Perspectives for the Improvement of Diagnosis of Pneumoconiosis Chest Radiographs vs. CT Scanning

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Conventional chest radiograph

Advantages

- Simple to perform
- Cost effective
- Relatively specific in certain conditions
  - advanced silicosis, advanced coal worker's pneumoconiosis or advanced asbestosis
  - extensive and/or calcified pleural thickening
- Low radiation exposure : effective dose 0.03 mSv
- Standardized classification method (ILO classification)

Chest Radiography in Dust Exposed Workers

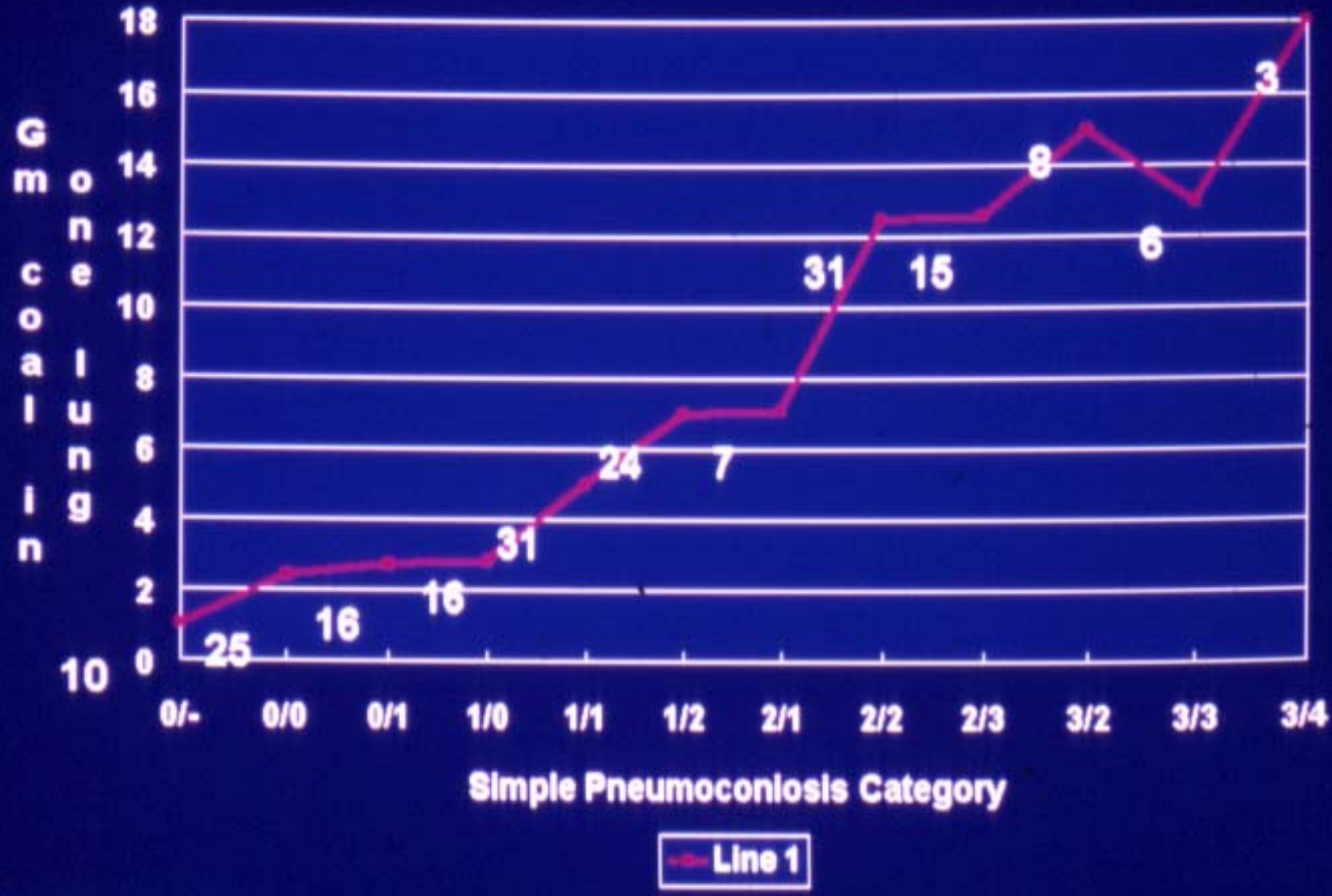
- Chest radiography has been useful tool in screening and surveillance of dust exposed workers
- Chest radiograph has been helpful in exposure response relationships
- Documents failures of dust control

Chest radiograph vs pathologic findings

- Relatively good correlation between lung pathologic findings and radiographic interpretation for dust-exposed workers with high profusion of small opacities (HNIZDO 1993)

- Good correlation between the dust content in the lung and the profusion of small opacities in coal miners

ILO Category vs Coal Content



Rossiter et al 1961

Chest radiograph vs pathologic findings

Chest radiographs relatively insensitive to early changes resulting from exposure to asbestos and silica:

No chest radiographically detectable parenchymal small opacities in $\simeq$ 20 % of asbestos-exposed workers with fibrotic changes on pathologic examination (Kipen 1987) and 25% of workers with autopsy evaluation versus radiographic study South African gold miners (Hnizdo 1993)

Conventional chest radiograph

Limitations

- Superimposition of structures of varying densities
- Mute zones – quiet zones
- Misinterpretation due to inadequate technique
  - underexposure or overexposure
  - incomplete inspiration
  - scapular overlap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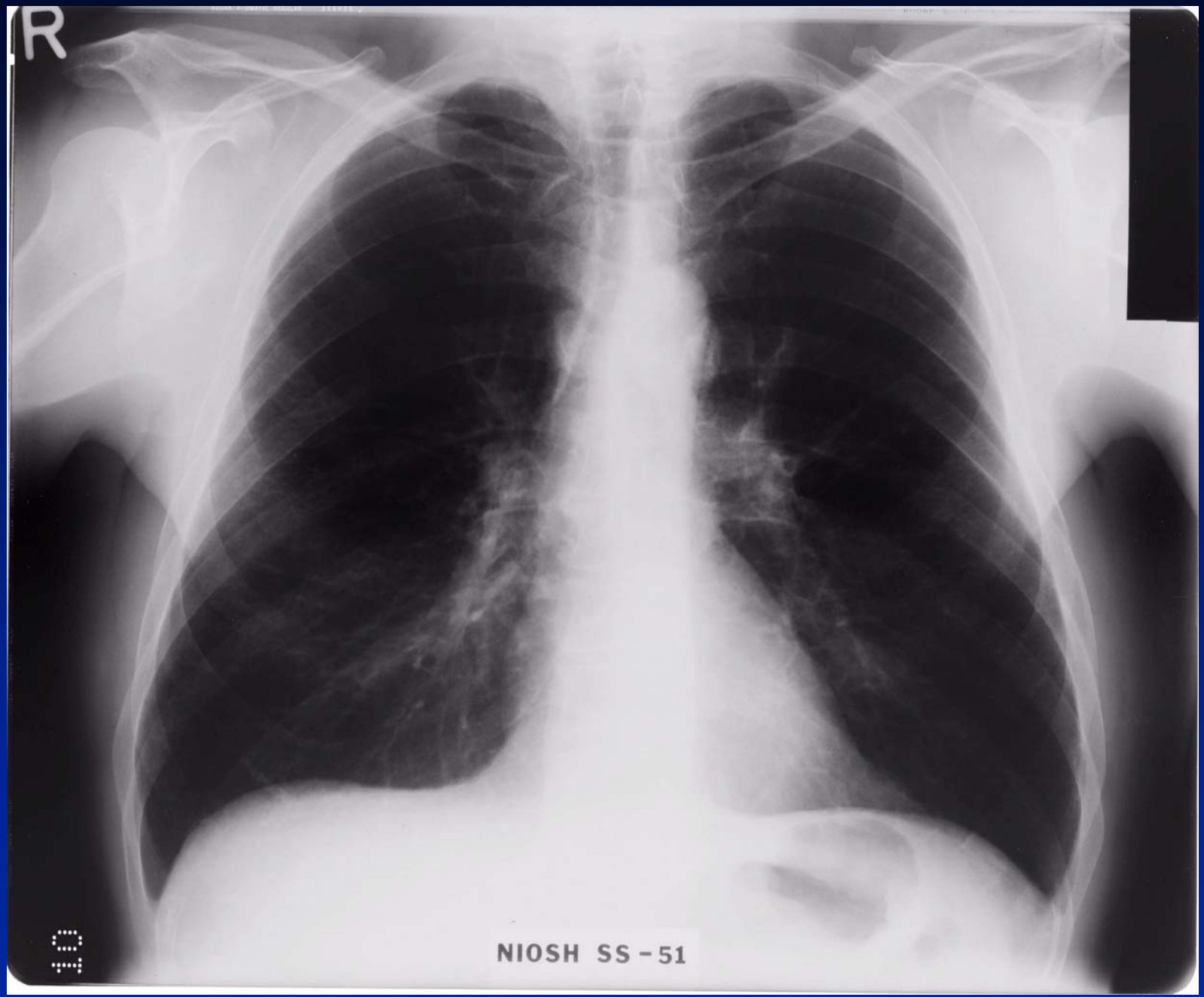
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Conventional chest radiograph

Limitations

- Misinterpretation due to patients' personal characteristics
  - obesity
  - tobacco consumption
  - age

Limitations of Radiographic Imaging

- Imperfect tool, not diagnostic gold standard
- Airway disorders not always seen
- Functional impairment not well evaluated or assessed
- Cannot provide certainty about the etiology of observed findings due to limited lung response patterns

Digital radiography

Two detector types currently used for chest radiography :

- Storage phosphor radiography = computed radiography (CR). Uses a photo stimulable phosphor screen as the image receptor

- Direct radiography (DR)
  Uses flat panel detector systems = digital, electronically readable radiography system that is characterised by a direct read-out matrix of electronic elements

Digital radiography

Reported benefits

- Allows images of sufficient diagnostic quality to be obtained from imperfect exposures $\Rightarrow$ fewer repeat examinations
- Images in digital form have the potential for further manipulation after processing to aid interpretation
- Images can be stored and transmitted more easily
- Lower radiation doses?

CT and HRCT

Advantages

- Eliminate superimposition of structures
- Allow investigation of the pleura all around the chest
- Distinguish pleural thickening from subpleural fat or muscles

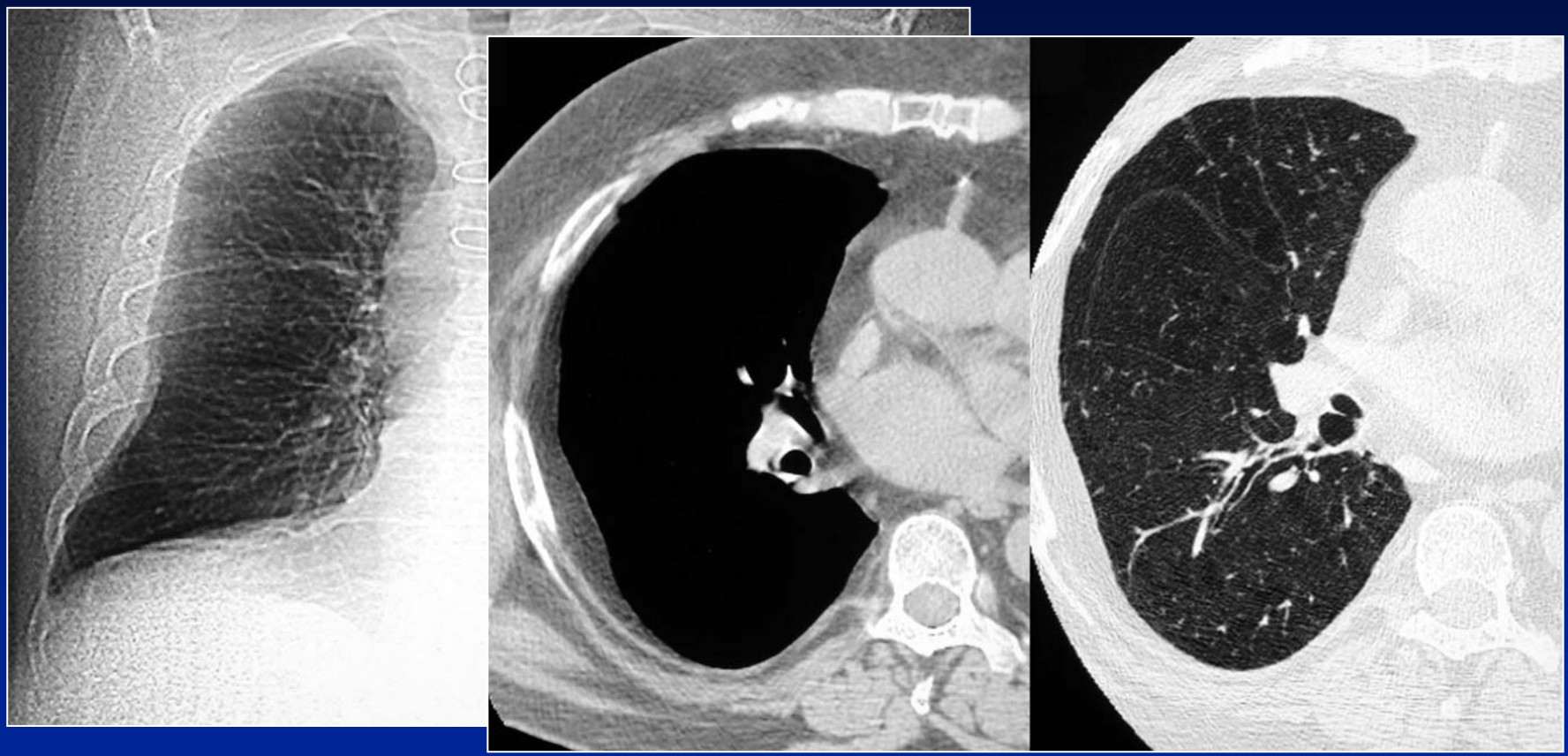
HRCT (1 – 3 mm sections)

Advantages

- Increases spatial resolution and provides detailed images of the lung parenchyma

- Slices in the prone position differentiate the gravity-induced images seen in the dependant part or the lung in the supine position from that due to interstitial lung diseases

Subpleural fat



HRCT and CT Advantages

- Visualize parenchyma even when pleural shadows are competing on the PA image
- See pleural surfaces in more detail, clearly superior to PA radiograph for recognition
- May clarify presence or absence of abnormalities on low profusion PA films

HRCT and CT Advantages

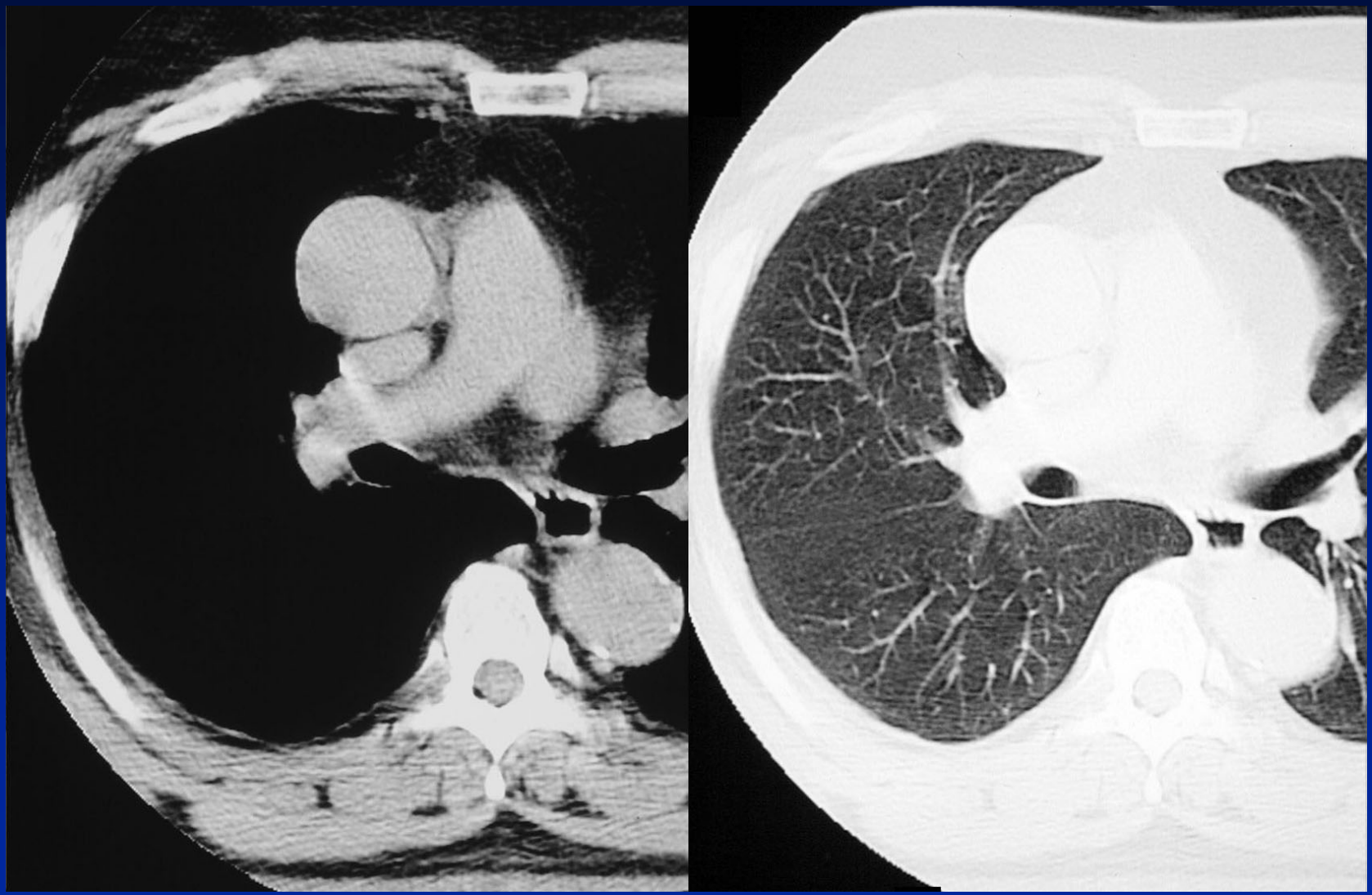
- More sensitive in early detection of interstitial abnormalities
- More sensitive in detection of emphysema
- Improves detection of coalescence opacities in silicosis and CWP
- Less inter-reader variability
- Improved association with functional abnormalities

CT and HRCT

Pay attention to pitfalls

Normal intercostal veins

Thoracic transversal muscle of the sternum



CT and HRCT

Limitations

- Heterogeneous availability
- High cost
- High radiation doses :
  - radiation dose from CT using 10 mm continuous sections $\simeq$ 200 times that of PA chest radiograph

CT scan and lung cancer

Asbestos and silica-exposed workers are at increased risk of lung cancer

Over the past 10 years, lung cancer screening studies using CT have detected up to 85% of lung cancers in stage I

However it has not yet been demonstrated that CT screening reduces lung cancer mortality

Small pulmonary nodules are detected in 20 to 50 % of cases in male smokers $\geq$ 50 yrs. No consensus on the way how to manage these nodules

Medical screening and health surveillance

- The routine use of CT and HRCT for screening or surveillance of pneumoconiosis remains limited due to :
  - high cost
  - limited international availability
  - high radiation exposure

Potential Applications of CT

- Equivocal CXR findings; further exploration of difficult cases
  - Borderline profusion films with ?? small opacities
  - Differentiation face-on pleural and parenchymal opacities
  - Discordance between CXR and pulmonary function tests or respiratory symptoms
- Early lung cancer detection?

Medical screening and health surveillance

- Chest radiography remains the most widely used radiologic screening tool for the assessment of large populations
- Radiographs of good quality, classified using the ILO system, and reported with consistency and accuracy are the most important tool for health screening and surveillance of workers exposed to mineral dusts

We see what we know!
And …

And…
We know what we see!

But can we think outside the box?

Why is silicosis so difficult to prevent?

- Silica is ubiquitous
- It takes only a small chronic exposure to cause disease
- Freshly fractured silica is even more toxic than aged silica
- Requires sustained effort in a tough social, economic, political, legal environment

Abnormal Radiograph of Patient With Severe Dyspnea

What is the most likely disease?

What changes occur from 1999 to 2000 and finally in 2001?

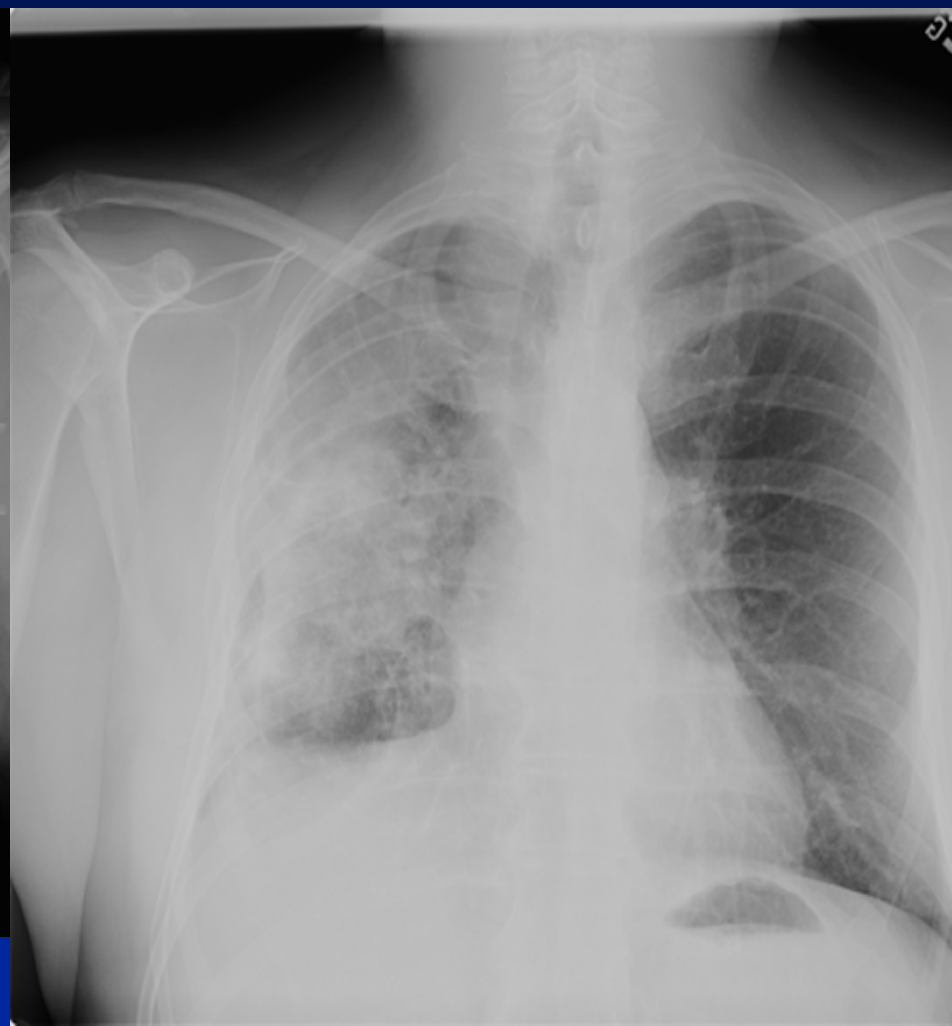
How and why did the changes occur?

PA CXR June 16, 1999

PA CXR April 7, 2000

PA CXR March 5, 2001 (one year F/U)

Comparison of the PA CXR's from April 07, 2000 and March 05,2001



The radiographs are from a young patient with a history of intense dust exposures.

While working as an underground coal miner, and operating a continuous mining machine.

The disease is accelerated silicosis, with bilateral progressive massive fibrosis.

There is also compensatory emphysema in addition to the large opacities.

The left lung then becomes almost entirely normal after a surgical procedure.

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Silica- Related Lung Disease Recognition and Prevention

Is Clearly A Complex and Challenging Problem