CONGRÈS
Imagerie Appliquée
à la Pratique Pneumologique

Mise à jour sur le nodule pulmonaire

A. Khalil[1,2], M.P. Debray[1]

1- Radiology department, CHU Bichât-Claude Bernard

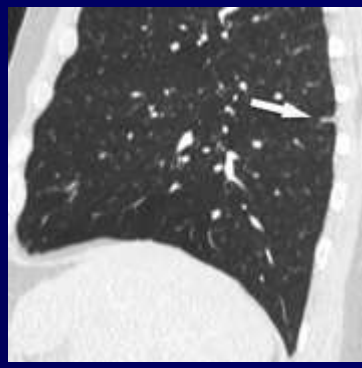
2- Paris University VII - Denis Diderot

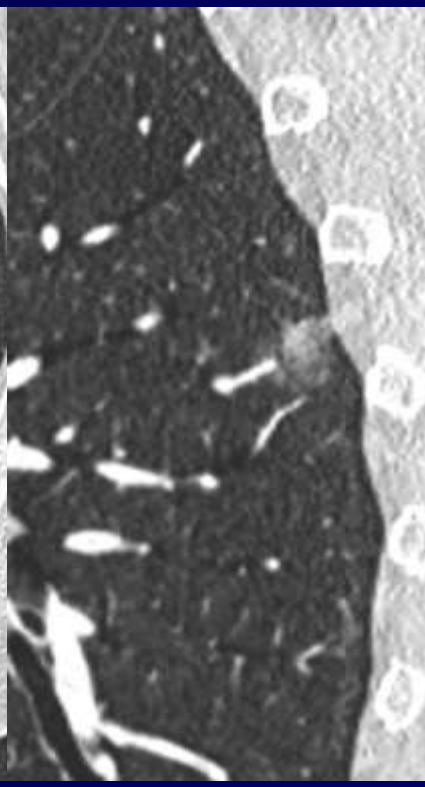
Plan

- Le nodule, est-il réel?
- Texture et taille: Nodule en verre dépoli pur (GGN), nodule partiellement solide, nodule solide
- Nodule pulmonaire solide (NPS)
- Malin vs Bénin
- Transitoire vs persistant
- Suivi/ recommandations
- Conclusion

Le nodule, est-il réel?

- Nodule:
  - Opacité ronde ou irrégulière
  - Diamètre: ≤30 mm
- Nodule en verre dépoli pur
- Nodule partiellement solide
- Nodule solide





Fleischner Society: Glossary of Terms for Thoracic Imaging[1]

David M. Hansell, MD, FRCP, FRCR
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Heber MacMahon, MB, BCh, BAO
Theresa C. McLoud, MD
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Jacques Remy, MD

Radiology 2008; 246:697–722

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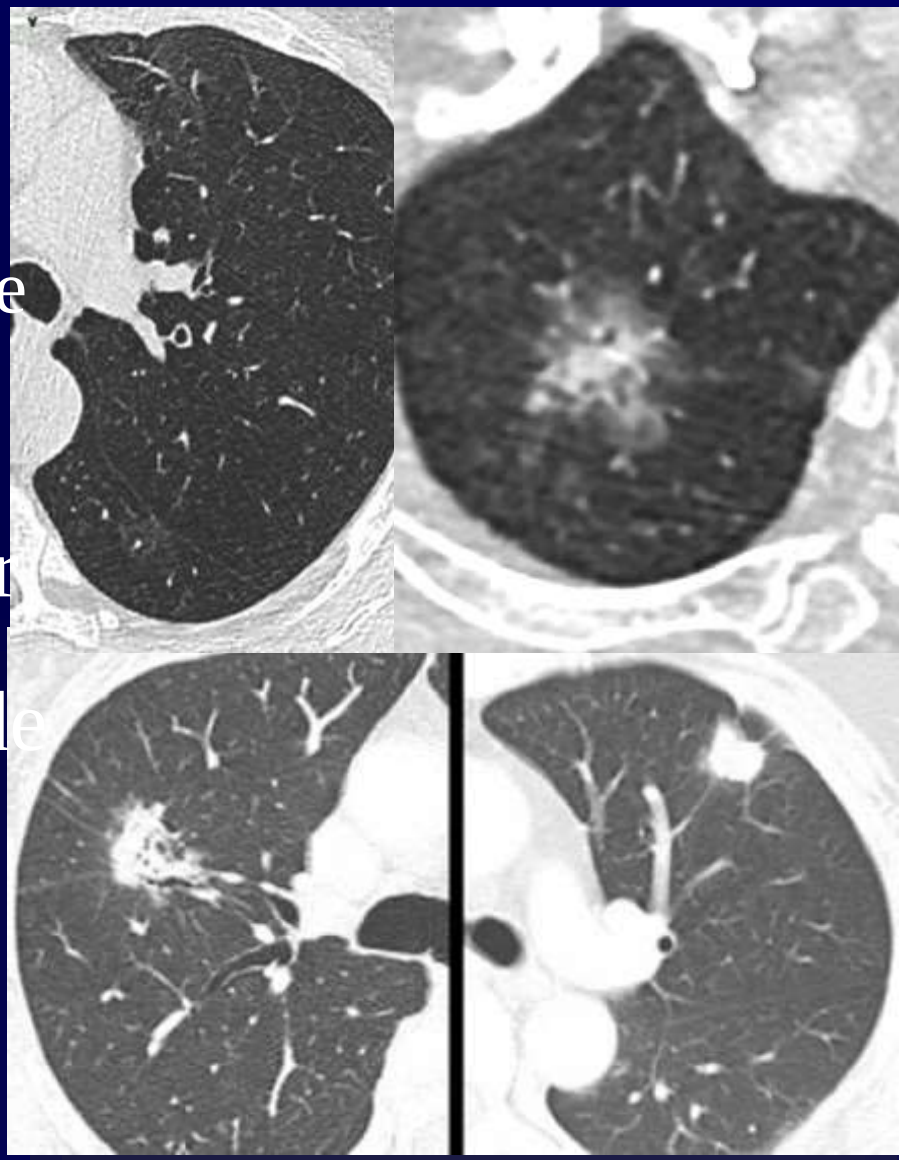

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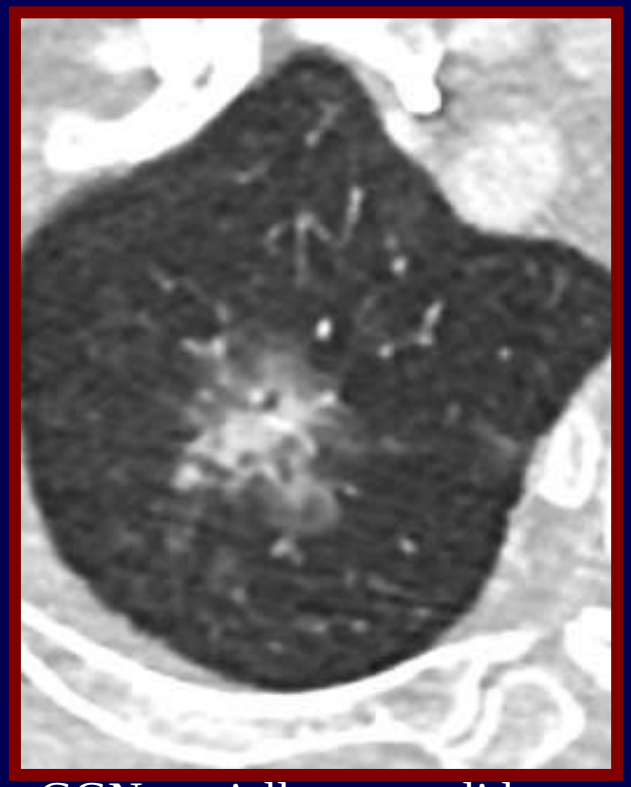
Texture du nodule➔ fréquence

GGN pur
15.8%



GGN partiellement solide
4.3%

Nodule solide
79.9%

Nodule sub-solide
20.1%

The NEW ENGLAND JOURNAL of MEDICINE

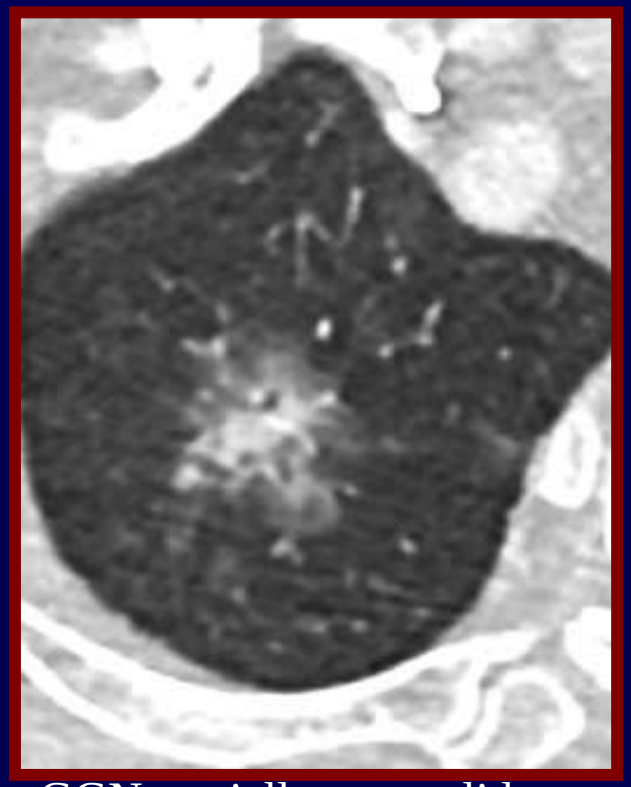
N Engl J Med 2013;369:910-9.
DOI: 10.1056/NEJMoa1214726

Probability of Cancer in Pulmonary Nodules Detected on First Screening CT

Annette McWilliams, M.B., Martin C. Tammemagi, Ph.D., John R. Mayo, M.D.,

Texture du nodule➔ Malignité

GGN pur
18%



GGN partiellement solide
64%

Nodule solide
7%

Nodule sub-solide
34%

CT Screening for Lung Cancer:
Frequency and Significance of Part-Solid and Nonsolid Nodules

Claudia I. Henschke[1]
David F. Yankelevitz[1]
Rosna Mirtcheva[1]
Georgeann McGuinness[2]
Dorothy McCauley[1]
Olli S. Miettinen[3]
for the ELCAP Group

AJR 2002;178:1053–1057

Taille du nodule➔ comment faire les mesures

How should the dimension of a solid pulmonary nodule be expressed?

For purposes of risk estimation, the dimension of small pulmonary nodules (<10 mm) should be expressed as the average of maximal long-axis and perpendicular maximal short-axis measurements in the same plane. For larger nodules and masses, both long- and short-axis measurements should be recorded (grade 2B evidence).

How should part-solid nodules be measured?

As with solid nodules, the average of the long and short dimensions of the nodule, including ground-glass and any cystic components, should be measured and recorded for smaller nodules (<10 mm). For larger nodules, both long and short dimensions should be recorded. For all part-solid nodules, the maximum diameter of the solid component should be measured if this component is >3 mm, understanding that measurements may be unreliable for small solid components. Dimensions of both solid and nonsolid components should be recorded to document change in the future (grade 2B evidence).

Which measurement unit should be used?

Measurements and averages should be expressed to the nearest whole millimeter (grade 1B evidence).

Should the dimension of every pulmonary nodule be measured?

No, small nodules <3 mm should not be measured due to accuracy limitations. Descriptors such as "micronodule" are preferable. Also, when multiple nodules are present, only the largest or morphologically most suspicious nodules need be measured. The location of each measured nodule should be explicitly referenced in the report (grade 1C evidence).

Recommendations for Measuring Pulmonary Nodules at CT: A Statement from the Fleischner Society[1]

Radiology: Volume 285: Number 2—November 2017

Alexander A. Bankier, MD, PhD
Heber MacMahon, MB, BCh
Jin Mo Goo, MD, PhD
Geoffrey D. Rubin, MD
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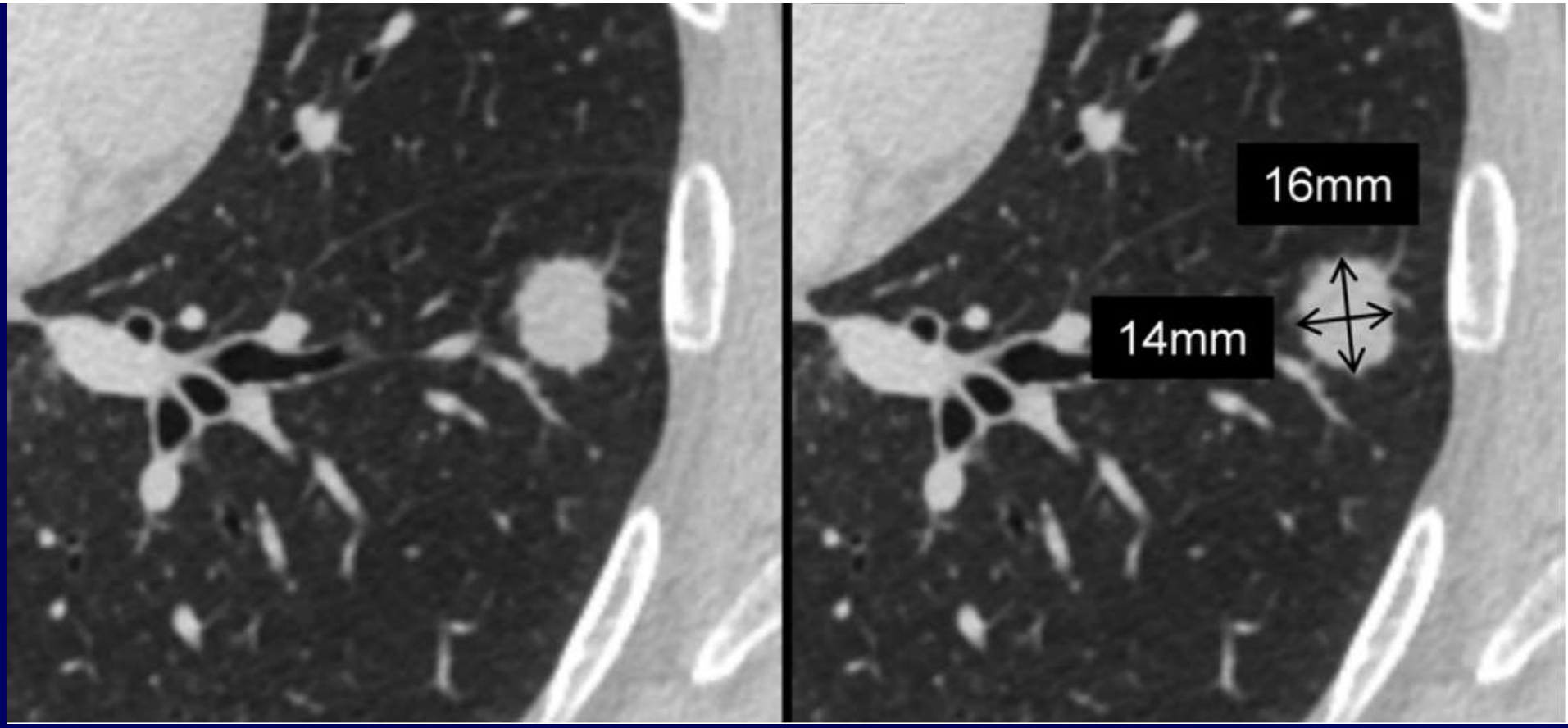

Solid nodule size	Size to be recorded
<10 mm	Average Long and Short axis
>10 mm	Long axis and Short axis

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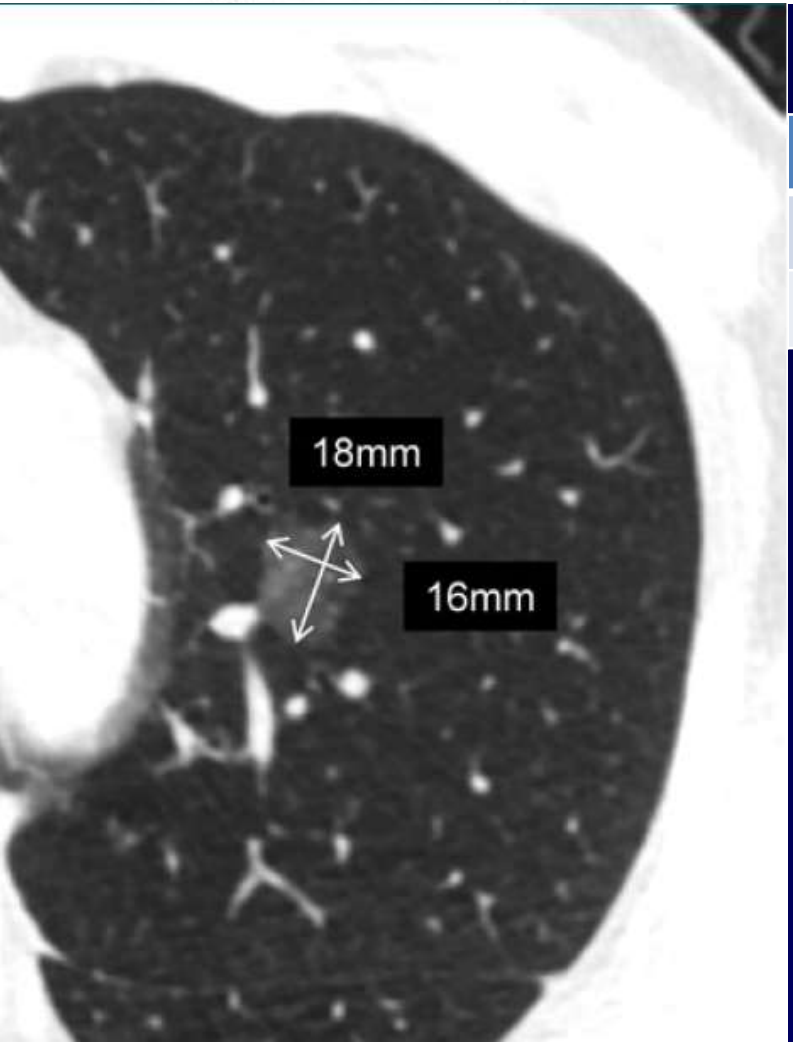

Pure GGN	Size to be recorded
<10 mm	Average Long and Short axis
≥10 mm	Long axis and Short axis

For this pure Ground Glass Nodule (GGN) we have to record the larger (18mm) and the smaller (16mm) diameter and not the average

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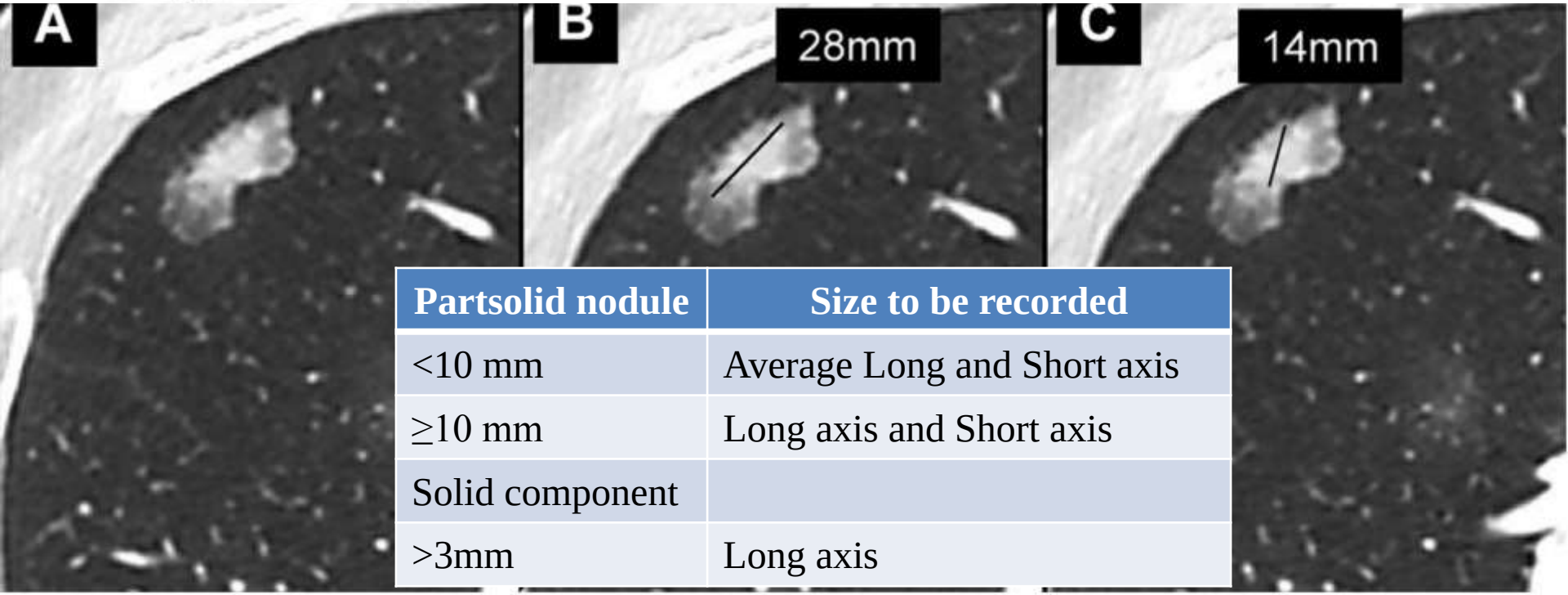

Partsolid nodule	Size to be recorded
<10 mm	Average Long and Short axis
≥10 mm	Long axis and Short axis
Solid component	
>3mm	Long axis

Figure 4: Transverse CT sections of a part-solid nodule in the right upper lobe. *A*, The solid component of the nodule is ill defined, resulting in variability of measurements, as performed by two radiologists. The two long-axis diameters of the solid component were, *B*, 28 mm and, *C*, 14 mm. On the basis of the clinical implications, we recommend use of the larger long-axis diameter. Only solid component measurements are shown in this figure; however, in clinical practice, nonsolid and solid components must be measured.

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Taille du nodule ➔ Malignité

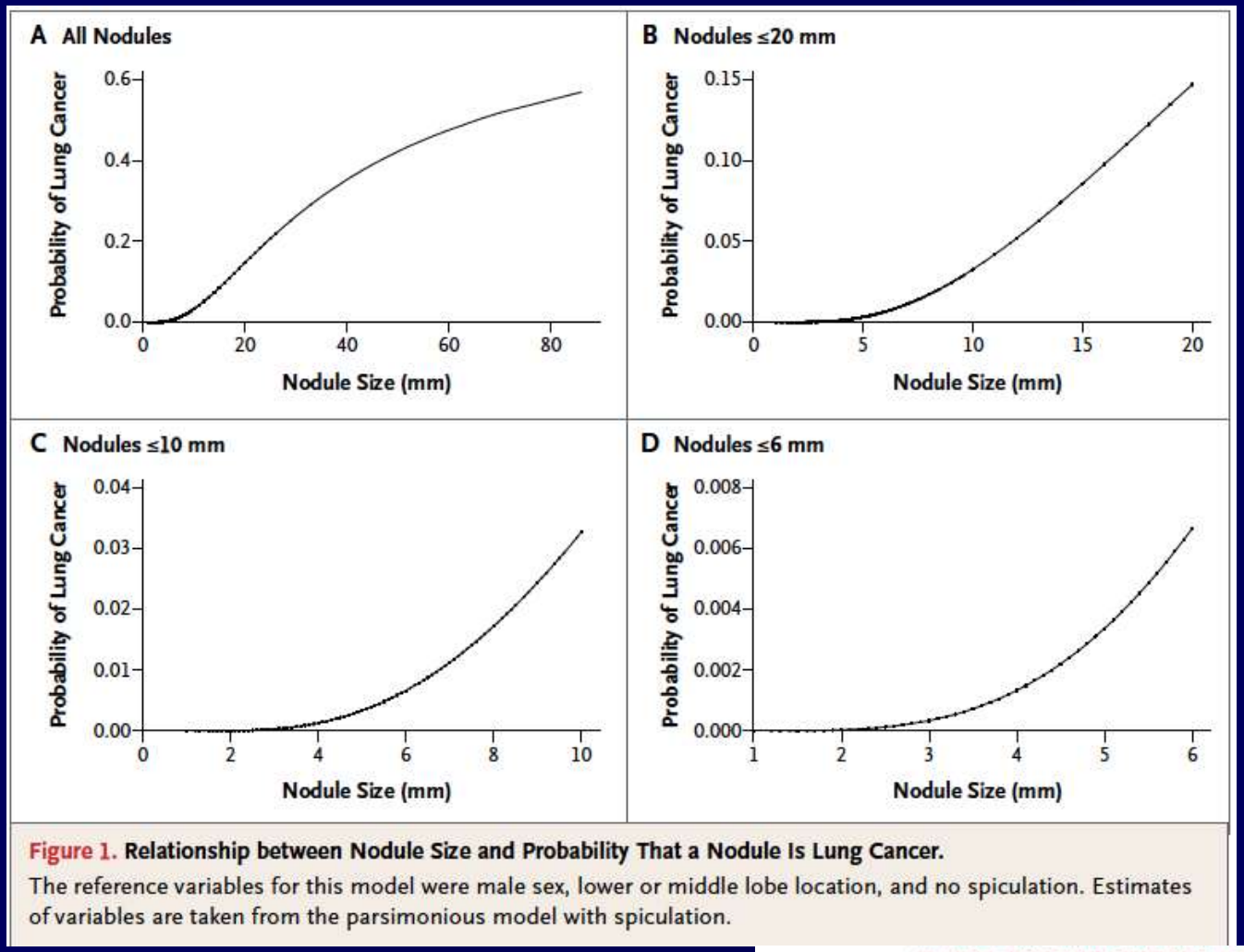

Figure 1. Relationship between Nodule Size and Probability That a Nodule Is Lung Cancer.

The reference variables for this model were male sex, lower or middle lobe location, and no spiculation. Estimates of variables are taken from the parsimonious model with spiculation.

The NEW ENGLAND JOURNAL of MEDICINE

N Engl J Med 2013;369:910-9.
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Probability of Cancer in Pulmonary Nodules Detected on First Screening CT

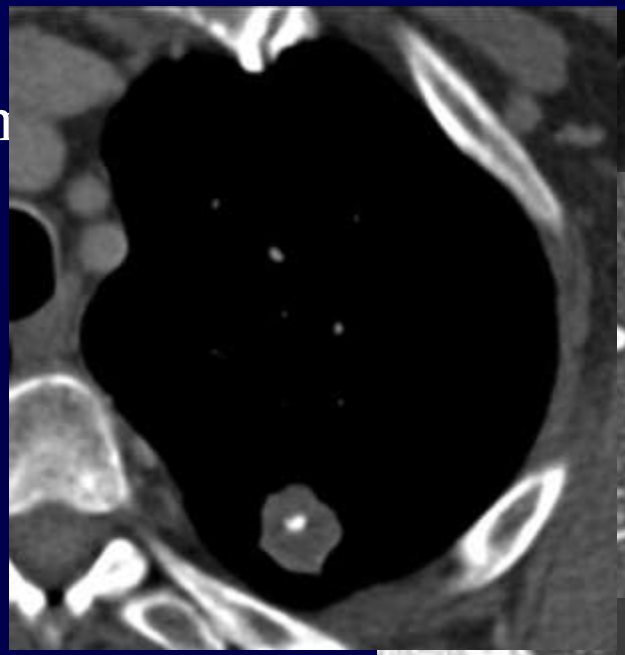
Annette McWilliams, M.B., Martin C. Tammemagi, Ph.D., John R. Mayo, M.D.,

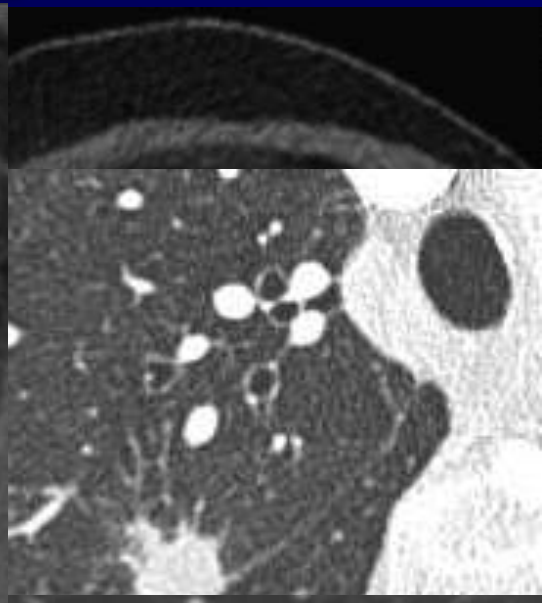
Nodule pulmonaire solitaire

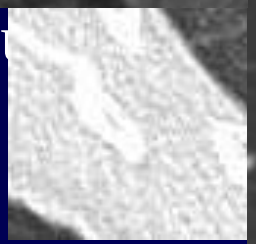
- Unique
- Traquer et éliminer le cancer
  - Nodule bénin
  - Nodule malin
  - Nodule suspect
  - Gestion systématique et *validée*
- Sans tuer
  - Le patient (iatrogénie +++)
  - La sécurité sociale

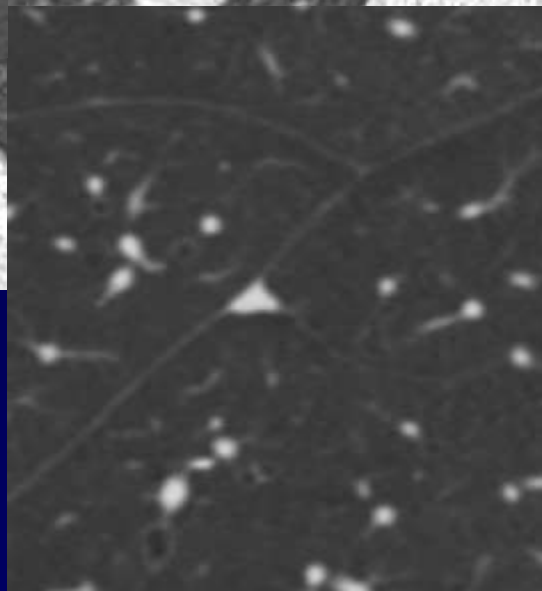
Nodule pulmonaire solitaire
Nodule solide/ Etiologies

- Causes malignes:
  - Cancer pulmonaire prin
    - NSCLC / SCLC
    - Tumeur carcinoïde
    - Lymphome
  - Métastase unique
- Causes bénignes:
  - Nodules scissuraux (ganglions intra pu pleuraux)
  - Granulome
  - Hamartochondrome
  - Autres causes

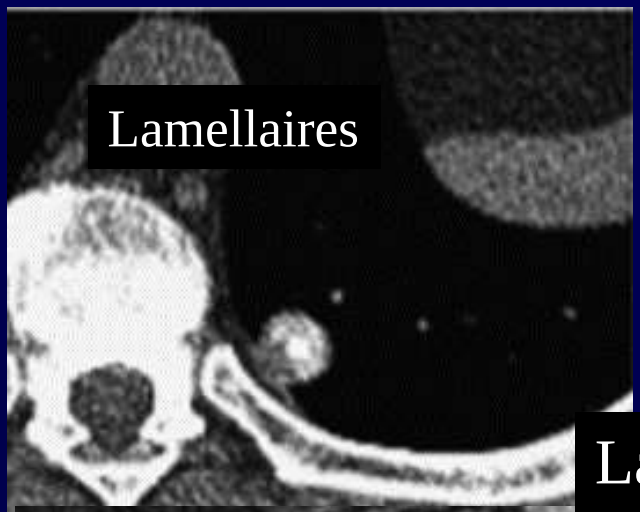




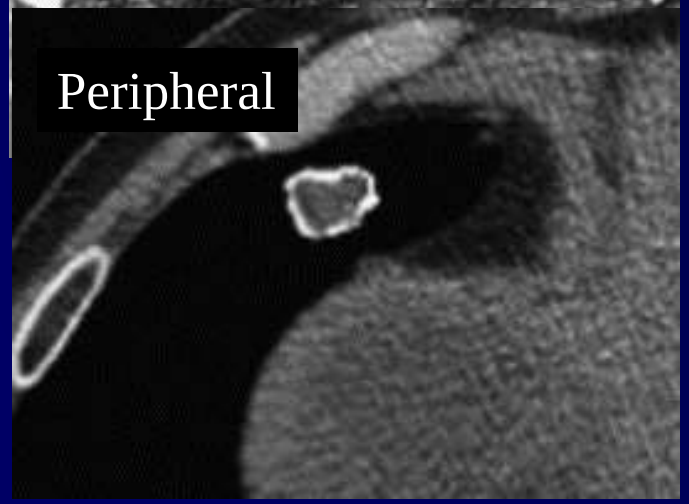


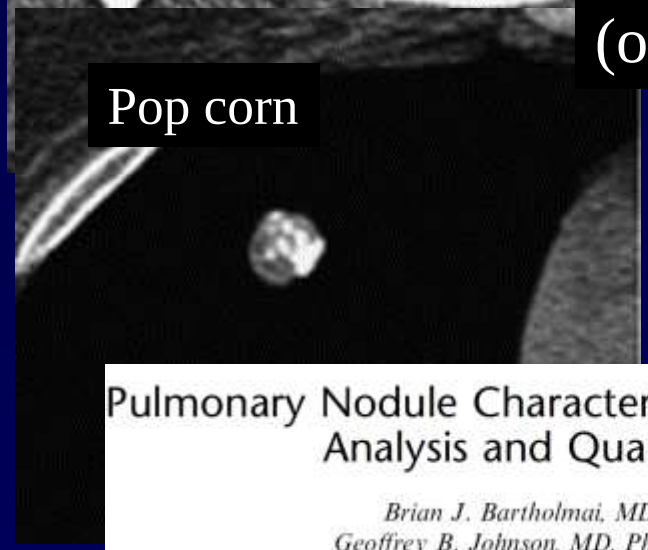


Nodule pulmonaire solitaire
Certainement bénin



Lack of cancer history (ostéosarcoma)





Pulmonary Nodule Characterization, Including Computer Analysis and Quantitative Features

Brian J. Bartholmai, MD, Chi Wan Koo, MD,**
Geoffrey B. Johnson, MD, PhD,† Darin B. White, MD,**
Sushravya M. Raghunath, PhD, Srinivasan Rajagopalan, PhD,‡*
Michael R. Moynagh, MB. BCh, Rebecca M. Lindell, MD,**

(*J Thorac Imaging* 2015;30:139–156)

Nodule pulmonaire solitaire Certainement bénin

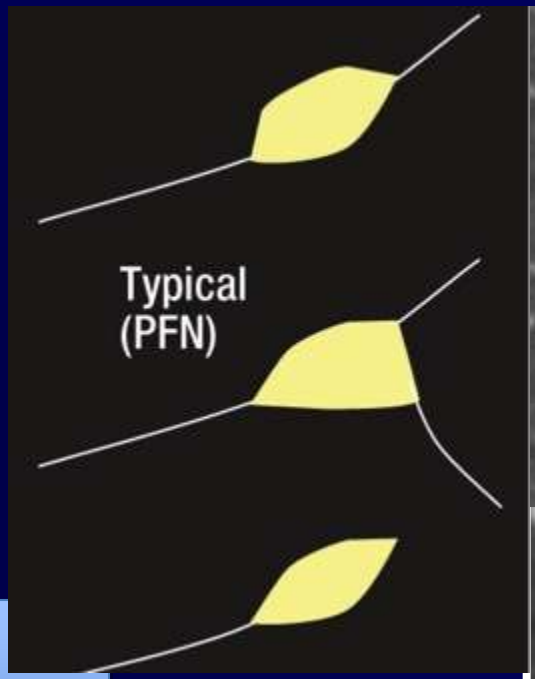
Nelson study
2994 participants

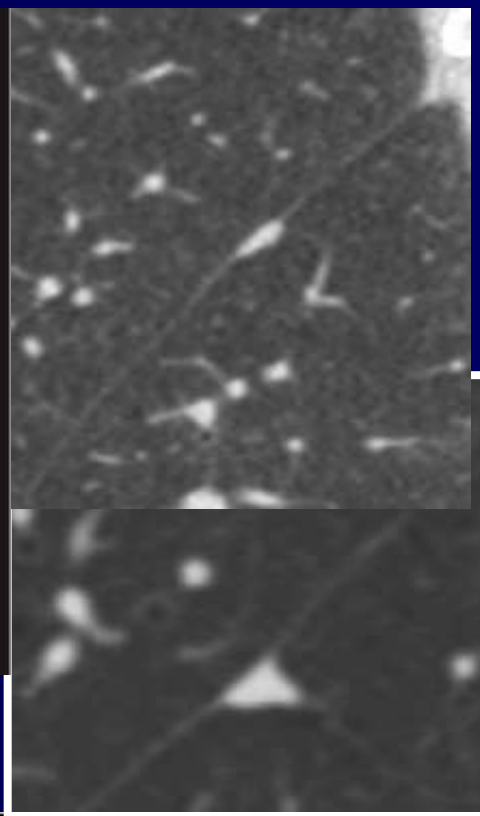
Nodules: 4026
1726 participants

794 nodules
convex/triangular perifissural
(4,4mm: 2.8 to 10.6mm)

3 years Follow-up:
↗volume in 123 nodules
With 66 (8.3%) volume doubling time <400 D

Histopathology of one:
➔ intrapulmonary lymph node
Follow-up of 793 non cancer development

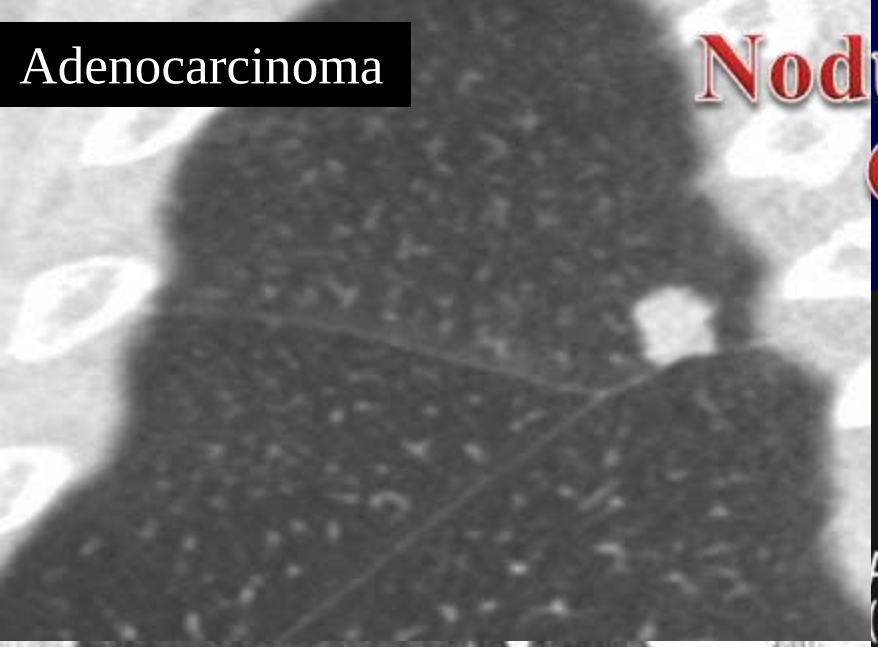




Bartjan de Hoop, MD, PhD
Bram van Ginneken, PhD
Hester Gietema, MD, PhD
Mathias Prokop, MD, PhD

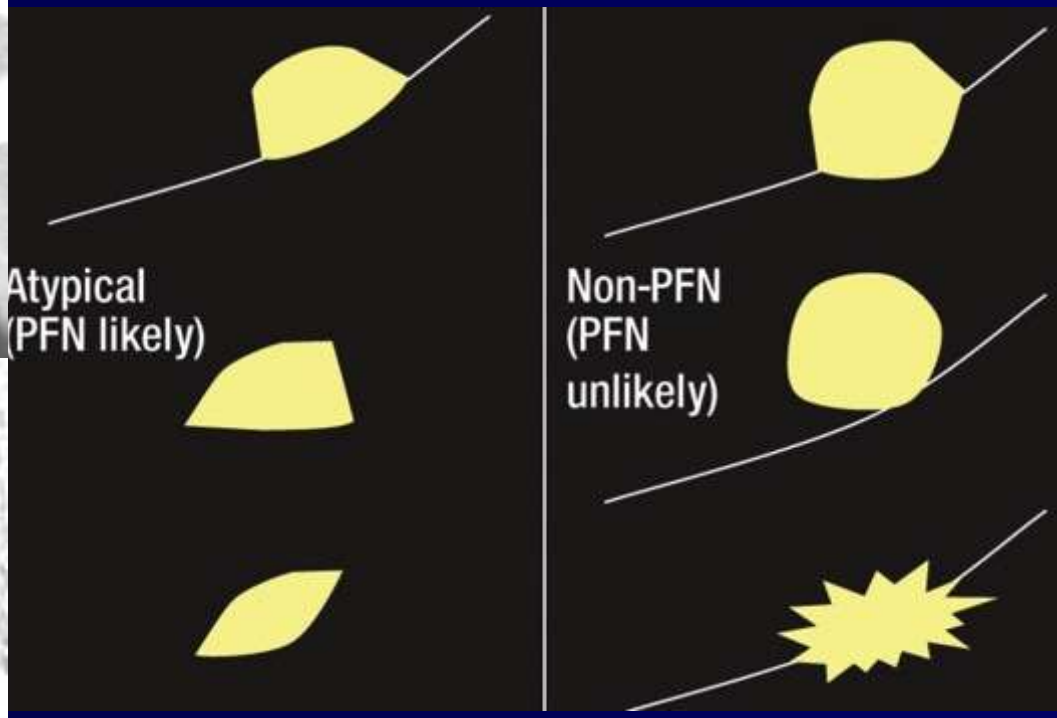
Pulmonary Perifissural Nodules on CT Scans: Rapid Growth Is Not a Predictor of Malignancy[1]

Radiology: Volume 265: Number 2—November 2012 ▪ *radiology.rsna.org*



Adenocarcinoma

Nodule pulmonaire solitaire Certainement bénin



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Nodule pulmonaire solitaire
Certainement bénin

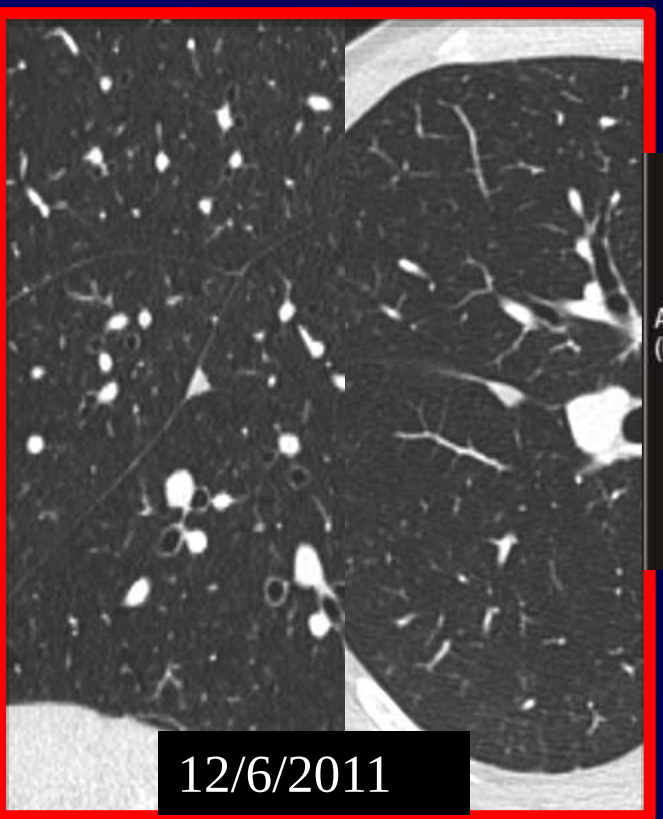
Critères des nodules scissuraux / ganglions intra pulmonaires

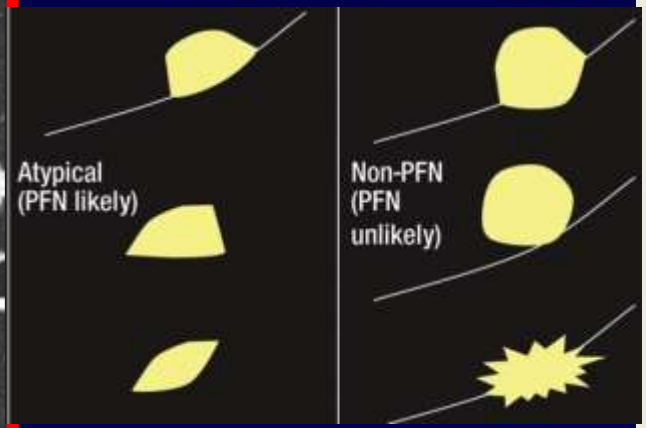
1- Forme polygonale < 10mm

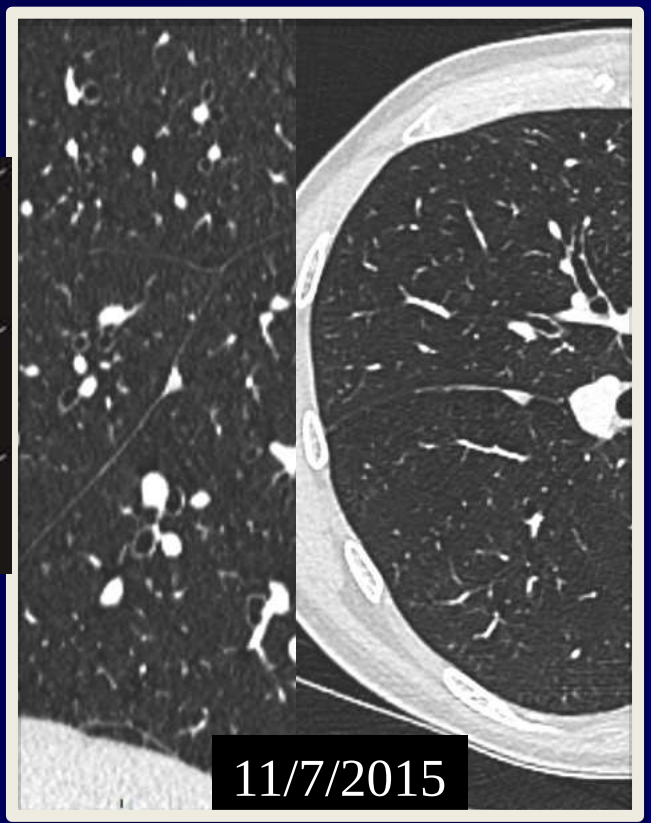
2- Siège <10 mm de la plèvre

3- Sous la carène

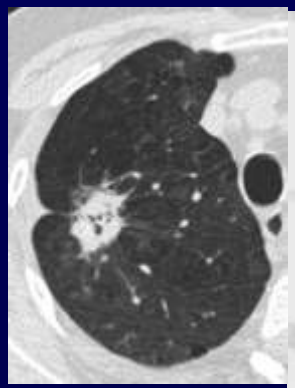
➔ ganglions intra-pulmonaires

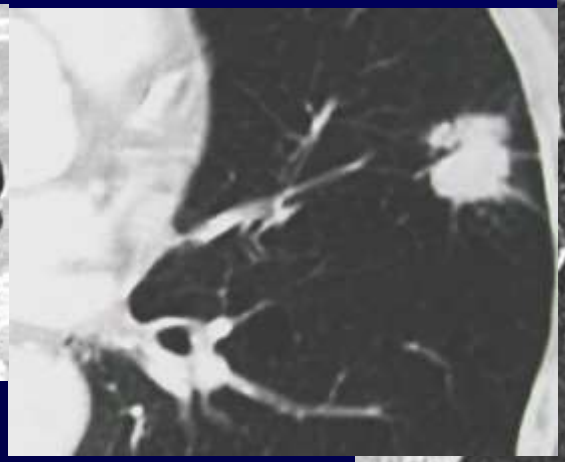


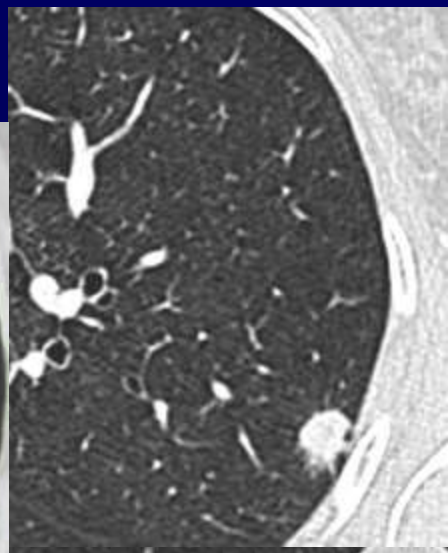




Nodule pulmonaire solitaire Probablement malin





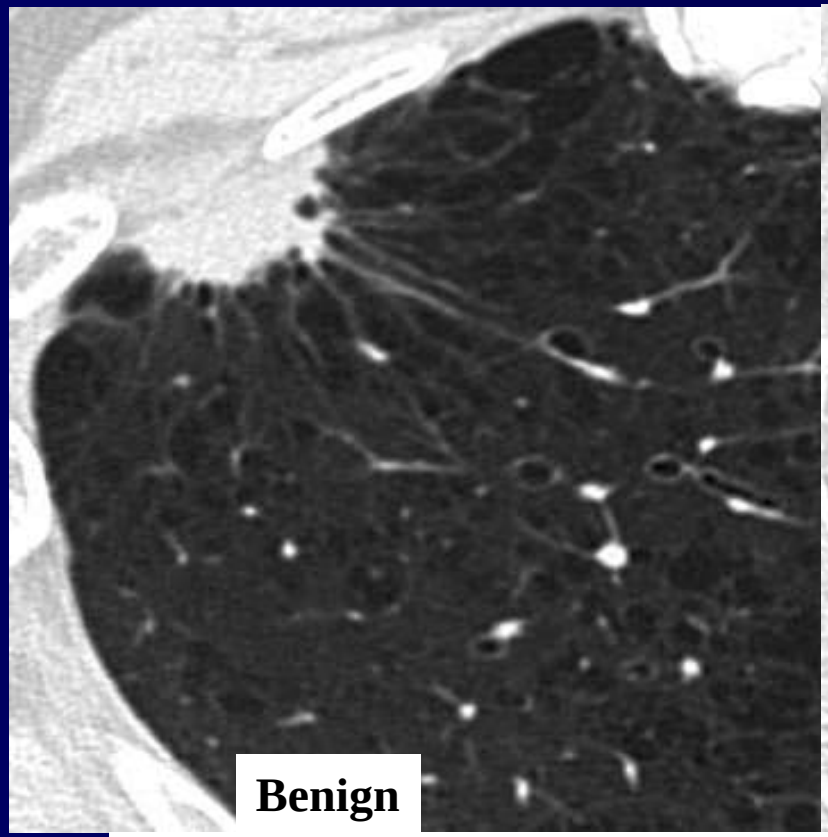


- Taille: > 10 mm
- Contours psiculé
- Structure: bronchogramme aérique et pseudo-cavitation (35% «malin» vs 5% «bénin»)
- Cavitation: épaississement de la paroi> 15 mm

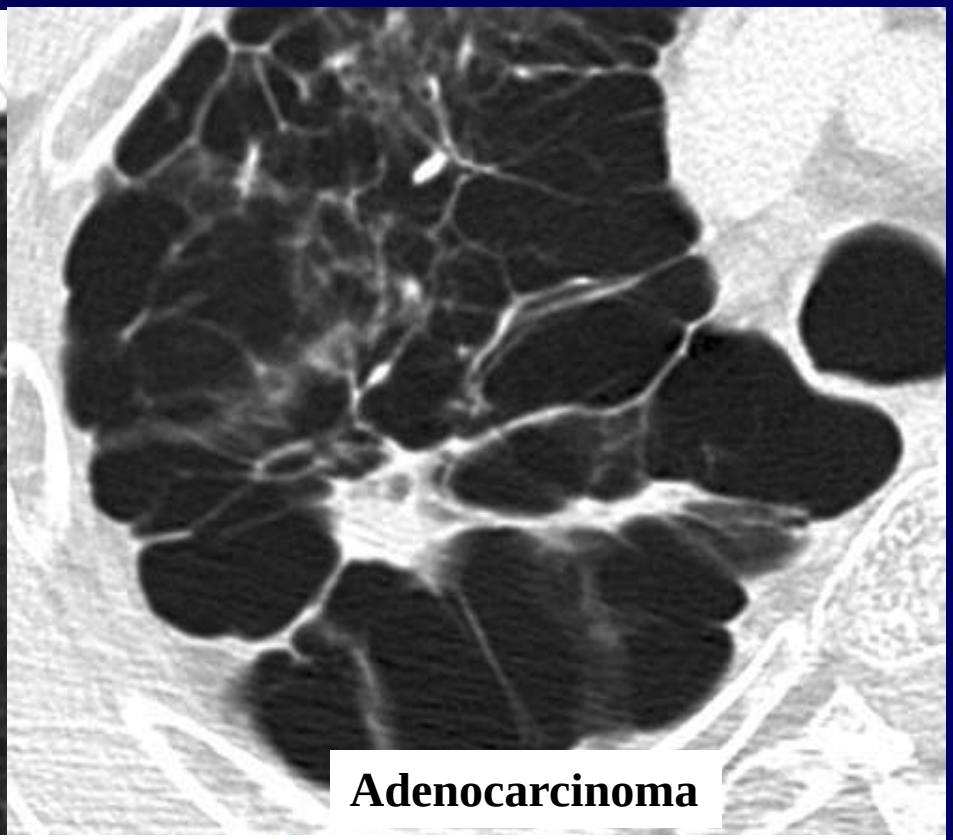
Nodule pulmonaire solitaire
Probablement malin

Nodules pleuraux métastatiques➔ Certainement malin

Nodule pulmonaire solitaire
Emphysème



Benign



Adenocarcinoma

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Radiology 2005; 235:266–273

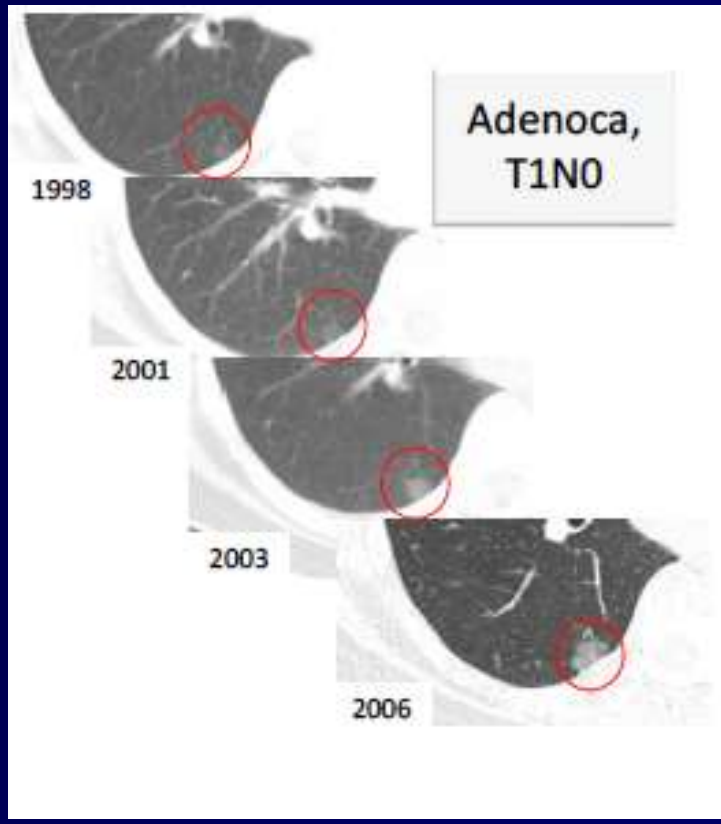
Peripheral Solitary Pulmonary Nodule: CT Findings in Patients with Pulmonary Emphysema[1]

Transitoire vs Persistant

Nodule en verre dépoli / nodule solide

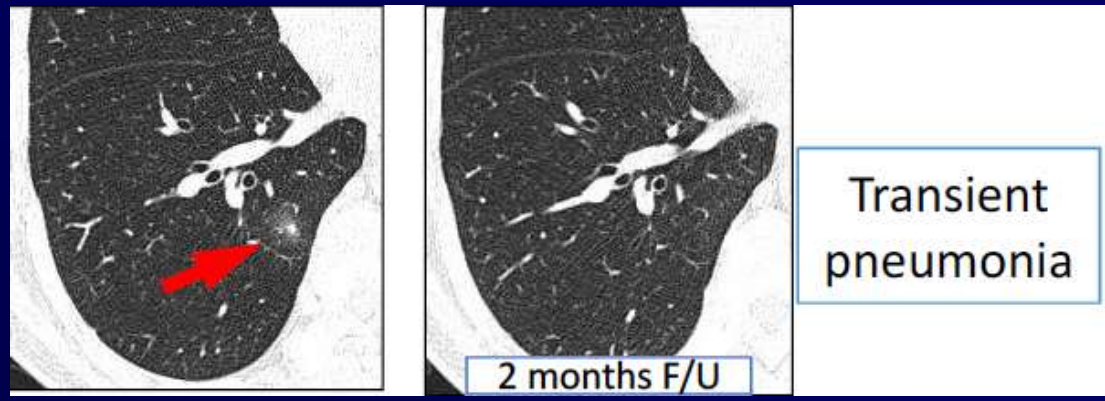
Classification des nodules ➔ Temps de doublement volumique

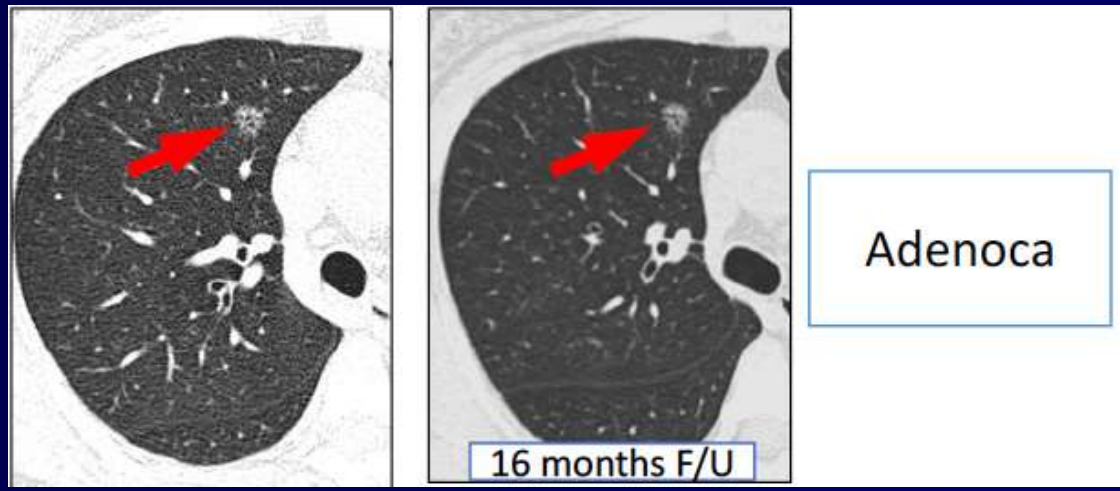
- *61 Primary lung cancer Hasagawa H, et al BJR 2000*
  - Pure GGN: **813** days
  - Part solid GGN: **457** days
  - Solid: **149** days
- *97 SSNs Song YS, et al Radiology 2014*
  - Pure GGN: **1832** days
  - PS (≤ 5mm solid) GGN: **1228** days
  - PS (> 5mm solid) GGN, **759** days



Transitoire vs Persistant

- Incidentally detected PSN
- 70% Transient
  - Young patient age
  - Detection at F/U
  - Blood eosinophilia
  - Lesion multiplicity
  - Large solid portion
  - Ill-defined border





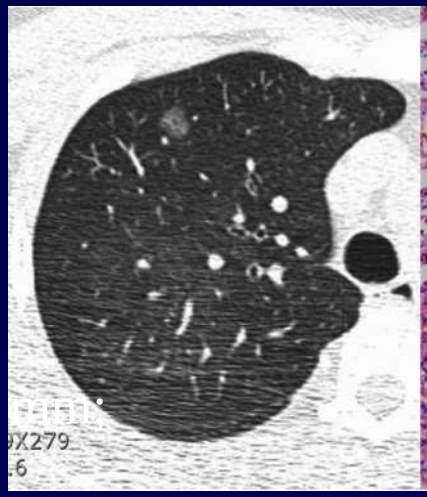
Transient Part-Solid Nodules Detected at Screening Thin-Section CT for Lung Cancer: Comparison with Persistent Part-Solid Nodules[1]

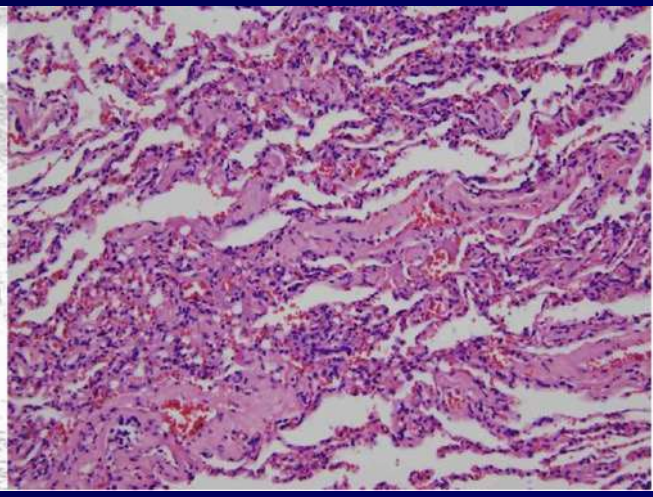
Sang Min Lee, MD
Chang Min Park, MD
Jin Mo Goo, MD

Radiology: Volume 255: Number 1—April 2010

Nodules en verre dépoli persistants (GGN)

- Hyperplasie Adénomatoide Atypique (HAA)
- Adenocarcinome In Situ (AIS)
- Adenocarcinome minimalement invasif (MIA)
- Adenocarcinome
- Foyer de fibrose focale:
  - Nodule solitaire (100%)
  - Lobes supérieurs(77.8%)
  - Taille des lésions(Moyen, 11.5 mm; 4.8-25.5 mm)
  - GGN pur : 88.9%
- Pneumonie organisée cryptogénique





Focal interstitial fibrosis manifesting as nodular ground-glass opacity: thin-section CT findings

Chang Min Park
Jin Mo Goo
Hyun Ju Lee

Eur Radiol (2007) 17: 2325–2331
DOI 10.1007/s00330-007-0596-z

Recommendations de suivi

Circonstances Texture Taille

Lung-RADS: dépistage

Category	Category Descriptor	Category	Findings	Management	Probability of Malignancy	Estimated Population Prevalence
Incomplete	-	0	prior chest CT examination(s) being located for comparison part or all of lungs cannot be evaluated	Additional lung cancer screening CT images and/or comparison to prior chest CT examinations is needed	n/a	1%
Negative	No nodules and definitely benign nodules	1	no lung nodules nodule(s) with specific calcifications: complete, central, popcorn, concentric rings and fat containing nodules	Continue annual screening with LDCT in 12 months	< 1%	90%
Benign Appearance or Behavior	Nodules with a very low likelihood of becoming a clinically active cancer due to size or lack of growth	2	solid nodule(s): < 6 mm new < 4 mm part solid nodule(s): < 6 mm total diameter on baseline screening non solid nodule(s) (GGN): < 20 mm OR ≥ 20 mm and unchanged or slowly growing category 3 or 4 nodules unchanged for ≥ 3 months			
Probably Benign	Probably benign finding(s) - short term follow up suggested; includes nodules with a low likelihood of becoming a clinically active cancer	3	solid nodule(s): ≥ 6 to < 8 mm at baseline OR new 4 mm to < 6 mm part solid nodule(s) ≥ 6 mm total diameter with solid component < 6 mm OR new < 6 mm total diameter non solid nodule(s) (GGN) ≥ 20 mm on baseline CT or new	6 month LDCT	1-2%	5%
Suspicious	Findings for which additional diagnostic testing and/or tissue sampling is recommended	4A	solid nodule(s): ≥ 8 to < 15 mm at baseline OR growing < 8 mm OR new 6 to < 8 mm part solid nodule(s: ≥ 6 mm with solid component ≥ 6 mm to < 8 mm OR with a new or growing < 4 mm solid component endobronchial nodule	3 month LDCT; PET/CT may be used when there is a ≥ 8 mm solid component	5-15%	2%
		4B	solid nodule(s) ≥ 15 mm OR new or growing, and ≥ 8 mm part solid nodule(s) with: a solid component ≥ 8 mm OR a new or growing ≥ 4 mm solid component	chest CT with or without contrast, PET/CT and/or tissue sampling depending on the *probability of malignancy and comorbidities. PET/CT may be used when there is a ≥ 8 mm solid component.	> 15%	2%
		4X	Category 3 or 4 nodules with additional features or imaging findings that increases the suspicion of malignancy			
Other	Clinically Significant or Potentially Clinically Significant Findings (non lung cancer)	S	modifier - may add on to category 0-4 coding	As appropriate to the specific finding	n/a	10%
Prior Lung Cancer	Modifier for patients with a prior diagnosis of lung cancer who return to screening	C	modifier - may add on to category 0-4 coding	-	-	-

Fleischner Society Guidelines : Fortuite

Fleischner Society 2017 Guidelines for Management of Incidentally Detected Pulmonary Nodules in Adults

A: Solid Nodules*

Nodule Type	Size			Comments
	<6 mm (<100 mm³)	6–8 mm (100–250 mm³)	>8 mm (>250 mm³)	
Single				
Low risk†	No routine follow-up	CT at 6–12 months, then consider CT at 18–24 months	Consider CT at 3 months, PET/CT, or tissue sampling	Nodules <6 mm do not require routine follow-up, but certain patients at high risk with suspicious nodule morphology, upper lobe location, or both may warrant 12-month follow-up (recommendation 1A).
High risk†	Optional CT at 12 months	CT at 6–12 months, then CT at 18–24 months	Consider CT at 3 months, PET/CT, or tissue sampling	Nodules <6 mm do not require routine follow-up, but certain patients at high risk with suspicious nodule morphology, upper lobe location, or both may warrant 12-month follow-up (recommendation 1A).
Multiple				
Low risk†	No routine follow-up	CT at 3–6 months, then consider CT at 18–24 months	CT at 3–6 months, then consider CT at 18–24 months	Use most suspicious nodule as guide to management. Follow-up intervals may vary according to size and risk (recommendation 2A).
High risk†	Optional CT at 12 months	CT at 3–6 months, then at 18–24 months	CT at 3–6 months, then at 18–24 months	Use most suspicious nodule as guide to management. Follow-up intervals may vary according to size and risk (recommendation 2A).

B: Subsolid Nodules*

Nodule Type	Size		Comments
	<6 mm (<100 mm³)	≥6 mm (>100 mm³)	
Single			
Ground glass	No routine follow-up	CT at 6–12 months to confirm persistence, then CT every 2 years until 5 years	In certain suspicious nodules < 6 mm, consider follow-up at 2 and 4 years. If solid component(s) or growth develops, consider resection. (Recommendations 3A and 4A).
Part solid	No routine follow-up	CT at 3–6 months to confirm persistence. If unchanged and solid component remains <6 mm, annual CT should be performed for 5 years.	In practice, part-solid nodules cannot be defined as such until ≥6 mm, and nodules <6 mm do not usually require follow-up. Persistent part-solid nodules with solid components ≥6 mm should be considered highly suspicious (recommendations 4A–4C)
Multiple	CT at 3–6 months. If stable, consider CT at 2 and 4 years.	CT at 3–6 months. Subsequent management based on the most suspicious nodule(s).	Multiple <6 mm pure ground-glass nodules are usually benign, but consider follow-up in selected patients at high risk at 2 and 4 years (recommendation 5A).

Note.—These recommendations do not apply to lung cancer screening, patients with immunosuppression, or patients with known primary cancer.

* Dimensions are average of long and short axes, rounded to the nearest millimeter.

† Consider all relevant risk factors (see Risk Factors).

Table 3: Comparison between Lung-RADS Guidelines and Fleischner Society Guidelines for the Management of Pulmonary Nodules

Lung-RADS Guidelines	Fleischner Society Guidelines
Single version published in 2014 (2) (addresses solid and subsolid nodules)	Updated version published in 2017 (6) (addresses solid and subsolid nodules) Older versions published in 2005 for solid nodules (7) and in 2013 for subsolid nodules (8)
Developed for the management of nodules in the setting of LCS CT	Developed for the management of incidentally detected nodules
Includes management of nodules that are new or growing	Does not address how to manage nodules that are new or growing
Applies to patients older than 55 years of age (current lower limit for LCS) and up to 80 years of age (upper age limit according to the U.S. Preventive Services Task Force)	Applies to patients older than 35 years of age, with no upper age limit
Applies to all patients undergoing LCS CT	Does not apply to immunosuppressed patients or those with a history of malignancy

Note.—Numbers in parentheses are reference citations.

Maria D. Martin, MD
Jeffrey P. Kanne, MD
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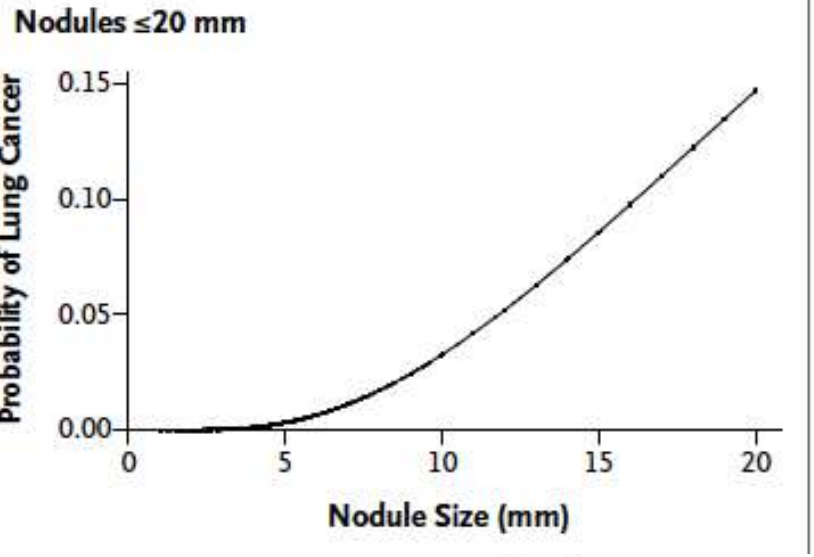
Ella A. Kazerooni, MD, MS
Cristopher A. Meyer, MD

Lung-RADS: Pushing the Limits[1]

RadioGraphics 2017; 37:1975–1993



uidelines for Management of ıcidental Pulmonary Nodules etected on CT Images: From the eischner Society 2017[1]

Nodule Type	<6 mm (<100 mm³)	6–8 mm (100–250 mm³)	>8 mm (>250 mm³)	Comments
Single				
Low risk†	No routine follow-up	CT at 6–12 months, then consider CT at 18–24 months	Consider CT at 3 months, PET/CT or tissue sampling	Nodules <6 mm do not require routine follow-up, but certain patients at high risk with suspicious nodule morphology, upper lobe location, or both may warrant 12-month follow-up (recommendation 1A).
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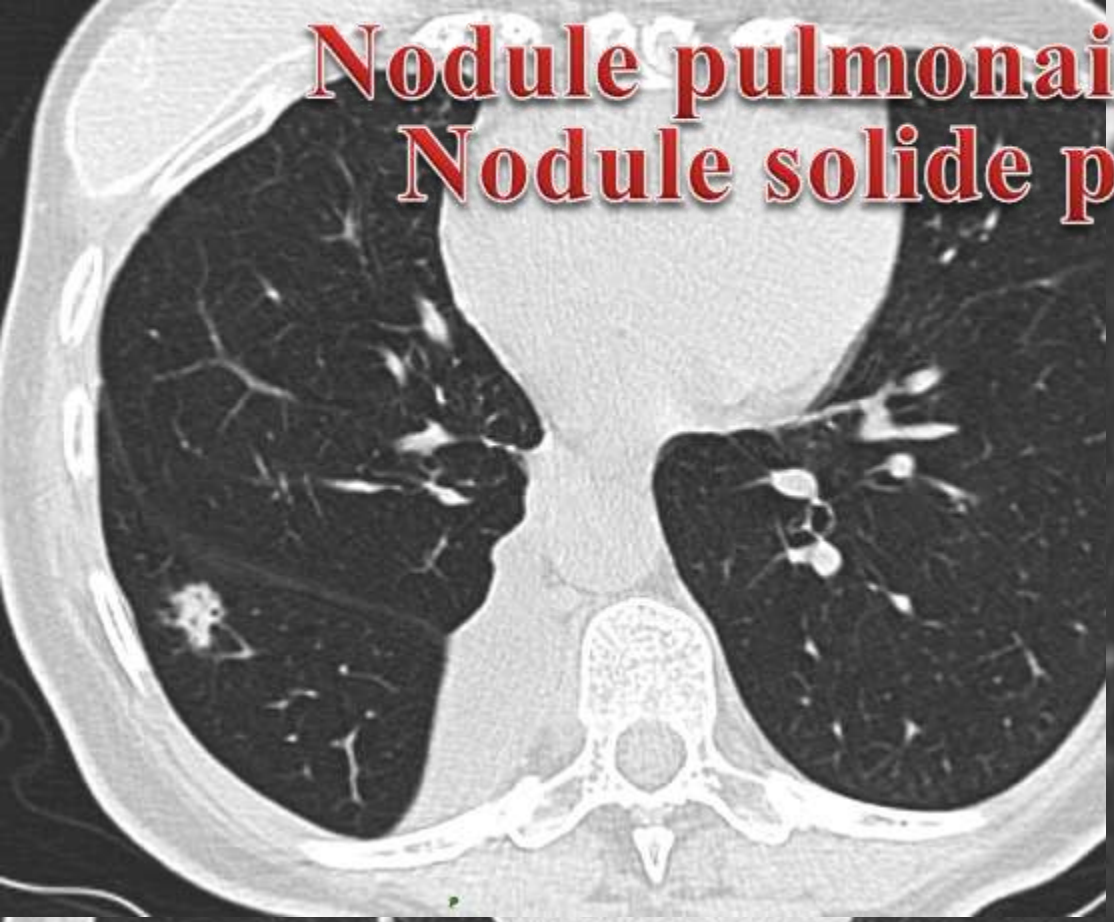
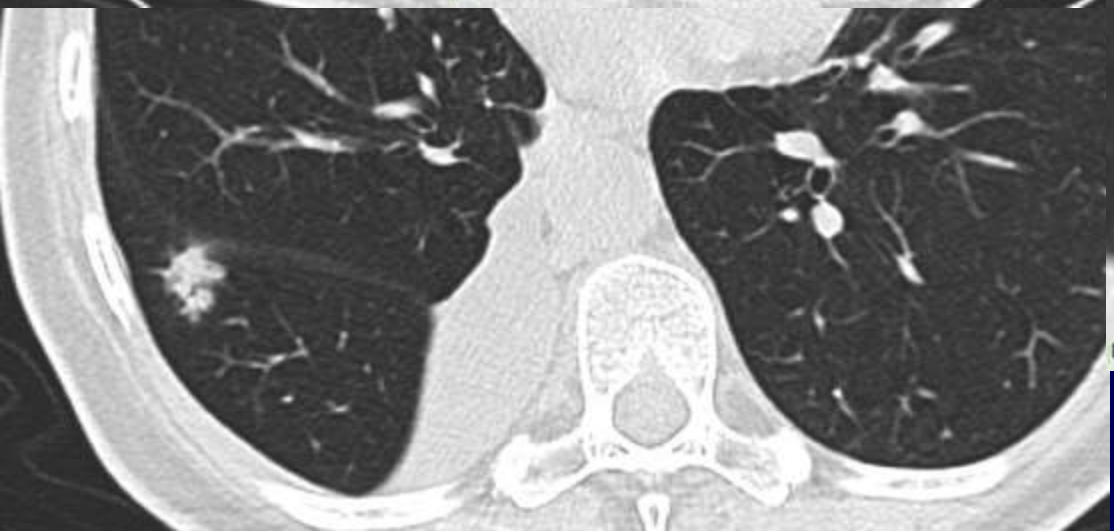
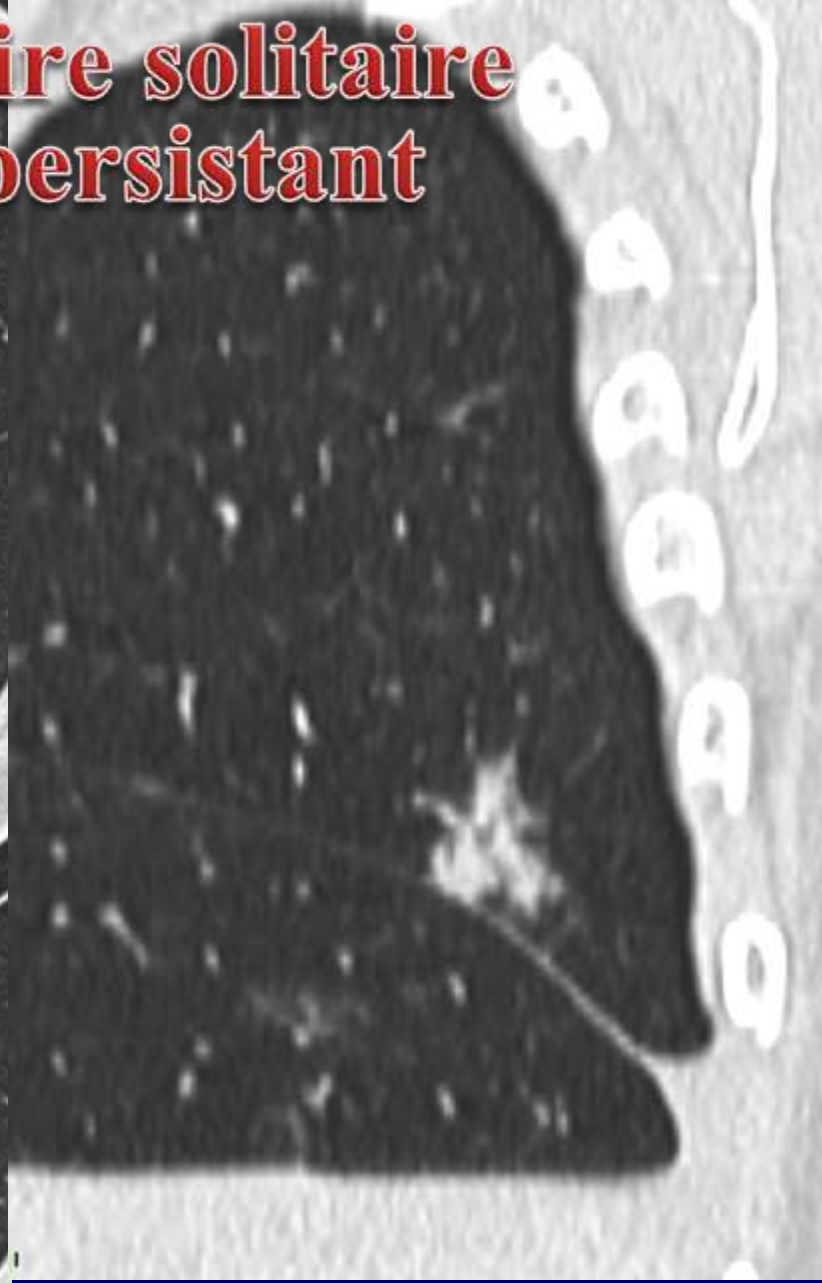
High risk†	Optional CT at 12 months	CT at 3–6 months, then at 18–24 months	CT at 3–6 months, then at 18–24 months	Use most suspicious nodule as guide to management. Follow-up intervals may vary according to size and risk (recommendation 2A).

Nodule pulmonaire solitaire
Nodule solide persistant

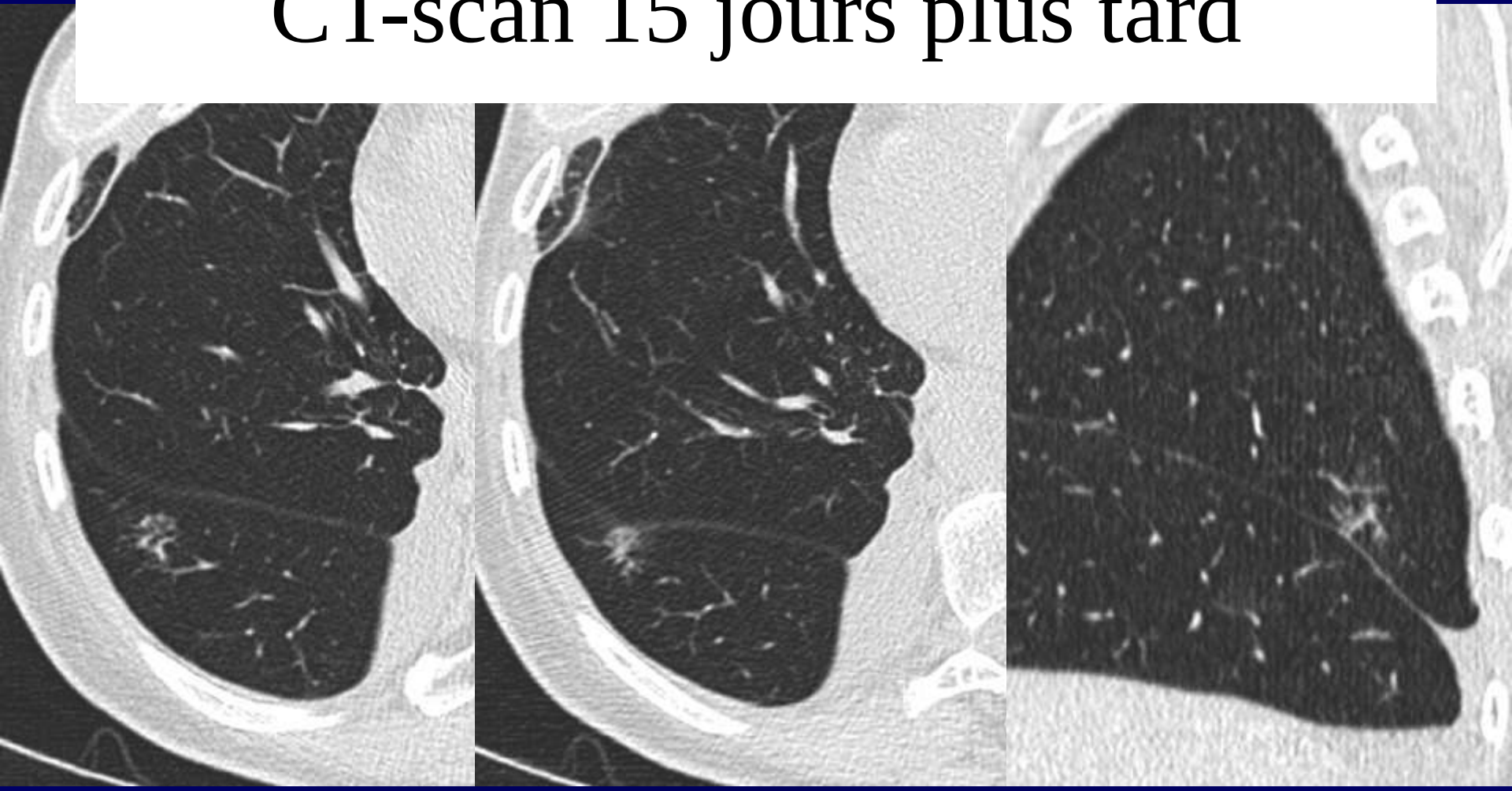


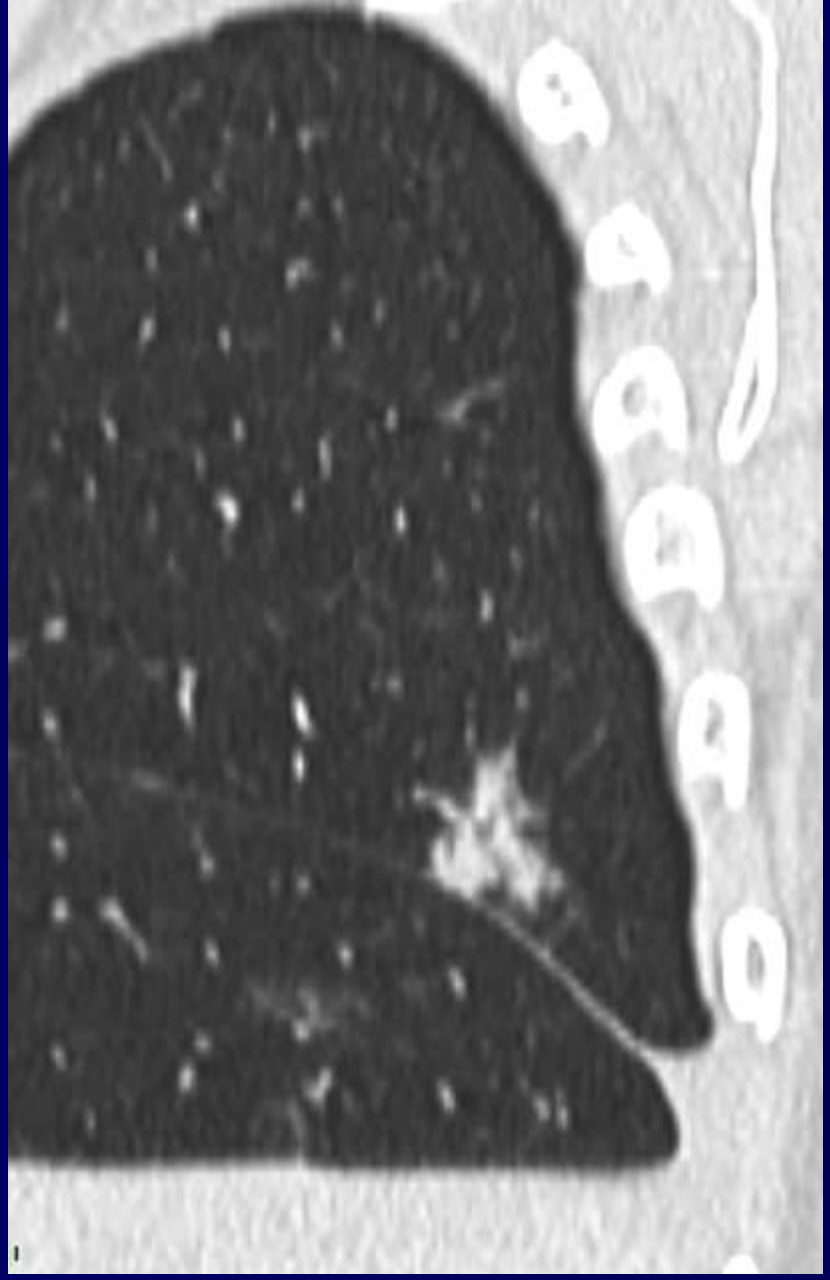


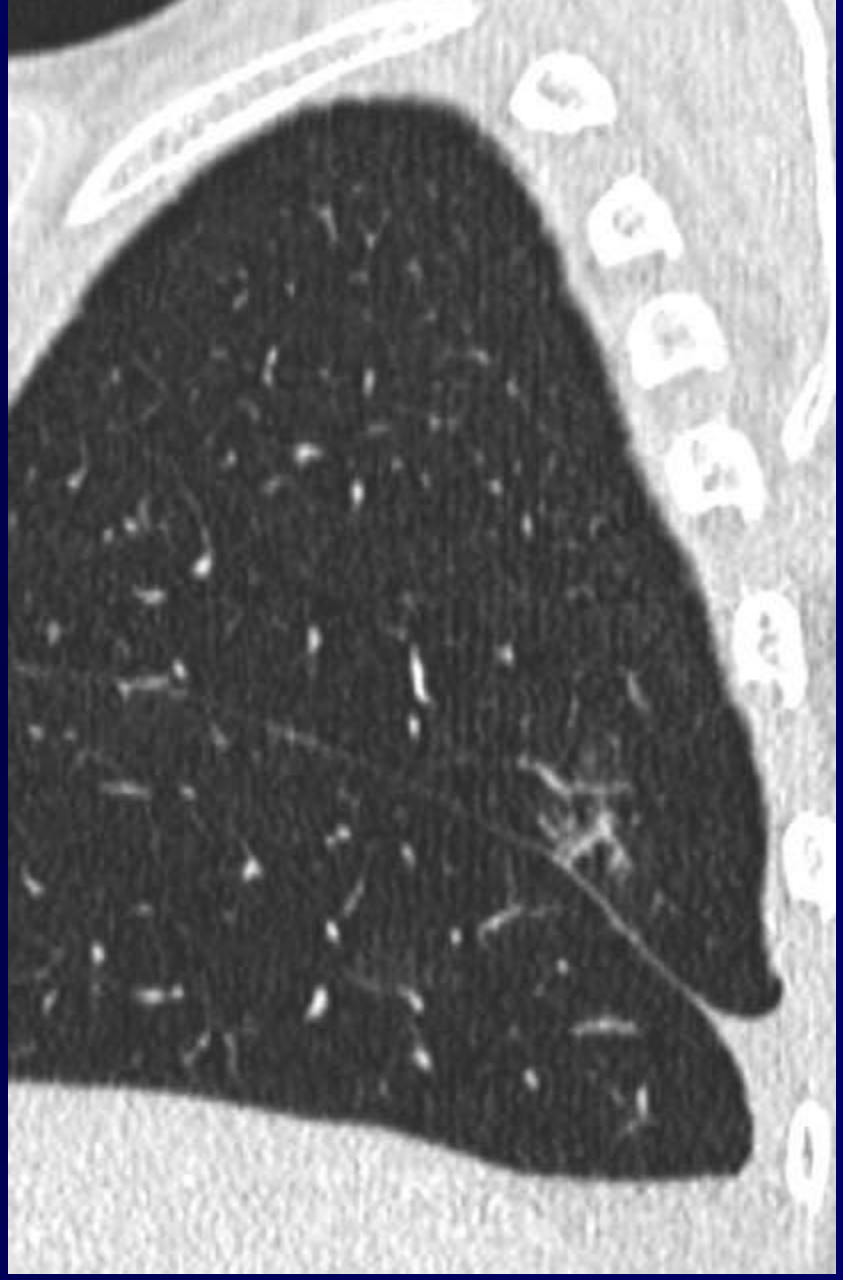


Nodule pulmonaire solitaire
Nodule solide ~~persistant~~ transitoire

CT-scan 15 jours plus tard







1er CT-scan

2nd CT-scan

Risque taille / Volume intervalle

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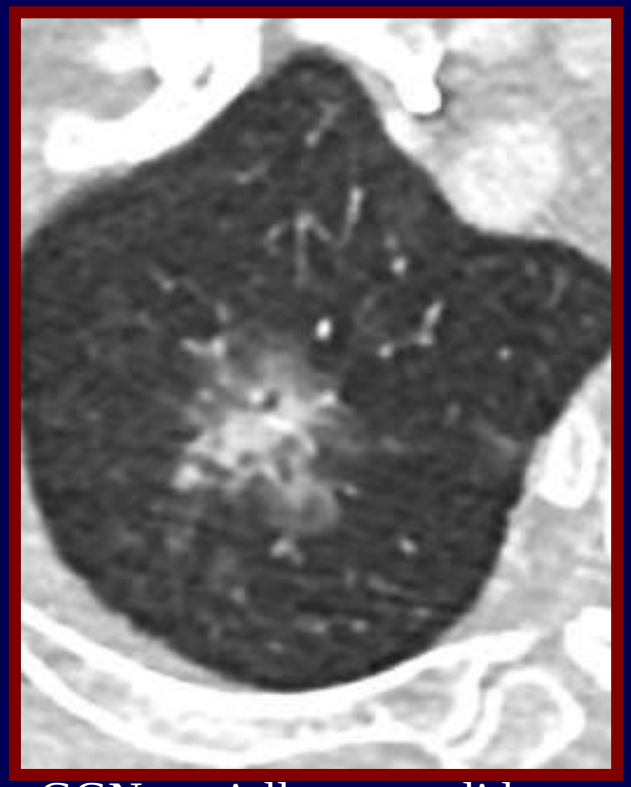
Guidelines for Management of Incidental Pulmonary Nodules Detected on CT Images: From the Fleischner Society 2017[1]

B: Subsolid Nodules*

Nodule Type	Size: <6 mm (<100 mm³)	Size: ≥6 mm (>100 mm³)	Comments
Single			
Ground glass	No routine follow-up	CT at 6–12 months to confirm persistence, then CT every 2 years until 5 years	In certain suspicious nodules < 6 mm, consider follow-up at 2 and 4 years. If solid component(s) or growth develops, consider resection. (Recommendations 3A and 4A).
Part solid	No routine follow-up	CT at 3–6 months to confirm persistence. If unchanged and solid component remains <6 mm, annual CT should be performed for 5 years.	In practice, part-solid nodules cannot be defined as such until ≥6 mm, and nodules <6 mm do not usually require follow-up. Persistent part-solid nodules with solid components ≥6 mm should be considered highly suspicious (recommendations 4A-4C)
Multiple	CT at 3–6 months. If stable, consider CT at 2 and 4 years.	CT at 3–6 months. Subsequent management based on the most suspicious nodule(s).	Multiple <6 mm pure ground-glass nodules are usually benign, but consider follow-up in selected patients at high risk at 2 and 4 years (recommendation 5A).

Texture du nodule➔ Malignité

GGN pur
18%



GGN partiellement solide
64%

Nodule solide
7%

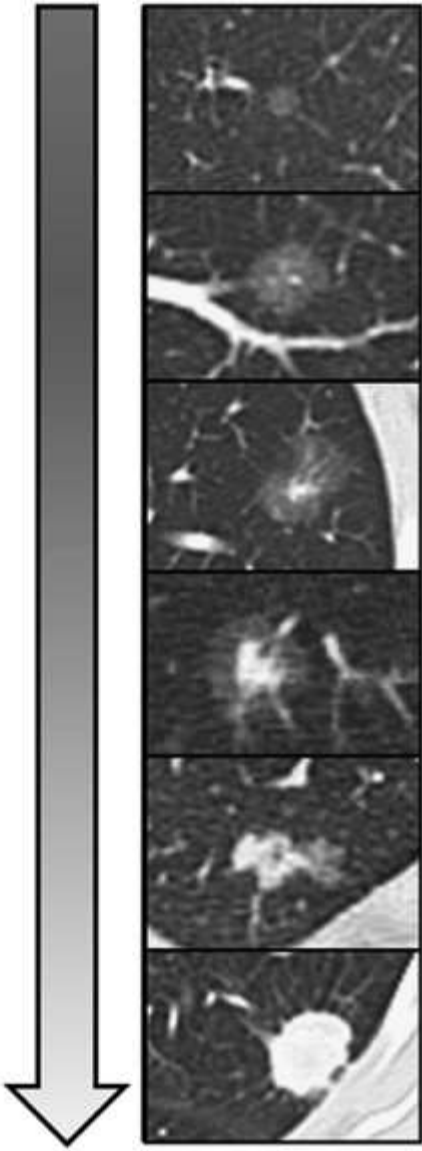
Nodule sub-solide
34%

CT Screening for Lung Cancer:
Frequency and Significance of Part-Solid and Nonsolid Nodules

Claudia I. Henschke[1]
David F. Yankelevitz[1]
Rosna Mirtcheva[1]
Georgeann McGuinness[2]
Dorothy McCauley[1]
Olli S. Miettinen[3]
for the ELCAP Group

AJR 2002;178:1053–1057

Noguchi 1995	WHO 2004	IASLC/ATS/ERS 2011	Main CT Features
	AAH	AAH	Pure GGN
A, Localized BAC	BAC	AIS	Pure GGN
B, Localized BAC with alveolar collapse			Pure GGN Part-solid GGN
C, Localized BAC with active fibroblastic proliferation	Adenocarcinoma mixed-subtype (with predominant BAC pattern)	MIA	Pure GGN Part-solid GGN
		Lepidic predominant adenocarcinoma (nonmucinous)	Part-solid GGN Solid nodule
		Invasive mucinous adenocarcinoma	Part-solid GGN Solid nodule Consolidation
D=Poorly differentiated E= Tubular F= Papillary tumor	Adenocarcinoma mixed-subtype (without predominant BAC pattern)	Invasive adenocarcinoma, classified by the predominant subtype (acinar, papillary, solid, micropapillary)	Solid nodule Part-solid with predominant solid component

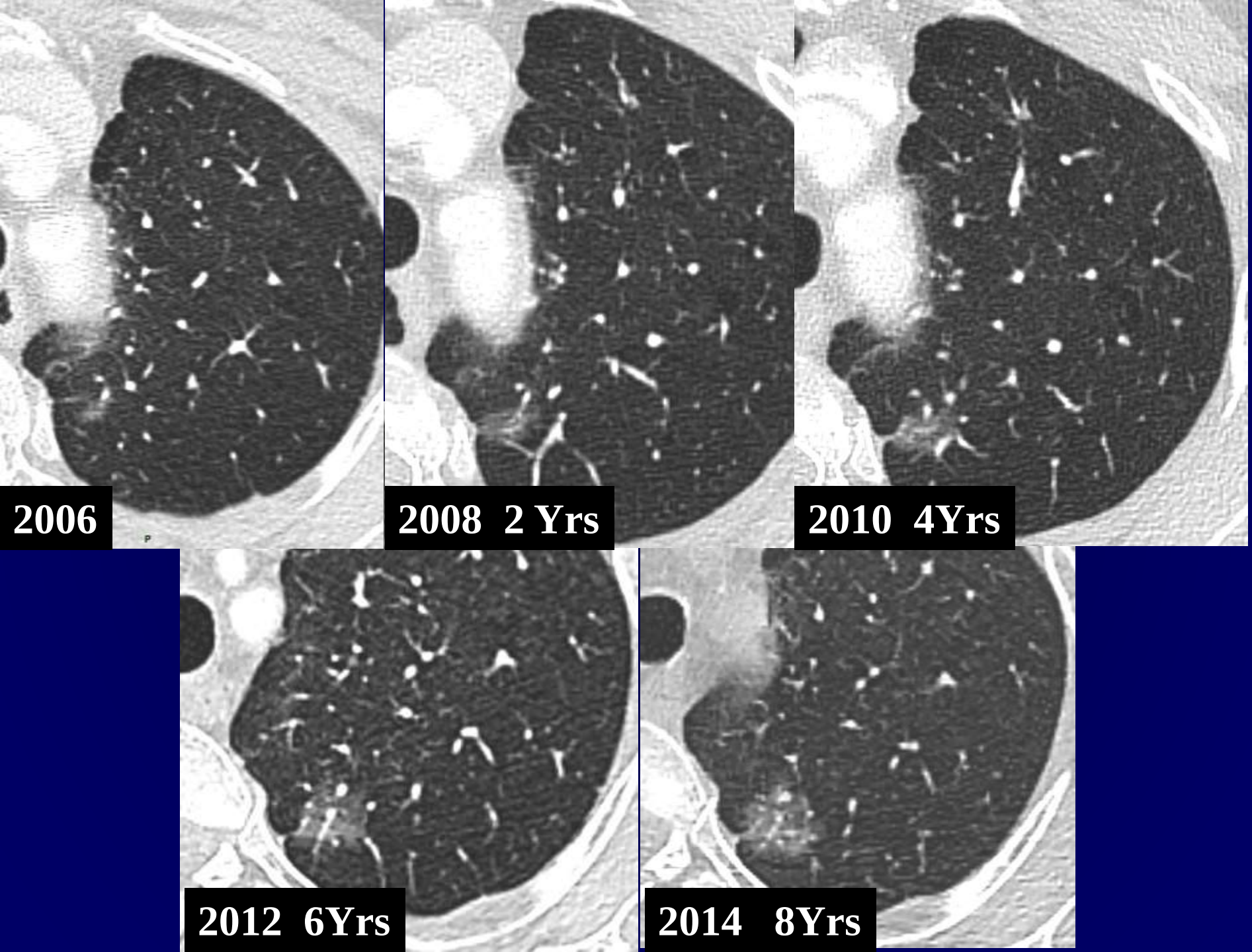


ELSEVIER

Seminars in ROENTGENOLOGY

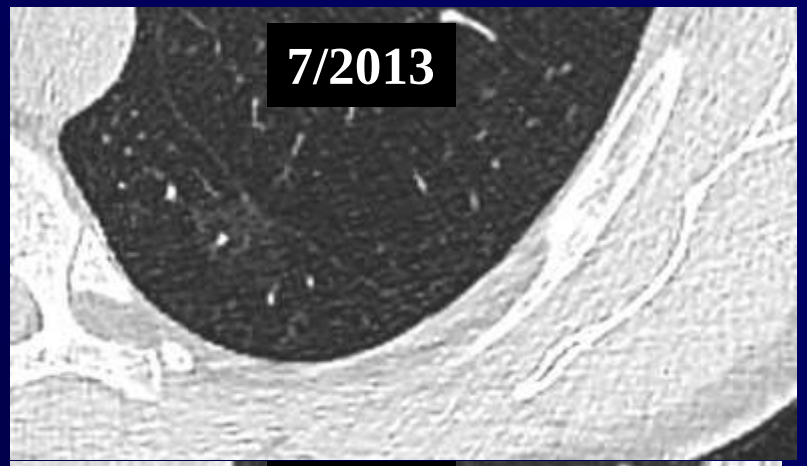
Subsolid Pulmonary Nodule Management and Lung Adenocarcinoma Classification: State of the Art and Future Trends Seminars in Roentgenology, 2013; 48:295–307

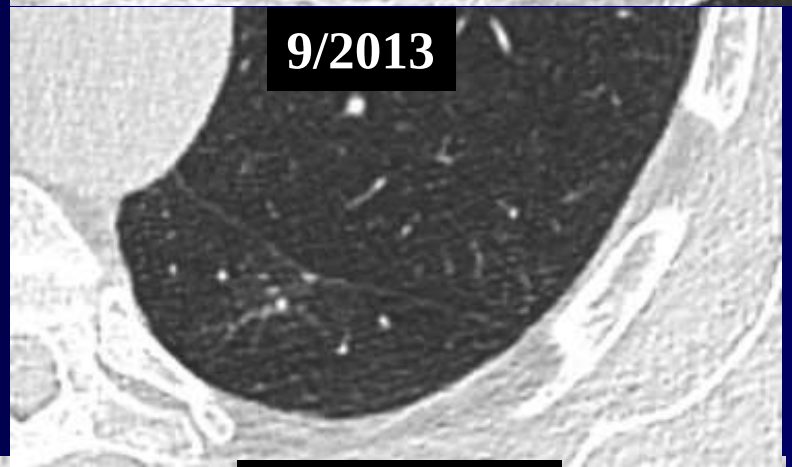
Myrna C.B. Godoy, MD, PhD,* Mylene T. Truong, MD,* Bradley Sabloff, MD,* and David P. Naidich, MD†

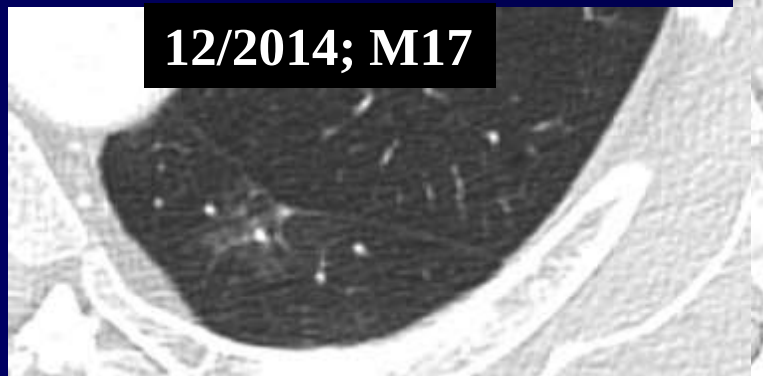

2006
2008 2 Yrs
2010 4Yrs
2012 6Yrs
2014 8Yrs

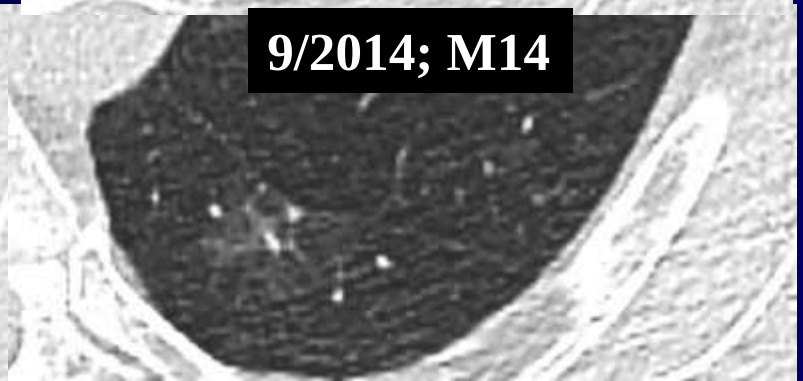
Suivi GGN: signes de progression

- ↗ de taille
- Développement d'une portion solide
- ↗ de la composante solide
- ↗ de la densité
- ↘ en taille avec apparition d'une portion solide









Suivi GGN: signes de progression

- ↗ de taille
- Développement d'une portion solide
- ↗ de la composante solide
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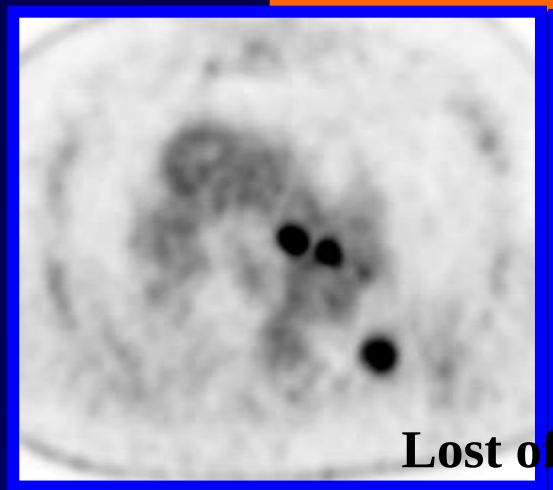
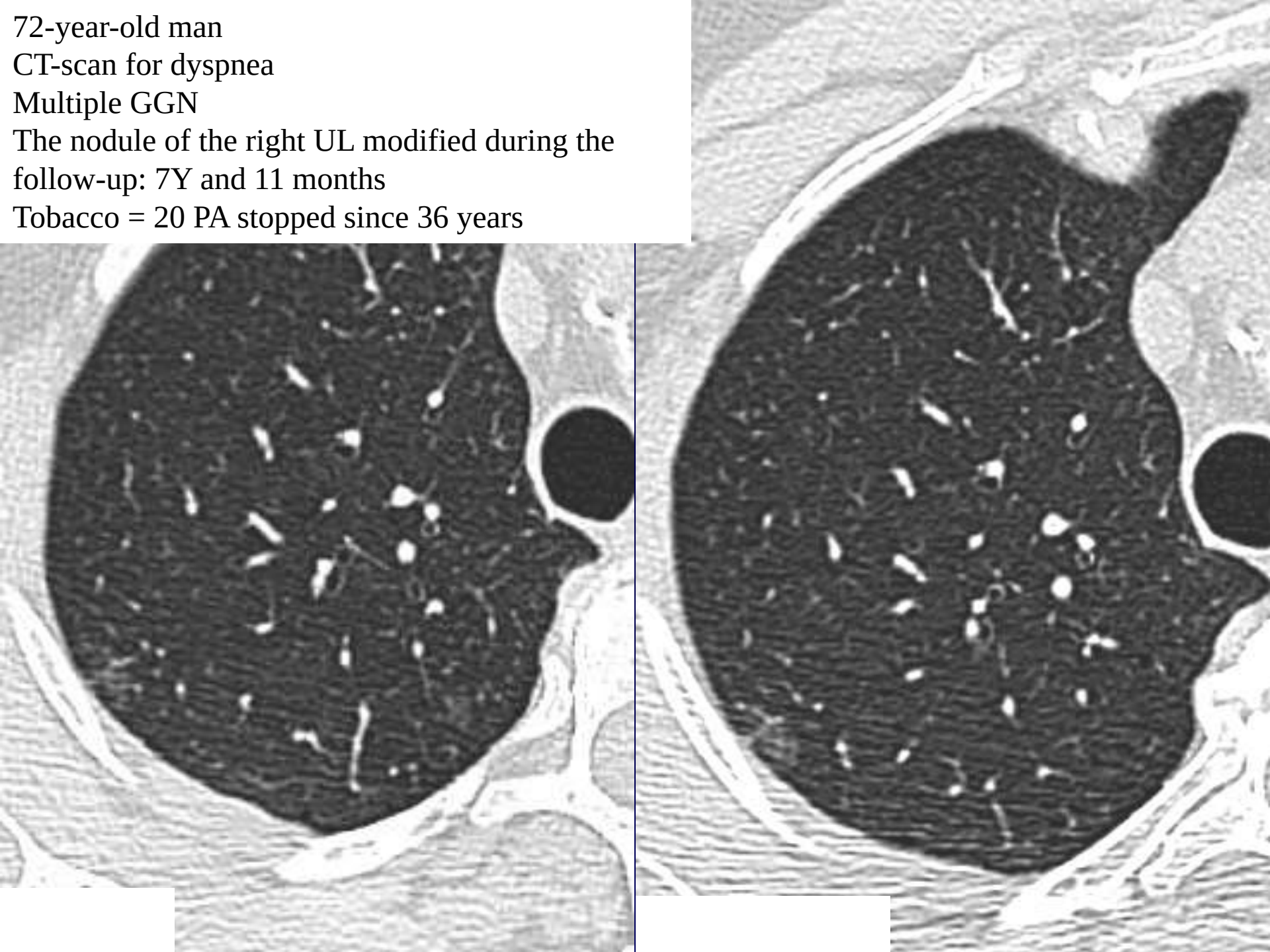
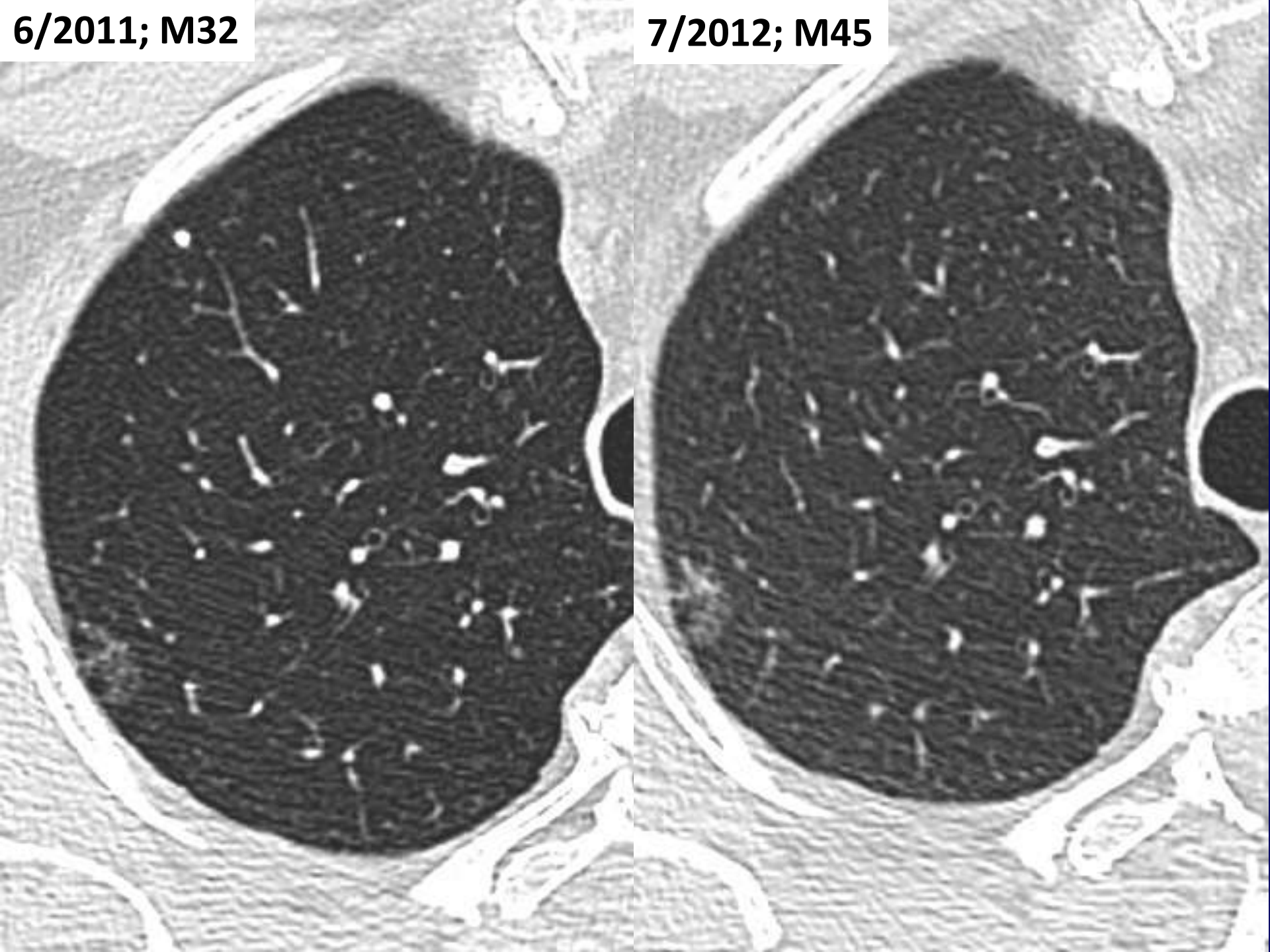
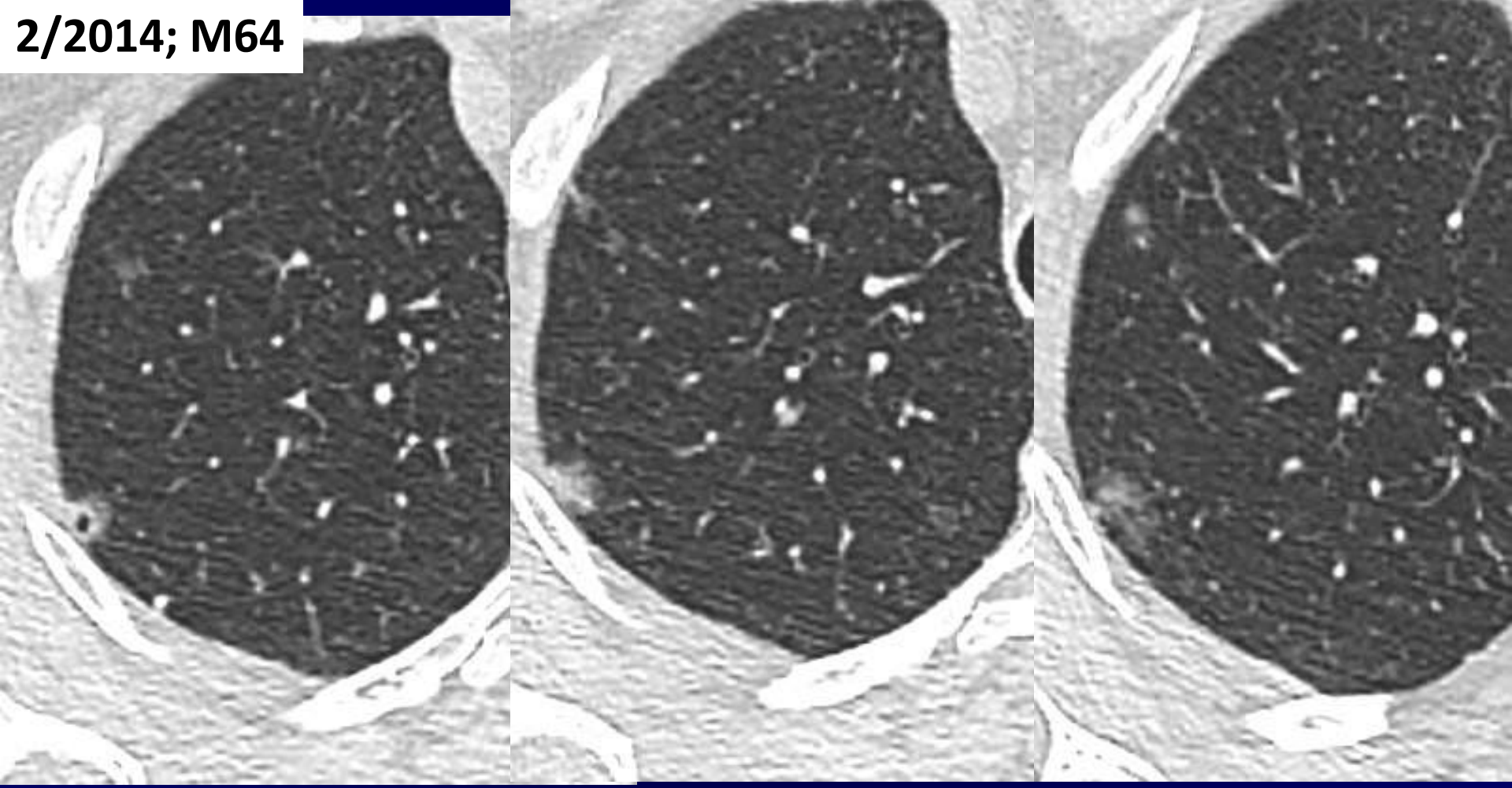


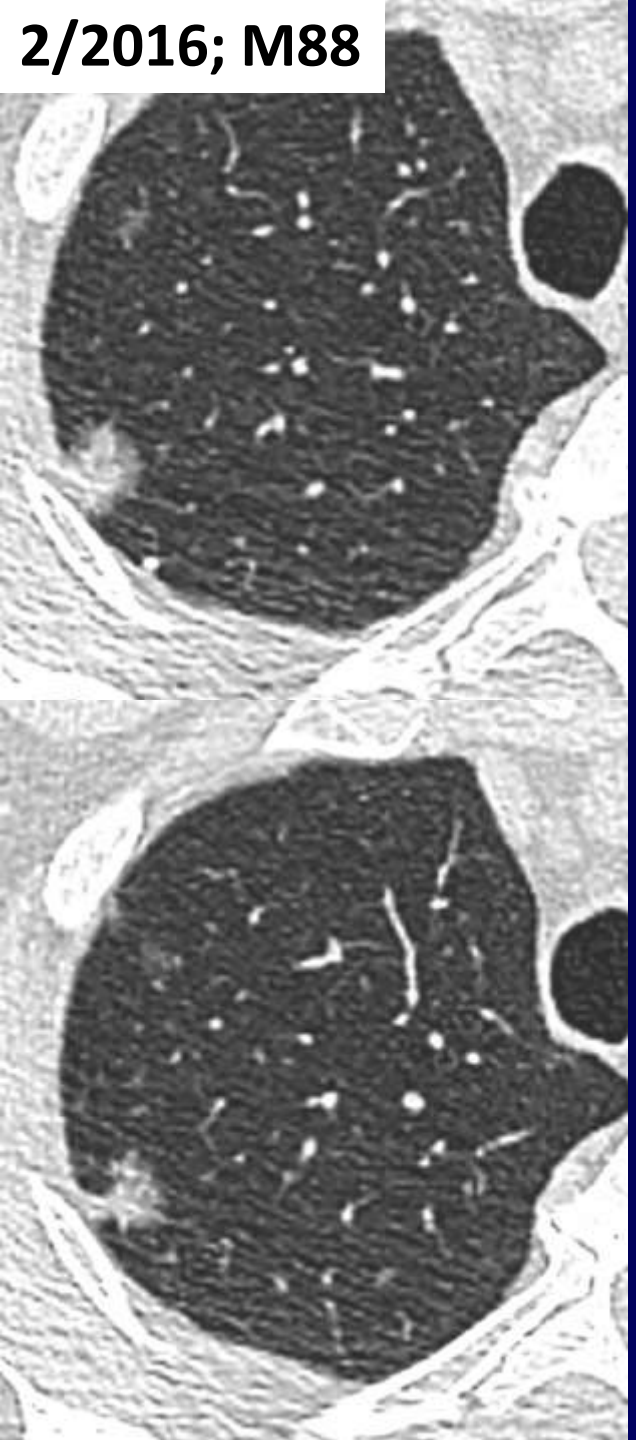
72-year-old man
CT-scan for dyspnea
Multiple GGN
The nodule of the right UL modified during the follow-up: 7Y and 11 months
Tobacco = 20 PA stopped since 36 years



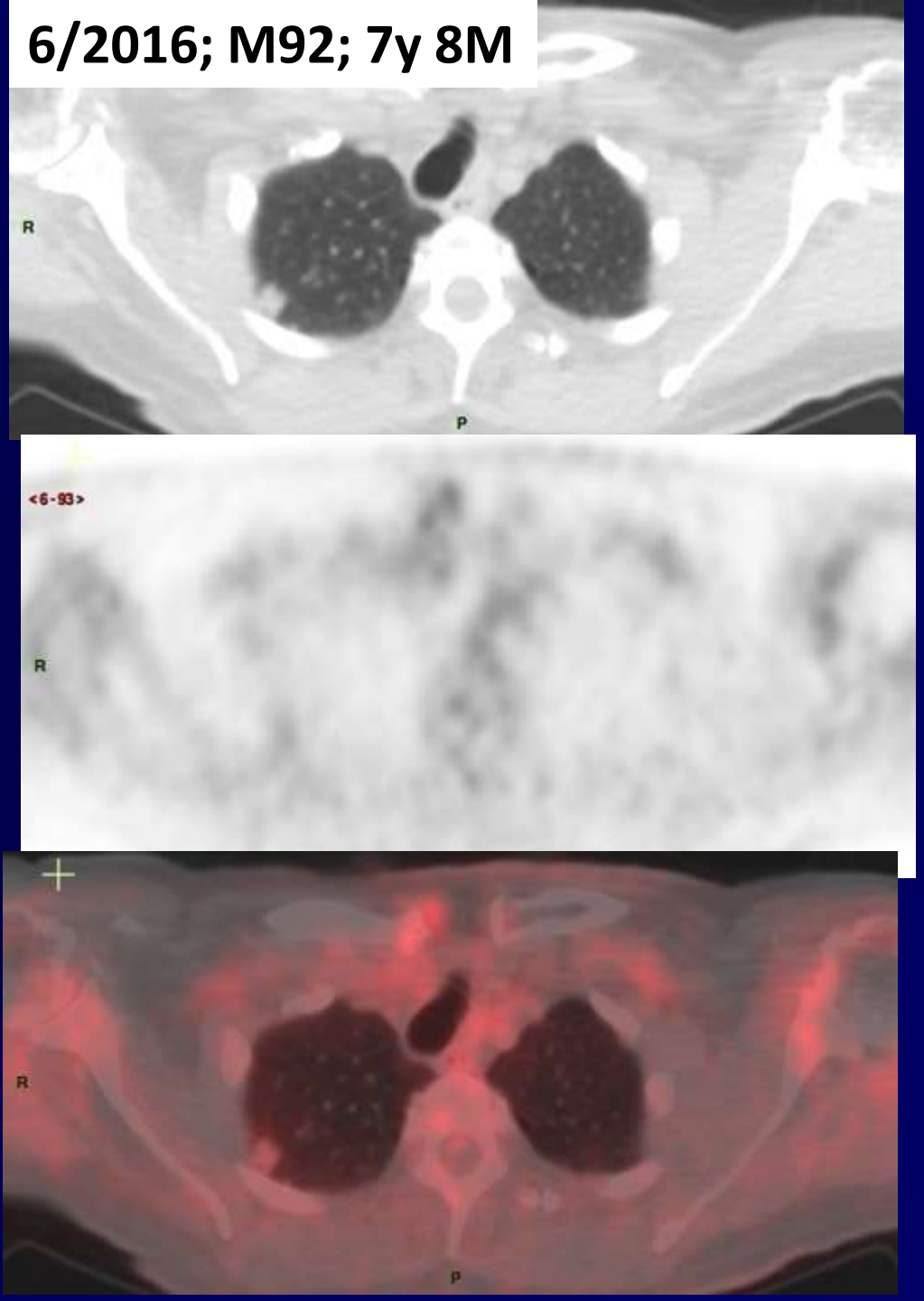

6/2011; M32
7/2012; M45

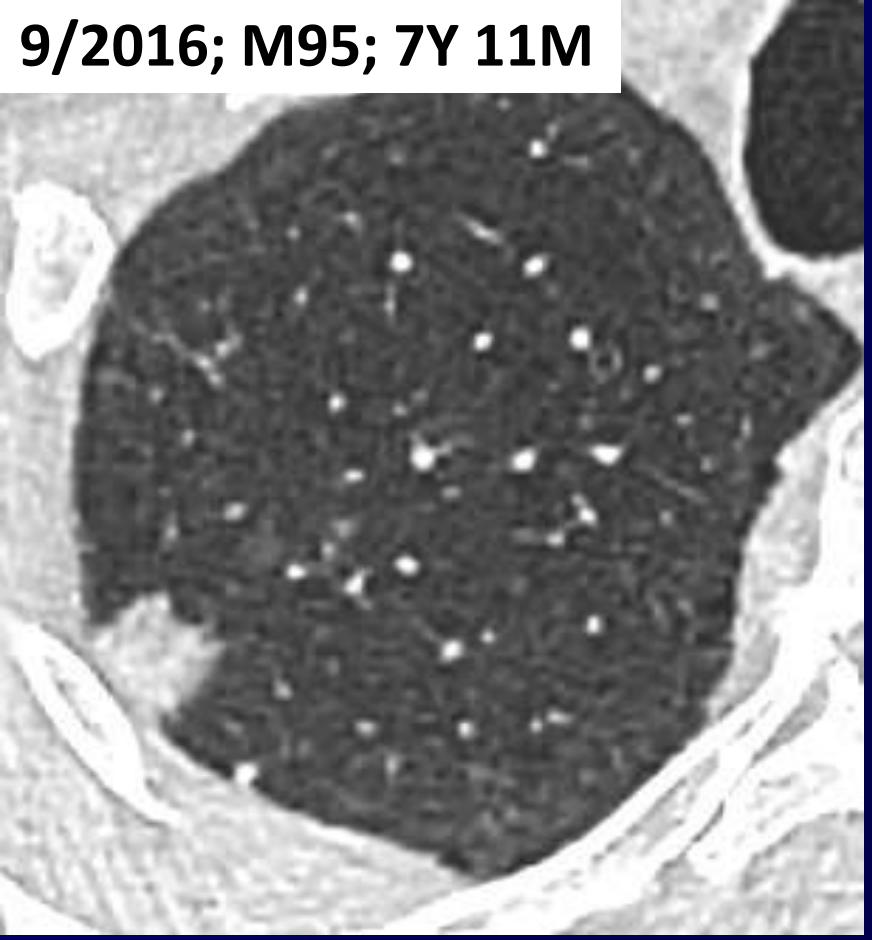

2/2014; M64

2/2016; M88



6/2016; M92; 7y 8M





Wedge suivi par une lobectomie supérieure droite

Conclusion

- Ecarter le nodule bénin (initiale / suivi)
- Le suivi:
  - La texture du nodule (solide / part-solide / GGN)
  - La taille du nodule
  - Les cirocnstances de détection (dépistage ou fortuite)

Conclusion

- GGN transitoires: fréquents
- GGN persistants: ADK et ces précurseurs
- Adénocarcinome du GGO a un pronostic favorable
- GGNs malins sont indolents et doivent être gérer en conséquence

université PARIS DIDEROT

CONGRÈS Imagerie Appliquée à la Pratique Pneumologique

Mise à jour sur le nodule pulmonaire

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2- Paris University VII - Denis Diderot