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ICH, IVH, Birth Trauma



Learning Objectives

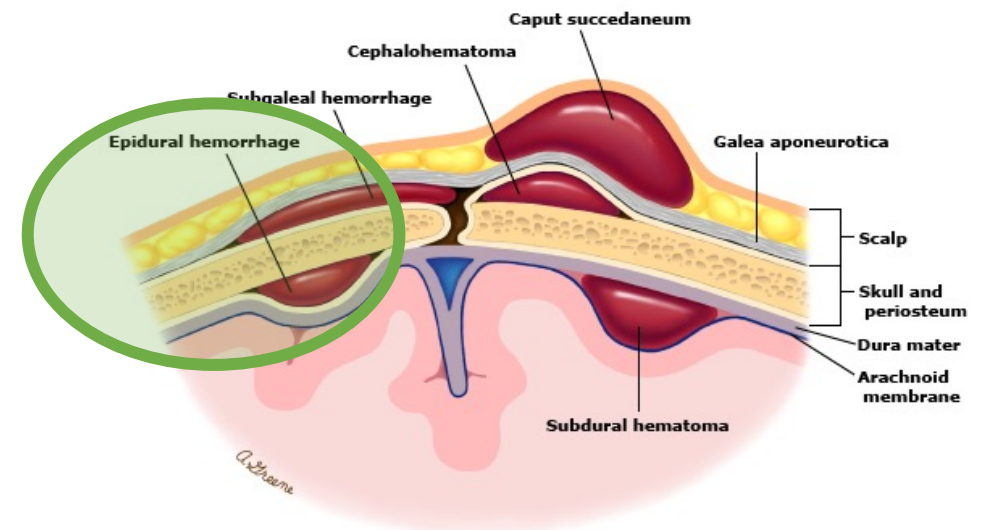
At the conclusion of this activity, participants should be able to:

1. Recognize and define intraventricular hemorrhage (IVH), intracranial hemorrhage (ICH), and most frequent intra/extracranial vascular injuries.
2. Review predisposing risk factors for IVH, ICH, and other vascular injuries.
3. Discuss diagnostic evaluations, formulate a management plan, and explain the prognosis.

Epidural hemorrhage

- Not common in neonates
- Injury to the **middle meningeal artery**, usually located in the parieto-temporal area
- **RF:** skull fractures, often associated with operative deliveries and primiparous mothers ¹
- **Presentation:** nonspecific neurological symptoms, seizures, hypotonia
- **Diagnosis:** CT or MRI*
- **Management:** Neurosurgical consultation, supportive therapy, surgical evacuation.

Neonatal extracranial and intracranial birth injuries



Modified from: Volpe JJ. *Neurology of the Newborn*, 4th ed, WB Saunders, Philadelphia 2001.

Graphic 53176 Version 11.0

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Subdural hemorrhage

- Up to 25% of all ICH
- The blood is going to be between the dura and the arachnoid membrane
- Results from tearing of the **veins and venous sinuses**, usually located in tentorium, or interhemispheric.
- **RF:**
 - Primipara, older multipara, small birth canal
 - Large full term, premature
 - Precipitous, prolonged
 - Breech extraction, foot/face/or brow presentation, infants delivered by vacuum, forceps, cesarean during labor. ²
 - Others: coagulation disorders, Vit K deficiencies

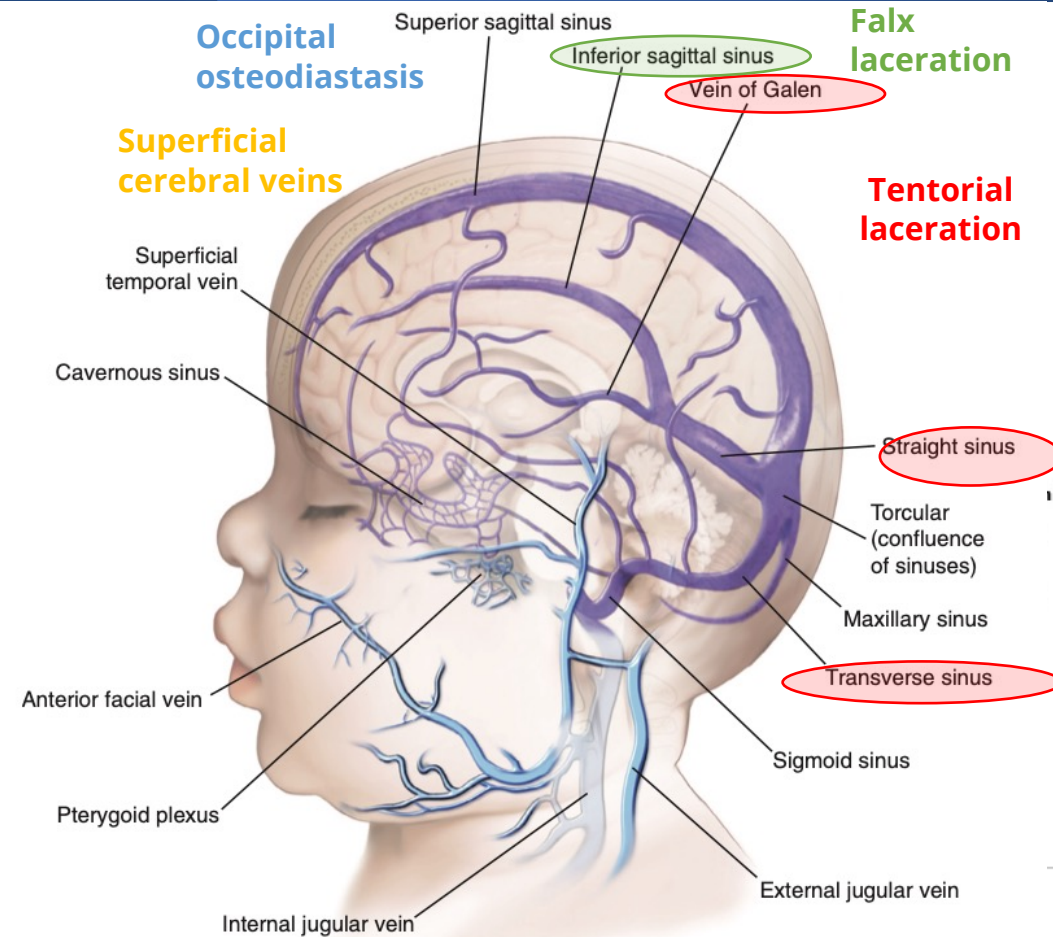


Figure 22.2 Major cranial veins and dural sinuses.

2. Towner, D et al. "Effect of mode of delivery in nulliparous women on neonatal intracranial injury." NEJM vol. 341,23 (1999): 1709-14. doi:10.1056/NEJM199912023412301

Subdural hemorrhage

- **Presentation** depends on severity and location.
 - In posterior fossa / infratentorial, or occipital osteodiastasis
 - **Severe** with acute signs: *comma, stupor, eye deviation (not altered by the “doll’s eyes” maneuver), unequal pupils, nuchal rigidity, opisthotonos, vital instability.
 - **Insidious**: initially silent, followed by lethargy, *full fontanel, irritability, vital instability.
 - Over convexities / superior, or anterior extension, superficial cerebral veins
 - Minimal to no symptoms.
 - **Severe** with acute signs: seizures, nonreactive pupils on the side of hemorrhage, hemiparesis.
 - **Insidious** onset: silent for months and then increase in head circumference.

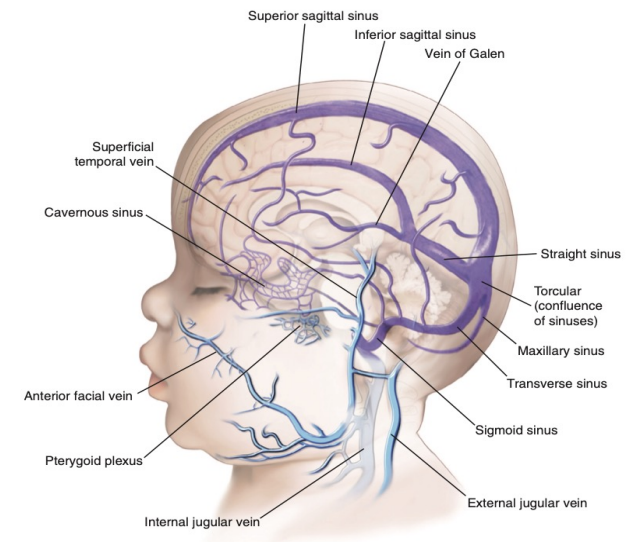
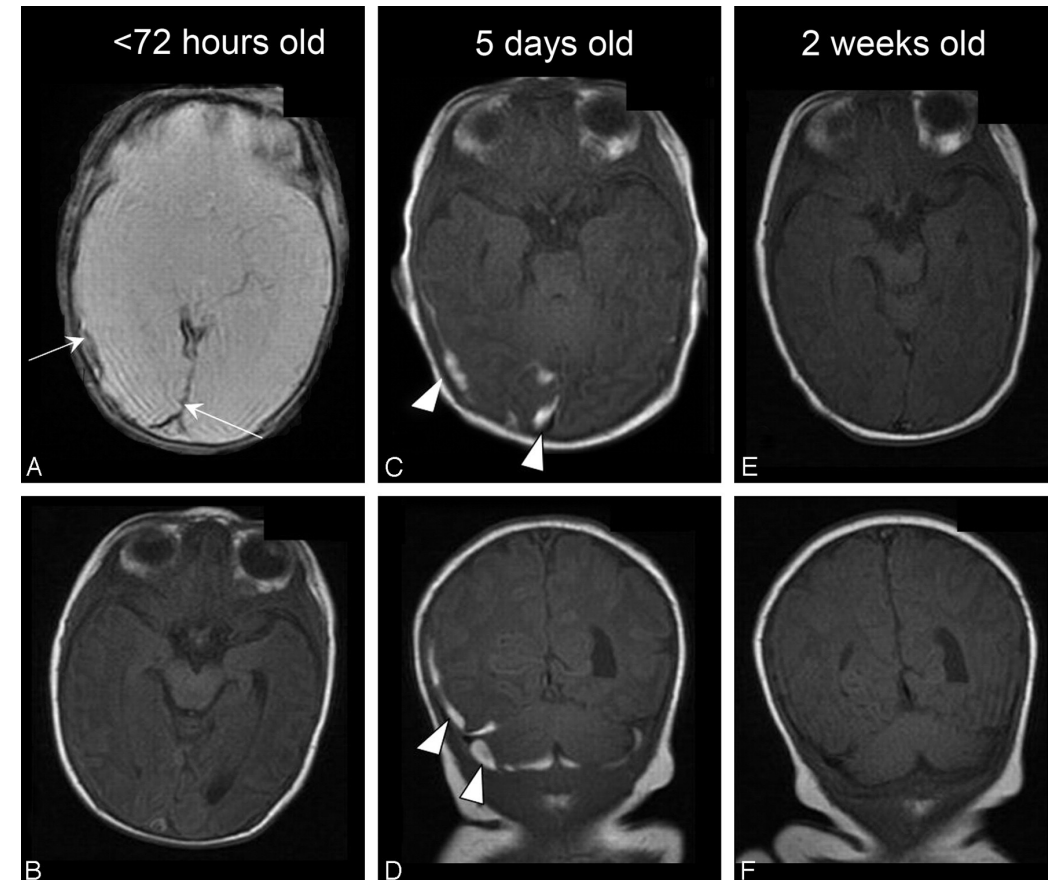


Figure 22.2 Major cranial veins and dural sinuses.

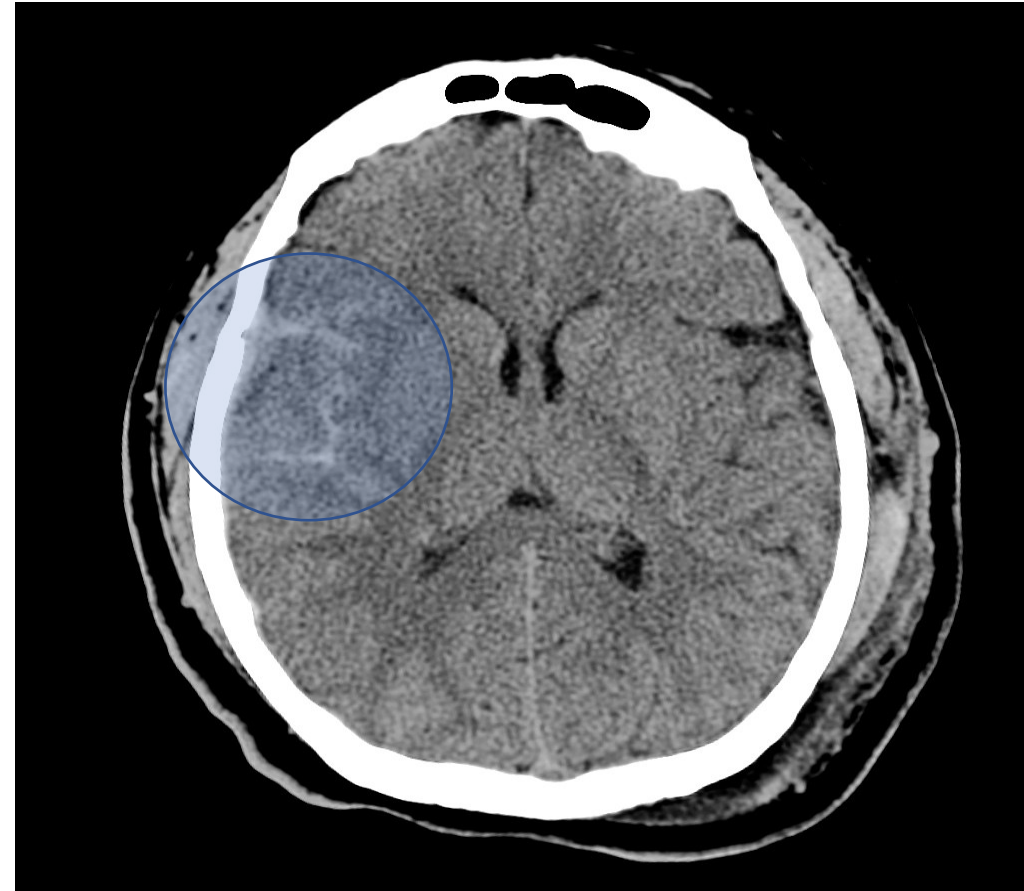
Subdural hemorrhage

- **Diagnosis:** CT or MRI*, US not as effective. 🙄
lumbar puncture → herniation
- **Management:** close monitoring, supportive therapy, neurosurgical evaluation for evacuation.
- **Prognosis** depends on the location:
 - Subdural hemorrhages on the **convexity** have a more benign outcome, risks for focal signs, and hydrocephalus.
 - Less severe **posterior fossa** hemorrhages if managed on time 80-90% will have a normal outcome; 10-15% can have sequelae that include hydrocephalus, and up to 5% mortality.
 - Severe **infratentorial** has a poor prognosis.

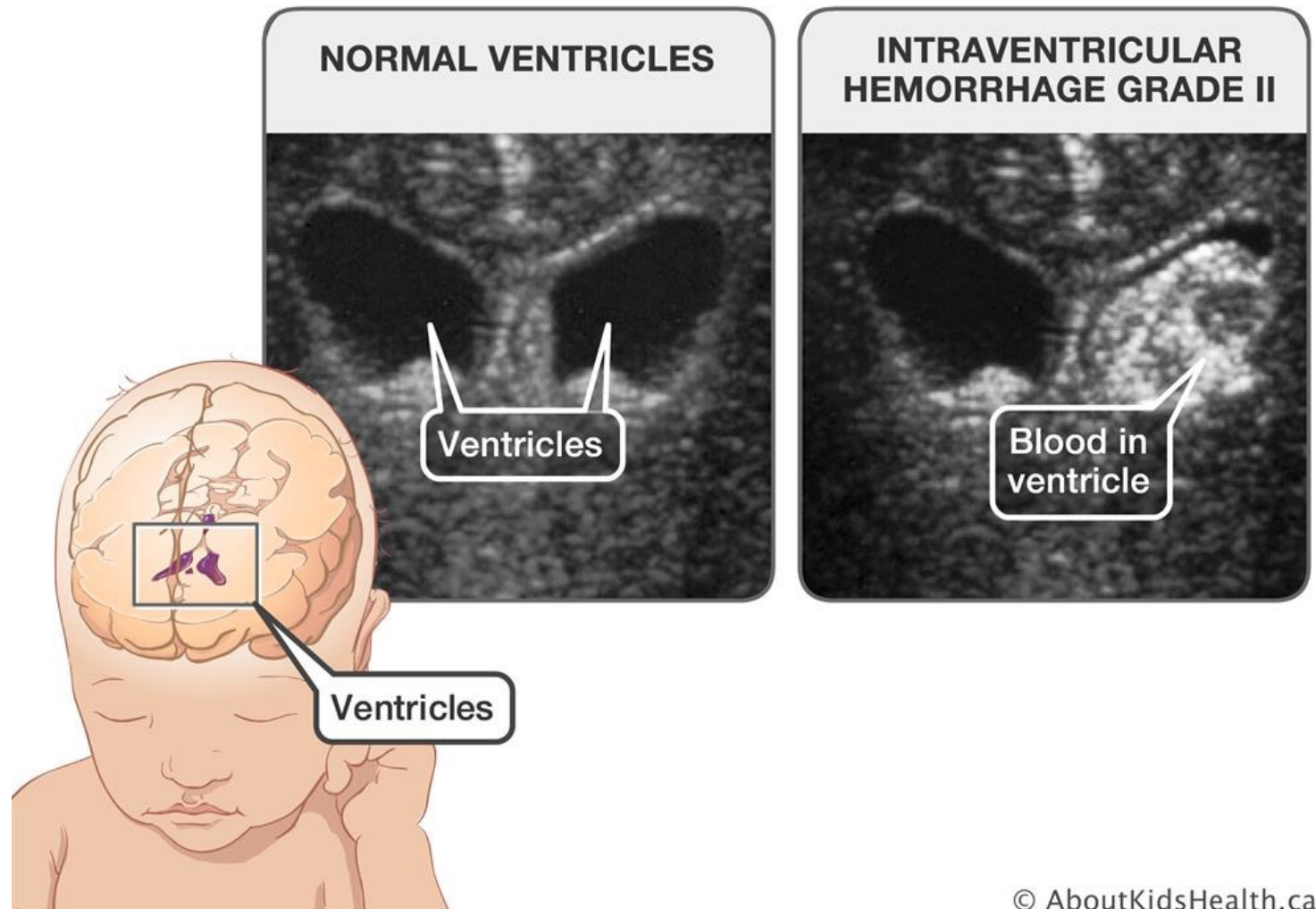


1ry Subarachnoid hemorrhage - SAH

- Up to **10%** of all ICH. Seen more in **premature** than FT infants.
- Caused by rupture of **bridging veins**, or the leptomeningeal anastomotic channels.
- Includes bleeding involving subpial space/superficial cerebral cortex.
- **RF:** It can happen in normal SVD, but the incidence increases with assisted deliveries or circulatory events related to prematurity.
- **Presentation:** often asymptomatic, can have early onset seizures, accompanied by apnea, and respiratory depression with catastrophic deterioration.
- **Diagnosis:** CT or MRI. LP with high RBC count and protein.
- **Prognosis:** good, hydrocephalus is an unusual complication.
- **Management** conservative.



Germinal
matrix
hemorrhage—
Intraventricular
hemorrhage
(GMH-IVH)

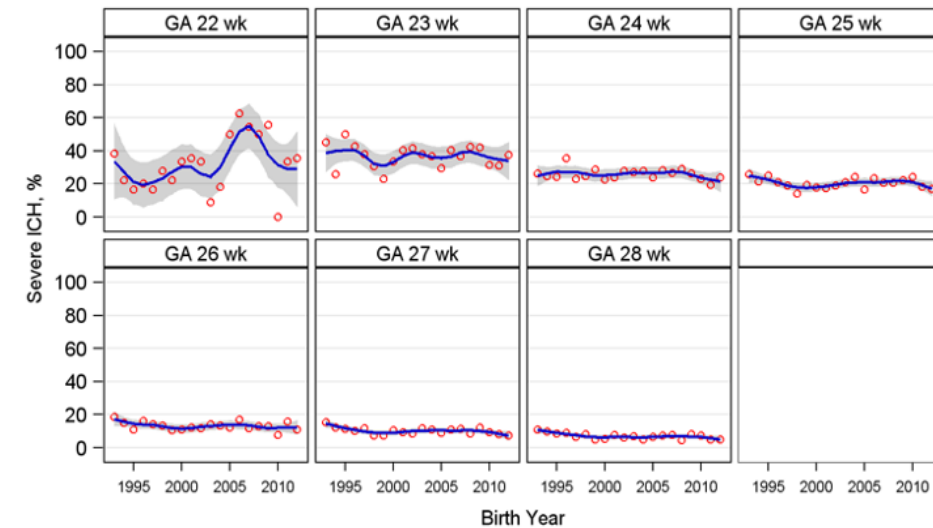


Intraventricular Hemorrhage – IVH

Epidemiology:

- More common in premature, especially if GA ≤ 28 weeks.
- Incidence for all IVH of $\approx 25\%$
- Depending on the centers/study data may vary.
- There is data on a decrease in severe IVH in the 28-26-week-old group population.
- There is an increased risk for all forms of IVH in the most immature and lower birth weight preterm infants.

eFigure 6. Severe intracranial hemorrhage (ICH) by birth year and GA for infants born at GA 22-28 weeks in NRN centers 1993-2012. In each graph, circles show the percent of infants born each year who were evaluated by cranial sonogram and diagnosed with grade 3-4 ICH, a smoothed curve shows the trend, and shading indicates a 95% CI for the curve. The year-GA interaction was significant, $p=0.03$. Relative risks for the change per year were adjusted for study center, maternal race/ethnicity, infant GA, SGA, and sex.



Adjusted RR (95% CI) for the change per year 1993-2012			
22 weeks	23 weeks	24 weeks	25 weeks
1.03 (1.00-1.07)	0.99 (0.98-1.00)	0.99 (0.98-1.00)	0.99 (0.98-1.00)
26 weeks	27 weeks	28 weeks	
0.987 (0.974-0.999)	0.984 (0.971-0.997)	0.973 (0.958-0.989)	

Stoll, Barbara J et al. "Trends in Care Practices, Morbidity, and Mortality of Extremely Preterm Neonates, 1993-2012." *JAMA* vol. 314,10 (2015): 1039-51. doi:10.1001/jama.2015.10244

Intraventricular Hemorrhage – IVH

TABLE 2. **Perinatal Factors Associated with Intraventricular Hemorrhage (IVH) in Preterm Infants**

Increased IVH Risk

- Maternal inflammatory conditions (ie, chorioamnionitis)
- Placental abruption

Decreased IVH Risk

- Antenatal glucocorticoids
- Maternal medications
 - Tocolytics in setting of preterm labor, specifically nifedipine or atosiban
 - Antibiotics in setting of chorioamnionitis

Possible Impact on IVH Risk

- Maternal transport before delivery
- Delivery mode and timing
- Preeclampsia

TABLE 3. **Delivery Room Factors Associated with Intraventricular Hemorrhage (IVH) in Preterm Infants**

Increased IVH Risk

- Hypothermia (moderate or severe)
- Factors that decrease cerebral blood flow
 - Hypoxemia
 - Hypotension (with signs of poor perfusion)
 - Hypercapnia
- Multiple intubation attempts (in VLBW infants)

Decreased IVH Risk

- Delayed cord clamping (no benefit found in preventing severe IVH)
- Umbilical cord milking (no benefit found in preventing severe IVH)

Subependymal Germinal Matrix

- 8 weeks – 36 weeks, regressed by term.
- Contains neuronal and glial stem cells
- Blood supply:
 - Heubner's artery*, anterior choroidal artery, and terminal branches of the lateral striate arteries.
 - “Immature vascular rete”, capillary bed.
 - Fan-shaped leash of short and long medullary veins that go to the terminal vein and lastly drain in the vein of Galen.

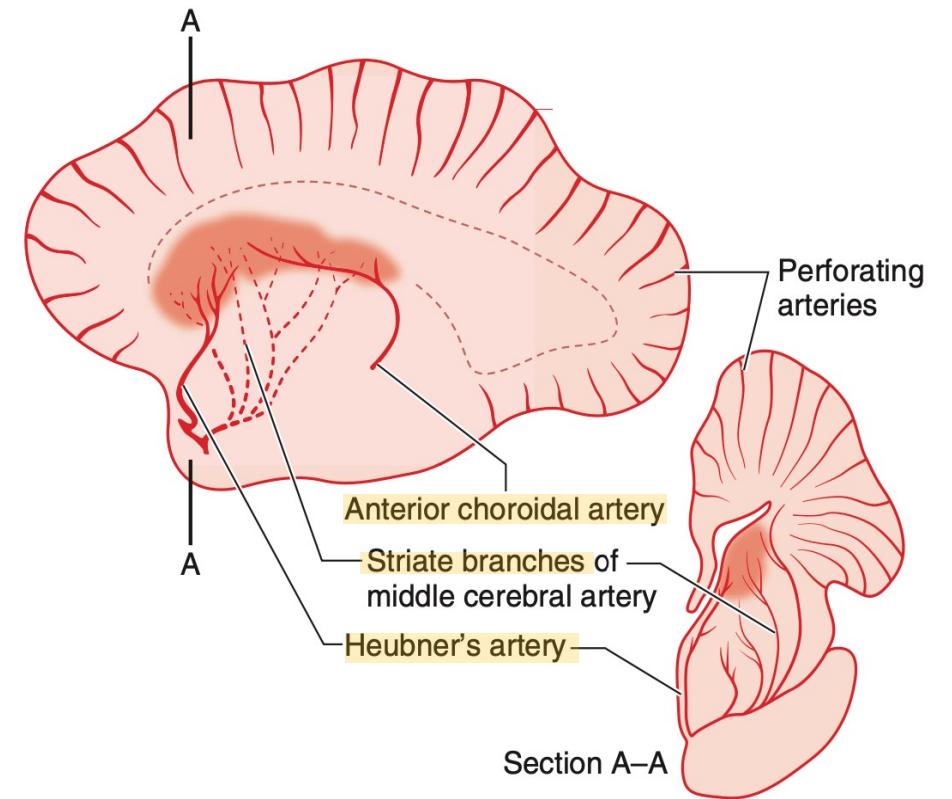


Figure 24.5 Arterial supply. Arterial supply to the subependymal germinal matrix at 29 weeks of gestation. (From Hambleton G, Wigglesworth JS. Origin of intraventricular haemorrhage in the preterm infant. *Arch Dis Child.* 1976;51: 651–659.)

Intraventricular Hemorrhage – IVH

- **Clinical**

- 50% within the first 24 hours after birth.
- 90% occur by 72 hours after birth

Presentation is **variable** from **silent** to **catastrophic**

- Catastrophic deterioration.
- Saltatory deterioration.
- Clinically silent*.

- **Diagnosis:**

- **CUS:** reliable and versatile in the clinical setting. High resolution, no radiation, portable and affordable.
- **MRI**
- **CT**

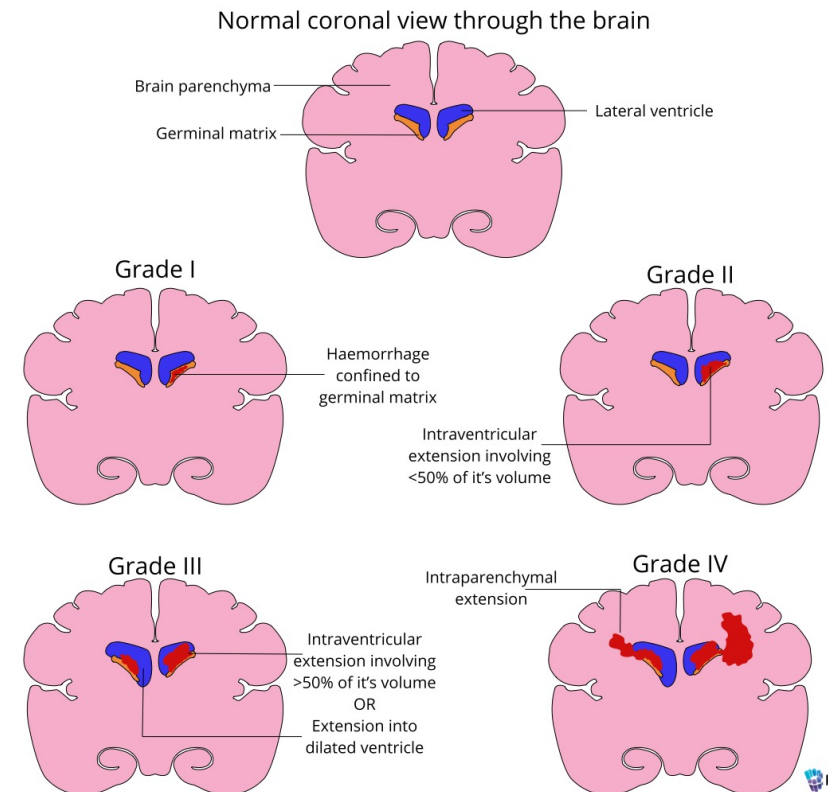
Intraventricular Hemorrhage – IVH

TABLE 17.3 Cranial Ultrasound Findings and Grades of Hemorrhages

Papile Criteria	Description	Volpe Criteria	Description
Grade I	Hemorrhage limited to the germinal matrix; may be unilateral or bilateral	Grade I	Blood in the germinal matrix area with or without minimal intraventricular hemorrhage (less than 10% of the ventricular space with blood)
Grade II	Blood noted within the ventricular system but not distending it	Grade II	Intraventricular hemorrhage with blood occupying 10%–50% of the ventricular space (sagittal view)
Grade III	Blood in ventricles with distension or dilation of the ventricles	Grade III	Intraventricular hemorrhage with blood occupying greater than 50% of the ventricles with or without periventricular echodensities
Grade IV	Intraventricular hemorrhage with parenchymal extension	Separate notation of other findings	Periventricular hemorrhagic infarction Cystic periventricular leukomalacia

Klaus and Fanaroff's Care of the High-Risk Neonate 7th Ed. – Neonatal Brain Disorders

Germinal matrix haemorrhage



Intraventricular Hemorrhage – IVH

- **Prognosis**

- Short term outcome

- Mortality depends on **grade and birthweight**, with the worst grades and smaller infants having the worst outcomes. In infants with apparent PVHI mortality is as high as 50% in <750 g and 20% >751 g.
 - Progressive **ventricular dilation**: about 75% of survivors have it regardless of weight, more often the higher the grade.

- Long-term outcomes depend on **immaturity**, the degree of **parenchymal injury**, and the presence of **complications** (e.g. hydrocephalus, PVL).

- **Mild IVH** (grade I-II) have higher odds (OR 1.39; 95% CI, 1.09 to 1.77) of **moderate–severe NDI** at **18-24 months**, compared with no IVH.
 - **Severe IVH** (grade III-IV) have even higher odds (OR 2.44; 95% CI, 1.73 to 3.42) of moderate-severe NDI compared with no IVH. Also has higher odds (OR 2.16; 95% CI, 1.36 to 3.43) of moderate-severe NDI when compared with mild IVH.
 - Infants with PVHI have been found to have some **type motor deficit and cognitive deficits**, depending on the lesion.

Intraventricular Hemorrhage – IVH

Management → Prevention

- Prevention of preterm birth
- Transportation in utero
- Prenatal pharmacological interventions (betamethasone)
- Optimal management of labor and delivery
- Temperature stabilization
- Appropriate newborn resuscitation
- Postnatal intervention concentrates on cardiorespiratory management to reduce fluctuations in cerebral perfusion, correction of other major hemodynamic disturbances, and correction of abnormalities of coagulation.

Intraventricular Hemorrhage – IVH

Management

- Initial or acute measures
 - Maintain brain perfusion
 - Prevention of cerebral hemodynamics disturbances
 - Serial US
- Monitor for development of posthemorrhagic hydrocephalus and periventricular leukomalacia (PVL)
- Progression of posthemorrhagic ventricular dilation will monitor closely and neurosurgery consultation evaluation for serial punctures, ventricular drainage, or shunt placement

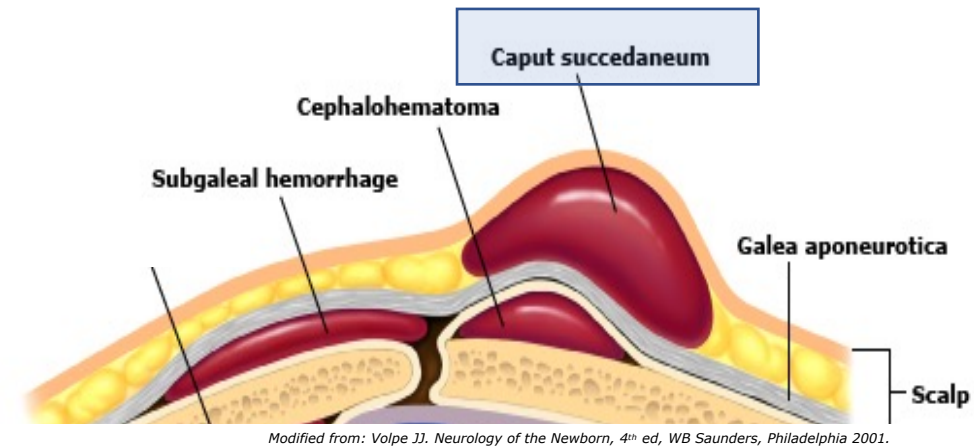
Extracranial hemorrhages



Extracranial hemorrhage

Caput succedaneum

- Common, hemorrhagic edema, present at birth.
- Is soft, superficial, and pitting.
- Crosses the suture lines
- Can be associated with cranial molding if noted at the vertex.
- Resolves spontaneously



Extracranial hemorrhage

Cephalohematoma

- Present in 1-2% of all births.
- Found subperiosteal
- More in boys, in primiparous, and use of assisted delivery
- Does not cross the suture lines. Swelling is apparent from hours to days, since the bleeding is slow.
- It feels firmer and tense upon palpation
- May be associated with skull fractures.
- Resolves spontaneously within 3-4 weeks.
- Follow indirect bilirubin.
- Calcification can be present after, as a palpable nodule until it is resorbed over 3 to 4 months.

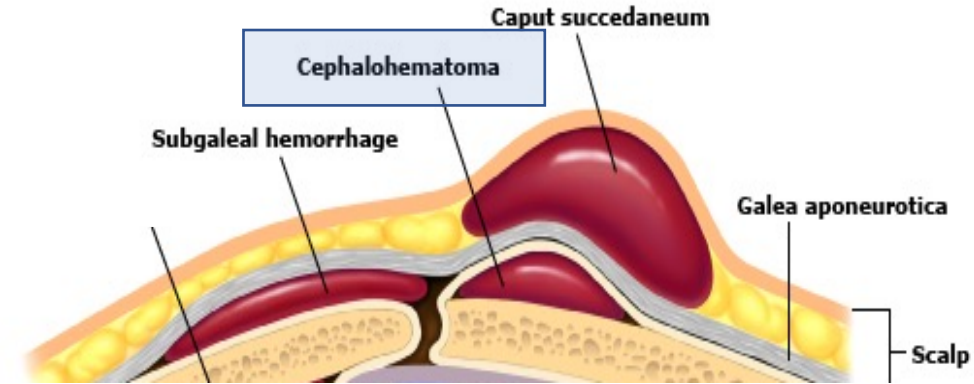


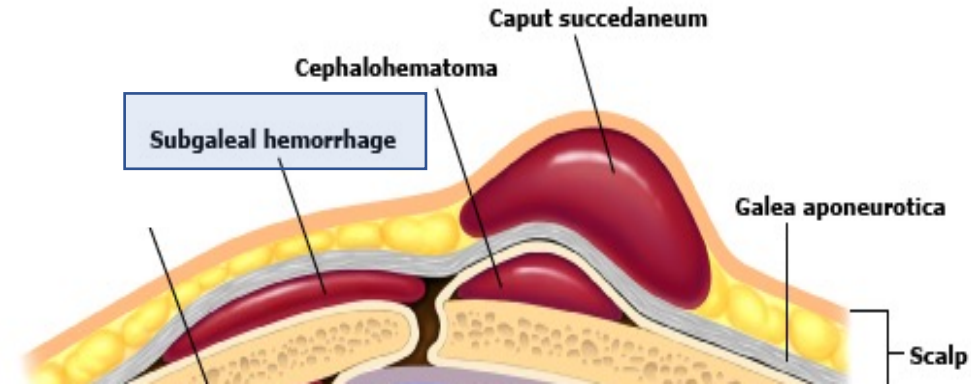
photo by Janelle Azy, MD

Images: <http://newborns.stanford.edu/PhotoGallery>

Extracranial hemorrhage

Subgaleal Hematoma

- Less common
- Beneath aponeurosis, damage to emissary veins that drain the dural sinus.
- May be associated with skull fractures.
- Fluid wave initially upon palpation, boggy mass.
- The blood beneath the scalp can go through the subcutaneous tissue of the neck and behind the ear.
- Up to 30% of blood volume can be sequestered.
- Follow for hyperbilirubinemia
- Resolves spontaneously within 2-3 weeks.



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