Role of PET /CT Fusion in diagnosis, staging and follow up of Bronchogenic carcinoma

Essay

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Radiology

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List of Abbreviations

- § BGO: bismuth germinate
- § C: carbon
- § CMS : the Centers for Medicare and Medicaid Services
- § CT : computed tomography
- § F: fluorine
- § FDG: fluorine 18 fluorodeoxyglucose
- § GLUT : glucose transporters
- § GSO : gadolinium silicate
- § H+ : hydrogen ions
- § IVC: inferior vena cava
- § LA: left atrium
- § LLL: Left lower lobe
- § LSO: lutetium oxyorthosilicate
- § Lt: left
- § LUL: Left upper lobe
- § LV: left ventricle
- § mCi: micro
- § MRI :magnetic resonance imaging
- § MRI-C :magnetic resonance imaging with contrast
- § NSCLC Non-small cell lung cancer
- § O:oxygen
- § PET : positron emission tomography
- § PET/CT: positron emission tomography/ computed tomography
- § PMTs: photomultiplier tubes
- § Ra: right atrium
- § RLL: right lower lobe
- § RML: right middle lobe
- § Rt: right
- § RUL : right upper lobe
- § RV: right ventricle
- § SCLC : Small cell lung cancer
- § SPN: simple pulmonary nodule
- § SUV: standard uptake value
- § SVC: superior vena cava
- § T4: thoracic vertebra 4
- § T5: thoracic vertebra 5
- § TTNA :Trans-thoracic needle aspiration

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Introduction

Lung cancer is one of the leading causes of morbidity and mortality. Various imaging modalities based on anatomic information continue to be important for the diagnosis and in the follow-up of this disease; however, they have a notable limitation of not allowing detection of morphologically normal but functionally abnormal tissues **(Krishnasetty, et al, 2005).**

Functional imaging with positron emission tomography (PET) is playing an increasingly important role in the diagnosis, staging disease, image-guided therapy planning and treatment monitoring of Bronchogenic carcinoma **(Krishnasetty, et al, 2005).**

PET with the labeled glucose analogue fluorine 18 fluorodeoxyglucose (FDG) is a relatively recent addition to the medical technology for imaging of cancer and FDG PET complements the more conventional anatomic imaging modalities of computed tomography (CT) and magnetic resonance imaging **(Krishnasetty, et al, 2005).**

CT is complementary in the sense that it provides accurate localization of organs and lesions, while PET maps both normal and abnormal tissue function. When combined, the two modalities can help both identify and localize functional abnormalities **(Krishnasetty, et al, 2005).**

Attempts to align CT and PET data sets with fusion software are generally successful in the brain; other areas of the body is more challenging, owing to the increased number of degrees of freedom between the two data sets **(Roberts , et al, 2005).**

These challenges have recently been addressed by the introduction of the combined PET/CT scanner, a hardware-oriented approach to image fusion. With such a device, accurately registered anatomic and functional images can be acquired for each patient in a single scanning session. Currently, over 800 combined PET/CT scanners are installed in medical institutions worldwide, many of them for the diagnosis and staging of malignant disease and increasingly for monitoring of the response to therapy **(Roberts, et al, 2005)**

While FDG uptake is not specific to cancer, it is well known that there is increased transport of glucose into malignant cells and up regulation of enzymatic activity resulting in increased tracer uptake. Combined PET/CT facilitates the separation of normal physiologic uptake from pathologic uptake, provides accurate localization of functional abnormalities, and reduces the incidence of false-positive and false-negative imaging studies. The imaging time for a whole-body scan is also markedly reduced **(Roberts, et al, 2005)**

PET/CT is a unique combination of the cross-sectional anatomic information provided by CT and the metabolic information provided by PET, which are acquired during a single examination and fused.
The functional and anatomic information offered by PET-CT is being recognized as crucial in the care of oncology patients. PET and PET-CT are playing an ever-increasing role in the management of oncologic disease. They have been accepted in the diagnosis, staging, and follow- up of non–small cell lung cancer, lymphoma, colorectal and esophageal cancer, melanoma, head and neck cancers, and breast cancer and for characterization of solitary pulmonary nodules **(Bar-Shalom, et al, 2003)**

Aim of the work

The purpose of this study is throwing light on the role of PET/CT in diagnosis, staging and follow up of bronchogenic carcinoma; this will be emphasized by presenting up-to-date informations about the effectiveness, accuracy, advantages and limitations of the use of PET/CT in management of bronchogenic carcinoma.

Anatomy

Lungs

Each lung is conical in shape, and has
- apex
- base
- three borders
- two surfaces

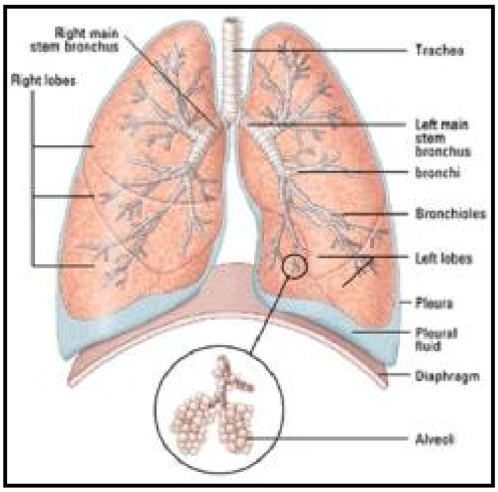

Fig 1

Apex
- rounded
- extends 2.5 to 4 cm into the root of the neck

Base

- broad and concave
- rests upon the convex surface of the diaphragm

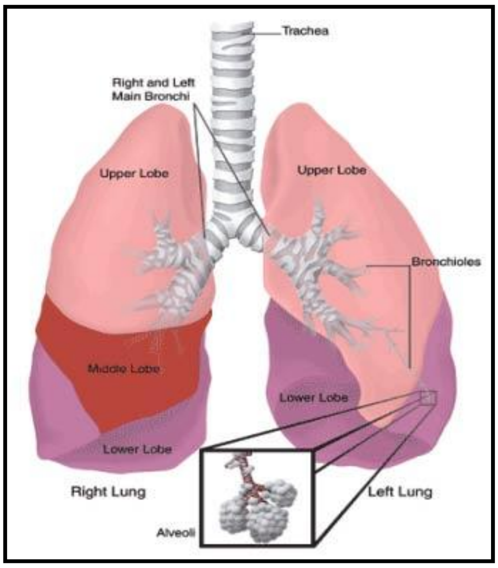

Fig 2

Surfaces
- costal surface
- mediastinal surface

Borders
- inferior border
- posterior border
- anterior border **(Goerres et al, 2002)**

Figures 1, 2 Lobar Anatomy of the lungs (Goerres, et al, 2002)

Fissures and Lobes of the Lungs

<u>Left lung</u>

- <u>**Fissure**</u>
  - Oblique fissure, which extends from the costal to the mediastinal surface of the lung both above and below the hilum, divides left lung into upper and lower lobes.

- **Lobes**
  - Upper lobe, Lies above and in front of this fissure, and includes the apex, the anterior border, and a considerable part of the costal surface and the greater part of the mediastinal surface of the lung.
  - Lower lobe, the larger of the two, is situated below and behind the fissure, and comprises almost the whole of the base, a large portion of the costal surface, and the greater part of the posterior border **(Goerres, et al, 2002).**

Right lung

- **Fissures**
  - Oblique fissure separates lower lobe from upper and middle lobe, Right oblique fissure is more vertical than left.
  - Transverse fissure separates middle lobe from upper lobe, Transverse fissure begins in the oblique fissure near the posterior border of the lung, and, running horizontally forward, cuts the anterior border on a level with the sternal end of the fourth costal cartilage; on the mediastinal surface it may be traced backward to the hilum **(Goerres, et al, 2002).**
- **Lobes**
  - Upper lobe
  - Middle lobe
  - Lower lobe

Hilum

- By which the lung is connected to the heart and the trachea.
- The structures composing the root of each lung are arranged similarly
  - The upper two pulmonary veins in front
  - The pulmonary artery in the middle
  - The bronchus and the bronchial vessels posteriorly **(Goerres, et al, 2002).**

Relationships

- The root of the right lung
  - lies behind the superior vena cava and part of the right atrium
  - Below the azygos vein.

- The left lung root
  - passes beneath the aortic arch and in front of the descending aorta
- Pulmonary ligament is below on both sides **(Goerres, et al, 2002).**

Tracheo-bronchial tree

Trachea

- Trachea divides at the level of Loui's angle into right and left main bronchi(**Carina)**

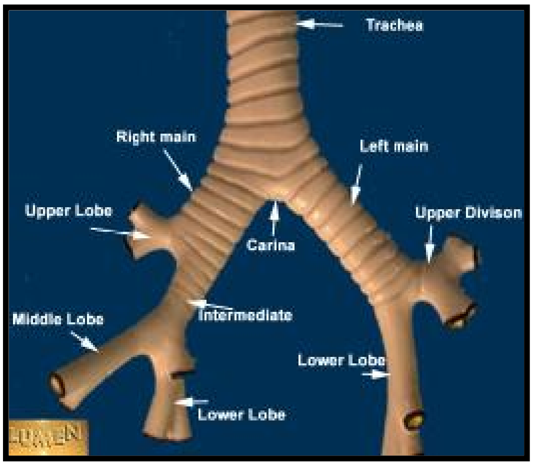

Fig 3 the tracheo-bronchial tree (Gruden, et al, 2000)

I. **Right main stem bronchus** Is short 2.5 cm in length and vertical

1. **Right upper lobe bronchus** takes off 2.5 cm. from the bifurcation of the trachea giving
   - **RUL segments**
     - Apical
     - Anterior
     - Posterior
2. **Right intermediate bronchus divides into:**
   - **Right middle lobe bronchus** takes off anteriorly
     - **RML segments**
       - Medial
       - Lateral
   - **Right lower lobe bronchus** passes downward and backward and divides into
     - **RLL segments**
       - Apical
       - Medial, first branch
       - Anterior
       - Posterior
       - Lateral (**Gruden, et al, 2000).**

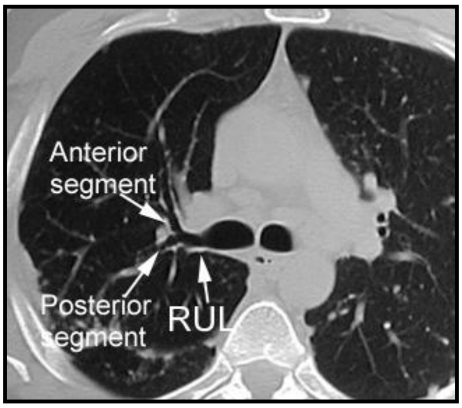

Fig 4

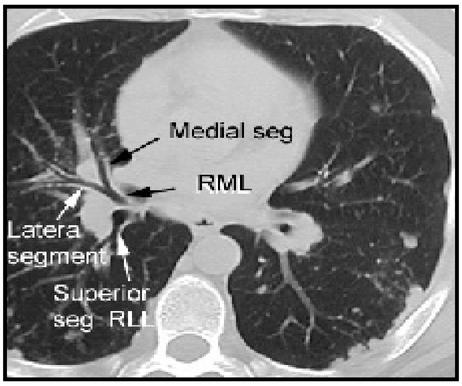

Fig 5

(Figures 4 - 6 axial CT cuts of the segmental branches of the right main bronchus (Gruden, et al, 2000)

II. **Left main stem bronchus**

5 cm long and oblique, Passes below the level of the pulmonary artery before it divides

1. **Left upper Lobe division**
   - **Left upper lobe**
     - **LUL segments**
       - Apical posterior
       - Anterior
   - **Lingula**
     - **Lingular segments**
       - superior
       - Inferior
2. **Left lower lobe bronchus**
   - **LL segments**
     - Superior
     - Andromeda
     - posterior
     - lateral **(Gruden, et al, 2000)**

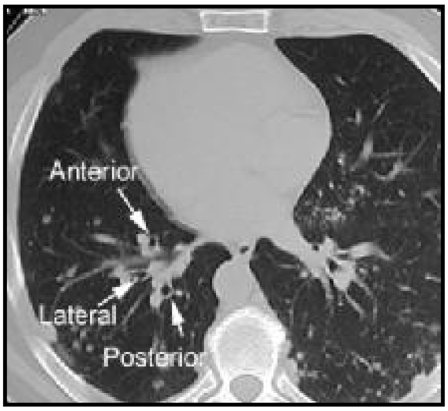

Fig 6

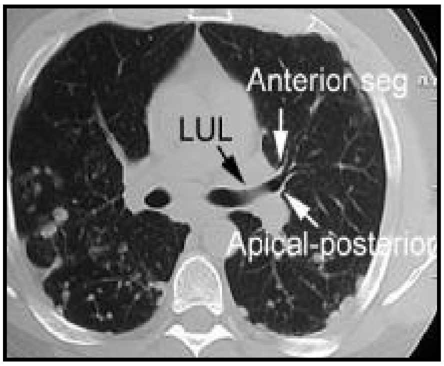

Fig 7

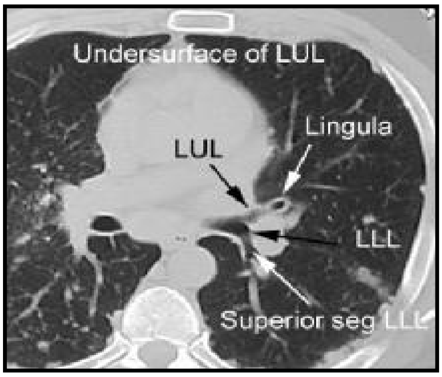

Fig 8

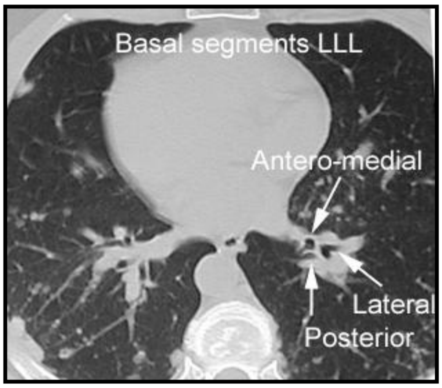

Fig 9

Figures 7 - 9 axial CT cuts of the segmental branches of the left main bronchus (Gruden, et al, 2000)