Birth Trauma as a Consideration in the Evaluation of Child Physical Abuse

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Types and Incidence of Child Maltreatment

- Neglect 79.5%
- Physical Abuse 18.0%
- Sexual+Psych+Medical Abuse 2.5%
- Infant/Child Deaths 1,560
- Child Fatalities < 3 y.o. 79.4%
  - Neglect 32.6%
  - Physical Abuse 22.9%
  - Multiple Types 40.8%

Reporters of Child Maltreatment

- 61.6% of reports were by professionals:
  - Teachers 17.5%
  - LE/legal professionals 17.5%
  - Social services staff 11.0%
  - Medical/Other Professional 15.5%
- 18.6% of reports were by non-professionals:
  - friends, neighbors, relatives
- 19.8% of reports were unclassified:
  - anonymous, unknown, other

Birth

- The birth process is a blend of compression, contractions, torques, and traction that can be complicated by fetal size, presentation, or neurologic immaturity and may lead to tissue damage, edema, hemorrhage, or fractures in the neonate. Obstetric instrumentation may further amplify the effects of these forces or may induce injury alone. Cesarean delivery does not guarantee an injury-free birth.

Birth Injury

- Fewer than 2% of significant birth injuries result in neonatal deaths.
- On an average there are 6-8 injuries per 1000 live births.
- Larger infants are more susceptible to birth trauma (largest number in infants > 4000-4500gms).
- Most birth traumas are self-limiting and have a favorable outcome.

Birth Injury

- Prematurity has specific concerns:
  - Intra-ventricular Hemorrhages
  - Retinopathy of Prematurity
  - Osteopenia/Decreased Bone Mineralization

Predisposing Factors for Birth Injury

- Fetal macrosomia/large-for-date infants>4500gms
- Fetal macrocephaly/large head
- Fetal anomalies
- Extreme prematurity/very low birth weight
- Instrumented deliveries - forceps (midcavity), vacuum
- Abnormal presentation (breech delivery)
- Abnormal or excessive traction during delivery

Predisposing Factors for Birth Injury

- Versions and extractions
- Deep, transverse arrest of descent of fetal presenting part
- Prima gravida
- Cephalo-pelvic disproportion
- Prolonged or rapid labor
- Oligohydramnios
- Oxygen deprivation

(Injury can also occasionally result from resuscitation)

Types of Birth Trauma/Injury

- Soft tissue injury
- Skull injury
- Facial injury
- Musculoskeletal injury
- Peripheral nerve injury
- Intra-abdominal injury
- Intra-cranial injury

Soft Tissue Injury

- Caput succedaneum:
  - A serosanguinous, subcutaneous, extra-periosteal fluid collection with poorly defined margins
  - Caused by pressure of the presenting part against the dilating cervix
  - Extends across the midline and over suture lines and is associated with head molding.
  - Does not usually cause complications and usually resolves over the first few days with observation only.

Soft Tissue Injury

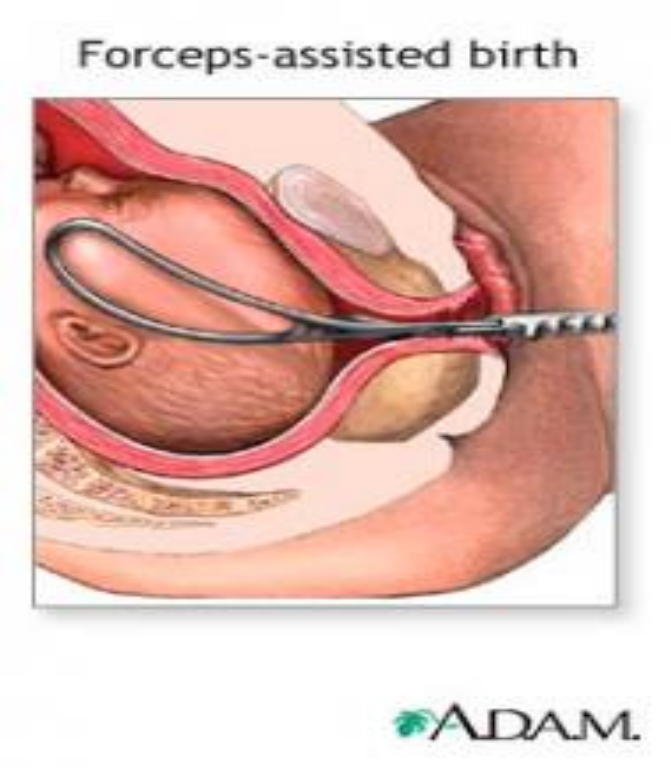
- Lacerations/abrasions:
  - Can occur from scalpel cuts during C-sections or instrumental delivery (vacuum, forceps)
  - Infection is a risk, but most lesions heal uneventfully.
- Crush/compression injuries:
  - Subcutaneous fat necrosis: Not usually detected at birth. Presents as irregular, nonpitting, subcutaneous, hard plaques with overlying dusky, red-purple discoloration on extremities, face, trunk, or buttocks.
  - May result from pressure during delivery. No treatment necessary. Sometimes calcifies.

Soft Tissue Injury

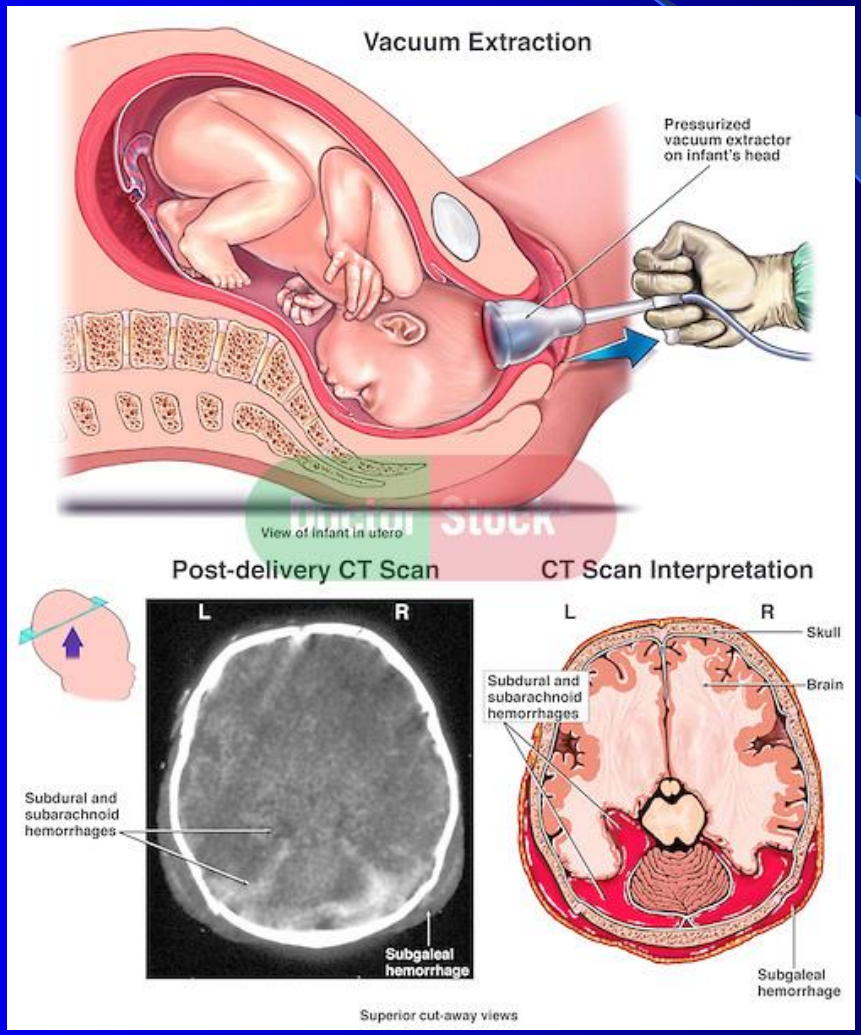
- Bruises:
  - Can occur from pressure of the presenting part against the cervix
  - Can occur from instrumental delivery (forceps, vacuum extraction)

Skin, Scalp, Skull

(Forceps-assisted Delivery)



Skin, Scalp, Skull
(Vacuum Extraction)



Skin, Scalp, Skull

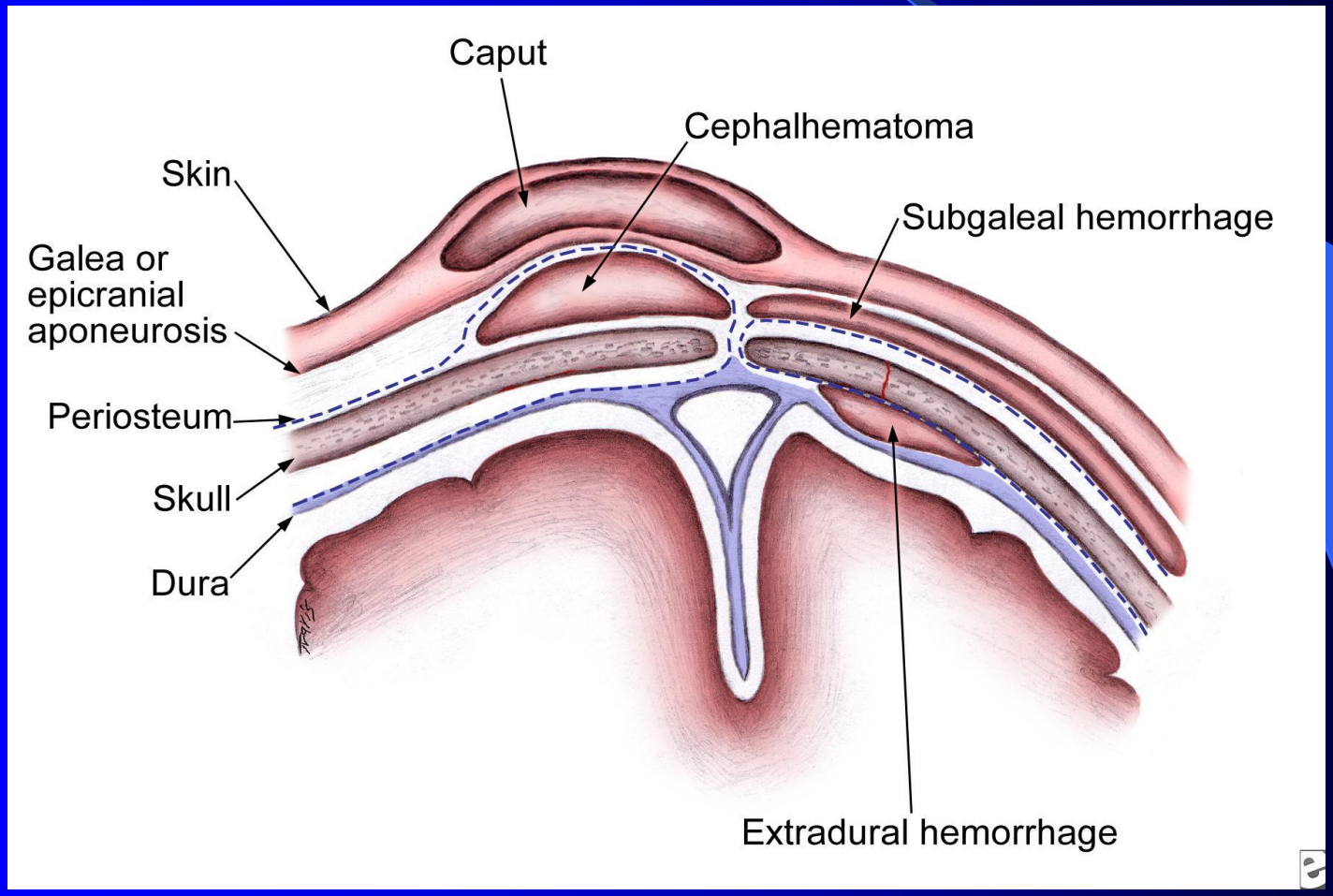
(Fat Necrosis)

Skull Injury

- Cephalhematoma:
  - Subperiosteal collection of blood from rupture of blood vessels between the skull and the periosteum. Extent is delineated by suture lines. Most commonly parietal.
  - Can cause anemia, hyperbilirubinemia, hypotension, infection. 5-20% have underlying skull fractures.
  - Resolves over weeks, occasionally with residual calcification
  - Diagnosed by skull x-rays or Head CT

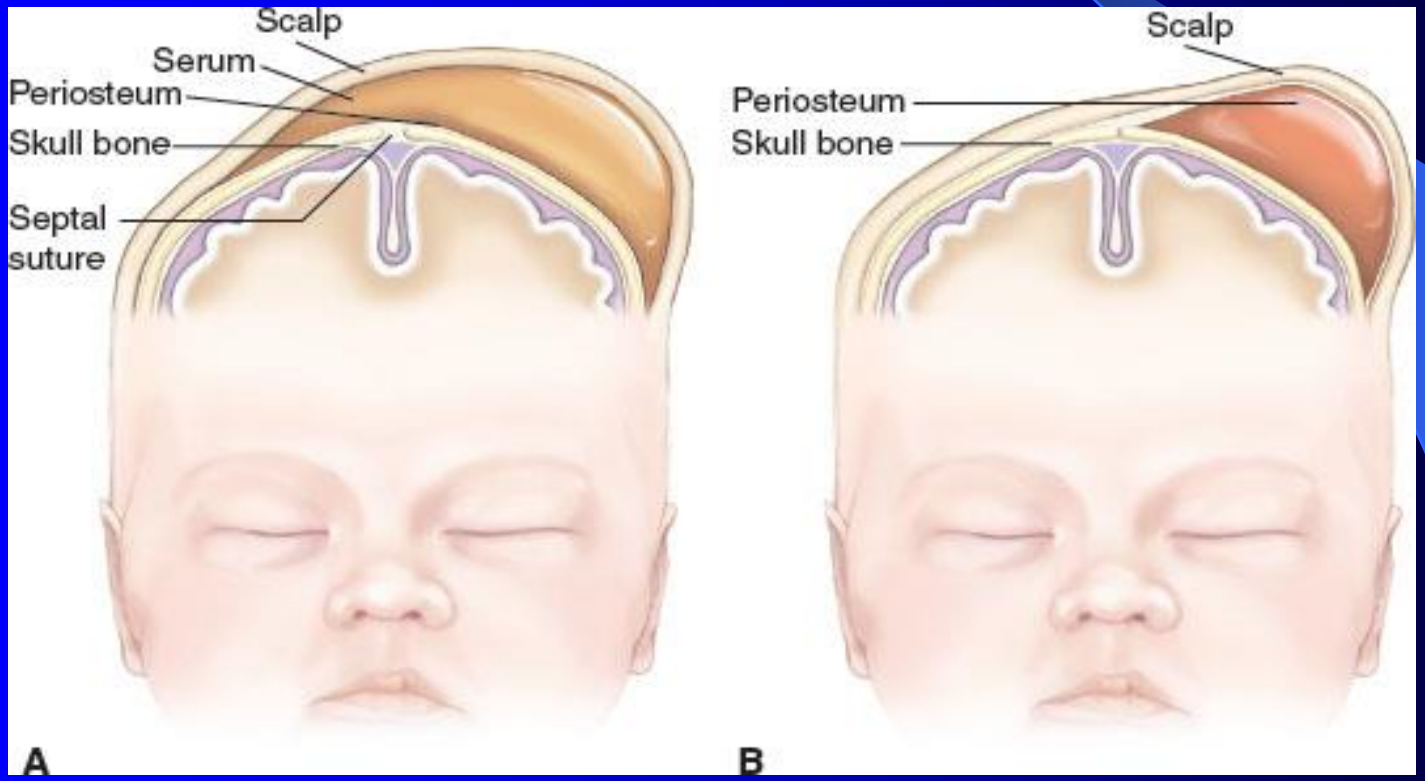
Skin, Scalp, Skull

(Caput, Cephalhematoma, Subgaleal Hemorrhage)



Skin, Scalp, Skull

(Caput and Cephalhematoma)



Skull Injury

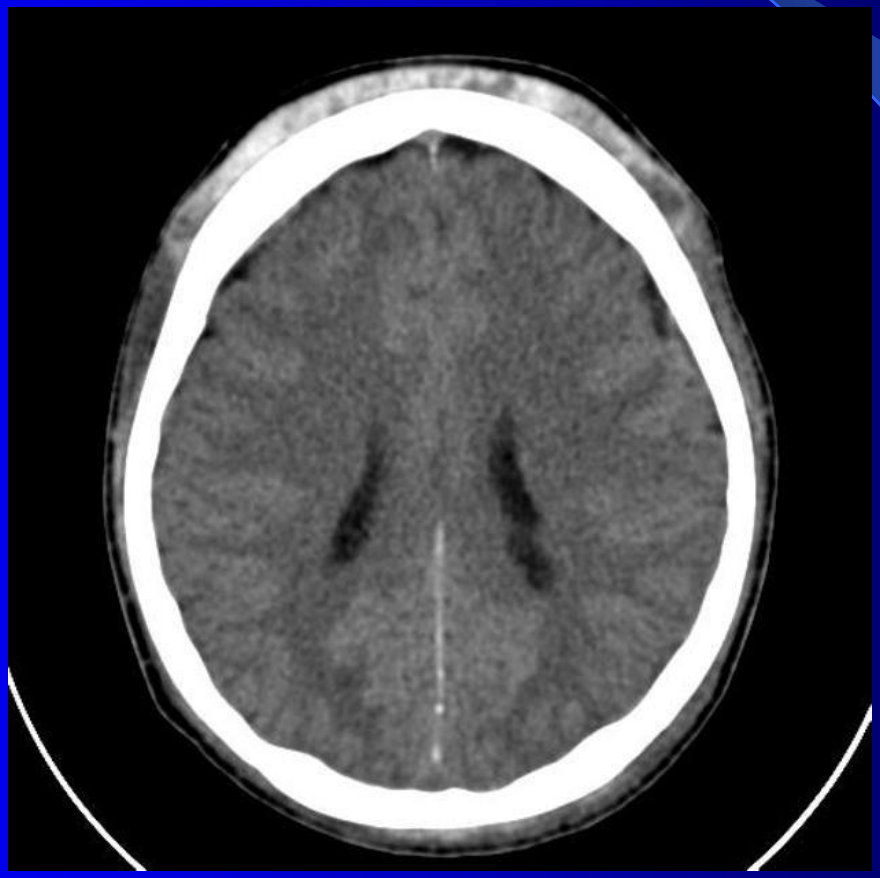
- Subgaleal hematoma:
  - Bleeding in the potential space between the skull periosteum and the scalp galea aponeurosis.
  - 90% result from a vacuum applied to the head at delivery.
  - 40% are associated head trauma (ICH or skull fracture)
  - Presents as a fluctuant, boggy mass over the scalp (especially occiput). Develops gradually 12-72 hours after delivery. If severe, can be noted immediately after delivery or may not be seen for hours. It spreads across the whole calvaria and crosses suture lines.

Skin, Scalp, Skull
(Subgaleal Hematoma)

- Can cause anemia, hemorrhagic shock, hyperbilirubinemia, hypotension, infection.

Skin, Scalp, Skull

Subgaleal Hematoma)



Skin, Scalp, Skull
(Skull Fractures)

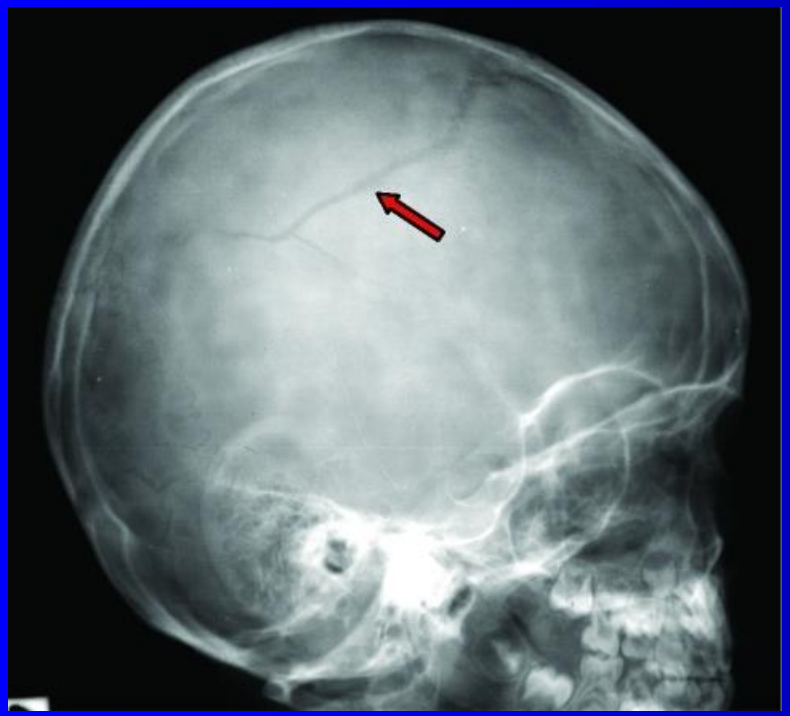
- Causes of newborn skull fractures:
  - Delivery technique
  - Instrumented delivery (forceps, vacuum extraction)
  - Abnormal presentation (head contacts mother's pelvis
- Types of newborn skull fractures:
  - Linear skull fractures
  - Depressed/ping-pong skull fractures:
    - Often accompanied by scalp lacerations
    - Can cause injury to the brain
    - May require surgery

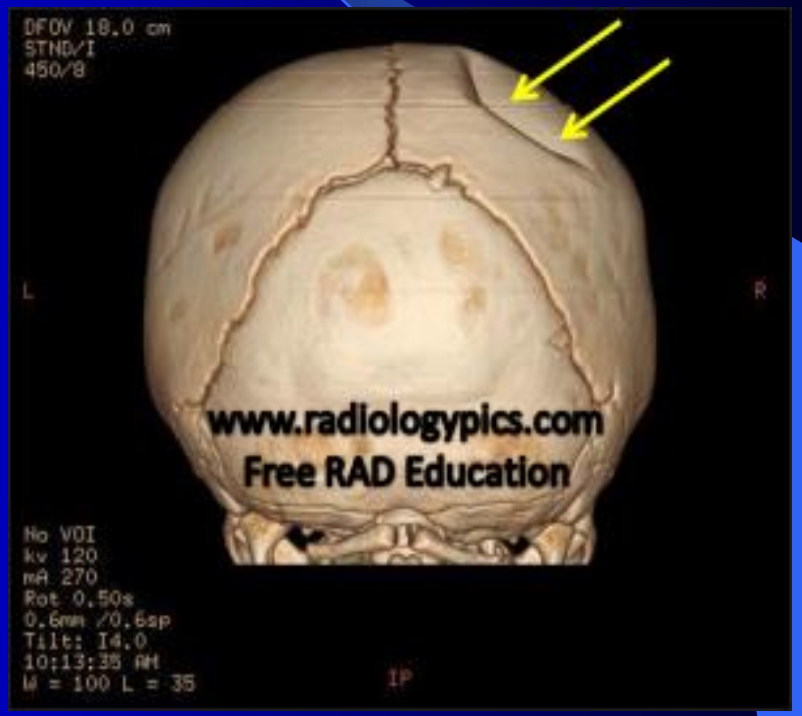
Skin, Scalp, Skull
(Skull Fractures)

- Basilar skull fractures:
  - Can cause bruising around the eyes and behind the ears
- Diastatic skull fractures:
  - Fracturing and widening of the suture bones

Skin, Scalp, Skull

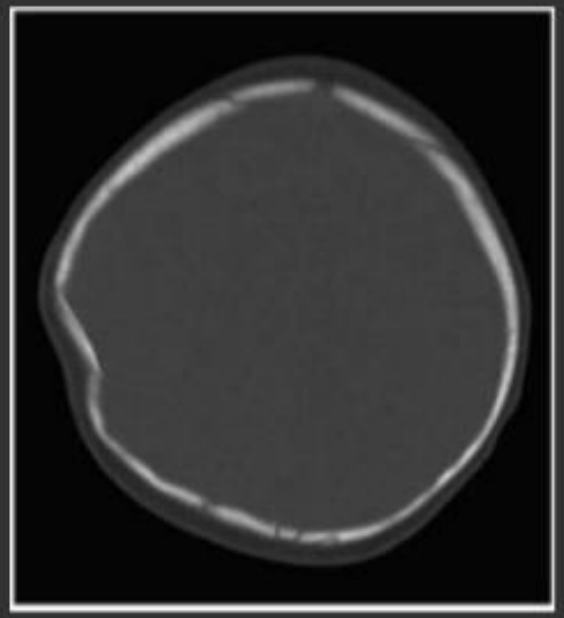
(Linear Skull Fractures)





Skin, Scalp, Skull

(Depressed/Ping-Pong Skull Fractures)



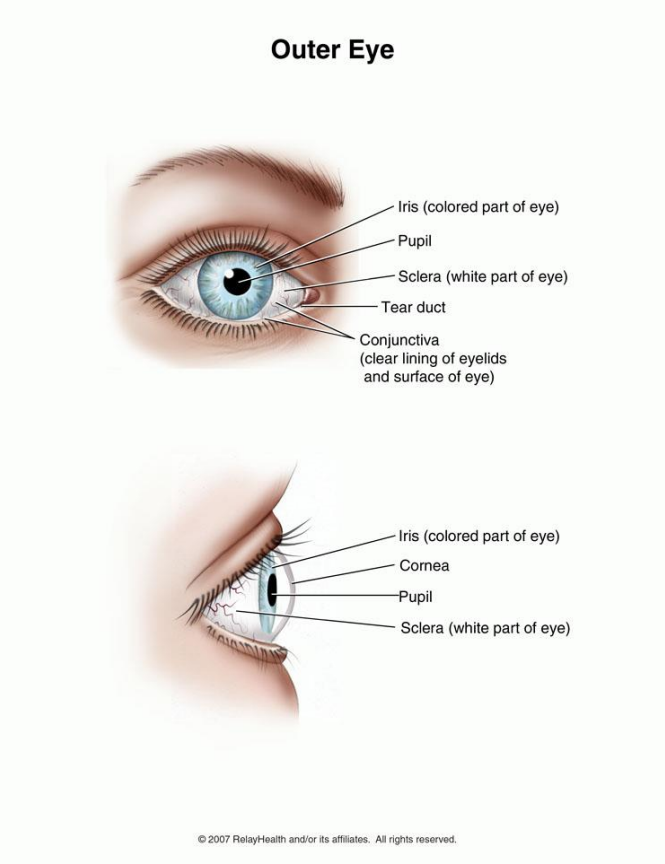
CT bone windows showing ping-pong skull fracture.
The multiple nondisplaced linear lucencies are normal sutures.

Facial/Eye Injury

- Subconjunctival hemorrhages:
  - Can be large or small, in any part of the conjunctiva
  - Resolve over weeks
- Retinal hemorrhages:
  - 13 studies with 1,777 newborn infants were reviewed:
    - NSVD: 25.6% had RHs
    - Vacuum Extraction: 42.6% had RHs
    - Forceps + Vacuum: 52% had RH
  - 59% of RHs were bilateral

Facial/Eye Injury

(Newborn Subconjunctival Hemorrhages)

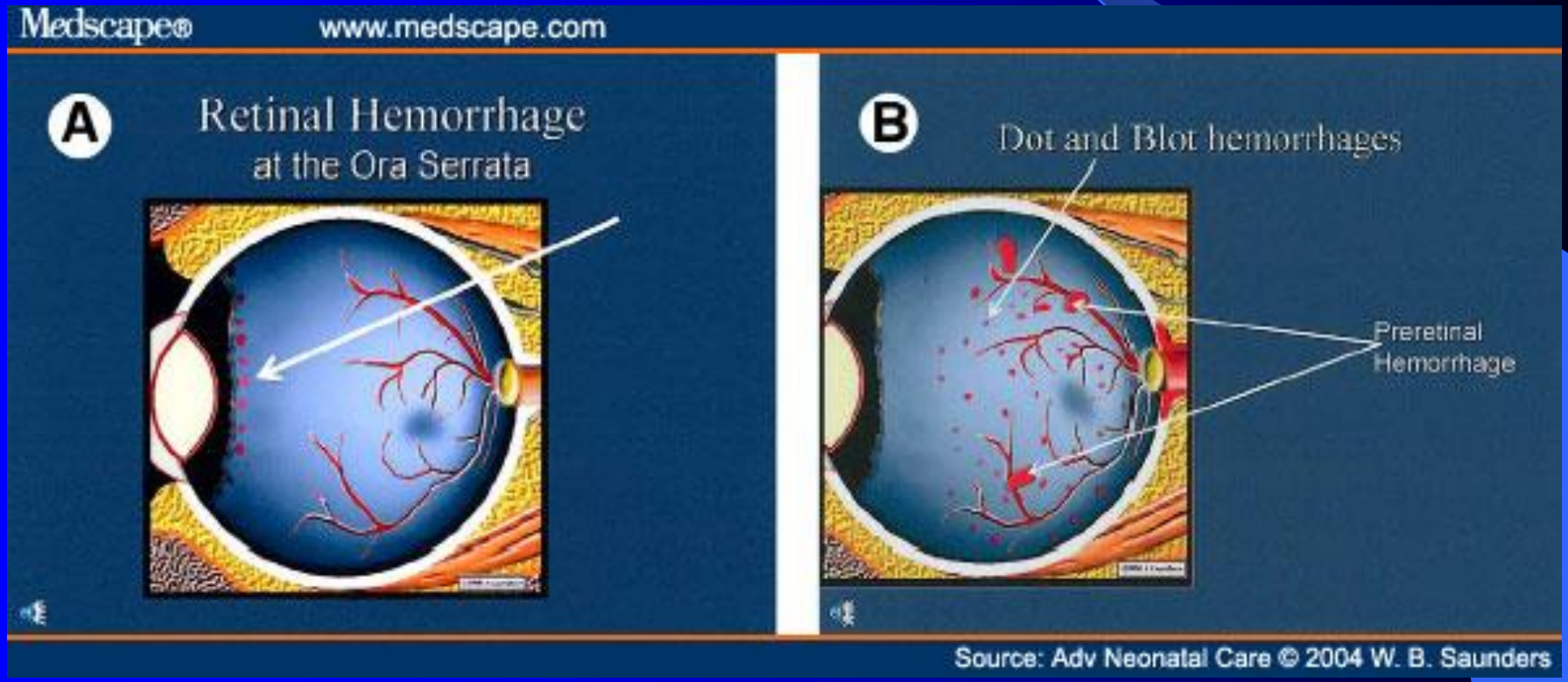


Facial Injuries

(Newborn Retinal Hemorrhages)

Facial/Eye Injury

(Newborn Retinal Hemorrhages)



Facial/Eye Injury
(Newborn Retinal Hemorrhages)

- Severity of retinal hemorrhages:
  - Mild: 22-56%
  - Severe: 18-37%
- Predominent location of retinal hemorrhages:
  - Intra-retinal
  - In the posterior pole
- Resolution of retinal hemorrhages:
  - Majority resolved within 10 days
  - Isolated cases persisted to 58 days

Facial/Eye Injury
(Retinal Hemorrhages)

- **Conclusions regarding Newborn RHs:**
  - Birth-related RHs in newborn infants occured in one-quarter of normal deliveries and were far more common after instrumental deliveries. They were commonly bilateral. They were predominantly intraretinal and in the posterior pole. They resolved rapidly, and very rarely persisted beyond 6 weeks.

"Newborn Retinal Hemorrhages: A Systemic Review". Journal of the American Association for Pediatric Ophthalmology and Strabismus. February 2013. Vol 17, Issue 1, pages 70-78.

Musculoskeletal Injury

- Newborn clavicular fractures:
  - Most frequently fractured bone in neonates during birth
  - Some correlation with birth weight, midforceps delivery, and shoulder dystocia
  - May present with pseudoparalysis, crepitus, palpable bony irregularity, sternocleidomastoid muscle spasm.
  - X-ray confirms fracture. Heals/stabilizes in 7-10 days.
  - For pain, limit arm motion by pinning sleeve to shirt.
  - Assess other associated injury to spine, brachial plexus, humerus.

Musculoskeletal Injury

(Clavicular Fracture)

Musculoskeletal Injury

- Newborn fractures of long bones:
  - May involve humerus, femur, radius/ulna, tibia/fibula
  - Present with decreased spontaneous movement of arm or leg followed by swelling/pain on passive movement.
  - OB may feel or hear a snap at the time of delivery.
  - X-rays confirm diagnosis and distinguish fractures from septic arthritis.
  - May have radial nerve injury with humeral fracture.
  - Hard callus forms in 8-10 days. Complete recovery occurs in 2-4 weeks. Ortho consult is recommended.

Musculoskeletal Injury

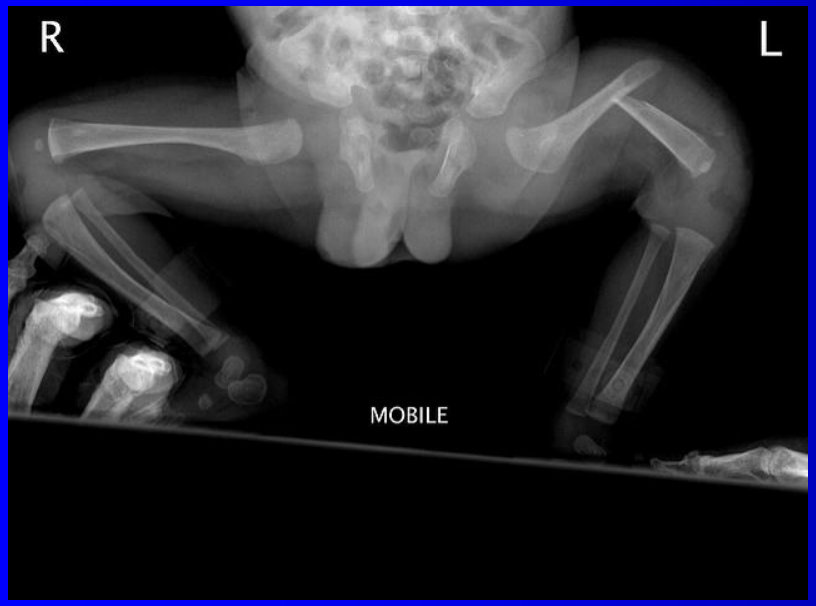
- Newborn femur fractures:
  - Considered rare in newborns and have been described with difficult deliveries
  - One study reported incidence varies between 0.13 and 0.077 per 1,000 deliveries
  - Risk factors include malpresentation, low birth weight, macrosomic baby and difficult or precipitous delivery
  - One study reported 60 % incidence in C/S, particularly predominant with breech presentation.
  - Other risk factors include OI, disuse osteoporosis after prolonged immobilization, osteopenia of prematurity.

Musculoskeletal Injury

- Newborn humerus fractures:
  - Second most common fractures in newborns
  - Can occur with shoulder dystocia during delivery
- Other less common newborn fractures
  - Rib fractures (including mid-posterior rib fractures)
  - Spine fractures
  - Mandible fractures
  - Classic metaphyseal fractures

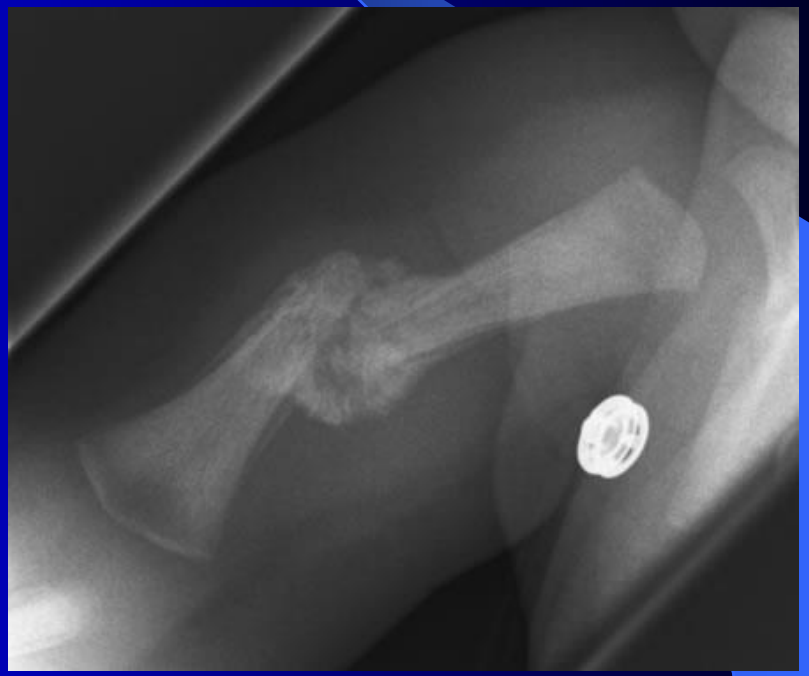
Musculoskeletal Injury

(Newborn Femur and Humerus Fractures)



Musculoskeletal Injury

(Hard Callus Formation of Newborn Femur and Humerus Fractures)



Musculoskeletal Injury

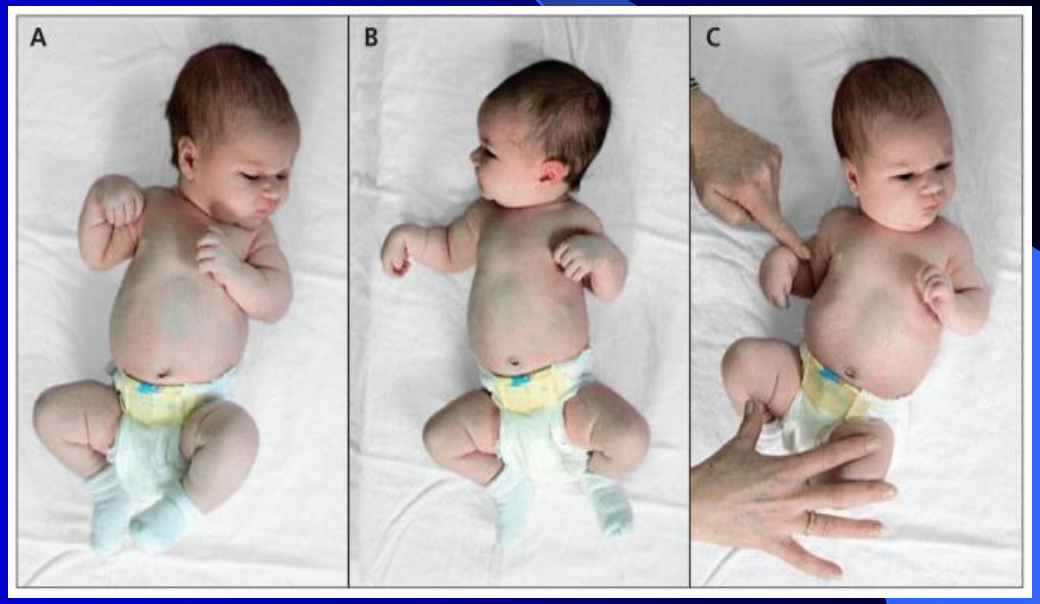
- Sternocleidomastoid injury
  - In congenital muscular torticollis the sternocleidomastoid muscle is tight and shortened.
  - Cause of congenital muscular torticollis is unknown but may be related to abnormal positioning (breech position) or "crowding" of baby in utero. This results in injury to the neck muscle. Increased muscle injury may result in tighter muscle.
  - Uterine crowding is more common in 1st born children, (more likely to have torticollis and hip dysplasia).

Peripheral Nerve Injury

- Facial palsy: forceps injury or more commonly from compression of infant head as it passes the sacrum
- Unilateral vocal cord paralysis
- Radial nerve palsy: normal shoulder, flexed elbow
- Lumbosacral plexus injury
- Brachial plexus injury:
  - Occurs most commonly in large babies, frequently with shoulder dystocia or breech delivery
  - Occurs in 0.5-2 per 1000 live births
  - Most common form is Erb Palsy (C5-C6)

Peripheral Nerve Injury

(Facial Nerve Injury and Radial Nerve Injury)

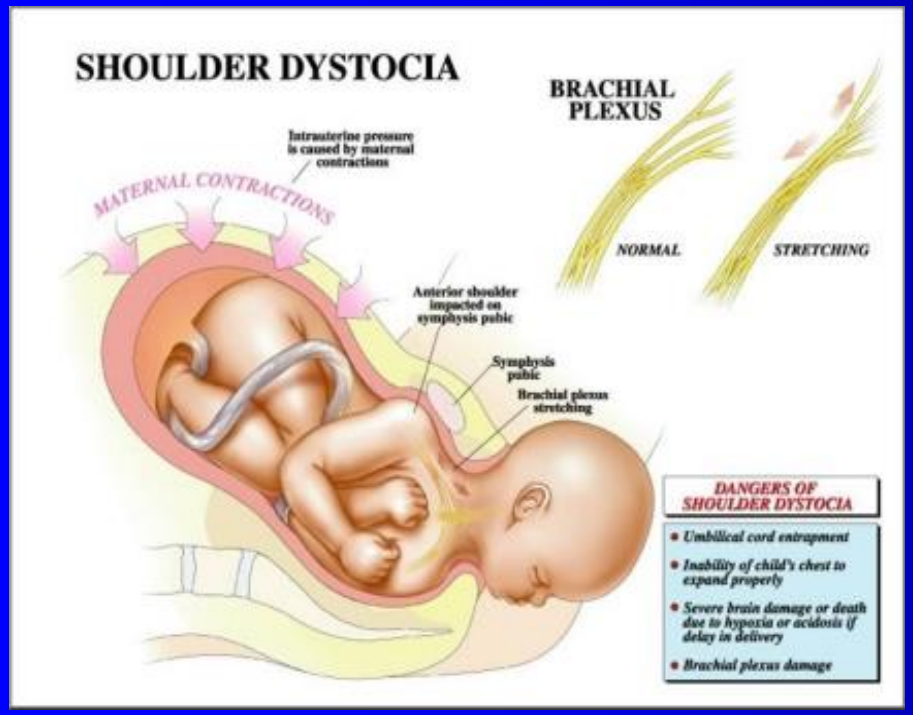


Peripheral Nerve Injury

- Brachial plexus injury:
  - Associated traumatic lesions include:
    - Fractured clavicle (10%)
    - Fractured humerus (10%)
    - Subluxation of cervical spine (5%)
    - Cervical cord injury (5-10%)
    - Facial palsy (10-20%)
  - Outcomes:
    - 88% of cases resolve in the first 4 months
    - 92% resolved by 12 months
    - 93% resolved by 48 months.

Perpherial Nerve Injury

(Brachial Plexus Injury)



Intra-Abdominal Injury

- Relatively uncommon and can sometimes be overlooked as a cause of death in the newborn.
- Hemorrhage is the most serious acute complication
  - Liver hematoma/rupture:
    - Most commonly damaged internal organ
    - Subcapsular hematoma is the most common lesion
    - Lacerations are less common
    - Risk factors are prematurity, postmaturity, coagulation disorders, asphyxia

Intra-Abdominal Injury

- Splenic injury:
  - Splenic rupture is about a fifth as common as liver laceration.
  - Predisposing factors and mechanisms of injury are similar to liver injuries.
- Adrenal hemorrhage:
- Renal hemorrhage

Intra-Cranial Injury

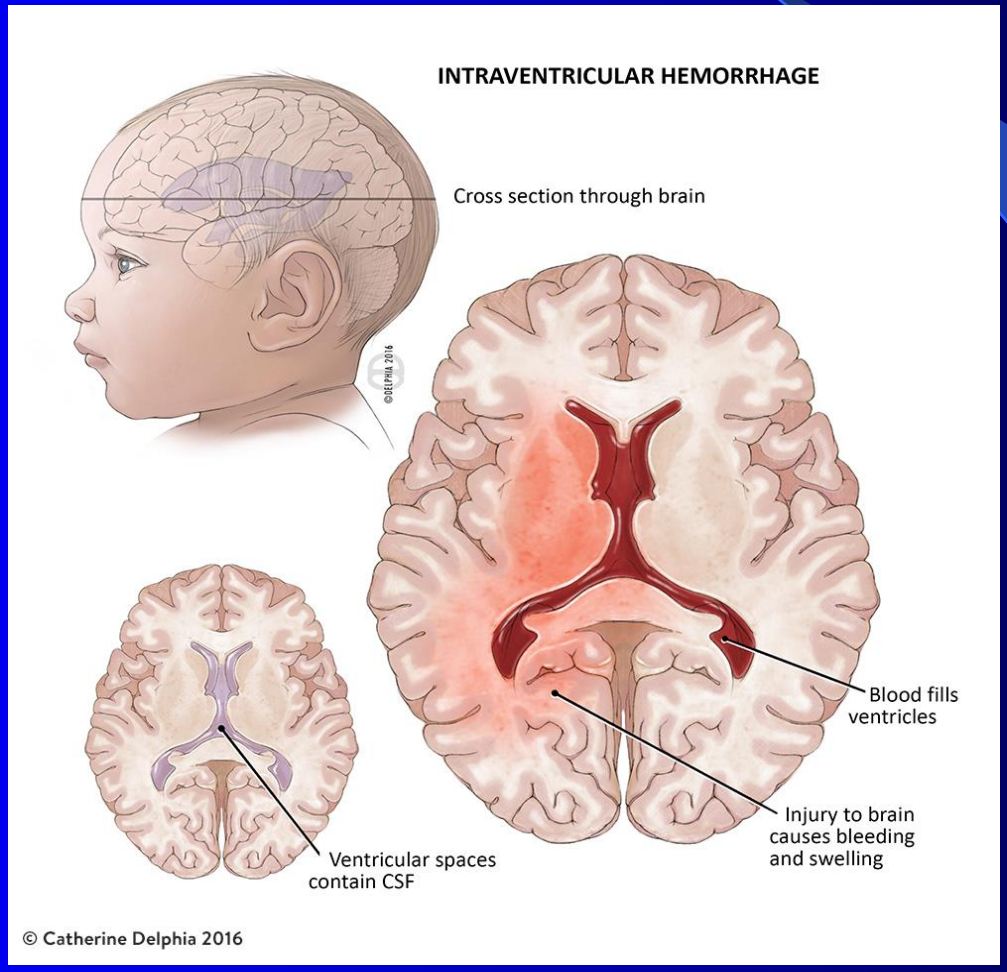
- Germinal matrix hemorrhage
- Intraventricular hemorrhage
- Subdural hemorrhage
- Subarachnoid hemorrhage
- Parenchymal hemorrhage

Intraventricular Hemorrhage

- Imaging studies show an inverse relationship b/w gestational age at birth and incidence of IVH:
  - <26 weeks'gestation: 40-50% of neonates have IVH
  - >32 weeks' gestation: <5% of neonates have IVH
  - Full-term neonates: ~25% have asymptomatic ICH after vaginal delivery on MRI
  - Symptomatic ICH: ~4/10,000 full-term neonates have symptoms, although the incidence is higher in instrumented births.

"Perinatal Intracranial Hemorrhages Pathology". Hawkins, et al. December 2015. Medscape.

Intraventricular Hemorrhage



Subdural Hemorrhage

- SDH is often associated with infants who experience NAI.
  - Study assessed normal size, incidence, distribution, and natural history of SDH in asymptomatic NBs using USG and MR within 72 hours of birth.
  - Birth history, delivery method, duration of each stage of labor, pharmaceutic augmentation, complications during delivery, postnatal physical exam were recorded.

"Prevelance and Evolution of ICH in Asymptomatic Term Infants". Rooks, et al. Am J Neuroradiol. June 2008. 1082-9.

Subdural Hemorrhage

- 101 asymptomatic term infants had Brain MR and USG performed at 3-7 days, 2 weeks, 1 month, and 3 months. Clinical F/U at 24 months was recorded.
- 46 of 101 neonates had SDH by MR imaging within 72 hours of delivery.
- SDH was seen in both vaginal and C/S deliveries.
- All neonates were asymptomatic and had normal findings on physical examination.

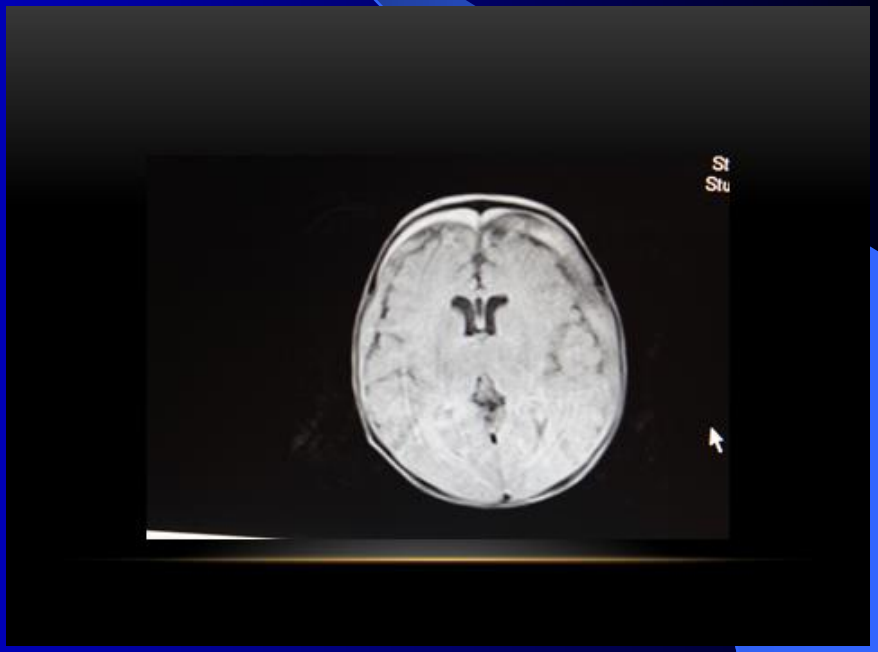
"Prevelance and Evolution of ICH in Asymptomatic Term Infants". Rooks, et al. Am J Neuroradiol. June 2008. 1082-9.

Subdural Hemorrhage

- 46 had supratentorial SDH in the posterior cranium.
- 20 (43%) also had infratentorial SDH.
- USG detected 11 of the 20 (55%) of the infratentorial SDH but no supratentorial SDH.
- Most SDHs present at birth were ≤ 3 mm and had resolved by 1 month.
- All SDHs resolved by 3 months on MR imaging.
- Most with SDHs had normal dev exams at 24 mos.

"Prevelance and Evolution of ICH in Asymptomatic Term Infants". Rooks, et al. Am J Neuroradiol. June 2008. 1082-9.

Subdural Hemorrhage

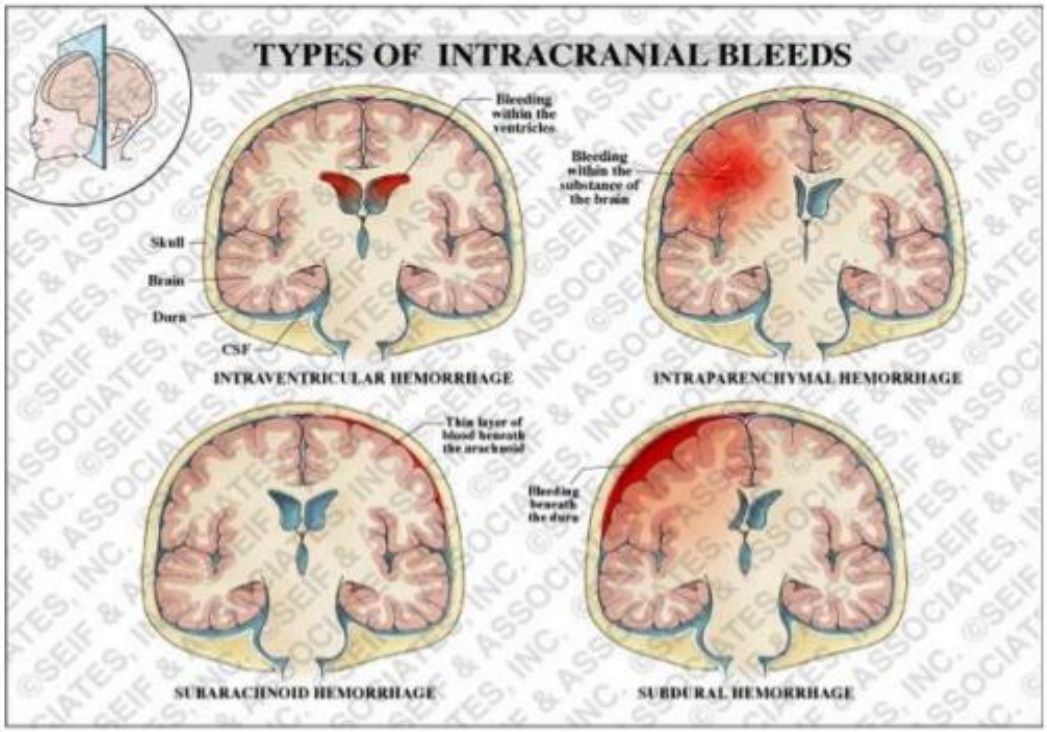


Subarachnoid and Intra-Parenchymal Hemorrhage

- Larger autopsy-based studies report small subdural, subarachnoid, and intracerebral hemorrhages in 20-30% of live births. Subarachnoid hemorrhages are the second most common ICH detected in newborns. Subarachnoid hemorrhages are most commonly associated with rupture of the bridging veins in the subarachnoid space or small leptomeningeal vessels. Incidence is higher with forceps assisted and vacuum extracted deliveries.

"Perinatal Intracranial Hemorrhages Pathology". Hawkins, et al. December 2015. Medscape.

Intracranial Hemorrhage



Child Abuse/Neglect Case

- 7wk baby presents to OSH with respiratory failure (viral URI), asymmetrical pupils, full fontanelle, intubated.
- Head CT: SDH L>R with 5mm MLS, HIE w/ loss of gray white matter differentiation (significant brain edema). SAH vs IPH. No other injuries seen.
- HPI: nasal congestion since birth, 1-2 days fussy, decreased po intake. Mother left briefly. Father with baby holding/trying to feed. Mother returned and observed baby make a weird cry and go limp.

Child Abuse/Neglect Case

- Called GP who called EMS. Agonal breathing.
- No hx falls, drops, impacts except <1yo sib fell head to head with baby 1wk prior with no change from baseline.
- When went lifeless/not breathing, father and GM tried to do CPR.
- FH: 1 member with multiple fractures.

Child Abuse/Neglect Case

- Per NSurg: acute traumatic injury that most likely occurred around time symptoms developed.
- Birth: C/S, breech, low fluid, threatened miscarriage. Baby appeared to do well. Home in 2-3days. Fussy since birth but healthy.
- Coagulation workup: normal.
- Eye exam: extensive, multi-layered RHs to periphery.

Child Abuse/Neglect Case

- CXR: 4-5 healing rib fractures-1 side.
- Per Radiology: Cannot rule out birth injury as cause of rib fractures. Recommended Skeletal Survey.
- Per NSurg: Head injury is acute, significant and not consistent with birth injury. Did not occur at same time as rib fractures.
- Ophthalmology: Extensive RH's. Cannot be dated, but less likely from birth at this age.

Child Abuse/Neglect Case

- Reported to DSS/CPS for suspicion of child physical abuse. Hematology and Genetics/ metabolism work-up.
- Reported to Law Enforcement as a serious physical injury believed to have resulted from abuse.
- Received records from PCP and delivery records for review.