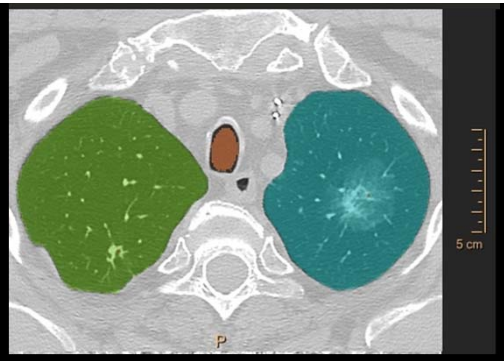
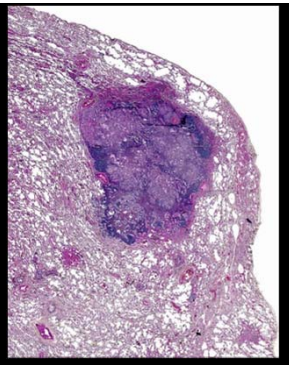





Lung nodules: Common pitfalls

ESTI-Feischner 2015-Barcelona
Emmanuel Coche, MDPhD
Head of Dept Medical Imaging
Cliniques Universitaires St-Luc
Brussels-Belgium

Background

- MDCT, PET-CT has improved the sensitivity and specificity for detection of pulmonary nodules
- Despite these technological advances, numerous pitfalls may result in misdiagnosis of pulmonary nodules
- The number of indeterminate lung nodules on CT is expected to further increase due to initiation of lung cancer screening programs

Aim of the presentation

- To review the most common pitfalls encountered in the diagnosis of lung nodules using Chest X-ray, CT, PET-CT
- To provide tips and tricks to the audience to avoid misinterpretation

Lung nodule: Definition

- A nodule appears as a rounded or irregular opacity, well or poorly defined, measuring up to 3 cm in diameter
- Size

  <3mm: micronodule

  3mm-3cm: nodule

  >3cm: mass

ELCAP study (% malignancy in relationship with nodule size)

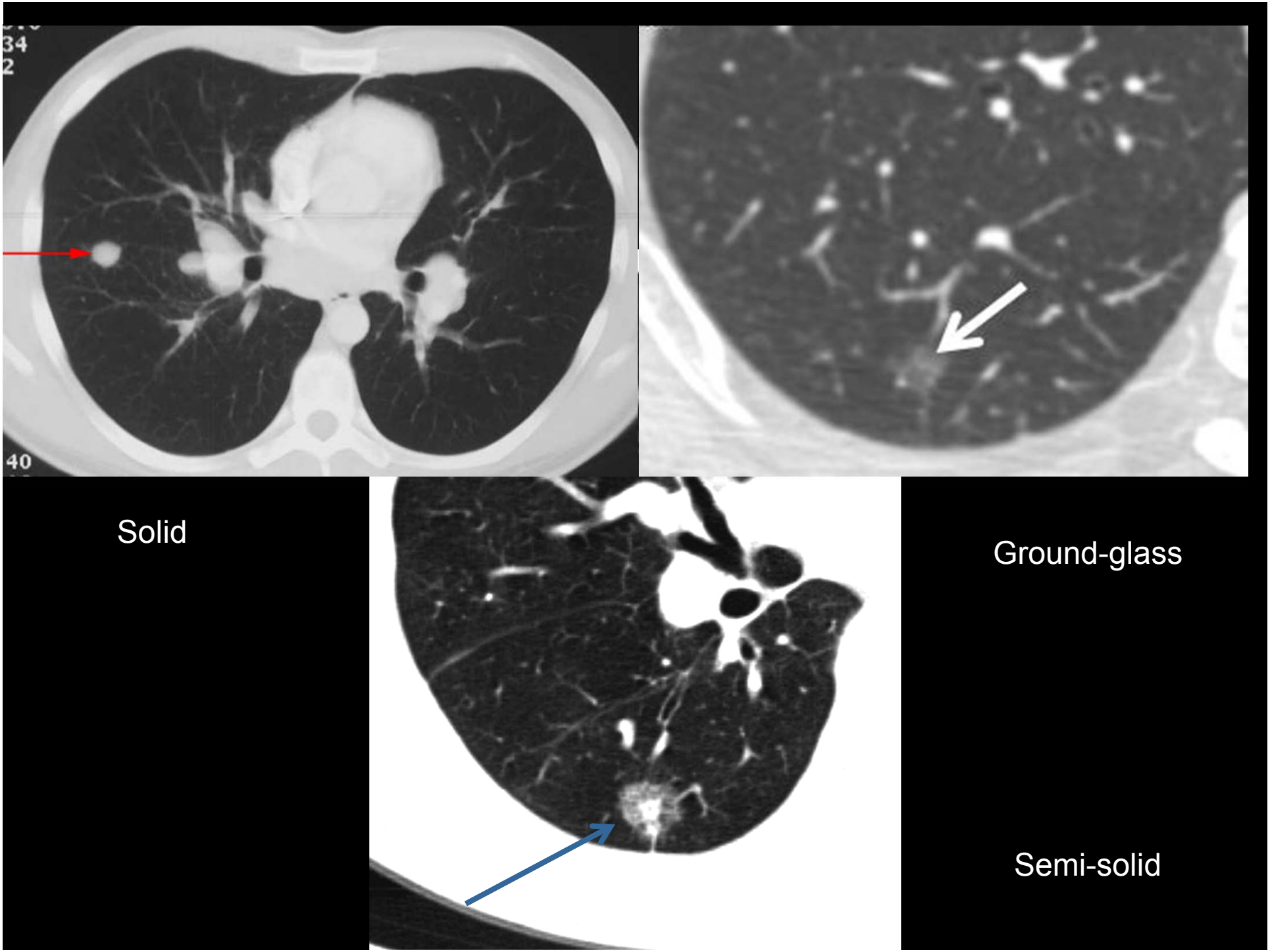
1%	<5mm
24%	6-10mm
33%	11-20mm
80%	>20mm

Hansell DM, Bankier AA, MacMahon H, McLoud TC, Müller NL, Remy J. Fleischner Society: glossary of terms for thoracic imaging. Radiology 2008; 246(3):697-722

Lung nodule: Definition

- Density
- 3 categories
  - Solid
  - Subsolid
  - Ground-glass
- *ELCAP study (% malignancy in relationship with density)*
- 7% solid nodules
- 18% ground glass nodules
- 63% semi-solid nodules

Henschke CL, McCauley DI, Yankelevitz DF, et al. Early lung cancer action project: overall design and findings from baseline. Lancet 1999 (354):99-105


Solid
Ground-glass
Semi-solid

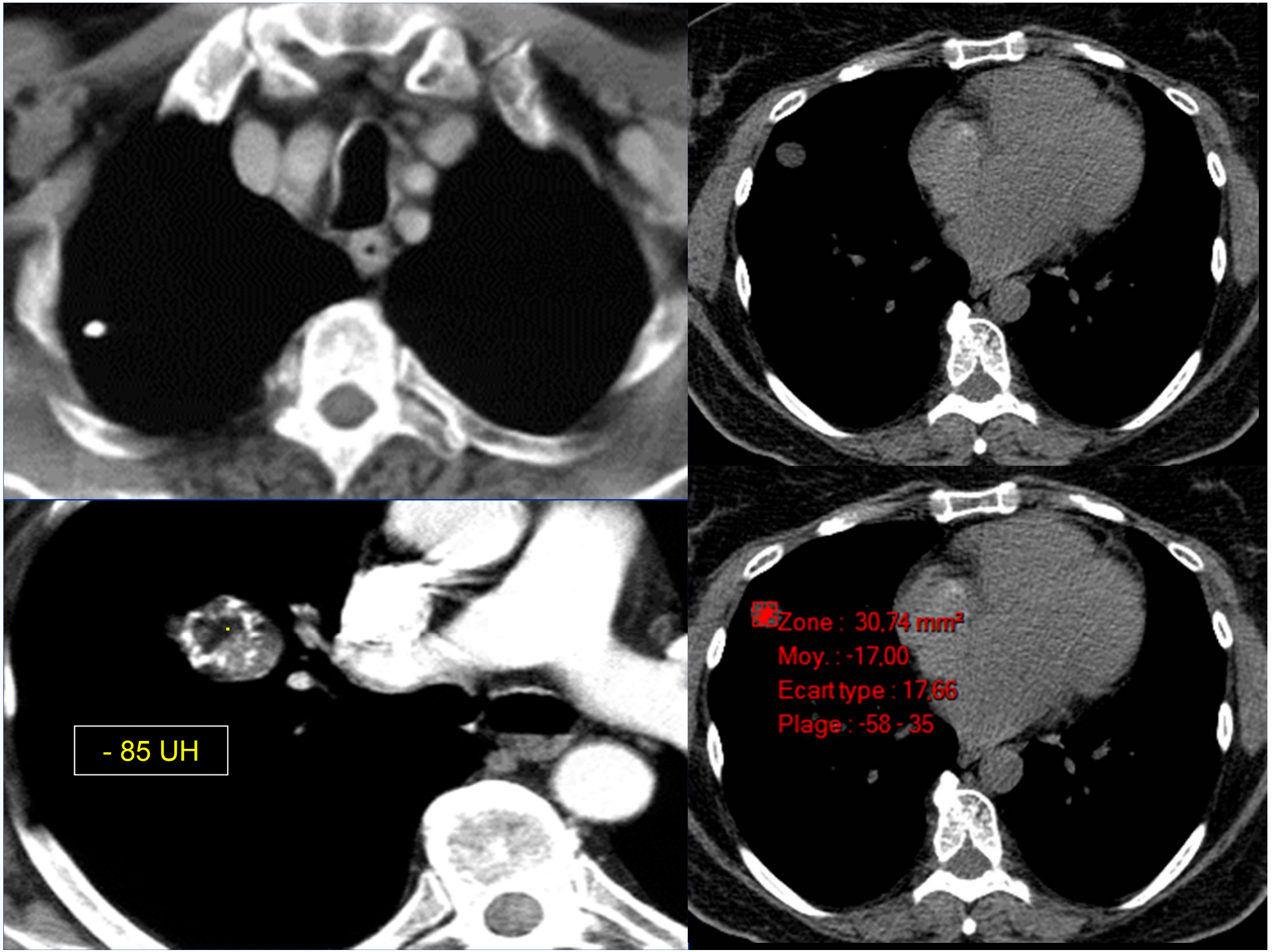
Specific nodules

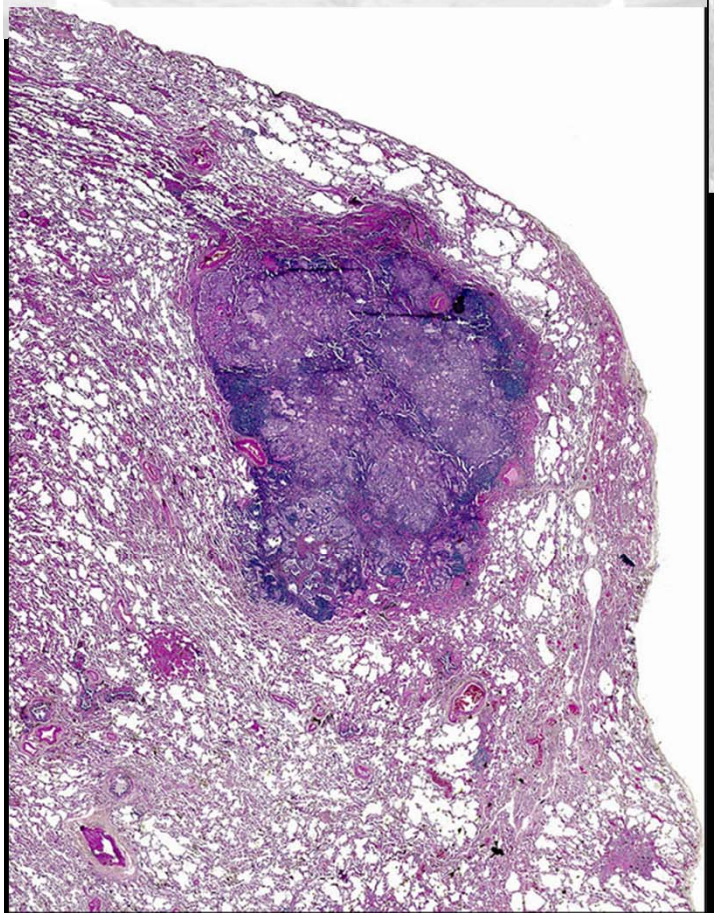
Benign:

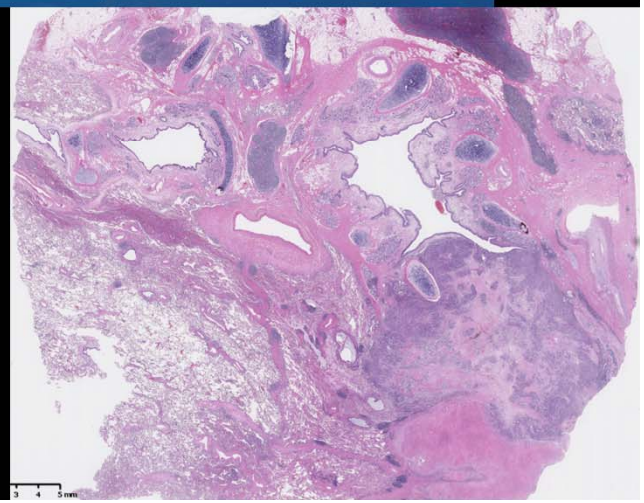
- ✓Fat content : HAMARTOMA
- ✓Central calcification : GRANULOMA
- ✓Polygonal, perifissural or near a septae: LYMPHNODE

Malignant:

- ✓Spiculated or irregular contours
- ✓microcalcifictions
- ✓Pleural tags


- 85 UH
Zone : 30,74 mm²
Moy. : -17,00
Ecart type : 17,66
Plage : -58 - 35

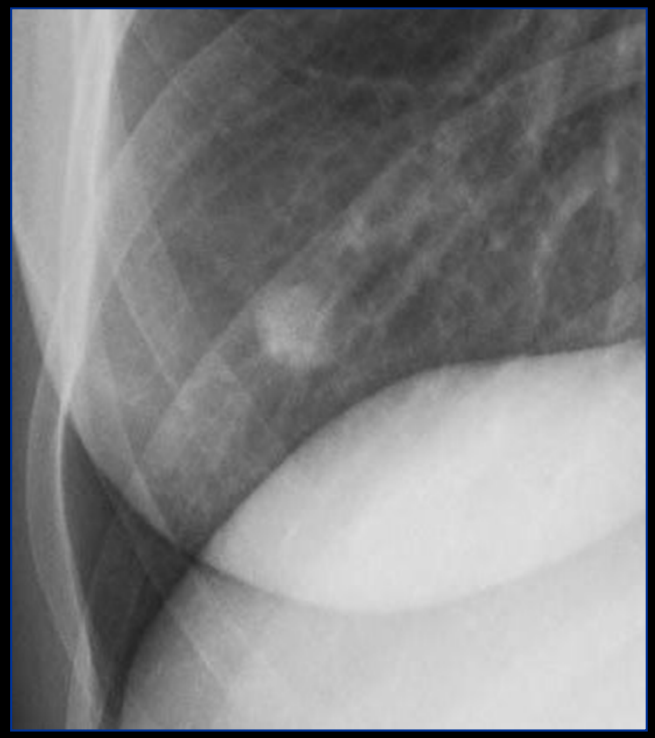


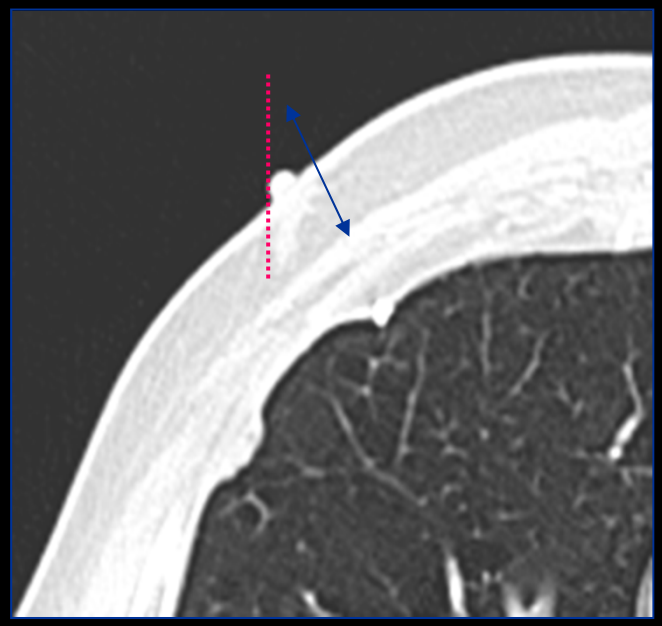


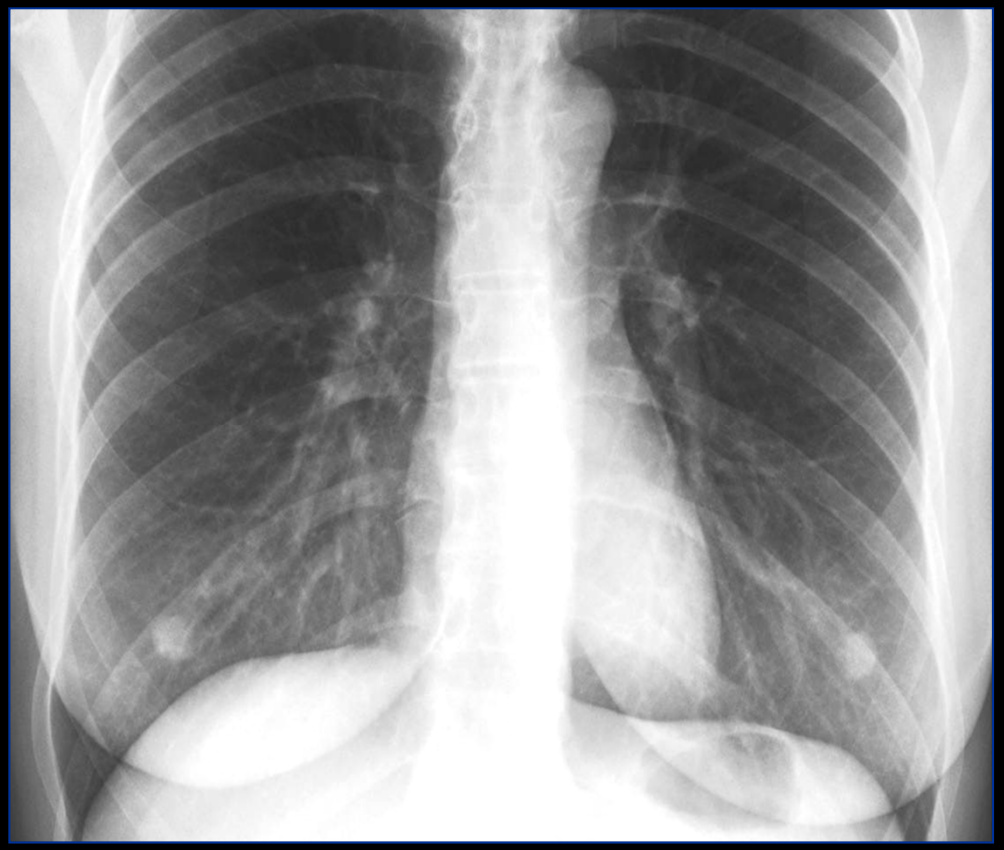
Chest X-ray

- Digital chest radiography is the most common radiological examination
- A solitary nodule is detected on 0,09-0,20% of all chest radiographs

Ost D, Fein AM, Feinsilver SH. The solitary pulmonary nodule. NEJM (2003);348(25):2535-42

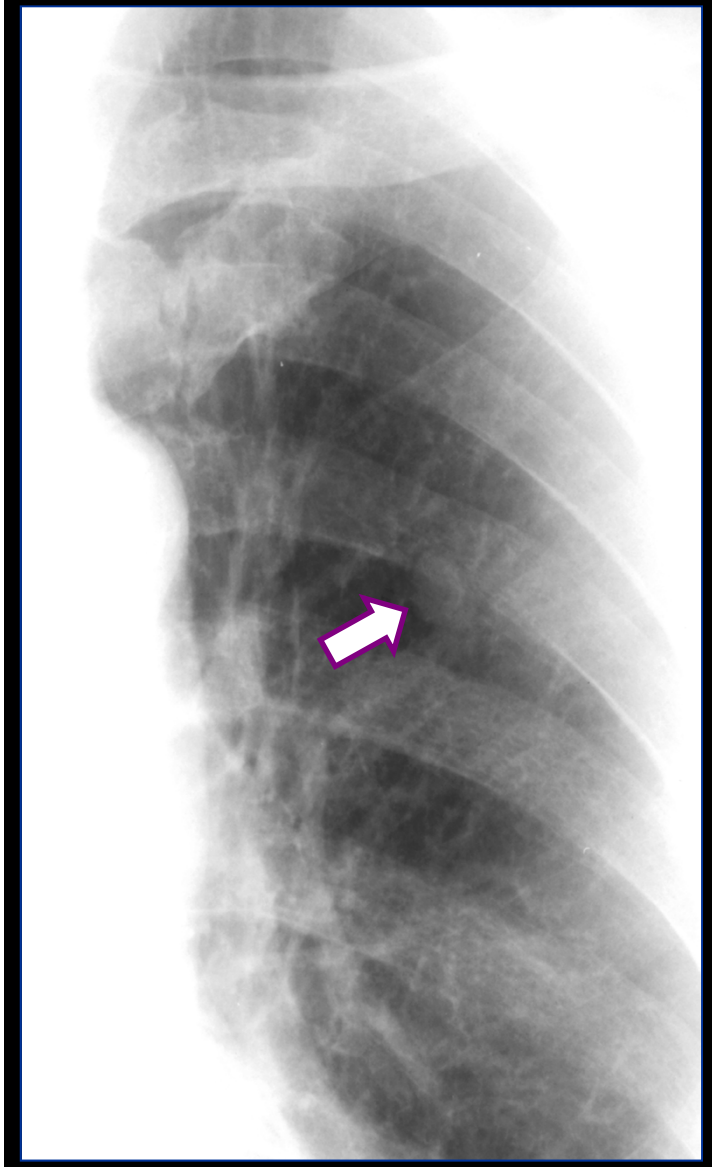




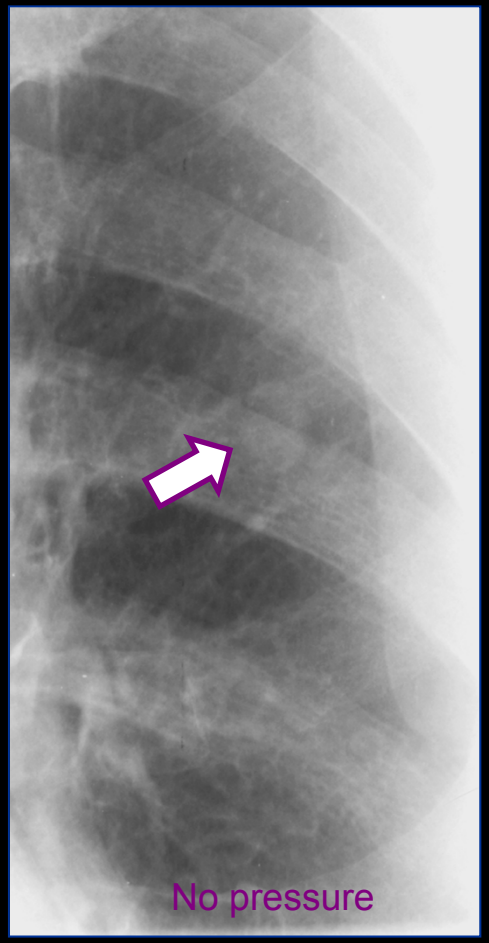


Nipple
(pseudo-nodule)

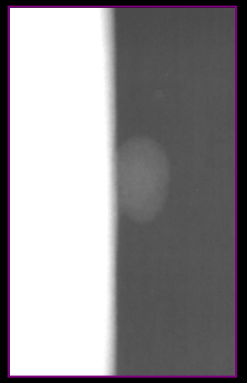
→ Nipple sign

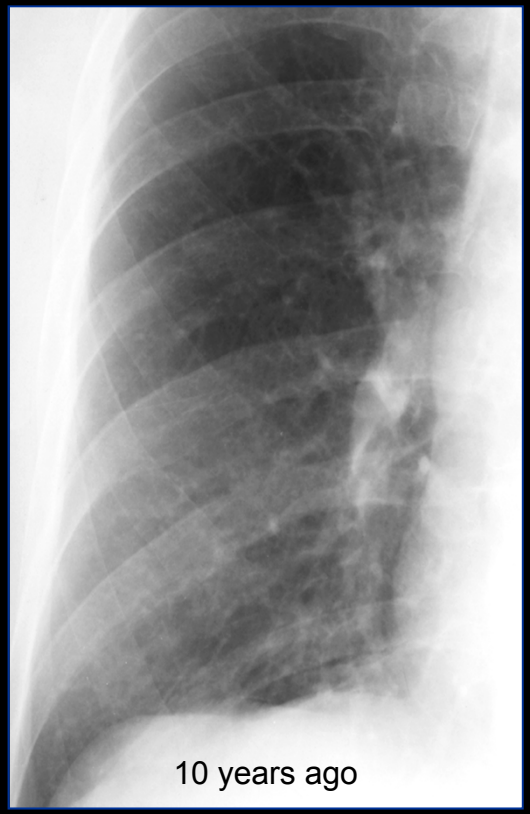


NODULE
or
PSEUDO-NODULE ?

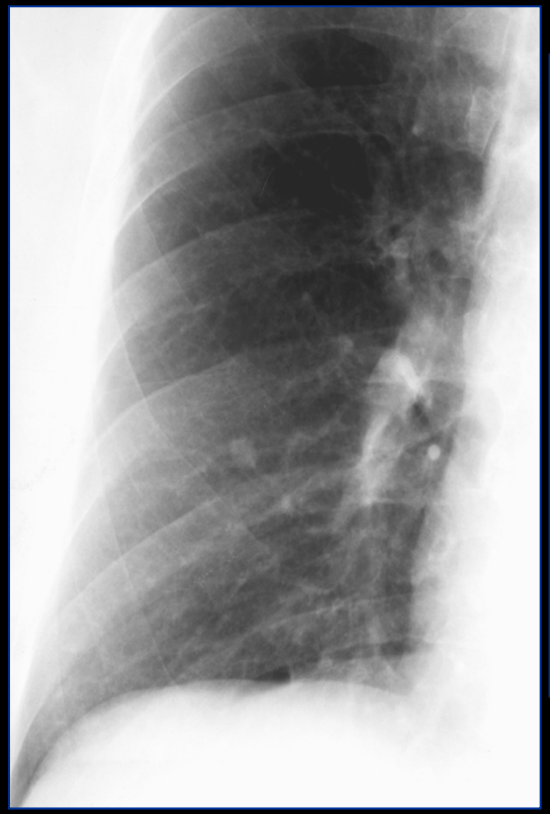


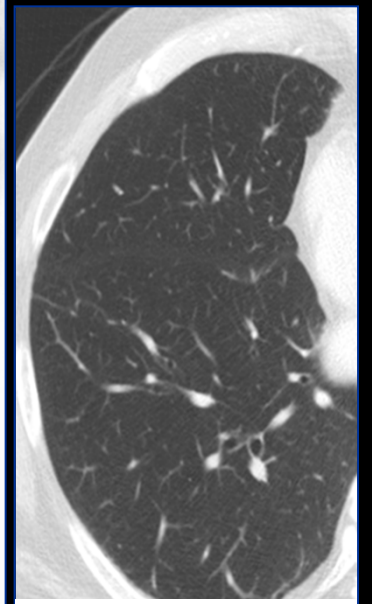
Fluoroscopy





10 years ago



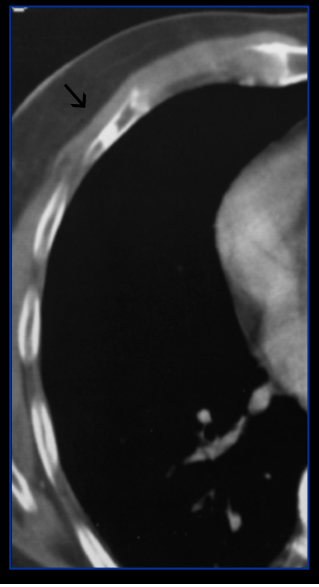


2 chest CT!!

FIRST EXAMINATION= FLUOROSCOPY/ULD CT

15 à 20% of nodules are pseudo-nodules

Fluroscopy / X-ray



Vertebral pseudo-nodule
(T11 / T12 / L1)

Multi-slice CT

- Increased number of nodules detected by MSCT with an estimation of 150,000 lung nodules each year in the United States
- Important number of indeterminate nodules requiring CT follow-up

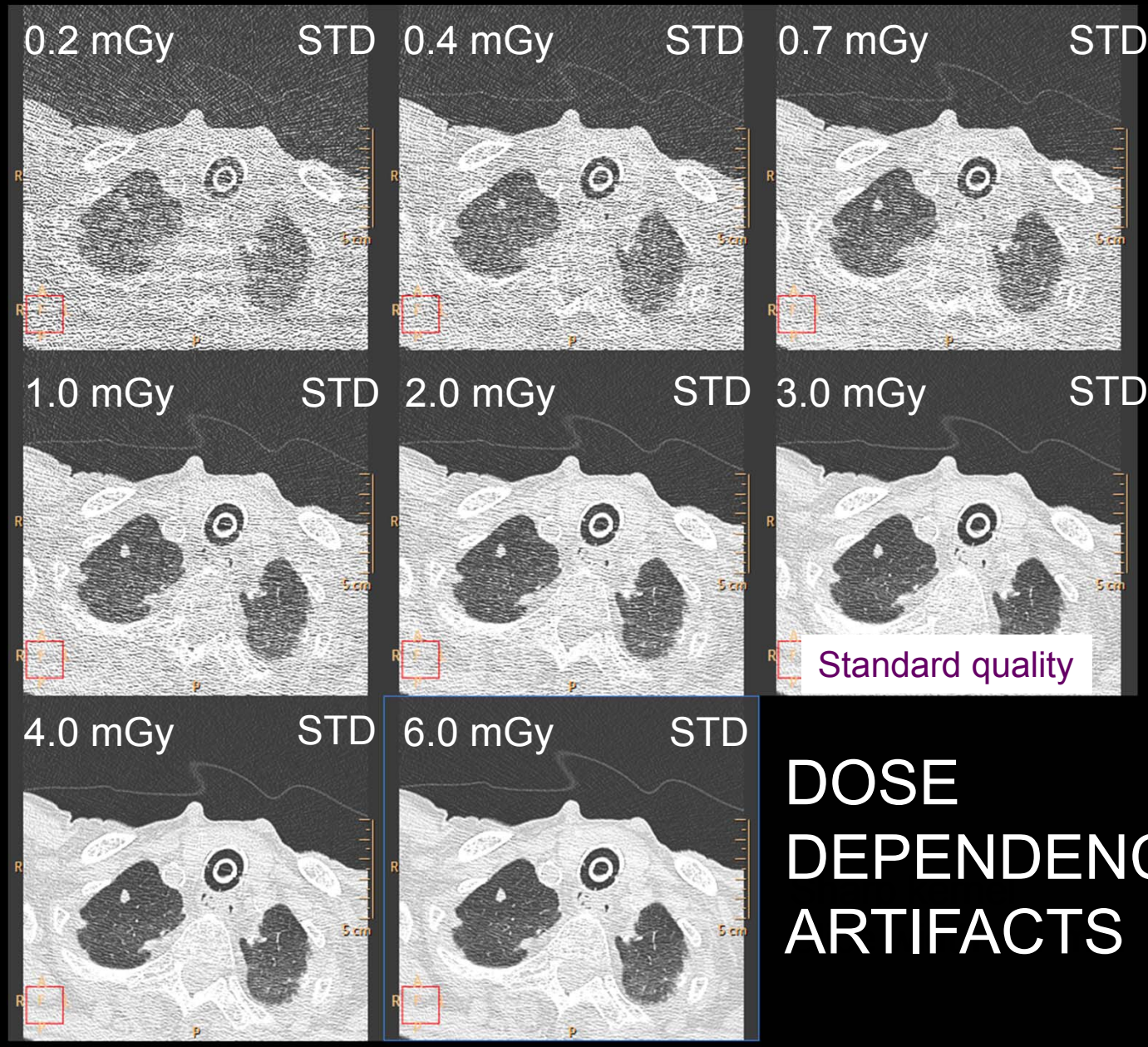
Godoy MC, Truong MT, Carter BW, et al. Pitfalls in nodule characterization. Semin. Roentgenol. April 2015

Common pitfalls in detection

- Lack of visualization
  - Very low dose, Artifacts
  - Disturbing envirronment
  - Dependent densities

Lung parenchyma vizualisation: STD

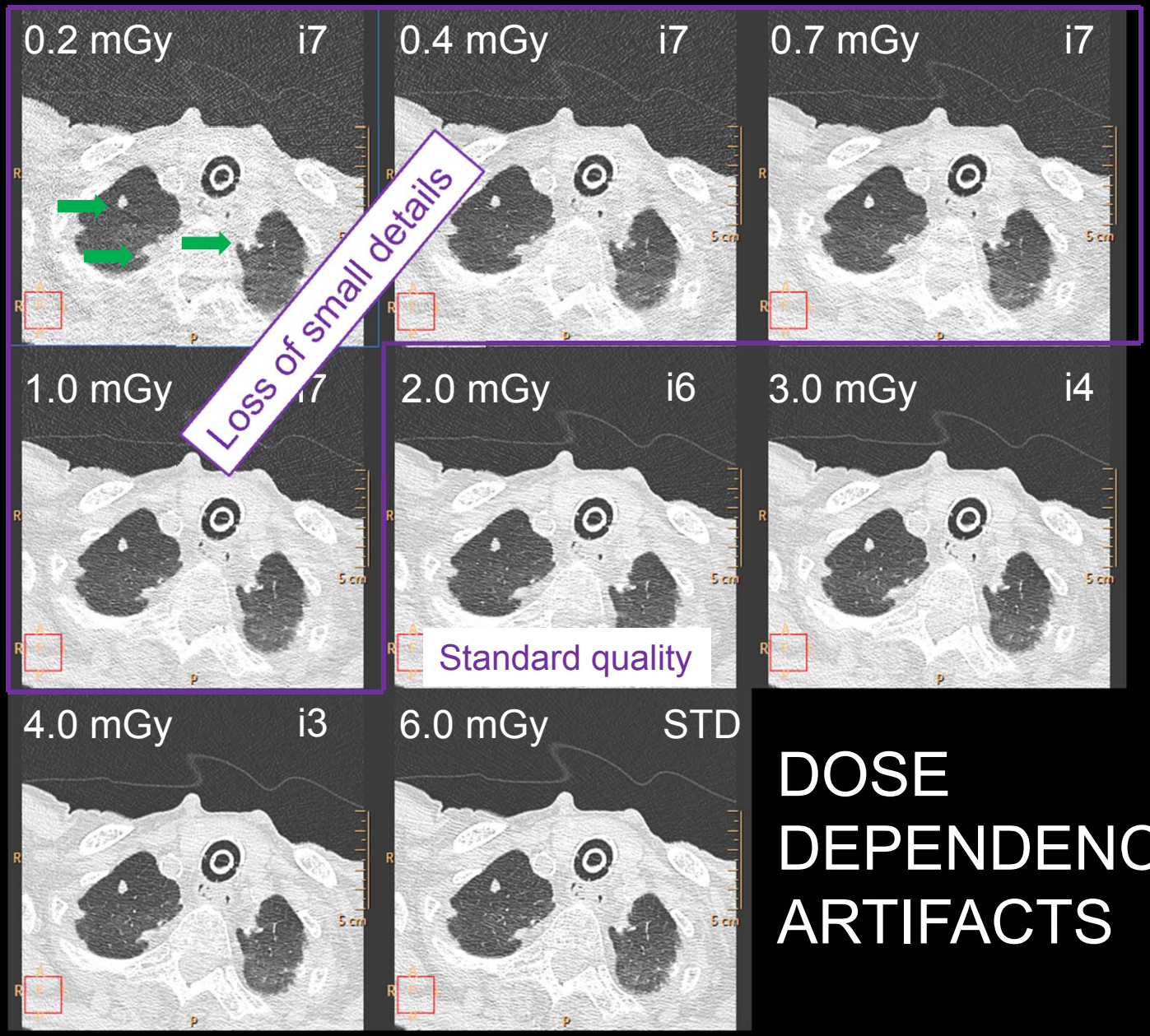
CADAVER SCANS



DOSE DEPENDENCE ARTIFACTS

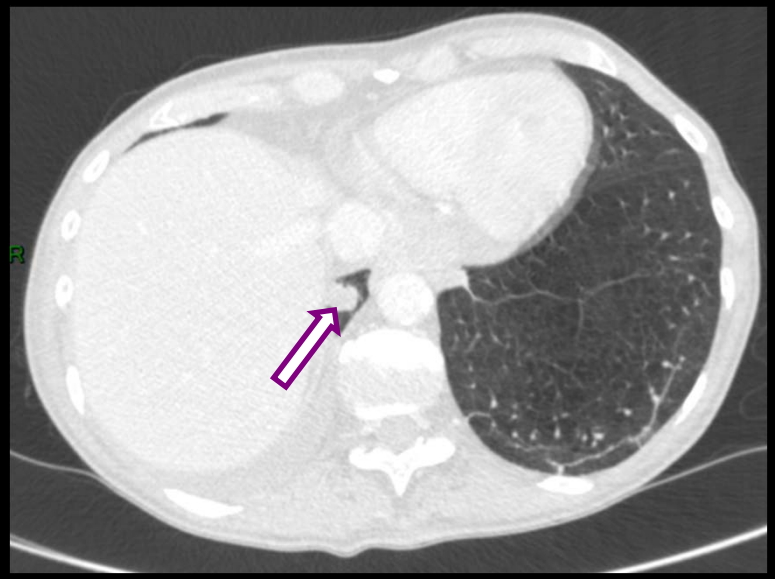
Lung parenchyma vizualisation: iDose^4

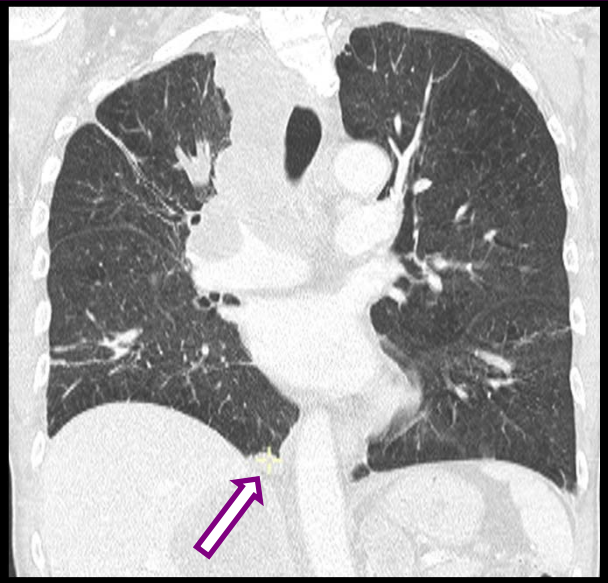
CADAVER SCANS

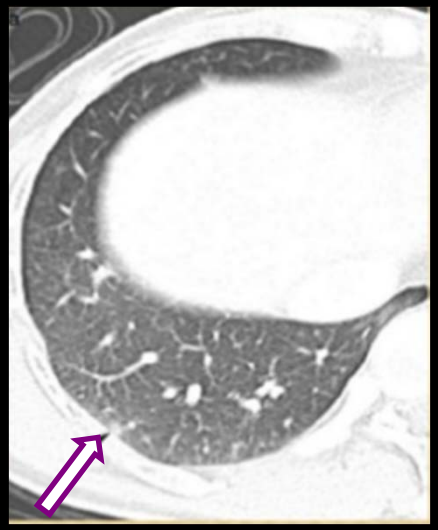


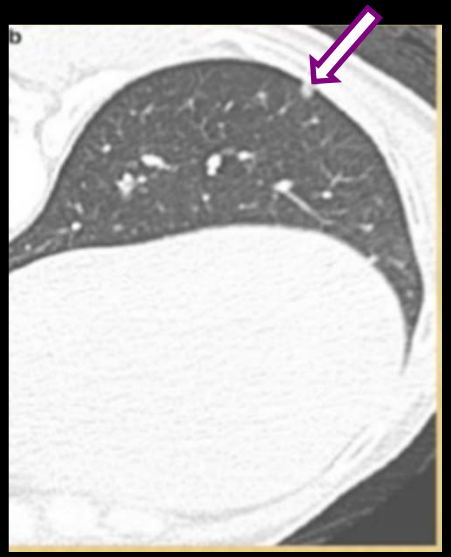
DOSE DEPENDENCE ARTIFACTS

Dependent densities and hidden areas









Tips and tricks

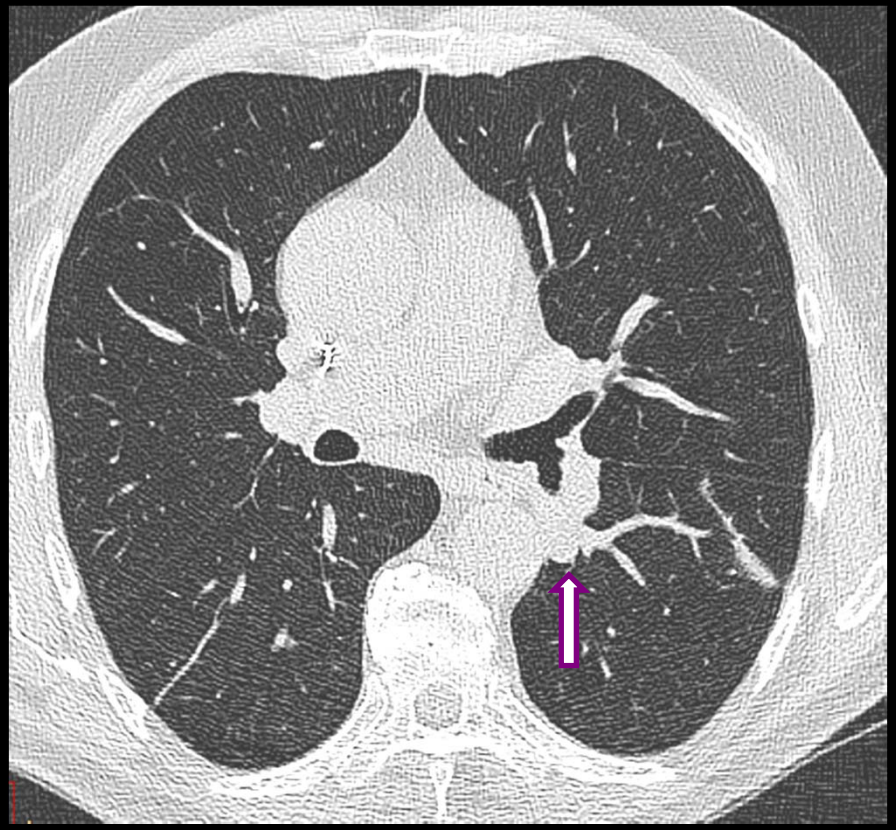
- Prone images shoud be obtained if suspicion in the costo-phrenic angles
- MPR
- Deep inspiration

Common pitfalls in detection

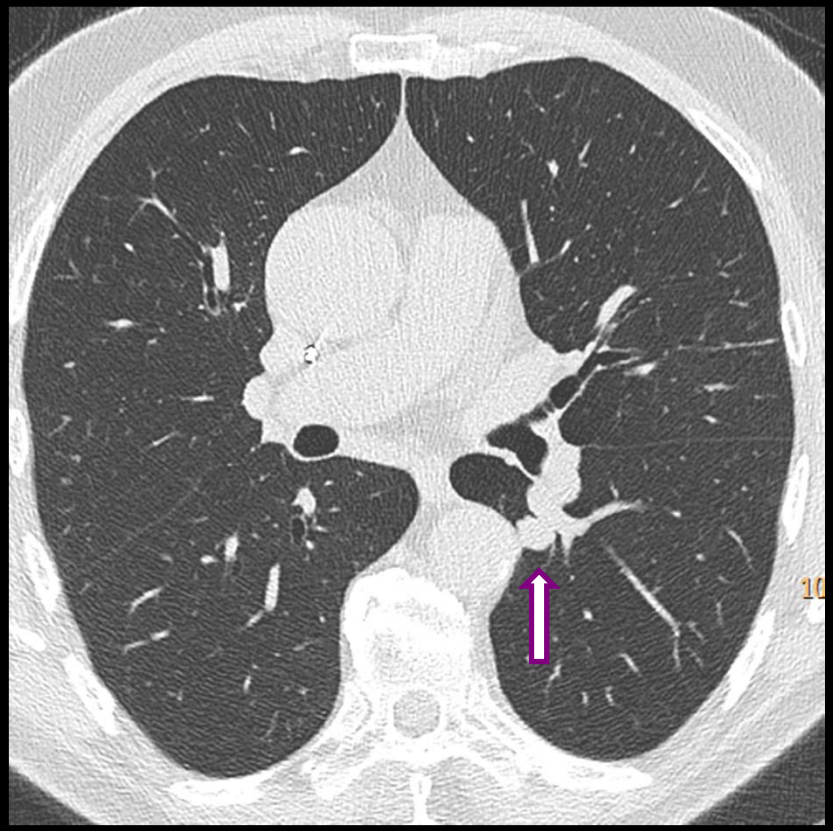
- Lack of visualization
  - Very low dose, Artifacts
  - Disturbing envirronment
  - Dependent densities

- Confusion with anatomical structures
  - Vessels
  - Bronchi (mucous plugs)
  - Chest wall (degenerative changes)

Vessels

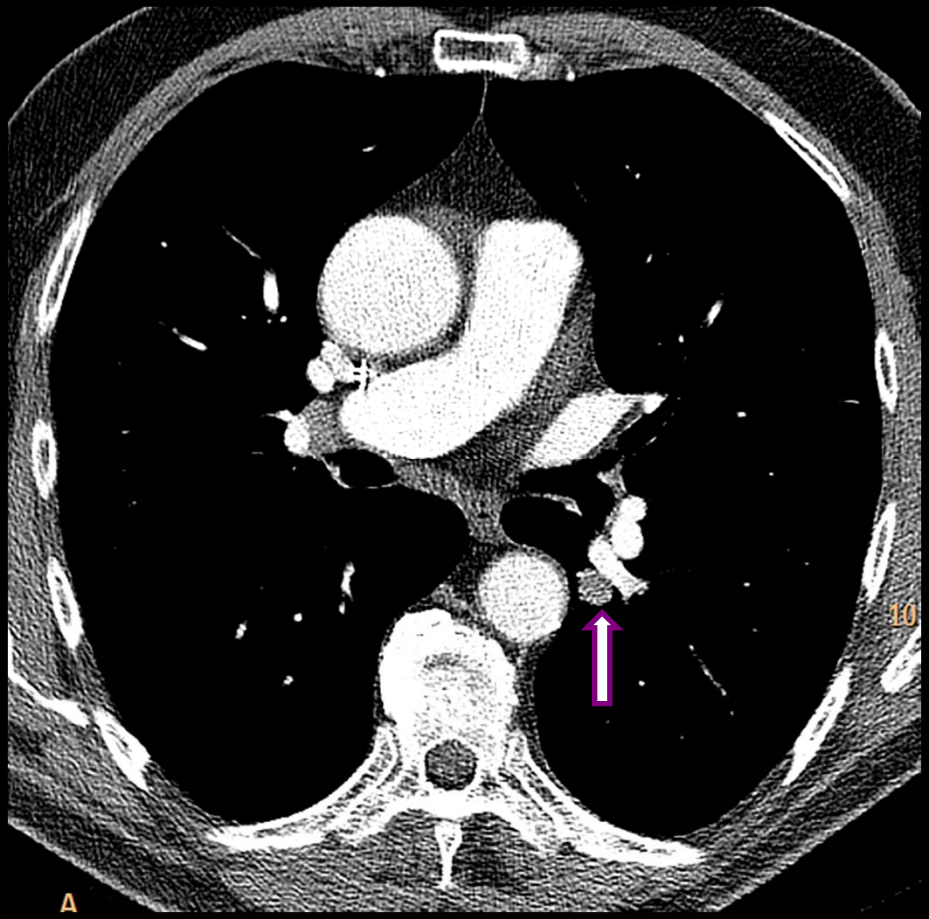


October 2014

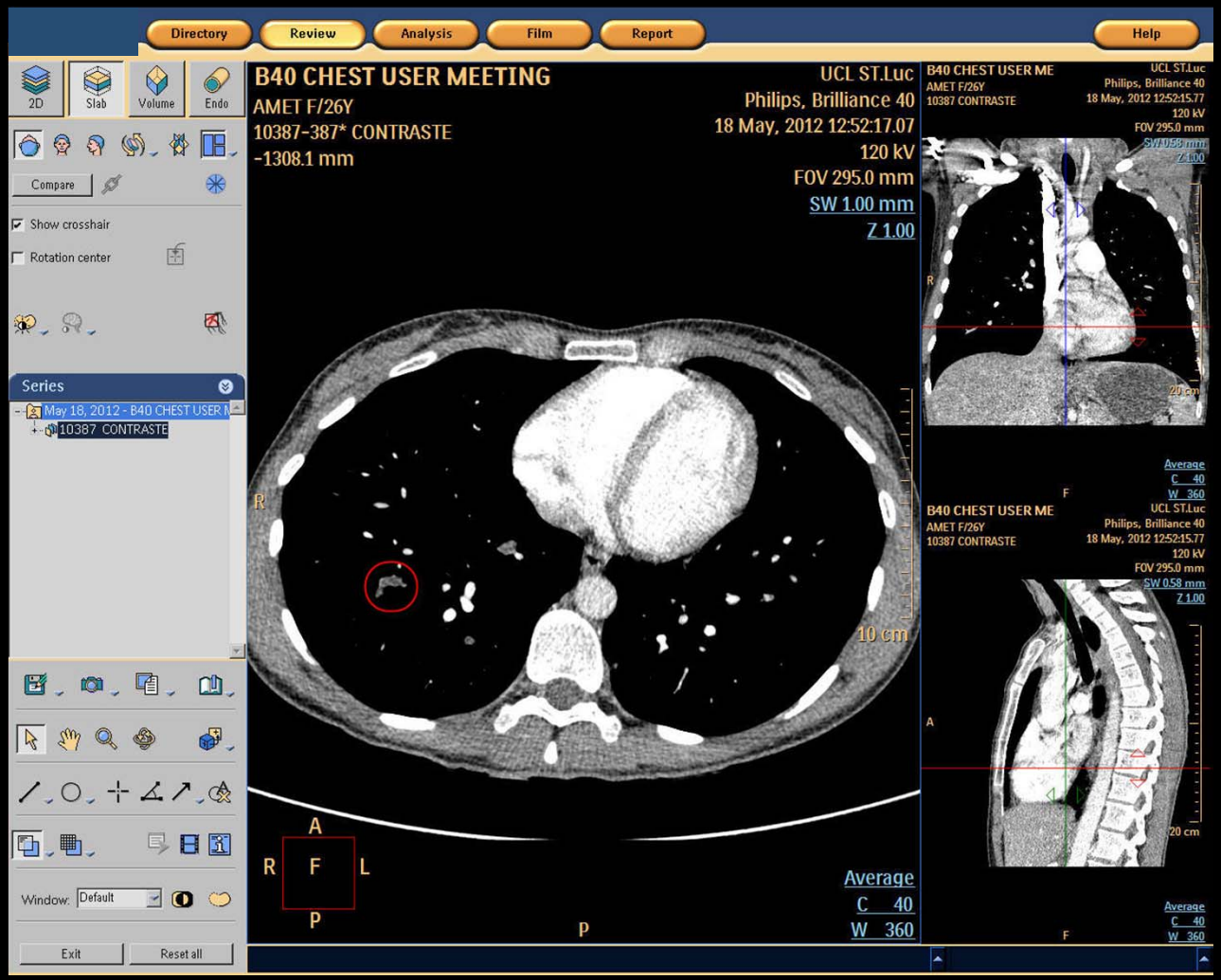


January 2015

CT with IV contrast/PET-CT

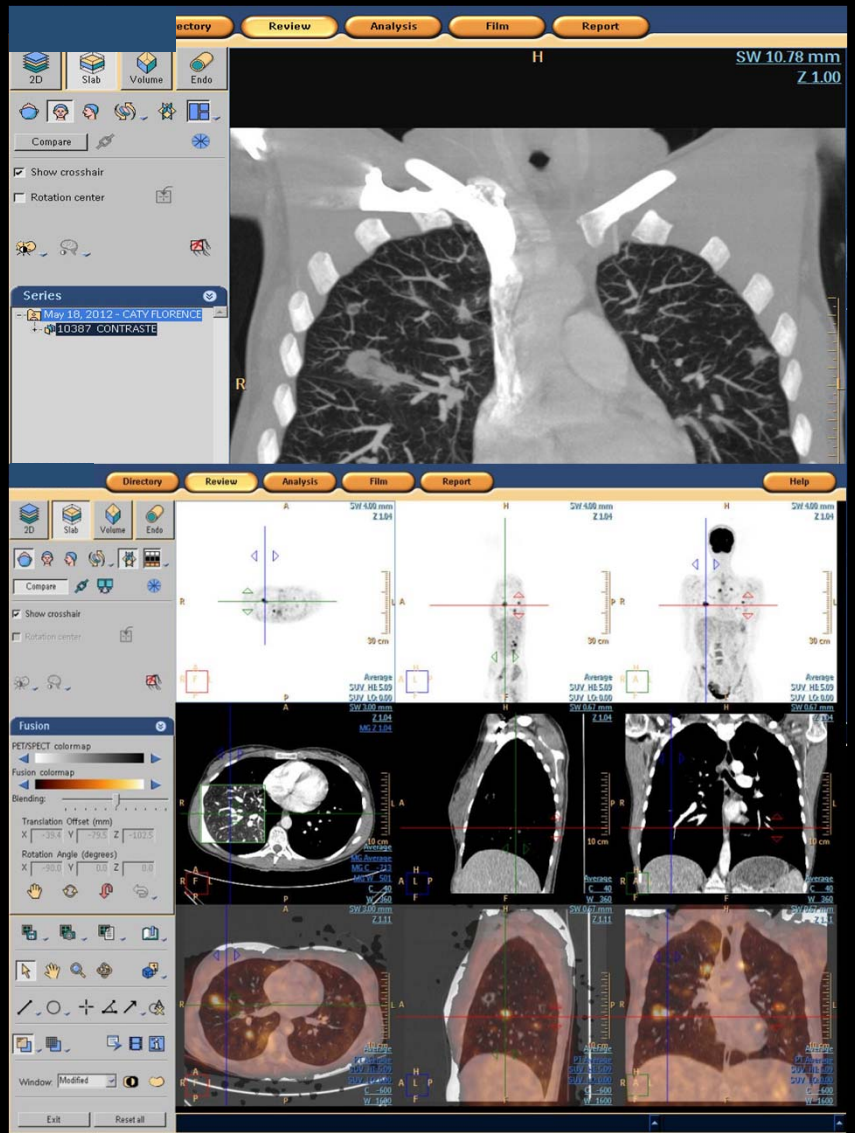


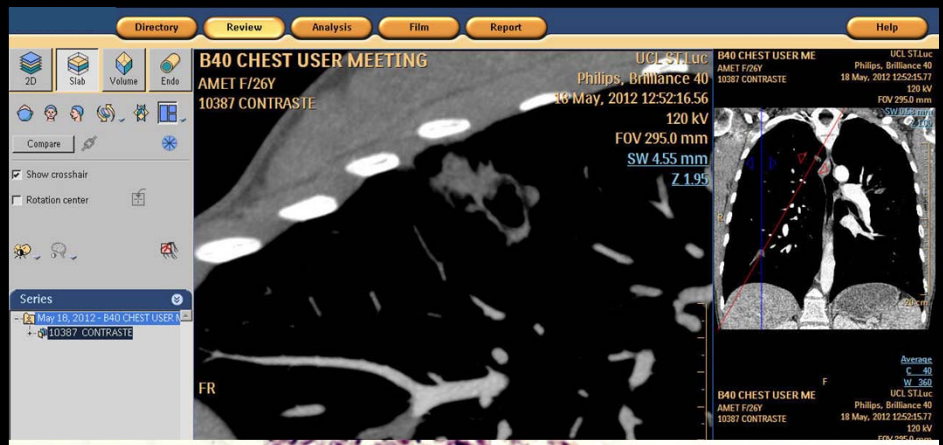
Vessels

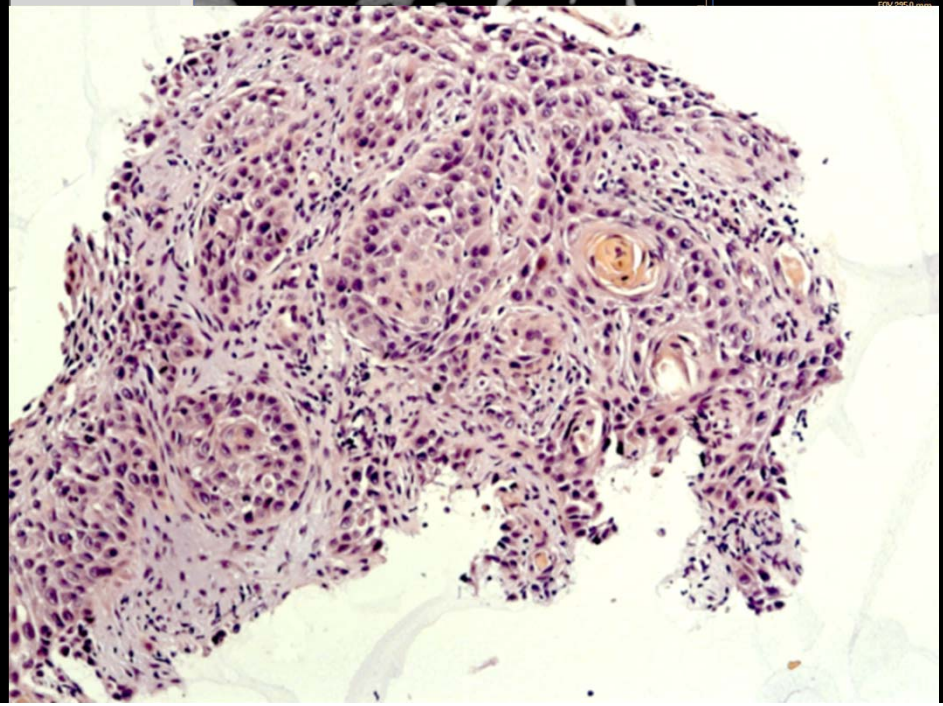


- Previous squamous cell carcinoma of the tongue (2010), moderately differenciated, CT1N0M0
- Treated by partial glossectomy, cervical lymphadenectomy (IV Left, III Right)
- Cough, haemoptysis, tooth extraction 1 month ago, local status unremarkable

MIP Mode + MPR

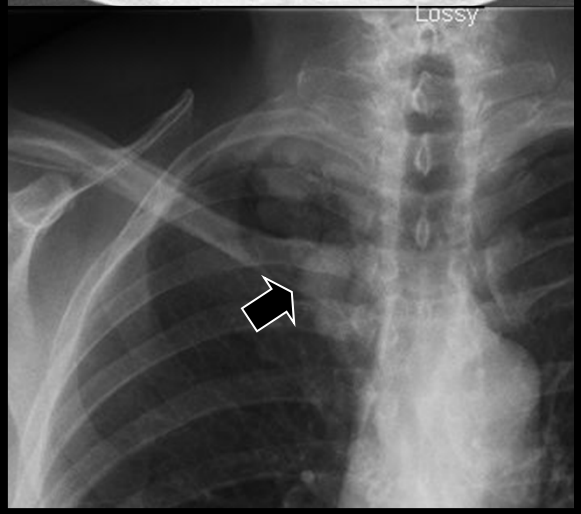

Directory
Review
Analysis
Film
Report
Help
2D
Slab
Volume
Endo
Compare
Show crosshair
Rotation center
Series
May 18, 2012 - CATY FLORENCE
10387 CONTRASTE
SW 10.78 mm
Z 1.00
Fusion
PET/SPECT colormap
Fusion colormap
Blending:
Translation Offset (mm)
Rotation Angle (degrees)
Window
Modified
Exit
Reset all


Directory
Review
Analysis
Film
Report
Help
B40 CHEST USER MEETING
AMET F/26Y
10387 CONTRASTE
UCL ST.Luc
Philips, Brilliance 40
18 May, 2012 12:52:16.56
120 kV
FOV 295.0 mm
SW 4.55 mm
Z 1.95
FR
Series
10387 CONTRASTE



Vascular abnormalities

Pulmonary arteriovenous malformation



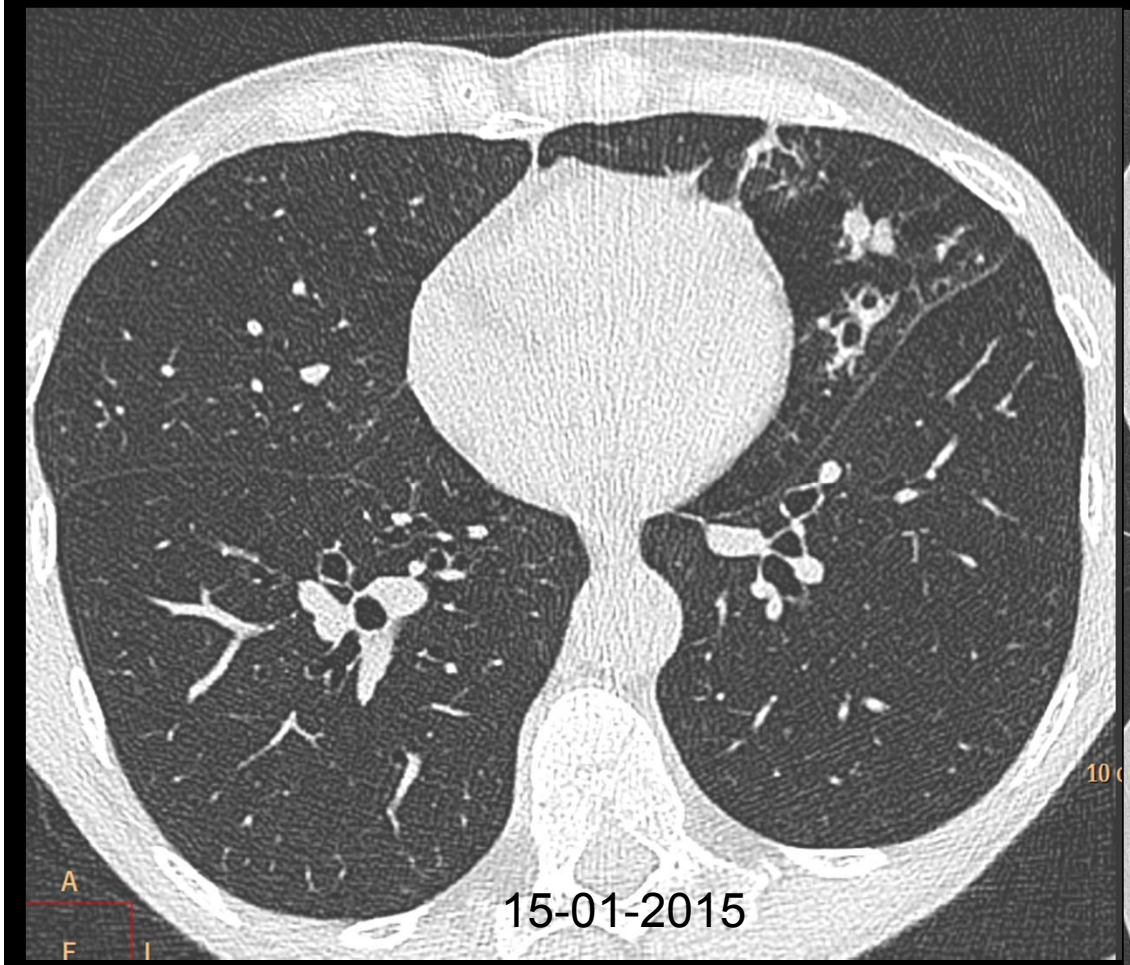
Pulmonary varix

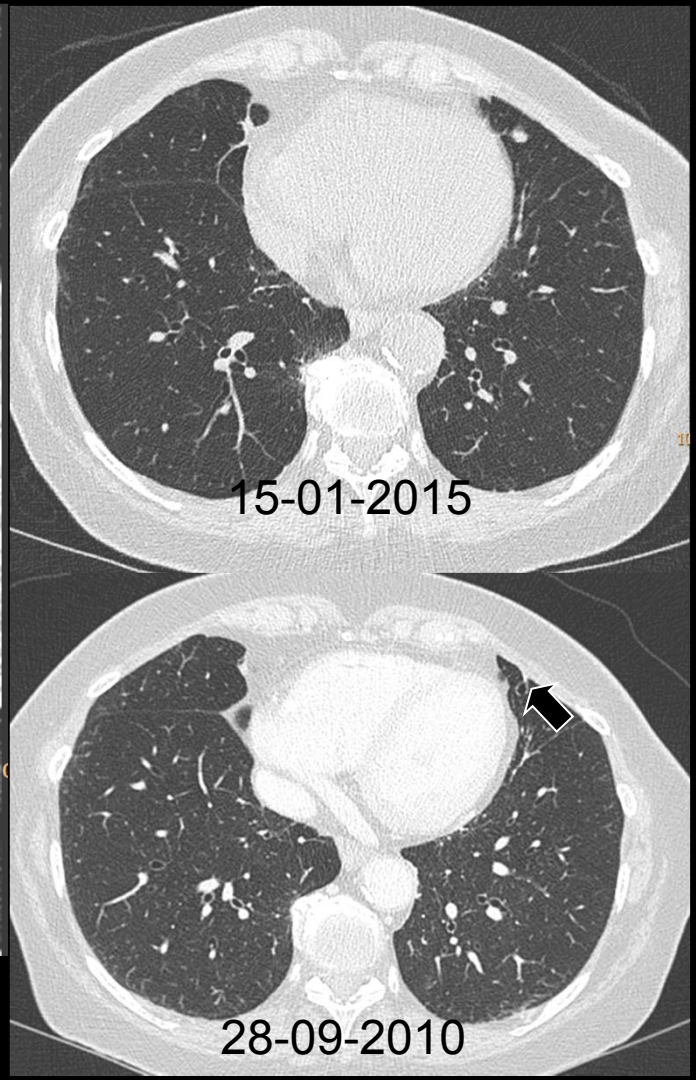
Pulmonary varix: a diagnostic pitfall. Davia JE, Golden MS, Price HL, Hastings JE, Cheitlin MD. Circulation (194);49(5):1011-2

Tips and tricks

- MPR-MIP
- Contrast medium opacification
- Vascular contact
- Clinical context

Confusion with bronchi



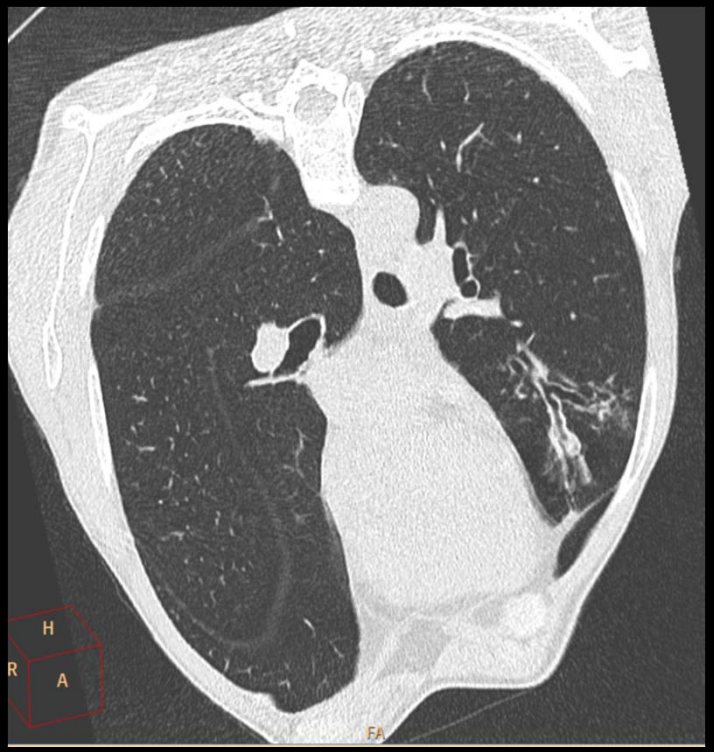


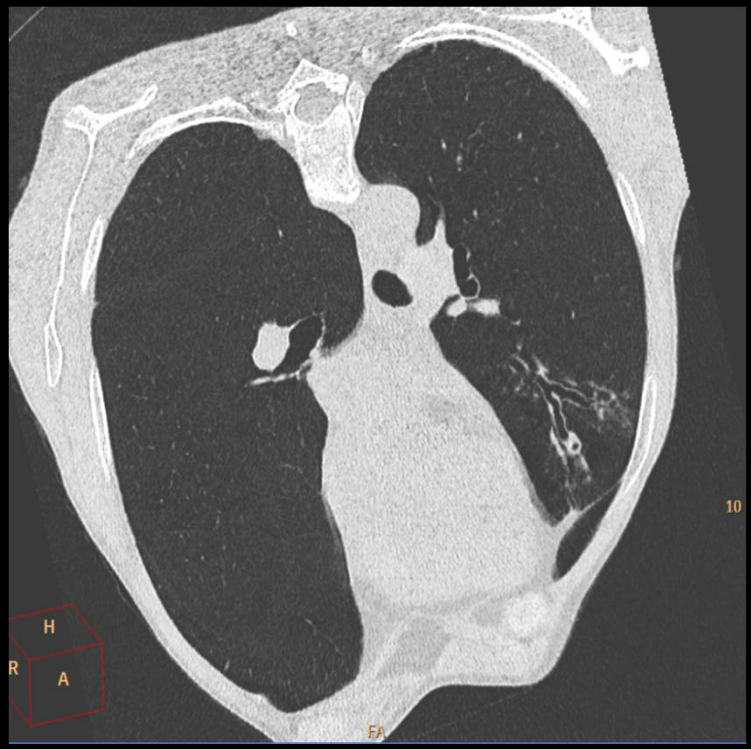
Comparison with previous examinations

Tips and tricks

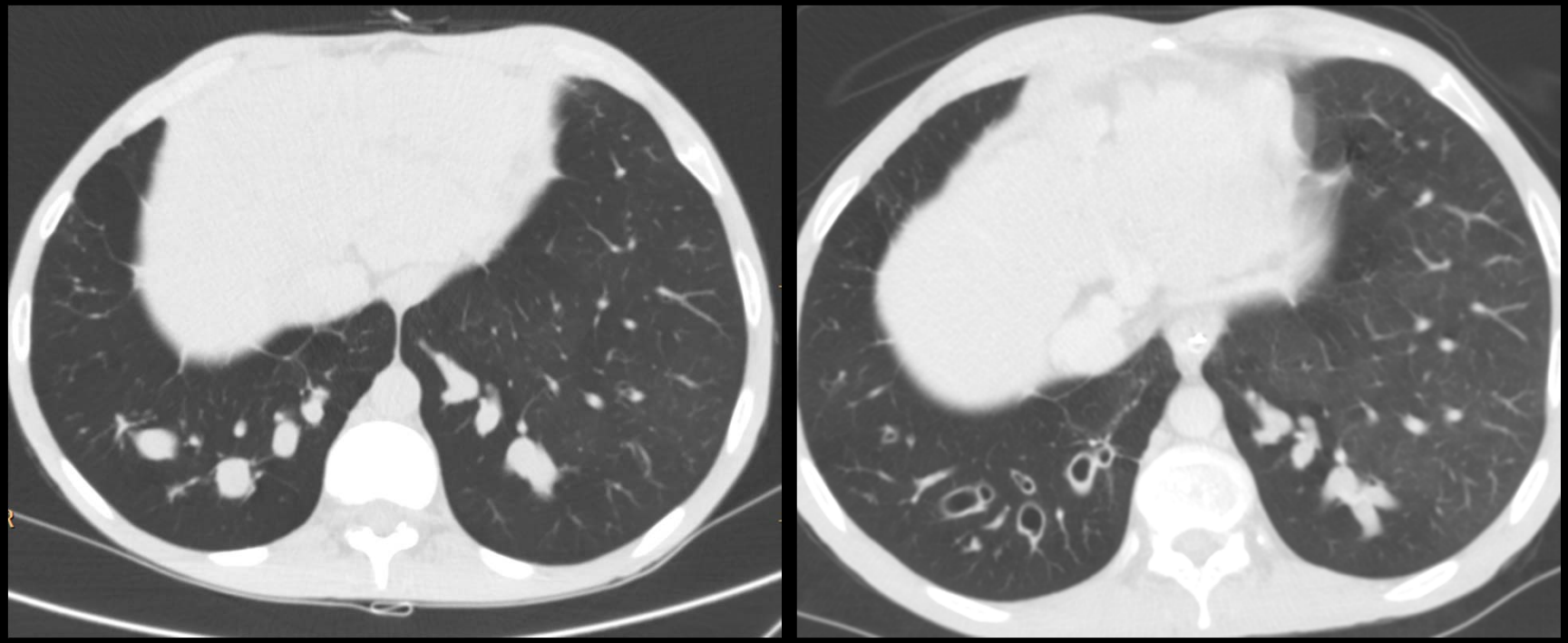
- MPR , Reformat to localize the bronchus path

  - **Minip analysis**
  - **Air within the nodule**

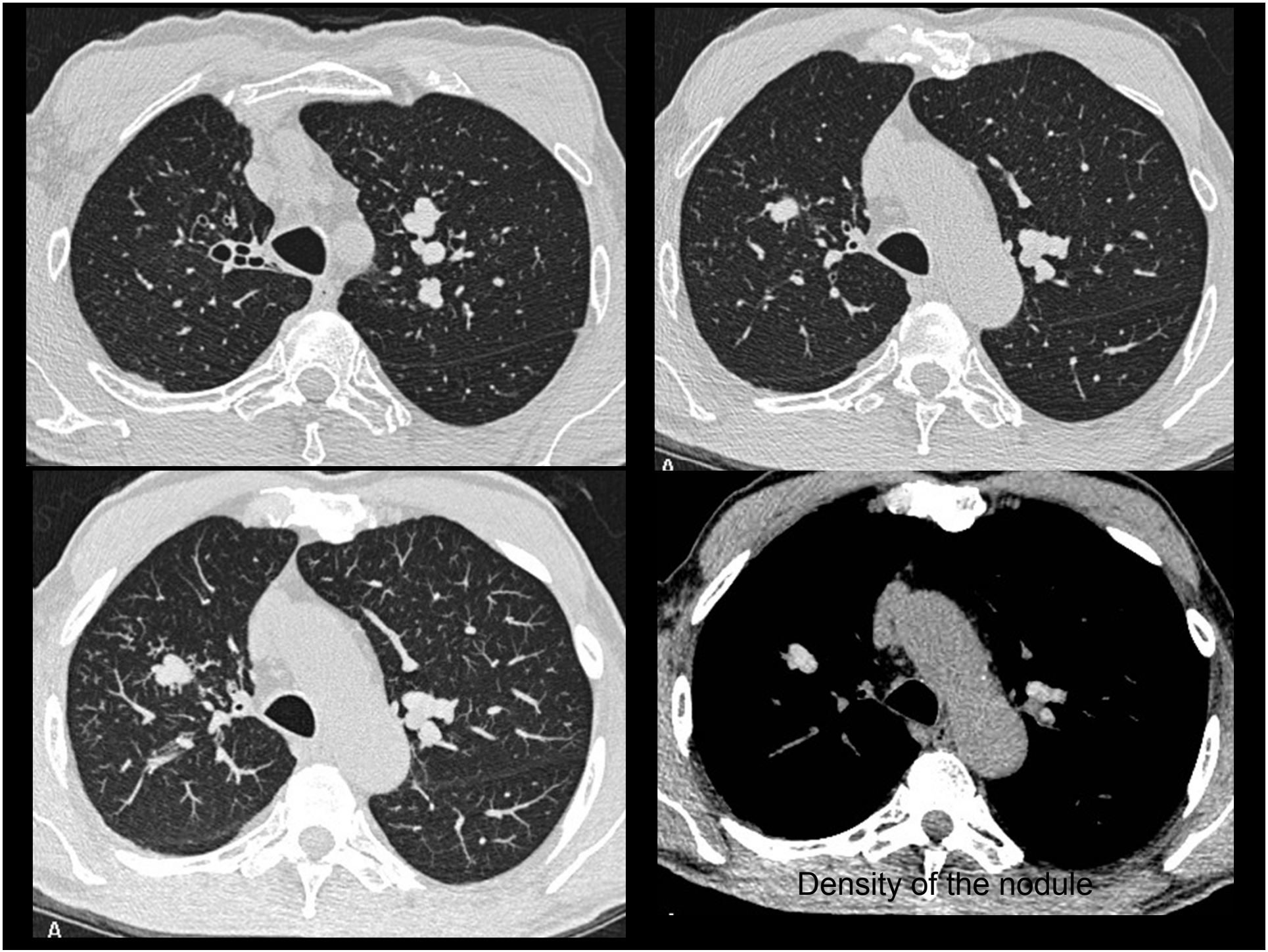




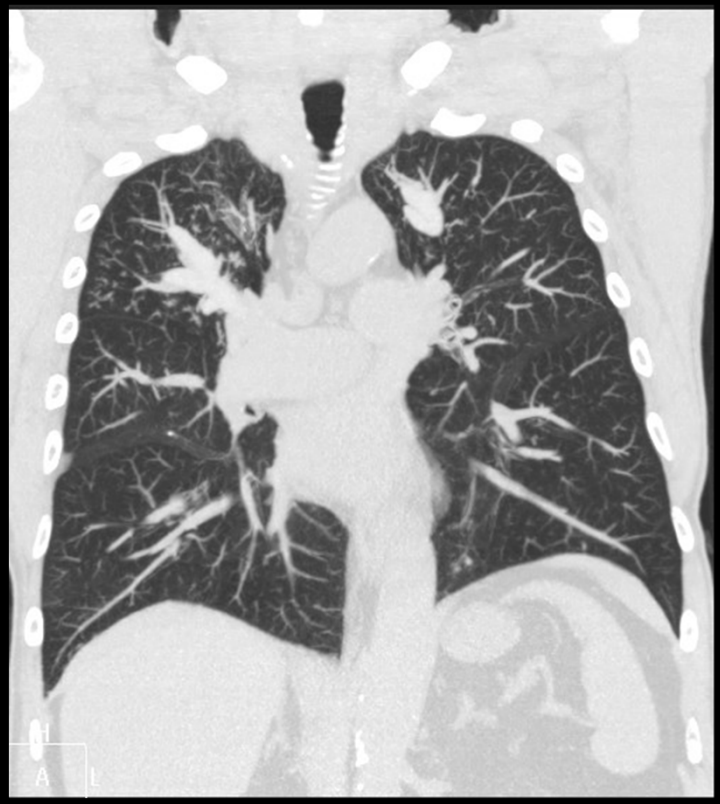
Tips and tricks



Follow-up CT after kinesiology


A
A
Density of the nodule

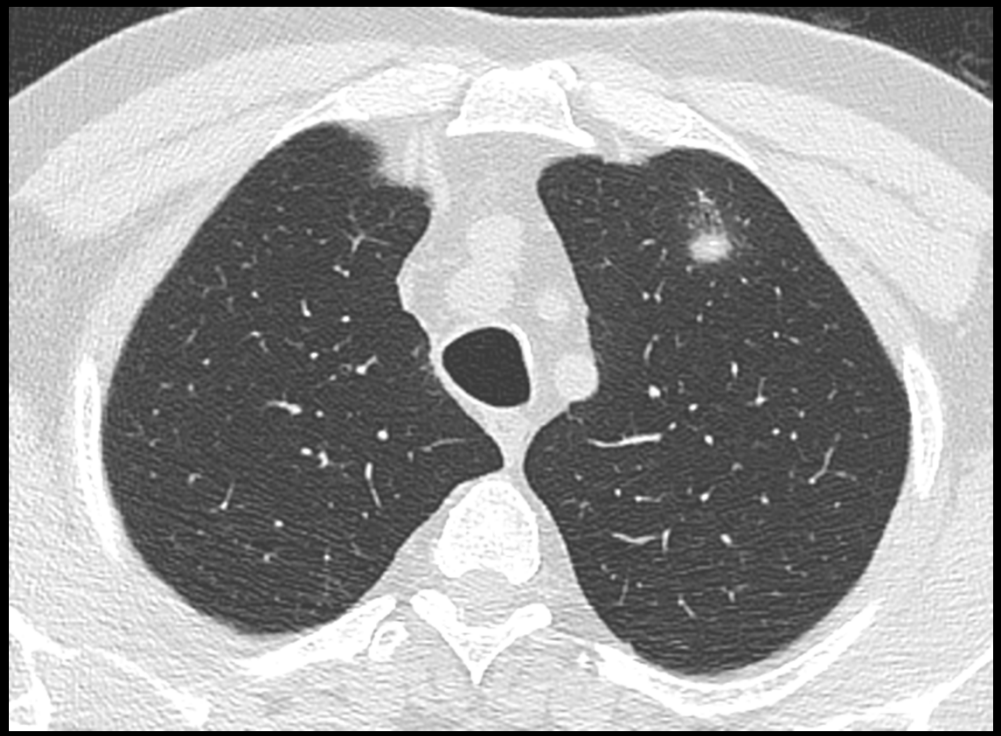
Multiplanar reformattions



ABPA

Courtesy G.Ferretti, Grenoble, France

Degenerative changes



Pseudonodules were present in 29 patients (12%).
Twenty-seven pseudonodules were caused by degenerative arthritis at the first costochondral junction, four at the first costosternal junction, and one at the sternoclavicular junction.

J Thorac Imaging1996 ;11(4):283-5.
Pulmonary pseudonodules on computed tomography: a common pitfall caused by degenerative arthritis.
Haramati LB, Haramati N.

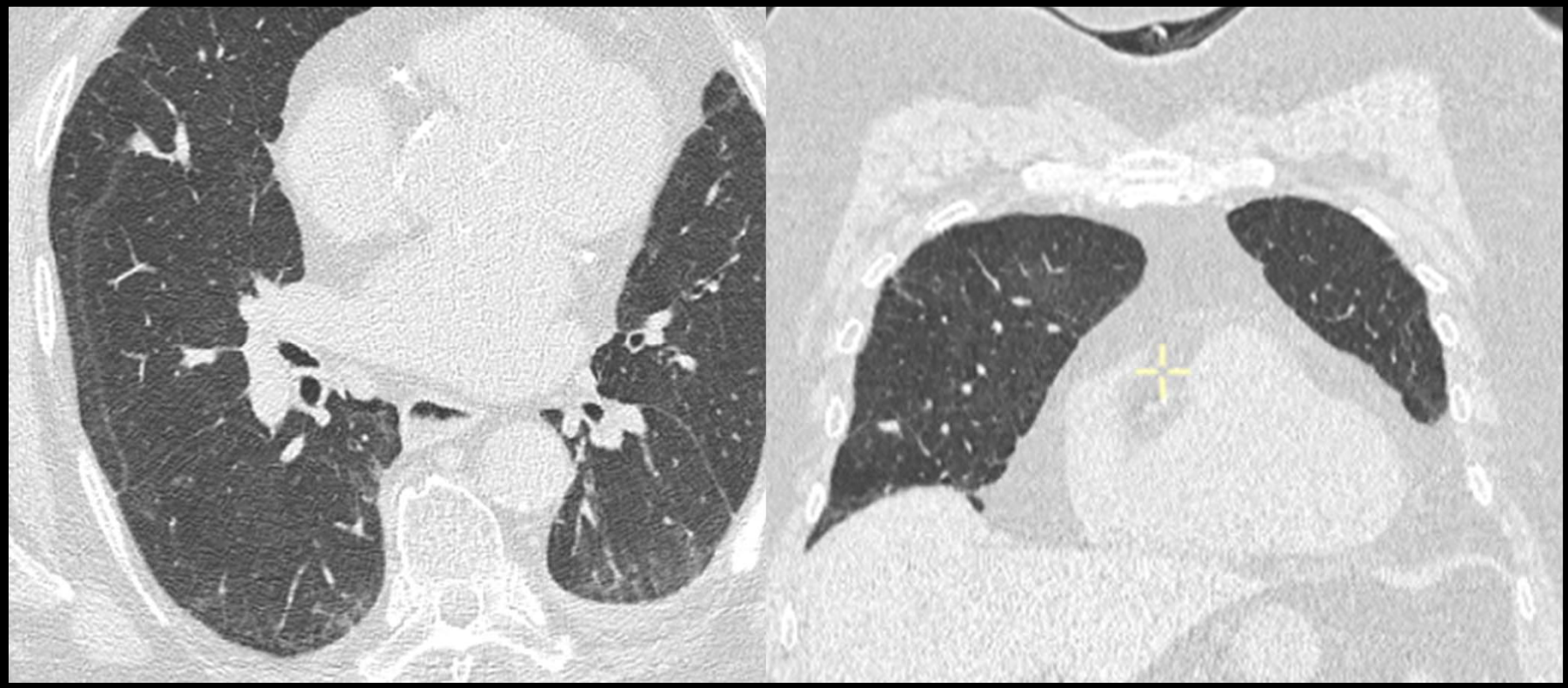
Tips and tricks

- Scrolling through thin slices
- Multiplanar analysis
- Adapted windows

Common pitfalls in diagnosis

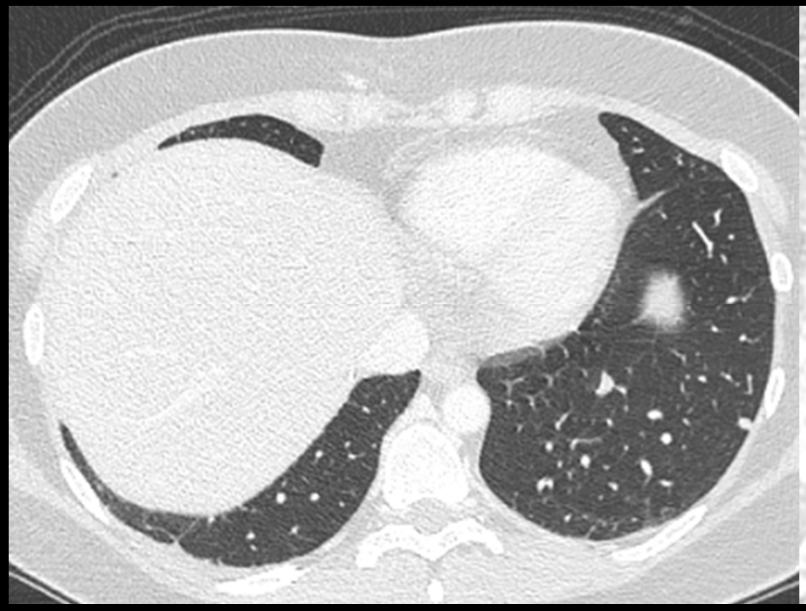
- Common findings
  - Intra-pulmonary lymphnode
  - Round pneumonia
  - Lung infarction
  - Intrafissural pleural effusion
  - Linear and round atelectasis
- Less common findings
  - Bubbly appearance mimicking emphysema
  - Difficult diagnosis for calcified metastasis

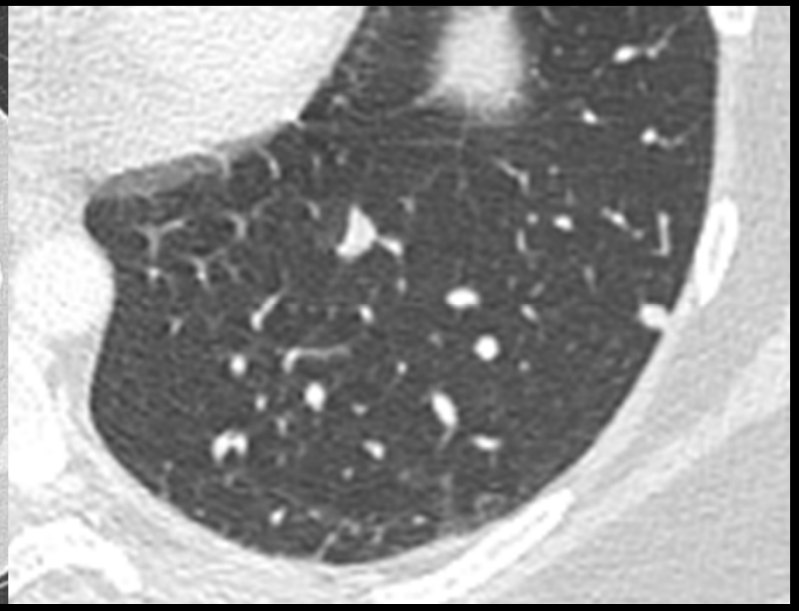
1.Intrapulmonary Lymph node

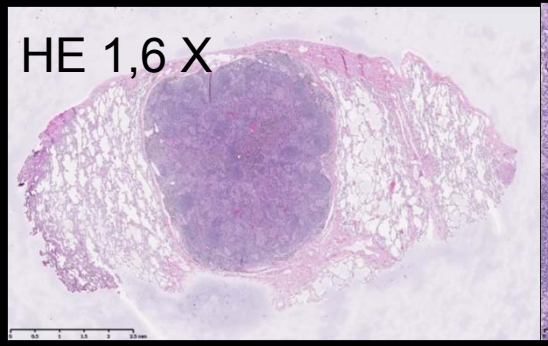


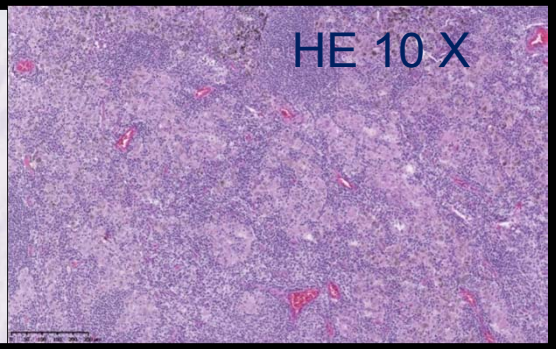
Myeong I, et al. Perfissural nodules seen at CT screening for lung cancer. Radiology (2010); 254:949-956. Shaham D, et al. CT features of intrapulmonary lymphnodes confirmed by cytology. Clin Imaging (2010):185-190

Intrapulmonary Lymph node









- Observed in 18 % of peripheral pulmonary nodules
- Predominant in the lower lobes and the right middle lobe

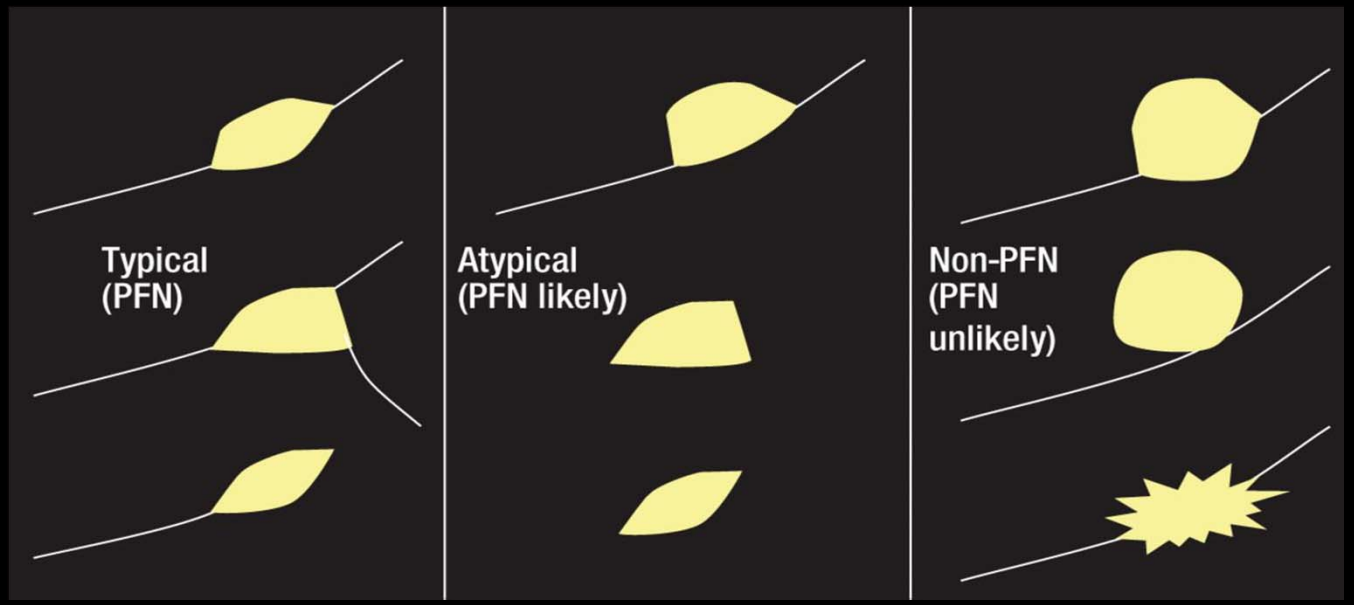
Bankoff MS, McEniff NJ, Bhadelia RA, Garcia-Moliner MG, Taly BD. Prevalence of pathologically proven intrapulmonary lymph nodes and their appearance on CT. AJR (1996);167:629-630

Characteristics of Intrapulmonary Lymph node

- Distance from pleura
  - <10 mm: 66,7%
  - 10-20 mm: 27,8%
  - >20 mm: 5,6%
- Diameter range: 3,3-8,5 mm
- Shape:
  - Oval: 33,3%
  - Round: 27,8%
  - Triangular: 27,8%
  - Trapezoidal: 11,1%
- Edges: Smooth: 100%

18 patients

Shaham D, et al. CT features of intrapulmonary lymphnodes confirmed by cytology. Clin Imaging (2010):185-190

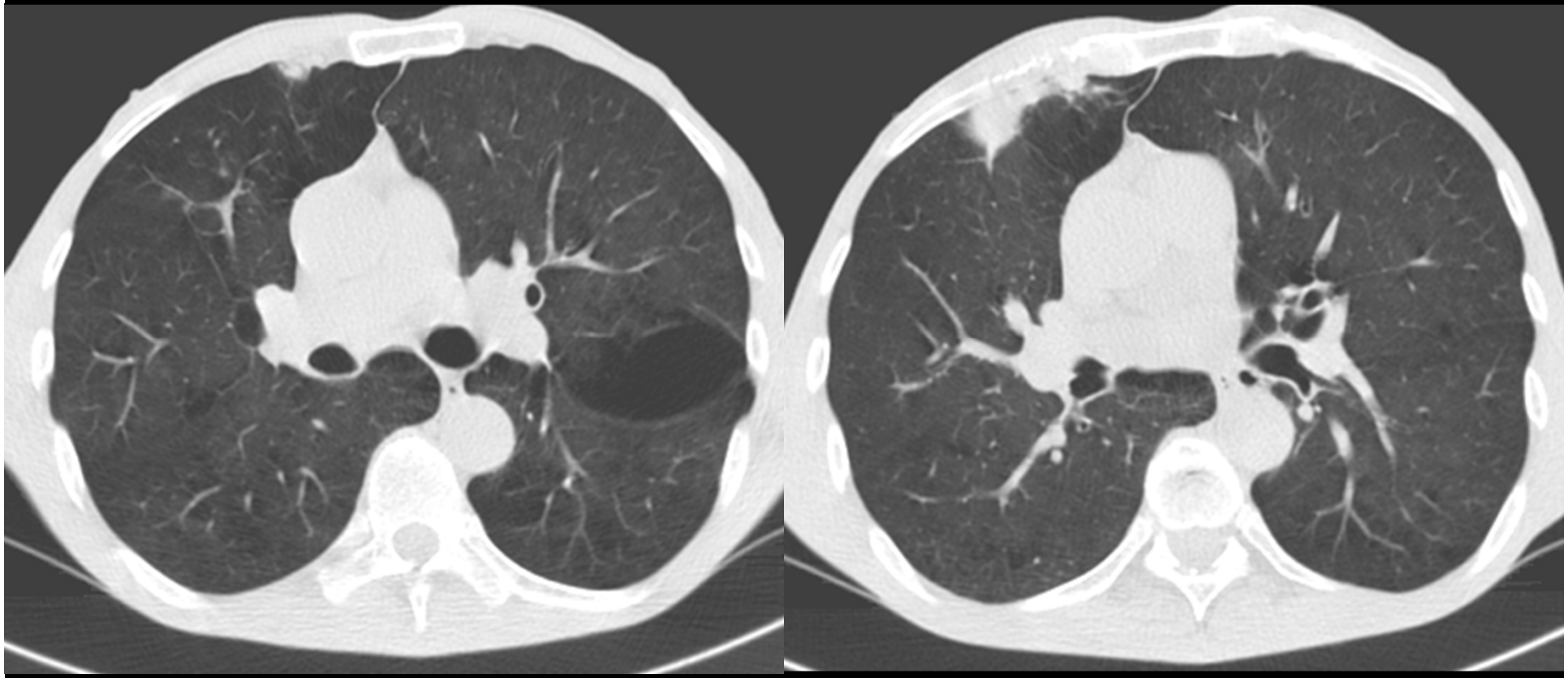


4026 nodules
19,7% classified as PFNs
8,3%: doubling time <400 days
None was malignant

Fissure-attached nodules that met previously described features of intrapulmonary lymph nodes were defined as typical PFNs. Atypical PFNs were nodules that either met all features but were not attached to a visible fissure or were fissure-attached nodules, convex on one side and rounded on the other. All other fissure-attached nodules with a shape that did not appear to be influenced by the fissure were defined as non-PFN.

Bartjan de Hoop; Bram van Ginneken; Hester Gietema; Mathias Prokop;
Radiology **2012,** 265, 611-616

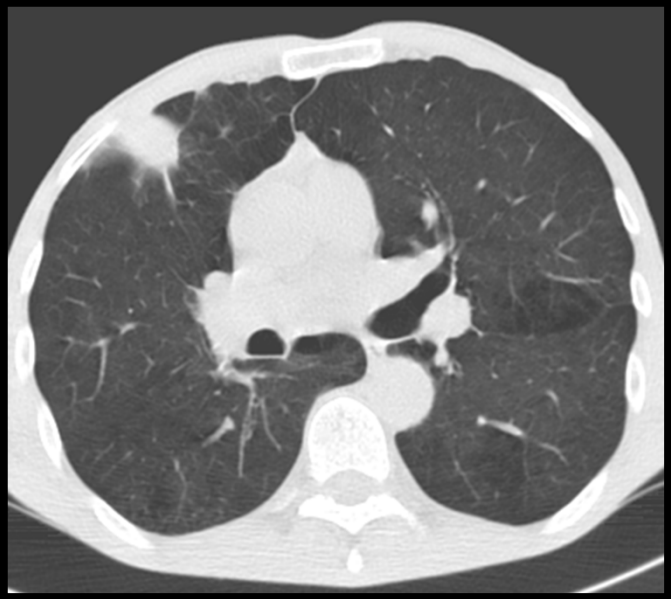
2. Round pneumonia

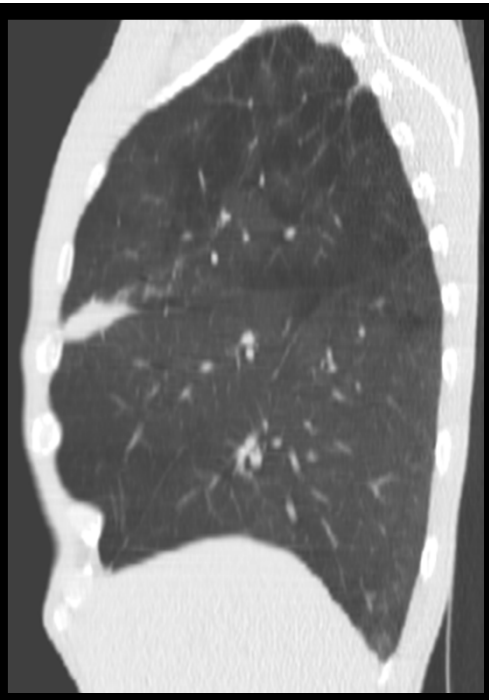


T=0

52-year-old **man**
Lung cancer **screening**
90 pack-year

T= 4 months

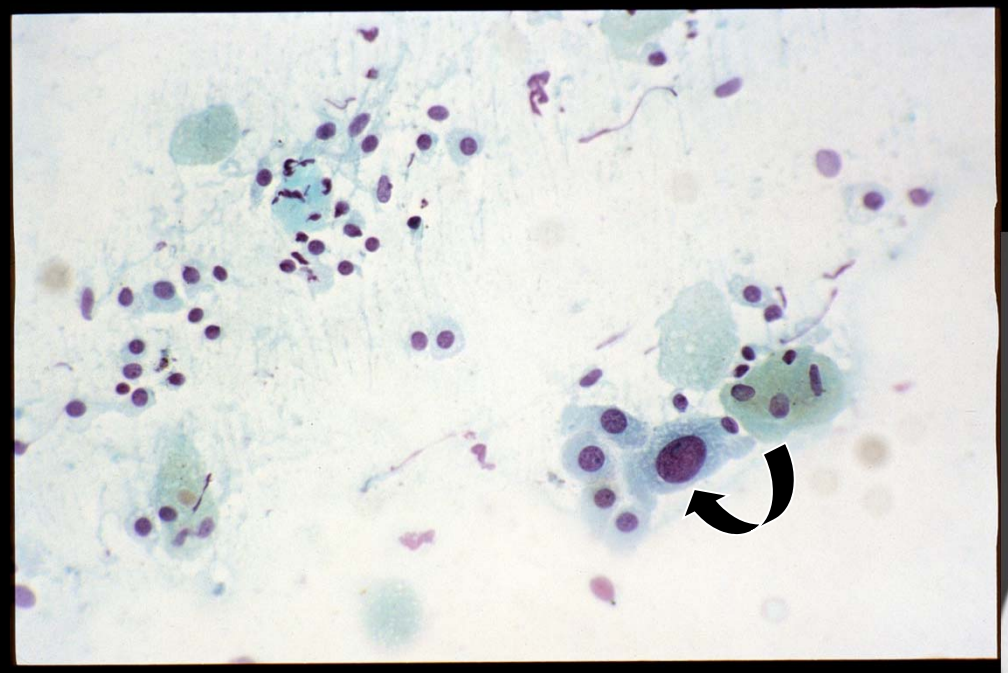


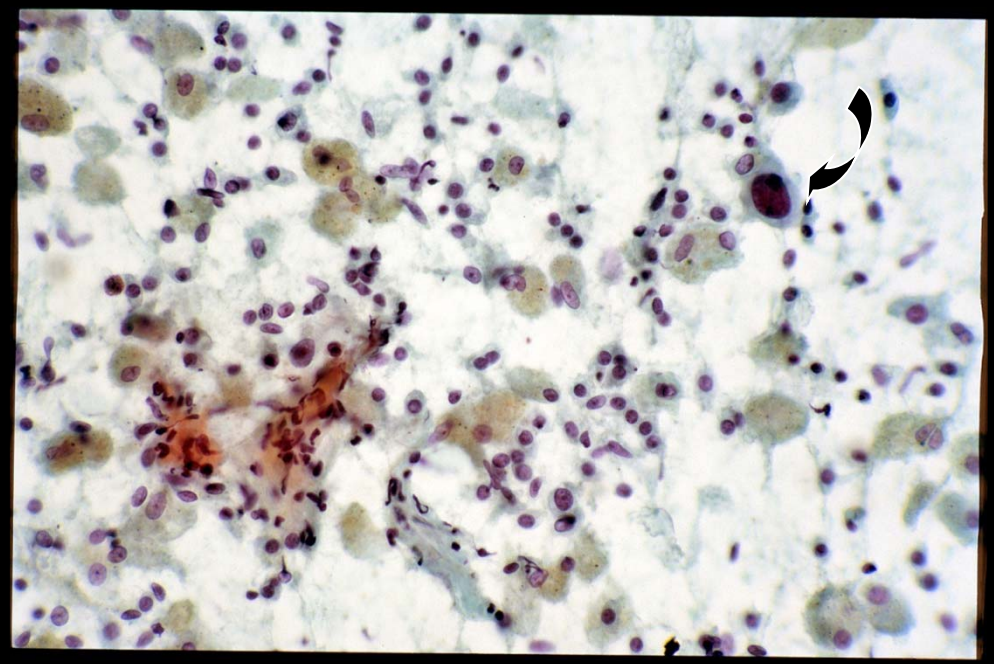


axial

coronal

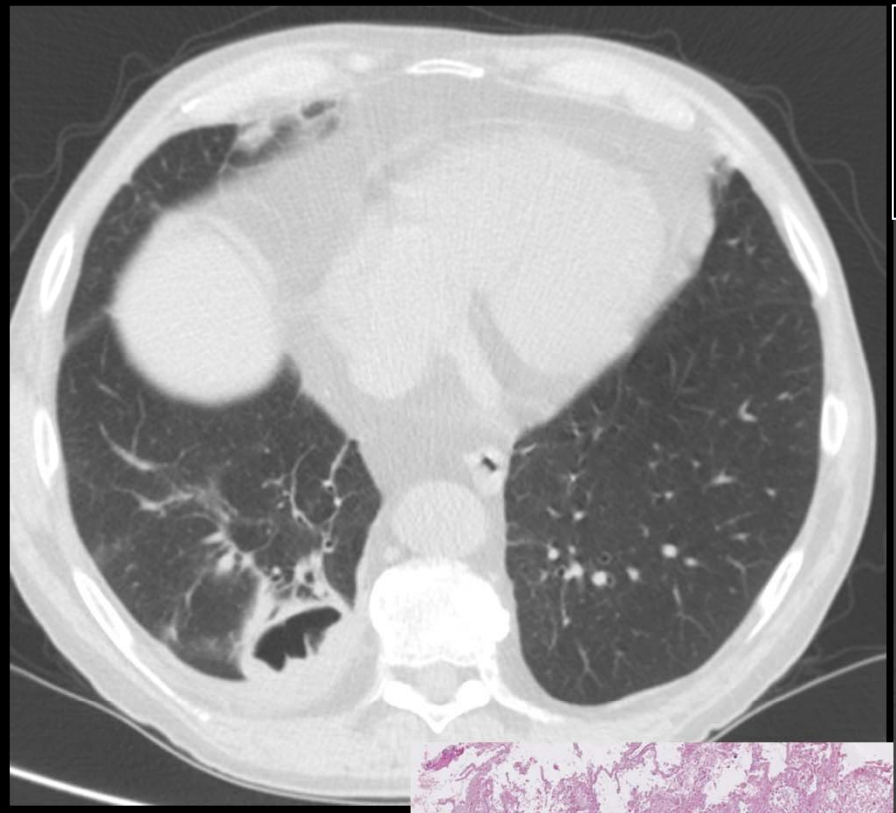
sagittal

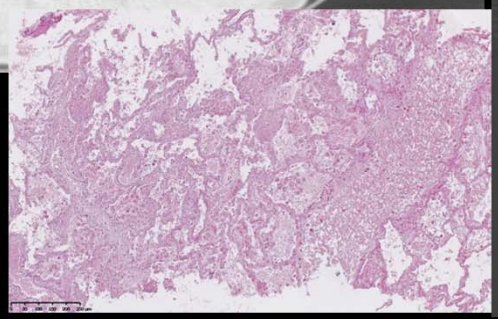




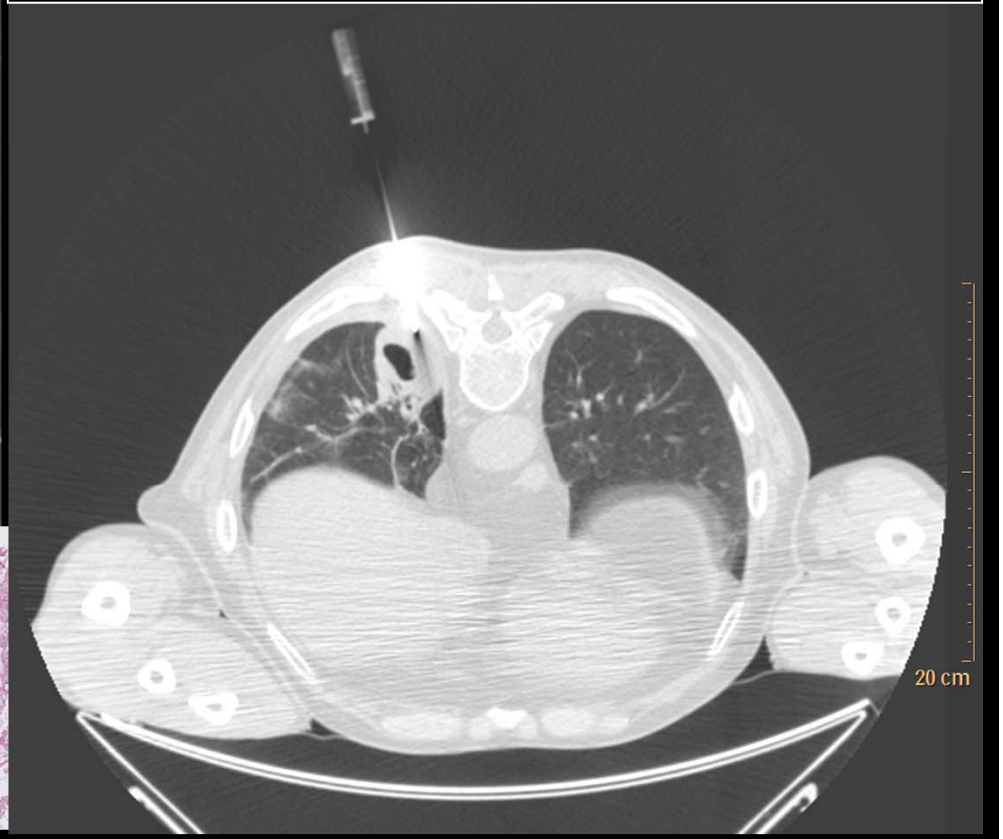
Follow-up CT and clinical data!

3. Lung infarction

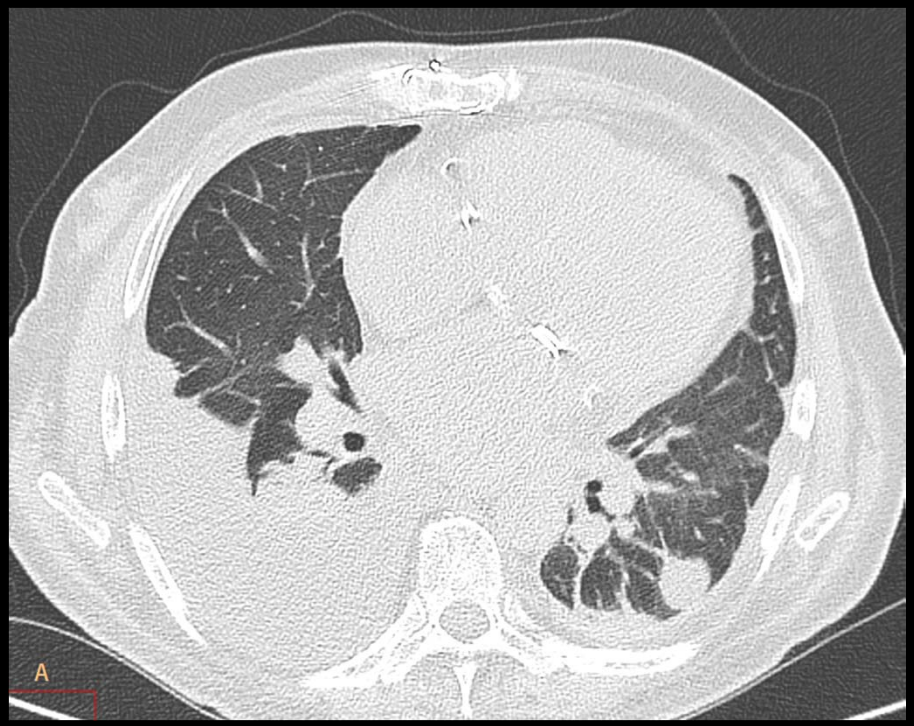




Review images with mediastinal window
Look for CT images with IV contrast

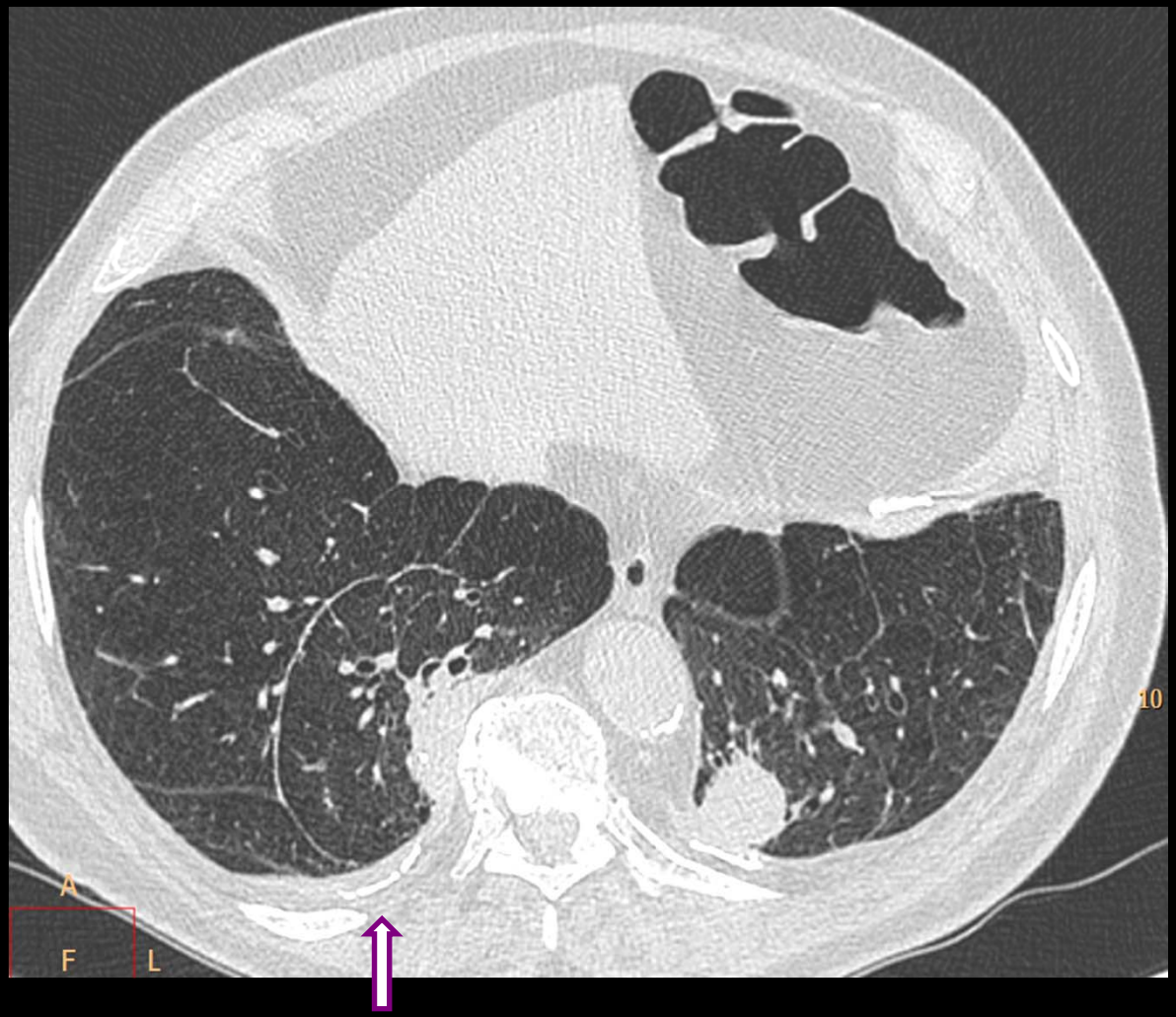


4. Intrafissural pleural effusion



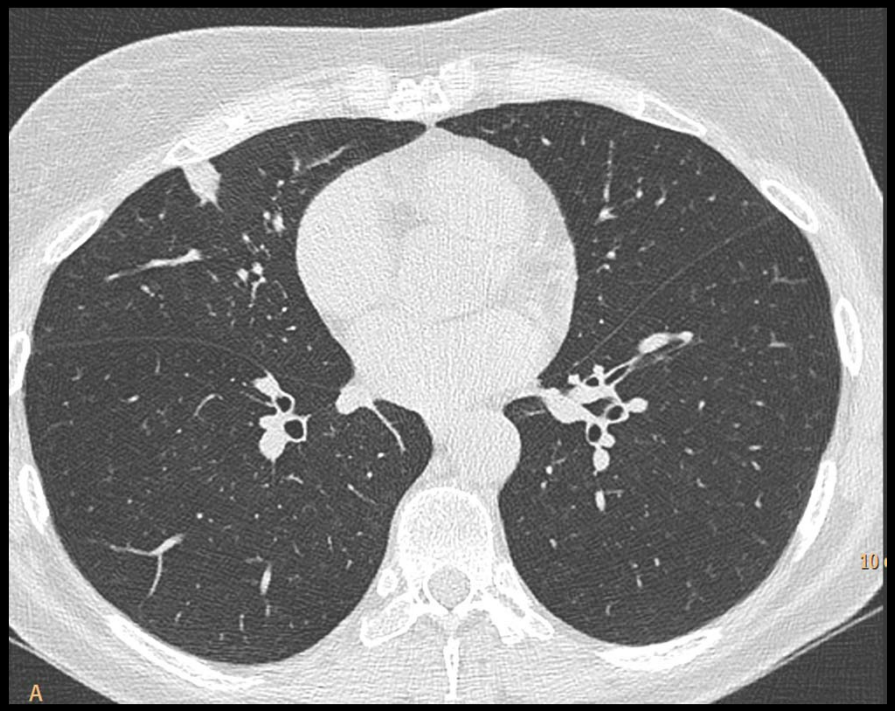
Oval-shaped abnormality- perform MPR
Measure density
Chek for associated pleural effusion

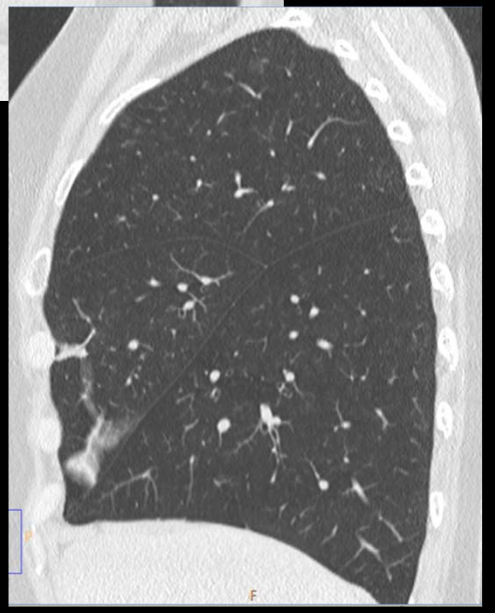
5.Round atelectasis



Look carefully for pleural plaques or calcifications, asbestos-related interstitium disease

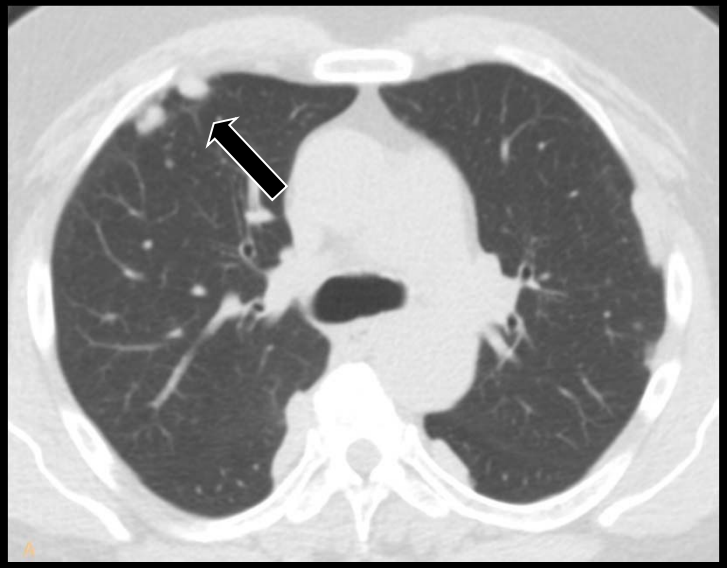
5. Linear atelectasis

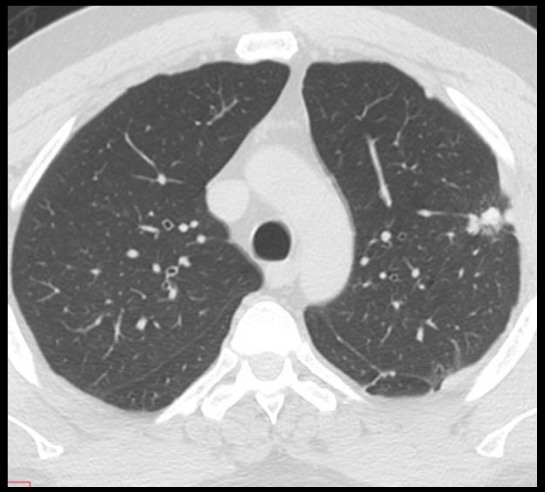




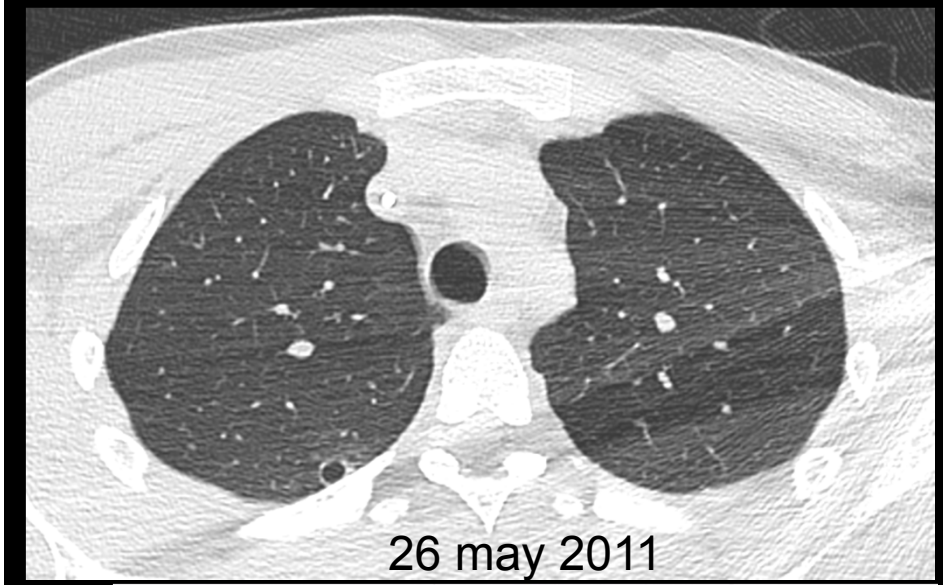
Perform MPR reconstructions!
Plate-like atelectasis: thin on axial slices

6. Focal pleural thickening

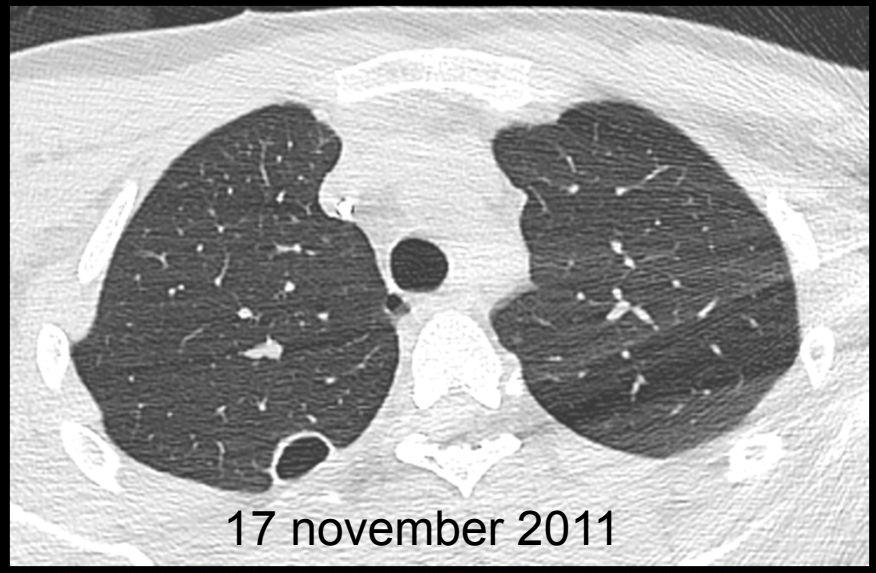




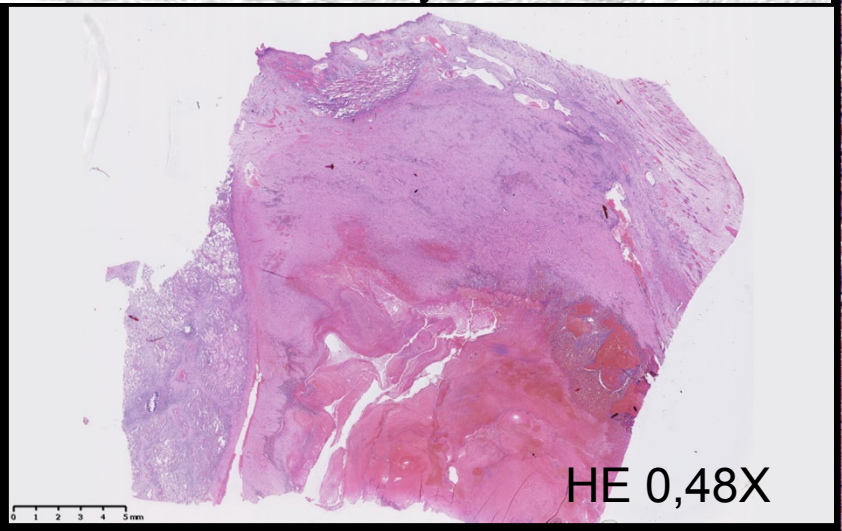
Bubbly appearance of malignant nodules mimicking emphysema



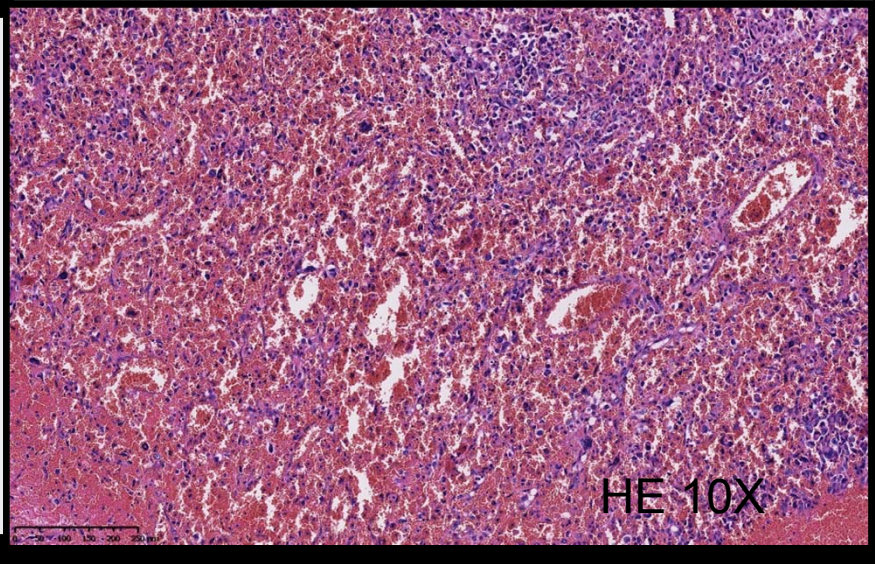
26 may 2011



17 november 2011

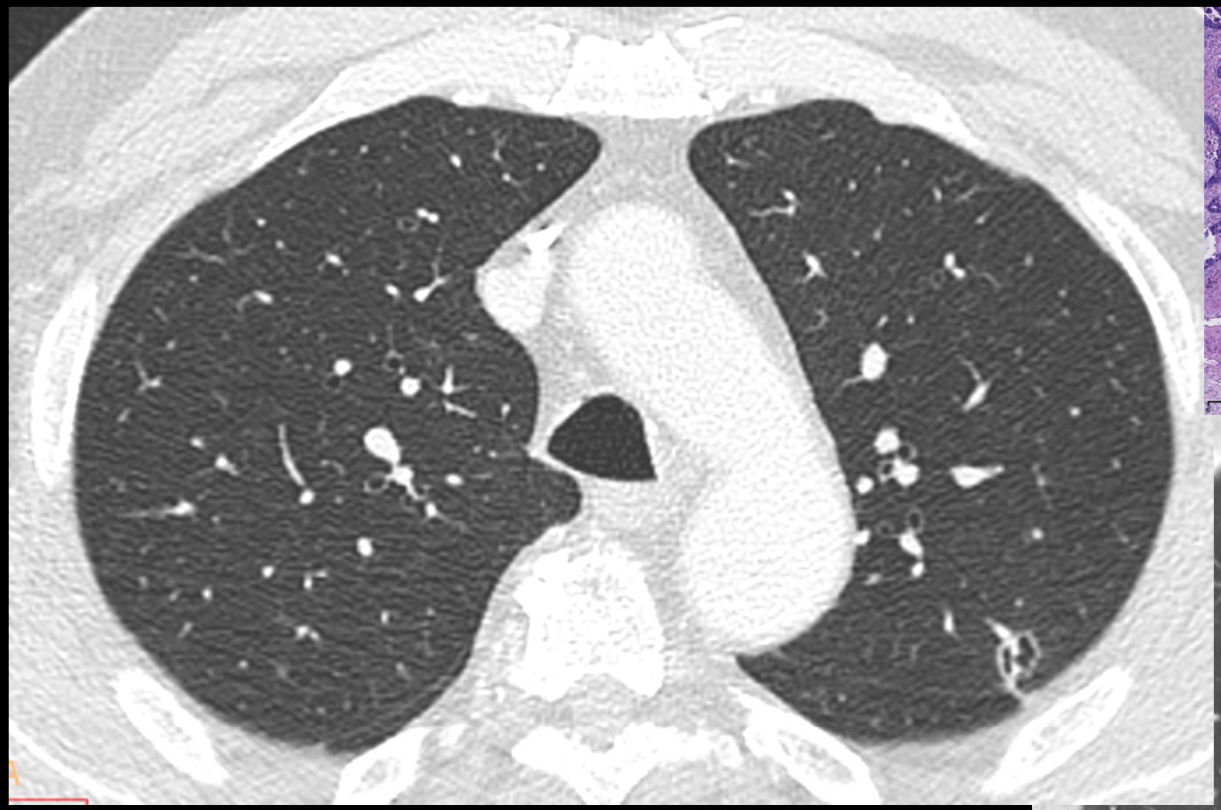


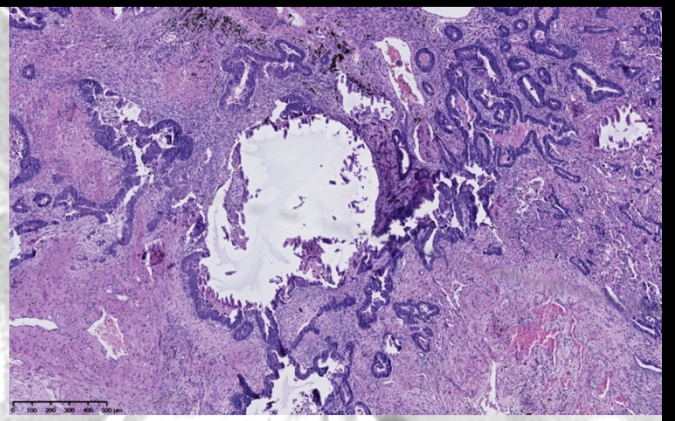
HE 0,48X



HE 10X

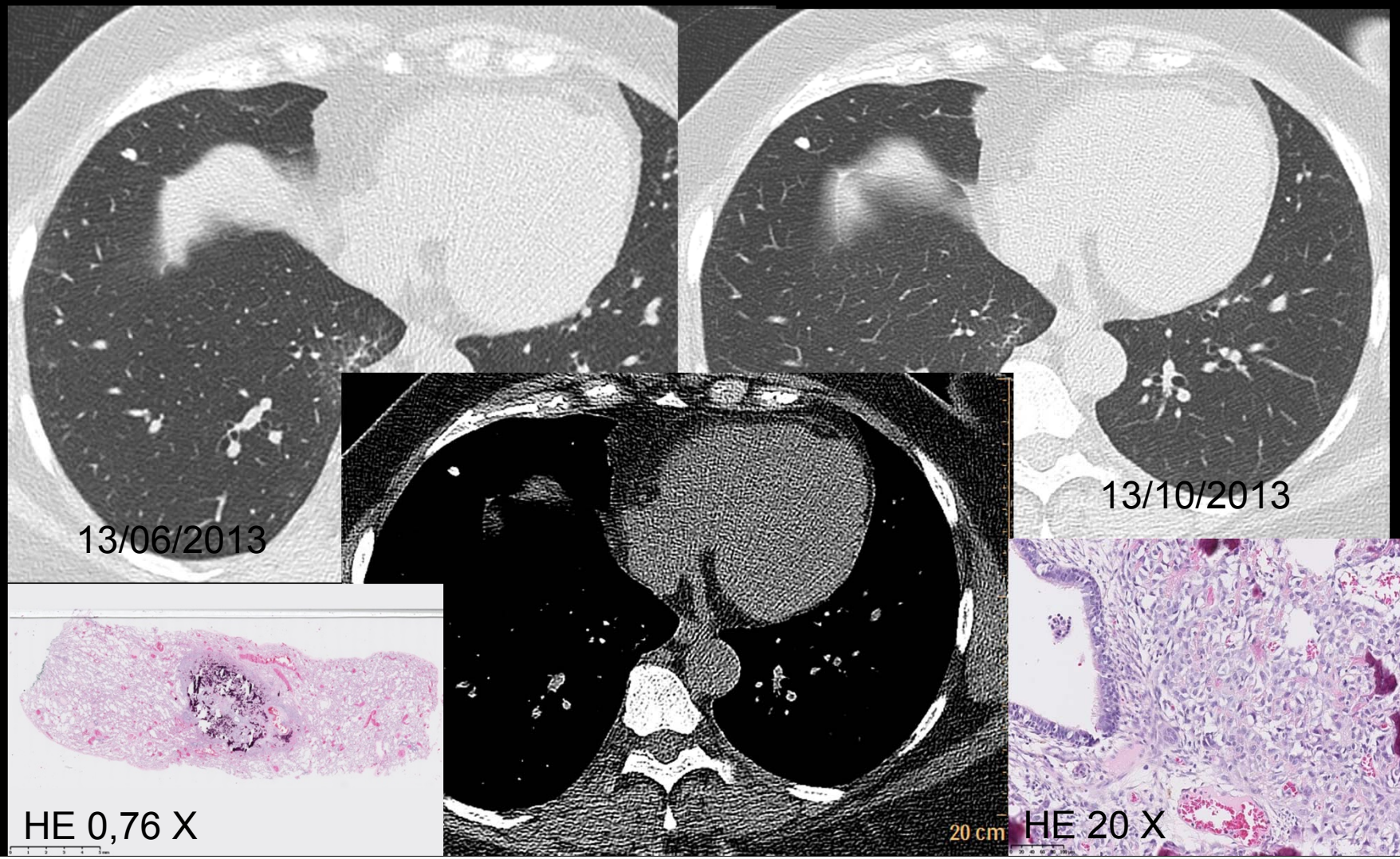
Bubbly appearance of malignant nodules mimicking emphysema





Weisbrod GI, et al. Cystic change (pseudocavitation) associated with bronchioloalveolar carcinoma. A report of four patients. J Thorac Imaging (1995):106-111

Malignant calcified nodule mimicking a granuloma

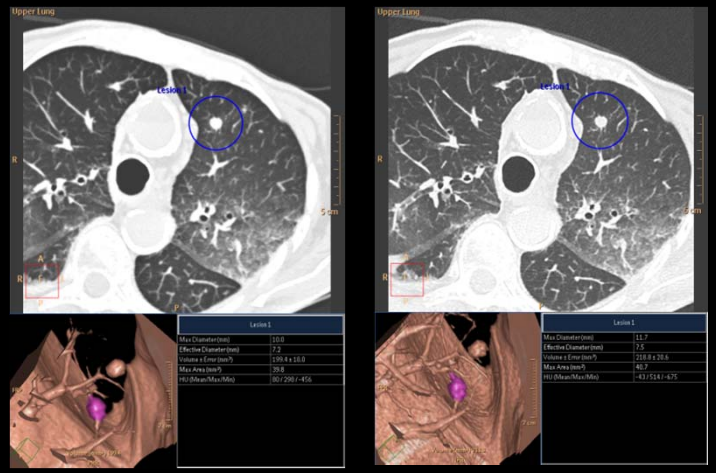


Common pitfalls in nodule follow-up

- Technical parameters (Size and attenuation!)
  - Slice thickness:≤ 2,5 mm (solid), ≤ 1 mm (subsolid,GGO)
  - Reconstruction interval: ≤ slice thickness
  - FOV: 25-35 cm
  - Kernels: High frequency/Low frequency
  - Kv: 120 kVp 40-80 mAs
- Time interval: see Fleischner recommendations
- Nodule Size: volumetry

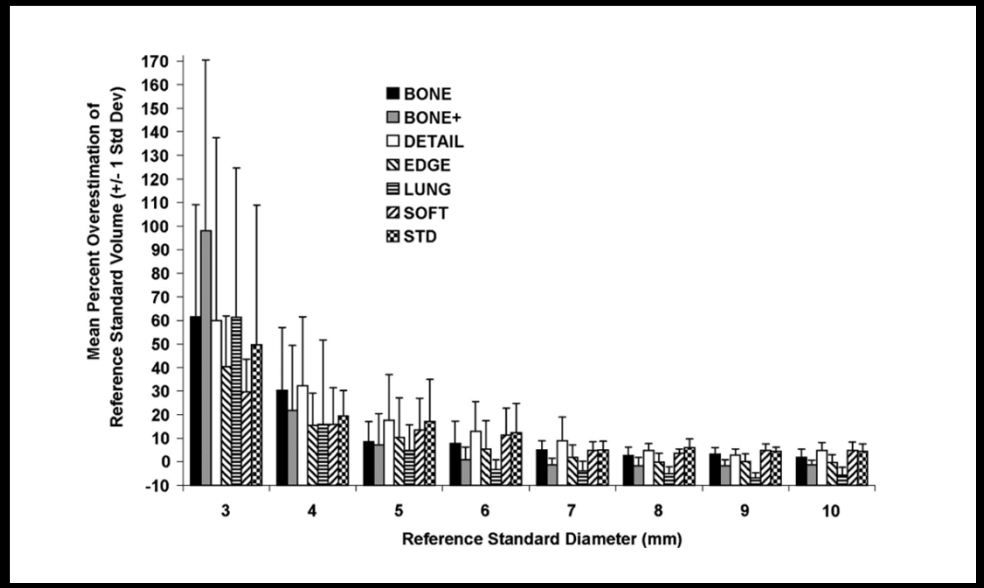
Truong et al. Update in the evaluation of the solitary pulmonary nodule. Radiographics (2014);34:1658-1679

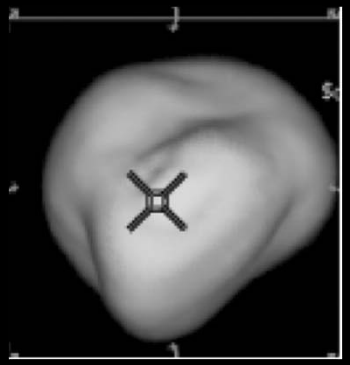
Effects of High spatial frequency reconstruction parameters



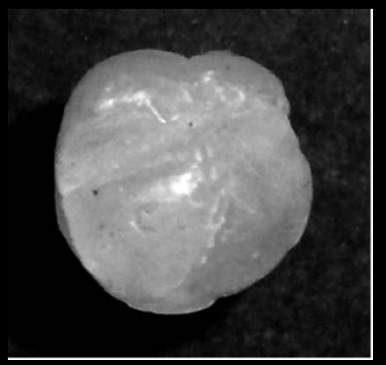
M-P Revel, C Lefort, A Bissery, et al. **Pulmonary Nodules: Preliminary Experience with Three-dimensional Evaluation . Radiology (2004);231:459-466**

Ravenel JG, et al. Pulmonary Nodule volume: effects of reconstruction parameters on automated measurements-A phantom study. Radiology (2008); 400-408



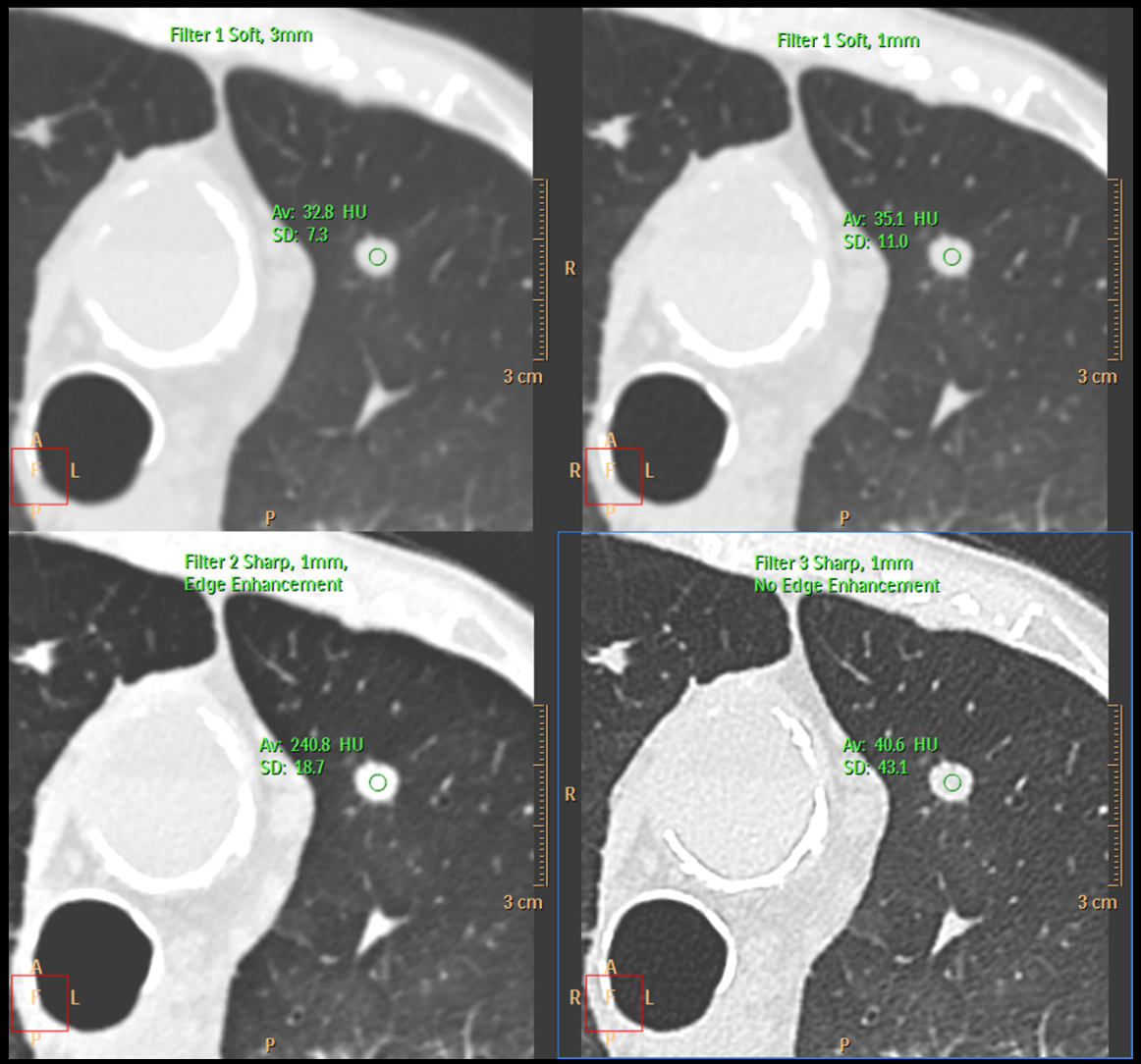


Soft tissue kernel



Bone kernel

CT parameters



The use of a high-frequency algorithm may result in high-attenuation areas, which may lead to false identification of calcium within a nodule

Truong et al. Update in the evaluation of the solitary pulmonary nodule. Radiographics (2014);34:1658-1679

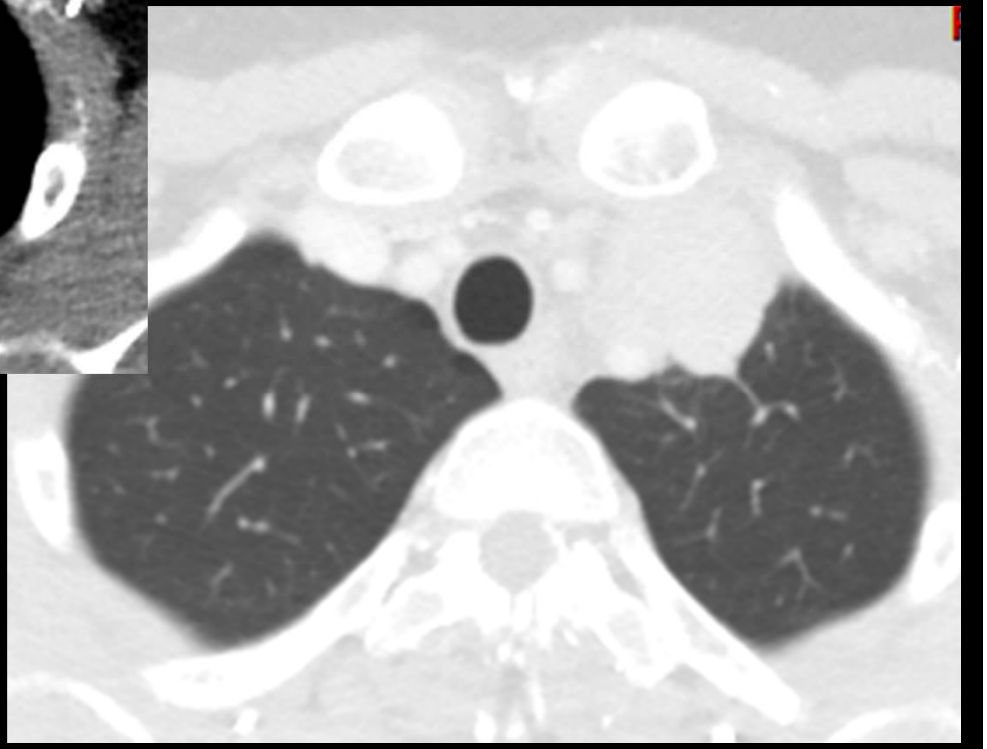
Segmentation and CT parameters

- Reconstruction kernels and FOV does not substantially affect volumetric measurements
- For nodules measuring 5-10 mm, a section thickness ≤ 1,25 mm should be used; thinner slices for smaller nodules
- Keep the same CT parameters constant for nodule follow-up

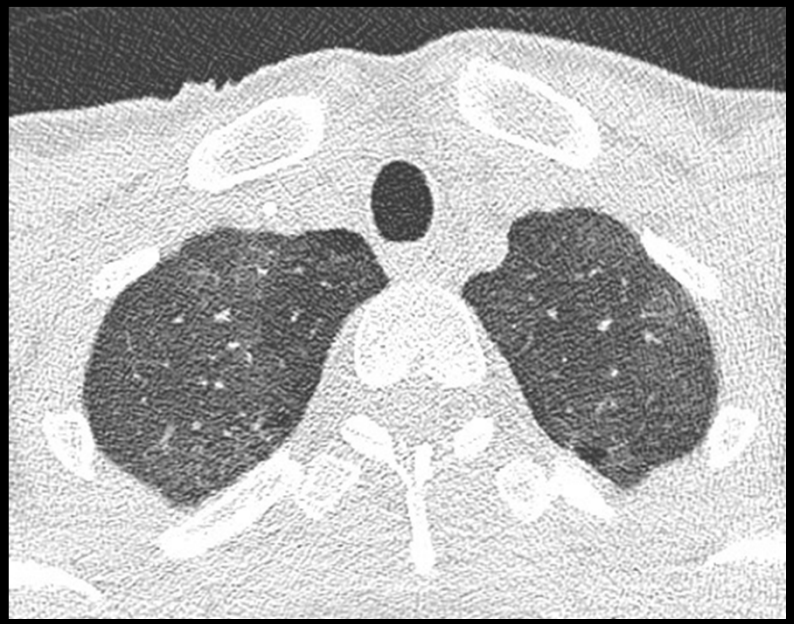
Ravenel JG, et al. Pulmonary Nodule volume: effects of reconstruction parameters on automated measurements-A phantom study. Radiology (2008); 400-408

Comparison with previous examinations

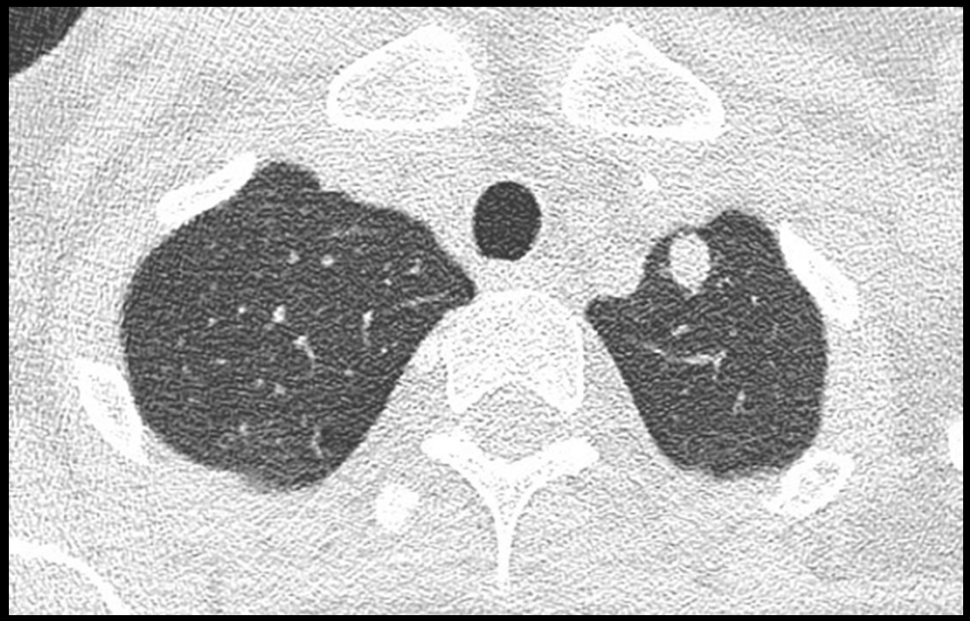
13-02-2015



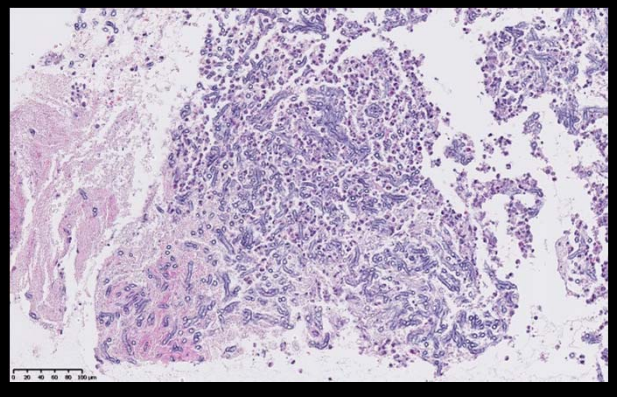
Comparison with previous examinations

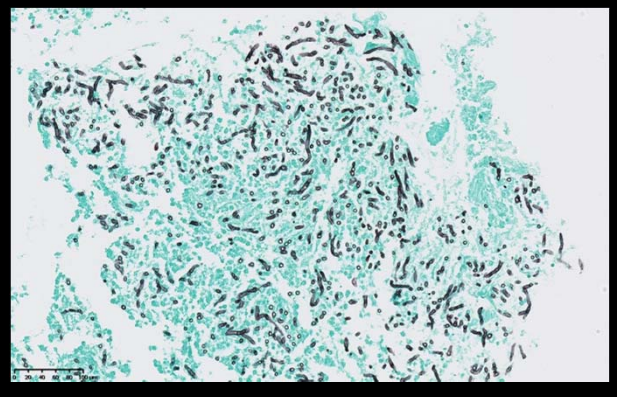


18-10-2012



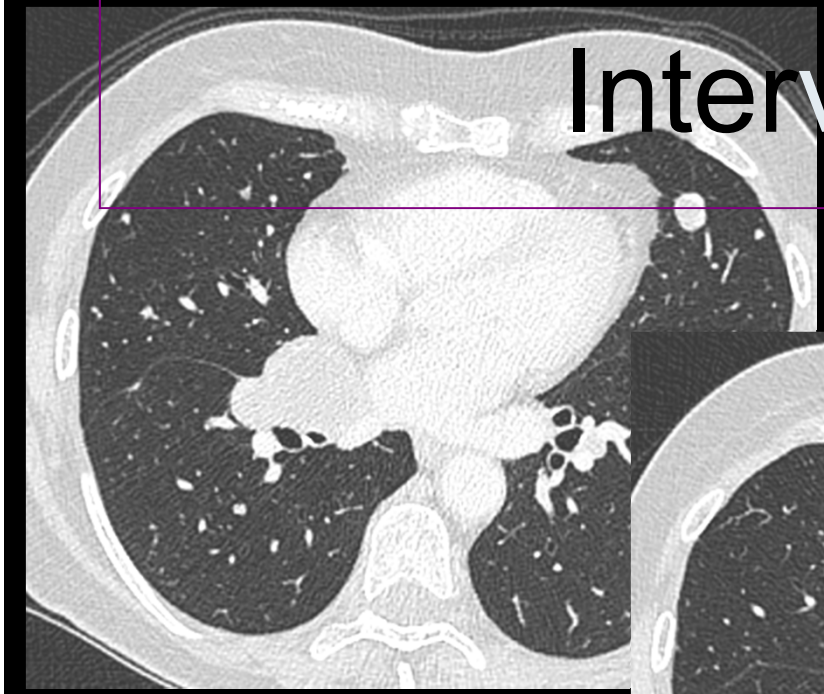
03-12-2012



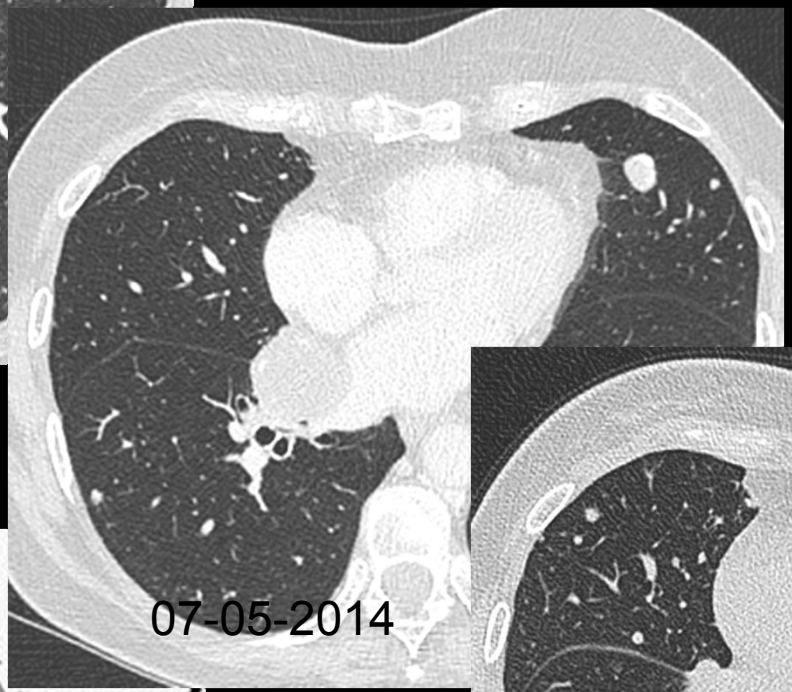


Grocott 20X

Interval change

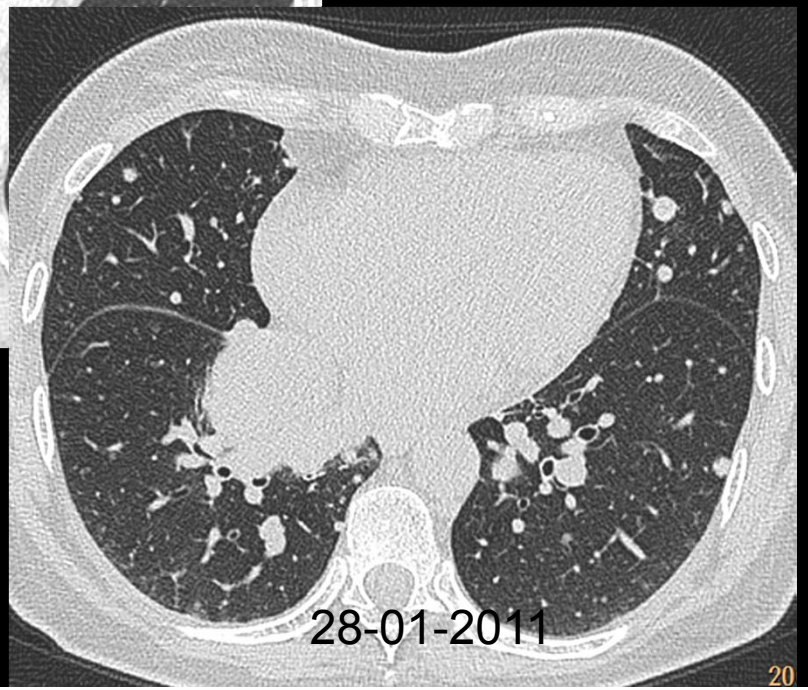


23-07-2014



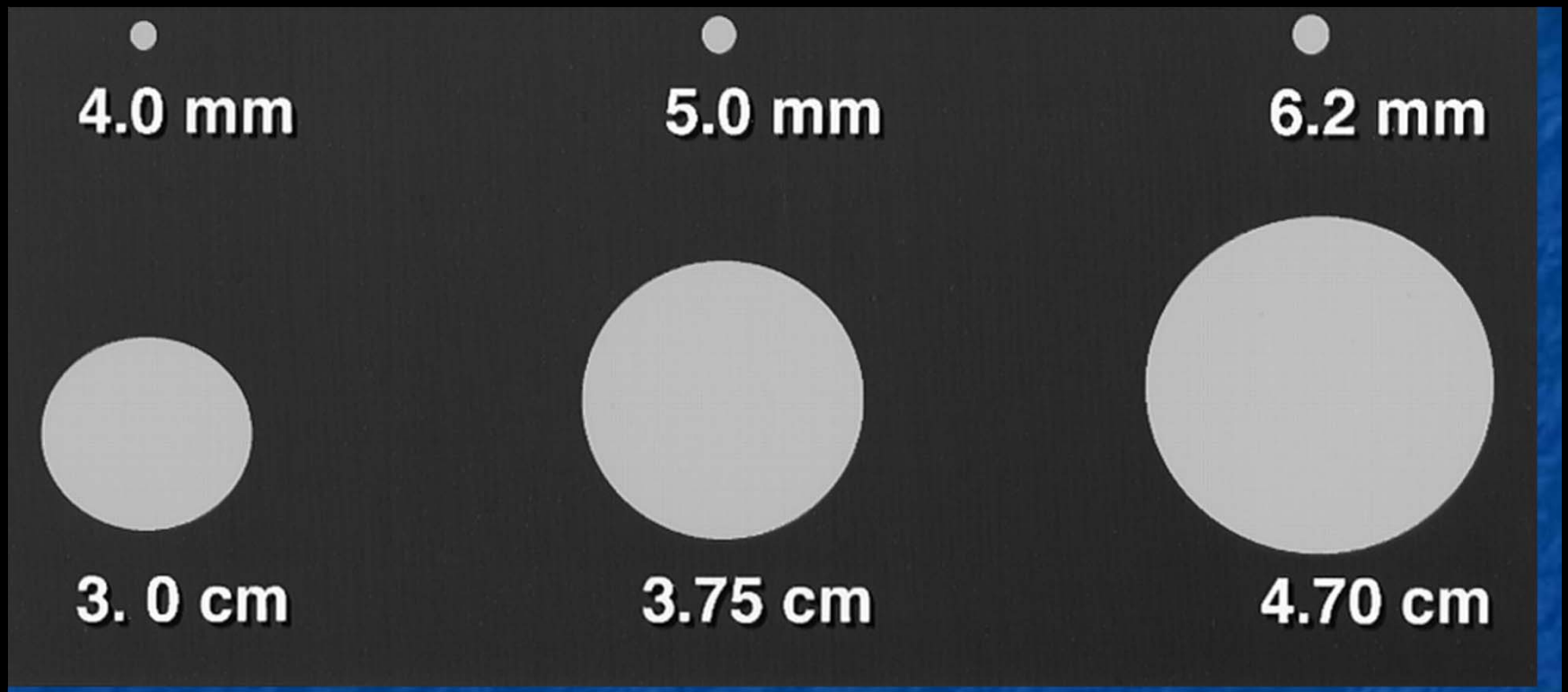
07-05-2014

Thyroid papillary carcinoma metastases



28-01-2011

Nodule Follow-up

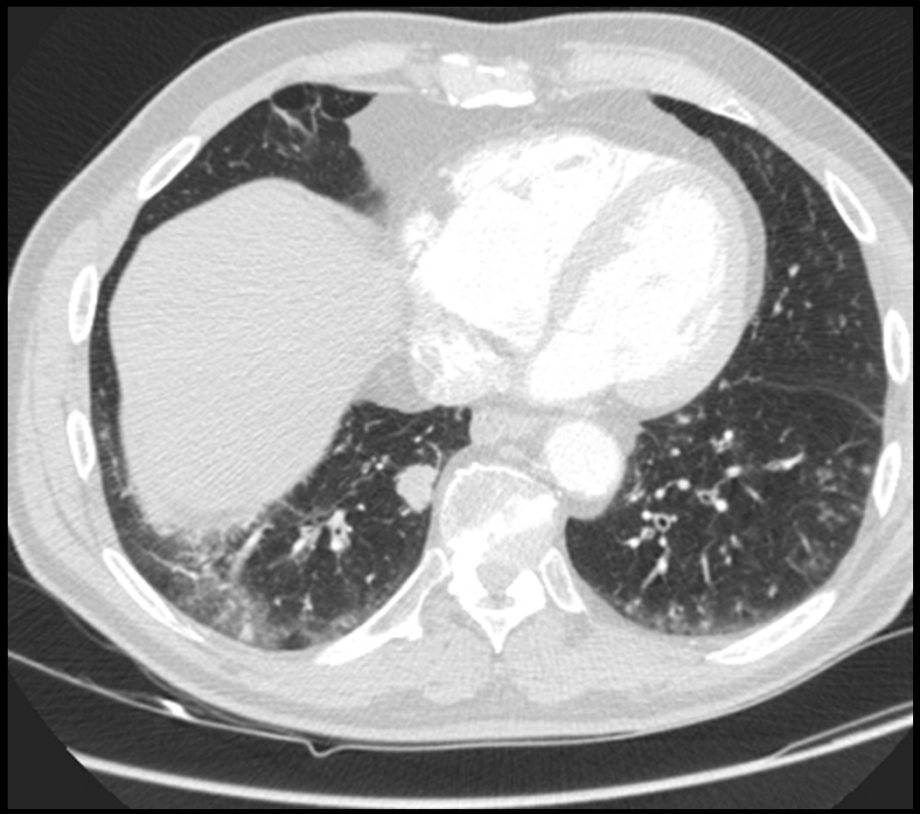


The upper and lower nodules are growing at the same rate. Because the human eye judges diameter, not volume, the bottom nodule appears to be growing faster.

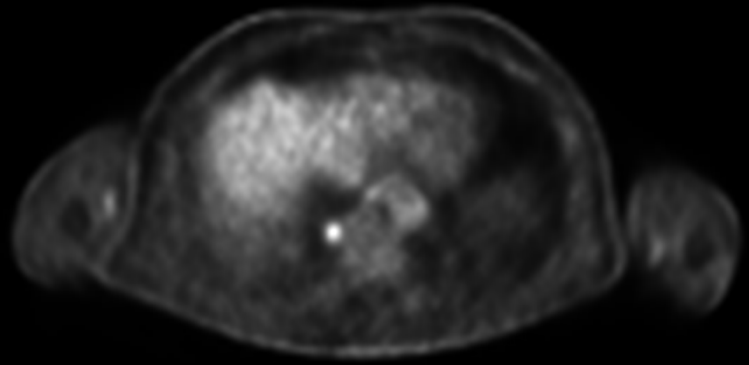
Erasmus JJ, McAdams HP, Connolly JE. Solitary Pulmonary Nodules: Part II. Evaluation of the Indeterminate Nodule. Radiographics 2000;20:59-66.

Spontaneous regression

- 76-year old man
  brain attack in 2010
  ischemic cardiopathy ; Triple pontage in 2014, surgery for lumbar spine



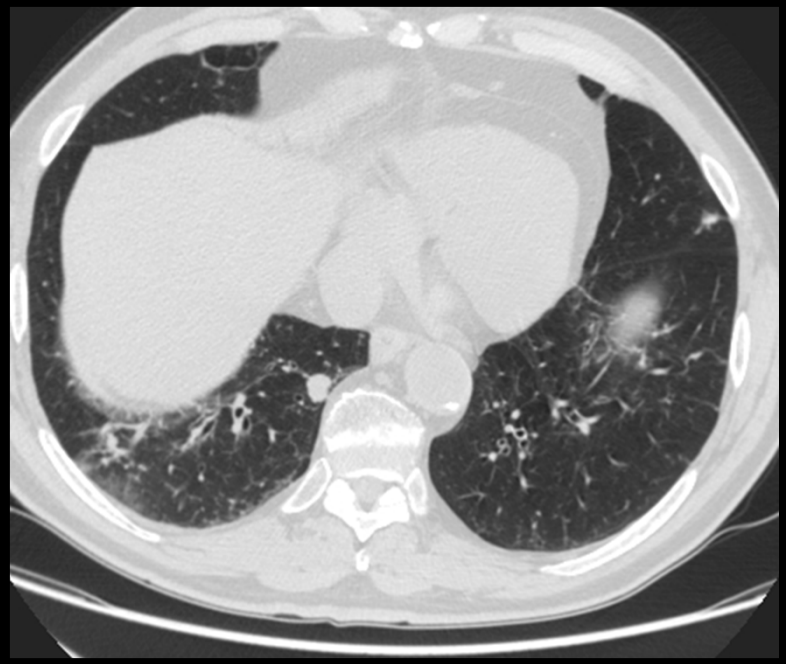
Lung Nodule RLL
PET +



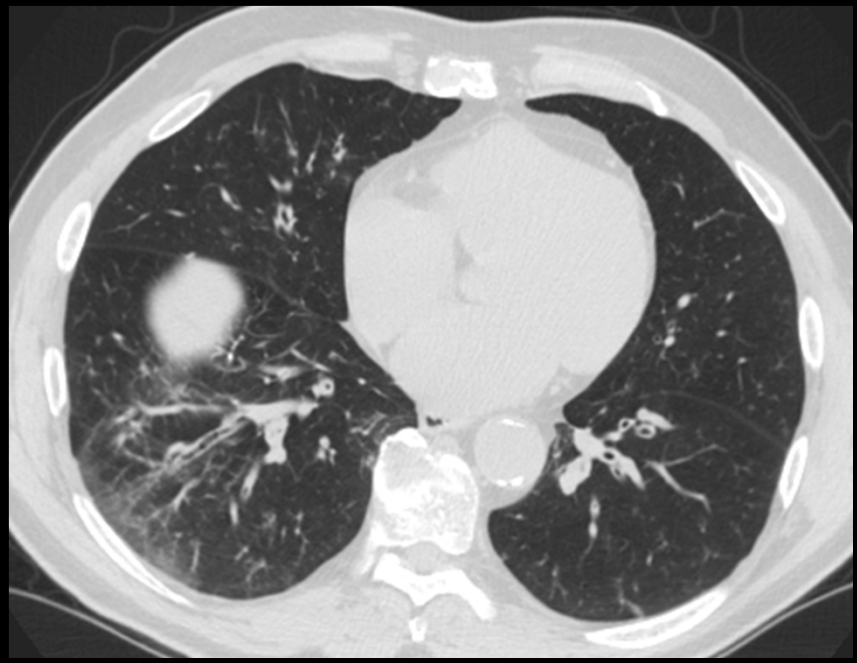
Courtoisy
G. Durand S. Bommart

Spontaneous regression

October 2014



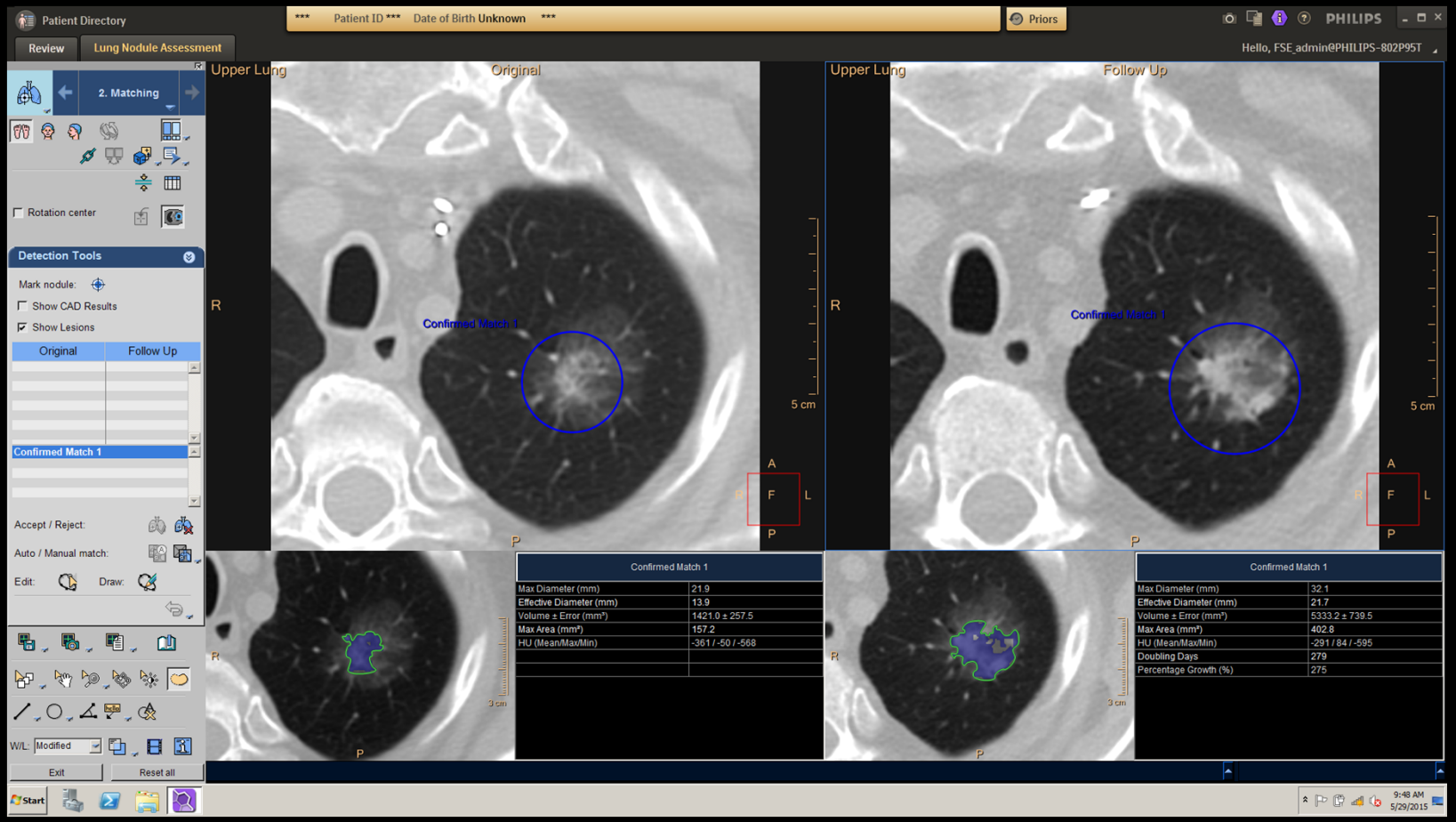
november 2014



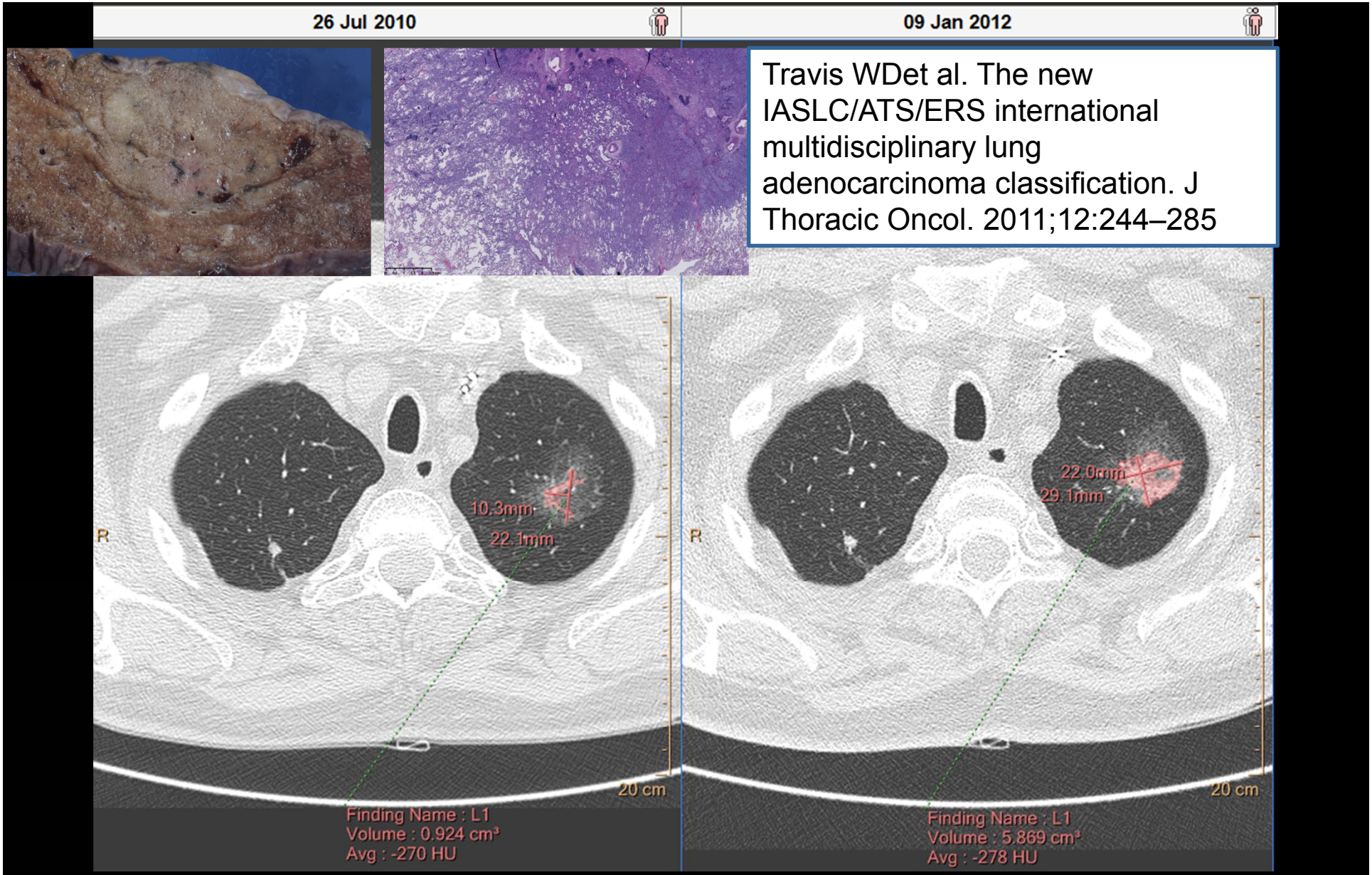
Fibrosis, inflammation…..

Choi SM, Go H, Chung DH, Yim JJ. Spontaneous regression of squamous cell lung cancer
Am J Respir Crit Care Med. 2013 15;188(4):e5-6

Follow-up for subsolid nodules



Naidich DP, Bankier AA, MacMahon H, et al. Recommendations for the management of subsolid pulmonary nodules detected at CT: a statement from the Fleischner Society, *Radiology (2013;266(1):304-17.*



The Fleischner recommendations advise the use of mediastinal window settings to evaluate the solid component; lung window settings are recommended for assessment of the ground-glass component

Follow-up for subsolid nodules

- Contiguous thin sections
- Electronic caliper measurements based on the average short and long axis
- Nodules with a solid component from 5-8 mm require a more agressive work-up
- No definite quantitative method is validated

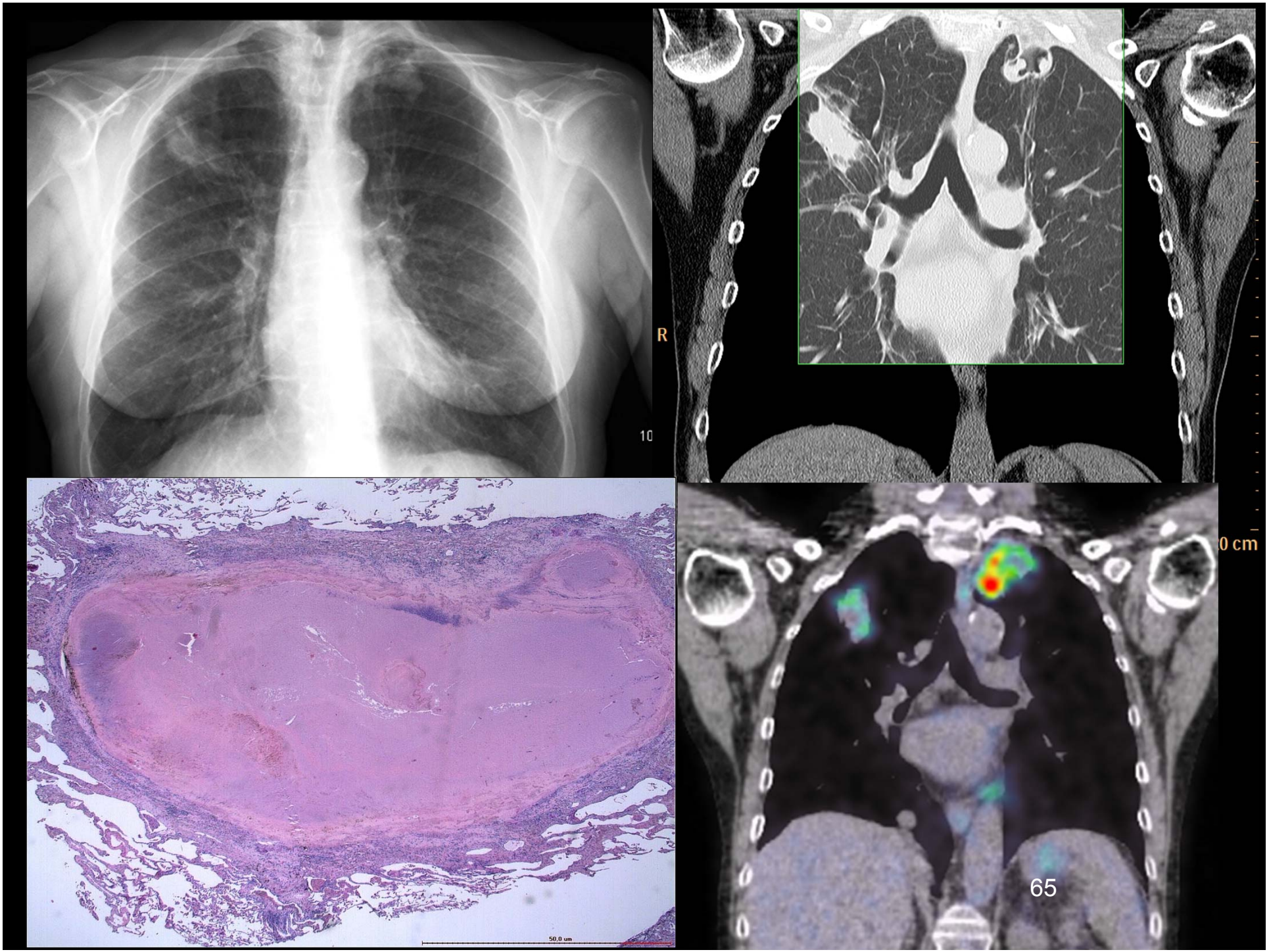
Naidich DP, Bankier AA, MacMahon H, et al. Recommendations for the management of subsolid pulmonary nodules detected at CT: a statement from the Fleischner Society, *Radiology (2013;266(1):304-17.*

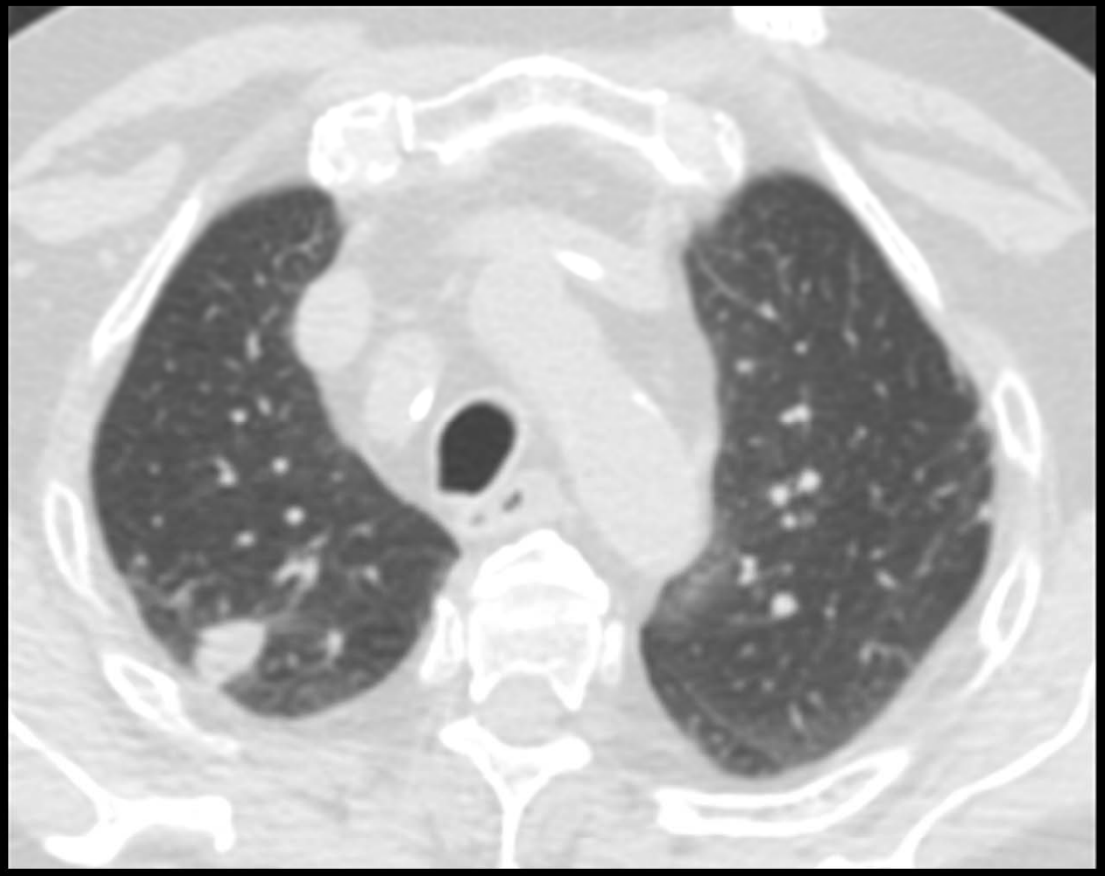
PET-CT

SUV >2,5

False positive: infectious, inflammatory (tbc, wegener, sarcoidosis…) lesions

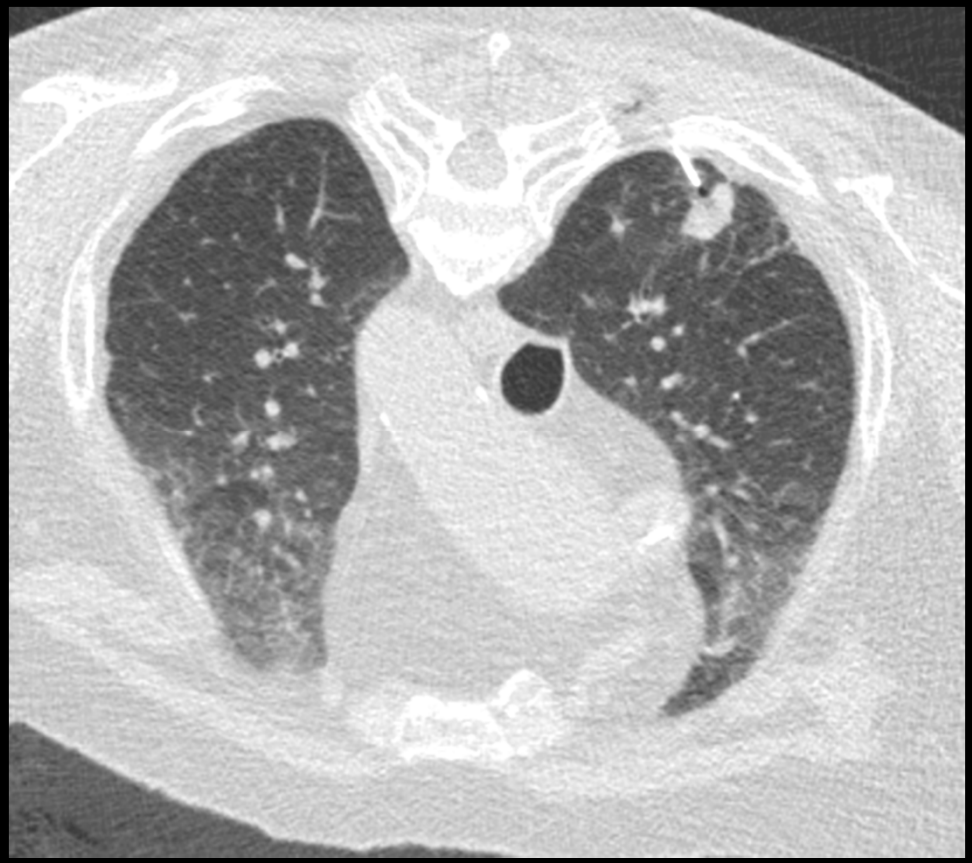
False negative: lesions<7 mm, mucinous adenocarcinoma, carcinoid tumors

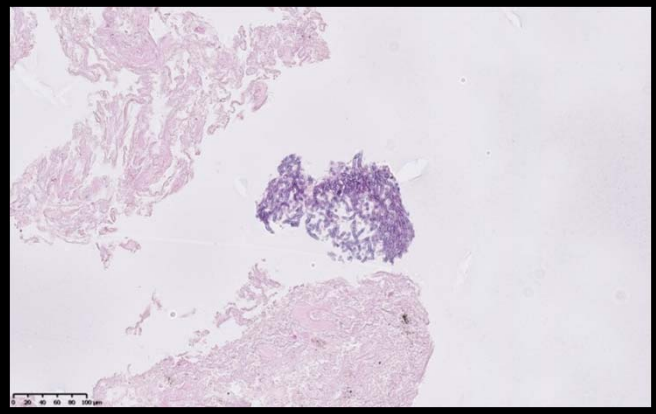

R
50.0 um
0 cm

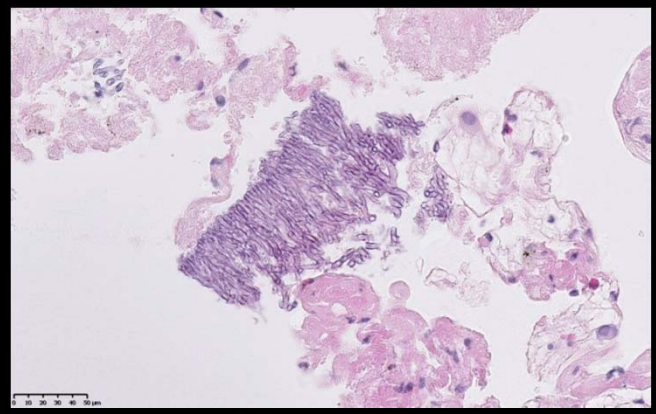


•78-year old male, colon adenocarcinoma 4 years ago

CT guided transthoracic biopsy







Histologic appearance from the right upper lobe biopsy demonstrates dichotomously branching hyphae, compatible with Aspergillus.

Take-Home message

- Many pitfalls in lung nodules detection and interpretation exist and usually can be avoided if the reader is aware of them

- Technical issues, artifacts, errors of perception and errors of interpretation, if not recognized can result in inappropriate diagnosis and treatment

Acknowledgments

- Delphine Hotton, Pathology Department
- Benoît Ghaye and members of the cardio-thoracic unit, Radiology Department, Cliniques Universitaires St-Luc, Brussels-Belgium
- Franca Brouwer and Alain Vlassenbroek, Philips Healthcare, Europe