Educational and Scientific Posters

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Transcatheter Aortic Valve Replacement (TAVR): Expanding Role of Radiology

CHANDRASEKARAN B, Kowal D and El Khudari H

Background Information: Aortic stenosis is a common valvular disorder of the elderly with high morbidity and mortality if left untreated. Historically, surgery has been the mainstay of therapy, but over the past few years, Transcatheter Aortic Valve Replacement (TAVR) performed by interventional cardiology is increasingly utilized in patients considered poor surgical candidates. Prosthetic valve positioning is of utmost importance, as improper implantation leads to suboptimal results.

Educational Goals/Teaching Points:
- Normal thickness, density (unenhanced and enhanced) and normal variants (apical thin point, false tendons, sigmoid septum, myocardial cripts) of the left ventricle on CT.
- Definition, CT appearance and example of:
  - transmural and non-transmural myocardial infarction
  - hypertrophic cardiomyopathy
  - left ventricular hypertrophy
  - myocardial perfusion defect
  - myocardial delayed enhancement
  - LV non-compaction
  - LV lipoma formation
- Artifacts and imaging pitfalls

Conclusions: TAVR is a complex procedure requiring the special skills of a multidisciplinary team including interventional cardiologists, cardiac surgeons and radiologists. As this procedure is made increasingly available, the radiologist must master implementation and interpretation of pre-procedural CT angiography scans, for which a sound understanding of the aortic root anatomy and pertinent reconstruction techniques is fundamental.

Left Ventricular Characterization with Computed Tomography: A Pictorial Review

HARVEY M and V Rojas C

Background Information: The purpose of this exhibit is to review normal myocardial appearance of the LV myocardium on CT images (focusing on unenhanced and enhanced ECG-gated images). We will review abnormalities of the LV myocardium, imaging appearance, differential diagnoses and imaging pitfalls. Correlative cardiac MRI images are shown when applicable.

Educational Goals/Teaching Points:
- Normal thickness, density (unenhanced and enhanced) and normal variants (apical thin point, false tendons, sigmoid septum, myocardial cripts) of the left ventricle on CT.
- Definition, CT appearance and example of:
  - transmural and non-transmural myocardial infarction
  - hypertrophic cardiomyopathy
  - left ventricular hypertrophy
  - myocardial perfusion defect
  - myocardial delayed enhancement
  - LV non-compaction
  - LV lipoma formation
- Artifacts and imaging pitfalls

Conclusions: Computed tomography is a useful modality for characterization of the left ventricle and can demonstrate a wide range of left ventricular pathology.
Anomalous Origin of Coronary Artery from the Pulmonary Artery: Postoperative Imaging Evaluation

KANDATHIL A, Dennie C, Pena E, Shah A and Agarwal P

Background Information: Anomalous origin of coronary artery from the pulmonary artery (AOCAPA) is a rare congenital anomaly which leads to coronary steal phenomenon and abnormal ventricular perfusion. This abnormality often presents early in life, though rarely late adult presentations may occur. It is important for all imagers to not only diagnose the abnormality pre-operatively, but be aware of the various types of surgical procedures, normal postoperative appearance and complications. This has become even more pertinent given the increasing importance of adult congenital heart disease in the context of improving surgical outcomes.

Educational Goals: The poster will focus on the various surgical procedures used for treating this abnormality. The ultimate aim of surgery is to create a two coronary artery system. Surgical techniques include coronary button transfer, Takeuchi procedure and placement of a coronary artery bypass graft with ligation of the anomalous coronary artery. This review will describe operative procedures, knowledge of which is crucial to understand the normal post operative appearance and evaluate for complications. Also, imaging appearance of complications specific to each procedure will be discussed and illustrated such as supravalvular pulmonic stenosis and baffle stenosis after Takeuchi repair, occlusion of bypass grafts or rarely inadequate growth of the coronary anastomosis after surgical relocation.

Conclusions: We hope to increase awareness among imagers about the various surgical options and normal imaging appearance after repair of AOCAPA. After reviewing this exhibit, the reader will be able to understand the normal post operative appearance specific for each surgical technique and their associated post-surgical complications.

Bypassing the Current Standard in CABG Evaluation: MDCT as a Diagnostic Tool

ST CLAIR SL, Pfeifer C, Wong M, Bhatti T and Perone R

Background Information: “S/P CABG“ is very common to see in the clinical history. Even though the incidence of coronary artery bypass grafting (CABG) is declining, the prevalence of CABG in our aging population remains high. The rate of failure in CABG was found to be 43 percent in the Project of Ex Vivo Vein Graft Engineering Via Transfection IV trial. In 2006 the American Heart Association Committee on Cardiovascular Imaging and Intervention released a statement regarding assessing coronary artery calcified plaque (CACP) with computed tomography (CT) and commented specifically on the use of CT Angiography to evaluate the patency of the bypass graft (Class IIb, Level of Evidence: C). They cited impressive results of a study with a sensitivity and specificity of 100% for detecting occlusion and 96% sensitivity and 100% specificity for detecting high-grade stenosis in patent grafts. Though cardiac catheterization remains the gold standard in the evaluation of graft integrity, CT coexists as a readily available, inexpensive, and safe means to evaluate patency which merits further study and consideration.

Educational Goals/Teaching Points: Radiologists and their clinical counterparts would benefit from familiarity with the appearance of graft failure. This exhibit will provide:
1. A pictorial review of the appearance of patent, stenotic and occluded vein grafts.
2. CT images will be accompanied by coronary angiography correlation in the same patient.
3. A discussion of the limitations of CT to diagnose stenosis and occlusion, as exemplified by a case of clip artifact obscuring a stenotic lesion confirmed with coronary angiography.

Conclusion: “S/P CABG“ is a clinical history that radiologists see all day, and every day. Graft failures after CABG are also very common. CT is a readily available, relatively inexpensive and safe way to evaluate the patency of grafts. The use of CT in evaluating graft patency, stenosis, and occlusion has emerged as a non-invasive tool that radiologists can use to increase the value of their services.
CT Evaluation of Atrial Septal Defects: What to Convey to the Interventionalist Prior to Percutaneous Closure

TRIVEDI PS, Quaife R and Vargas DB

Background Information: Percutaneous endovascular closure is now the treatment of choice for ostium secundum, the most common subtype of atrial septal defects (ASD). A number of anatomic variables contribute to feasibility of percutaneous ASD closure and its relative success rate. Identifying and understanding them is essential to providing effective pre-procedural imaging evaluation.

Educational Goals/Teaching Points: Relative advantages of computed tomography over magnetic resonance and echocardiographic imaging for pre-procedural planning are briefly reviewed and our optimized protocol detailed. Key elements to discuss include:
- Maximal defect diameter
- Rim width and stability
- Presence of fenestrations and other congenital defects
- Extent of cardiac shunt/pulmonary arterial resistance
- Relative orientation of venous inflow and arterial outflow structures

These are contextualized by integrating our institutional experience (35 cases) with published evidence on anatomic predictors of successful percutaneous closure. Explanatory case images supplement discussion of these elements with particular emphasis on appropriate patient selection and case planning.

Conclusions: Radiologists now play a vital role in triaging ASD patients towards percutaneous versus surgical correction and assisting the interventionalist with pre-procedural planning, including evaluation of anatomic suitability and identification of prognostic factors. Knowledge of associated salient clinical and radiological findings is therefore critical to optimizing outcomes for ASD patients.

Cardiac Diffusion Weighted Imaging: A New Kid on the Block

BRONCANO J, Luna A, Martin T and Sanchez Gonzalez J

Background Information: With recent advancements in functional and molecular imaging, MRI based sequences have made an important improvement in the characterization of normal and pathological tissues. Specifically, diffusion weighted imaging (DWI) has become a powerful tool in those terms, not only differentiating benign versus malignant processes, but also resulting in a useful and widespread biomarker with prognostic implications. Although the application of DWI in the thorax is technically demanding, there are several approaches which could be applied. Currently the acquisition of DWI in the heart is feasible. The chance to nicely depict cardiac edema opens a window for the evaluation of acute ischemia or myocarditis. In addition, as in other body regions, DWI may also allow the estimation of the aggressiveness of cardiac masses.

Teaching Points:
1. To analyze the technical adjustments to perform DWI of the heart.
2. To review the potential clinical applications of cardiac DWI.

Conclusions: DWI of the heart is a feasible technique which could depict the presence of myocardial edema in situations such as in ischemic and inflammatory myocardium. It also permits the characterization of cardiac masses.
Recognizing and Mitigating Artifacts from Pacemaker/Defibrillators in Patients Undergoing Cardiac Magnetic Resonance Imaging

DAY K, Oliva I, Sharma P and Jokerst C

Background Information: Cardiac magnetic resonance imaging (CMRI) provides a large amount of anatomic and functional information such as gold standard right ventricular analysis and high special resolution myocardial viability imaging. Patients with severe heart failure often have implantable pacemakers/defibrillators to prevent sudden death (ejection fractions < 35%) or to treat arrhythmias. There have been safety concerns about MRI in these patients in the past which precluded them from receiving a CMRI. There is now a growing body of literature supporting safe MRI in selected patients with implantable pacemakers/defibrillators. The presence of the device within the field of view introduces predictable artifacts which limit the diagnostic utility of CMRI. The purpose of this exhibit is to show examples of the most common artifacts and describe troubleshooting techniques to reduce or eliminate these artifacts in order to improve image quality and diagnostic yield.

Educational Goals/Teaching Points:
1) Introduction with background
2) Sequences and associated artifacts:
   a. Black-blood turbo spin echo – Distortion artifact
   b. Balanced steady state free precession (bSSFP) – “Banding” artifact
   c. Gradient recalled echo (GRE) – Dephasing artifact
   d. Delayed enhancement – Susceptibility artifact
   e. Minimizing repetition time and echo time
   f. Swapping phase- and frequency- encoding direction
   g. Multiple averages to boost signal to noise
   h. Limiting specific absorption rate
3) Protocol optimization:
   a. Cardiac device location
   b. Spoiled gradient recalled echo vs. bSSFP
   c. Shimming
   d. Frequency scout
   e. Increasing resolution
   f. Using thinner slices
   g. Increasing bandwidth
   h. Increasing bandwidth
   i. Increasing bandwidth
   j. Increasing bandwidth
   k. Increasing bandwidth
Conclusions: CMRI artifacts related to pacemakers/defibrillators can degrade image quality and obscure important findings. Recognizing artifacts and understanding how to avoid or minimize their effects is an essential skill for those desiring to perform CMRI on patients with pacemakers/defibrillators.

Bicuspid Aortic Valve Disease: What the Radiologist Needs to Know

GADDAM S, Cohen SL, Levsky JM and Haramati LB

Background Information: Bicuspid aortic valve (BAV) is the most common congenital cardiac malformation (1-2% of the population). The causative genetics of this abnormality are now partly elucidated. BAV may present in isolation, associated with anomalies such as aortic coarctation, or as part of a syndrome (e.g., Turner, Shone, or Williams). Isolated BAV is rarely detected in childhood; however by age 50 years, the majority of patients have valvular dysfunction - more frequently stenosis than regurgitation. Bicuspid aortic valves are prone to calcification, yielding classic chest radiographic appearances. BAV has several sub-types which are best characterized by cine imaging en face. Although echocardiography is the initial diagnostic imaging study for the evaluation of patients with BAV, it may be limited in patients with poor sonographic windows or in the presence of marked valve calcification. Complications of BAV arise from associated aortopathy which results in dilatation or aneurysm of the ascending aorta in the majority of adults older than 50 years. Other complications of BAV include an increased risk of aortic dissection and endocarditis. Clinical guidelines for aortic valve replacement and ascending aortic replacement will be discussed with an emphasis on the role of CT and MRI in guiding management. Population studies in the US and Canada showed normal life expectancies for patients with BAV treated with contemporary medical and surgical therapy.

Educational Goals/Teaching Points: Will discuss the following:
1. Epidemiology of Bicuspid Aortic Valve
2. Valve Morphology and Classifications
3. Genetics, Associated Syndromes, and Molecular Features
4. Coronary Anatomy and Associated Cardiac Anomalies
5. Aortopathy
6. Radiological Findings and the Role in Guiding Management
7. Interventions

Conclusions: BAV is common. Radiologists should recognize its varied morphologies, clinical significance, and expected complications, as CT/MR imaging is a mainstay for guiding management.
Routine and Emerging Cardiac MR Techniques: The Cardiac MR Exam of the Future

GHANEIE A, Prather A, Fattouch TH, Rojas CA, Nallamshetty L and Jeong DK

**Background Information:** Cardiac magnetic resonance (CMR) has become an integral part of cardiac imaging. It is a safe non-invasive modality which provides valuable data about cardiac anatomy, function, and pathology. The conventional cardiac exam revolves around 2D cine SSFP to assess function and late gadolinium enhancement (LGE) to evaluate myocardial integrity. Based on the clinical indication, other sequences are added including double IR, triple IR, first pass perfusion, myocardial tagging, phase contrast, T2*, and MRA. While highlighting these sequences, this exhibit mainly focuses on the emerging CMR techniques which can supplement or potentially replace older protocols.

**Educational Goals:**
1. Applications of native T1 mapping, T2 mapping, and extracellular volume (ECV) imaging including quantifying edema, detecting protein, fat, and iron deposition, and assessing extracellular matrix (ECM) expansion. Advantages over conventional T2W and LGE are highlighted.
2. Advantages of single breath-hold 3D cine SSFP for assessing ventricular function compared to conventional 2D cine SSFP. The quality of non-contrast and contrast-enhanced scans with intra- or extravascular agents are compared.
3. Advantages of free-breathing self-navigated isotropic 3D whole heart imaging for evaluating the coronary arteries and complex cardiac anatomy.
4. Applications of time-resolved phase contrast 3D (4D flow) MRI and its advantages over conventional 2D phase contrast imaging.

**Conclusions:** CMR remains the gold standard for evaluation of ventricular function and myocardial pathology. Emerging MRI techniques can provide quantitative data, excellent image quality, and potentially shorter scan times. Currently, these techniques are supplementary but may soon become integral components of CMR.

Eosinophilic Lung Disease – A Review of Radiologic and Clinical Findings

BERNHEIM A and Goyal N

**Background Information:** The purpose of this exhibit is:
- To review the epidemiology, clinical manifestations, and known associations of eosinophilic lung diseases.
- To explore the radiologic characteristics of eosinophilic lung diseases on various imaging modalities.
- To identify other entities in the imaging differential diagnosis for eosinophilic lung diseases.

**Educational Goals/Teaching Points:**
- Definitions, Background, and Relevant Epidemiology of Eosinophilic Lung Diseases
- Entities include Acute Eosinophilic Pneumonia, Hypereosinophilic Syndrome, and Chronic Eosinophilic Pneumonia
- Discussion of Clinical and Radiologic Manifestations
- Differential Diagnostic Considerations
- Imaging Techniques and Findings
- Example Cases
- Management Approach

**Conclusions:** The key teaching points of this exhibit are:
- Eosinophilic lung diseases have a varied clinical presentation and may be associated with several other abnormalities.
- Characteristics imaging findings in addition to clinical clues suggest these diagnoses.
- Several therapeutic options are utilized in the management of eosinophilic lung diseases.
Pulmonary Manifestation of Metabolic and Storage Lung Disease

AL AJMI EA, Dupuis I, Nair JR, Taylor J, Belley G and Kosiuk J

Background Information: Metabolic and storage diseases are a heterogeneous group of conditions characterized by underlying biochemical abnormality. Lungs may be involved as isolated pulmonary manifestation or part of the systemic syndrome. The non-specific clinical presentation and the slow course of the disease process pose a diagnostic dilemma. High-resolution computed tomography (HRCT) is a valuable tool in the diagnosis of these clinical conditions.

Educational Goals/Teaching Points: Metabolic and storage lung diseases discussed in this exhibit would include Pulmonary Alveolar Proteinosis (PAP), Pulmonary Amyloidosis, Metastatic Pulmonary Calcification, Dendritic Pulmonary Ossification, Pulmonary Alveolar Microlithiasis and Storage diseases.

The exhibit would aid:
1) Identification of the various metabolic and storage lung diseases.
2) Correlation of clinical and characteristic HRCT findings in various metabolic and storage lung diseases to improve better understanding of the disorders.
3) Discussion of the relevant differential diagnosis of each of these disorders.

Conclusion: Knowledge of clinical features and imaging manifestations of these diverse but rare groups of disorders is important for radiologists and clinicians. HRCT not only helps in diagnosis but has prognostic significance in assessing disease progression and evaluating response to treatment.

Forgotten Treasure: Chest Radiography in Acquired Heart Disease

BEASLEY M, Terry NLJ, Sonavane SK, Watts JR, Nath H and Singh SP

Background: Cardiac imaging has undergone a tremendous expansion with the advent of EKG-gated cardiac computed tomography (CCTA) and cardiovascular magnetic resonance imaging (CMRI). However, the chest radiograph (CXR) is frequently the first imaging study performed and is extensively utilized in follow-up of patients with cardiac disease. Moreover, the diagnosis of previously unrecognized cardiac disease can start with recognition of the disease findings on CXR. Current residents and fellows often have very limited experience in recognizing cardiac diseases on chest radiographs. This educational poster will review the findings in acquired cardiac disease and its complications on standard and dual-energy CXR (DECXR).

Educational Goals:
1. Review normal cardiovascular anatomy on CXR.
2. Demonstrate the findings of acquired heart disease on CXR and DECXR including valvular disease, ischemic disease, cardiomyopathy, and cardiac tumors as well as cardiac disease secondary to pulmonary vascular disease or pericardial disease.
3. Emphasize the utilization of DECXR in the detection of calcification and mediastinal abnormalities on radiography.
4. Inferring abnormal cardiac physiology from CXR findings.

Conclusion: The radiologist’s ability to identify and characterize the findings of acquired cardiac diseases on chest radiography is still valuable to the diagnosis and follow-up of these diseases. This ability is based on knowledge of the anatomy displayed on CXR and the physiologic causes of changes in the cardiac anatomy displayed. Correct identification of the presence of cardiac disease and the appropriate differential can then help guide the use of more advanced imaging.
HRCT Patterns Made Simple: A Pictorial Essay

FERRA M, Wong M, St. Clair S, Raoof S and Perone R

Background Information: The secondary pulmonary lobule represents the smallest organizational unit of the lung visible on HRCT. This lobule is bounded by connective tissue containing pulmonary veins, lymphatics, and up to a dozen acini housing respiratory bronchioles, alveolar ducts, sacs and alveoli. In the center of the lobule is the terminal bronchiole and bronchiolar artery. Disease processes which affect different segments of the secondary pulmonary lobule produce characteristic patterns on HRCT which can be used to narrow the differential diagnosis and expedite the delivery of appropriate patient care.

Teaching Points:
• Highlight the major imaging patterns of pulmonary disease as seen on HRCT.
• Utility of these imaging patterns in narrowing the differential diagnosis of pulmonary disease thus expediting appropriate patient management and care.
• Pathophysiologic basis of each imaging pattern of pulmonary disease in relation to the anatomy of the secondary pulmonary lobule.
  • Cystic: Examples (emphysema, lam, plch, pcp, bronchiectasis, and lip)
  • Ground Glass/Consolidation: Examples (pneumonia, both typical and atypical etiologies, adenocarcinoma)
  • Mosaic: Examples (infectious small airway disease, chronic thromboembolism, hyperisitivty pneumonitis)
  • Reticular: Examples (CHF, ILD, atypical infections)
  • Nodular: Examples (bronchiolitis, hypersensitivity pneumonitis, miliary infection, metastatic disease, sarcoid, pneumoconiosis, lymphangitic spread of disease)

Conclusions:
• Define the salient features of the classic HRCT patterns and the associated component of the lobule that is affected.
• Emphasize the importance of categorizing patterns of pulmonary disease as a means of narrowing the differential and expediting appropriate patient care.
Illustrate in the form of a pictorial essay the most common disease entities associated with each HRCT pattern.

Chest Radiographic Findings in Near-Drowning Cases

PAIGE JS, Naheedy J and Yen A

Background: In the United States, unintentional drowning causes approximately 8,000 deaths annually with an additional 7,000 patients requiring hospitalization for nonfatal drowning injuries. If not assessed and treated properly, nonfatal drowning patients may suffer from neurologic sequelae and late-onset pulmonary disease such as acute respiratory distress syndrome (ARDS). Chest radiography (CXR) is readily available, and radiologic findings are helpful in assessing baseline status and monitoring care. Therefore, it is critical that healthcare workers are familiar with common CXR findings in nonfatal drowning cases.

Teaching Points: Pulmonary injuries in nonfatal drowning cases may occur with inhalation of as little as 1-3 cc/kg of water and typically show three discriminant stages of severity on CXR. Stage 1 reflects an acute laryngospasm from inhaling a small amount of water, with findings of post-obstructive pulmonary edema that should reverse over 24-48 hours. Stage 2 is similar to Stage 1, but with increased water content in the stomach. Stage 3 can take one of two forms:
  • Persistent laryngospasm (20% of cases) with worsening post-obstructive pulmonary edema leading to secondary apnea and asphyxia, or
  • Hypoxia-induced relaxation of the larynx (80% of cases) resulting in aspiration of water and development of permeability edema.

Conclusions: Given the wide spectrum of clinical presentations following nonfatal drowning events, chest radiographs are an essential tool in the early identification of patients with significant pulmonary and airway manifestations. Furthermore, knowledge of the radiographic presentations in the various stages of pulmonary involvement can help guide clinicians in their care of these patients and monitoring response to therapy.
Inhalation Lung Injury from Chemical Exposure

RESTREPO CS, Carrillo J and Restrepo C

Background Information: Acute and chronic inhalation lung injury from numerous chemical compounds may result from accidental, intentional or occupational exposure. Most common chemical agents associated with lung injury include smoke inhalation, hydrocarbons (gasoline), household cleaning agents (chlorine), phosgene sulfur dioxide, hydrogen chloride, hydrogen sulfide, nitrogen dioxide, and ammonia. Depending on the type and amount of irritant gas, or chemical inhaled, the victim can experience from mild respiratory discomfort to severe lung injury and death. Gaseous agents typically produce widespread damage with extensive acute lung injury clinically manifest as acute respiratory distress syndrome. Surviving patients may develop irreversible changes including fibrosis, scarring, bronchiectasis and pulmonary cyts.

Educational Goals/Teaching points: To review the pathophysiology and imaging manifestation of inhalation lung injury after exposure to the most common chemical agents.

Conclusions: Inhalational lung injury may occur after exposure to numerous chemical agents with clinical manifestation ranging from minor respiratory symptoms to severe airway and parenchymal injury with significant morbidity and mortality. Both acute and chronic lung injury with irreversible damage may occur.

Cardiothoracic Imaging Spectrum of Sickle Cell Disease

DONURU A, Lakhani P, Weinstein J and Sundaram B

Background Information: Sickle cell disease (SCD) is a genetic cause of anemia. Along with improved survival of patients with SCD, complications due to SCD and treatment are frequently encountered. Cardiothoracic complications are the leading cause of morbidity of patients with SCD. Complications are poorly understood as the clinical features are often non-specific. Hence awareness of imaging findings may help to correctly identify these complications.

Educational Goals/Teaching Points: We plan to review the pathophysiology of following disease entities and their imaging features pertaining to SCD:

- Pulmonary hypertension
- Acute chest syndrome and vascular occlusive disease
- Lung infections
- Obstructive lung disease
- Transfusion dependent disease (myocardial iron overload)
- Correlation lung physiology parameters and imaging features
- Skeletal system changes

Conclusions: Awareness of the pathophysiology and imaging findings of SCD will help to understand the imaging spectrum and appropriately triage patients with SCD.
Congenital Bronchopulmonary Anomalies Encountered in Adults

DONURU A, Sharma D, Lakhani P and Sundaram B

**Background Information:** Congenital anomalies of the lung can be grouped as anomalies related to bronchopulmonary structures, vasculature, or combined. Imaging plays a central role in diagnosing these conditions. Due to early diagnosis and improved management, many children with congenital bronchopulmonary anomalies survive longer in adulthood. These conditions may be asymptomatic and incidentally encountered in adult imaging. Some of these anomalies are benign while others may result in complications. Careful analysis of imaging with full understanding of these conditions is needed to correctly diagnose and manage these conditions.

**Educational Goals/Teaching Points:** We aim to illustrate a spectrum of imaging appearances of these congenital conditions encountered in our institution. We also plan to discuss the clinical significance of these conditions. These entities include the following:

- **Bronchopulmonary anomalies:** Pulmonary agenesis, bronchial atresia, anomalous bronchial branching, bronchogenic cyst, tracheal bronchus, tracheal diverticulum and Williams–Campbell syndrome.
- **Vascular anomalies:** Anomalous origin of the left pulmonary artery from the right pulmonary artery (pulmonary artery sling), agenesis of pulmonary artery, partial or total anomalous pulmonary venous return, pulmonary arteriovenous malformation.
- **Combined anomalies:** Hypogenetic lung syndrome and bronchopulmonary sequestrations.

**Conclusions:** Knowledge of imaging appearances and clinical significance of congenital bronchopulmonary abnormalities encountered in adults may lead to their correct diagnosis and management.

Central Airway Diagnoses on Frontal and Lateral Chest Radiography

BERNHEIM A and Goyal N

**Background Information:** The purpose is to demonstrate a number of diseases affecting the central tracheobronchial tree that can be recognized on routine chest radiography examinations. The objective is also to foster an understanding that the chest radiograph can be an initial and often critical clue in recognizing significant pathology within this often overlooked anatomic region.

**Educational Goals/Teaching Points:** A multitude of central tracheobronchial pathologies can be diagnosed on a routine chest radiograph. These include entities such as Mounier-Kuhn syndrome, saber-sheath trachea, foreign bodies, and mucoid impaction. Entities that compress or displace the trachea are also addressed, including aortic ectasia and a variety of mediastinal masses.

**Conclusions:** The chest radiograph, often thought of as the primary initial imaging examination for pulmonary parenchymal pathology, can be an important study for recognizing important pathology of the central tracheobronchial tree as well. The radiologist’s familiarity with these entities and their presentation on chest radiography is important to identifying many of these important diseases.
Diffuse Panbronchiolitis: A Pictorial Review

HAJA MOHIDEEN SM, Velaga J, Ng YL and Cheah F

Background Information: Diffuse panbronchiolitis is a rare inflammatory condition of unknown aetiology. It is largely restricted to Japan and other parts of Asia but is increasingly recognized worldwide. If untreated, it can progress, leading to bronchiectasis, respiratory failure and death. Hence early diagnosis and treatment may reduce patient morbidity and mortality.

Educational Goals/Teaching Points: The aim of this pictorial review is to present the typical imaging features on chest radiography and computed tomography with illustrative examples. The pathogenesis, clinical features and natural history of this entity will be reviewed. The approach to diagnosis and the differential diagnoses will also be discussed.

Conclusions: Radiology plays an important role in the diagnosis and management of diffuse panbronchiolitis. Awareness and knowledge of this condition will facilitate early diagnosis and treatment to reduce patient morbidity and mortality.

Beyond Bronchitis: A Review of the Congenital and Acquired Abnormalities of the Bronchus

KAPROTH-JOSLIN KA, Hobbs SK and Chaturvedi A

Background Information: The bronchi are the main branching components of the conduction zone which connect the trachea to the respiratory zone containing the bronchioles and alveoli. The most common condition affecting the bronchi is bronchitis, a nonspecific disorder which occurs then the bronchi become swollen secondary to infection or irritation. Additional bronchial disorders include both congenital and acquired causes, some of which are asymptomatic and may be discovered incidentally on imaging.

Educational Goals: We will review basic bronchial anatomy and the most commonly encountered variants, including plain film and CT imaging. We will then present an image rich discussion of the congenital and acquired causes of bronchial disease, with an emphasis on the typical imaging patterns associated with each condition and a presentation of the common causative etiologies:

Congenital conditions:
- Accessory cardiac bronchus
- Tracheal bronchus
- Segmental bronchial agenesis/aplasia/hypoplasia
- Bronchomalacia (Williams-Campbell Syndrome)

Acquired conditions:
- Bronchitis, both acute and chronic
- Infection
- Irritation
- Bronchiectasis secondary to:
  - Cystic fibrosis
- Infections
  - Allergic bronchopulmonary aspergillosis
  - Pulmonary fibrosis
  - Bronchial obstruction secondary to:
    - Foreign bodies
    - Neoplasms (lung carcinoma, carcinoid tumor, adenoid cystic carcinoma, hamartoma, mucoepidermoid tumor)
  - Granulomatous disease
  - Asthma, both acute and chronic
  - Bronchiolith

Conclusions: Bronchial disorders are both congenital and acquired in etiology and are sometimes discovered incidentally on imaging. Imaging interpretation is dependent on knowledge of basic bronchial anatomy and its common congenital variants. Recognizing the image findings frequently encountered with these bronchial lesions, as well as the understanding of common causative etiologies, helps to narrow the differential diagnosis, assisting both the radiologist and the ordering physician in patient management.
Non-Malignant Lesions of the Tracheobronchial Tree - A Pictorial Essay

PARAVASTHU MS, Chung T, Weisbrod G and Patsios D

Background: Abnormalities of the central airways are not uncommon. When clinically suspected CT offers the best non invasive modality of assessment of the central airways. A variety of non malignant entities can affect the central airways either causing narrowing or enlargement or occasionally mimic malignancy. The abnormalities may be diffuse or focal and this pictorial review focuses on the non malignant entities of the tracheobronchial tree.

Educational Goals: The review is intended to give a comprehensive imaging appearances of common and rare disease processes affecting the central airways such as tracheal stenosis, relapsing polychondritis, amyloidosis, Wegeners granulomatosis, tracheal papillomatosis, tracheopathia osteochondroplastica and rare entities such as Rosai Dorfman syndrome, and tracheobronchomegaly. Emphasis is also made on the imaging appearances and the usefulness of CT and other post-processing techniques in assessment of the central airways.

Conclusion: Diffuse and focal non-malignant abnormalities of the trachea and main bronchi are not uncommon and thorough knowledge of the imaging techniques, imaging appearances of the wide variety of non-malignant entities and imaging techniques of the trachea is important to increase the diagnostic accuracy.

A Game of Clue: Solving the Case of Bronchiectasis

WONG M, Maeder ME, St Clair SL, Ferra M and Perone RW

Background Information: Bronchiectasis is undoubtedly commonly encountered by radiologists, perhaps even on a daily basis, and represents a common end-stage and irreversible change to the bronchioles and bronchi due to widely variable causes such as chronic infection, proximal airway obstruction or congenital abnormalities. Many different disease states manifest themselves predominantly by bronchiectasis with specific radiographic patterns; being able to accurately identify the type of bronchiectasis and distribution as well as other associated findings in the lungs may help and guide the radiologists in narrowing their differential diagnoses and understand the underlying pathogenesis of their patient’s disease. Here we attempt to provide an educational pictorial essay on the different types of bronchiectasis as well as the multiple different bronchiectasis-associated diseases in hopes to refresh our knowledge and perhaps relearn this common but sometimes overlooked subject. We would also like to present a diagnostic algorithm proposed by Cantin et al. that may aid the radiologist in deciphering complicated cases of bronchiectasis.

Educational Goals:
• To present a pictorial essay and review the different types of bronchiectasis and its differential diagnoses based on type, distribution and associated findings.
• To present a helpful algorithmic approach when encountering a case of bronchiectasis to help the radiologist in narrowing the differential diagnoses.

Conclusion: Bronchiectasis represents end-stage change to bronchioles and bronchi; based on its type and distribution, may in fact be helpful clues for the radiologist thus increasing diagnostic acumen and often facilitating accurate diagnosis of the underlying disease.
The Detection of Retained Surgical Foreign Bodies on the Chest Radiograph

AHMAD W and Reeser P

**Background Information:** All patients undergo examination with standard chest radiographs after open thoracic surgery. The detection of retained foreign bodies is an important consideration for any radiologist interpreting these studies.

**Teaching Points:**
- Review of the most commonly used surgical equipment which may be retained during operative procedures.
- Review of the radiological signs to observe when imaging retained foreign bodies on the chest radiograph.
- Presentation of a case of a retained foreign body which had an unusual appearance on chest radiograph.

**Conclusions:** The educational poster will review commonly used surgical instruments which may be retained as foreign bodies. Pictures of these instruments will be included. The radiographic appearance of each of these instruments as a retained foreign body will then be discussed with examples. Images of chest radiographs of patients with retained foreign bodies will be presented. Finally, a case of an unusual appearing retained foreign body will be discussed.

The Anterior Mediastinum: Expanding the Differential Beyond the 4 Ts

KAPROTH-JOSLIN KA, Hobbs SK, Chaturvedi A and Wandtke JC

**Background Information:** The anterior mediastinum contains lymph nodes, thymus, fat, nerves, vessels, and occasionally the thyroid gland, with lesions of this region typically arising from these structures. The commonly taught differential diagnosis for anterior mediastinal masses is the 4 Ts: thymic lesions, terrible lymphoma, teratoma, and thyroid lesions, accounting for the majority of the anterior mediastinal lesions. A careful review of a patient’s past medical history, clinical presentation, and imaging characteristics of the lesion can often lead to an expansion/tailoring of the differential diagnosis which is specific to the patient.

**Educational Goals:** We will review normal anatomy of the anterior mediastinum and its imaging appearance on radiography and CT. We will briefly review the 4 Ts: thymic lesions, terrible lymphoma, teratoma (germ cell tumors), and thyroid lesions. We will then expand the differential diagnosis of the anterior mediastinum with an image rich presentation of less common anterior mediastinal masses & their clinical management, including:

- Neoplastic:
  - Benign: Lipoma, parathyroid adenoma, paraganglioma
  - Malignant: Metastatic disease, liposarcoma, sarcoma, primary lung cancer
- Infectious: Tuberculosis, histoplasmosis, abscess
- Autoimmune/Inflammatory: Sarcoidosis, Castleman’s disease, silicosis
- Traumatic/iatrogenic: Hematoma, complications of endovascular repair, acute mediastinitis
- Congenital: Bronchogenic/pericardial cysts, diaphragmatic hernia
- Other: Idiopathic/drug induced lipomatosis

**Conclusions:** Expanding/tailoring the differential diagnosis of anterior mediastinal masses beyond the 4 Ts is often necessary given a specific patient’s past medical history, clinical presentation, and imaging characteristics of the lesion. Understanding the normal anatomy of the anterior mediastinum, as well as the common and uncommon etiologies which can arise is an important function of the radiologist in guiding the diagnosis and clinical management of these conditions.
**Posterior Mediastinum: A Multimodality Approach**

**OCCHIPINTI M, Heidinger BH, Eisenberg RL and Bankier AA**

**Background Information:** Disorders of the posterior mediastinum include a wide variety of entities, which are a diagnostic challenge in daily clinical practice. To help radiologists master this challenge, many classifications of mediastinal diseases have been proposed, either anatomical or radiological. However, these classifications do not provide all the evidence required to characterize the individual entities and to refer them to appropriate treatment.

**Educational Goals/Teaching Points:**
- To show specific imaging features of individual disorders of the posterior mediastinum, grouped according to the anatomical origin of these disorders: spine and nervous system, vessels, esophagus, lymph nodes, airways, adipose tissue, diaphragm, and extra-thoracic lesions extending into mediastinum.
- To highlight clinical, histological, and imaging characteristics useful in the differential diagnosis.
- To streamline the imaging algorithms for these conditions and to emphasize modality-related answers to morphological questions that can provide more precise diagnostic information. For instance: is there involvement of the epidural space, compression of the spinal cord and nerve roots? Are there calcifications and where are they localized? Is there any sign of intra- or extra-thoracic tumor or inflammatory disease? Has this disorder resulted in any complication?

**Conclusions:** Each imaging modality plays a fundamental role in the detection and characterization of these disorders, answering different morphological questions needed to provide definite diagnostic information. The choice of the best imaging modality to characterize the disorders of posterior mediastinum is fundamental to reduce unnecessary diagnostic workup, costs, and patient distress, as well as to allow an earlier diagnosis and treatment.

**Bubble Trouble - Cystic Lesions of the Thorax: Imaging and Diagnosis**

**THOMAS PJ and Maldjian P**

**Background Information:** Cystic masses within the lungs or mediastinum can be diagnostically challenging for radiologists. This exhibit will review clinical and radiologic features of these lesions, and provide a practical approach for correct diagnosis of specific entities.

**Educational Goals/Teaching Points:** We will review the pertinent features of various cystic lesions of the thorax, including: bronchogenic cyst, esophageal diverticulum, esophageal duplication cyst, diaphragmatic hernia, lateral thoracic meningocele, pancreatic pseudocyst, thymic cyst, pericardial cyst, infected bullae, lung abscess, and cystic neoplasms. Participants will understand the primary clinical and radiologic features useful for distinguishing between these entities. Key imaging features on radiographs, CT, PET/CT and MRI will be presented.

**Conclusions:** Cystic lesions are frequently encountered in imaging studies of the thorax. Knowledge of the clinical and radiologic presentations of these conditions is important for accurate diagnosis and appropriate management.
Myth Busters: Fact versus Fiction Involving Common Contrast Media Questions

PHELAN JA, Mergo P, Restauri N, Vargas D, Suby-Long T, Sachs P and Gladish G

**Background Information:** The use of contrast media is common and often necessary in today’s radiology department. Unfortunately, the potential for adverse reaction exists, ranging from minor to life threatening. Given some events can be severe, individuals (including board certified radiologists) may refrain from using contrast in appropriate situations from longstanding myths concerning contrast material.

**Educational Goals/Teaching Points:** This educational poster is dedicated to addressing and resolving common contrast myths. One example includes appropriate use of contrast in pregnant or breastfeeding patients. Another inaccuracy concerns seafood allergy and administration of IV contrast. One last example includes cross-reactivity between iodinated and gadolinium-based contrast. This exhibit will also touch on types and management of reactions.

**Conclusions:** Contrast may greatly benefit diagnostic capability and should be used when indicated. Accurate knowledge of contrast and side effects aids in protocoling and appropriate use of IV contrast. Alternatively, inappropriate nonuse of contrast should be avoided. Last, if a reaction does occur, we should promptly identify the reaction type and treat accordingly.

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Thoracic Manifestations and Complications of Neurofibromatosis Type 1, From the Benign to the Catastrophic

FENEIS J, Yen A and Brouha S

**Background Information:** Neurofibromatosis (NF) Type 1 is an important genetic disorder with variable widespread clinical manifestations. This exhibit will provide a pictorial review of typical and atypical thoracic manifestations of NF Type 1 with emphasis on chest radiographic and CT features and with pathologic correlation.

**Teaching Points:**
- Introduction/Background on NF Type 1
- Typical Thoracic Manifestations:
  - Skeletal: Scoliosis, ribbon ribs, rib notching
  - Neoplasms: Peripheral neurofibromas, malignant peripheral nerve sheath tumor (MPNST)
- Atypical Thoracic Manifestations:
  - Pulmonary: Fibrosis, bullae
  - Neoplasms: Malignant triton tumor, metastatic disease
  - Vascular: Aneurysms +/- rupture

**Conclusions:** Reviewing complex thoracic manifestations of NF Type 1 may enhance the ability of radiologists to diagnose rare but important complications of typical and atypical presentations, thereby potentially preventing catastrophic sequelae.
Different Patterns of Lung Calcifications and Other High-Attenuation Abnormalities on CT and their Clinical Relevance; A Pictorial Review

FATTOUCH TH, Ghaneie A, Nallamshetty K, Hazelton T and Rojas C

Background Information: Lung calcifications and other high density abnormalities are commonly seen on computed tomography (CT). Pulmonary calcifications are often either dystrophic and metastatic, while other high attenuation pulmonary abnormalities can occur from a wide range of substances and metals ranging from barium to iron to methyl methacrylate. These abnormalities present with different morphologic features, locations and distribution. Understanding the different patterns of lung calcifications and other high-attenuation abnormalities can aid in making an accurate diagnosis and help guide management. In this pictorial review, we will discuss the etiologies, pathophysiology, distribution, morphologic features, relevant imaging findings and differential considerations.

Educational Goals/Teaching Points:
• Describe the different etiologies and pathophysiology of commonly seen lung calcifications and other high-attenuation abnormalities.
• Familiarize the radiologist with the typical imaging features of entity-specific lung calcifications and other high-attenuation abnormalities, which can be idiopathic, infectious, inflammatory, metabolic, vascular or occupational in etiology.
• Identify and describe associated relevant imaging findings to aid in the diagnosis.

Conclusions: Lung calcifications and other high-attenuation abnormalities are commonly seen on CT. These often occur with different infectious, inflammatory, metabolic, vascular or occupational processes. Depending on the etiology, these often have different morphologic imaging features, distribution and associated imaging findings that can aid in the diagnosis of the underlying condition.

Intrathoracic Calcifications, What’s Forgotten from Mundane to Exotic: A Systematic Review of Radiological Facts to Help Guide Interpretation, Diagnosis and Follow Up

VINU NAIR S, Lamus D and Restrepo CS

Background Information: The frequency with which intrathoracic calcifications are encountered on conventional chest radiographs and cross-sectional imaging, make radiologists sometimes overlook those which may indicate a localized disease or even changes of a generalized disease process. Knowledge of the characteristic patterns and locations of intrathoracic calcifications help in establishing accurate diagnosis or even guide follow-up of progression of proven diseases.

Educational Goals/Teaching Points: Intrathoracic calcifications may be a result of harmless sequelae of a remote process or a significant pathological process. Gross calcifications are usually seen on conventional chest radiographs whereas the smaller deposits require further investigations with computed tomography (CT). 5 main patterns are classically recognized:
• Focal parenchymal- Healed infectious/mycotic/parasitic diseases, benign/malignant lesions or lesions with malignant potential, metastasis.
• Diffuse parenchymal- Occupational exposures, autoimmune diseases, inherent diseases – amyloidosis/alveolar microlithiasis, cardiac valve/vascular calcifications, thyroid masses.
• Pleural- Occupational exposures, healed pyo/hemothorax, benign/malignant tumors of pleura.
• Nodal- Old healed infections, malignant lymph nodes.
• Chest wall- Costochondral calcifications, post-traumatic calcifications.

Conclusions: Intrathoracic calcifications occur due to a wide range of abnormalities involving the lung, mediastinum, lymph nodes, pleura and chest wall. In order to categorize what to “bury” within the body of the report and what is worth mentioning in the impression, in-depth knowledge of the patterns and locations of these calcifications is important. This exhibit presents a systematic approach for the radiologist to follow when these intrathoracic calcifications are encountered.
Radiological Spectrum of Lung Hernias


Background information: Lung hernias are relatively rare. Hernias can be seen in conditions associated with increased intrathoracic pressure or reduced resistance offered by the supporting elements of the thorax or both. The main causes are idiopathic, post-infectious, spontaneous, posttraumatic, postoperative and iatrogenic secondary to chest tube insertion. Accordingly, we see intercostal, transcervical, parasternal and transdiaphragmatic lung herniations. They are often discovered incidentally and maybe seen in patients with chronic obstructive airway disease. Lung hernias may lead to complications such as infection and incarceration with ensuing gangrene. All these manifestations have distinct radiological appearances. These patients may present with localized chest pain, fever or hemoptysis. Additionally, lung hernias are prone to trauma themselves.

Teaching Points:
• To study different types of lung hernias
• To discuss the role of radiological imaging including 3D reconstruction in the diagnosis and evaluation of lung hernias and their complications

Conclusion: Lung hernias can be identified on plain radiography; however, MDCT gives exact information about site and size and is the imaging modality of choice to evaluate their potential complications. An attempt is made in this exhibit to discuss radiological appearances and clinical implications of lung hernias.

Down to a “T”: A Compressive Review of Anterior Mediastinal Masses and an Approach to Diagnosis

SCALI E, Donagh C, Karjala G and Sedlic T

Background Information: Anterior mediastinal masses are commonly encountered in daily practice occurring in all age groups in both symptomatic and asymptomatic patients. Traditional teaching focuses on the four “T”s (Thymus, thyroid, teratoma and terrible lymphoma) as the primary differential considerations but there are a variety of cysts and tumors that can occur in this region. The radiologist has an important role in identifying, correctly localizing and accurately characterizing the components of these masses to provide a succinct differential diagnosis. In many cases imaging guided biopsy can provide tissue for definitive diagnosis and treatment planning.

Educational Goals/Teaching Points: After viewing this exhibit the reader will be able to:
• Describe normal mediastinal anatomy and the important radiologic signs used to localize pathology to the anterior mediastinum.
• Discuss the differential diagnosis of anterior mediastinal masses based on age and symptomatology.
• Describe the radiographic and cross-sectional imaging appearance of solid and cystic anterior mediastinal masses.
• Describe characteristic CT and MRI imaging features of anterior mediastinal masses that help to narrow the differential diagnosis.
• Recognize pitfalls in diagnosis including mimics of anterior mediastinal masses.
• Discuss the principles of a safe percutaneous image-guided biopsy.

Conclusions: A diverse variety of pathologies can be encountered in the anterior mediastinum. Although many of these masses have similar imaging appearances, correct anatomical localization and familiarity with characteristic features seen on CT and MRI imaging allow correct diagnosis in many cases.
Thoracic Imaging Findings in IgG4 Related Disease with Clinicopathologic Correlation

MCINNIS MC, Wallace ZS, Lim S, Stone JH and Sharma A

Background Information: IgG4-RD is a rare disorder characterized by an IgG4 positive lymphocytic infiltration. This disease may involve a single organ system or, more commonly, involve multiple organs, resulting in a wide variety of imaging presentations. Diagnosis is frequently delayed due to the protean manifestations of the disease, lack of recognition of IgG4 as a diagnosis and the overlap of findings with other more common illnesses.

Educational Goals/Teaching Points:
- Describe the imaging manifestations of IgG-4-RD in the thorax on thin-section chest computed tomography (CT) and positron emission tomography (PET), in a cohort of IgG4-RD patients treated at a tertiary referral center.
- Divide the findings according to anatomical involvement of the mediastinum, lungs, airways, pleura and pericardium.
- Correlate the radiologic findings with histology obtained in pathology proven cases for each anatomical region.
- Illustrate how IgG4-RD may mimic a variety of benign and malignant thoracic diseases such as lung cancer, lymphoma, infection and interstitial lung disease.

Conclusions: IgG4-RD has a varied presentation in the thorax, and can involve multiple regions including the lungs, airways, pleura, pericardium, or mediastinum. Knowledge of the breadth of thoracic imaging findings is important in recognizing this rare disease.

Complications in the Native Lung Following Unilateral Lung Transplant

CHAN BY, Kanne JP and Meyer CA

Background Information: Single lung transplants improve availability of a limited resource by potentially treating two recipients from a single donor. However, the remaining diseased native lung is predisposed to a number of complications. Although complications in the lung allograft are more common, native lung complications occur frequently with an incidence estimated around 15%. Significant native lung complications are associated with increased post-transplant morbidity and mortality.

Educational Goals/Teaching Points:
1. To discuss the role of single lung transplantation
   - Rationale for single versus bilateral lung transplantation
   - Incidence of single lung transplantation
   - Indications for single lung transplantation
2. To introduce the disadvantages of single lung transplantation
   - Incidence of native lung complication
   - Morbidity:
     - Hyperventilation of native lung
     - Prolonged hospital stay
     - Mechanical ventilation
   - Mortality:
     - Shorter post-transplant survival in patients who develop native lung complications
3. To review imaging presentations of complications primarily or entirely involving the native lung:
   - Infection – bacterial, fungal, and tuberculous
   - Bronchial obstruction and atelectasis
   - Pneumothorax
   - Bronchopleural fistula
   - Pulmonary embolism
   - Pulmonary infarction
   - Malignancy

Conclusions: 1. Although less common compared to complications in the lung allograft, native lung complications are a significant cause of post-transplant morbidity and mortality. 2. Familiarity with the imaging manifestations of disease in the native lung is important for prompt detection of native lung complications.
Radiation-Induced Lung Disease: A Pictorial Review of Multimodality Imaging Findings

HUSSIEN A, Jeudy J and White C

Background Information: Advances in radiotherapy technology (RT) over the last few decades have improved delivery of radiation therapy. It is important for radiologists to be familiar with the radiological findings associated with these advances in order to differentiate expected radiation-induced lung injury (RILD) from recurrence, infection, and other lung disease.

Teaching Points: The purpose of this pictorial review is to illustrate the multimodality imaging findings of the wide spectrum of the RILD and describe alterations of traditional patterns of RILD due to the advent of newer methods of planning and delivering RT including: Three-dimensional (3D) conformal radiation therapy (CRT), stereotactic body radiation therapy (SBRT), 4D CT techniques and proton therapy. 3D CRT and SBRT are designed to deliver the maximum therapeutic radiation dose to the tumor while minimizing irradiation of surrounding normal structures. The complex configuration of the multiple beams that deliver the radiation dose to the tumor in 3D CRT and SBRT produces patterns of lung injury that differ in location and extent from those seen after conventional radiation therapy and varies according to the time elapsed after the completion of therapy. The integration of morphologic information obtained at CT with metabolic information obtained at positron emission tomography is helpful in distinguishing RILD from residual, recurrent, and new cancers.

Conclusions: Radiologic manifestations of RILD can vary according to the RT technique used. Knowledge of this temporal relationship and an understanding of the expected patterns of RILD associated with different RT techniques are needed to suggest a diagnosis of RILD and to differentiate RILD from recurrent tumor or superimposed infection.

Thoracic Manifestations of Primary Histiocytic Disorders

APPIAWIAH N, Browne L, Sirajuddin A, Ocazionez D, Restrepo CS and Vargas D

Background Information: Histiocytic disorders are complex set of disorders in which dendritic cells and macrophages have been implicated. Primary histiocytoses are a heterogeneous group of diseases many of which involve multiple organs. As such, they present a challenging diagnosis for the radiologist, clinician and pathologist. Pulmonary Langerhan’s Cell Histiocytosis (PLCH) is a well-known entity to the thoracic radiologist. Systemic Langerhans Cell Histiocytosis (LCH), although typically seen in children may affect a wide age range. Although most commonly associated with osseous, hepatic and central nervous system involvement, disease affecting the lungs is occasionally seen. Rosai-Dorfman and Erdheim-Chester disease are rare entities, both of which have intrathoracic manifestations.

Teaching points:
• Familiarize the radiologist with the clinical presentation of primary histiocytic disorders
• Illustrate the imaging findings of
• Pulmonary LCH: Upper lobe predominant nodules, bizarre cysts, pneumothorax, pulmonary fibrosis
• Systemic LCH: Cysts, fibrosis, osseous lesions
• Rosai-Dorfman Disease: Mediastinal lymphadenopathy with central FDG avidity, pulmonary nodules, diffuse interstitial involvement, cardiac masses
• Erdheim-Chester Disease: Periaortic/perivascular infiltration, cardiac infiltration, pericardial effusion and/or thickening, symmetric smooth interlobular septal thickening, ill-defined pulmonary nodules, ground glass opacities, upper lobe predominant cysts
• Briefly discuss the role of the radiologist in the management and follow up of these patients

Conclusion: Thoracic radiologists commonly encounter PLCH when imaging young adult smokers and the radiographic and CT findings are well known. The remainder of the spectrum of primary histiocytic disorders is more obscure. These rare diseases may pose a diagnostic challenge to the interpreting radiologist and ordering clinician. The radiologist should be aware of the clinical and imaging presentation of these diseases, and their differential diagnoses.
Pipe Trouble: Pathology of the Tracheobronchial Tree
PATEL M, Knobel A, Walczyszyn M, Palka W and Perone R

Background Information: There are a number of disease processes that can affect the tracheobronchial tree. The involvement can be focal or diffuse depending on the disease process. Patients often present with non-specific symptoms, and cross-sectional imaging can aid in detection and characterization of these entities that are often difficult to diagnose clinically. In many cases, multiplanar imaging and utilization of virtual bronchoscopy can help to further delineate pathology and anatomic variants.

Educational Goals/Teaching Points:
• To review the anatomy and discuss imaging techniques available to evaluate the tracheobronchial tree.
• To discuss anatomic variants and different pathology associated with trachea and the main-stem bronchi.
• Discuss cases of focal diseases and provide correlation with virtual and/or fiber-optic bronchoscopy including: tracheal stricture/stenosis, benign neoplasms, primary malignant neoplasms, secondary malignant neoplasms, tracheoesophageal fistula, tracheal diverticulum, foreign bodies.
• Discuss cases of diffuse disease processes and provide correlation with virtual and/or fiber-optic bronchoscopy of the trachea including Mounier-Kuhn disease, relapsing polychondritis, amyloidosis, tracheopathia osteoplastica, saber-sheath trachea, tracheobronchomalacia, infectious disorders.

Conclusions: Pathology of the tracheobronchial tree can be focal or diffuse. Radiologic imaging is a vital tool in diagnosing pathology that can often present a diagnostic dilemma for clinicians. It can better demonstrate extent of pathology and help characterize lesions prior to bronchoscopy and tissue sampling. In this educational exhibit, it is our aim to highlight the importance of correlating radiological imaging with clinical history, bronchoscopy and histology in achieving an accurate diagnosis.

MRI of the Chest: Where Are We Now?
ZHANG S, Amadi C and Barbosa E

Background Information: MR imaging of the chest was explored initially in the late 1980s. Since then, MRI has evolved into a vital imaging modality for many organ systems; however, MRI of the chest remains one of the most challenging applications due to various obstacles such as respiratory motion, cardiac motion, vascular pulsatility, air susceptibility, and particularly paucity of signal in the aerated lung. More recent technical advances such as multichannel phased-array coils, small flip angle techniques, parallel imaging, partial Fourier acquisitions have allowed MRI to gain ground in thoracic imaging. Currently, MRI is the modality of choice for evaluation of lesions in the mediastinum and in the chest wall, as well as of superior sulcus neoplasms. MRI may also be as valuable as CT for evaluation of pulmonary masses, consolidations and vascular diseases, including pulmonary nodules. CT is still superior to MRI for fine parenchymal interstitial diseases, cystic lung diseases and emphysema.

Educational Goals/Teaching Points: To demonstrate the potential utility of proton MRI in diagnosis and management of thoracic diseases, using clinically available pulse sequences. Upon completion, the participant should be able to:
• Discuss the usefulness of MRI in diagnosing pulmonary nodules/masses, pulmonary infections, its advantages and limitations, and potential application in selected patient populations.
• Assess the role of MRI in the characterization of mediastinal masses and vascular diseases, and its advantages over CT.
• Discuss the scenarios in which MRI adds relevant information to the staging of lung cancer.
• Understand the basic pulse sequences for chest MRI.

Conclusions: MRI is currently able to: depict subcentimeter pulmonary nodules with clinically available pulse sequences; demonstrate pulmonary infections; refine the staging of superior sulcus neoplasms; and better characterize mediastinal masses and vascular diseases.
Trapped and Entrapped Lung: Imaging Manifestations of Unexpandable Lung

KAO SD, Yen A, Thistlethwaite P and Brouha S

Background Information: The term ‘unexpandable lung’ describes failure of visceral and parietal pleural re-adherence due to a variety of etiologies such as pleural disease, airway obstruction, and lung fibrosis. Two types of pleural disease cause unexpandable lung: ‘lung entrapment’ due to active disease such as malignancy or infection/inflammation, and ‘trapped lung’ due to remote inflammation resulting in a fibrous peel.

Educational Goals/Teaching Points: The radiologist should recognize trapped lung and lung entrapment as distinct entities, understand that each portends differing management, know what to expect on imaging, and exclude other causes of unexpandable lung. In lung entrapment, imaging findings depend on the underlying condition but typically show complex pleural effusions (e.g. nodules, loculation, thickening). Incomplete lung expansion is expected post thoracentesis or chest tube placement. In patients that have underlying diseases such as fibrosis, tumor burden, or endobronchial obstruction, treatment is aimed at the underlying parenchymal/bronchial lung disease that limits lung expansion. Pleurectomy and decortication, with the goal of restoring lung volume and function, are reserved for patients that have incomplete lung expansion from chronic pleural effusions, usually from a para-pneumonic process. Trapped lung usually manifests as pleural thickening and loculation, but without clinically active disease. Reduced size of the affected hemithorax is attributable to negative pressures. The pleural effusion is remarkably constant in size over time and will rapidly reaccumulate with thoracentesis. Management is conservative, as most cases are asymptomatic. Decortication is performed to restore lung volume and augment lung function.

Conclusions: Unexpandable lung from pleural disease reflects two distinct pathophysiologic entities that should be recognized and differentiated on imaging whenever possible, given differences in management strategies.

Imaging the Post-Operative Chest Wall

LICHTENBERGER JP, Khorashadi L and Carter BW

Background Information: Many patients with chest wall disorders benefit from surgical intervention, and the available interventions continue to develop and evolve. Modern surgeries range from cosmetic and functional improvement in patients with congenital disorders to curative or palliative treatments in patients with malignant disease of the chest wall. Identifying chest wall surgeries on imaging studies is often the first step in understanding a patient’s underlying disease. Furthermore, the search for chest wall surgical complications often begins with understanding the surgical procedure and devices used.

Educational Goals/Teaching Points:
- Describe and categorize chest wall surgeries based on frequency, clinical indication and desired clinical result.
- Determine the best imaging modality to investigate post-operative complications or to surveil for disease recurrence.
- Recognize the imaging appearance of common chest wall surgeries and the expected anatomic result.
- Anticipate and detect complications of chest wall surgeries and disease recurrence in the case of malignant disease.

Conclusions: The challenge in interpreting post-operative chest imaging studies is twofold: chest wall surgeries are changing and developing and post-operative complications may be difficult to detect. This exhibit will address this challenge by exploring modern chest wall surgeries, focusing on the radiologist’s role in detecting complications and disease recurrence. Ultimately, patient care will be improved by the radiologist’s ability to provide more clinically relevant, informed interpretation.
CT Angiography Illustrating Preoperative Assessment and Postoperative Complications of TAVR

COCHRAN ER, Williams JR and Sandler KL

Background Information: Since 2002, TAVR has allowed patients who were previously considered non-surgical candidates for open aortic valve replacement (AVR) to have their aortic stenosis treated. We have found that thorough preoperative planning including detailed measurements utilizing CT angiography (CTA) are paramount to successful valve replacement. It is the goal of this educational exhibit to define terms and critical measurements that are needed in the pre-procedural assessment of patients, as well as demonstrate some of the more common post-operative complications.

Educational Goals/Teaching Points: CTA is performed from the base of neck to the proximal thigh. Images of the chest are obtained with cardiac gating to best evaluate the aortic annulus and aortic root. The radiologist may then:
- Describe iliac, subclavian, and aortic anatomy, including tortuosity, calcifications, presence of significant stenosis and length of stenosis.
- Describe the ascending aorta-LVOT angle, as a more obtuse angle makes implantation more favorable.
- Determine the location of the annular plane and report the annular long axis, short axis, perimeter, and area.
- Measure the left and right annular-ostial distances, assess adequacy of the coronaries, and assess the size of the aortic root.
- Postoperative CTA images will be provided to illustrate common complications of the procedure, particularly those relating to injury of access vessels.

Conclusions: TAVR has provided a unique opportunity to treat aortic stenosis in patients who were previously felt to be inoperable. Obtaining detailed measurements of the aortic annulus and access vessels with CTA is essential to provide the best preoperative assessment and to avoid common postoperative complications.

Microwave Tumor Ablation: How We Do It

CAMPOS LA and Healey T

Background Information: Lung cancer is a leading cause of cancer-related death and surgical resection is the gold standard treatment. Over the past decade image-guided ablation therapies have emerged as a minimally invasive treatment option for patients who are poor surgical candidates. Microwave ablation has many advantages over radiofrequency ablation. The data behind microwave ablation has been supportive and the number of these procedures being performed is increasing with multiple radiology departments now incorporating this cutting edge option for their patients. At Rhode Island Hospital, we were the first in the world to use microwave ablation to destroy lung tumors and have established a busy yet efficient ablation service. We have learned that establishing an ablation service requires much more than mere technical capability and appropriate equipment in order to provide the best possible outcomes for our patients and to maintain a steady referral stream.

Educational Information/Teaching Points: Our goal is to provide practicing radiologists an example of steps necessary in developing a new tumor ablation service. This will entail proper patient selection, pre-procedure planning and patient education, necessary procedural devices, optimal technique, post procedure monitoring, preparedness for complications, adverse effects, long term care and follow-up.

Conclusion: Microwave ablation is a viable treatment option for primary lung malignancies and metastases. Establishment of a microwave ablation service requires the development of a clinical service which runs like any other clinical service in medicine and will require a full team in order to succeed. Identifying administrative staff, mid-level caretakers, nurses capable of administering conscious sedation and post procedural monitoring will be crucial.
Radiographic Identification of BioSentry Tract Sealant Plug on Post Procedural Imaging after Percutaneous Transthoracic CT Needle Biopsy

GRAGE RA, Keogh S and Naveed MA

Purpose: It has been shown that by using a BioSentry® Tract Sealant System, a dehydrated hydrogel plug, placed in the needle tract after a computed tomography (CT) guided percutaneous core biopsy of the lung with a coaxial needle technique, pneumothorax and chest tube placement are reduced. Understanding the radiographic appearance of this plug on subsequent cross sectional imaging is necessary to differentiate this plug from new disease.

Method: Seventy-five patients that had undergone a CT-guided percutaneous core biopsy had follow up with CT cross-sectional imaging. All patients had been treated with the BioSentry Tract Sealant System during their lung biopsy procedure. CT scans were reviewed by one radiologist.

Result: Seventy-five patients had subsequent imaging that confirms the plug in the lung parenchyma. Results will be shown on identification of the plug vs. lung nodule.

Conclusion: It is important for radiologists to be able to identify the BioSentry® Tract Sealant Device being used to reduce complications associated with percutaneous core biopsies of the lung vs other potential nodules developing in the lung. Presented here are the radiographic appearances of the plug on subsequent imaging.

Image Guided Diagnosis and IR Guided Management of Common and Uncommon Causes of Hemoptysis

GUL M, Chaudhry A, Ferretti J and Moore W

Background Information: Hemoptysis is the expectoration of blood that originates from airways or lung ranging from blood-streaked sputum to gross blood. In-hospital mortality risk factors include: Mechanical ventilation, airspace opacities involving two or more quadrants on admission chest radiograph, bleeding from the pulmonary artery, cancer, aspergillosis, and alcoholism. Initial management revolves around: Airway, breathing, circulation, etc. Airway protection is the chief concern and there should be a low threshold for intubation. The next step is to identify the source of hemorrhage and the most common causes of massive hemoptysis (bronchiectasis, infection (TB, aspergilloma) and lung cancer) should be considered. The majority of cases have an identifiable etiology with bronchial arteries the most common source of bleeding. Bronchial artery embolization (BAE) is often regarded as the therapeutic method of choice for the management of massive hemoptysis.

Teaching Points:
1. Pictorial review of bronchial anatomy and discussion of common variants.
2. Case based review highlighting common and uncommon causes of hemoptysis.
3. Discuss different interventional radiology guided treatment options/techniques and prognosis of the above entities.

Conclusion: Massive hemoptysis is a potentially life-threatening clinical entity requiring prompt diagnosis and treatment. Management of moderate to massive hemoptysis requires a team-based approach with early intervention through bronchial artery embolization. Understanding of bronchial anatomy and the various entities that result in hemoptysis will aid in faster diagnosis and treatment, thereby improving patient morbidity and mortality. Occasionally, recurrent hemoptysis requires identification and embolization of nonbronchial arteries and/or collateral branches to achieve high clinical success in controlling hemoptysis.
Dose Reduction in the Age of Reform: Anatomy of Successful Quality Initiatives

PFEIFER CM and St. Clair S

Background Information: As the healthcare climate has shifted and prompted physicians to become more aware of the value of their services than ever before, the American Board of Radiology has deployed this lexicon into new examinations used for certification and maintenance of certification. Also incumbent upon radiologists is the need to adhere to proper dose modulation as we move toward an environment of meaningful use and patient-accessible medical records.

Educational Goals: This presentation will describe language employed in Six Sigma process improvement algorithms as well as Lean manufacturing principles as these elements apply to modern-day thoracic radiology. Recent successes at our institution in dose reduction through proper radiographic collimation of chest radiographs and low-dose computed tomography protocols will be detailed in addition to education of ordering clinicians regarding the American College of Radiology Appropriateness criteria. The definition of critical-to-quality metrics will be discussed as well as a description of thoracic-radiology-relevant Lean wastes. A physician-initiated transition to paperless medical records highlights improvements in turnaround times which has led to faster availability of results and a positive impact on medical care.

Conclusions: Using Quality Improvement language, this presentation demonstrates proper usage of the terminology now required of radiologists seeking board certification and re-certification. Methods to improve value as thoracic radiologists are emphasized.

Radiologic Features of Infectious Aspergillosis: A Case Based Review

SEDAGHAT F and Chudow C

Background Information: Aspergillosis is a mycotic disease caused by mold of the Aspergillus species (most commonly A. Fumigatus). Aspergillus is frequently encountered, commonly found in decaying leaves and old building materials. Inhalation of aspergillus spores rarely causes infection in healthy, immunocompetent individuals. However, in the setting of immunodeficiency or underlying cavitary pulmonary disease aspergillosis may result in a life threatening pathology.

Educational Goals/Teaching Points: There are multiple forms of infectious aspergillosis with variable imaging features. By recognizing predisposing factors to aspergillus infection and the disease’s imaging and clinical manifestations, radiologists can expedite appropriate testing and therapy. Utilizing a case based review we aim to help radiologists:
• Identify the four subtypes of infectious aspergillosis.
• Recognize characterisitic imaging and clinical findings for each subtype.
• Formulate clinically relevant differential diagnoses for suspected cases of infectious aspergillosis.

Conclusions:
• Aspergillosis, while a rare cause of disease in immune competent individuals, is frequently encountered in immunocompromised patients and those with underlying cavitary pulmonary disease.
• Saprophytic (aspergilloma) and angioinvasive aspergillosis produce classic imaging findings (the Monad and halo signs, respectively). These signs are fairly specific and in the appropriate clinical setting should always raise concern for pulmonary aspergillosis.
• Air-way invasive and semi-invasive (chronic necrotizing) aspergillosis produce non-specific imaging findings (tree and bud/centrilobular nodules and cavitary lesions, respectively). Infectious aspergillosis should be considered when these imaging patterns are seen in the setting of immunodeficiency.
It’s A Zoo: A Radiologic Review of Thoracic Zoonotic Infections in the United States

RICHARDS JC, Vargas D, Suby-Long T and Restrepo CS

Background Information: In the past months, news outlets have reported various zoonotic infections such as Ebola and pneumonic plague, which has lead to heightened awareness amongst both the general public and healthcare professionals. The manifestations of zoonotic infections in thoracic imaging is an interesting but poorly described topic. However, by understanding the geographic and demographic background of such infections, the radiologist will be more aware and include a zoonotic infection in the differential diagnosis when appropriate.

Educational Goals/Teaching Points: Identify the common and uncommon zoonotic infections in the United States, with particular attention to those which have thoracic manifestations. Describe the geographic and demographic tendencies for zoonotic infections. Describe “host” species for each infection. Demonstrate imaging examples of specific infections such as pneumonic plague, hantavirus, etc., with provided clinical history.

Conclusion: With heightened awareness of zoonotic infections in the United States, the radiologist needs to be aware of both common and uncommon zoonotic infections with their radiologic manifestations, geographic and demographic tendencies, in order to include such a diagnosis in the differential when appropriate.

Don’t Slack on MAC – A Pictorial Essay on the Spectrum of Imaging Manifestations of Pulmonary Non-Tuberculosis Mycobacterium Infections in the Immunocompetent and in the Immunocompromised

WONG M, Ferra M, Walczyszyn M, Mina B and Perone RW

Background Information: Non-tuberculous mycobacterial infections are a relatively newer discovery compared to their better known counterpart - Mycobacterium tuberculosis. Due to its increasing prevalence in the non-AIDS population, there has been recent emphasis on non-tuberculous mycobacterial infections with the American Thoracic Society and Infectious Diseases Society of America releasing diagnostic guidelines in their joint official statement in 2007, emphasizing the role of radiological as well as microbiological findings for establishing accurate diagnosis. However, radiological presentation of non-tuberculous mycobacterial lung disease varies widely depending on the comorbidities of the affected patient and can be divided into subtypes depending on immunocompetency. In this poster, our goal is to present a pictorial essay on the different presentations of non-tuberculous mycobacterial lung disease in the hope of bringing greater awareness and diagnostic acumen of the radiologist to this disease entity.

Educational Goals:
• To discuss the epidemiology and pathophysiology of pulmonary non-tuberculous mycobacterial (NTMI) infections.
• To review the three basic imaging patterns of pulmonary NTMI in immunocompetent patients through a pictorial essay with attention to High Resolution CT(HRCT) findings.
• To compare and contrast the imaging appearances of pulmonary NTMI in the immunocompetent and immunocompromised hosts.

Conclusion: It is critical for the radiologist to recognize the different imaging presentations of NTMI on HRCT in order to promptly direct the clinician attention to this disease entity whose prevalence is increasing and clinical presentation often subtle and nonspecific.
Spectrum of Thoracic Extranodal Non-Hodgkin Lymphoma: Detection Strategies and Problem-Solving

BLIGH MP, Borgaonkar J, Burrell S and Manos D

Background information: Extranodal non-Hodgkin lymphoma (NHL) commonly involves thoracic sites. Manifestations of disease are highly variable, particularly in the lungs. Patients with lymphoma may be immunosuppressed and at risk for atypical infections and treatment-related inflammatory conditions. Distinguishing extranodal lymphoma from benign entities can be challenging. However, accurate diagnosis is important for staging and therapy. We review the typical and unusual imaging manifestations of NHL in the lung, pleura, heart, pericardium, tracheobronchial tract, esophagus, chest wall and breast with emphasis on computed tomography (CT). We describe strategies for characterizing indeterminate lesions where diagnosis may affect management.

Education Goals/Teaching Points:
• Pulmonary NHL manifestations include ground glass opacity, consolidation, focal or diffuse nodularity, interstitial thickening or combined patterns. Some NHL subtypes show predilection for certain patterns.
• Pleural effusion associated with nodal disease is usually benign and related to lymphatic obstruction. Associated pleural thickening increases the likelihood of malignant effusion.
• Pericardial effusion usually signifies malignant involvement and is often associated with solid pericardial disease.
• Chest wall invasion related to nodal or pleural NHL is uncommon but should be carefully excluded as it may affect staging.
• Further imaging or endoscopic/percutaneous tissue sampling may be helpful for diagnosis of indeterminate lesions depending on site of involvement and impact on management.

Conclusions:
• Pulmonary NHL manifests variably but morphology and associated clues can support diagnosis.
• Search strategies and checklists are helpful to detect subtle disease in the chest wall, pleura and pericardium.
• Familiarity with available diagnostic problem-solving tools is important to direct workup of uncertain extranodal findings.

Imaging Assessment after Multimodality Therapy in Esophageal Carcinoma

CARTER BW, Palacio D, Truong MT and Betancourt SL

Background Information: CT and PET/CT are useful in assessing response after multimodality therapy for advanced esophageal carcinoma. Interpretation of these examinations is optimized by knowledge of the potential complications associated with surgery, chemotherapy, and radiation therapy performed as part of the treatment regimen for esophageal carcinoma. The most common post-surgical complications include anastomotic leak, stricture, and functional conduit disorders. Complications of chemotherapy and radiation therapy are more diverse and include cardiovascular (pericardial effusion and cardiomyopathy), pulmonary (diffuse alveolar damage, nonspecific interstitial pneumonitis, organizing pneumonia, and radiation-induced lung disease), pleural (pleural effusion and esophagopleural fistula), esophageal (esophagitis, esophageal stenosis, and esophageal ulceration), and upper abdominal abnormalities.

Educational Goals/Teaching Points: To describe and review the CT and PET/CT findings of complications associated with surgery, chemotherapy, and radiation therapy in patients with esophageal carcinoma.

Conclusions: Awareness of the spectrum of appearances of complications following surgery, chemotherapy, and radiation therapy for esophageal carcinoma is important in preventing misinterpretation.
Imaging of Primary Thoracic Sarcomas

CARTER BW, de Groot PM, Shroff G, Little BP, Betancourt SL and Gladish GW

Background Information: Primary thoracic sarcomas are rare neoplasms that may arise from the lungs, pleura, mediastinum, or chest wall. These lesions can only be diagnosed once sarcoma-like primary pulmonary tumors and metastatic disease have been excluded. In general, most thoracic sarcomas manifest as large, heterogeneous masses. However, a wide range of imaging presentations on CT and MRI has been described, and tumors may manifest as solitary pulmonary nodules, endobronchial lesions, and intravascular filling defects. A combination of clinical and imaging features can often be used to generate focused differential diagnoses and guide further management.

Educational Goals/Teaching Points:
- Review the incidence and etiology of uncommon sarcomas that occur in the chest.
- Identify key features of specific tumors across multiple imaging modalities.
- Utilize clinical and radiologic information to generate focused differential diagnoses.
- Summarize basic treatment strategies employed in the management of thoracic sarcomas.
- Understand the role of thoracic imaging in the evaluation of chest wall neoplasms.

Conclusions: Primary thoracic sarcomas are rare primary tumors with which many radiologists may be unfamiliar. An understanding of the various imaging presentations of these neoplasms across multiple imaging modalities is necessary to guide appropriate patient management.

Pulmonary Arterial Filling Defects Behaving Badly: Pulmonary Artery Sarcoma

MALONE CD, McKee JM, Brouha S, Koning J, Johnston M and Yen A

Background Information: Pulmonary artery sarcomas (PAS) are rare but lethal tumors that can mimic large pulmonary thromboemboli (PE). Symptoms, including dyspnea, chest pain, and cough, are similar to PE and have been reported to persist 3-13 months before diagnosis, likely due to original misdiagnosis. As median survival is improved with curative resection versus palliative resection in more advanced cases, it is essential that the radiologist have a high index of suspicion for PAS in order to avoid delay in diagnosis.

Educational Goals: This exhibit will review the appearances of PAS across different imaging modalities and highlight findings that help differentiate PAS from PE. Both PAS and PE demonstrate pulmonary arterial filling defects on computed tomography (CT). However, PAS more often occupies the entire lumen of a main or proximal pulmonary artery, expands or invades the arterial wall, exhibits heterogeneous attenuation, and may have concurrent metastatic lung disease. Magnetic resonance imaging (MR) with gadolinium shows delayed enhancement of the filling defect, although this is variable depending on the amount of tumor necrosis. Diffusion-weighted imaging (DWI) may show restricted diffusion of the filling defect and any lung metastases. PAS demonstrates increased uptake on positron emission tomography (PET) compared to PE, although septic emboli and tumor emboli from other primaries may also show increased uptake. Finally, suspicion should be raised for PAS when a filling defect persists or increases in size on follow up imaging despite proper anticoagulation therapy.

Conclusions: PAS often mimics PE in clinical presentation and appearance on imaging. Suspicious features on CT warrant further workup with PET/CT and/or contrast enhanced MR with DWI.
Pitfalls in Interpretation of Oncologic Thoracic PET/CT

MEIRELLES G, Capobianco J and Oliveira M

Background Information: PET/CT imaging is now an integral part of the management of patients with thoracic neoplasms, improving staging, therapy control and prognostic assessment of these patients. However, many artifacts and pitfalls can be seen on the examination, like normal variants, physiologic areas of 18F-fluoro-2-deoxy-D-glucose (FDG) uptake, acquisition or reconstruction artifacts, false-positive and false-negative findings.

Educational Goals/Teaching Points: The main teaching points of this exhibit are to describe and illustrate the main pitfalls and artifacts in the interpretation of oncologic thoracic PET/CT examinations, including false-negative and false-positive findings, and to present strategies for avoiding misinterpretation of oncologic thoracic PET/CT examinations. The authors will illustrate the physiologic uptake of FDG, normal variants, artifacts (misregistration, truncation, FDG embolism and extravasation), potential pitfalls, like brown-fat FDG uptake, lipomatous hypertrophy of the interatrial septum, pleural uptake related to talc pleurodesis, radiation-induced injuries, iatrogenic causes of FDG uptake, muscular FDG uptake, FDG uptake induced by G-CSF and EPO, false-negative results (small lesions, mucinous tumors, adenocarcinomas in situ and minimally invasive tumors) and false-positive findings, such as infectious processes, atherosclerosis and granulomatous diseases (like sarcoid).

Conclusions: Awareness of normal FDG distribution, physiological uptake and variants is mandatory before interpreting oncologic thoracic PET/CT examinations. False-positive and false-negative findings can be avoided with knowledge of their main aspects and by careful interpretation of CT and PET findings. When these points are well known by the radiologist, PET/CT is a powerful imaging technique for characterizing pulmonary lesions, providing accurate staging for lung neoplasms and contributing for therapy control and assessment of patient prognosis.

Atypical Pulmonary Metastasis: Not so Atypical After All

SHEERAN D and Bueno J

Background Information: The typical patterns of pulmonary metastatic disease are well defined and recognized as multiple solid pulmonary nodules due to hematogenous dissemination, and lymphangitic carcinomatosis. Various systemic neoplasms are known to also cause “atypical” pulmonary metastasis more frequently than others. Recognition of this atypical presentation is not always easy and can be commonly initially misdiagnosed as non-neoplastic entities such as infection, sequela from granulomatous disease, pulmonary embolism, or other benign entities. Such a misdiagnosis can lead to a suboptimal delay in diagnosis and treatment. Recognition of these less frequent patterns is essential, and radiologists should be familiar with the more common neoplastic entities causing atypical metastasis and the variable imaging presentations.

Educational Goals/Teaching Points: After reviewing this presentation, the learner will be able to 1) list frequent pathologies associated with atypical pulmonary metastasis such as squamous cell carcinoma of the head and neck, sarcomas, adenocarcinoma of the GI tract, choriocarcinoma, breast and colon carcinoma, melanoma, and renal cell carcinoma; 2) recognize the main patterns of atypical pulmonary metastatic disease, as follows: cavitation, calcification, CT halo sign, consolidation, tumor embolism and endobronchial metastasis; 3) list the most common mimickers of atypical metastatic disease, such as fungal infection, post transplant lymphoproliferative disease (PTLD), organizing pneumonia, and second primary neoplasms.

Conclusions: Recognition of the wide variety of patterns of pulmonary metastatic disease is essential for the general and subspecialized radiologist, as it will reduce the delay in diagnosis and optimize patient treatment regimens and outcomes. Although these type of manifestations are known as “atypical”, the reality is they are commonly seen as typical pattern of metastasis in a well-defined group of neoplasms.
Untie the “Knot”: Pictorial Review of Thoracic Extranodal Lymphomas

TSAI EB, Patel MK and Jude CM

Background Information: Thoracic extranodal lymphoma is defined as lymphomatous infiltration of non-nodal tissue and may occur as primary or secondary involvement. Primary extranodal lymphomas present with the main bulk of the disease at an extranodal site and may involve that site’s contiguous lymph node group. They are most commonly non-Hodgkin lymphomas. Secondary extranodal involvement may occur with both Hodgkin and non-Hodgkin disease. Extranodal thoracic lymphomas may involve any site in the thorax, including thymus, lung, pleura, heart and pericardium, esophagus, thyroid, breast, chest wall and thoracic spine. Recognition of primary versus secondary lymphomatous involvement of thoracic organs has therapeutic implications.

Educational Goals/Teaching Points: The purpose of this presentation is to:
- Illustrate the spectrum of thoracic extranodal lymphomas.
- Review the role of cross-sectional imaging for diagnosis, staging and follow-up.
- Discuss relevant clinical features and prognosis.

Conclusions: Primary extranodal thoracic lymphomas have distinct clinical, radiological and pathological features. Specific imaging findings and patterns of spread are encountered in some primary entities. Secondary extranodal lymphomas have the bulk of the disease separate from the non-nodal site. Recognition of primary versus secondary lymphomatous involvement of thoracic organs has prognostic and therapeutic implications.

ACR LungRADS: Structured Reporting and Management for CT Lung Cancer Screening

VUMMIDI DR, Kazerooni E and Quint L

Background Information: Lung cancer is the leading cause of cancer-related death in the United States. The National Lung Screening Trial (NLST) demonstrated that low dose CT screening significantly and cost effectively reduces lung cancer specific mortality. The United States Preventative Services Task Force’s favorable grade “B” recommendation may result in lung cancer screening becoming a covered benefit from January 2015 under the Affordable care act. The American College of Radiology LungRADS is a structured reporting and audit tool designed to help practice appropriate, safe and quality lung cancer CT screening.

Methods: This exhibit will describe and illustrate the LungRADS reporting categories and management, which are based primarily on nodule size, consistency (solid, part solid or non-solid) and growth. There are 5 LungRADS categories, 0 through 4 based on the highest risk finding with two modifiers, S and C, as follows:
- 0: Incomplete examination or evaluation.
- 1: No nodules and definitely benign nodules.
- 2: Nodules with a very low likelihood of becoming a clinically active cancer (negative screen), for which the recommended management is to continue annual screening.
- 3: Probably benign finding(s) and includes nodules with a low likelihood of becoming a clinically active cancer for which the recommended management is a 6 month interval CT.
- 4A: Higher risk nodule for which a 3-month interval CT is recommended. If unchanged or smaller, patients are referred back to their annual screening calendar.
- 4B: Highest risk nodules for which CT with or without contrast, PET-CT and/ or tissue sampling is recommended.
- S: Other clinically significant or potentially significant findings.
- C: Prior diagnosis of lung cancer and is disease free, having returned to annual screening.

Conclusion: Widespread adoption of LungRADS can maximize the benefits of lung cancer CT screening using standard nomenclature for reporting and data collection that can be used to benchmark radiologist performance and ensure that safe, quality CT screening is available to the public.
Imaging of Pulmonary Tuberculosis in The New Century

ZHANG S, Amadi C and Gupta N

Background Information: The role of imaging in tuberculosis (TB) has shown exponential growth, as in all spheres of medicine. While any organ of the body can be involved by TB, the lung remains the most commonly involved organ. The possibility of a tubercular etiology is often first suggested on an imaging study and undiagnosed TB can be detrimental to individual as well as society. In a known case of TB, imaging not only assess the extent of disease including guiding aspirations and biopsies but also extremely helpful in its subsequent management. Imaging also plays a tremendous role in therapeutic drainage of pathological tubercular collections.

Educational Goals/Teaching Points: The purpose of this exhibit is to demonstrate the various imaging characteristics of pulmonary TB and update on new imaging application in this entity. On review of this exhibit, the participants should be able to:

- Recognize and understand the common and uncommon radiologic findings of pulmonary tuberculosis including complications such as bronchopleural fistula and Rasmussen aneurysm.
- Recognize radiological features such as primary vs post-primary, and active vs inactive TB.
- Discuss features of pulmonary TB in HIV positive patients.
- Discuss the usefulness of PET/CT in management of pulmonary TB describing different patterns on PET/CT.

Conclusions: While chest radiograph remains the initial modality for suspected TB, chest CT is the modality of choice for further characterizing the disease with possibility to differentiate primary vs post-primary and active vs inactive TB. MRI may be of use in selected patient group such as pediatric patients due to lack of ionizing radiation. Recent PET/CT utilization in TB may improve the diagnostic imaging sensitivity and specificity, and may help in assessing the lesion activity, as well as extent of the disease and treatment response.

Current Concepts in Lung Transplant Rejection: Clinical, Radiographic, and Pathologic

CLAYTON J, Singer J, Kanne JP, Jones KD, Chung JH and Elicker BM

Background information: Complications following lung transplantation remain common in large part as a result of the high incidence of acute and chronic rejection. Imaging, in particular high-resolution CT, plays a key role in the diagnosis and management of transplant recipients with suspected rejection. Recent advances have provided new insights into the different manifestations of rejection.

Educational Goals/Teaching Points: The goal of this exhibit is to explore the spectrum of clinical, radiographic, and pathologic features associated with acute and chronic rejection. Specific topics include:

- List the major indications for lung transplant
- Explain routine surveillance regimens in transplant recipients
- Review the main differences between acute and chronic rejection
- Explore how a diagnosis of rejection impacts treatment
- Describe the features of acute cellular rejection including:
  - Clinical features
  - Pathologic features and grading
  - Radiographic appearance including differential diagnosis
- Discuss antibody mediated rejection
- Describe the clinical, radiographic, and pathologic features of bronchiolitis obliterans syndrome (the classic form of chronic rejection)
- Detail newly described phenotypes of chronic rejection including restrictive allograft syndrome and acute fibrinous and organizing pneumonia

The ultimate goal is to synthesize clinical, laboratory, pathologic, and imaging data into a clear and coherent picture in surveillance of lung transplant recipients.

Conclusions: Acute and chronic rejection are major complications of lung transplantation for which radiologists should have a clear understanding of the spectrum of manifestations and the importance of a multidisciplinary approach to diagnosis and treatment.
Imaging of the Cardiothoracic Manifestations of Vasculitis: Pearls and Pitfalls

BHATTI ZS, Vummidi D and Singer O

**Background Information:** Vasculitides are a rare but serious group of inflammatory disorders affecting large, medium, and small vessels throughout the body, producing a vast array of clinical manifestations. Many of these disorders invariably affect cardiothoracic structures to varying degrees. Accordingly, cardiothoracic imaging of vasculitis demonstrates a remarkably wide spectrum of overlapping imaging patterns, ranging from aortic mural thickening to cavitary pulmonary nodules. Since clinical features are often nonspecific and cardiothoracic imaging features are heterogeneous, differentiation of vasculitides can be challenging for radiologists and other healthcare professionals.

**Educational Goals/Teaching Points:** The goals of this educational exhibit are:
1) To review the revised Chapel Hill Consensus classification of vasculitis.
2) To discuss the clinical and imaging manifestation of the most common vasculitides, with emphasis on cardiothoracic involvement.
   • Large Vessel: Takayasu’s disease, Giant cell arteritis
   • Medium Vessel: Polyarteritis nodosa, Behcet’s disease
   • Small Vessel: Granulomatous polyangitis, Eosinophilic granulomatous polyangitis, Microscopic polyangitis
3) To highlight pearls and pitfalls in the radiologic diagnosis of vasculitides with illustrative examples.
4) To propose a diagnostic algorithm, integrating imaging features with clinical history, laboratory data, and histopathology.

**Conclusions:** Vasculitides are a heterogeneous group of disorders with frequently confusing overlapping clinical and imaging features. A systematic approach that integrates clinical, laboratory, and histopathologic findings with radiologic appearances is crucial to arriving at an accurate diagnosis.

Rings and Slings through the Ages

LEB JS, Rezai Gharai L, Haramati LB and Blumfield E

**Background Information:** Vascular rings and slings are terms which refer to the abnormal development of vascular and often ligamentous structures, derived either from the ventral or dorsal embryonic vascular arches or from the branchial arches connecting them. Rings and slings may cause variable encirclement or compression of either the trachea alone or the trachea and esophagus. Multimodality imaging is commonly utilized for the diagnosis and several different anatomic variants exist. These abnormalities encompass approximately 1% of congenital cardiovascular anomalies and with the increase in cardiothoracic cross sectional imaging, more cases and variants are being encountered. It is therefore essential for every cardiothoracic imager to have a basic understanding of these entities and their different manifestations.

**Educational Goals/Teaching Points:** The purpose of this exhibit is to review the common and rare types of vascular rings and slings, the proposed embryology behind their development, their imaging appearances, the role imaging plays in their evaluation and the appropriate imaging algorithm that should be utilized. Emphasis will be placed on presentations at various ages and less common anomalies. Cases will include: 1. Right aortic arch with an aberrant left subclavian artery; 2. Double aortic arch with an atretic left arch; 3. Right aortic arch with a left-sided ligamentum arteriosum originating from an aortic diverticulum; 4. Circumflex retro-esophageal aortic arch; 5. Pulmonary sling with symptomatic tracheal stenosis.

**Conclusions:** Vascular rings and slings present at all ages. Understanding the embryology, and the varied clinical and imaging presentations is key for radiologists to accurately diagnose any “ring” that may be “slung” their way.
Pulmonary Artery Involvement in Acute Aortic Syndrome

MANN H, Henry T and Kanne J

Background Information: When an acute aortic syndrome involves the presence of an acute intramural hematoma in the proximal ascending aorta, the presence of a “shared” adventitia between the aorta and pulmonary artery permits the extension of the hematoma into the pulmonary artery wall. This may result in subtle-to-substantial deformation and narrowing of the pulmonary artery lumen, sometimes simulating acute pulmonary embolism. When mediastinal hemorrhage occurs in the acute aortic syndrome there may be retrograde dissection of blood into the lung along the broncho-arterial sheaths, producing findings that may be confusing to those not familiar with its appearance.

Educational Goals/Teaching Points:
- Explain and illustrate the relevant anatomy contributing to these phenomena.
- Use clinical cases to demonstrate the findings on computed tomography examinations.
- Clarify the nature of the findings that may lead to false-positive interpretations of primary pulmonary artery pathologic conditions.

Conclusions: This exhibit will demonstrate unusual involvement of proximal pulmonary arteries in the acute aortic syndrome

Alternative Diagnoses Found on Pulmonary Embolism MRA

NAGLE SK, Reeder SB, François CJ, Grist TM, Bannas P and Schiebler ML

Background Information: Pulmonary embolism magnetic resonance angiography (PE-MRA) can be used as an alternative to computed tomography angiography (CTA) for patients with renal failure or at increased risk of radiation-induced malignancy. However, one of the barriers to acceptance of PE-MRA by cardiothoracic radiologists is the perception that PE-MRA cannot identify the relevant alternative diagnoses that can be identified during CTA. Based upon a clinical experience of more than 700 clinical PE-MRA studies over the last 7 years, we have learned that PE-MRA is not only an excellent alternative to CTA but that it shows alternative diagnoses surprisingly well.

Educational Goals: This educational poster illustrates the many alternative diagnoses that can be identified on PE-MRA. These include rib fracture, pneumonia, pulmonary abscess, breast mass, portal venous thrombosis, peritoneal metastases, pleural effusion, septic emboli, and pericarditis. In many cases, the lesion conspicuity on MRA is greater than on CTA. Specific goals:
- Familiarize the cardiothoracic radiologist with the appearance of several alternative diagnoses to pulmonary embolism on PE-MRA
- Describe the key pulse sequences used for PE-MRA
- Describe the utility of each of these sequences in identifying alternative diagnoses

Conclusion: Many alternative diagnoses to pulmonary embolism can, in fact, be easily identified on PE-MRA. This concern should not be a major factor in deciding whether to use CTA or MRA for the diagnosis of pulmonary embolism.
Test Bolus for CTPA: What Else Can We Learn?

SAWLANI RN, Baruah D, Goodman L, Lath C, Fuhrman K and Shahir K

**Background Information:** The test bolus for CT pulmonary angiography is an often-overlooked sequence that is both essential to troubleshooting study quality and may contain valuable clinical information in patients with pulmonary hypertension.

**Educational Goals/Teaching Points:** This educational poster will review the literature as well as provide our current state of clinical practice in the technical management of the test bolus on pulmonary embolus studies. The current standard of adding a fixed time to the peak of the test bolus was outlined in the literature in 2003, but CT technology has since made significant advances. More recently, our institution has found that utilizing pulmonary transit time (peak of ascending aorta to peak of pulmonary artery) and assessing for hemodilution (HU ascending aorta vs. HU pulmonary artery) are helpful in attaining optimal pulmonary arterial opacification with reduced contrast dose. The test bolus may also contain valuable prognostic data in patients with pulmonary hypertension. In a recent article from *Pulmonary Circulation*, pulmonary arterial transit time and full-width half maximum of the bolus first pass demonstrated a strong correlation with adverse outcomes, cardiac index, and pulmonary vascular resistance index in patients with pulmonary hypertension. At our institution, pilot observational data demonstrate that similar information can be extracted from pulmonary arterial CT test bolus images. Preliminary data will be presented from a retrospective review of patients with known pulmonary hypertension.

**Conclusions:** After viewing our poster, the reader will have an updated perspective on bolus timing to produce high quality CT pulmonary angiography studies as well as a look at the potential future of dynamic pulmonary artery imaging in the evaluation of pulmonary hypertension.

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CT Measurement of Central Pulmonary Arteries to Diagnose Pulmonary Hypertension (PHTN): More Reliable than Valid?

TERPENNING S, Ketai L, Lin CT, Kligerman S and Jeudy J

**Objective:** To verify the accuracy of CT measurement of main PA diameter > 3.15 cm in diagnosis of PHTN, determine inter-rater agreement for this measurement and determine whether addition of RPA or LPA measurement improves accuracy.

**Materials and Methods:** Retrospective review identified 95 patients who underwent chest CTs within 3 months of cardiac catheterization between January 2010 and December 2012. Three cardiothoracic radiologists with different levels of experiences measured MPA, RPA and LPA diameters on CTs performed on 45 normal and 50 PHTN (mean MPA pressure > 25 mmHg) patients. Groups were similar in age (56 ± 14 and 54 ± 14). Readers were blinded to catheterization data and other reader’s measurements.

**Results:** Using 3.15 cm main MPA diameter as a threshold, reader sensitivities for PHTN were 76%, 74% and 74% and specificities of 60%, 62% and 71%. Per-case inter-rater agreement was good, kappa values > 0.65. Body surface area did not differ between false positive (2.1 ± .4) and true negative patients (2.0 ± .3). Incorporation of RPA or LPA diameter > 2.2 cm to detect PHTN increased the sensitivities to 90%, 90% and 94% but degraded specificities to 36%, 29% and 33%.

**Conclusion:** Measurements of MPA on chest CTs are reproducible but diameters > 3.15cm are not specific for PHTN. False positives cannot be identified based on patient size. Incorporation of RPA or LPA measurements can improve sensitivity but severely degrades specificity. Diagnosis of PHTN based solely on CT measurement of central pulmonary arteries may not be sufficiently accurate for clinical use.
Comparison Between CT and MRI in Preoperative Evaluation of Thymic Epithelial Neoplasms

BENVENISTE MF, Truong M, Betancourt SL, Sabloff B, Carter BW and Marom EM

Objectives: To assess if MRI of the chest is as accurate as CT in staging, especially assessing local mediastinal invasion as well as pleural or lung metastatic involvement. Additionally, a comparison between routine SE T1/T2 weighted MR images and newer sequences (3D LAVA and fast spin echo triple echo Dixon) was obtained to detect if faster sequences can replace older sequences without loss of accuracy, leading to a short MRI study.

Materials and Methods: After IRB approval and informed consent was obtained, we prospectively reviewed preoperative fluoroscopy, CT and MRI studies of 16 newly diagnosed patients with thymic epithelial malignancy. Both methods were compared and correlated with Masaoka-Koga staging as well as assessed for invasion into the mediastinum, pericardium, phrenic nerve, pleura, lung and vasculature.

Results: The performance of the different MRI sequences and CT was similar for staging (sensitivity= 100%, specificity= 60% and accuracy=87.5%). Similar results were obtained when assessing mediastinal, pericardial, vascular, pleural and lung involvement. Phrenic nerve involvement did not result in diaphragmatic motion impairment both by fluoroscopy and MRI. Additionally, there was no significant difference when assessing tumor involvement by different MRI sequences.

Conclusion: MRI is as accurate as CT in the staging of patients with newly diagnosed thymic epithelial malignancy. Phrenic nerve involvement did not impair diaphragmatic motion depicted by fluoroscopy or MRI. To decrease cumulative radiation dose to patients, MRI can replace CT in the staging of thymic epithelial malignancies.

Clinical Relevance: Staging, assessment of the pleura and assessment of local vascular involvement in newly diagnosed patients with thymic epithelial malignancy by MRI is as accurate as CT, with the advantage of reducing patient radiation dose.

Granulomatous Lung Disease: Distinguishing Clinical Features and Imaging Findings

KUSMIEREK JE, Kanne JP and Meyer C

Background Information: Granulomatous lung diseases (GLD) include a variety of conditions characterized by Type IV hypersensitivity reaction and granuloma formation. GLD may be classified as infectious (due to mycobacteria, fungi and parasites) or noninfectious. Noninfectious GLD are further subdivided into inhalational, immunodeficiency, vasculitis, neoplastic, drug toxicity, lymphoproliferative, and idiopathic. Inhalational disorders are the largest category and include hypersensitivity pneumonitis, chronic aspiration (lentil aspiration syndrome), and pneumoconiosis (talc and beryllium). Host immunodeficiencies include chronic granulomatous disease and granulomatous-lymphocytic interstitial lung disease associated with combined variable immunodeficiency. Bronchocentric granulomatosis and granulomatosis with polyangiitis are examples of granulomatous vasculitides. Granulomatous reactions to drug therapy include immune-reconstitution inflammatory syndrome and TNF-alpha antagonist therapy. Sarcoidosis, while a common diagnosis, is idiopathic and thus a diagnosis of exclusion. Although most radiologists are aware of the need to exclude an infection before diagnosing a noninfectious GLD, there is less familiarity with the specific imaging features that aid in the differential diagnosis. The imaging approach is based on distribution, morphology of the lesions, and associated signs.

Educational Goals/Teaching Points: The goal of this presentation is to familiarize the audience with radiographic and CT assessment of GLD, including typical imaging findings with emphasis on features that may narrow the differential diagnosis. In addition, clinical presentations, pathologic correlates, and imaging pitfalls are briefly discussed.

Conclusions: Imaging plays an essential role in evaluation of GLD. Distinguishing infectious from noninfectious causes is the priority, given the implications for management and treatment. A more focused differential diagnosis can be established based on distribution and morphology of imaging findings in correlation with clinical presentation.
Quantification of Pulmonary Gas-Transfer in Patients with Idiopathic Pulmonary Fibrosis (IPF) Utilizing Hyperpolarized 129Xe Gas-Transfer Spectroscopy and Imaging

MAMMARAPPALLIL JG, Kaushik SS, McAdams HP, Driehuys B and Roos J

Objectives: Inhaled hyperpolarized (HP) 129Xe diffuses across the alveolar-capillary membrane and dissolves into two compartments: interstitium (barrier) and red blood cells (RBC) resulting in a 200 ppm frequency 129Xe resonance shift. This study sought to quantify global and regional pulmonary gas-transfer using HP 129Xe gas transfer MR spectroscopy and MRI, in healthy volunteers and subjects with IPF.

Materials/Methods: Gas transfer spectra were acquired in 11 healthy volunteers (HV) and 6 IPF subjects using 200-mL of HP 129Xe. Global gas-transfer was quantified on a 1.5T GE clinical scanner using the ratio of the areas under the curves of the RBC and barrier resonance spectra. This RBC:Barrier ratio was correlated with DLCO. Regional gas-transfer defects on RBC images were visually scored by dividing each lung into 16 regions. The presence or absence of 129Xe RBC signal in each region was correlated with the extent of fibrosis in the same region on CT.

Results: The RBC:Barrier ratio in IPF subjects was significantly reduced (0.16) when compared to healthy volunteers (0.55). Compared to HV, IPF patients had significantly greater 129Xe signal in the barrier and less 129Xe signal in RBCs. The RBC:Barrier ratio correlated significantly with DLCO (r = 0.89). RBC gas transfer defects within a total of 64 regions were in 28% in regions with no fibrosis, in 39% in regions with mild fibrosis and 33% in regions with severe fibrosis by CT.

Conclusion: Gas-transfer MR spectroscopy and imaging using HP 129Xe can detect global and regional diffusion impairment in IPF patients and may correlate with extent of pulmonary fibrosis depicted by CT.

Clinical Relevance/Application: 129Xe MRI can provide a radiation-free method for assessment of regional gas transfer and may be a useful to assess response to therapy.

Magnetic Resonance Imaging of Part Solid Nodules

KOO C, White D, Lingineni RK, McGee KP, Tsang V and Sykes AG

Objectives: To assess how well magnetic resonance imaging (MRI) characteristics can distinguish benign from malignant part solid pulmonary nodules and predict the aggressiveness of the latter. Additionally, we compared MRI-derived parameters with morphologic and physiologic values derived from CT and PET/CT.

Materials and Methods: Institutional review board-approved study of 33 participants (23 women, mean age 73.5 ± 13.8 years) with 32 biopsy-proven lesions. 3T unenhanced pulmonary MRI exams were performed with regions of interest (ROIs) drawn around lesions for T1, T2, T2* and diffusion weighted sequences. Apparent diffusion coefficient (ADC) and T2* values were calculated. Two weeks later the ROIs were redrawn. MRI parameters were compared with lesion pathology, maximal standard uptake value (SUVmax) and Hounsfield units (HU). MRI lesion visibility was correlated with percentage of solid component. Intra- and inter-observer agreements were determined.

Results: Only ADC values correlated with malignancy potential (p < 0.05). ADC ≥ 2.7 μm2/ms predicted malignity with 88.7 % sensitivity (AUC 0.76). ADC and T2* inversely correlated with adenocarcinoma subtypes (p < 0.05). No MRI parameters predicted tumor aggressiveness (p > 0.11). SUVmax did not correlate with any MRI parameters (p > 0.56). Visibility on T1 weighted images correlated with percentage of solid component (p < 0.03). There was good intra-observer agreement for T1 values and good inter-observer agreement for T1 and T2 values.

Conclusions: 3T MRI with quantitative ADC values demonstrated potential for discriminating benign part solid pulmonary nodules from malignant lesions. ADC and T2* values correlate with adenocarcinoma subtypes.

Clinical Relevance/Application: ADC can provide quantitative measures for distinguishing malignant from benign nodules. Additionally, both ADC and T2* value correlated with adenocarcinoma subtypes.

STR Funded Research
How Low Can You Go? Assessing the Effects of Lowering Tube Potential on Chest CTs Reconstructed with Filtered Back Projection

CHALFANT JS, Ihde LL, Solmaz Tuncer A, Wilcox A, Hassani C, Lin LL and Lee C

Objective: Comparative evaluation of radiation dose and subjective quality of chest computed tomography (CT) exams performed with different tube voltages and reconstructed with filtered back projection (FBP).

Methods: We retrospectively reviewed 87 adult inpatients who had undergone two chest CTs with different tube voltages but otherwise identical protocols (median 141 days between scans) on the same scanner. CTs were performed with conventional (120 kV) and reduced tube voltages (80 kV if body mass index (BMI) < 20, 100 kV if BMI 20-25); FBP reconstruction was used. 16 paired studies were subjectively graded on a 5-point scale for image quality and noise by three blinded thoracic radiologists (exams independently assessed in random order).

Results: 69 patients had 100 kV and 120 kV studies, with a mean dose-length product (DLP) difference between groups of 131.4 mGy-cm (dose savings 20.1% with lower kV). 3 patients had 80 kV and 120 kV studies, with a mean DLP difference of 80.3 mGy-cm (dose savings 21.2%). 15 patients had 80 kV and 100 kV studies, with a mean DLP difference of 84.5 mGy-cm (dose savings 19.3%). Subjective grading of image quality and noise was significantly worse in lower kV studies (p < 0.01). For image quality, the higher kV exam received a higher score 50% of the time; 13% of lower kV studies had substantially reduced diagnostic confidence (score 1 or 2). For image noise, the higher kV CT received a higher score 50% of the time; 17% of lower kV exams had substantial/above average noise (score 1 or 2).

Conclusion: Chest CTs with lower tube voltages conferred a 20% radiation dose savings compared to higher tube voltages in the same patients. However, subjective image quality and noise were significantly worse, with diagnostic confidence substantially reduced in 13%.

Clinical Relevance: Decreasing tube potential of chest CTs performed with FBP should only be considered in select patients due to significant reduction in image quality and increase in noise.

Ultra-low Contrast and Radiation Dose MDCT Pulmonary Angiography (CTPA): Feasibility and Evaluation of Image Quality using 80 kVp/35-50 ml and 120-140 kVp/100 ml Protocols


Objectives: Evaluate image quality for CTPA using ultra-low contrast (35-50ml) and reduced radiation dose (80kvp).

Materials/Methods: A retrospective search revealed 17 consecutive patients who underwent CTPA using low contrast (35-50ml Optiray 350) and radiation dose (80kvp, auto-mAs), and 15 consecutive patients using a traditional protocol (100ml Optiray 350; 120-140kvp, auto-mAs), performed on a 16-slice scanner. CTDIvol and DLP were recorded. Mean HU values for the main (MPA), right (RPA), and left (LPA) pulmonary arteries were measured. Images were independently and blindly graded by 2 readers on a 1 to 5 scale for image quality for assessing pulmonary emboli and non-vascular thoracic pathology (5 = Excellent, 4 = Good, 3= Adequate, 2 = Poor, 1= Non-diagnostic), and for perceived image noise (1 = None/Minimal, 2 = Mild, 3 = Moderate, 4 = Moderate-to-Substantial, 5 = Substantial).

Results: Mean HU values were greater for the reduced contrast/dose protocol (MPA 598 ± 247, RPA 613 ± 240, LPA 588 ± 251) than the traditional protocol (MPA 309 ± 99, RPA 311 ± 106, LPA 314 ± 102). The two readers scored image quality for detecting pulmonary emboli better for low-dose (4.6 ± 0.7) than the traditional protocol (3.9 ± 1.0). Image quality for non-vascular findings was considered good-to-excellent for both protocols (4.6 ± 0.7 for the low-dose, 4.9 ± 0.3 for the traditional protocol). Image noise was mild for low-dose (1.85 ± 0.50) and none/minimal for the traditional protocol (1.1 ± 0.3). CTDI and DLP values were less for low-dose (4.9 ± 1.1; 138.9 ± 29.6) than the traditional protocol (15.8 ± 4.7; 454.2 ± 152.8). All values were statistically significant (p<0.01). Mean patient weight was not statistically different for the low dose (73 ± 18kg) and traditional protocols (81 ± 27kg), p<0.36.

Conclusions: Iodinated contrast and radiation dose can be reduced by 70% on CTPA while maintaining good-to-excellent scan quality.

Clinical Relevance/Application: CTPA with ultra-low dose is feasible, which may reduce potential intravenous iodine contrast toxicities.
Incidental Findings in Pre-operative Cardiac Computed Tomography Evaluation for Transcatheter Aortic Valve Implantation (TAVI)

HUSSIEN AF, Jeudy J, Kligerman S and White C

Objective: For many patients with aortic stenosis, transcatheter aortic valve implantation (TAVI) has become a viable alternative to surgery. Cardiac CT obtained for anatomic assessment of the aortic root structures prior to TAVI often detects incidental findings. The prevalence and clinical significance of these findings have not been well described.

Materials and Methods: This retrospective study examined incidental findings in 150 consecutive patients (71 women & 79 men; mean age, 71 years) with aortic stenosis undergoing pre-operative ECG-gated cardiac CT evaluation for TAVI during a 1-year period. A thoracic fellow and cardiothoracic radiologist reviewed all images in consensus and categorized incidental findings as pulmonary or non-pulmonary. Incidental findings were recorded, and medical records were reviewed for follow up diagnostic examinations.

Results: There were 199 incidental findings in 82% (123/150) of patients. Of these findings, pulmonary nodules were the most common incidental finding, noted in 27% (41/150) of patients. Seven of these nodules measured 1 cm or more, requiring further clinical work-up. One nodule demonstrated hypermetabolic activity on PET and is awaiting biopsy. 3/150 patients (2%) were found to have pulmonary emboli, requiring therapeutic management. Emphysema was seen in 11% (16/150) of patients. Pulmonary edema and pleural effusions occurred in 14% (21/150) of patients. Airway disease was identified in 10% (15/150) of patients. Thyroid nodules and hiatal hernias were the most common extra-pulmonary incidental findings and occurred in 5% (8/150) and 4% (6/150) of patients, respectively.

Conclusion: Cardiac CT requested for evaluation for TAVI has a high yield of incidental and sometimes significant findings.

Optimization of Spatial and Contrast Resolution for Coronary Artery Wall Imaging: A Phantom Study

KASHANI H, Ursani A and Paul N

Objectives: Evaluation of optimal spatial resolution during CT coronary angiography for detection of vulnerable plaque: A phantom study.

Methods: A purpose built coronary plaque phantom was used. Base platform simulated non enhanced myocardial tissue measuring 40 HU @ 120 kVp; 0.5-3.0mm diameter cylinders mimicking cholesterol, muscle and triglyceride in CT density, were embedded into the base to resemble a spectrum of lumen stenosis. Vessel lumen was opacified with iominated contrast. Phantom was inserted into an anthropomorphic chest and scanned on a second generation wide volume 320MDCT (VISION, Toshiba, Otawara, Japan) using CTDI of 2.4-33.7 mGy, 80-135 kVp and 27.5-247.5 mAs. Trans-axial CT images were reconstructed at 0.5/0.35 mm slice thickness/overlap using Filtered Back Projection (FBP), and standard reconstruction kernels used in coronary artery imaging. Quantitative analysis including measurement of image spatial resolution using the Modular transfer function (MTF) was performed to evaluate the optimal images for discrimination of low density plaque.

Results: Higher resolution was consistently measured at kVp of 80 and 100 with mA of 200-400. Photoelectric effect is higher at lower level of energy which explains higher absorption and better contrast. Higher current reduces the noise and increases the contrast to noise ratio (CNR) to the point that the resulting scatter radiation increases the noise and decrease the CNR.

Conclusions: Lower energy level creates a better resolution for detection of lipid rich coronary artery plaque.

Clinical Relevance: Adjusting radiation kVp and mA are important to optimize the coronary wall imaging in CT coronary angiography. For optimum coronary wall imaging, CT coronary angiography protocol should be different than the one used for lumen imaging.
Are Radiologists Necessary, or Can We Trust Softwares to Automatically Analyze Function?
Cardiac Function Reporting in Triple-Rule-Out Patients Before and After Focused Education of Readers

HEWETT L, Honko N, Seabrook N and Suranyi P

Objectives: To assess radiologist performance in using post-processing imaging workstation software following educational video lectures aimed at improving accuracy of left ventricular (LV) volume measurement of CT Triple-Rule-Outs (TRO) using semi-automated software.

Materials/Methods: 336 TRO patients’ CT datasets were retrospectively analyzed using post-processing software: first, with no human input (AUTO) and then by manual adjustment of LV delineation (MANUAL) to obtain LV volumes and functional data for the LV (ESV, EDV, SV, EF). These data were then compared with the reported values (REPORT) from the patients’ medical records. 168 random TROs from 2009-2010 (PRE), and 168 random TROs from 2013 (POST) were analyzed by blinded investigators. The focused education was done in 2011-2012.

Results: Statistically significant (p<0.01) correlations were found between EFREPORTED and EFAUTOMATED, both vs. EFMANUAL for both datasets. Correlation coefficients pre-education were R = 0.75 for EFREPORTED-PRE and R = 0.71 for EFAUTOMATED-PRE. Post-education correlation coefficients were, R = 0.87 for EFREPORTED-POST and R = 0.78 for EFAUTOMATED-POST. EFAUTOMATED-PRE systematically underestimated EFMANUAL-PRE by an average of 9.1 +/- 9.2% which was significantly more (p < 0.01) than the error found in EFREPORTED-PRE of 5.8 +/- 8.4%. EFAUTOMATED-POST underestimated EF by 8.0 +/- 4.8%, by significantly(p < 0.01) more than EFREPORTED-POST, of 3.0 +/- 7.8%. No significant difference was found between EFAUTOMATED-PRE vs. EFAUTOMATED-POST. However, EFREPORTED-POST were significantly (p < 0.01) more accurate than EFREPORTED-PRE.

Conclusions: Educational intervention can improve practice quality/accuracy in cardiac function reporting. Radiologist “supervision” is crucial in post-processing, as over-reliance on softwares may lead to misdiagnosis.

Unfamiliar Objects: Modern Biomedical Devices Identified on Chest Radiography

DENT J, Shiau M, Ko J and Brusca-Augello G

Background Information: The number of implantable medical devices approved for diagnostic and therapeutic use has increased in recent years. Many devices, such as cardiac stents, pacemakers, and defibrillators, are widely used and familiar to most radiologists. However, identification of some devices has proven to be a challenge due to less common use or recent development. In some instances, the device’s radiographic appearance may not reflect its physical appearance, as some of its components may contain complex internals or radiolucent materials. Alternatively, new products may resemble well-known devices but serve an entirely different function. Accurate radiographic interpretation requires understanding the function and appearance of new and possibly elusive biomedical devices on chest radiography.

Educational Goals/Teaching Points: The primary objective of this presentation is to introduce several less commonly encountered and newer medical devices, as they appear on chest radiography. We have selected the following nine devices:

Cardiac:
- Left ventricular assist device (LVAD)
- Transcatheter aortic valve replacement (TAVR) valves
- Mitral valve clip

Thoracic (subcutaneous):
- Subcutaneous implantable defibrillator (S-ICD) system
- Implantable cardiac monitor (ICM)

Gastrointestinal:
- Gastroesophageal reflux management system
- Endoscopic clip (endoclip)

Pulmonary:
- Endovascular pulmonary artery monitoring system

This educational review will describe the purpose, anatomic positioning, and radiographic appearance of each device. The knowledge gained will minimize misinterpretation of these devices and help to identify potential complications that impact patient care.

Conclusions: It is of utmost importance to learn about modern biomedical devices and how they appear on chest radiography in order to detect potential abnormalities and prevent inaccuracies in radiograph interpretation.
Tracheomalacia In COPD: Does Change in Severity of Collapse over Time Support the Utility of Routine Follow-up Imaging?

SONG KC, O’Donnell CR, Boiselle PM and Litmanovich DE

Objectives: COPD is a recognized risk factor for tracheomalacia (TM), which is increasingly diagnosed using MDCT. Our purpose is to evaluate serial changes in expiratory tracheal collapse among subsets of COPD patients with and without TM in order to better define the role of follow-up CT imaging in this setting.

Materials/Methods: 38 COPD patients (GOLD-criteria) prospectively underwent paired inspiratory-dynamic expiratory CT imaging at baseline and annually for 2 years using a standardized 64-MDCT scanner protocol. A validated technique was used to measure cross-sectional area and forced expiratory reduction (% collapse) in the tracheal lumen. Group mean and individual differences were assessed across time points and for subsets of patients with TM (defined as >70% collapse, n = 27) and without TM (≤ 70% collapse, n = 11). The magnitude of individual change in % collapse over time was graded as: I, < 10%; II, 10 –20%; III, > 20%. Grade III changes were considered potentially clinically significant. Change in % collapse for each patient between each time point was assessed by pairwise comparisons (N = 114).

Results: There was no significant difference in mean % collapse by time (66 ± 18, 68 ± 17, 67 ± 17), and no serial difference in % collapse between subjects with and without TM at baseline (P = 0.126). Comparing individual’s repeat measurements, 33 (87%) had only Grade I or Grade II difference between any 2 measures, while 5 (13%) patients showed grade III change for at least one comparison [only 6% across all (n = 114) pairwise comparisons]. Patients with grade I change had a lower FEV1 (63% vs. 75%, p < .04).

Conclusions: Expiratory tracheal collapse is relatively stable over time in COPD patients, even among those with TM at baseline. Further study is needed to determine which clinical and physiological parameters are the best predictors for determining the need for serial follow-up CT imaging in this population.

Clinical Relevance/Application: In the absence of clinical changes, routine follow-up CT may not be indicated for monitoring expiratory tracheal dynamics in a general COPD population.

Rare Causes of ILD Mimicking Common Imaging Patterns of Diffuse Parenchymal Lung Disease

BATRA K and Torrealba J

Objectives: Learn the expanded differential diagnosis of common imaging patterns on HRCT. Gain knowledge of rare diffuse parenchymal lung diseases mimicking imaging patterns of NSIP, HSP and possible UIP.

Materials and Methods: Case series of 5 unusual ILD mimics, including: capillary hemangiomatosis with racemose lymphangectasia, amyloidosis, pleuroparenchymal fibroelastosis, neurofibromatosis and DIPNECH. HRCT findings with pathologic correlation. Multiplanar depiction of the lesions.

Conclusion: HRCT readers should be aware of the rare differential diagnoses mimicking common ILDs.
How Accurate are We at Determining the Degree of Inclination on Portable Chest Radiographs

JADIDI N, Grage R, Mohammed M, Edelstein A and Ogden K

Objectives: This study compares the current method of acquiring the angle of inclination for a portable chest radiograph, relying on the radiology technologist’s subjective estimate in the degree of uprightness, to an objective measure derived from an inclinometer. We focused on the relative variability in the estimates at different angles.

Materials/Methods: The technologist’s estimate of the degree of uprightness and the respective measurements from an inclinometer were obtained on a total of 363 portable chest radiographs. The inclinometer was read by a radiology resident and then compared with the technologist estimate.

Results: The mean of the differences between the technologist estimate and the inclinometer was 0.37° with a sample standard deviation of 11.80°. The coefficient of variation (COV) was calculated at each increment to assess the relative variability between estimates at different angles. The sample size at 0° was too small and was therefore excluded. The COV values at 15°, 30°, 45°, 60°, 75°, and 90° were 106%, 42%, 35%, 22%, 11%, and 8%, respectively.

Conclusion: The dispersion of the estimated angles of inclination relative to the inclinometer measurements decreased as the angle of inclination increased from 0 to 90°.

Clinical Relevance/Application: The standard practice of using an inclinometer by the radiology technologist will likely improve the accuracy and precision of the patient’s angle of inclination, particularly when the patient is nearly supine. An angle of inclination reported accurately will optimize interpretation of portable chest radiographs by enabling distortion due to projection and effects of gravity on structures to be accounted for appropriately.

Inappropriate Use of Chest Radiographs within the ICU Setting

STEPHENS MJ and Reed J

Objectives: To evaluate inappropriate use of chest radiographs in the ICU setting.

Materials/Methods: Use of chest radiographs was tracked in the ICU during a period of one month. The reason, timing of the radiograph, and patient history were reviewed in conjunction with the ACR appropriateness criteria to determine if a chest radiograph was appropriate for each of the obtained chest radiographs.

Results: We determined that in our hospital approximately 25% of chest radiographs in the ICU setting maybe inappropriate under current accepted criteria. The most common culprit for inappropriate use appeared to be related to routine orders made the previous day without regard to the patient condition at the time of the actual radiograph.

Conclusions: We found overutilization of chest radiographs in the ICU setting within our hospital to be common and related to routine orders. These orders often led to poor clinical indication for exam and resulted in a less refined diagnostic radiology reports.

Clinical Relevance/Application: By understanding the underlying cause of chest radiograph overutilization within the ICU setting we hope to develop workflow related updates through education and institutional changes to reduce volume and increase relevance of performed chest radiographs.
Complications of Percutaneous CT-guided Core Needle Biopsy: The Effect of Needle Trajectory and Lesion Size

RUCHALSKI K, Abtin F, Ruchalski K, Bracha A, Genshaft S and Suh R

Objectives: To evaluate the effect of needle approach on complication rate for coaxial 20-gauge core needle biopsy (CNB) of intra-thoracic lesions. The relationship between lesion location and complication rate was also investigated.

Materials/Methods: A total of 61 patients underwent 63 percutaneous CT-guided transthoracic CNBs during an 11 month period using a 20-gauge core needle. To evaluate effect of needle trajectory, the shortest distance from pleura to the lesion periphery was measured, and the angle between this line and the needle tract was calculated. Biopsy approach was defined as direct for angles <45 degrees and tangential for >45 degrees. The complication rate for each needle approach was calculated. Lesions were classified by their shortest distance perpendicular to the pleura as peripheral (<2 cm), middle (2-4 cm), or central (>4 cm). The rates of each type of complication for the 3 types of lesions were calculated.

Results: Of the 63 biopsies there were 7 major (11%) and 8 minor complications (13%). The major complication rate for direct & tangential trajectory was 3% and 19% (p = 0.047), while the minor complication rate was 19% and 6% (p = 0.14). There were 28 peripheral, 19 middle, & 16 central lesions. More major complications occurred with central lesions than middle or peripheral lesions (25%, 11%, and 4%). The minor complication rate was 13%, 5%, & 18%. The correlation between lesion location and complication rate was not significant. A histologic diagnosis was obtained in 90% of cases.

Conclusions: The rate of major complications from transthoracic CNB was increased with less direct needle approach. The lesion location did not significantly increase complication rates.

Clinical Relevance/Application: Using a tangential needle approach may increase the risk of major complications when undergoing CNB of thoracic lesions but may be necessary for lesion access to improve yield. Lesion depth may not be a useful indicator of transthoracic CNB complication risk.

Extremely Low False Negative Rate of Transthoracic CT Guided Needle Biopsy Using a 17 Gauge Coaxial Needle and Routinely Obtaining Multiple Cores: Long Term Follow up of Non-malignant Diagnoses

FLETT PC and Teel G

Objectives: To retrospectively determine the false negative and complication rate of transthoracic CT guided core lung biopsy using a 17 gauge coaxial system and routinely obtaining an average of 6 cores.

Methods: We reviewed non malignant biopsies over a three year period between September 2009 and August 2012. In each case, an average of 6 specimens were obtained using a 17 gauge coaxial cutting needle. A true negative was defined by non-malignant initial pathology along with resolution on follow up imaging, lack of growth after two years, or surgical resection confirming benignity. Significant complications were defined as pneumothorax requiring chest tube placement, hemorrhage resulting in termination of the procedure, or death.

Results: Of 135 nodules, 100 were positive for malignancy and 35 were negative, including 27 true negatives and 2 false negatives. 6 cases were considered indeterminate due to inadequate follow up and were omitted from the final statistical analysis. The two false negatives included a 6mm squamous cell carcinoma and a case of Hodgkin lymphoma. There were 6 complications including one death, which occurred prior to obtaining any core specimens.

Conclusions: Our technique of obtaining an average of 6 cores using a 17 gauge coaxial needle under CT guidance has a diagnostic accuracy of 98% and sensitivity of 98%, comparable to the well established and highly accurate technique of US guided breast biopsy. Current accuracy rates for transthoracic lung biopsy reported in the literature range from 88% to 98%. Our rate of pneumothorax and hemorrhage were 0.06% and 0.11%, respectively.

Clinical Relevance: Transthoracic CT guided lung biopsy using a 17 gauge coaxial system to obtain multiple cores is a highly accurate diagnostic procedure with a low complication rate.
A Public and Open Source Chest Computed Tomography Computer-Aided Detection Tool for Pulmonary Nodules

BALKMAN JD and Black WC

Objective: The American College of Radiology (ACR) LungRADS guidelines for pulmonary nodule reporting along with increased acceptance of lung cancer screening both provide new opportunities for chest computed tomography (CT) computer-aided detection (CAD). This work describes the development, evaluation, and public distribution of an open source CAD tool for pulmonary nodule detection in an effort to provide greater access to such technology.

Methods: CAD software was developed using Python NumPy/SciPy freeware, distributed to a public software code repository (www.github.com/jbalkman/chestdetect) and deployed as a cloud computing web application created by the authors (www.chestdetect.com). The algorithm utilizes total variation denoising and a combination of 3-D morphologic erosion, dilation, and labeling to isolate nodules. Software testing was performed using 3.75 mm slice chest CT image stacks exported as TIFF files from 12 different patients.

Results: A total 14 pulmonary nodules measuring 4-20 mm (mean = 10 mm; standard deviation = 5 mm) were reported across the patient panel, each patient having either one or two nodules. The CAD tool detected 14 of 15 nodules (93% sensitivity) and flagged on average 2.5 false positives per image (FPPI) across the 12 studies (FPPI range = [0,6]). The smallest nodule (4 mm) was the only not detected. The software is publicly available through a live web application where users can submit image stacks and review results using a modern browser.

Conclusions: Open source computer vision software could potentially be used to detect pulmonary nodules on chest CT studies within the LungRADS guidelines. This approach enables the deployment of CAD tools as a public web application running on a cloud server.

Clinical Relevance: A universally accessible cloud-based web application for detecting pulmonary nodules could potentially help standardize and provide equal access to CAD technology for lung cancer screening programs worldwide.

Structured Cardiothoracic Radiology Reports using Natural Language Processing

LAKHANI P, Donuru A, Flanders A and Sundaram B

Background Information: At most institutions, radiologists are not usually held to a standardized method of reporting, which leads to variation in the style, order, and content of radiology reports. Multiple studies have shown that structured radiology reports are preferred by both referring clinicians and radiologists over traditional “free-form” or unstructured radiology reports. Structured reports use a standard lexicon, and are presented in a consistent style and order. RadLex, a radiology-specific ontology sponsored by the RSNA (Radiology Society of North America), is one such standardized lexicon. There are many benefits to structured reporting, in that it improves the quality of communication, data-mining/research, quality assurance, regulatory and billing compliance, and patient care. However, “point and click” structured reporting solutions have been shown to be cumbersome and time-consuming, increase “look-away” time from the images, and may hinder interpretation of complex cases. Moreover, these latter concerns become amplified in environments where there are greater demands for productivity.

Educational Goals/Teaching Points:
- Highlight the concept of Natural Language Processing (NLP) and its relevance to radiology reporting, and specifically cardiothoracic imaging.
- Demonstrate a custom NLP solution that converts free-text chest X-ray and cardiothoracic CT reports into structured radiology reports.
- Describe the architecture and concepts of the solution in an easy-to-understand fashion.
- Show actual examples of free-text and converted structured radiology reports.
- Outline strengths and pitfalls of the NLP solution.
- Discuss future directions in this area of research.

Conclusions: Natural Language Processing solutions can automatically generate structured radiology reports in cardiothoracic imaging, resulting in improved report quality without sacrificing productivity of the radiologist.
CT and PET/CT Performance in Detection of Disease Recurrence Post-Stereotactic Ablative Radiotherapy of Stage I Non-Small Cell Lung Cancer

GUO H, Terrone D, Bristow M, Diehn M, Loo Jr. BW and Leung A

Objectives: Evaluate performance of CT and PET/CT in detection of disease recurrence in patients treated with stereotactic ablative radiotherapy (SABR) for stage I non-small cell lung cancer (NSCLC).

Materials/Methods: All patients who had undergone SABR for stage I NSCLC in our institution between June 2004 to November 2011 with available pre-treatment and post-treatment CT and PET/CT scans, and minimum 2 years follow-up were included in this retrospective study. 31 patients (19 men; 12 women; mean age, 74.4 years) with 36 tumors (adenocarcinoma, n = 18; squamous cell, n = 11; not specified, n = 7) fulfilled eligibility criteria. Disease recurrence (local, n = 7; regional, n = 2; distant, n = 2) was diagnosed in 11 patients. CT scans were reviewed by 2 blinded observers with consensus decision; local recurrence on CT was defined by increasing opacity that showed sequential growth on two consecutive studies. PET/CT studies were reviewed by single blinded observer; local recurrence on PET/CT was defined by focally increased FDG uptake with a SUVmax (focus) divided by SUVmax (irradiated lung) > 1.5.

Results: CT correctly identified 7 cases of recurrence (local, n = 5; lung metastases, n = 2) with sensitivity 64%, specificity 100%, and accuracy of 89%. PET/CT correctly identified 10 cases of recurrence (local, n = 6; regional, n = 2; metastatic, n = 2) with sensitivity 91%, specificity 72%, and accuracy of 78%. The single false negative on PET/CT occurred in a case where the tumor at baseline was of low FDG-avidity (SUVmax=0.6). PET/CT false positives were caused by inflammatory/infectious disease. Combining the two modalities resulted in 100% sensitivity for disease recurrence.

Conclusions: CT and PET/CT are complementary modalities in detection of post-SABR recurrence of NSCLC.

Clinical Relevance: CT and PET/CT used in combination maximize sensitivity in detection of disease recurrence in patients with early stage NSCLC treated by SABR.

Patient Centered Care: Implementing Integrated Practices System with Disease Management for Pulmonary Nodule Tracking

MICHAEL SE, Lutynski M, Nguyen B, Sobieszczyk M, Prezioso E, Liotta R and Nations JA

Objective: Utilizing Integrated Practices System (IPS), Disease Management (DM) has been incorporated as the key component in a patient-centered Pulmonary Nodule Tracking Program (PNTP) to improve patient outreach and system-wide efficiency, with the goal to detect lung cancer earlier in high-risk patients as a process improvement project.

Methods: Under an institutional IPS, the Radiology and Pulmonology departments collaborated with DM to establish a PNTP as a process improvement project in 2014. This PNTP enrolled appropriate patients into a database. DM uses this database to track and schedule patients for low-dose chest CT. Using this early cohort of patients enrolled throughout 8 months, we evaluated the patient outreach rate and the efficiency of the system by the amount of time spent on each patient.

Results: In this PNTP, there was 100% outreach to this cohort of 135 patients enrolled over 8 months, with 126 patients (93.3%) scheduled for their follow-up chest CT to date. The remaining 6.7% had valid reasons to disenroll. DM estimated an average 20-minute interaction per patient, suggesting total savings of 45 hours for patients and providers throughout 8 months.

Conclusions: Disease Management has a key role in an institutional IPS for appropriate patient tracking based on standard of care practices, with the goal to improve patient outcomes. A patient-centered Pulmonary Nodule Tracking Program with DM results in 100% outreach and improved system-wide efficiency as demonstrated; time is saved for patients, physicians, and clerical services. Tracking is on target for high-risk patients, with the aim to reduce loss to follow-up.

Clinical Relevance: Fleischner Society guidelines are utilized as the standard of care for lung nodule follow up, especially those considered high-risk. Improved outreach and compliance can be achieved by using a patient-centered Pulmonary Nodule Tracking Program with DM.
Value of Chest CT for Early Detection of Thoracic Metastasis of Hepatocellular Carcinoma

SUR BW and Hobbs S

Objectives: The purpose of this retrospective study is to investigate frequency of thoracic metastasis of hepatocellular carcinoma (HCC) and its metastatic patterns.

Materials/Methods: Retrospectively reviewing from October 2010 to August 2014, electronic radiology information system and electronic medical record were reviewed to identify subjects who were diagnosed with HCC based on tissue biopsy and showed thoracic metastasis on staging or surveillance chest CT scan.

Results: 166 patients underwent chest CT and 21 patients (12.7%) showed metastasis in the thoracic region. Initial staging scans revealed thoracic metastasis in 5 patients. 16 patients showed new thoracic metastasis in their surveillance scans. Average time period since their initial diagnosis was 418 days (median 235 days). 67% of patients showed growing multiple pulmonary nodules (14 out of 21). Osseous metastasis was seen in 29% of patients (6 out of 21) and mediastinal or axillary lymphadenopathy was seen in 24% of patients (5 out of 21). Among these patients, one patient showed both growing pulmonary nodules and osseous lesions, one patient showed both growing pulmonary nodules and mediastinal lymphadenopathy, and another patient showed growing pulmonary nodules, mediastinal lymphadenopathy, and osseous lesions simultaneously in their CT scans.

Conclusion: Pulmonary nodules were the most common manifestation of thoracic metastasis. Yet, significant number of patients showed thoracic metastasis limited to bony lesions or lymphadenopathy. Given the substantial number of patients developing thoracic metastasis and various metastatic patterns, it is valid to include chest CT study as a part of surveillance protocol for HCC.

Clinical Relevance/Application: Chest CT scan should be considered as a part of routine HCC surveillance protocol to detect early thoracic metastasis, which can aid clinicians in providing appropriate treatment for patients.

Anterior Mediastinal Masses: Prevalence and CT Image Characteristics in the Framingham Heart Study

ARAKI T, Nishino M, Gao W, Dupuis J, O'Connor GT and Hatabu H

Objectives: To investigate the prevalence and CT image characteristics of anterior mediastinal masses in the Framingham Heart Study (FHS) and their association with the participants’ characteristics.

Materials/Methods: In this IRB approved study, chest CT scans of 2571 FHS participants (mean age 58.9 years, 51% female) were retrospectively reviewed. Two radiologists evaluated for the presence of anterior mediastinal masses, their shape, contour, location, invasion of adjacent structures, fat content, and calcification. For participants with anterior mediastinal masses, a previous CT scan was reviewed for interval size change of the masses, when available. Participants’ characteristics were studied for any association with the presence of anterior mediastinal masses.

Results: Of 2571, 23 participants (0.9%) had anterior mediastinal masses on CT. The most common CT characteristics were oval shape, lobular contour, and midline location. Six out of eight masses with available prior CT scans demonstrated an interval growth in size over a median period of 6.5 years. No risk factors for anterior mediastinal masses were detected among participants’ characteristics, including age, sex, BMI, and cigarette smoking.

Conclusions: The prevalence of anterior mediastinal masses is 0.9% in the FHS. Those masses may increase in size when observed over 5 years. Investigation of clinical significance in incidentally found anterior mediastinal masses with a longer period of follow-up would be necessary.

Clinical Relevance/Application: Incidental encounters with anterior mediastinal masses on CT are becoming more common. It is important for radiologist to be familiar with their general findings on CT and natural course. A longer period of follow-up may reveal interval growth of the masses.
**100-kVp Pulmonary 64-MDCT Angiography: Comparison of Vascular Enhancement and Image Quality With 50 ml IV Contrast Material to 30 ml IV Contrast Material in a Randomized Clinical Trial**

**DAVOODI M, Belasabadi S, Evaz Davani M, Rahim F and Bijan B**

**Objectives:** The purpose of this study is to semi quantitatively assess the vascular enhancement & image quality of pulmonary CT angiography (CTA) using 64-slice MDCT with reduced IV contrast dose in comparison to standard contrast dose.

**Materials/Methods:** 100 patients with suspected pulmonary embolism (PE), weighting < 85 kg with no congestive heart failure (CHF) or irregular supraventricular tachycardia (SVT), were randomly assigned to 2 groups (Group-A, n = 50; IV contrast 50ml iohexol [Omnipaque 350mgI/ml], Group-B, n = 50; IV contrast 30ml iohexol [Omnipaque 350mg I/ml]). In both groups other conditions were the same; 100 kVp, 100 mA with care dose, pitch 1.5, flow rate 4ml/s and contrast media administrations were followed by 40cc IV saline chaser. Attenuation values were measured in the main, right main, selected lobar, segmental and sub-segmental branches. Intravascular enhancement homogeneity from central to sub-segmental level were also assessed visually using a semi-quantitative score (1 = poor, 2 = good, and 3 = excellent).

**Results:** There was no significant statistical difference in age, gender and scan length between groups. Pulmonary embolisms were found in group A & 12 pulmonary embolisms in group B (mostly of segmental type). The mean attenuation measurements of the main, right main, selected lobar, segmental and sub-segmental pulmonary arteries for Group-B were 250, 252, 271, 305 & 323 HU, respectively and for Group-A were 303, 305, 318, 330 & 335 HU, respectively. Enhancement homogeneity was “good” in both groups; with no significant statistical difference in subjective image quality scores (p > 0.05).

**Conclusions:** In individuals weighting <85 kg, with no CHF or irregular SVT, pulmonary CTA can be performed with lower IV contrast agent volume without altering the image quality.

**Clinical Relevance:** Reduction of contrast media and associated adverse effects in pulmonary CTA.
Assessment of Contrast Enhanced Chest CT for Suspected Superior Vena Cava Occlusion Using a Dual Injection Protocol and Delayed Imaging

TEDLA SG, Shiau MC, Brusca-Augello G, Alpert JB and Ko JP

Objective: To compare the quality of vascular contrast enhancement using a biphasic injection CT technique, with delayed imaging versus uniphasic injection when evaluating for superior vena cava (SVC) occlusion.

Methods: The institution database was utilized to identify patients that underwent chest CT with non-ionic contrast for suspected SVC occlusion during 2005-2014. In 53 patients, 18 received biphasic protocols, entailing 130-140 cc of contrast, followed by a mixture of 10 cc of contrast with 90 cc of normal saline. The 35 patients that underwent the uniphasic protocol received a contrast bolus of 85-150 cc. Images were assessed by 3 radiologists for a diagnosis of SVC occlusion, degree of obstruction using a 5 point scale, presence of collaterals, image quality using a 3 point scale, and evidence of biphasic protocol. Statistical analysis was used to make comparisons between uniphasic and biphasic protocols.

Results: There was a higher degree of SVC enhancement and homogeneous opacification without streak artifacts in the biphasic protocol compared to the uniphasic protocol (p = < 0.001). Similarly, bilateral brachiocephalic vein enhancement, homogeneity, and reduced streak artifacts were statistically better with the biphasic protocol (p = < 0.001). The diagnosis of SVC occlusion (p = 0.060-0.129) and degree of occlusion (p = 0.146-0.231) was not significantly different between the two protocols.

Conclusions: The biphasic protocol results in superior homogeneous enhancement of the SVC and surrounding vasculature with reduced streak artifacts.

Clinical Relevance: Using a biphasic protocol for the evaluation of SVC occlusion improves contrast enhancement and image quality without increased radiation exposure.

The Effect of a Clinical Decision Algorithm on Increasing the Responsible use of CT Pulmonary Angiography

GUICHET P, Cen S, Wilcox A and Lee C

Objectives: To assess the utility of a human-operated clinical decision algorithm on reducing inappropriate utilization of CT pulmonary angiography (CTPA) for diagnosing acute pulmonary emboli (PE).

Materials/Methods: Starting January 2013, residents at our institution began implementing a clinical decision algorithm consisting of required thresholds of Wells score and/or D-dimer (D-dimer > 200 ng/mL unless Wells score > 4) prior to approving CTPAs for inpatients and emergency department patients with suspected acute PE. 2348 consecutive CTPA examinations (1185 men and 1163 women) from January 2012 through December 2013 were evaluated. Results of the CTPA, Wells score, and D-dimer were recorded; chi-squared and receiver operating characteristic (ROC) analyses were performed.

Results: After implementation of the clinical decision algorithm, there was a 5.6% reduction in CTPA orders and a 9.1% reduction in the number CTPAs performed while maintaining comparable positive yield [positivity increased from 11.1% (136/1230) to 12.6% (140/1118) (p = 0.3)]. ROC analysis revealed that D-dimer was a better predictor for PE (AUC = 0.76) than both Wells score alone (AUC = 0.57) and Wells score + D-dimer (AUC = 0.67). The negative predictive value (NPV) of a Wells score ≤ 4 and a D-dimer ≤ 580 ng/mL was 1.0.

Conclusions: Implementation of a human-operated clinical decision algorithm led to a significant reduction in inappropriate CTPA utilization. D-dimer alone has good prediction accuracy for PE. At our institution, the clinical decision algorithm’s D-dimer threshold can be safely increased to 580 ng/mL for further reductions in CTPA over-utilization.

Clinical Relevance/Application: In this era of limited resources and radiation concerns, radiologists should implement a clinical decision algorithm to improve utilization of CTPA. A D-dimer level should be requested whenever possible.
Inter- and Intra-observer Variability of Cardiac Output Determination: Quantitative 4D CT Imaging of Contrast Enhancement in the Main Pulmonary Artery

RAJEBI H, Scalzetti E and Ogden K

Objectives: Cardiac output (CO) can be measured noninvasively based on the indicator dilution method, using timing bolus images (TBI) obtained during routine CT pulmonary angiography (CTPA). We evaluated the inter- and intra-observer variability of the calculated CO to assess the reliability of the measurement.

Materials/Methods: With IRB permission, we retrospectively reviewed 30 patients, selected randomly from a larger cohort having CTPA for suspected pulmonary embolism. TBI consisted of 40mm volumes made in the mid-thorax every 2s, beginning 4s after the start of contrast infusion given at 5ml/s, ending after contrast wash-out from the main pulmonary artery (MPA). Attenuation was measured twice by two readers in the MPA at a similar anatomic level in each volume. After fitting a gamma variate curve to time-attenuation data for each set of measurements, CO was calculated from the area under the curve. To assess inter- and intra-observer variability, mean differences of paired sets of data and their standard deviations were calculated and statistical significance was determined. Also, linear correlation between the CO numbers (Spearman’s coefficient of correlation), their reliability through the intraclass correlation coefficient (ICC), and limits of agreement (Bland and Altman method) were evaluated.

Results: None of the means differed significantly between sets of CO measurements (p > 0.05 for all pairs). Spearman’s coefficient of correlation and ICC were significantly high for all measurements (> 0.9) indicating good agreement and excellent reliability respectively. The 95% agreement limits showed no trend towards over- or underestimation

Conclusions: The measured CO in our study shows insignificant inter- and intra-observer variability.

Clinical Relevance/Application: For patients undergoing CTPA, it is possible to quantitate CO with good repeatability and reproducibility.