Pulmonary Anomalies
Mammalian Airway Differentiation
Pulmonary Development

• Five stages
  • From foregut to tracheal bud (embryonic phase)
  • Pseudoglandular phase (6-16 wk)
  • Canalicular phase (16-26 wk)
  • Saccular phase (26-36 wk)
  • Alveolar phase (>36 wk)
Pulmonary Development

• Two important periods
  • Branching morphogenesis
    • From foregut to tracheal bud (embryonic phase)
    • Pseudoglandular phase (6-16 wk)
  • Late gestation growth spurt
    • Canalicular to saccular stage (23-26 wk)
**Pseudoglandular stage**
16-18 wks

**Saccular stage**
26-36 wks

**Alveolarization**
~36 wks → 18 months
Pulmonary Development

• Late gestation growth spurt
  • 22-26 weeks: type II cells secrete fluid
  • Alveoli fill up with lung fluid
  • Lung fluid causes alveolar stretch
  • Alveolar stretch stimulates lung growth + maturation
  • No stretch = no growth spurt
Abnormal Lung Development

• Main result: pulmonary hypoplasia
  • When normal lung development is impaired
  • Often associated with some lung immaturity

• The fetus doesn’t need lungs! (Placenta)
  • Pulmonary problems are neonatal problems
Fetal Conditions
Leading to Pulmonary Hypoplasia

• Final common pathway:
  • Compression of lungs
  • Preventing alveolar stretch
  • Delayed or arrested lung growth/maturation
Fetal Conditions
Leading to Pulmonary Hypoplasia

• Final common pathway:
  • Compression of lungs
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Fetal Conditions
Leading to Pulmonary Hypoplasia

• Absent fetal breathing:
  • Muscular dystrophy-like syndromes
  • Neurological anomaly (no breathing motion)
Fetal Conditions
Leading to Pulmonary Hypoplasia

• Extrinsic chest compression:
  • Chronic oligohydramnios/anhydramnios (no fluid)
    • Bilateral urinary obstruction, renal failure
    • Bilateral renal agenesis (Potter syndrome)
    • Chronic amniotic leak
Fetal Conditions
Leading to Pulmonary Hypoplasia

• Intrinsic chest compression:
  • Chest mass
  • Congenital Cystic Lung Lesion
Fetal Conditions
Leading to Pulmonary Hypoplasia

- Intrinsic chest compression:
  - Congenital Diaphragmatic Hernia
Pulmonary Hypoplasia

- Final common pathway:
  - Lung cannot expand
  - No alveolar stretch
  - No stimulus for late growth spurt

- At 26-28 weeks
Congenital Diaphragmatic Hernia

- Bochdalek: Posterolateral (most common)
  - Left >> Right
- Morgagni: Anterior; less common, better Px
- 1:2,500 births
Congenital Diaphragmatic Hernia

- Poor prognostic indicators:
  - Early diagnosis (<25 weeks)?
    - Indicates prolonged lung compression
  - Stomach in the chest?
  - Polyhydramnios?
  - Liver in the chest
  - Lung-Head Ratio (LHR)
  - MRI volumetry
Congenital Diaphragmatic Hernia

- Prognosis:
  - 1970s: >80% mortality at birth
    - Impetus for fetal intervention?
  - 1980s-90s: Improved postnatal care
  - 1990s: 60-70% survival
  - New century: >75% survival
  - Severe subgroup: mortality still elevated
    - Who are they?
Congenital Pulmonary Airway Malformation (CPAM)

- Cystic Adenomatoid Malformation (CCAM)
- Pulmonary sequestration
- Bronchogenic cyst
- Common origin?
  - Abnormal tissue ‘buds off’
  - Combinations
  - Hybrid lesions (contain > 1 type)
Congenital Pulmonary Airway Malformation (CPAM)

• Cystic Adenomatoid Malformation (CCAM)
• Pulmonary sequestration
  • Extralobar sequestration
  • Intralobar sequestration
• Bronchogenic cyst
Congenital Pulmonary Airway Malformation (CPAM)

• In utero:
  • May become very large
  • Mass effect
  • Pulmonary hypoplasia
  • Hydrops (mediastinal shift)
    • “Kink” in vena cava
    • Impaired blood return
    • Cardiac failure
Congenital Pulmonary Airway Malformation (CPAM)

• Natural evolution:
  • Phase of rapid growth (20-25 weeks)
  • 1980s:
    • CPAM grows →
    • causes pulmonary hypoplasia →
    • compresses mediastinum →
    • causes hydrops →
    • fetal death
  • Now: 70-80% regress partially or completely
Prenatal Treatment Options

• Reasons to intervene before birth:

  • Is the fetus at risk of dying?

  • Is the newborn at risk?

  • Is there a long-term risk?
Prenatal Treatment Options

• Is the fetus at risk of dying?
  • Pulmonary hypoplasia: not a fetal problem (Placenta!)
  • Complex genetic/chromosomal anomalies (including lung hypoplasia): little to offer
  • Growing chest mass: risk of mediastinal compression and hydrops (impaired venous return to the heart)
Prenatal Treatment Options

- Is the fetus at risk of dying?
  - Only *fetal* reason to treat: if impending fetal hydrops
  - CCAM/Sequestration (rarely bronchogenic cyst)
  - If few, large (growing) cysts: puncture/drainage
  - If (semi)-solid: surgical resection?
Prenatal Treatment Options

• Is the newborn at risk?
  • General purpose of prenatal intervention:
    • Prevent (or reverse) pulmonary hypoplasia
    • Treat the condition in utero, and allow enough time for the lungs to catch up
    • Only justifiable if extreme hypoplasia
      • But most lesions WILL regress by term
Postnatal Treatment Options

• Is there a long-term risk?
  • Recurrent pulmonary infections
    • CCAM, intralobular sequestrations: communicating with airways (pores of Cohn)
  • Risk of malignancy (CCAM; others as well?)
  • Hybrid lesions (contain more than one type)
  • In general: elective, postnatal resection