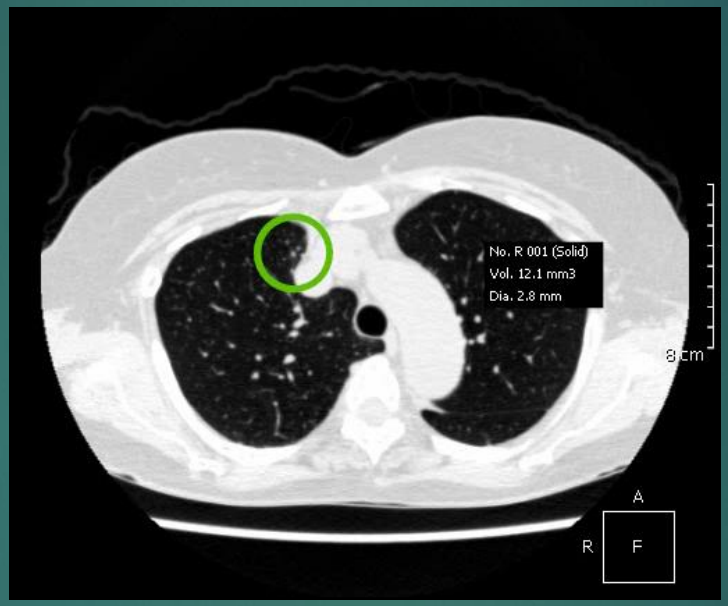
Misleading findings at a chest CT computer-assisted detection system for lung cancer screening using ultra-low dose CT



Hiroshi Moriya, MD PhD; Manabu Nakagawa, MD PhD; Koutarou Sakuma, MD; Tsunemitsu Horie, RT; Ohara General Hospital, Fukushima JAPAN

Katsuhiko Murakami, RT; Fukushima Medical University

Tomokazu Numano, RT PhD; Metropolitan University Tokyo

Teaching points

1. To explain the clinical utility of a computer-assisted detection system (CAD) for lung cancer screening using ultra-low dose CT.
2. To show the false-positive CT findings in CAD system.
3. To show the false-negative nodules in CAD system.
4. To show the misleading findings using ultra-low dose CT.

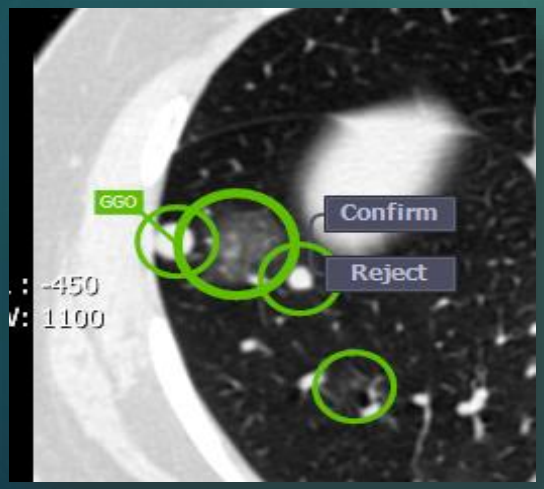
Materials and Methods

- Computer-assisted lung nodule detection system: Xelis lung Solution(INFINITT JAPAN). Effective diameter:1mm.
- Lung metastases: 995 nodules of cases with post-operative status of digestive organ cancer or breast cancer. CT scanner: Aquilion ONE (Toshiba medical systems),,plain chest scan, conventional dose,FC17/FC13.
- Lung cancers: 50 nodules of cases of lung cancer screening. CT scanner: Aquilion ONE,plain chest scan, ultra-low dose scan (240mA,120mA,60mA; ACTive study protocol), FC17/FC13.

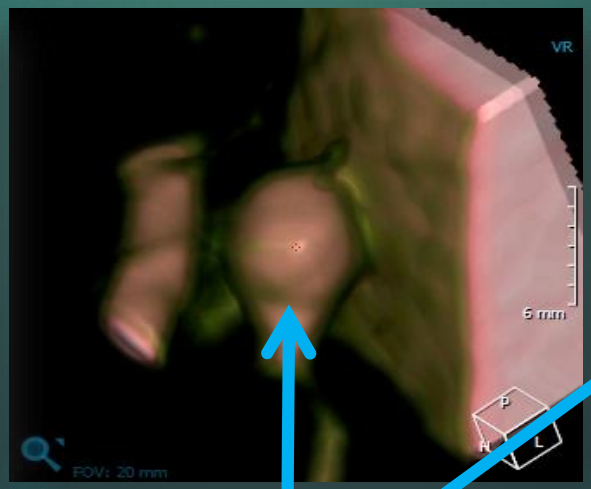
Computer-assisted lung nodule detection system that were used for this study (Xelis-Lung Solution : INFINITT JAPAN)

Features

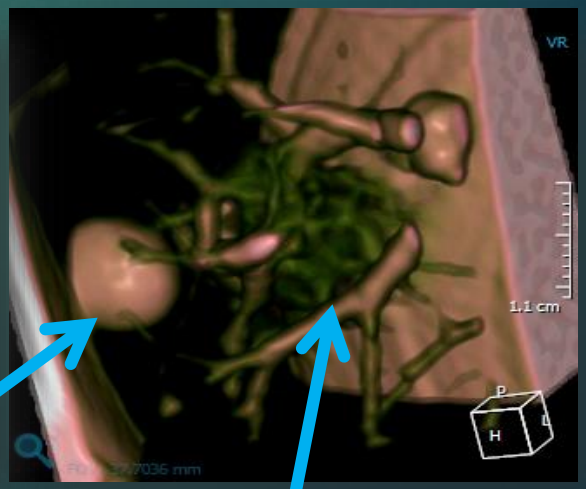
- Automatic Lung Nodule Detection
- Very short computation time for automatic detection
- - Typically, 20-40 seconds in a recent modern quad-core workstation
- 3D View - nodules that attach to adjacent vessels can be identified
- GGO (Ground-Glass Opacity) type nodules and solid type nodules can be automatically detected.
- Regions labeled as nodules are highlighted on the images



Automatically detected nodules: Solid and GGO types (Green circle)



VR Rendition of Solid nodule



VR Rendition of GGO nodule

Radiologist-detected-nodules versus CAD-detected-nodules - lung metastases -

	Detected by radiologist	Not detected by radiologist	Total
Detected by CAD	357 5.07±2.70mm	235 2.68±0.78mm	592
Not detected by CAD	49 6.72±5.59mm	0	49
Total	406	235	641

number of detected nodules and diameters of nodules

False positive of CAD: 354
3.31±2.27mm

CAD detected a large number of nodules less than 3 mm. As a result, there was an increase in false positives. And, there were some large nodules in false negative of CAD, however, there was no oversight of the radiologists.

Diameters of nodules and positive predictive value

	True Positive	False-negative	False-positive	Sensitivity	Positive predictive Value (%)
Reference (All)	592	49	354	0.923	0.625
3mm or more	313	36	110	0.896	0.739
5mm or more	92	17	20	0.844	0.821
5mm～10mm	81	10	14	0.89	0.852

- When limited to the size of 5-10mm, sensitivity was 89%, and positive predictive value was 85%.
- Detection algorithm is quite different from the thinking patterns of radiologists, CAD can be used as a supportive system for pulmonary nodule screening.

Clinical evaluation of a chest CT computer-assisted detection system for small pulmonary nodules
Hiroshi Moriya, Tsunemitsu Horie, Tomokazu Numano, Katsuhiko Murakami and Maiko Kudo Annu.Rep.Ohara Hosp. 53:3-7,2013

Detectability of lung cancer in low-dose conditions

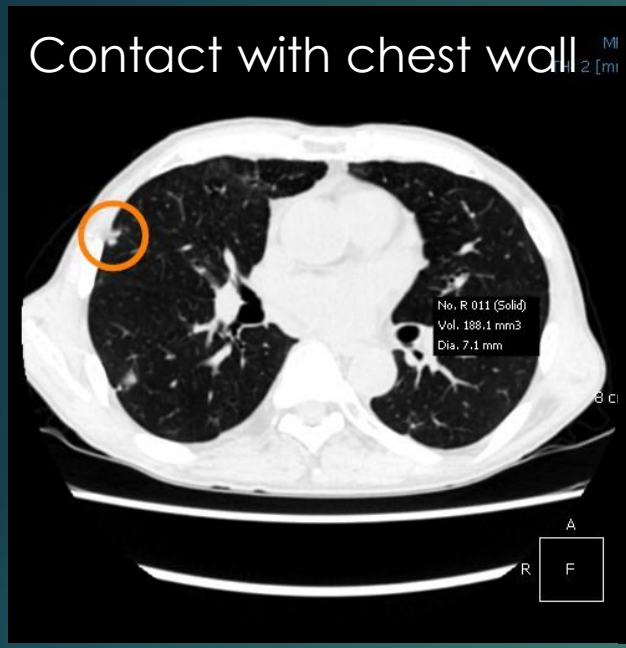
	True positive	False-positive	False-negative
240mA FBP	50	22	1
120mA FBP	40	36	11
120mA AIDR3D	41	29	10
60mA FBP	35	34	16
60mA AIDR3D	29	35	22

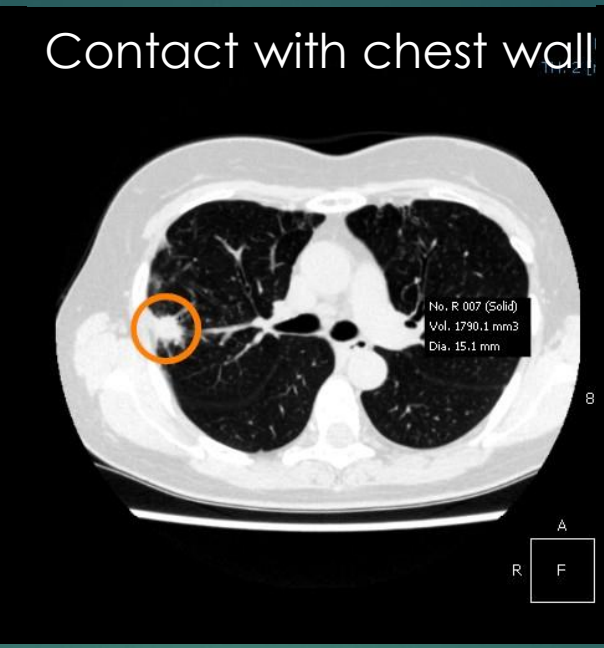
There was an increase of false positive nodules and false-negative nodules in low dose conditions.
A detection rate of nodules in CAD system may decrease by dose reduction.

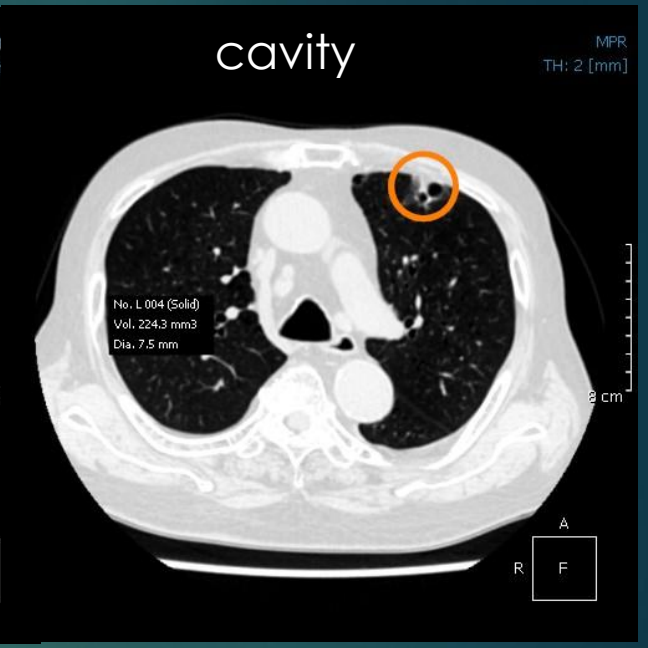
False-negative & False-positive nodules in CAD system

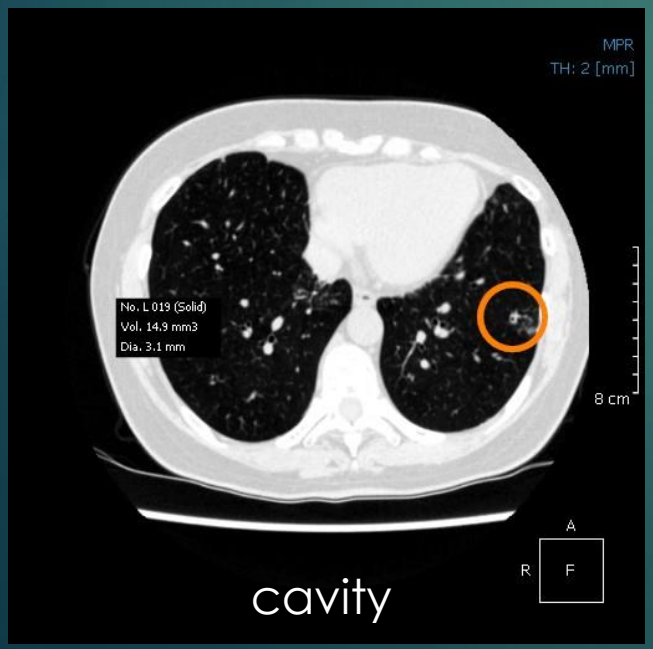
False-negative nodule		False-positive nodule	
contact with chest wall	17	scar	140
contact with pleura	4	mucoid impaction	54
contact with diaphragm	1	bronchus	35
contact with vessel	1	vessel	49
cavity	8	calcification/metal	37
GGO	8	blurred shadow	29
polygonal shape	3	wall/pleura	7
irregular shape	3	colon	4
too small	3	small nodule	4
too large	2	polygonal shape	2
high density	1		

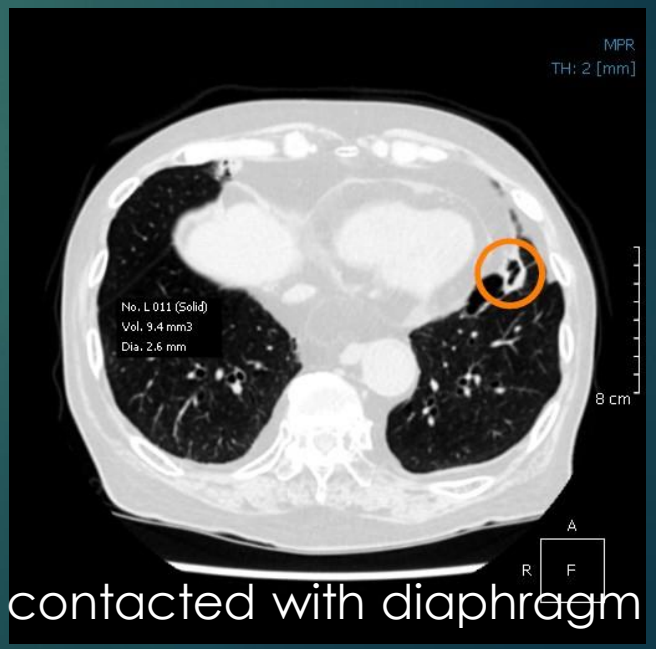
False-negative nodules in CAD system



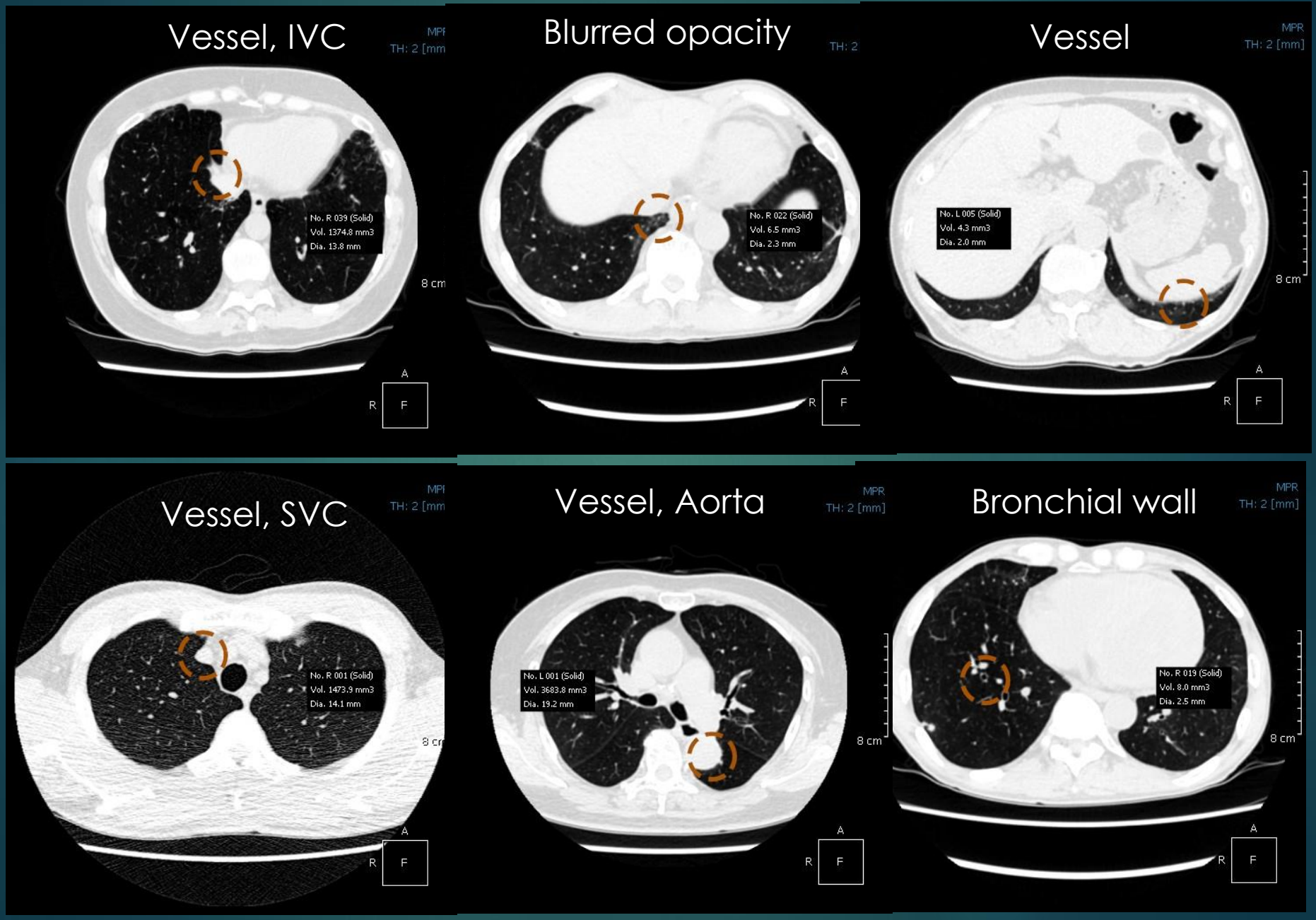




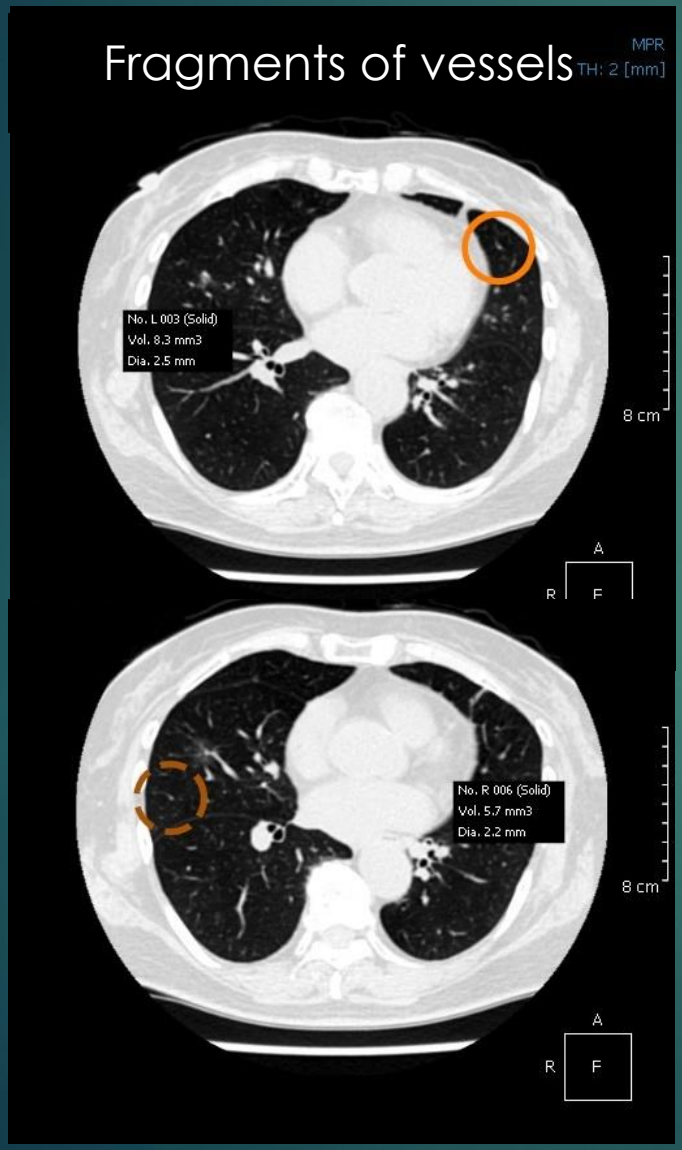


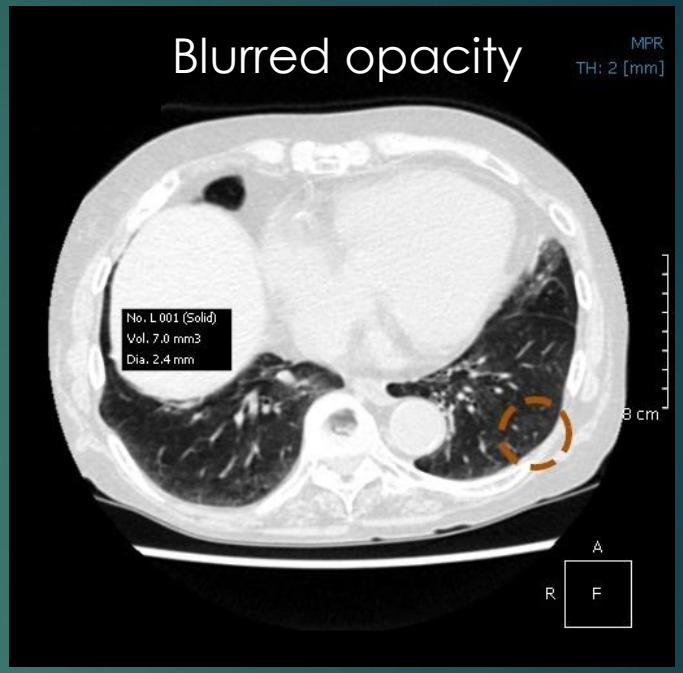


False-positive nodules in CAD system



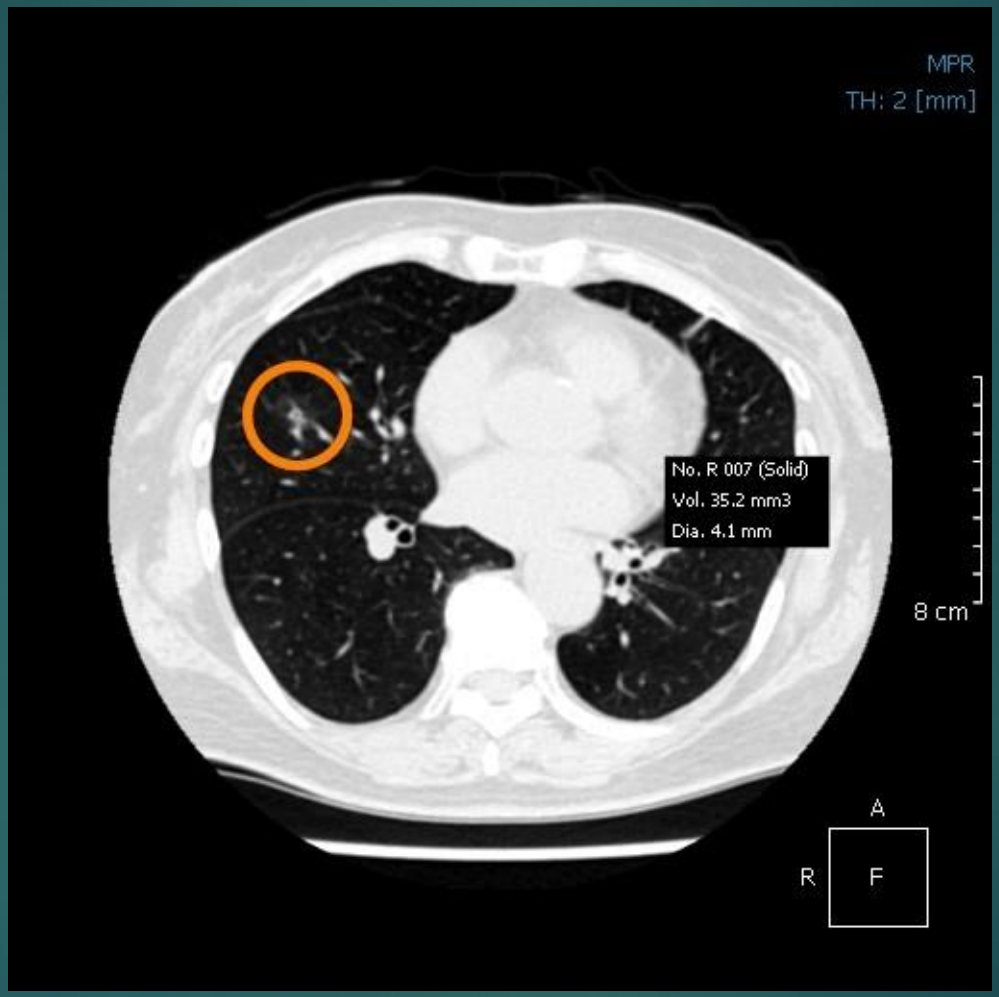
False-positive nodules in ultra-low dose condition





They were some false positives by fragmentation of the small vessels or irregularity of the lung field density in a low dose condition.

False-negative nodule in ultra-low dose condition



This nodule became a detection distress in low dose condition.

Conclusion

- CAD detected a large number of nodules less than 3 mm.
- There was an increase of false positive nodules and false-negative nodules in low dose conditions.
- A detection rate of nodules in CAD system may decrease by dose reduction.
- However, detection algorithm is quite different from the thinking patterns of radiologists, CAD can be used as a tool of double check in pulmonary nodule screening.
- There were some large nodules in false negative of CAD, but, there was no oversight of the radiologists. Radiologist performance of detecting lung nodules would improve with the use of CAD.
- CAD is useful to pick up the nodule candidate that require observation for screening of pulmonary cancer or metastases in patients with known cancer and lung cancer screening.