Imaging Diagnosis and Staging of Lung Cancer

By Mamdouh Mahfouz MD
Radio diagnosis
Cairo University
mamdouh.m5@gmail.com

www.ssregypt.com
Lung Cancer

- The most common cause of deaths worldwide
- Cigarette smoking is by far the most common risk factor accounting for 90%

- **Four main histologic groups**
  - Adenocarcinoma 35%
  - Squamous cell carcinoma 30%
  - Small cell carcinoma 20%
  - Large cell carcinoma 15%
Imaging strategy

- Characterization of the primary lesion
- Local relationship to the pleura, chest wall, mediastinum and airways
- Distant tumor spread to the bones, liver, brain and suprarenal glands
Characterization of the primary lesion

- Peripheral nodule
  - **Benign characters:** small < 2cm, rounded, smooth edge, with calcium and no change in size over 2 years period
  - **Malignant characters:** more than 2.5 cm, spiculated edge, no calcium
- **Helpful clinical data:** patient’s age and smoking
Benign pulmonary nodule with smooth edge and central calcifications
Malignant pulmonary nodule with speculated edge and ipsilateral deposits
Peripheral Bronchogenic carcinoma

Solitary peripheral subpleural nodule 52%
- Upper lobe distribution 70%
- Calcification 1%
  - Speculated margin due to demoplastic reaction
Characterization of the primary lesion

Peripheral nodule

Dynamic CT or MR Imaging

Malignant nodules produce significant increase in density or signal intensity than benign nodules in the first transit of contrast bolus. DD pulmonary AVM
Characterization of the primary lesion

Peripheral or central mass

- Solid mass lesion of whatever edge, matrix
- Central areas of necrosis and breakdown
- Areas of matrix calcification [7-14% of cases]
- Smooth, lobulated, speculated edge
- Pleural tail ?!
Central and peripheral bronchogenic Carcinomas
M 62 Y with chest pain and hemoptysis
Calcium is present in 7-14% of Bronchogenic carcinomas.

Bronchogenic carcinoma with central breakdown and pleural tails.
M 62Y
Bronchogenic Ca. with breakdown on follow up 3 months
M 44Y had thyroid cancer treated with thyroidectomy, recently developed chest pain. 1st Xray showed rt sided opacity diagnosed as pneumonia with no response to treatment. 2nd Xray showed progression of the disease and CT was done.
Peripheral mass lesion

Assessment of chest wall invasion [was considered a contraindication for surgical excision of lung cancer]

MRI is more sensitive than CT in detection of chest wall invasion

Imaging signs of chest wall invasion

- Rib destruction [CT]
- Tumor extension beyond the chest wall [MRI]
Chest wall invasion

MRI can differentiate tumor tissue from chest wall muscles
Chest wall invasion

MRI advantages

- Multiplanar imaging
- Can differentiate tumor tissue from chest wall muscles
- Cine MRI during breathing can assess the tumor movement against the pleural surface
- In Pancoast’s tumors, MR can assess invasion of the brachial plexus and subclavian vessels
- The accuracy of MRI versus CT in this domain in 94% for MRI compared to 63% for CT
Apical bronchogenic carcinoma [Pancaost’s tumor] with chest wall invasion
Pancoast’s tumors, MR can assess invasion of the brachial plexus, subclavian vessels and the spine
Central mass

- Airway involvement
- Mediastinal invasion

Bronchial obstruction by the primary tumor → obstructive pneumonia and atelectasis

The anatomy of the bronchi is better assessed by CT separation of tumor tissue from atelectasis is better by MRI
Central bronchogenic carcinoma with bronchial obstruction and atelectasis
Central lung cancer and atelectasis
Central mass

- Mediastinal invasion
  - Minimal invasion = tumor within the mediastinal fat = may be amenable for surgical resection
  - Gross invasion = involvement of vital structures = precludes surgical resection
Bronchogenic carcinoma with mediastinal invasion and lymphadenopathy

M 64Y
Large cell cancer with mediastinal fat invasion and contralateral nodes
Gross Mediastinal invasion

- Superior vena cava
- Pulmonary arteries
- Pericardium and heart

Invasion of left atrium
Bronchogenic carcinoma with mediastinal invasion

SVC occlusion

Encasement of the pulmonary artery
Bronchogenic carcinoma with mediastinal invasion
And fistulous communication with esophagus
Mediastinal lymph nodes

A cut off size of 10 mm → about 60% sensitivity

- 13% of normal sized nodes contains tumor tissue
- 37% of nodes measuring 2-4 cm may not be malignant
- Detection of calcium in the nodes = benign nature
- PET achieved a high degree of accuracy in assessment of nodal metastases. [93% sensitivity, 99% specificity]
Peripheral bronchogenic carcinoma with positive axillary and mediastinal nodes by PET Scan
Percutaneous transthoracic needle biopsy

- Well established tool in diagnosis of lung cancer in up to 95% of cases
  - Allows early diagnosis
  - Used for diagnosis of lung nodules, masses or infiltrates specially if malignancy is suspected
  - Can assess Metastatic disease to lymph nodes and chest wall for staging of the primary lesion
  - Helps to establish a definite diagnosis of non small cell cancer or benign lesion before surgery
Percutaneous transthoracic needle biopsy

Criteria for optimal procedure

- Peripheral lesion
- More than 2cm
- Short need tract
- Perpendicular pathway
- No obstacles in the needle way
  - Bone
  - Major vessels
  - Emphysematous bulla
Steps of PTNB
Steps of PTNB
PTNB complications

- Pneumothorax 30%
  - Usually small, asymptomatic, stable
  - Develops immediately following the procedure
  - The rate of significant post biopsy pneumothorax requiring intervention is about 6%, increased by
    - Patient’s age COPD
    - Greater depth of the lesion
    - Multiple trials
PTNB complications

Hemoptysis 5-10%
✦ Self-limited
✦ Massive fatal hemoptysis
  - Large-calibre needle > 18 G
  - Low prothrombin concentration <50%

Other less common complications as air-embolism, tumor implantation along the needle tract, hemothorax,....
PTNB complications

Factors that increase the incidence of complications

✦ Severe COPD
✦ Bleeding disorders
✦ Pulmonary arterial hypertension
✦ Suspected pulmonary AVM
✦ Small size of the lesion
Imaging of distant tumor spread

Metastatic spread usually affect

- Brain
- Suprarenal glands
- Liver and bones
T1 Tumor less than 3cm not invading the main bronchi

4th ed Philadelphia, 1992
Tumor Staging

**T2**

*Tumor more than 3cm*

- Invading the pleura
- Invading the main bronchi 2cm or more distal to the carina
- Associated with atelectasis

**Tumor Staging**

**T3**

**Tumor of any size with**

- Invading the pleura, chest wall, diaphragm, pericardium
- Invading the main bronchi less than 2cm from the carina
- Associated with atelectasis of the whole lung

Tumor Staging

T4 Tumor of any size

- Invading the mediastinum, heart, spine, major vessels
- Malignant effusion

47 Y Female with undifferentiated carcinoma grade III invading the heart

**Lymph node Staging**

**N1** patients are still candidates for surgery with lower 5-year survival rate.

**N1** Ipsilateral nodes
  - Peribronchial
  - Hilar

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No nodes = best prognosis
**Lymph node Staging**

- **N2** patients do not benefit from surgery

**N2 Ipsilateral nodes**
- Mediastinal
- Subcarinal

Lymph node Staging

- **N3** patients are not surgical candidates

**N3**

- Contralateral nodes
  - Contralateral hilum
  - Contralateral mediastinum
  - Supraclavicular

4th ed Philadelphia, 1992
Mediastinal lymph nodes

- Affect the prognosis and therapeutic decisions
- The prognosis is best in absence of nodal disease
- $N_1$ patients are still candidates for surgery with lower 5-year survival rate
- $N_2$ patients do not benefit from surgery
- $N_3$ patients are not surgical candidates
- Imaging depend only on the size of lymph nodes
Thank you
سبحانك الهم و بحمدك نشهد أن لا إله إلا أنت نستغفرك و نتوب إليك

Thank you
CT shows minor changes at the left hilum
MRI shows endobronchial mass
Final Staging

I: 
II: 
III: 
IV: 

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Prevascular

Retrocaval
F 70 with abdominal pain, US showed splenomegaly, CT showed LNs+ lung deposits
60 Y M Peripheral bronchogenic carcinoma with metastatic lymphadenopathy and lymphangitis carcinomatosa
Figure 4. Sagittal views from a gadolinium-enhanced three-dimensional 3D/MR angiogram of a 56-year-old man. The dissection does not involve the brachiocephalic artery (A) (arrow), the left common carotid artery (B) (arrow), or the left subclavian artery (C) (arrow).
Figure 7. Contrast-enhanced 3D MR angiogram in a 42-year-old woman with a remote history of motor vehicle accident. A, Oblique maximum intensity projection and (B) sagittal image demonstrate the saccular aneurysm (s), which is a traumatic pseudoaneurysm.
Figure 8. MR images in a 46-year-old woman. A, Sagittal MR angiogram shows an aneurysm of the ascending aorta (A) with involvement of the aortic root, characteristic of aortoannular ectasia. B, Transverse cine GRE image demonstrates a regurgitant jet (j) from the ascending aorta (A) into the left ventricle (LV).
Figure 3. Imaging of mediastinal lymph nodes showing the value of the coronal plane for assessing aorticopulmonary window and subcarinal nodal stations. A, PA radiograph of the chest shows a poorly defined left upper lobe mass and an abnormal convex contour of the aorticopulmonary window (arrow). B, A coronal T1-weighted MR image of the chest confirms the presence of aorticopulmonary window lymph node enlargement (solid arrow) and also reveals the presence of a subcarinal nodal mass (open arrow). These two nodal stations are optimally assessed in the coronal plane. (From Boiselle PM, Patz EF, Vining DJ, et al: Imaging of mediastinal lymph nodes: CT, MR, and FDG PET. Radiographics 18:1061–1069, 1989; with permission.)
Figure 10. Forty-eight-year-old man with left upper lobe lung cancer and presumed invasion of the left pulmonary artery. A, Axial T1-weighted spin-echo (TR/TE = 1304/25) MR image shows a left upper mass with encasement of the left pulmonary artery (p). B, Axial T1-weighted spin-echo (TR/TE = 1304/25) MR image shows a possible enlarged contralateral paratracheal lymph node (arrow). C, Compared to a computed tomography scan, it is apparent that the MR image finding actually reflects the confluence of three smaller lymph nodes (arrow) which are better visualized on CT scanning because of superior spatial resolution.
Figure 4. Patient with asbestosis and a desquamative interstitial pneumonia reaction. Diffuse ground-glass infiltrates are more easily distinguished from surrounding retracted emphysema on the MR image with 7-ms TE (A) than on the MR image with 20-ms TE (B). Peripheral vessels are more visible with TE of 7 ms because of improved signal-to-noise ratio. The increased signal intensity within the pulmonary arteries on the TE 7 ms sequence arises from the decreased flow effects at this short echo delay.
Figure 5. MR images with TE 7 (A) and 20 (B) ms (identical windows and levels) in a patient with Churg-Strauss syndrome (confirmed on biopsy). Airless regions of lung caused by dense infiltrate are seen equivalently with both techniques. Areas of partial infiltration (straight arrows) and vascular structures within normal lung (curved arrows), however, are visualized better on image with TE of 7 msec.
Figure 12. Comparison of MR imaging and CT in assessing airspace opacification in a 5-year-old boy with hypersensitivity pneumonitis. A, Proton density weighted spin-echo MR image (TR 1782, TE 20) at the level of the great vessels shows extensive bilateral areas of increased signal intensity. B, CT scan (10 mm collimation) shows distribution of areas of airspace opacification similar to that seen on the MR image.
Figure 17. Malignant mesothelioma in a 57-year-old man. Coronal T2-weighted (4500/105) with fat saturation (A) and axial T1-weighted (821/14) with fat saturation (B) gadolinium-enhanced images reveal nodular pleural tumor encasing the right lung, involving the pericardium (black arrow), and extending into endothoracic fascia (white arrow).
Cavitating neoplasm
M 42Y Central adenocarcinoma with deposits in the lung and nodes
F47Y with chronic cough 4 years, sarcoidosis
Miliary TB