Approach to Pediatric Plain Films

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Normal neonatal chest

Figure 1. Normal chest x-ray of a two-hour-old newborn infant, in compliance...
Inside-out or outside-in Approach

• Inside-out approach
  • Begin with mediastinum/heart
  • Lungs/diaphragm
  • Bones
  • Soft tissues
• Penetration: should be able to see thoracic spine through heart, and left hemidiaphragm traced to spine

• Inspiration: 9-10 posterior ribs

• Positioning: Clavicular heads should be equidistant from spinous process
Inside-Out

- Trachea
- Aorta
- Thymus
- Heart
“Normal anatomy”

- Trachea is to the right of midline
- Left aortic arch
- **Symmetry is your friend**
  - —> Right I Left
Figure 1. Normal chest x-ray of a two-hour old newborn infant, in compliance.
Figure 1. Normal chest x-ray of a two-hour-old newborn infant, in compliance
• Neonate

• Normal thymic shadow on frontal radiograph should be more than twice width of 3rd thoracic vertebrae

• Smaller dimensions
  • Involution
  • Hypoplasia
• Triangular-shaped inferior margin of normal thymus

• Commonly seen on right side

• Can also be bilateral

• Should not be confused with “Spinnaker sail sign” which indicates pneumomediastinum
• Spinnaker Sail sign

• Thymus is made up of 2 lobes

• Pneumomediastinum displaces lobes off mediastinum
• “Notch sign”

• Inferior border of thymus blends with border of cardiac silhouette

*Figure 9.* Twenty-two-day-old newborn infant x-ray demonstrating “notch-sign” (arrow).
• “Wave sign”

• Gentle undulation on surface of thymus caused by rib impressions
• Normal variation in size

• 2 month old: prominent, rounded shape

• 7 year old: assumes “quadrilateral shape” with convex margins

• 12 year old: triangular configuration.
• 3 hr old and 4 day old male

• Thymic atrophy.

• Response to any stress

• sepsis, major surgery, use of steroids or other immunosuppressants
Thymus changes shape with respiratory cycle

• Expiration

• Inspiration
Hodgkin’s Lymphoma

- Accounts for 10-15% of childhood tumors
- Present with nodal or extra nodal disease
- Mass effect from nodal diseases such as SVC obstruction
- Infiltrative involvement of organs
- Can often present with B symptoms
- Fever, night sweats, weight loss
• Radiographic features depend on location and subtype of lymphoma
Mediastinal Teratoma

- Most common extragonadal germ cell tumors
- Account for 55% of anterior mediastinal tumors in children
- Typical presentation is below 1 year of age (immature teratoma)
- May be detected antenatally
• Clinical presentation

• Mass effect
  • Respiratory distress, neck mass,

• Endocrine function
  • Hormone production (beta-HCG, insulin)

• Rupture
  • Chest pain, hemoptysis, respiratory failure, pleural effusions, cardiac tamponade
• Solid masses with fatty and cystic components. Calcifications.

• Xray

• Indistinguishable from other causes of anterior mediastinal mass

• Calcifications may be visible

• CT

• Large mass, anterior mediastinum

• Calcifications
Treatment

- Mature teratoma: surgery
- Seminoma: chemotherapy followed by surgery for residual disease
- Non- Seminomatous: chemotherapy and surgery
Surfactant Deficiency

- Risk factors
  - Prematurity
  - Maternal diabetes
  - Prenatal asphyxia
  - Chorioamnionitis
Figure 1. Normal chest x-ray of a two-hour-old newborn infant.
• Diffuse “ground glass” lungs
• Low lung volumes
• Waxes and wanes with doses of surfactant
• Air bronchograms may be evident
• Hyperinflation in non-ventilated patient excludes diagnosis
• Associations

• Persistent PDA: due to reduced oxygen stimulus

• Germinal matrix hemorrhage

• Necrotising enterocolitis
• Complications

• Acute
  • Pulmonary interstitial emphysema (tx related)
  • Pulmonary hemorrhage

• Chronic
  • Bronchopulmonary dysplasia
  • Subglottic stenosis from intubation
  • Recurrent pulmonary infections
• Differential diagnosis
  • Neonatal pneumonia
  • Pulmonary edema
  • Pulmonary hemorrhage
Pulmonary interstitial emphysema

- Almost always associated with mechanical ventilation or continuous positive airway pressure in first weeks of life

- Other risk factors
  - Reduced lung compliance, prematurity
  - low birth weight
  - meconium aspiration syndrome
  - pneumonia
• First week of life newborns on ventilatory support

• Increased alveolar pressures and poor compliance

• Alveolar rupture with escape of air into adjacent interstitial and lymphatics

• Overall

• Lung volumes are increased

• Maybe focal affecting one lobe or diffuse and bilateral

• No predilection for particular lobe
• Typically incidental finding

• May present with air-block complications such as
  • Pneumomediasinum
  • Pneumothorax
  • Pneumopericardium
  • Pneumoperitonium
  • Subcutaneous emphysema
• Cystic or linear lucency’s in intersitium radiating from hilum

• Affected segment is often hyper expanded and static in volume on multiple radiographs

• Pneumo: thorax/pericardium/mediastinum/peritoneum
• Differential diagnosis

• Partially treated surfactant deficiency

• Bronchopulmonary dysplasia

• Congenital pulmonary airway malformation

• Congenital lobar overinflation

• Congenital diaphragmatic hernia
PIE on CT
Transient Tachypnea of Newborn

• Aka
• Retained fetal fluid or wet lung disease
• Neonate with tachypnea in first few hours of life, resolving within 48 hrs
• Most common cause of respiratory distress in term or near term newborns
• Grunting, nasal flaring within first 6 hrs of life
• Can be mild cyanosis
- Perihilar streakiness- interstitial edema
- Small pleural effusions
- Fissural prominence
- Normal chest radiograph by 48-72 hrs postpartum
• First day of life x-ray.  X-ray at 48hrs
Meconium aspiration

- Secondary to intrapartum or intrauterine aspiration of meconium
- Usually in setting of fetal distress
- Usually in term and post term infants
- Usually history of meconium stained fluid at birth
- Aspirated meconium causes small airway obstruction and chemical pneumonitis
• Increased lung volumes
• Hyperinflated lungs with flattened diaphragms
• Secondary to distal small airway obstruction and air trapping
• Asymmetric patchy pulmonary opacities
• Due to subsegmental atelectasis
• Rope like opacities
• Pleural effusions maybe present
• **Pneumothorax and pneumomediastinum**
  • Due to increased alveolar tension from obstructed airways
• Multifocal consolidation
• Due to chemical pneumonitis
2 examples of Meconium aspiration of x-ray
Meconium aspiration
Complication
Pneumothorax
Neonatal Pneumonia

- Inflammatory changes caused by neonatal infection
- Leading cause of morbidity and mortality
- Acquired transplacentally or perinatally
- Risk factors
  - Premature rupture of membranes
  - Prolonged and complicated labors
  - Prematurity
  - Immune disorders
  - Maternal systemic infection
  - Chorioamnionitis
- Fetal asphyxia- gasping and aspiration of infected amniotic fluid
• Fetal distress or tachycardia
• Respiratory distress
• Sepsis
• Other physical exam finding depending on offending organism...
• Maternal systemic infection
  • Rubella
  • CMV
  • Treponema Pallidum
  • Listeria
  • TB
  • HIV
• Most commonly isolated Bacteria
  • Strep (group A and B)
  • Staph A.
  • E. coli
  • Klebsiella
  • Proteus
• Imaging findings variable

• Normal chest

• Focal or diffuse opacities

• Interstitial opacities—similar to surfactant deficiency

• Patchy parenchymal opacities with air bronchograms
2 examples of neonatal pneumonia on x-ray
Round Pneumonia

- Common imaging manifestation of bacterial pneumonia in children and young adolescents
- Underdeveloped pathways of collateral ventilation
  - Pores of Kohn
  - Canals of Lambert
  - In adults, permit lateral dissemination of infection through lobe \(\rightarrow\) lobar pneumonia
- In one study
  - 75% of patients were under 8 years old and 90% were under 12
• Round-is opacities
• Irregular margins
• **Air bronchograms**
Air bronchogram

- Phenomenon of air-filled bronchi (dark) being made visible by the opacification of surrounding alveoli (grey/white).

- Caused by a pathologic airspace/alveolar process, in which something other than air fills the alveoli.

- Air bronchograms will not be visible if the bronchi themselves are opacified (e.g. by fluid) and thus indicate patent proximal airways.
• Differential diagnosis

• **Neuroblastoma:**
  • Arise anywhere along paraspinal sympathetic chain
  • May contain calcifications

• Typ 3 CPAM

• Bronchogenic cyst
Reactive airway disease

- General term for pediatric disease entity characterized by wheezing, shortness of breath and coughing
- Initial episodes frequently referred to as bronchiolitis
- Unlike asthma, which is chronic, reactive airway disease is usually transient
- May be triggered by
  - Viral URI, esp RSV
  - Pollen and mold
  - Cigarette smoke
  - Extreme cold
- Most (60%) of children with wheezing before age 3 will outgrow it by age 6
• Clinical findings

• Increased respiratory rate

• Retractions

• Cough

• Fever

• Rhinorrhea
• Imaging findings

• Peribronchial thickening

• Primarily lobar or segmental bronchi

• May produce tram-track like linear densities

• Hyperinflation

• Atelectasis from mucus plugging
• Differential diagnosis

• Usually difficult to distinguish viral bronchiolitis and asthma in young children

• 2 may coexist

• Foreign body aspiration

• Anaphylactic reaction
• Treatment
• Bronchodilator
• Steroids
• Oxygen
Foreign body aspiration

- Potentially fatal
- Immediate recognition is important
- Children under 4 at increased risk
- 70% are witnessed to have choking episode at time of aspiration
- May otherwise present with cough, dyspnea or irritability
• Aspirated material is not always visible on radiographs

• Often in organic

• Seeds, nuts
• Imaging findings

• Image during expiration to

• May be normal in 30% of cases

• If large enough, may see interrupted bronchus sign

• Check valve mechanism: air enters but cannot exit—> hyper inflated lung

• Lobar atelectasis
Atelectasis

Normal Bronchiole

Blocked Bronchiole

Area of collapsed lung
2 examples of bronchus cut-off sign
Atelectasis by Lobe

Right upper lobe collapse
Right upper lobe collapse

Juxtaphrenic peak
Left upper lung lobe

Left upper lobe collapse
Luftsichle sign

- Air crescent sign
- Herniation of the superior segment of the hyperinflated left lower lobe between the mediastinum & the collapsed left upper lobe.
Right middle lobe collapse
Congenital Lobar Over-inflation

- Congenital lung abnormality resulting in progressive overinflation of one or more lobes
- Classically: hyperlucent lung segment with over inflation and contralateral mediastinal shift
- M:F. 3:1
- Mechanism
  - Obstruction
  - Cartilage deficiency
  - Dysplasia
  - Immaturity
- Most cases are idiopathic
- May be associated with aberrant left pulmonary artery and congenital heart defects
• Presentation

• Respiratory distress

• Most commonly neonatal period- usually within first 6 months of life
• Predilection for lobes
  • LUL - most common 40-45%
  • RML 30%
  • RUL 20%
  • May involve more than a single lobe 5%
  • Much rarer in lower lobes
• Imaging

• Immediate post partum: opaque because of fetal lung fluid or may show diffuse reticular pattern related to distended lymphatic channels filled with fetal lung fluid

• Later

• Area of hyper lucency with paucity of vessels

• Mass effect on mediastinum and diaphragm

• Decubitus film lying on affected side shows little or no change in lung volume
• Treatment

• Asymptomatic patients are typically followed

• Lobectomy considered in severe cases
• Differential diagnosis

• Bronchial atresia: parenchymal distal to atretic segment can have air trapping

• Sawyer James Syndrome: unilateral lucency secondary to post infectious obliterative bronchiolitis. Typically following viral infection such as adenoviruses or mycoplasma pan in infancy or early childhood

• Congenital pulmonary airway malformation
- Congenital Pulmonary Airway Malformation
- Multicystic pulmonary mass
  - classification→ cysts of varying sizes
- Variable amounts of air/fluid
- Very often noted on prenatal ultrasound
- Neonate- progressive respiratory distress
  - typically solid mass, and gradually fills with air
  - Often, radiograph may appear normal
  - CT always warranted.
<table>
<thead>
<tr>
<th>Type</th>
<th>Description</th>
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<tbody>
<tr>
<td>Type 0</td>
<td>Rarest, arises from trachea or bronchi and involves whole lung; commonly fatal</td>
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<tr>
<td>Type 1</td>
<td>Commonest (60-70%), arises from distal bronchi or proximal bronchioles: single or multiloculated 2-10 cm sized cyst. Reported association with malignancy</td>
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<td>Type 2</td>
<td>15-20% of CPAMs; multiple cysts 0.5-2 cm in diameter with intervening solid-appearing areas</td>
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<tr>
<td>Type 3</td>
<td>5-10% of CPAMs. Alveolar origin; can have small cystic areas (&gt;0.5 cm) with solid tissue or are mostly solid appearing</td>
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<tr>
<td>Type 4</td>
<td>10-15% of CPAMs. Acinar origin. Large air-filled or fluid-filled cysts up to 10 cm; strongly associated with pneumothorax, indistinguishable from cystic pleuropulmonary blastoma</td>
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CAPM: Congenital pulmonary airway malformation
• CPAM in a 6 month old with
Cases

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