Pediatric radiology

Dr. Asim Ahamed
The initial assessment of the paediatric CXR should include:

1) Technique of the exam, to include patient positioning, proper exposure and the degree of inspiration
2) Position of all tubes and lines ((endotracheal tube: tip above the carina, umbilical artery catheter: tip in lower thoracic aorta away from renal artery origins, umbilical vein catheter: tip in lower right atrium)).
3) Mediastinal and cardiac shadows.
4) Airway and lungs
5) Pulmonary vascular pattern
6) and evaluation for pneumothorax, pneumomediastinum, and pneumoperitoneum
7) Abdomen
Normal neonatal CXR feature:

- Thymus may be prominent. The thymus is normally prominent on chest films during the first few years of life. Less noticeable after 3-4 years of age. It is clearly visible to the right or left or on both sides of the mediastinum. In the right chest it often has a typical sail shape with a horizontal lower border and an outer border paralleling the chest wall. It frequently abuts anterior ribs leading to an undulating appearance. The normal thymus is not typically very radio-opaque but it usually permits visualization of pulmonary vessels through it, it does not compress the airway or adjacent vasculature. In most neonates, temporary thymic involution is seen during episodes of acute illness. Thymic rebound or regrowth is often seen after recovery from a severe illness or after chemotherapy.

- Heart shadow is quite prominent and globular in outline. Normal cardiothoracic ratio is up to 65%.

- Air bronchogram may be seen in the medial third of the lung fields.

- Diaphragm usually lie at the level of 6th rib anteriorly.
CXR of neonate shows superior and anterior mediastinal shadowing with sail shape appearance and smooth right outline. Features of normal thymus.
Endotracheal tubes (ETT):
• Is clearly recognized in the midline in the neck and upper chest as it has an opaque wall.
• Ideally the tip of should lie between C7 and T4, 1.2cm below the vocal cords, or 2cm above the level of carina.
Nasogastric tube:
Is seen in the **stomach**, it should not be positioned at the gastro-oesophageal junction or above for fluid will reflux into the oesophagus with a risk of aspiration.
**Umbilical arterial catheter (UAC):**

- The umbilical artery is a direct continuation of the internal iliac arteries, thus; the catheter is recognized by the characteristic loop formed by its entry position into the umbilicus from it loops down into the pelvis to join to the internal iliac artery before passing into the common iliac artery and aorta.
- T9/10 is preferred position
- Position of T12-L2 should be avoided (to avoid renal and superior mesenteric arteries)

**The umbilical venous catheter (UVC):**

- The UVC passes straight from the umbilicus through the intrahepatic portion of the umbilical vein, through the ductus venosus into the IVC and thus to the right atrium.
- Ideally the tip should be maintained at the IVC/RA junction at T8-T9, but this position is hard to be achieved.
Umbilical arterial catheter (UAC)
The umbilical venous catheter (UVC):
Which is which?
This is a neonate with a tube in the right main-stem bronchus. The left lung is atelectatic.
Neonatal respiratory distress syndrome

**Common causes:**

**Hyaline membrane disease:**
- Premature neonate, diabetic mother.

**CXR signs include:**
- Granular pattern throughout both lung.
- Air bronchogram.
- Poor pulmonary expansion.

**Complication**
- Pneumothorax.
- Pulmonary interstitial emphysema.
- Patent ductus arteriosus.
- Bronchopulmonary dysplasia.

**Transient tachypnoea:**
- Cesarean section

**CXR signs include**
- Prominent interstitial pattern with thickening of lung fissures.
- Small pleural effusion.
- Rapid resolution over 24 hours.
Meconium aspiration syndrome:
• Over expanded lungs containing dense, patchy and linear shadowing.
• May be complicated by pneumonia or pneumothoracic.

Pulmonary edema (cardiac failure):
• Cardiomegaly (not reliable sign in neonates).
• Combination of alveolar and interstitial opacification bilaterally.

Neonatal pneumonia:
Range of appearances may be seen in CXR:
• Lobar consolidation.
• Patchy widespread consolidation.
• May mimic HMD.

Congenital diaphragmatic hernia:
• 70%-90% are left sided and the majority are posterolateral through the foramen of Bochdalek.
• An anterior hernia through the foramen of Morgagni presents later.

Complication of mechanical ventilation:
• Air leakage
• Pulmonary interstitial emphysema.
• Pneumothorax.
• Pneumomediastinum.
• Pneumopericardium.
• Pneumoperitoneum.
•CXR of neonate showing granular pattern through the both lungs with airbronchogram and volume loss. Features of HMD.
Meconium aspiration syndrome:
Transient tachypnea of the newborn (retained fetal fluid):
a. This frontal film reveals strand-like densities extending from the hila throughout both lungs. The heart is not enlarged. Lung volume is increased
b. Lateral film shows fluid in the major fissure
c. Frontal radiographs of the same child 2 days later.  
Chest is normal
CXR showing

- Bubbly appearance in the left hemithorax, which is continuous with the abdomen cavity (air-filled small bowel loops).
- Mediastinal shift to the right side.
- Non aerated left lung.
- Contrast study for confirmation.
Pattern of pulmonary infection in children

Pattern of viral infection:
• The most common pattern seen is **bilateral** para hilar infiltration, this consists with irregular linear opacity extending into each lung from the hilar complexes with bronchial wall thickening. Lymphadenopathy and atelectasis may be involved in this pattern.
• Mycoplasma pneumonia may has the similar pattern.

Bronchiolitis:
• Although it caused by viral infection, it is different clinical entity.
• The usually CXR pattern seen is **over expanded** lungs due to bilateral air trapping. Atelectasis may complicated sever cases.

Bacterial infection:
• The typical CXR pattern is alveolar consolidation, e.g. **fluffy opacity with air bronchogram** that may be segmental /lobar (lobar pneumonia) or bilateral (opportunistic infection) in distribution.
• Early infection in children may presented as (round pneumonia). This seen on CXR as a dense round opacity, that may be mistaken for a mass the clinical setting should provide the diagnosis and follow up CXR show evolution of round opacity.

▶ Note that there may be overlap between these patterns.
Interstitial shadowing with prominent linear pattern, suggesting viral pneumonia or mycoplasma pneumonia.
CXR shows overexpansion of lungs (depressed and flattening of diaphragm). Atelectasis in the RT upper lobe. (note opacity associated with local lung volume loss). Bronchiolitis
Lobar pneumonia, demonstrating air bronchogram, and loss of mediastinal contour indicating the infection is in the left upper lobe (lobar pneumonia).
Bilateral air space shadowing with prominent air bronchogram, suggesting opportunistic infection or pulmonary edema
CXR shows dense **round opacity** in the upper right zone. As the patient is child presented with fever and cough, diagnosis as has round pneumonia. After antibiotic therapy, this opacity completely resolved.
Inhaled foreign body

• The overall tendency is for the foreign bodies to enter the more vertically orientated right main bronchus.

• Films taken in expiration as well as inspiration. Expiration will show air trapping (increase in volume and transradiancy) within the obstructed lung and mediastinal shifting away from the obstructive emphysema on expiration.
First CXR showing loss of volume in the left lung with patchy collapse in the apex of the left lower lobe; in inspiration the mediastinum is slightly to the left; second CXR in expiration the volume and transradiancy of the left lung increase with the mediastinum swinging to the right. indicating obstruction in LT side.
Abdomen

Malrotation:

- Radiological features:
  - Contrast study:
    - Duodenojejunal junction displaced **medially, inferiorly or both**. (normally D.J.J lies to the left of the midline (at least over the vertebral pedicle) at the level of the pylorus. (contrast meal)
    - High caecum, particular if directed medially (contrast enema or follow through), support the diagnosis.
  - US: reversal sign (superior mesenteric vein lying abnormally anterior and to the left to superior mesenteric artery)

Midgut volvulus:

- Radiological features
  - Contrast study:
    - The presence of a volvulus may be indicate by the classic `corkscrew' appearance of the duodenum and proximal jejunum twisting around its mesenteric axis.
    - US: whirlpool sign (twisting of the superior mesenteric vein and mesentery around the artery)
Malrotation. Contrast meal (A) demonstrating abnormally low position of the duodenojejunal junction (DJJ). Further case (B) demonstrating both inferior and medial displacement of the DJJ.
Midgut volvulus presenting as a classic 'corkscrew' appearance of the duodenum and proximal jejunum on lateral view.
RSK

Rickets:
• The trabeculae are fuzzy and irregular. The metaphyseal regions are irregular, with cupping and fraying appearance. The apparent distance between the metaphysis.

• Rickets of prematurity in this population is demonstrated by bright cortical bone. The bones are not cupped or frayed because the infants are not growing.
Children fractures

• **Salter–Harris fractures:** Fractures involving the growth plate. Four grades. Severe length discrepancies and other growth disturbances can occur from these fractures.

• **Incomplete fractures:**
  - green stick fracture; is characterized by a bowed long bone with a break on the convex surface but apparent cortical continuity on the concave surface.
  - Torus fracture; there is buckling on one side of the cortex.
  - corner fracture; injuries here cause avulsion of a piece of bone from the metaphysis, it is common with abuse child injuries.
Type I: fracture through physis

Type II: fracture through physis and into metaphysis

Type III: fracture through part of physis and out through growth center

Type IV: fracture through growth center, through physis, and across metaphysis

Type V: crush injury to physis

[Diagram of different types of fractures through a bone]
a. Greenstick fracture. The fracture appears to extend halfway through the diaphysis. *Note the* bowing of the radius and ulna.

b. Torus fracture. *Note the* buckling at the medial aspect of the distal radius.
Bucket-handle fracture of distal femur. A thin avulsion of bone at the femoral metaphysis resembles the resting handle of a bucket. This fracture is commonly seen in the battered child syndrome.
Non accidental injury (child abuse, battered child syndrome, shaken baby syndrome).

- It is medico-legal.
- Particular types of fractures are considered highly suspicious for child abuse:
  - Multiple fractures in different stages of healing.
  - Metaphyseal corner ("bucket-handle") fractures.
  - Posterior rib fractures.
- In cases of suspected child abuse, the search for skeletal injury is performed with a full skeletal survey.
- Non osseous signs can have a role in diagnosis e.g. Bilateral subdural hematoma.
Frontal chest radiograph demonstrate callus around multiple healing posterior rib fractures.