

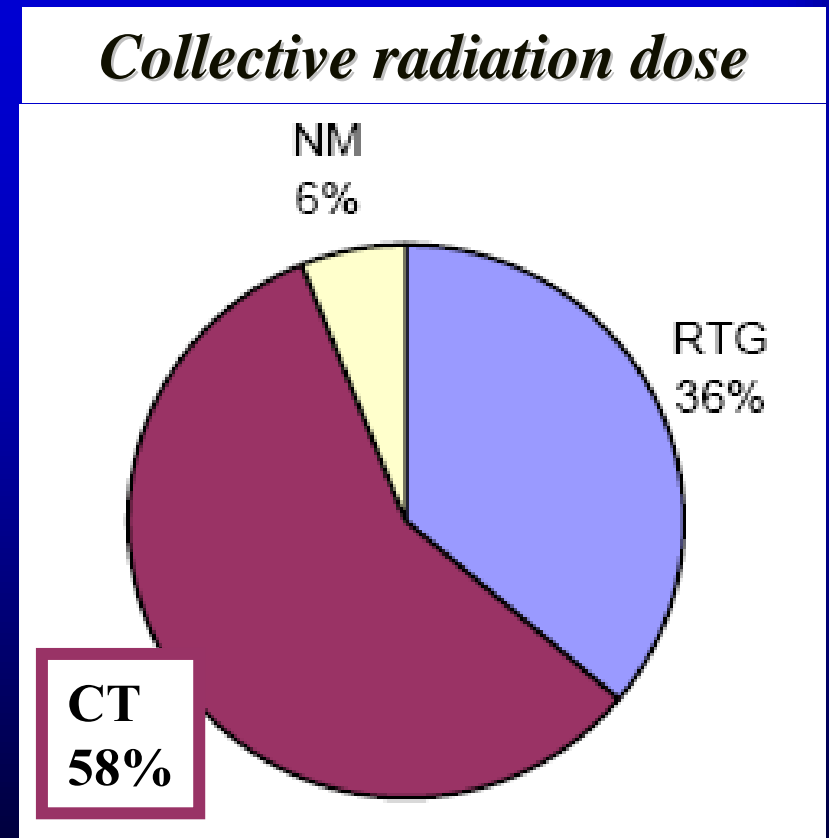
***Radiation doses at chest CT  
close to that of a combined  
chest x-ray and tomosynthesis***

**Ulf Nyman, Lasarettet Trelleborg, Sweden**



# *Radiology exams in Sweden 2005*

• <b>Conventional</b>	<b>3 944 747</b>	<b>72%</b>
• <b>CT</b>	<b>651 885</b>	<b>12%</b>
• <b>Ultrasound</b>	<b>475 020</b>	<b>9%</b>
• <b>MR</b>	<b>268 232</b>	<b>5%</b>
• <b>Nuclear med</b>	<b>103 159</b>	<b>2%</b>
• <b>Total</b>	<b>5 443 043</b>	
• <b>Population</b>	<b>9 047 752</b>	
• <b>Exams/person</b>	<b>0.6</b>	



**Radiology 2008;249:  
1034-1041**

**Sahlgrenska Academy  
University of Gothenburg  
Sweden**

# **Comparison of Chest Tomosynthesis and Chest Radiography for Detection of Pulmonary Nodules: Human Observer Study of Clinical Cases<sup>1</sup>**

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Sara Zachris  
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Susanne Khe  
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**Conventional PA tomography, abandoned 30 years  
ago for CT now appearing in new digital clothes**

Radiology

2008;249:1034-1041

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Comparison of Chest  
Tomosynthesis and Chest  
Radiography for Detection of  
Pulmonary Nodules: Human  
Observer Study of Clinical Cases<sup>1</sup>

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Radiology

**Conventional PA tomography, abandoned 30 yrs  
ago for CT, now appearing in new digital clothes**

# *Chest Tomosynthesis*



<i>Effective dose</i>	<i>mSv</i>
• Chest PA	0.014
• Chest lateral	0.039
• Scout	0.011
• 60 tomograms	0.122
• Total	≈0.2

*Båth et al. Rad Prot Dos*  
*2010;139:153-8*

# *Chest computed tomography*

- **X-ray tube potential** 120-140 kVp
- **X-ray tube loading** 100-500 mAs

*Diederich & Lenzen Cancer 2000;89:2457-60*

- **Mean effective dose (max)** ~7 (17) mSv

*Swedish Radiation Safety Authority Report 2008:02, [www.ssm.se](http://www.ssm.se)*

*Mettler et al. Literature review. Radiology 2008;248:254-63*

# *Chest effective radiation dose (mSv)*

<i>Sweden 2006</i>	<i>X-ray</i>	<i>CT</i>
• Mean	0.07 (0.1*)	6.6 (7*)
• Third quartile	0.09	8.0
• Min value	≤0.02	≤3.4
• Max value	≥0.27 (0.24*)	≥17 (18*)

*\*Mettler et al. Literature review. Radiology 2008;248:254-63*

# *Chest Tomosynthesis*

- **Radiation dose ~2% of that of a chest CT**
- *Båth et al. Rad Prot Dos 2010;139:153-8.*
  
- **Detect more nodules than chest x-ray**
- *Vikgren et al. Radiology 2008; 2008;249:1034-1041*



# ***Chest computed tomography***

- The relatively high radiation doses used in chest CT are remarkable considering the chest is a *very high contrast* organ system**
- Air to soft tissues                    1000 HU**
- Fat to soft tissues                    150 HU**
- Soft tissues to bone                    400 HU**

# *Radiation doses*

- **Chest CT** **7 mSv**
  - Swedish/international mean dose
- **Chest tomosynthesis** **0.2 mSv**
  - 3% of the chest CT dose
- **Chest CT** **0.2 mSv**
  - *Herzog Radiologe 2002;42:691-6, Kubo AJR 2008;190:335-43.*
- **Same dose and apart from lungs, details of chest wall, pleura and mediastinum may be depicted**
- **Why then regress to conventional tomography?**

# Low-dose chest CT for pulmonary nodules

Study	Year	No. of Patients	Standard Current-Time Product (mAs)	Reduced Current-Time Product (mAs)	Peak Kilovoltage (kVp)	Smallest Acceptable mAs
Rusinek et al. [34]	1998	18	200	20	120	20
Gartenschlager et al. [35]	1998	71	200	30	120	30
Diederich et al. [36]	1999	80	100	25	120	25
Nitta et al. [39]	1999	56	50	6	120	6
Itoh et al. [41]	2000	30	—	0-50	120	20
Karabulut et al. [37]	2002	25	200	50	120	50
Hetmaniak et al. [42]	2003	58	250	30, 10	120	30
Weng et al. [38]	2004	30	130	43	120 or 140 <sup>a</sup>	43
Gergely et al. [40]	2005	72	150	5	120	5

Note—Dash = not applicable for this reference.

<sup>a</sup>For kVp, 120 kVp was used for standard mAs (130 mAs) and 140 kVp was used in conjunction with reduced mAs (43 mAs).

# *Low dose Chest CT*

<i>Siemens Somatom 16</i>	<i>1</i>	<i>2</i>	<i>Routine</i>
• Kilovoltage	80	120	120
• Effective mAs	17	11	50
• mAs/pitch (pitch 1.5)			
• CTDI <sub>vol</sub> (mGy)	0.3	0.9	4
• CT dose index			
• DLP (mGy*cm)	~13	~36	~150
• dose-length product			
• Effective dose (mSv)	~0.2	~0.6	~2.5

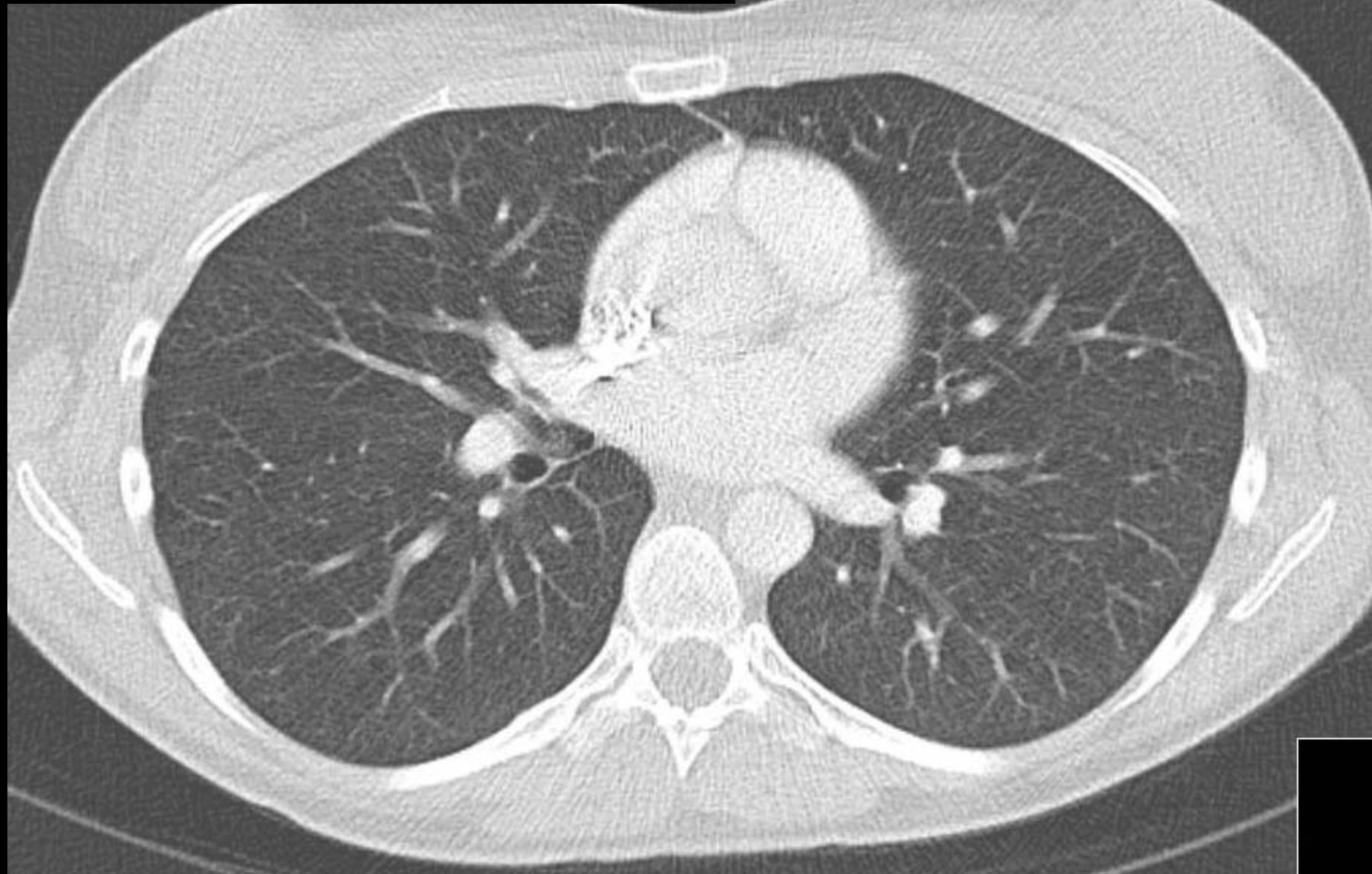
# *Testing Low Dose Chest CT*

<i>Siemens Somatom 16</i>	<i>1</i>
● <b>Kilovoltage</b>	<b>80</b>
● <b>Effective mAs</b>	<b>17</b>
• mAs/pitch (pitch 1.5)	
● <b>CTDI<sub>vol</sub> (mGy)</b>	<b>0.3</b>
• CT dose index	
● <b>DLP (mGy*cm)</b>	<b>~13</b>
• dose-length product	
● <b>Effective dose (mSv)</b>	<b>~0.2</b>

# *Testing Low Dose Chest CT*

<i>Siemens Somatom 16</i>	<i>1</i>	<i>2</i>
• Kilovoltage	80	120
• Effective mAs	17	11
• mAs/pitch (pitch 1.5)		
• CTDI <sub>vol</sub> (mGy)	0.3	0.9
• CT dose index		
• DLP (mGy*cm)	~13	~39
• dose-length product		
• Effective dose (mSv)	~0.2	~0.6

**120 kV, 11 effective mAs, pitch 1.5**

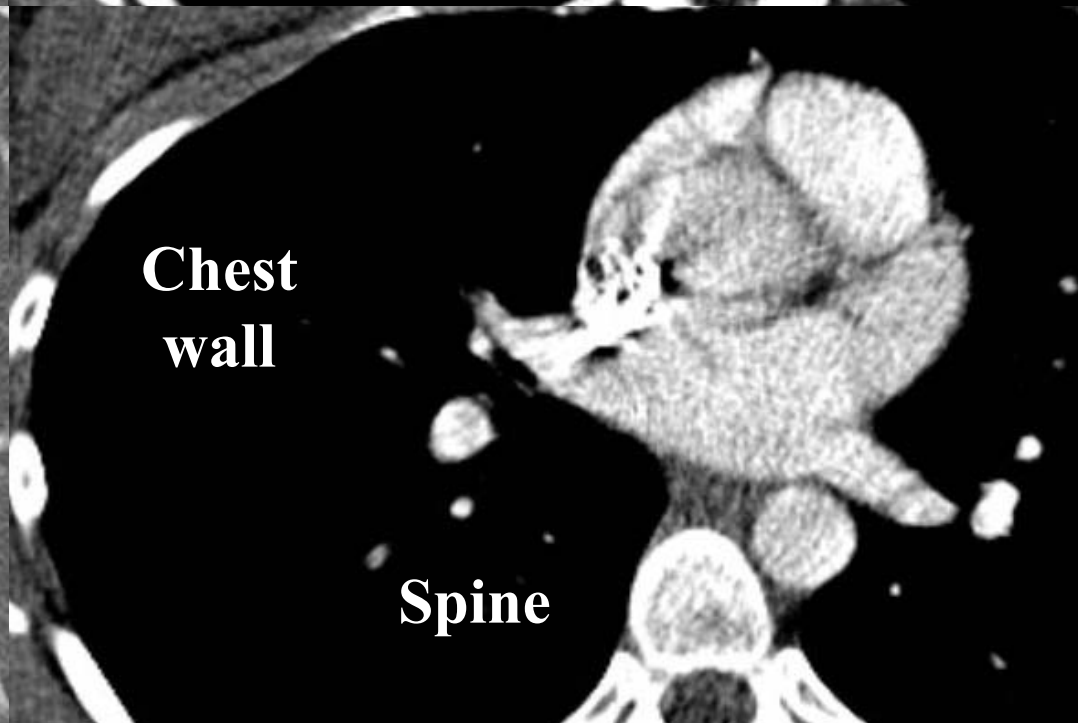
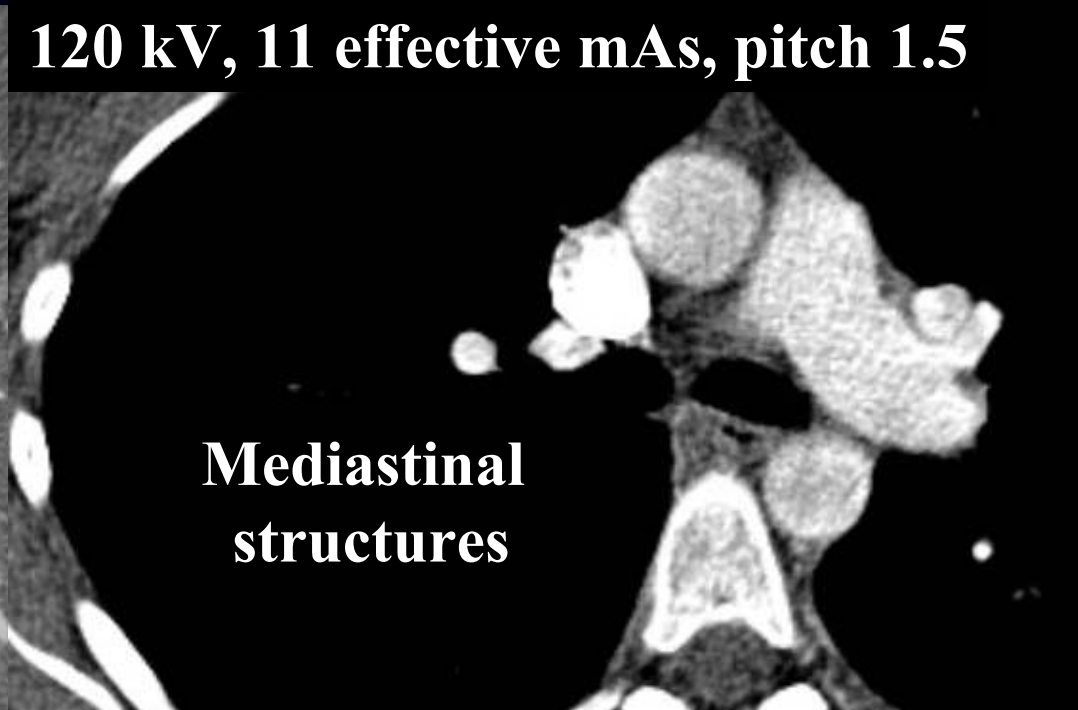
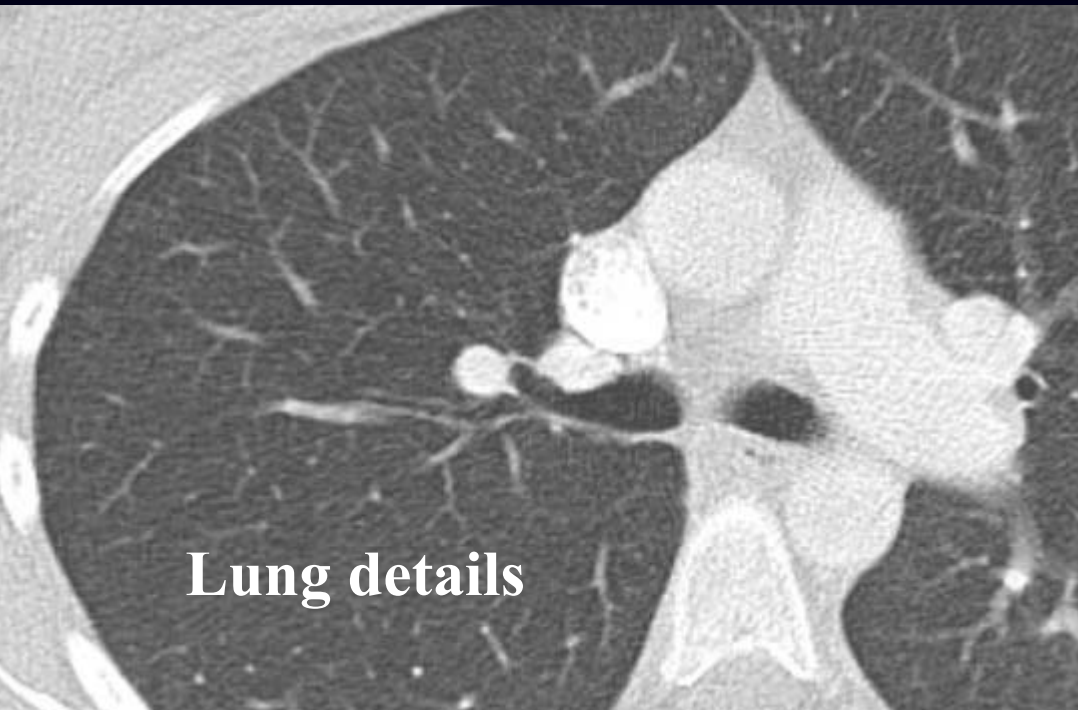


**120 kV, 11 effective mAs, pitch 1.5**



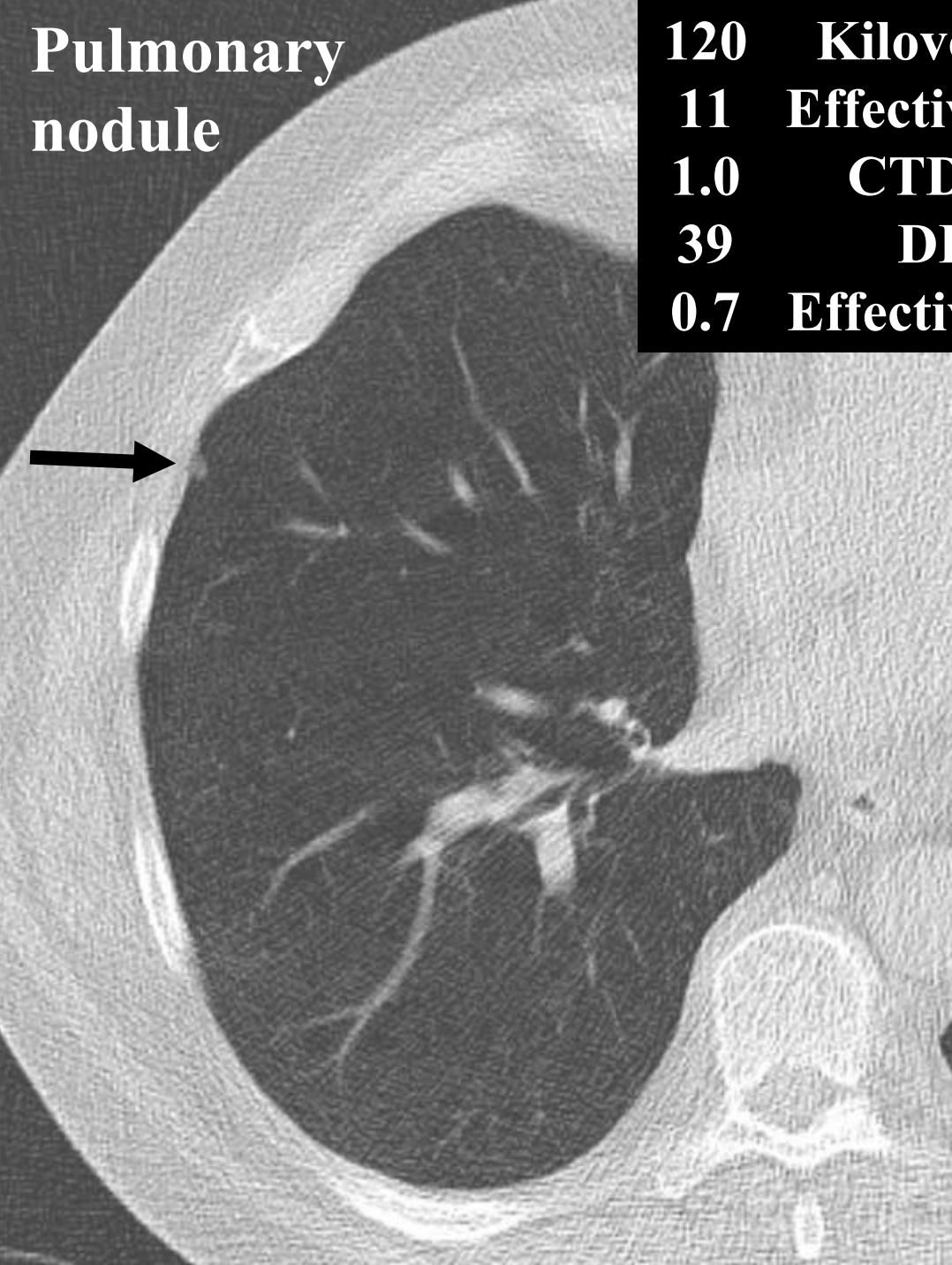
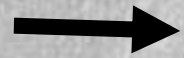
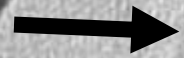


**120 kV, 11 effective mAs, pitch 1.5**



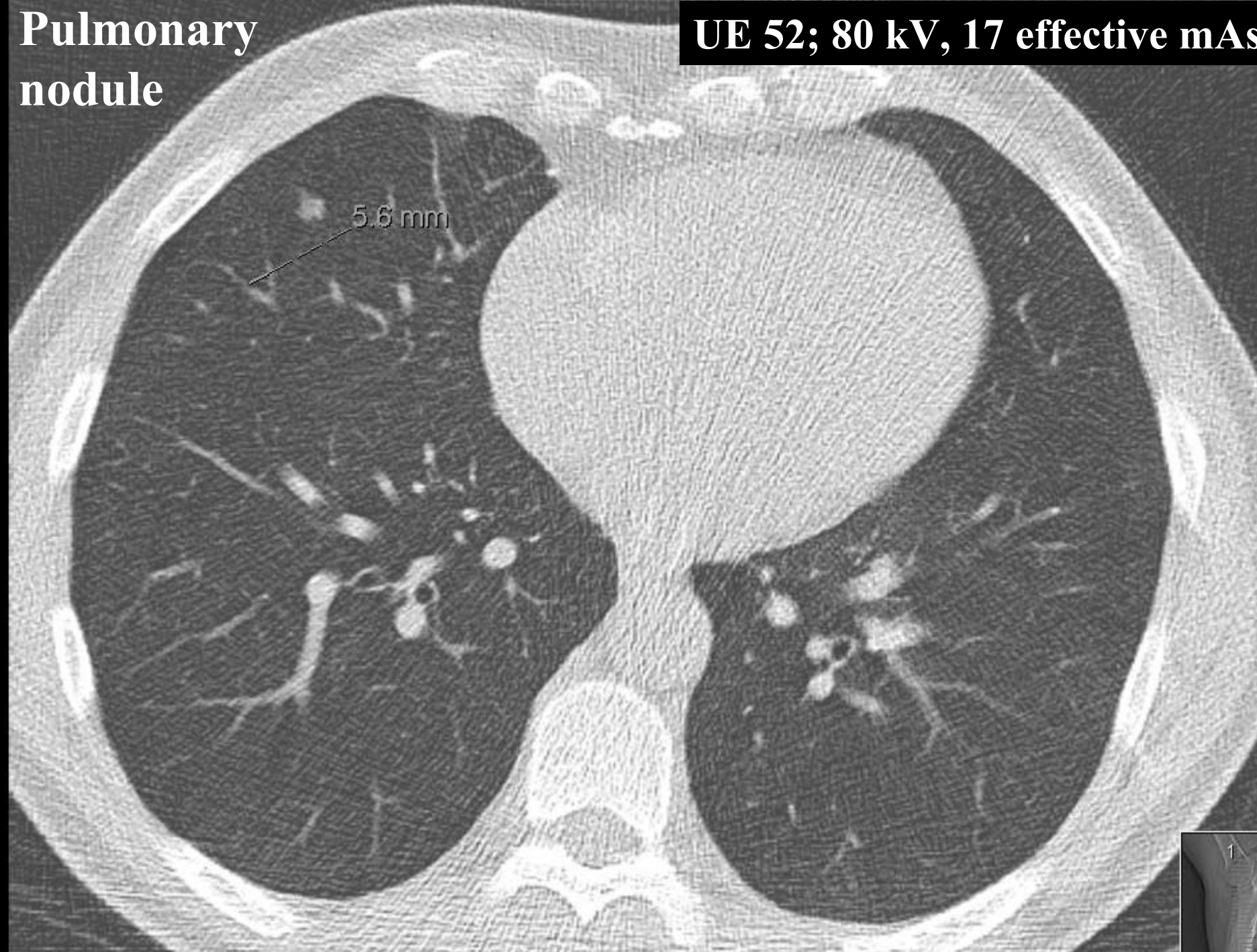
**Pulmonary  
nodule**

<b>120</b>	<b>Kilovoltage</b>	<b>120</b>
<b>11</b>	<b>Effective mAs</b>	<b>50</b>
<b>1.0</b>	<b>CTDIvol</b>	<b>4.1</b>
<b>39</b>	<b>DLP</b>	<b>155</b>
<b>0.7</b>	<b>Effective dose</b>	<b>2.6</b>



**Pulmonary  
nodule**

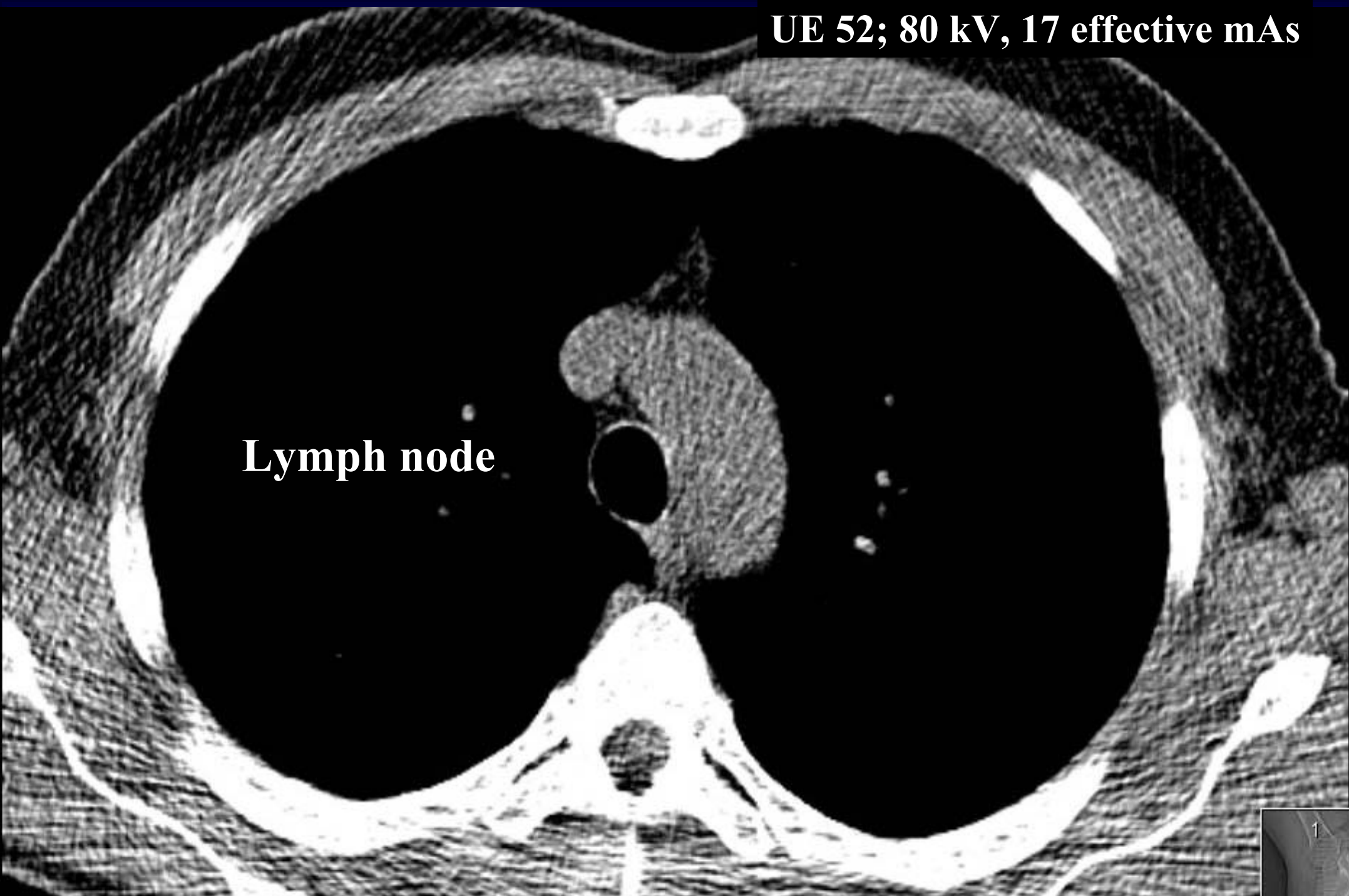
**UE 52; 80 kV, 17 effective mAs**





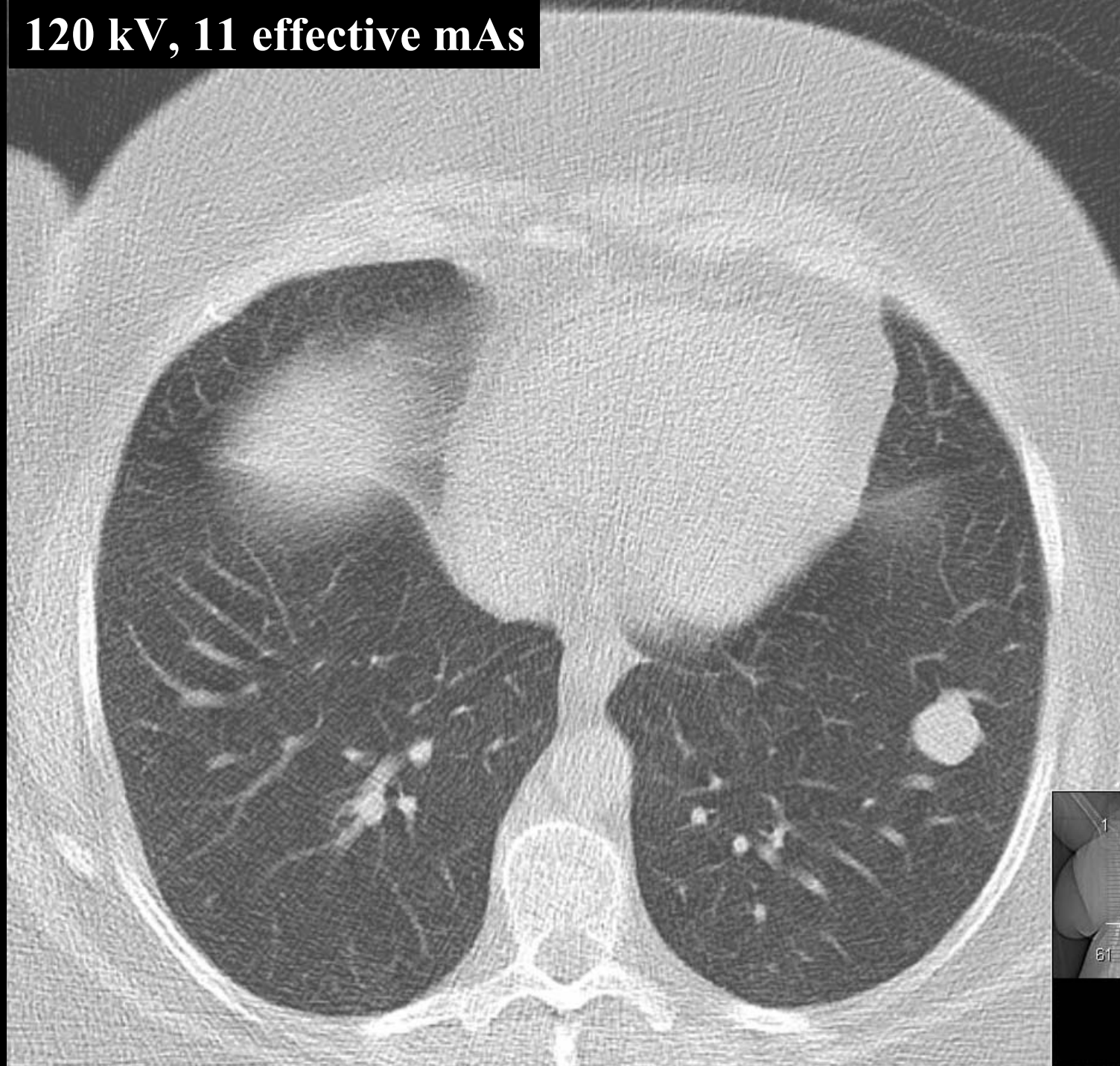
UE 52; 80 kV, 17 effective mAs

Lymph node





120 kV, 11 effective mAs

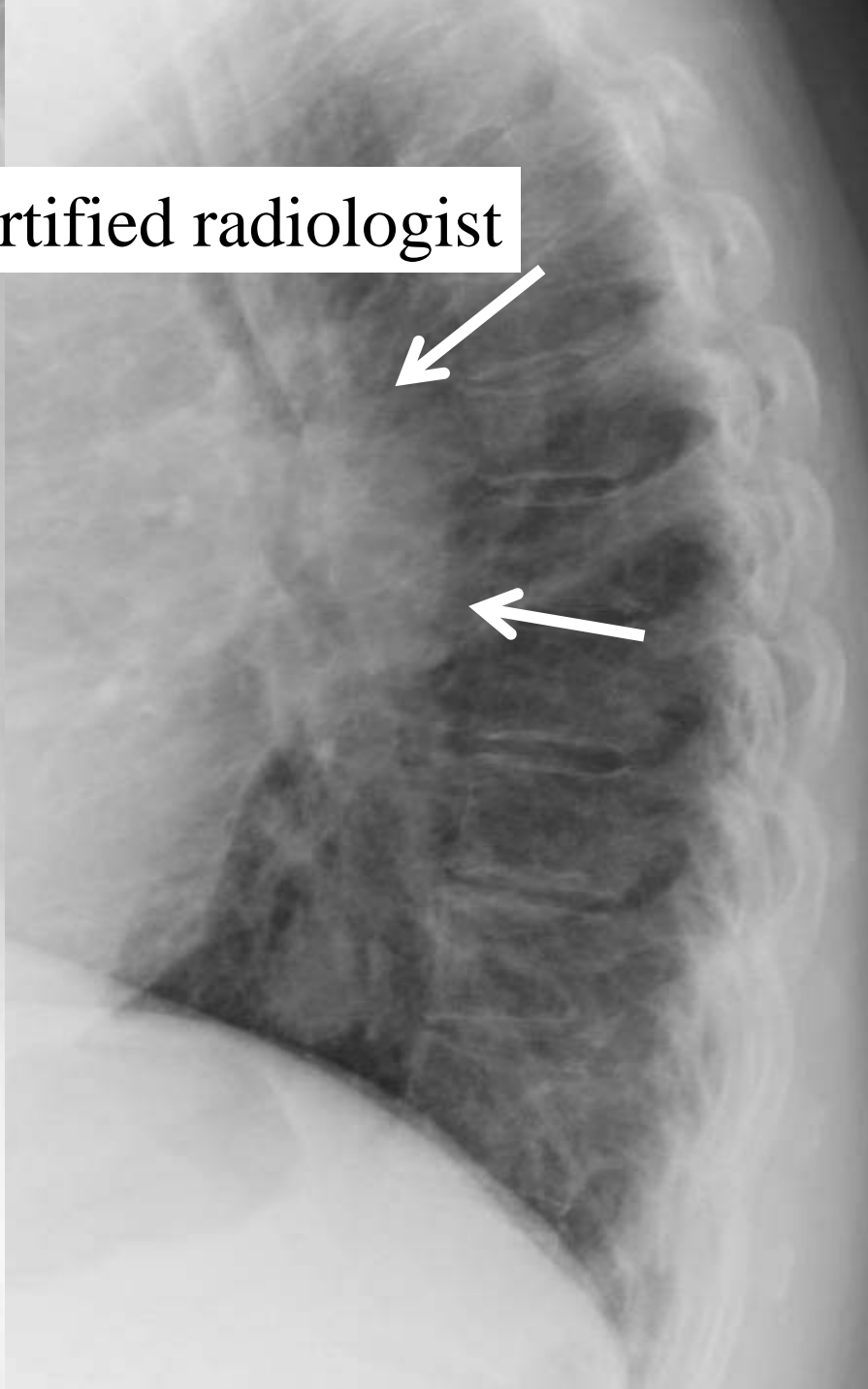
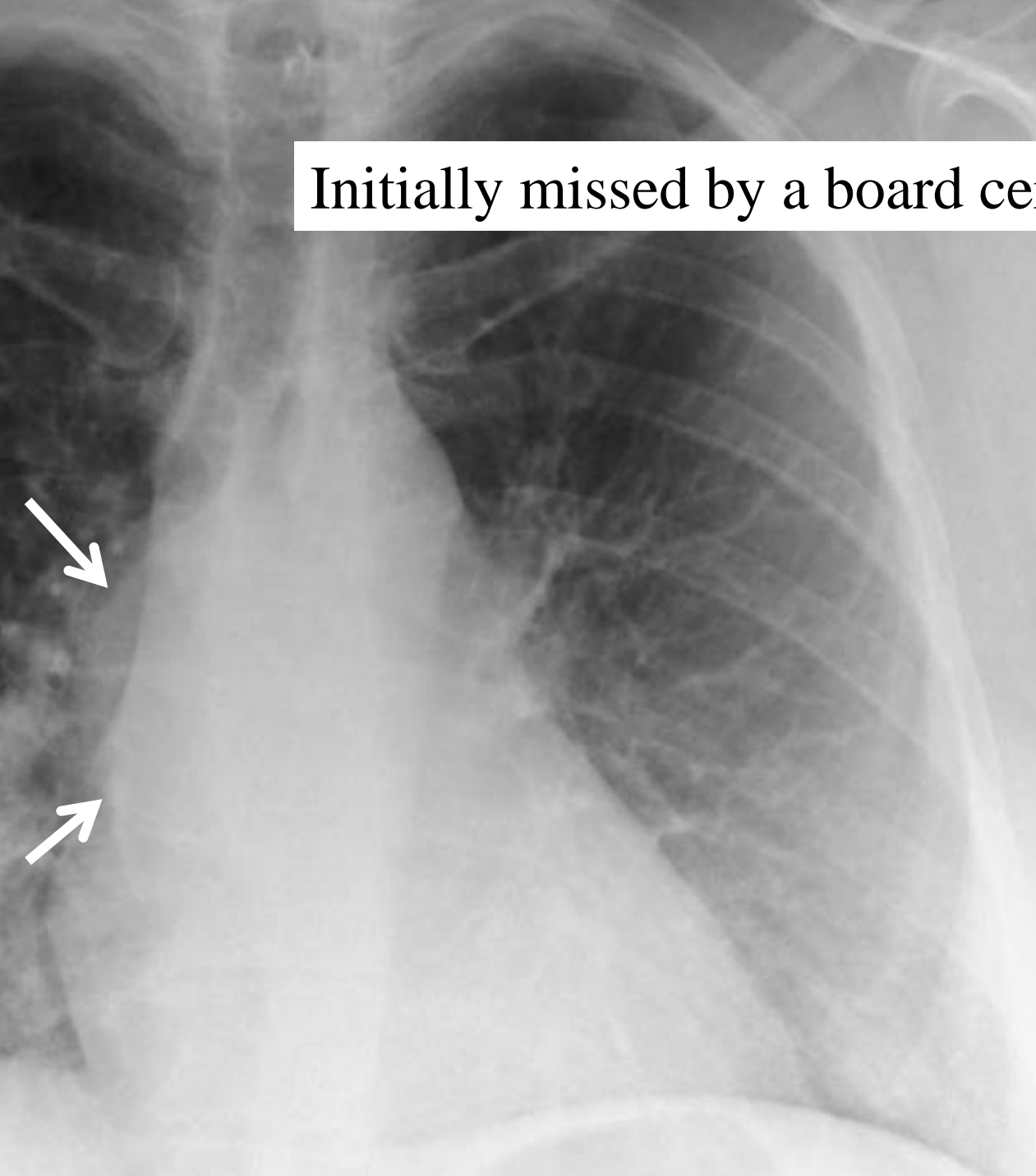


120 kV, 11 effective mAs



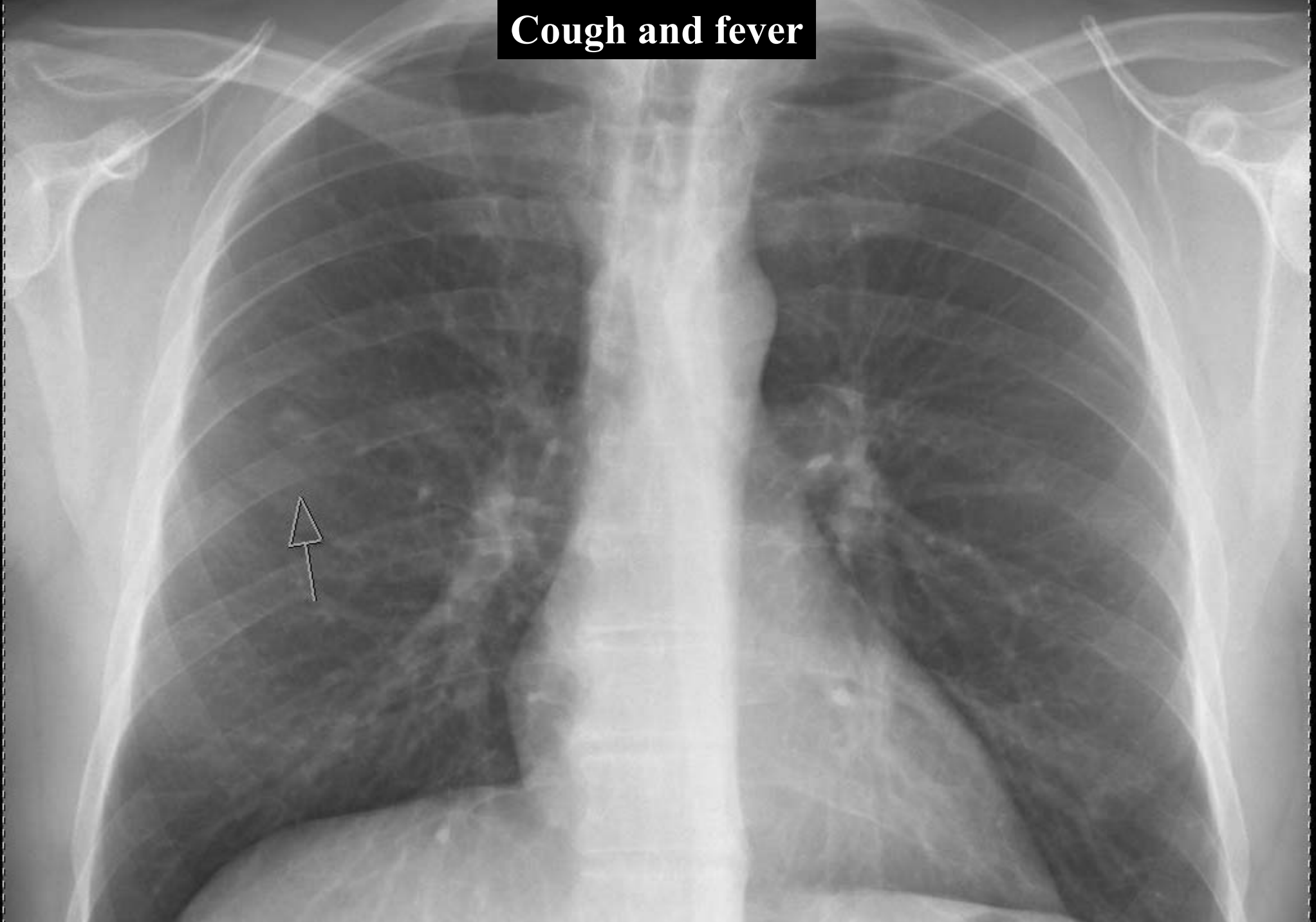


Initially missed by a board certified radiologist

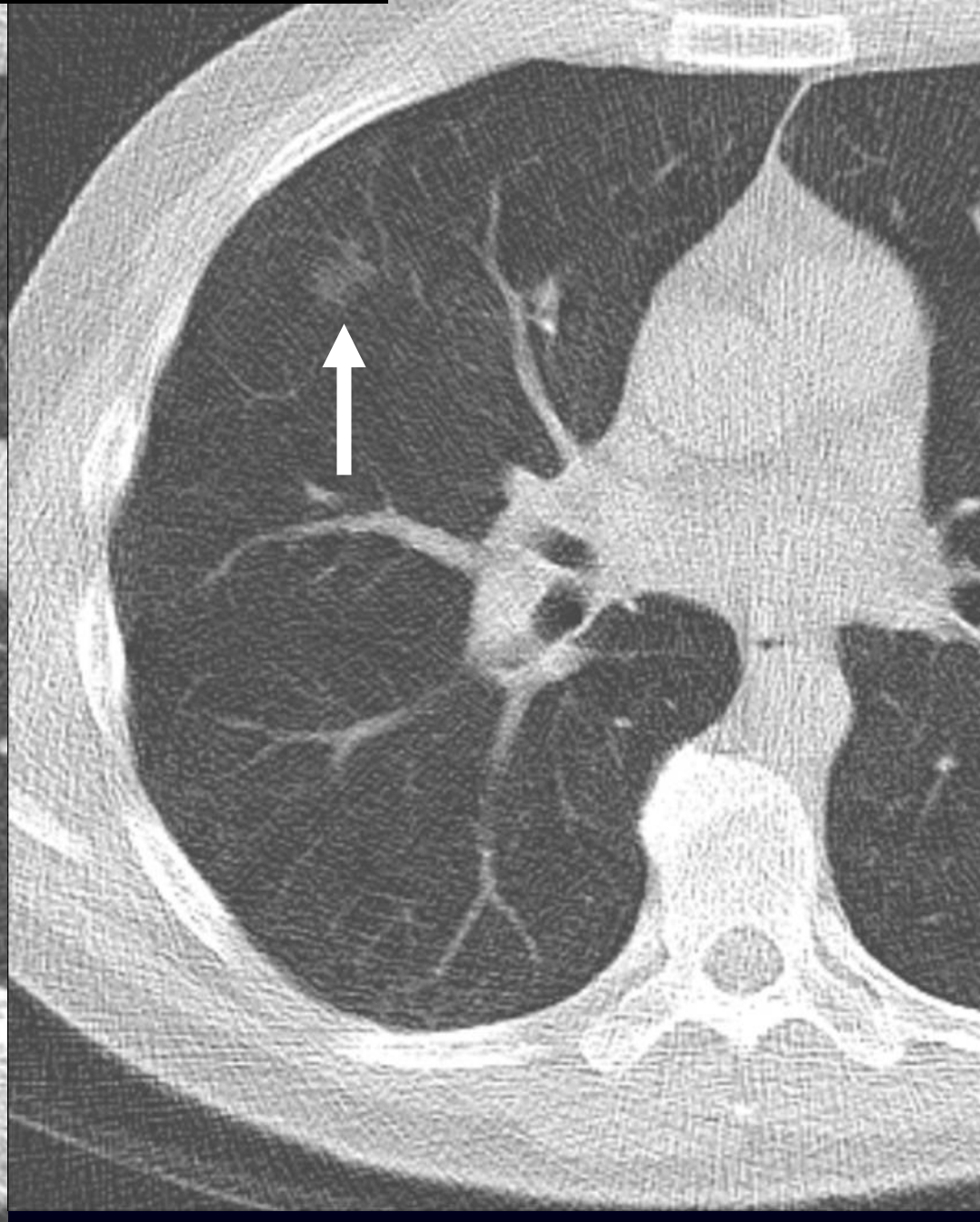
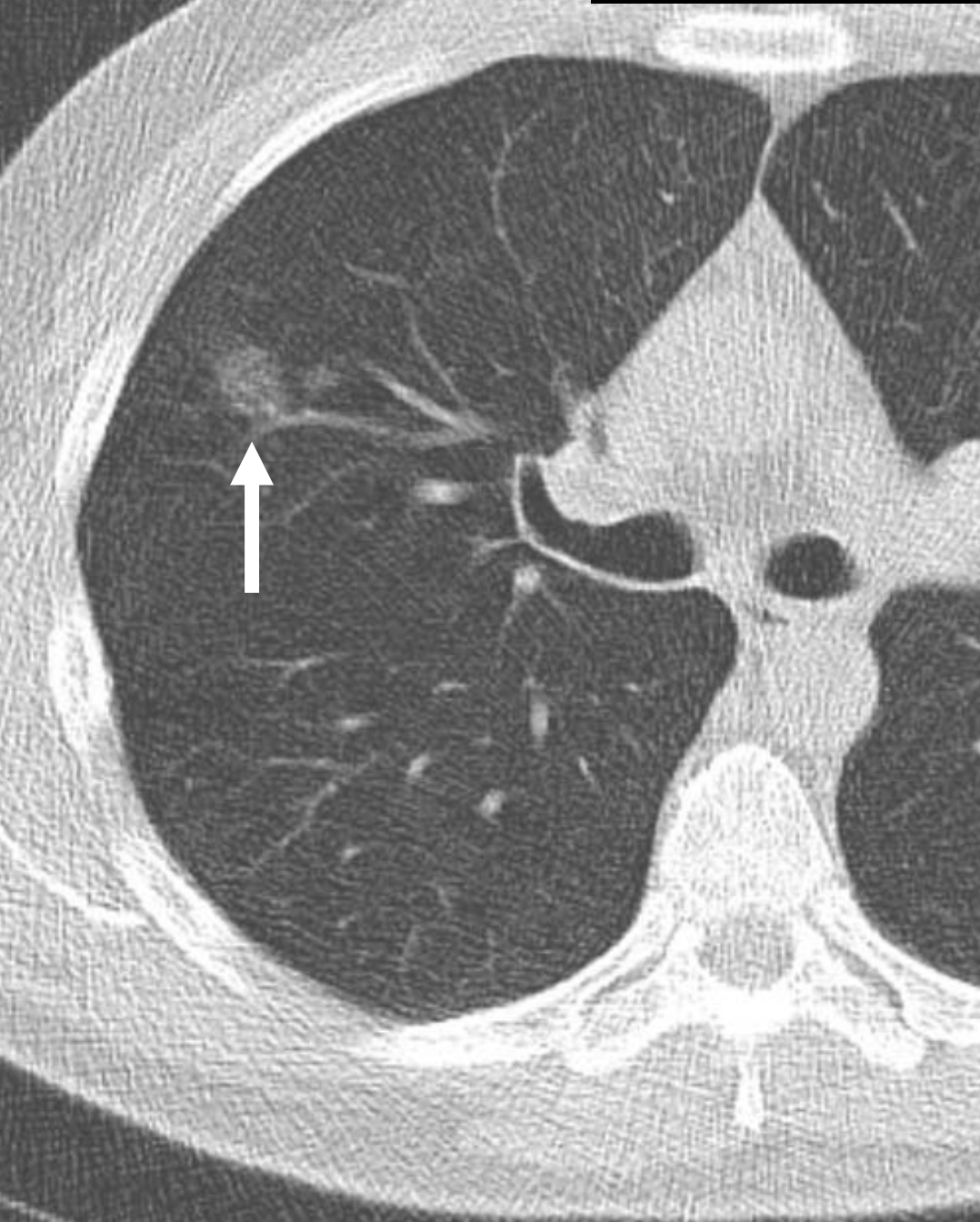




**Cough and fever**



**IN37; 80 kV, 17 effective mAs**



**IN37; 80 kV, 17 effective mAs**

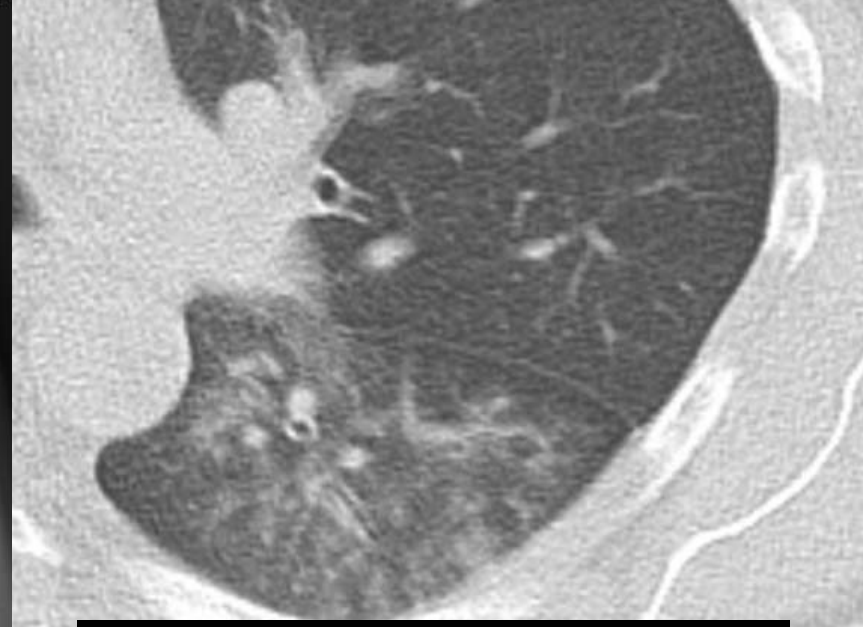




**High fever and CRP, and antibiotics no effect. Source?**

ni2

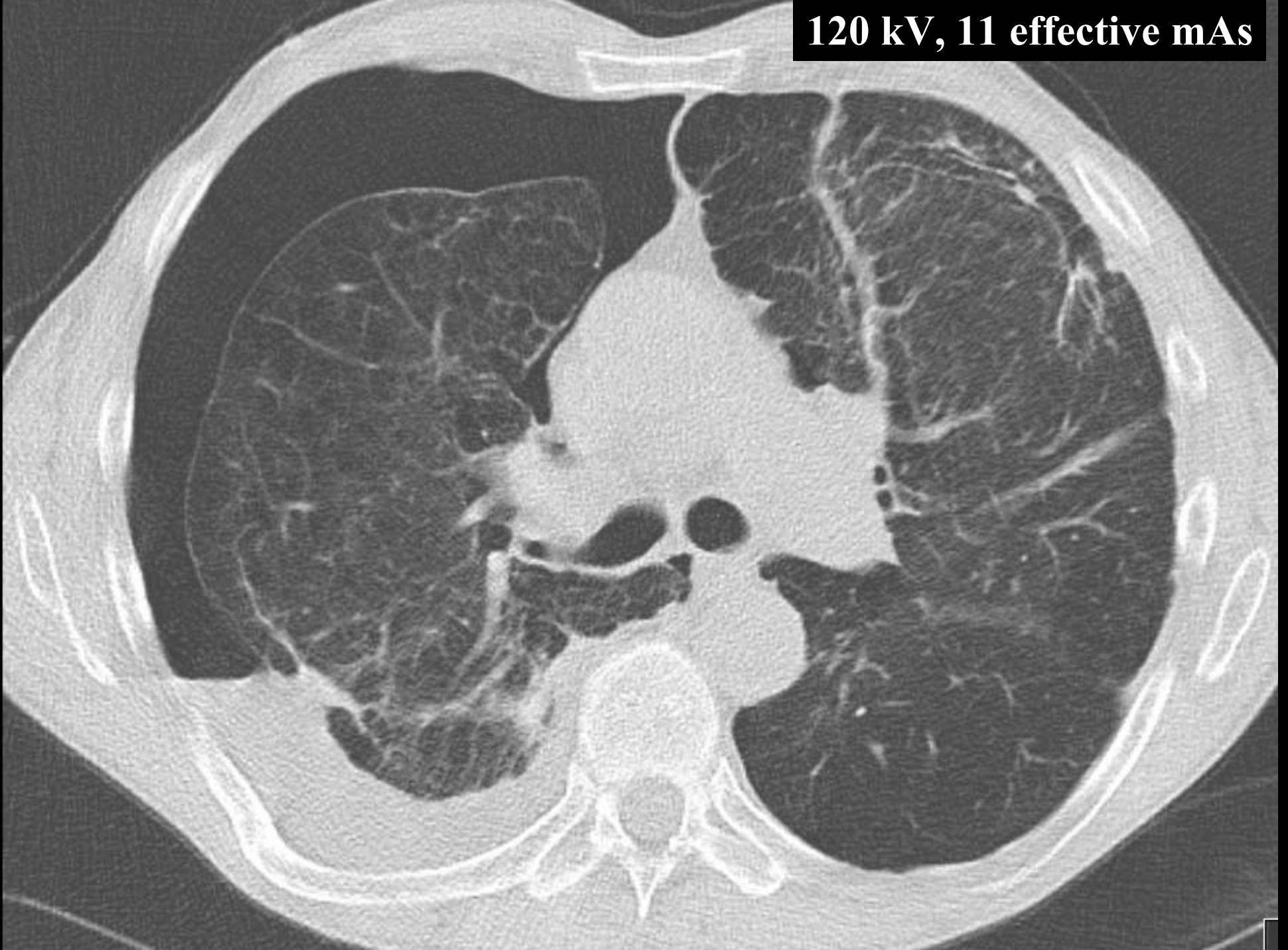




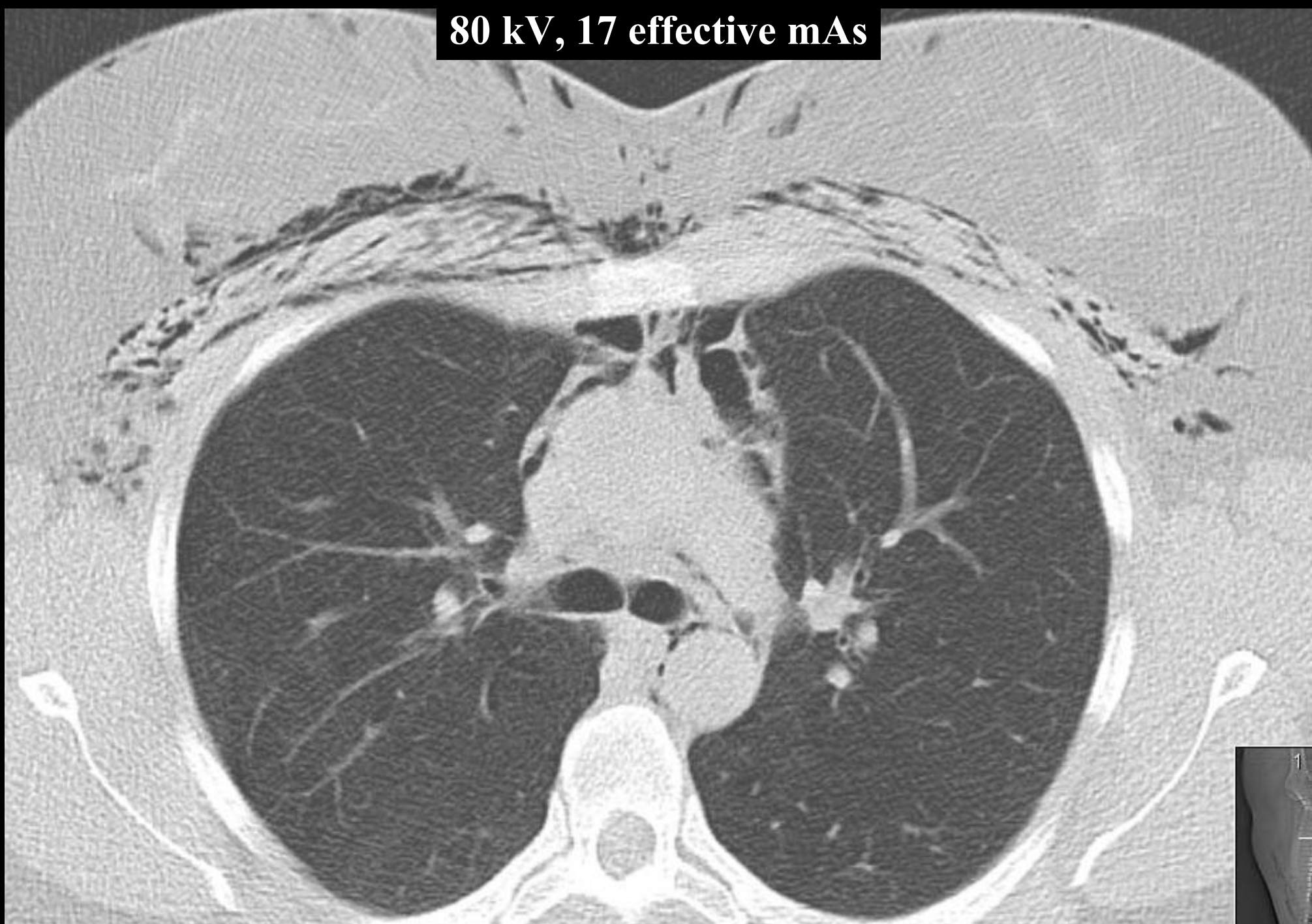
**120 kV, 11 effective mAs**



**120 kV, 11 effective mAs**



80 kV, 17 effective mAs



# *Conclusions*

- **It is possible perform diagnostic pulmonary CT at radiation doses not far from those of chest tomosynthesis.**
- **Of particular value in *children and young adults*, and to replace *bedside chest x-rays*, not seldom of suboptimal quality.**
- **Low-dose chest CT also depicts details in chest wall, pleura and the mediastinum.**



## *Conclusions*

- **It may be more cost-effective to go for dedicated low-price and low-dose chest CT**
- **Studies comparing low-dose chest CT vs. tomosynthesis are warranted**

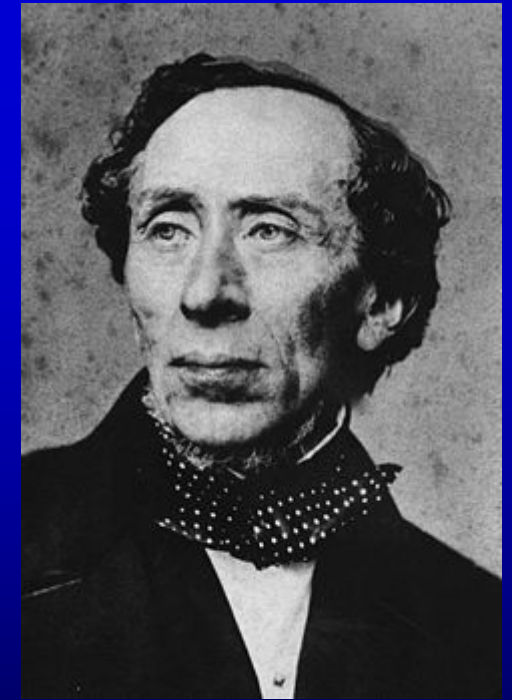
# *Indikationer*

- **Barn – unga individer**
- **Främmande kropp?**
- **Lungförändring?**
- **Kontroll lungförändring?**
- **Tumör uppföljning unga individer**

# *Datortomografi thorax*

	<i>Mini</i>	<i>Rutin</i>	<i>Vissa</i>
• Kilovolt	80	120	120
• Effektiv mAs	17	50	200
• CTDIvol (mGy)	0,3	4	16
• DLP (mGy*cm)	13	150	600
• Effektiv dos (mSv)	0,2	2,5	10
• Lungröntgen		0,1	
• CT thorax Sverige		6,6 (3,4-17)	

# *The Emperor – tomography – may still be Naked!!*



*H.C. Andersen,  
Danish author  
1805-1875*



*Fabian 7 yrs*

*Kajsa 5 yrs*

*Lukas 1 yrs*

*The grandchildren honors H.C Andersen!*





