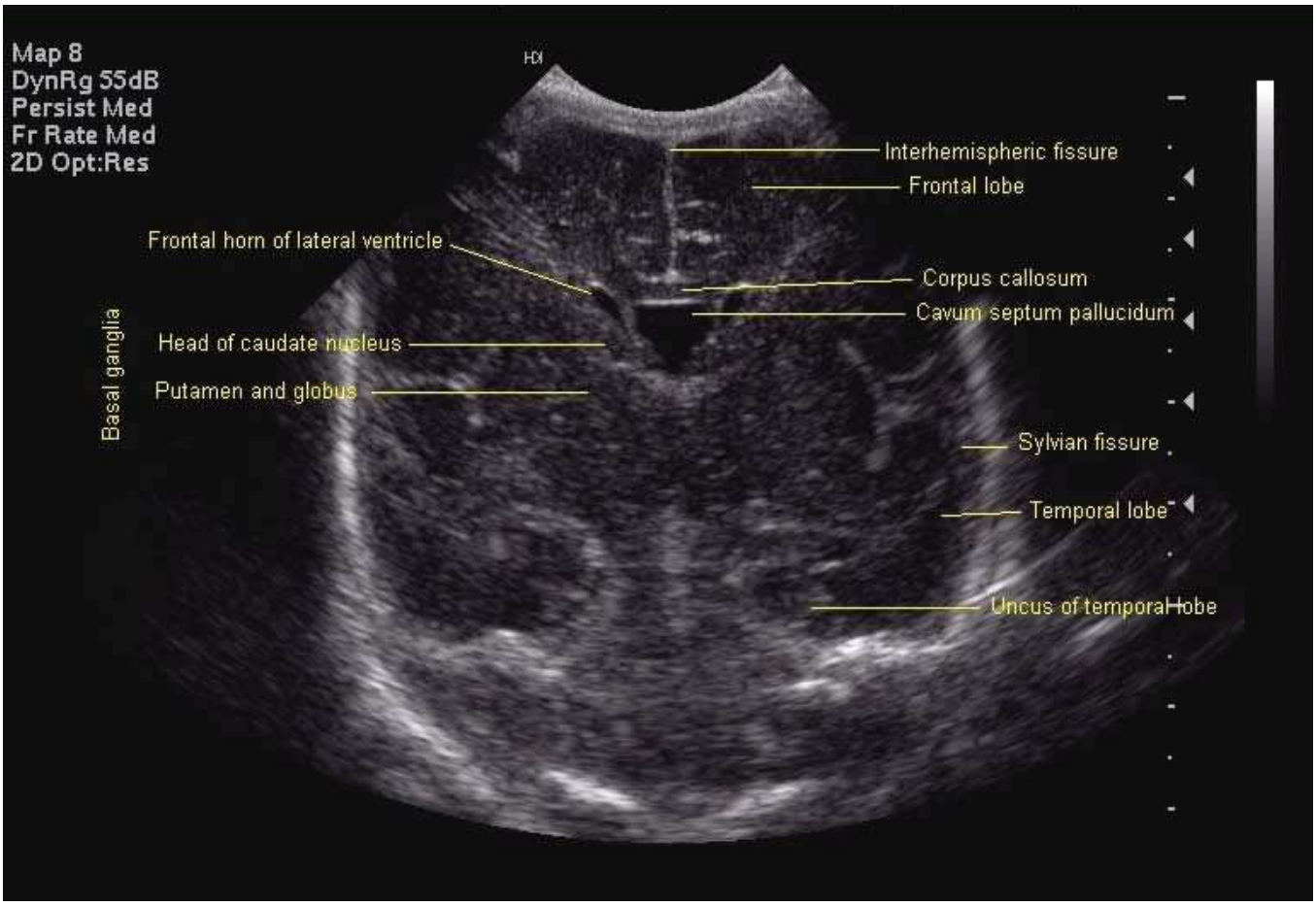
Anterior Horns of the Lateral Ventricles

The transducer is angled back. The CSF in the lateral ventricles appears as a dark image. The lateral ventricles are larger in preterm infants than in term infants. Asymmetry between the lateral ventricles is common and is not necessarily abnormal. The pellucidum cavum sits between the lateral ventricles and is often large in preterm infants. The corpus callosum appears above the cavum.



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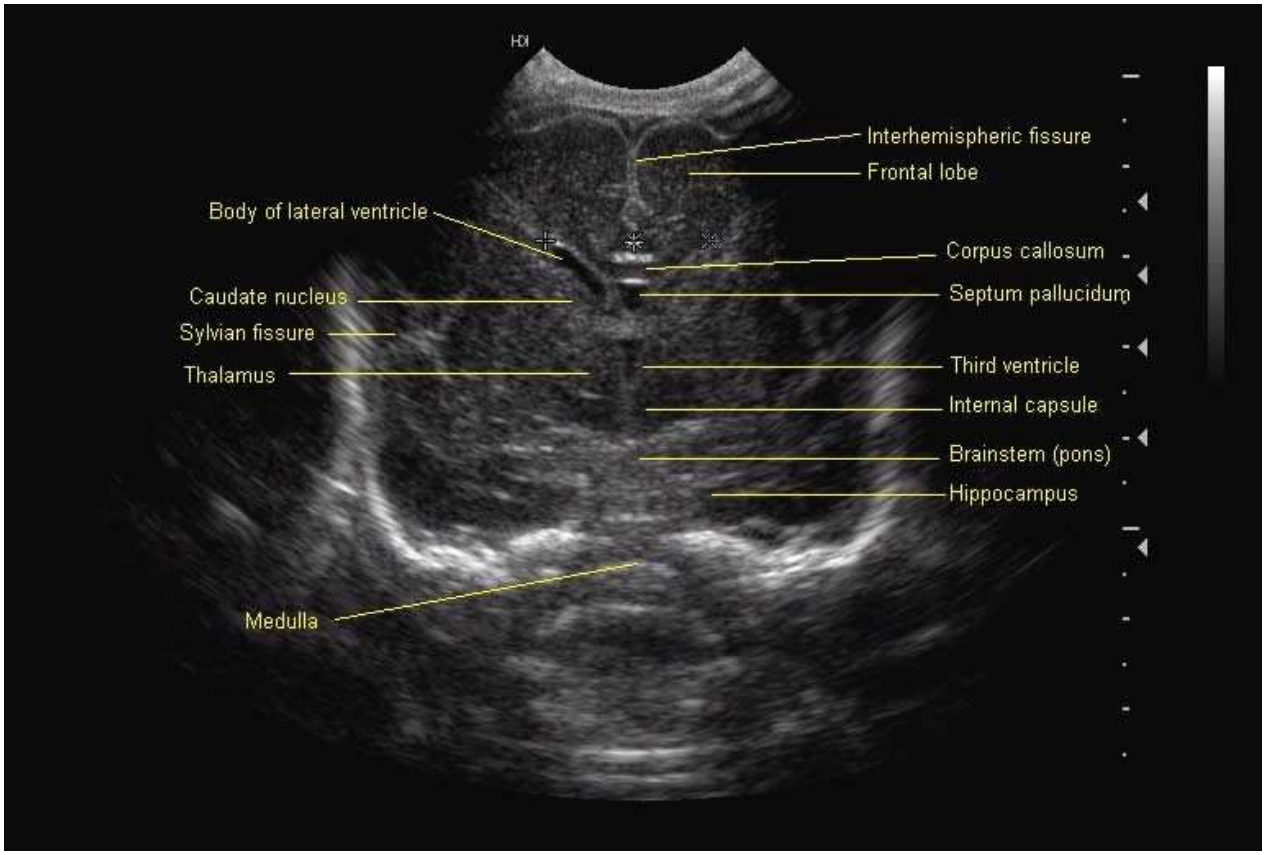
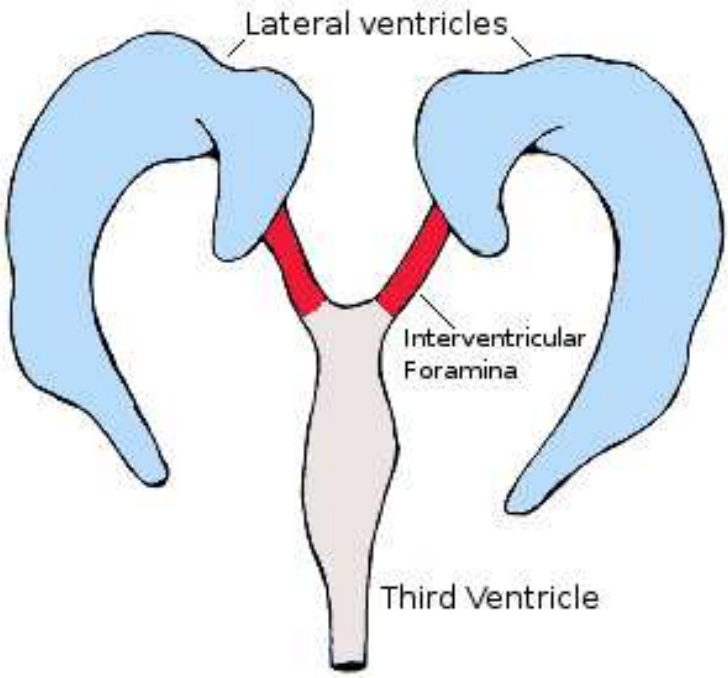
The Third Ventricle

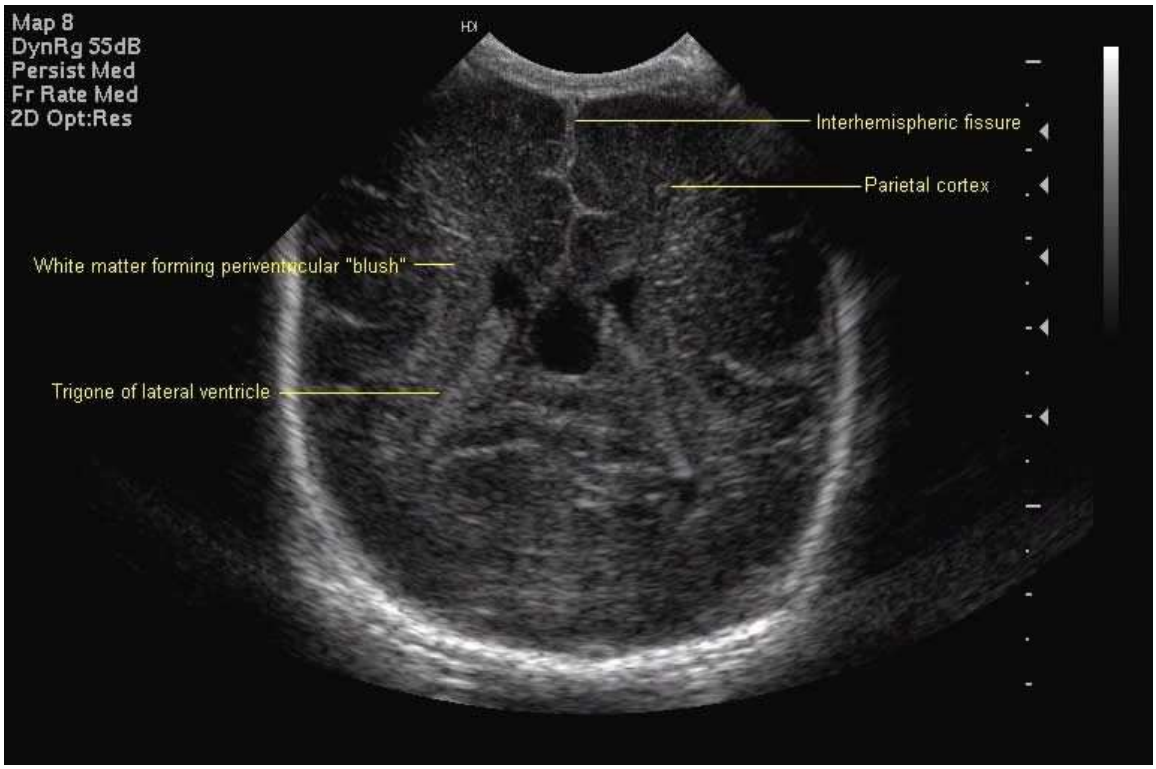
With the transducer shifted slightly further back, the third ventricle appears below both lateral ventricles and the septum pellucidum. It is often small and difficult to see, but can vary considerably in size. The foramen of Monro (connecting lateral and 3rd ventricles) may be clearly seen. The brainstem may be seen as a tree-like shape.





Trigone

Angling further back cuts through the trigones of the lateral ventricles. The choroid plexus fills the lateral ventricles in this view and is prominent in preterm infants. Choroid plexus haemorrhage may be difficult to differentiate from bulky choroid. The white matter around the lateral ventricles may appear quite echodense (bright) in this plane and is sometimes called a "blush" or "flare".



Angling the transducer further results in an image that slices above the lateral ventricles. In this plane, the occipital cortex may be visualised.

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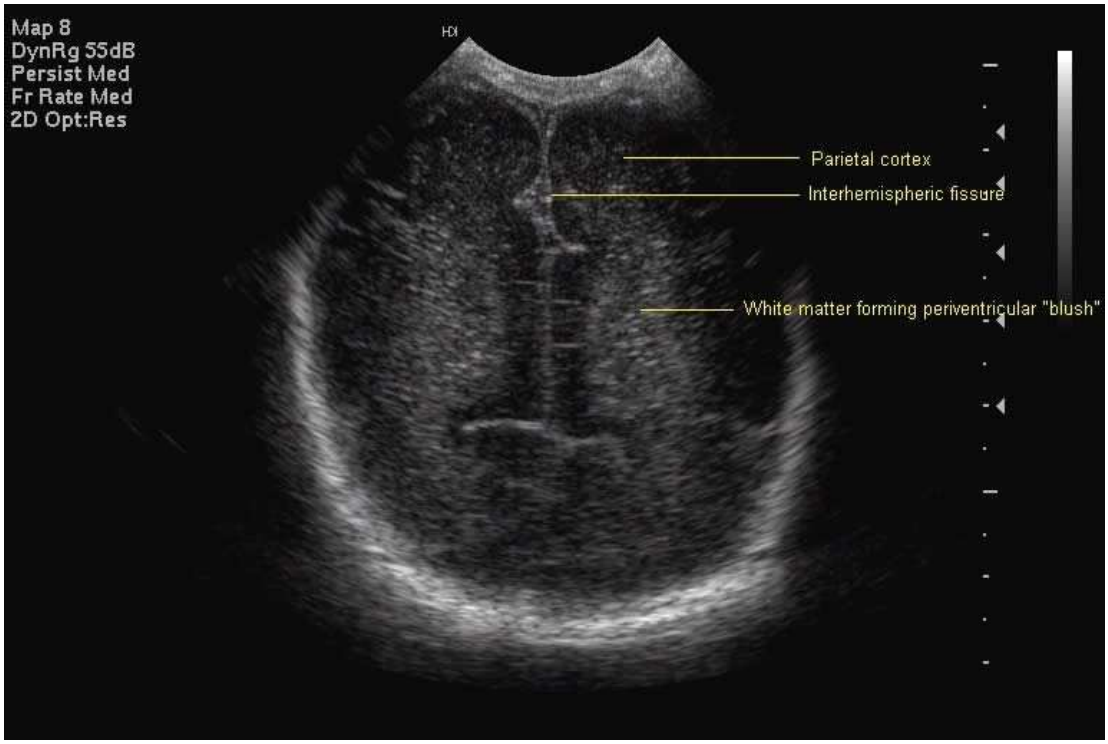

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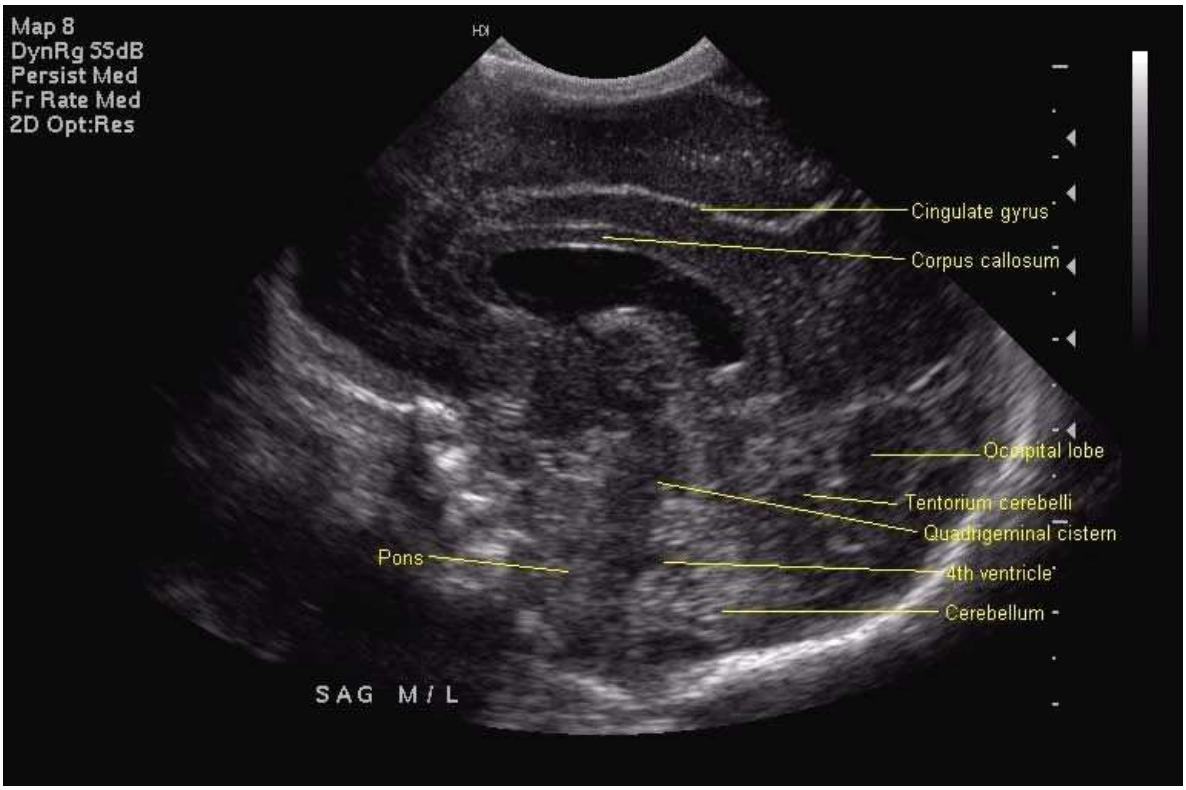
Sagittal Views

Midline Sagittal

This identifies useful landmarks. The cerebellar vermis shows up as an echogenic image in the posterior fossa. The 4th ventricle sits in front of this. The cisterna magna sits below the cerebellar vermis and is not very echogenic. The corpus callosum is seen sweeping from anterior to posterior with the cingulate gyrus above and parallel to it. The parieto-occipital sulcus is seen well above the posterior fossa.



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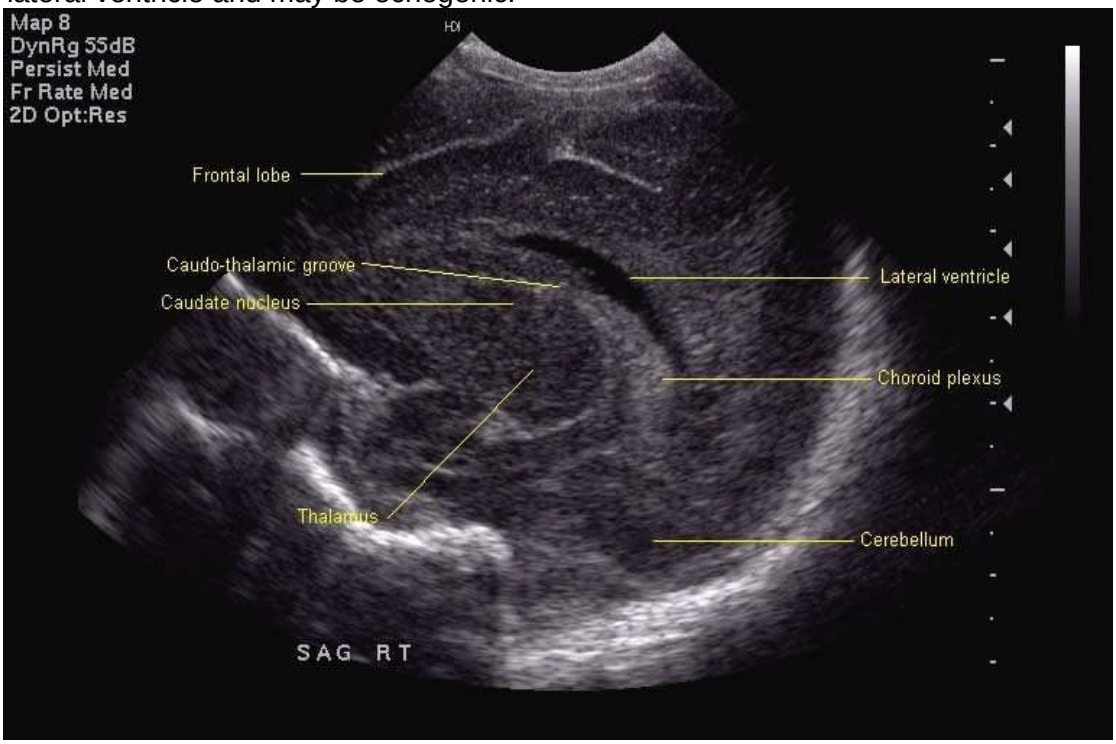
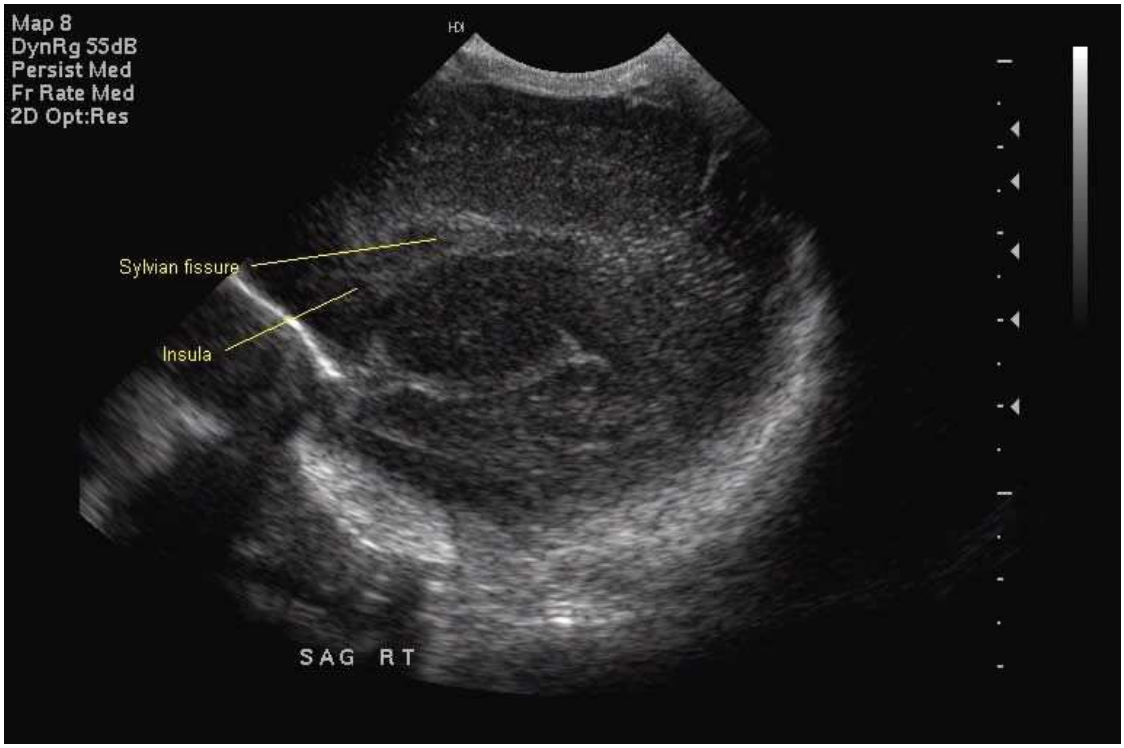
Angled Parasagittal

The shape of the lateral ventricle is the key landmark for this view. The caudate nucleus lies below the floor of the frontal horn of the lateral ventricle; the thalamus lies behind and below it. The occipital horn of the lateral ventricle is filled with choroid plexus. The choroid tucks up in the caudothalamic groove in the floor of the lateral ventricle and may be echogenic.



Tangential Parasagittal

Further angulation of the transducer laterally results in a section lateral to the lateral ventricles. The Sylvian fissure is the key landmark in this view.



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Requesting Scans/Storing Images/Uploading to PACS

Request scans on patient centre. Then log onto CRIS, enter the hospital number and the investigation you have requested will be highlighted in red. Click on the investigation to change and then click change, attend and attend a second time.
All images should include the infant's name and hospital number as well as the date performed.
Images should upload to PACS automatically.

Documentation

Document on the cranial ultrasound form with patient name, DOB and hospital number.
Document findings, any reviews and when the next scan is due.

References

Standard Neonatal Cranial Ultrasound Scan Views
http://www.adhb.govt.nz/newborn/TeachingResources/Radiology/HUSS/NeonatalHUSSViews.htm

NHS Forth Valley Cranial Ultrasound Guideline
http://www.nhsforthvalley.com/__documents/qi/ce_guideline_wcdneonatal/cranial_uss.pdf

Southern W Midlands ODN Cranial Ultrasound Scans in Newborns https://www.networks.nhs.uk/nhs-networks/southern-west-midlands-newborn-network/documents/SWMNN%20-%20Cranial%20Ultrasound.pdf

North Trent Neonatal Network Cranial Ultrasound Guideline
http://www.yorkshirehumberodn.nhs.uk/Guidelines%20south/Cranial%20ultrasound%20guideline.pdf

Sauve, R et al. (2001) Routine screening cranial ultrasound examinations for the prediction of long term neurodevelopmental outcomes in preterm infants. *Paediatric s & Child Health,* 6 (1) pp39-43.

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