

# NEONATAL CRANIAL ULTRASOUND PROTOCOL

UW Medicine

**BILLING CODE: UENC**  
**PATIENT PREP -No prep**

*See information about **SUBGALEAL HEMATOMAS** on page 13. These exams are to always be considered **STAT** and very emergent. Include full cranial ultrasound as well as the superficial structures.*

**\*\*Exams are usually done in the NICU, where there are strict disinfection guidelines. All personnel entering the NICU must use good hand washing technique along with use of disinfecting gel.**

**\*\*Upon arrival to the neonatal unit, you must remove all jewelry and wash your hands and arms up to your elbow. At UW Montlake, the hand washing station is located in the hall to the left of the elevators. ALSO BE SURE TO SIGN THE STAFF/VISTOR LOG that is hanging near the hand washing station.**

**\*\*Always call the RN before going to the floor to make sure they are not clustering care or that the mother is breast feeding and needs privacy.**

**\*\*Always read the sign on the patient door before entering. If the patient is in isolation, follow the instructions. If there is a sign that says "72," that means that they baby is in its first 72 hours of life, and you need to contact the RN before going in.**

**\*\*If an IV is present in the anterior fontanelle, or if the patient is on a CPAP machine, speak to the nurse prior to performing the exam to discuss how to best access the anterior fontanelle.**

**\*\* Doors of isolette should never be left open unless you are standing at the patient's bedside. Double check these are closed before leaving.**

**\*\*Thoroughly clean the transducer and machine with Oxivir wipes between each patient.**

**\*\*Individual gel packs must be used to minimize any spread of infection.**

**\*\* Tips to helping to maintain body temperature:**

- Use warm washcloths from the blanket warmer to cover them if unbundled.
- Use Air Boost to help keep the isolette warm while scanning. Turn off when finished.
- Thoroughly clean the gel off before leaving.
- Rebundle them as you found them when finished. Call the nurse for assistance for babies under 30 weeks.

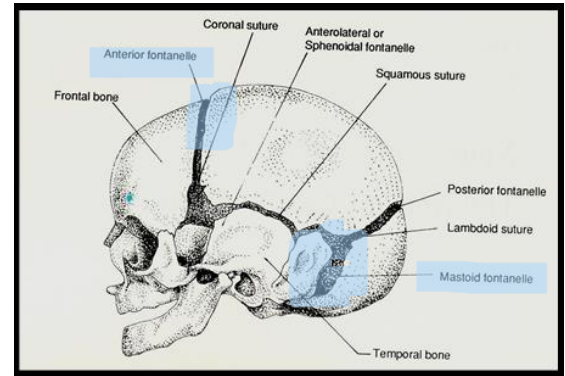
## **TRANSDUCER SELECTION:**

Scanning is to be performed with dedicated neonatal head probes - multiple-foci C8.0 - 5.0MHz or higher transducers. Additional images are needed with a L12 or L18 Linear probe.

**IMAGE LABELING:** In the title section of all images, include the date of birth, gestational age at birth, and birth weight.

**ULTRASOUND WINDOWS:** The drawing below illustrates the neonatal skull (lateral view) with the major sutures. The anterior and mastoid fontanelle are most often used.

- **ANTERIOR FONTANELLE**
  - Primary cranial imaging window open until 9-18 months, longer in premature infants and with increased intracranial pressure.
- **MASTOID FONTANELLE**
  - Posterior to ear
  - Used to better visualize the cerebellum and posterior fossa



**NORMAL ANATOMY**

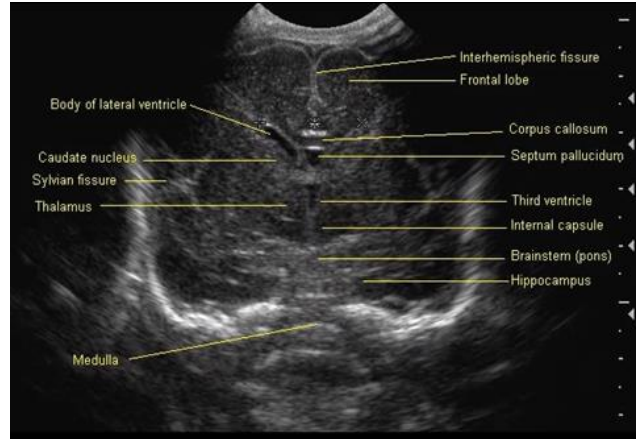
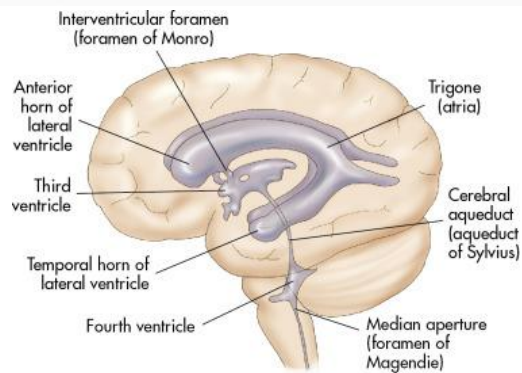
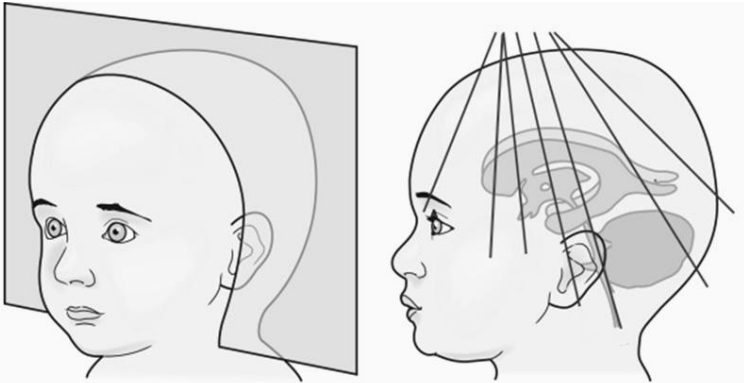
1. Interhemispheric fissure  
 2. Frontal lobe  
 3. Cavum septi pellucidum  
 4. Lateral ventricle (a frontal horn, b atrium)  
 5. Corpus callosum  
 6. Temporal lobe  
 7. Insula  
 8. Third ventricle  
 9. Basal ganglia (a) caudate nucleus  
 10. Choroid plexus  
 11. Posterior frontal to parietal lobe  
 12. Lateral fissure

1. Interhemispheric fissure  
 2. Frontal lobe  
 3. Cavum septi pellucidum (a cavum vergae)  
 4. Lateral ventricle (a frontal horn, b atrium, c occipital horn, d temporal horn)  
 5. Corpus callosum (a genu, b splenium)  
 6. Temporal lobe  
 7. Insula, limen  
 8. Third ventricle  
 9. Basal ganglia (a) caudate nucleus  
 10. Choroid plexus  
 11. Parietal lobe  
 12. Lateral fissure  
 13. Thalamus  
 14. Uncus temporalis  
 15. Cerebellar vermis (a) and hemisphere (b)  
 16. Occipital lobe  
 17. Parieto-occipital sulcus  
 18. Collicular plate  
 19. Calcarine sulcus  
 20. Base of pons  
 (\*) Fourth ventricle  
 (arrow) superior temporal sulcus  
 (arrowhead) cisterna magna  
 (#) Cingulate gyrus

eurUS.brain: technique and reporting: standard (para)sagittal sections

## IMAGES TO OBTAIN

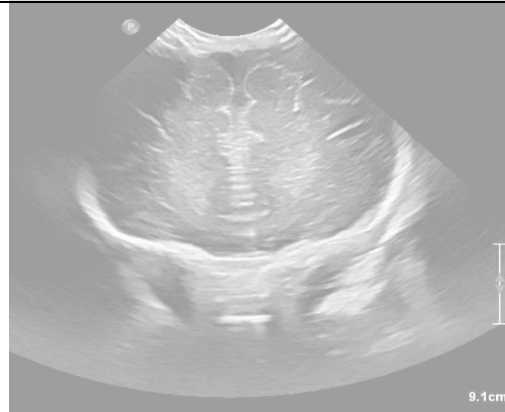
### CORONAL VIEWS ANTERIOR FONTANELLE



1. **VERIFY RIGHT** - Prove correct transducer positioning by angling probe towards patients' right side. Always have the right side on the left of screen regardless of patient position.

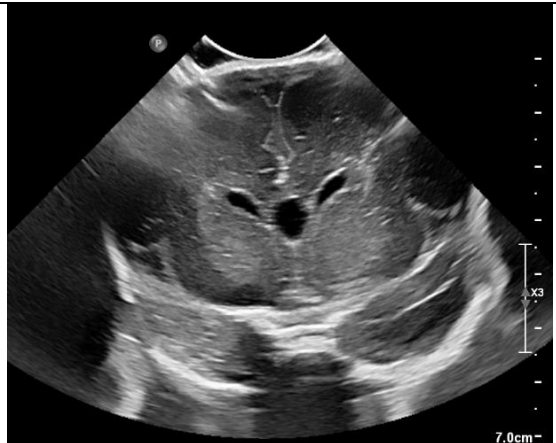


2. **Frontal lobe anterior to frontal horns, orbits will be seen deep to skull base**



**CORONAL VIEWS  
ANTERIOR FONTANELLE (continued)**

3. Frontal horns, sylvian fissure



4. Level of MCAs



5. Foramen of Monroe, 3<sup>rd</sup> ventricle, thalami



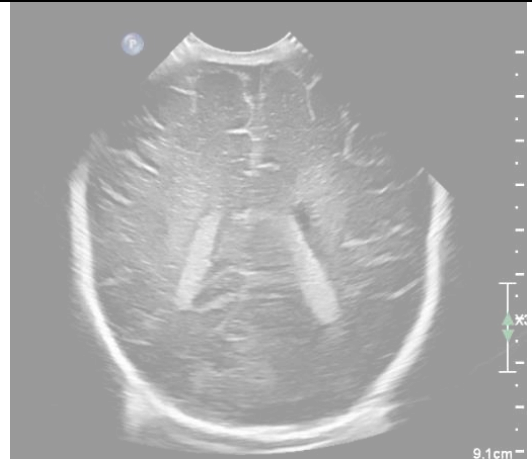
6. Body of the lateral ventricles



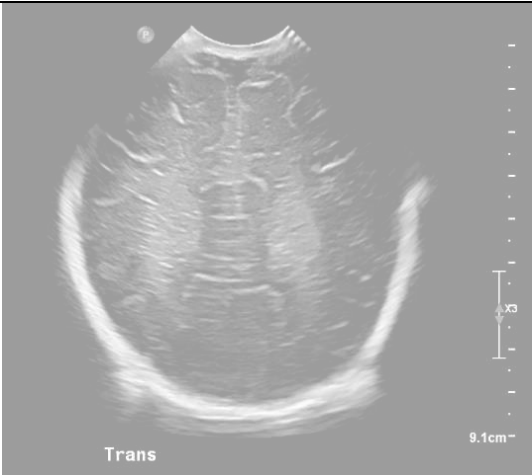
**CORONAL VIEWS**

**ANTERIOR FONTANELLE (continued)**

7. Trigone/Atria of ventricles, choroid plexus



8. Parieto-occipital parenchyma



9. **CINE SWEEP** from orbits to posterior parieto-occipital parenchyma.

**(CINE SWEEP)**

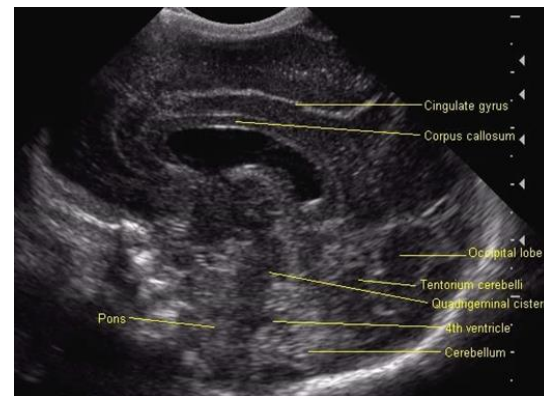
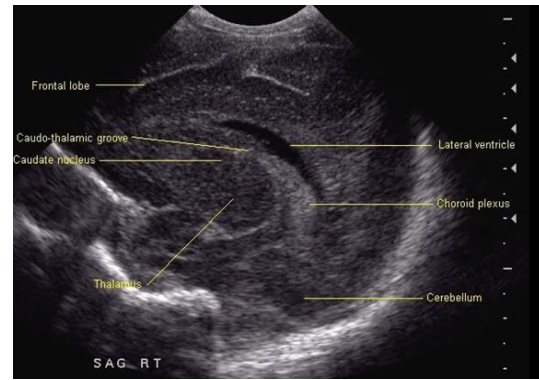
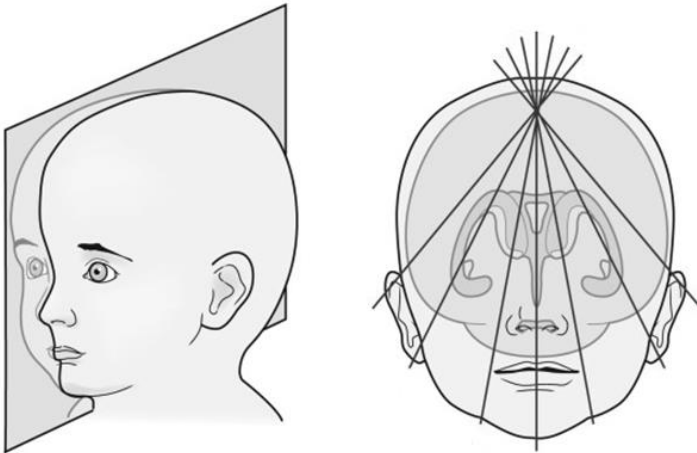
10. **LINEAR PROBE** (L12 or L18) - Level of germinal matrix, and subdural space



11. **CINE SWEEP w/ LINEAR PROBE** - orbits to posterior parieto-occipital parenchyma.

**(LINEAR CINE SWEEP)**

## SAGITTAL VIEWS ANTERIOR FONTANELLE



1. Midline through corpus callosum, CSP, 3<sup>rd</sup> ventricle, brain stem and cerebellar vermis



2. Lateral ventricle at caudo-thalamic groove - Right/Left

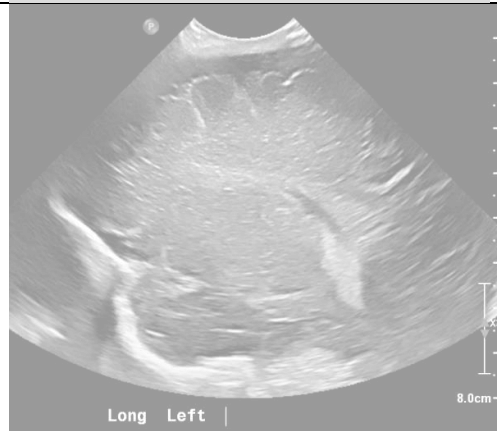


**SAGITTAL VIEWS  
ANTERIOR FONTANELLE (continued)**

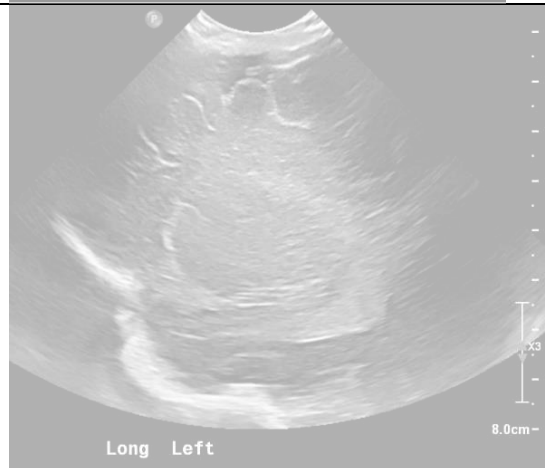
3. Lateral ventricle showing entire length of anterior, body, posterior, and temporal sections - Right/Left



4. Periventricular parenchyma - Right/Left



5. Lateral to ventricle, deep white matter - Right/Left



6. **CINE SWEEP** from midline through lateral deep white matter- Right/Left

**(CINE SWEEP)**

7. **CINE SWEEP w/ LINEAR PROBE** - Right to left

**(LINEAR CINE SWEEP)**

**TRANSVERSE/AXIAL VIEWS FROM MASTOID FONTANELLE**



**TRANSVERSE/AXIAL VIEW**- US transducer positioned almost parallel to the orbito-meatal line and above the tragus, slightly separating the external auricle.

1. Superior anterior view through the cerebral peduncles



2. VERMIS Middle view through the vermis



3. Inferior-posterior view through fourth ventricle and inferior vermis and cisterna magna



4. **CINE SWEEP** from superior to inferior

**(CINE SWEEP)**



## CORONAL VIEWS FROM MASTOID FONTANELLE

*Only needed if abnormality is seen in Transverse View*



### CORONAL VIEW

- US transducer placed along the coronal suture and moved slightly from the tragus to a retroauricular position.

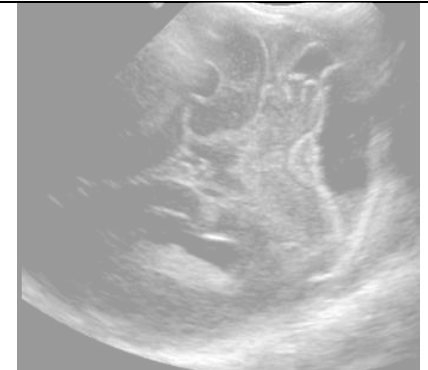
1. Through the anterior cerebellar hemispheres



2. Through the vermis



3. Through the posterior cerebellar hemispheres



4. **CINE SWEEP** from anterior to posterior

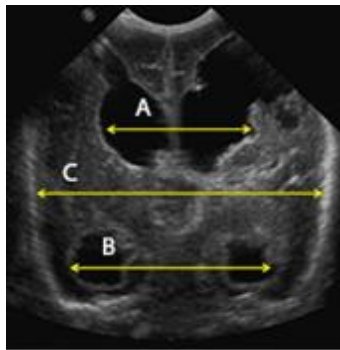
**(CINE SWEEP)**

## INTRACRANIAL PATHOLOGY

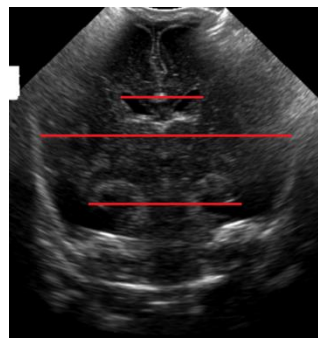
- Cine clips should be used to further document any suspected pathology.
- Identify and document any of the following:
  - Hydrocephalus/Ventriculomegaly
  - Subependymal hemorrhage (with or without ventricular invasion)
  - Subependymal hemorrhage with ventricular dilatation
  - Intraventricular hemorrhage with intraparenchymal invasion
  - Periventricular areas of parenchymal cysts/infarct

### **VENTRICULOMEGALY ADDITIONAL IMAGES:**

If the infant has ventriculomegaly please take these extra measurements in addition to the normal neonatal head protocol. Rounding of the frontal horns is an indicator of ventriculomegaly. These measurements should be done at the Viewpoint workstation to ensure the same measurement technique is used between exams.

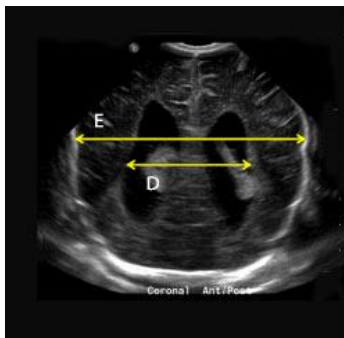


ABNORMAL

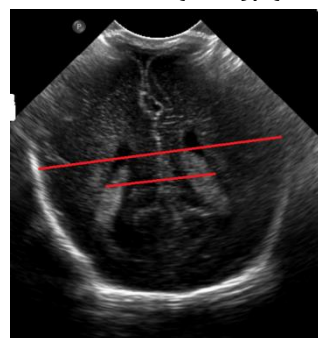


NORMAL

1. Image to be taken at the Foramen of Monroe – when you see the temporal horns and midbrain
  - The widest distance across the ventricular walls of frontal horns (A): \_\_\_cm
  - The widest distance across the ventricular walls of the temporal horns (B): \_\_\_cm
  - The widest internal skull diameter at the Foramen of Monroe (C): \_\_\_cm
  - **Calculate the FTHR: Frontal temporal horn ratio  $(A+B)/(2*C)$**



ABNORMAL

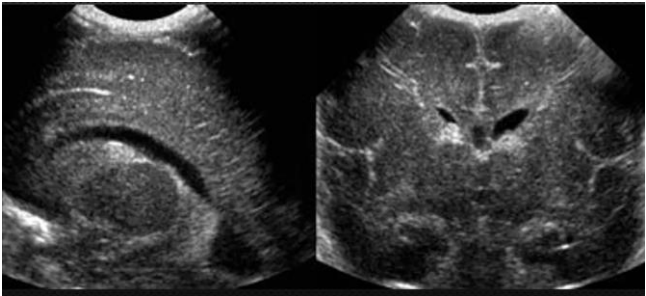

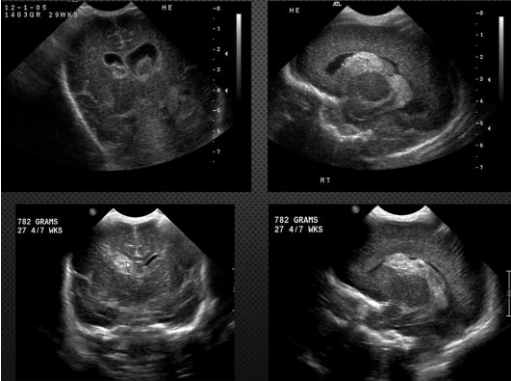
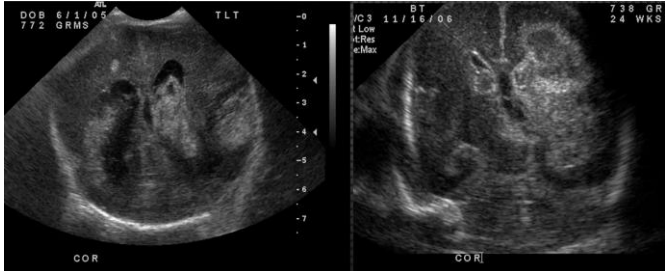


NORMAL

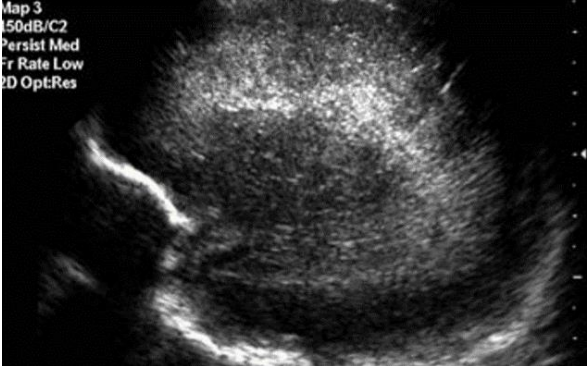
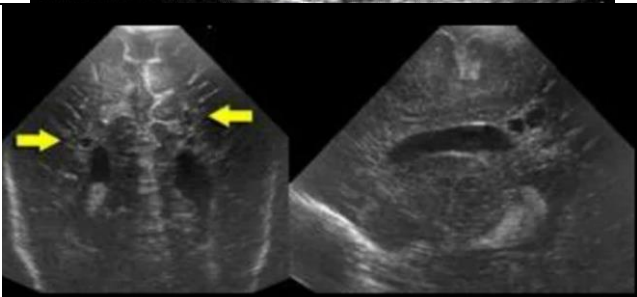

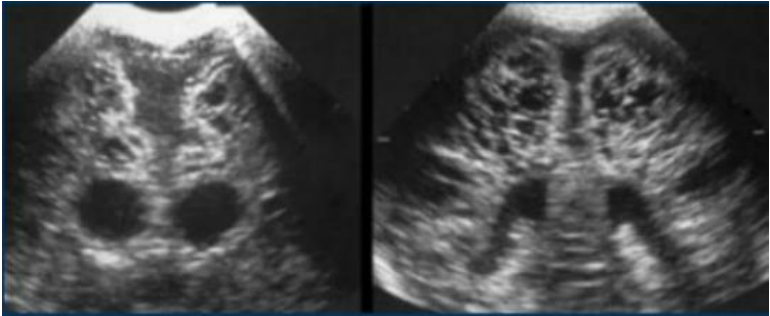
2. Image to be taken at the Trigone/Atria
  - The widest bioccipital horn diameter (D): \_\_\_cm
  - The widest biparetal diameter (E): \_\_\_cm
  - **Calculate the FOR: Fronto occipital ratio  $(A+D)/(2*E)$**

Cut offs - Normal =0.4, Mild=0.55, Moderate=0.60, Severe=0.7 for both FOR and FTR.  
Shunt needed when the ratio is greater than 0.55

## INTRACRANIAL HEMORRHAGE CLASSIFICATION (According to Papille)

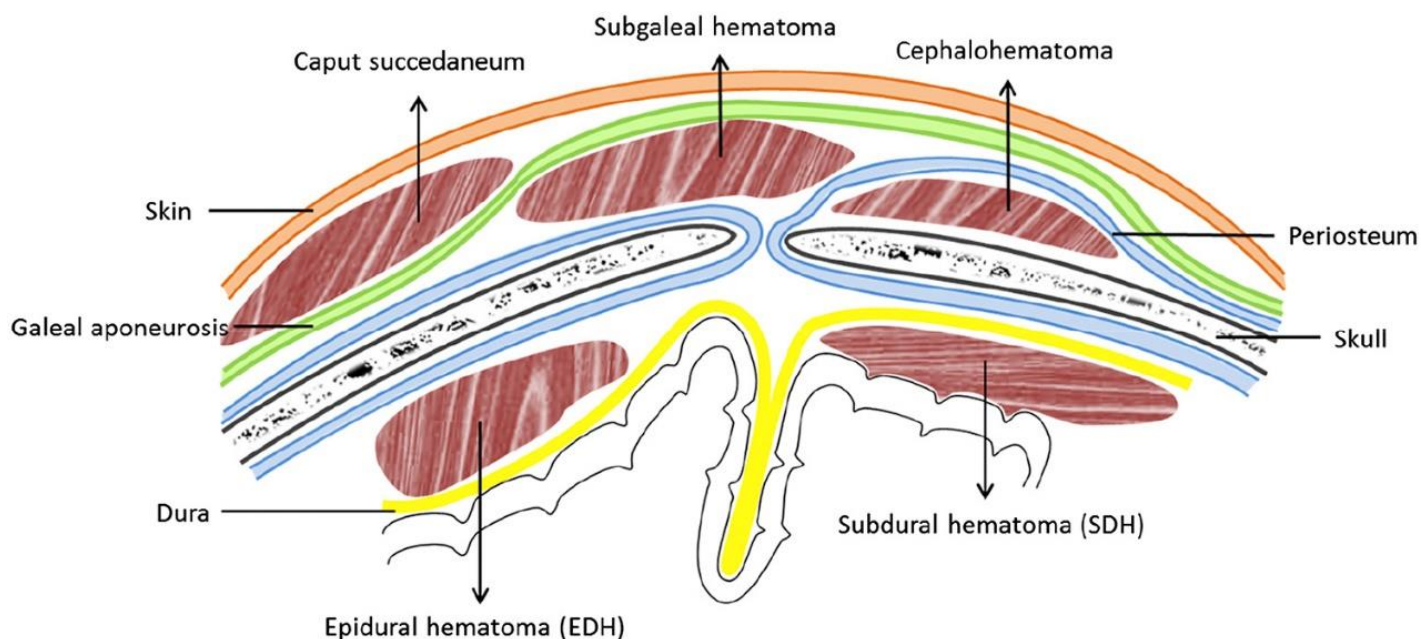
<p>Grade 1</p>	<p>Hemorrhage limited to subependymal germinal matrix.</p>	
<p>Grade 2</p>	<p>Hemorrhage extending into ventricular system occupying &lt; 50% of ventricles, with no ventriculomegaly</p>	
<p>Grade 3</p>	<p>Hemorrhage extending into ventricular system occupying &gt;50% of lateral ventricles with ventriculomegaly</p>	
<p>Grade 4</p>	<p>Hemorrhage grade 1, 2 or 3 with extension into brain tissue.</p>	

## GRADING OF PERIVENTRICULAR LEUKOMALACIA (PVL) -

<p>Grade 1</p>	<p>Echogenic persisting longer than 7 days (Considered Flaring if less than 7 days)</p>	
<p>Grade 2</p>	<p>Developing into small periventricular cysts</p>	
<p>Grade 3</p>	<p>Developing into extensive periventricular cysts</p>	
<p>Grade 4</p>	<p>In deep white matter developing into extensive subcortical cysts</p>	

## TYPES OF EXTRACRANIAL HEMATOMAS

*The incidence of these has increased with use vacuum assisted delivery.*



### SUBGALEAL HEMATOMA

***NOTE: These exams are to always be considered STAT and very emergent.***

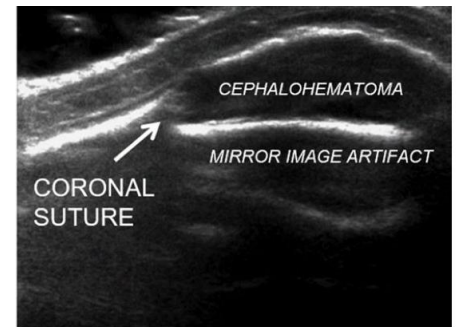
Subgaleal hemorrhage (SGH) is a preventable cause of morbidity and mortality in the neonate. All involved in the care of the neonate need to be aware of the importance of prompt diagnosis, monitoring and aggressive treatment to prevent hemorrhagic shock, organ failure, and neonatal death. The most critical time for the development of SGH is less than 12h after birth.

*Blood volume loss can be massive in SGH. It is estimated that the subgaleal space can accommodate up to 300 milliliters of blood. An average term newborn weighing 3 kilograms has a total blood volume of 240 milliliters, thus the subgaleal space can accommodate the infants entire blood volume resulting in complete exsanguination.*



## IMAGES TO OBTAIN FOR EXTRACRANIAL HEMATOMA EVALUATION

- Images should be obtained at the area of concern with a high frequency linear probe.
- Measure hematoma in three dimensions.
- Use a panoramic view if necessary to measure the extent of hematoma.
- Show suture location in relation to hematoma.
- Document hematoma with and without color.
- Cine clip in sagittal and transverse through hematoma.
- **Full cranial ultrasound protocol to be completed in addition.** Close attention to be paid to the epidural/subdural space deep to the area of concern for superficial hematoma as these can coexist. Be aware of mirror image artifact.



## FEATURES OF EXTRACRANIAL HEMATOMAS:

### SUBGALEAL HEMATOMA:

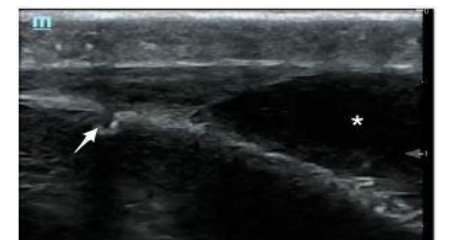
- Soft fluctuant mass
- Crosses over suture line
- Poorly defined borders
- Can also have skull fracture
- Presents after birth & progressively worsens; resolves over 2-3wks
- Mortality rate is reported to be from 12-25%.



*Subgaleal hematoma (\*) seen crossing over suture lines (arrow)*

### CEPHALOHEMATOMA:

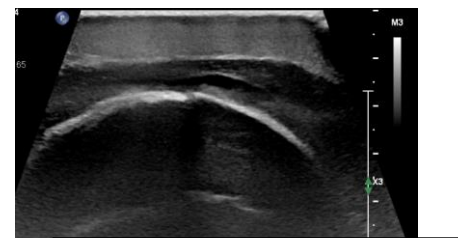
- Firm mass
- Does not cross over sutures
- Well defined borders
- Presents after birth & increases for 12-24hrs; resolves over weeks or months
- Rarely severe



*Cephalohematoma (\*) seen bound by suture lines (arrow)*

### CAPUT SUCCEDANEUM:

- Edema of superficial tissues
- Poorly defined borders
- Usually limited to presenting portion of the skull or vacuum site
- Maximum size at birth; resolves over hours or days



*Thickened subcutaneous tissues, likely caput succedaneum, with subgaleal hematoma seen crossing over suture lines*

## NEONATAL HEAD PROTOCOL HISTORY

	Date	Changes made	By whom
Updated	6/7/2021		Becky Marion
Updated	6/1/2022	-Coronal/Sagittal Mastoid views removed unless abnormality seen -Linear images required – two cine sweeps, one 2D image at GM -Added images for landmark reference and pathology comparison	Manjiri Dighe, Shaun Bornemeier, Becky Marion and Renee Betit Fitzgerald
Reviewed	2/24/2023	Still images reduced, sweeps to remain NICU floor policies/etiquette revised	Protocol review team
Added	9/15/2024	Added extracranial imaging section and subgaleal hematoma information	Renee Betit Fitzgerald

### REFERENCES:

Subgaleal Hematoma at the Contralateral Side of Scalp Trauma in an Adult Chen, Ching-En et al. Journal of Emergency Medicine, Volume 53, Issue 5, e85 - e88  
<https://doi.org/10.1016/j.jemermed.2017.06.007>

Acuña J, Adhikari S. Point-of-care Ultrasound to Distinguish Subgaleal and Cephalohematoma: Case Report. Clin Pract Cases Emerg Med. 2021 May;5(2):198-201.  
<https://doi.org/10.5811/cpcem.2021.3.51375>.

<https://www.ncbi.nlm.nih.gov/pmc/articles/PMC8143819/>  
<https://slideplayer.com/slide/17363132/>