Section VI – Chest Radiology

110. You are shown a lateral chest radiograph (Figure 1). What structure is labeled by the arrows?

A. Right pulmonary artery
B. Right superior pulmonary vein
C. Left superior pulmonary vein
D. Left pulmonary artery

Findings:
Tubular comma-shaped opacity represents the left pulmonary artery. It is situated above and posterior to the left upper lobe bronchus. The left upper lobe bronchus is represented as an oval lucent structure.

Rationale:
A: The right pulmonary artery is situated within the opacity anterior to the left upper lobe bronchus.
B: Incorrect.
C: This is visible anterior and superior to the left upper lobe bronchus.
D: It is situated above and posterior to the left upper lobe bronchus.
111. You are shown CT images of the chest (Figures 2-4) of a 60-year-old woman. What is the MOST LIKELY diagnosis?

A. Allergic bronchopulmonary aspergillosis
B. *Mycobacterium avium complex* infection
C. Chronic bronchitis
D. Williams-Campbell syndrome

**Findings:**
CT scan shows bronchiectasis within both lungs, particularly in the right middle lobe and lingula. In addition, centrilobular opacities resembling tree-in-bud are noted within both lungs.

**Rationale:**
A: Allergic bronchopulmonary aspergillosis is a complex hypersensitivity reaction to aspergillus organisms colonizing the bronchial lumen. The inflammatory reaction results in cellular infiltration and release of proteolytic enzymes which produce tissue damage in the bronchial wall. Excessive mucus production leads to mucoid impaction of the airways. The radiographic hallmark is central bronchiectasis.

B: It is usually seen in women greater than 60 years old. The infection consists of bronchiectasis commonly involving the right middle lobe and lingula, and centrilobular nodules.

C: It is a poorly characterized entity. It is felt to be present in patients who have chronic sputum production and productive cough. On imaging, findings of emphysema often predominate. Bronchial wall thickening and centrilobular opacities may be present.

D: It is a rare disease characterized by congenital cystic bronchiectasis due to defective cartilage in the bronchi.
112. You are shown four axial images from a CT scan of the chest (Figures 5-8) of a 35-year-old woman. What is the MOST LIKELY diagnosis?

A. Metastasis
B. Sarcoidosis
C. Miliary tuberculosis
D. Hypersensitivity pneumonitis

Findings:
Numerous tiny nodules are present within both lungs along the subpleural interstitium, fissures and the peribronchovascular interstitium. The lung bases are spared.

Rationale:
A: The distribution of nodules in metastatic disease are randomly distributed.
B: The distribution of nodules in sarcoidosis are in the perilymphatic distribution. This case has classic features seen in sarcoid.
C: Miliary tuberculosis presents with tiny 1-2 mm randomly distributed nodules. This appearance is absent in our case.
D: The nodules seen in hypersensitivity pneumonitis are centrilobular in distribution and have a ground-glass appearance. This pattern and distribution are not present in our case.
113. You are shown PA and lateral chest radiographs (Figures 9 and 10) of a 50-year-old man. What is the MOST LIKELY diagnosis?

A. Lobar pneumonia  
B. Bochdalek hernia  
C. **Endobronchial lesion**  
D. Loculated pleural effusion

**Findings:**
A triangular opacity is seen in the right lower hemithorax on the frontal radiograph. In addition, the trachea is deviated to the right suggesting volume loss in the right lung. The lateral radiograph shows an opacity in the posterior lower aspect obscuring the posterior diaphragm. The constellation of the above findings represents right lower lobe atelectasis.

**Rationale:**
A: Incorrect.  
B: Incorrect.  
C: The findings described above are those of right lower lobe atelectasis. When lobar atelectasis is present, further investigation should be performed to evaluate for an endobronchial lesion. CT scan performed on this patient (not shown) showed a lung cancer in right lower lobe bronchus.  
D: Incorrect.
114. You are shown three axial images from a CT scan of the chest (Figures 11-13) of a 40-year-old man. What is the MOST LIKELY diagnosis?

A. Relapsing polychondritis  
B. Rhinoscleroma  
C. Tracheobronchopathia osteochondroplastica  
D. Wegener’s granulomatosis

**Findings:**
Small calcified nodules are noted along the inner aspect of trachea, protruding into the tracheal lumen.

**Rationale:**
A: It is a systemic disorder characterized by recurrent episodes of cartilage inflammation. On imaging, thickening of the anterior and lateral tracheal wall is noted. The posterior membrane of trachea is spared. These features are not present in our case.
B: It is a granulomatous infection caused by klebsiella rhinoscleromatis. This disease primarily affects the upper respiratory tract. In a small percentage of patients, the trachea may be affected. When involved, circumferential thickening of tracheal wall is noted.
C: This is a condition of unknown etiology which is characterized by the presence of multiple submucosal osteocartilaginous nodules along the anterior and lateral wall of the trachea. The posterior wall of the trachea is spared. Our case shows typical features of this entity.
D: It is a granulomatous vasculitis which may involve the upper and lower respiratory tract. Tracheal involvement results in narrowing and thickening of the trachea. Our case does not show those features.
115. You are shown PA and lateral chest radiographs (Figures 14 and 15) of a 60-year-old man with severe hemoptysis. What is the next MOST appropriate step?

A. Intravenous antibiotic therapy  
B. Transthoracic needle biopsy  
C. No treatment necessary  
D. Conventional angiography

Findings:
A pre-existing cavity containing a mycetoma is present.

Rationale:
A: Incorrect.  
B: Incorrect.  
C: Incorrect.  
D: Aspergilloma or mycetoma or a fungus ball consists of aspergillus hyphae, mucus and cellular debris which is present in a pre-existing cavity. It grows as a saprophytic organism and as a rule is noninvasive. Thus, no treatment is necessary in asymptomatic individuals. However, in some individuals severe hemophysis may occur and be life threatening. In those individuals, conventional angiography is performed for embolization of bronchial arteries which supply the cavity.
116. You are shown a PA chest radiograph (Figure 16) and two axial images from a CT scan of the chest (Figures 17 and 18) of a 22-year-old man. What is the MOST LIKELY diagnosis?

A. Postinfectious bronchiolitis
B. Poland syndrome
C. Absent left pulmonary artery
D. Congenital lobar emphysema

Findings:
Chest radiograph shows a small left hyperlucent lung. CT scan of the chest shows decreased attenuation and vascularity in the left lung. In addition, mild bronchiectasis is also noted in the left lung.

Rationale:
A: The radiographic findings present in this case are typical of Swyer-James syndrome. The syndrome is believed to be related to a viral bronchiolitis in childhood. This manifests as a small hyperlucent lobe or lung. The hyperlucency is due to bronchiolar obliteration. Air-trapping on expiration scan is also noted.
B: Incorrect.
C: Incorrect.
D: Incorrect.
117. You are shown three axial images from a CT scan of the chest (Figures 19-21) of a 40-year-old man who is 2 months status post bone marrow transplant. What is the MOST LIKELY diagnosis?

A. Cytomegalovirus pneumonia
B. Pulmonary edema
C. Pulmonary hemorrhage
D. Invasive aspergillosis

Findings:
CT scan shows diffuse ground-glass opacities within both lungs.

Rationale:
A: Cytomegalovirus (CMV) pneumonia occurs in patients who are 30-90 days status post bone marrow transplantation. On imaging, CMV pneumonia demonstrates ground-glass opacities and areas of consolidation. Pulmonary complications following bone marrow transplantation are attributed to the chemotherapeutic agents utilized before transplantation, the degree of immunosuppression and the interaction of the graft with the host. The complications have been grouped according to their time of presentation relative to the day of the transplantation, into early and late complications. The early phase is further subdivided into the neutropenic phase and the early phase. The neutropenic phase is considered the first 30 days following transplantation. During this phase, non-infection causes include pulmonary edema, hemorrhage and drug-induced lung injury occur. Infectious causes include fungal pneumonia, such as invasive aspergillosis. The early phase occurs between 30-90 days after transplantation. In this phase, opportunistic infections from pneumocystis jiroveci and CMV are common. Bronchiolitis obliterans and cryptogenic organizing pneumonia are late complications of transplantation.
B: Incorrect.
C: Incorrect.
D: Incorrect.
118. You are shown a PA chest radiograph (Figure 22) and three axial images from a CT scan of the chest (Figures 23-25) of a 35-year-old man. What is the MOST LIKELY diagnosis?

A. Arteriovenous malformation
B. Bronchial atresia
C. Scimitar syndrome
D. Sequestration

Findings:
Chest radiograph shows a small right lung, dextroposition of the heart and a curved anomalous vessel in the lower right hemithorax. CT scan of the chest shows the anomalous pulmonary vein entering the inferior vena cava.

Rationale:
A: Incorrect.
B: Incorrect.
C: It is also known as congenital pulmonary venolobar syndrome. It is a congenital anomaly that consists of hypoplasia of the right lung and the right pulmonary artery. There is anomalous venous drainage of the right lung into systemic venous system, usually below the diaphragm into the inferior vena cava. The above findings are present in our case.
D: Incorrect.
119. You are shown three axial MR images (Figures 26-28) of a 32-year-old woman. What is the MOST LIKELY diagnosis?

A. Goiter
B. Teratoma
C. Thymoma
D. Lymphoma

Findings:
T1 weighted, and T1 fat saturated post-contrast and T2 fat saturated images show solid, cystic and fatty elements within an anterior mediastinal mass.

Rationale:
A: Thyroid goiters demonstrate continuity with the thyroid gland and are usually heterogenous in attenuation. They may contain cystic elements as well as calcification but do not contain fat.
B: They are heterogenous in attenuation containing both solid and cystic elements. Calcification is common but presence of fat is highly suggestive of the diagnosis.
C: They are well rounded soft tissue density lesions in the anterior mediastinum. They do not contain fat and thus would not have the appearance of the lesion in our case.
D: They have variable appearance, ranging from single soft tissue mass to a large lobulated lesion. They may be homogenous or heterogenous in attenuation but they do not contain fatty elements, which are present in our case.
120. Which one of the following statements is TRUE regarding Langerhans cell histiocytosis?

A. Lower lobe nodules predominate.
B. There is proliferation of immature smooth muscle.
C. It has well-defined round cysts.
D. Most patients are cigarette smokers.

Rationale:
A: Incorrect.
B: Incorrect.
C: Incorrect.
D: Approximately 95% of the patients with Langerhans Cell Histiocytosis have a history of smoking cigarettes. It is characterized by the presence of granulomas containing large number of Langerhans cells and eosinophils, resulting in destruction of lung tissue. It occurs in young adults and the incidence is equal in both males and females. Nodules up to 1 cm in diameter are common. These nodules frequently cavitate and in the end state of the disease a cystic pattern can be noted. The cysts are typically bizarre in shape. The findings of irregular shaped cysts and nodules occur mostly in the upper lobe distribution. The bases, particularly the costophrenic angle, are spared.

121. Which of the following organisms is MOST commonly implicated in fibrosing mediastinitis?

A. *Histoplasma capsulatum*
B. *Actinomyces israelii*
C. *Treponema pallidum*
D. *Coccidioides immitis*

Rationale:
A: Fibrosing mediastinitis is a rare disorder characterized by chronic inflammation and fibrosis of mediastinal soft tissues. There are many causes of fibrosing mediastinitis. The most frequently implicated process is infection, of which Histoplasma capsulatum is the most common cause. Complications of fibrosis within the mediastinum lead to encasement and compression of mediastinal structures. Those that are particularly involved include superior vena cava, trachea and bronchi, and pulmonary artery and veins. Aorta and great vessel involvement is extremely rare.
B: Incorrect.
C: Treponema pallidum, the causative organism of syphilis, has been associated with fibrosing mediastinitis but less commonly than histoplasmosis.
D: Coccidioides immitis, the organism that causes Coccidioidomycosis or valley fever, is not associated with fibrosing mediastinitis.
122. Which one of the following statements is TRUE regarding pleural effusions?

A. Split-pleura sign noted on contrast-enhanced CT scan is diagnostic of empyema.
B. Lung cancer with malignant pleural effusion implies stage IIIB disease.
C. Transudative pleural effusion is present in asbestos-related pleural disease.
D. Cirrhosis is associated with exudative pleural effusion.

**Rationale:**
A: Split-pleura sign is not specific for empyema. It may be seen in any disease that results in pleural inflammation or infiltration of pleura by tumor.
B: Stage IIIB disease is characterized by tumor invasion of mediastinal structures, contralateral mediastinal or hilar lymph adenopathy, supraclavicular adenopathy, and malignant pleural and pericardial effusions.
C: Pleural effusion can be transudative or exudative. Distinction between the two is important as the causes and management of the two differs. Transudative effusion usually result from an increase in the capillary hydrostatic pressure or a fall in the colloid osmotic pressure. Common causes include congestive heart failure and cirrhosis. Exudative effusions are caused by an increase in microvascular permeability as a result of inflammation or tumor. Few causes include infection, malignancy, collagen vascular disease and asbestos exposure.
D: Incorrect.

123. Which one of the following statements is TRUE regarding Kaposi's sarcoma?

A. It is caused by the human papilloma virus infection.
B. Imaging of lesions shows peribronchovascular distribution.
C. It is seen exclusively in patients who are intravenous drug users.
D. There is an increased uptake of Ga-67 in lesions on imaging.

**Rationale:**
A: Incorrect.
B: Kaposi's sarcoma (KS) is a tumor derived from primitive vascular tissues, occurring in patients with Acquired immune deficiency syndrome (AIDS). It is much more common in patients who acquire AIDS through sexual contact and occurs less frequently in intravenous drug abusers. It is believed to occur as a result of herpes virus infection. On CT, KS appears as spiculated nodules in the peribronchovascular distribution. On Ga-67 scintigraphy, KS lesions do not demonstrate uptake.
C: Incorrect.
D: Incorrect.
124. What is the average energy of a 100-kVp x-ray beam?

A. 10 KeV  
B. 20 KeV  
C. 40 KeV  
D. 80 KeV

**Rationale:**  
A. Incorrect.  
B. Incorrect.  
C. The average energy of a polychromatic x-ray beam is usually one-third to one-half of the maximum kVp depending on the beam filter. Hence the average energy for 100 kVp x-rays would be between 33 – 50 keV and therefore 40 keV is correct.  
D. Incorrect.

125. According to the ACR Appropriateness criteria, which one of the following is the MOST appropriate first radiological examination in the evaluation of a patient with chest pain and suspicion of aortic dissection?

A. Chest radiograph  
B. Aortic angiogram  
C. MRI of the chest  
D. Chest CT with contrast

**Rationale:**  
A: According to the ACR Appropriateness Criteria, chest radiograph is the most appropriate first radiologic examination to be performed in a patient with chest pain and high suspicion for aortic dissection.  
B: Incorrect.  
C: Incorrect.  
D: Incorrect.
126. Which one of the following statements is TRUE regarding fat embolism syndrome?

A. It occurs in 20% of patients with long bone fractures.
B. It appears radiographically as peripheral wedge-shaped opacities.
C. **Patients present with hypoxia, altered mental status, and petechial rash.**
D. It appears as central low-attenuation filling defects in the pulmonary artery branches.

**Rationale:**
A: Fat embolism syndrome occurs in about 2% of patients with fat embolism. It almost universally occurs following long bone fractures on intra-medullary rod placement. The prognosis is poor in older patients and with more severe injuries.
B: Typically, a pulmonary edema pattern develops radiographically within 24 to 72 hour window after long bone fractures.
C: Fat embolism syndrome presents with a classical clinical triad of hypoxia, and respiratory failure, altered mental status and petechial rash. Free fatty acids released during long bone fractures cause endothelial damage and permeability edema.
D: The fat droplets are microscopic and lodge in the pulmonary capillaries. The fat droplets do not completely obstruct the capillary blood flow because the droplets are fluid in nature. CT scan shows bilateral ground glass opacities which typically resolve in 1 to 3 weeks. Endoluminal filling defect in the pulmonary artery containing fat is rare.

127. A digital radiograph is excessively dark when presented on a properly calibrated PACS workstation. What is the MOST LIKELY cause for this suboptimal image?

A. Overexposure of the imaging plate
B. Underexposure of the imaging plate
C. Incorrect kVp selected by the technologist
D. **Image processing failure**

**Rationale:**
A. When digital images are overexposed, the resulting image is usually rendered with a normal average grayscale. Very low quantum noise is the hallmark of an overexposed radiograph.
B. When a digital radiograph is underexposed, the resulting image is usually rendered with a normal average grayscale. Excessive quantum mottle is the hallmark of underexposed radiographs.
C. Which limits the mAs. When manual exposure control is used, incorrect kVp results in over- or under-exposure. In either case, image processing should control the image contrast to produce a normal average grayscale range.
D. Very dark or very light digital radiographs are most often the result of a failure of the image-processing algorithm.
128. In which of the following conditions is hypertrophic pulmonary osteoarthropathy seen?

A. Septic emboli
B. **Lung carcinoma**
C. Cryptogenic organizing pneumonia
D. Rheumatoid arthritis

**Rationale:**
A: Incorrect.
B: Hypertrophic pulmonary osteoarthropathy is a painful periosteal reaction that most commonly involves the hand and feet. It is frequently seen in patients with severe chronic lung disease such as emphysema and lung cancer. Relief of symptoms commonly follows resection of the primary neoplasm. Pulmonary osteoarthropathy may precede discovery of neoplasm by up to 2 years.
C: Incorrect.
D: Incorrect.

129. Which one of the following statements is TRUE regarding a solitary pulmonary nodule?

A. The presence of calcification suggests benignity.
B. Transthoracic needle biopsy has shown greater than 90% diagnostic accuracy for all nodules.
C. **Granulomas can show positive FDG uptake similar to that seen with malignant nodules.**
D. A doubling time of less than 1 month for nodules is highly suggestive of malignancy.

**Rationale:**
A: Eccentric calcification can be identified in small percentage of lung carcinomas which may incorporate adjacent calcified granulomas or they may themselves calcify. In these instances, the calcification is often stippled or punctuate.
B: Lesions such as hamartoma and granuloma have a much lower diagnostic accuracy.
C: PET is a physiologic imaging technique that was 2-[fluorine-18] – fluoro-2-deoxy-D-glucose (FDG), a D-glucose analog, that is labeled with a positron emitter (18F). Increased glucose metabolism in lesions result in increased uptake and accumulation of FDG. Thus, metabolically active lesions will demonstrate increased FDG uptake. The degree of FDG accumulation is measured using standardized uptake ratio (SUR). Typically, lung cancers demonstrate SUR of greater than 2.5. For nodules greater than 1 cm, FDG-PET has sensitivity of about 95%. However, its role in evaluation of SPN should be approached with caution. The reason is infectious (granulomas) and inflammatory solitary pulmonary nodules can demonstrate increased FDG uptake and thus may give false-positive results.
D: Doubling time of less than one month suggest a very high doubling time and is suggestive of infection.
130. Which one of the following structures is present in the wall of the secondary lobule?

A. Pulmonary artery
B. Terminal bronchiole
C. Bronchial artery
D. Pulmonary vein

**Rationale:**
A: Incorrect.
B: Incorrect.
C: Bronchial artery originates from the aorta or intercostal arteries. They travel from the pulmonary hila to the level of the terminal bronchioles within the peribronchovascular interstitium.
D: The secondary pulmonary lobule is a hexagonal shaped structure measuring about 1-2.5 cm. The wall (interlobular septa) of the lobule contains connective tissue, pulmonary vein and lymphatics. The central portion of the lobule contains pulmonary artery and terminal bronchiole.

131. Which one of the following statements is TRUE regarding a bronchogenic cyst?

A. It is a low-signal intensity lesion on T1- and T2-weighted MR images.
B. It is a well-defined spherical subcarinal mass.
C. It demonstrates enhancement after intravenous contrast administration.
D. It occurs most commonly in the left lower lobe.

**Rationale:**
A: Incorrect.
B: Bronchogenic cysts are congenital lesions thought to originate from the primitive ventral foregut and may be mediastinal, intrapulmonary, or, less frequently, in the lower neck. Approximately two-thirds are within the mediastinum, and one-third is intraparenchymal. They account for 40%-50% of all congenital mediastinal (intrathoracic) cysts, and there is a slight male predominance. Numerous studies have documented the rare frequency of bronchogenic cysts, with an average incidence of 20 cases over a 20-year period. The cysts contain mucoid material and are lined by ciliated columnar or cuboidal epithelium. Their walls contain smooth muscle and often cartilage. They are sometimes intrapulmonary, typically in the medial third of the lung. If in a mediastinal location, they may be paratracheal (usually right-sided), carinal, or hilar. The carinal location is most frequent.
C: Incorrect.
D: Incorrect.