Parturitional Brain Injury

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Definition of parturitional injury

• Any condition that affects the fetus adversely during labor and delivery

• May be caused by:
  – Hypoxia and infection (birth injury)
  – Mechanical forces (birth trauma)

Introduction

• Life starts with a mechanical trauma
  – Squeezed together by a muscular wrapping
  – Pushed through a narrow, bony canal with multiple bumps
  – Getting your neck extended, rotated and pulled
  – Life line (umbilical cord) may be compressed
  – Possibly additional “medieval” instrumentation
  – All of this for many minutes or even hours

• Life starts with a “stress” trauma
  – And then suddenly lots of light, noise and many crying/emotional people around you,....
Subjects who try to relive the “I am stuck feeling”

Epidemiology

- Significant variability across the world

- Dramatically decreased in last decades
  - Birth trauma in 3% of all live births
  - Accounts for less than 2% of neonatal deaths
  - Even when the injuries are benign, birth trauma may result in significant anxiety for a family

Risk factors for Birth Trauma

- Maternal risk factors
  - Diabetes
  - Obesity
  - Small pelvis
  - Large weight gain
  - Induction of labor
  - Epidural analgesia
  - Primiparity
  - History of macrosomic infant

- Infant risk factors
  - Macrosomia (>3500g)
  - Delayed and prolonged delivery
  - Abnormal presentation
  - Instrumented delivery
  - Perinatal depression
  - Shoulder dystocia

Kinds of mechanical injury

- Mechanical injury to
  - The brain and skull
  - The spinal cord
  - The head and neck region
    - Skin lacerations and hematomas
    - Clavicular fracture
    - Brachial plexus injury
    - Facial nerve injury
    - Phrenic nerve injury
    - Laryngeal nerve injury
    - Nasal injury
Incidence of types of birth trauma

Extracranial injuries

- Scalp abrasions and lacerations
  - Frequent
  - Vaginal and instrumental delivery (10%)
  - Scalp, face, cheek, ear
  - Rarely of clinical significance

Extracranial injuries

- Caput succedaneum
- Subgaleal hematoma
- Cephalohematoma

Bumps may look very similar, clinical significance is however very different!!!

Extracranial injuries

- Clinical presentation usually allows to differentiate the various swellings
- Difference is the location, composition and etiology of the fluid collection

Caput succedaneum

- Serous-sanguineous fluid collection within the scalp between skin and galea or epicranial aponeurosis
- Results from high pressure exerted on infant’s head during labor
- Presenting portion of the scalp, usually the vertex

Caput succedaneum

- Present at delivery, decreases spontaneously within 24-48h
- Soft swelling, irregular margins, petechiae, purpura and/or ecchymosis, pitting edema
- Fluid shifts from side to side with head position
- Crosses sutures, often crosses the midline
**Caput succedaneum**

- Primigravida, diabetic mother, shoulder dystocia
- Caput succedaneum +10d

**Caput succedaneum**

- 20-40% of vacuum extractions \(\rightarrow\) artificial caput also known as "chignon"
- Difficult, prolonged deliveries, PROM (no amniotic fluid to cushion), primigravidas
- May also be seen intrauterine: Oligohydramnios, Braxton-Hicks contractions

- No treatment, imaging used to exclude other extracranial hematomas

**Subgaleal hematoma**

- Serous-Sanguinous fluid collection between galea aponeurosis and periosteum
- May be mistaken for caput succedaneum because swelling (also) crosses sutures
- Not always clinically apparent immediately post partum, but develops/enlarges over hours-days

**Subgaleal hematoma**

- Results from tearing of emissary veins (connects dural sinuses with scalp veins)
- Most often after vacuum assisted delivery
- May also occur spontaneously, or due to skull fractures or rupture of synchondrosis

**Subgaleal hematoma**

- Potentially life threatening condition
- Subgaleal space extends from the orbital ridges to the nuchal ridge, ears and connects into the neck along the superficial neck fascia (260 ml, term infants)
  - No tamponading characteristics
  - Blood volume term neonate: 85 mL/kg
  - Hypovolemic shock and death may occur

**Subgaleal hematoma**

- Bleeding disorders can result in large hematomas and delayed presentations
  - Vitamin K deficiency
  - Thrombocytopenia
  - Hemophilia
  - DIC, consumption coagulopathy
- Neonate may develop hyperbilirubinemia
- Usually resolution in 2-3 weeks, good long term outcome
- Occasionally blood transfusion, blood products or surgical evacuation
**Subgaleal hematoma**

- Hyperdense, crossing sutures, extending into the neck region

**Cephalohematoma**

- **Sanguinous** fluid collection between periosteum and bony calvarium
- Usually not present at birth (unless long labor), develops within 24h
- Firm, tense mass, does not cross sutures

**Cephalohematoma**

- Ellipsoid, contained blood collection, limited to the boundaries of the sutures

**Cephalohematoma**

- Bilateral, contained by the sutures, some additional subgaleal fluid

**Cephalohematoma**

- Result from shear forces during birth that tear emissary and diploic veins resulting in hemorrhage in the subperiostal space

**Cephalohematoma**

- Hemorrhage slowly lifts periosteum from calvarium
- Tamponade by periosteum
- Most frequently in parietal location, R:L=2:1 (?)
- May be unilateral or bilateral
- May cross midline in occipital region
- Co-existing CS or SH may obscure suture boundaries
Cephalohematoma
- More common in primigravidas, macrosomia, instrument assisted delivery, prolonged/difficult labor and deviant position
- May also be present in utero
  - Oligohydramnios
  - Premature rupture of membranes
- Twice as often in boys than in girls (?)
- Overlying skin is not discolored
- Mass cannot be transilluminated or shifted
- Painful on palpation

• Prognosis is excellent, usually resolves spontaneously within weeks-months, unless…
- Complications
  - Underlying skull fracture (5-18%)
  - Anemia
  - Hyperbilirubinemia
  - Infection

Cephalohematoma
- Infection:
  - If infant has local erythema, unexplained fever or sepsis, cephalohematoma may be source of infection (E. Coli and Staph aureus)
  - Cellulitis, osteomyelitis or meningitis may result
  - Scalp electrodes, needle aspiration for decompression

Extracranial hematomas
- Problem in daily life
  - Often several hematomas affecting multiple compartments are present simultaneously
  - Clear differentiation may be limited
Extracranial hematomas

Spontaneous recovery on follow up

Differential diagnosis of bumps

Meningocele

Epidermal inclusion cyst

Posttraumatic encephalocele

Skull fractures

- Skull fracture must be suspected if there is an cephalohematoma or intracranial hemorrhage
- Caused by compression during labor while skull pushed against maternal pelvis or due to forceps blades
- Kind of fractures
  - Linear fractures
  - Depressed fractures
  - Occipital osteodiastasis
  - Leptomingeal cysts (rare complication)

Skull fractures

- Linear fractures
  - Usually asymptomatic, heal without intervention
  - Frequently parietal bone
  - Cephalohematoma may be associated
  - No relation between size of cephalohematoma and presence of fracture

Skull fractures

- Depressed fractures
  - Indentation of skull
  - Ping pong ball type defect
  - Surgical intervention may be required

Skull fractures

- Depressed fractures
  - Often associated with additional hematomas
  - May obscure the lesion or anatomical boundaries

Ping pong fracture + subgaleal hematoma + SDH
Skull fractures

- Leptomeningeal cysts
- Occur along fracture lines
- Meninges are trapped within the fracture line, CSF pulsations widens fracture line → growing fracture

Skull fractures

- Occipital osteodiastasis
- Separation of squamous and lateral occipital bone
- Anterior displacement and upward rotation of squamous portion by suboccipital pressure (breech delivery)
- Posterior fossa SDH, brainstem/cerebellum injury

Caution: skull fractures

- Sutural diastasis
- Intracranial edema or hematomas
- DD Non-accidental injury

Intracranial injuries

- 5-6/10'000 life births
- Risk factors: Forceps (x6), vacuum, prolonged delivery, macrosomia
- EDH, SDH, SAH, IVH
- Parenchymal contusion/laceration
Epidural hemorrhage

- Between calvarial bone and dura mater
- Shear forces and vertical overriding/molding of skull bones -> injury to dura mater
- May be arterial or venous
- Typically associated with instrument assisted delivery
- Surgical intervention may be necessary

Frequently associated with cephalohematoma or skull fracture with secondary injury to the middle meningeal artery
- Middle meningeal artery in neonates not yet embedded -> EDH rare (2% of all intracranial hemorrhages)
- Often close to sutures

Epidural hemorrhage

Vertical shear, no fracture

EDH + Cephalohematoma

Subdural hemorrhage

- In virtual space between dura mater and arachnoidea
- Shear forces tear the bridging veins and venous sinuses
- Skull molding and sutural diastasis -> dural sinus injury
- Supra- and infratentorial
- Along falx and tentorium
- Most common intracranial hemorrhage
- Subtle symptoms <-> irritability, seizures, bradycardia, full fontanel

Dural sinuses may be dense in neonates, blood is usually denser

Posterior fossa SDH with extension into spinal canal and small ischemic lesion

Subdural hemorrhage
Subarachnoid hemorrhage

- Between arachnoidea and pia mater
- Rupture of small veins bridging leptomeninges
- Seizures, irritability, apnea, somnolence, focal neurology
- 2nd most common intracranial hemorrhage
- Often associated with IVH (reflux)
- Usually good prognosis

Parenchymal hemorrhage

- Isolated parenchymal hemorrhage is very rare
- In combination with skull fracture
- Due to additional pathology
  - Direct trauma (instrumentation)
  - Coagulation disorders
  - AVM/AVF
- Symptoms and treatment depend on location

Associated head, neck, spine injury

- Clavicular fracture
- Brachial plexus injury
- Phrenic nerve injury
- Facial nerve injury
- Laryngeal nerve injury
- Nasal injury

Overall rare but may result in:
- Stridor
- Respiratory distress
- Feeding difficulties
- Cosmetic deformity

Skull fracture, subarachnoid hemorrhage, subdural hematoma, intraventricular blood, extracranial/multicompartment hematomas

Skull fracture, subdural hematoma + intraparenchymal hematoma

Skull fracture, subdural hematoma, clavicular fracture, brachial plexus injury, phrenic nerve injury, recurrent nerve injury, macrosomia, shoulder dystocia
Associated head, neck, spine injury

- Brachial plexus injury
  - 1/1000 births
  - Erb palsy (90%): C5/C6 (No Moro reflex)
  - Klumpke palsy: C7-T1 (No Moro + no grasp reflex)
  - Horner: Sympathetic fibers of T1
- Spontaneous recovery is the rule

Associated head, neck, spine injury

- Facial nerve palsy
  - In 0.8% of birth trauma
  - Forceps delivery (posterior blade)
  - 33% spontaneous
  - 2M:1F
  - Usually spontaneous recovery in hours-weeks
  - No value for imaging other than to rule out developmental facial nerve palsy (Moebius)

Associated head, neck, spine injury

- Rare condition
- Difficult delivery with deviant fetal position
- Spinal cord injury should be ruled out if a child is hypotonic with flaccid quadriplegia or paraplegia

Preexisting conditions that make a neonate more vulnerable

- Atelosteogenesis type III
Preexisting injury that may delay/complicate delivery

Early diagnosis may prevent additional injury

Child, mother and obstetrician will thank you

Preexisting injury

Child, mother and obstetrician will thank you

Preexisting injury

Finally, image gently, ALARA

Child, mother and obstetrician will thank you

Thank you