Radiologic Assessment of the Elderly Chest

: Normal Aging vs Clinical Significances

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Normal Age-Related Alterations on Chest Radiographs
Radiologic examinations of the elderly are rising continuously due to progressive increase in life expectancy.

Structural and functional changes occur in the thorax involving lung parenchyma, airways, mediastinum, chest wall, and diaphragm with advancing age.

For accurate interpretation of the chest radiographs and CT, distinguishing physiological and pathological changes is important.

The purpose of this exhibit is to review age-related structural changes in chest radiographs and chest CT.
By having an understanding of the typical imaging findings frequently seen in the elderly, radiologists can better distinguish normal aging from pathology and thus avoid common pitfalls and provide appropriate management.
Changes in the Lung with Age

- Age-related alveolar hyperinflation
- Reticular densities, subpleural basal
- Ground-glass opacity, basal dependent
- Mosaic attenuation pattern
- Incidental lung nodules
- Air cysts
Normal Age-Related Lung Alterations on Chest Radiography

A longitudinal investigation, Age range: 41-82 years
Three chest radiographs: initial, 10 years, 18.5 years

<table>
<thead>
<tr>
<th>Pulmonary observations on chest radiography at three examinations</th>
</tr>
</thead>
<tbody>
<tr>
<td>Observations</td>
</tr>
<tr>
<td>---------------------------------------------------------------</td>
</tr>
<tr>
<td>Increased lung markings</td>
</tr>
<tr>
<td>Pulmonary fibrosis</td>
</tr>
<tr>
<td>Hyperaeration</td>
</tr>
<tr>
<td>Kerley B lines</td>
</tr>
</tbody>
</table>

- Persons demonstrating at least one of the 4 evaluated pulmonary parenchymal findings: 13% initially and 27% finally, *increasing prevalence with age.*
- None of these findings correlated with smoking status

Acta Radiologica 1993;34:53
**CT Feature of Lung Morphology in the Elderly**

<table>
<thead>
<tr>
<th>CT Feature</th>
<th>Older Group (n = 40)*</th>
<th>Younger Group (n = 16)*</th>
<th>P Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Reticular pattern</td>
<td>24 (60)</td>
<td>0 (0)</td>
<td>&lt;.001†</td>
</tr>
<tr>
<td>Cysts</td>
<td>10 (25)</td>
<td>0 (0)</td>
<td>.02‡</td>
</tr>
<tr>
<td>Bronchial dilation</td>
<td>24 (60)</td>
<td>1 (6)</td>
<td>&lt;.001†</td>
</tr>
<tr>
<td>Bronchial wall thickening</td>
<td>22 (55)</td>
<td>1 (6)</td>
<td>&lt;.001†</td>
</tr>
<tr>
<td>Ground glass opacity</td>
<td>0 (0)</td>
<td>1 (6)</td>
<td>NS‡</td>
</tr>
<tr>
<td>Interlobular septal thickening</td>
<td>7 (18)</td>
<td>0 (0)</td>
<td>NS‡</td>
</tr>
<tr>
<td>Centrilobular emphysema</td>
<td>2 (5)</td>
<td>0 (0)</td>
<td>NS‡</td>
</tr>
</tbody>
</table>

- All findings are independent of pack-year smoking history
- **CT findings usually associated with interstitial lung disease may be part of the normal spectrum of senescent lung** and should not be over-interpreted to represent clinically important disease.

Radiology 2009;251:566
Age-related Alveolar Hyperinflation

- So-called “Senile Emphysea”
- *Physiological alveolar hyperinflation without destruction*
- During the aging process, the alveolar ducts increase in diameter and the alveoli become larger and shallower.
- *Age-related density reduction of the lungs on CT:*
  Approx. 50 HU between the ages of 20 and 70

Mean lung attenuation: statistically significantly decrease with increasing age

Semin Nucl Med 2007;37:103
Age-related alveolar hyperinflation in a non-smoker. Chest radiograph shows uniform hyperlucent lungs with flattened diaphragms which mimic findings of emphysema. However, chest CT shows no emphysema.

★ **Age-related alveolar hyperinflation:** homogeneously distributed across the entire lung  **vs Actual emphysema:** mainly affect the upper or lower lobe, depending on the phenotype
Ground Glass Opacity

- Homogeneous ground glass opacity in the **basal dependent lungs**.
- Due to shallow inspiration depth and dependent position of the parenchyma.

⭐ Normal >> Interstitial lung disease
- Homogeneous
- Reversible in prone position

Homogeneous ground glass opacity in the basal dependent lungs (arrows) in CT scans.
Mosaic Attenuation Pattern

- Common finding in aging patients
- Result of accidental images of expiration or respiration due to limited patient cooperation during the examination

**Air-trapping**: Aging and smoking are possible predisposing factors.
- 76% in an asymptomatic cohort ≥ 61 years of age.
- Lower lobe predominance

Radiology 2000;214:831
Mosaic attenuation pattern in lower lungs on CT scan. It is caused by expiration or limited respiration during CT examination.
Subpleural and basal reticular pattern

- Frequently seen in asymptomatic elderly, 60% of the older non-smokers group (age 80.6 ± 4.2, N= 40)

  Radiology 2009;251:566

- A normal spectrum of morphology of aging lung
- Possible causes: Increased collagen deposit and progressive fibrosis with aging, Alveolar collapse in relatively underventilated portions of the lung.
- No relationships between smoking history and reticular pattern
- No correlation between PFT and reticular pattern
- CT findings usually associated with IPF are frequently seen in asymptomatic elderly individuals (75 years or older). These findings may not necessarily represent clinically relevant interstitial lung disease.

★ Therefore, CT diagnosis of IPF must be cautious in the elderly.
Subtle reticular densities in both lower subpleural lungs on CT in asymptomatic non-smokers. This limited subpleural basal reticular pattern is not associated with traction bronchiectasis or honeycombing.

★ Incidental findings >> subclinical low-grade ILD

- Limited extent
- No honeycombing and traction bronchiectasis
Localized reticular densities

- Incidental finding
- Focal interstitial fibrosis
- Associated with right-sided thoracic spine osteophytes

Focal reticular densities (circle) in right lower lobe, adjacent to a thoracic spine osteophyte on CT

AJR 2002;179:893
Incidental Pulmonary Nodules

Chest Radiographs

1950s: 1/500 (0.2%) on chest radiographs
1999, ELCAP: 7% on chest radiographs

Low dose CT

• 8~74% on screening LDCT, in asymptomatic volunteers, mainly smokers or former smokers between the ages of 55 and 75
• Non-calcified nodule detected CT: 25~70 %
• Malignant nodule: 1 % of detected nodules
• Early diagnosis of lung cancer vs Common false-positive findings
Intrapulmonary lymph nodes

A common cause of incidental small pulmonary nodule on CT

- Well-circumscribed, angular in shape, solid nodule
- Subpleural region, below the level of the carina

Clinical imaging 2013;37:487

Small nodules on right lower lobe subpleural lung (arrows) on CT in a 55-year-old woman with history of uterine cervical cancer. These nodules are confirmed histologically as intrapulmonary lymph nodes. Subpleural nodules located in the lower lungs should be kept in mind that they may be intrapulmonary lymph nodes even though the patient has malignancy.
Perifissural nodules on CT

- Well-circumscribed, smooth, solid nodules
- Triangular or oval shape, <10mm in diameter, below the level of the carina
- Intrapulmonary lymph node

★ **A low likelihood for malignancy → No CT follow-up required**

Radiology 2010;154:949

Small ovoid nodules in interlobar fissures (arrows) on CT. These **perifissural nodules** are consistent with intrapulmonary lymph node and are not needed further follow-up.
Air cysts

• **A part of the normal aging process of the lungs**
• 7.6% on chest CT (2633 participants, mean age 59.2 years, range 34–92 years; 50% female), *prevalence increased with age.*
• Asymptomatic individuals older than 40 years
• *No association with cigarette smoking or emphysema*
• Associated decreases in DLCO and BMI
• *Solitary, the peripheral area of the lower lobes, remain unchanged or slightly increase in size over time*

Thorax 2015;70:1156
But, Multiple air cysts with its count of five or more may need to be evaluated for the possibility of cystic lung diseases.

Small thin-walled air cysts in RML and LLL (arrows) on CT.
Changes in the Airways

Tracheobronchial wall cartilage calcification

- Common appearance in the elderly female
- No clinical significance

Diffuse cartilage calcification along the tracheobronchial wall in 83-year-old-woman
**Saber-sheath trachea**

- Parietal malacia → increases the tracheal AP diameter and collapse of the lateral walls
- *A sign of hyperinflation, but normal aging findings*

**Increased AP diameter of intrathoracic trachea** with diffuse tracheal wall calcification in a 74-year-old man. He is a past smoker with no emphysema or chronic obstructive lung disease.
Increased bronchoarterial ratio and bronchial wall thickness

- Increased CT bronchoarterial ratio and bronchial wall thickness with age
- Relative hypoxemia existing in an aged cohort → vasoconstriction and relative bronchial dilation

★ Caution for the diagnosis of bronchiectasis in the elderly:
  bronchoarterial ratio greater than 1.5, bronchi visible into the lung periphery, and lack of distal tapering of the bronchial diameter

**Increased bronchoarterial ratio** (arrows) in lower lobes on thin-section CT in an asymptomatic 76-year-old woman. She is a nonsmoker and has no known lung disease.
Heart

Cardiac enlargement

- Increased myocardial muscle mass and thickness due to myocyte hypertrophy and increased connective tissue matrix

Coronary artery calcification

Extracoronary calcifications

- Aortic valve calcifications, mitral valve/annulus calcifications
- Due to fat, collagen, and calcium salt deposition
- Mild heart valve regurgitation in 90% of healthy patients over 80 years of age

Chest radiograph shows mild cardiomegaly, mitral annular calcification (arrow), and diffuse aortic wall calcification in a 92-year-old woman.

Coronary artery calcification and extracoronary calcifications in the elderly: No clinical significance in healthy patients, but cardiovascular disease risk factors
Aorta and Great Vessels

- Lengthening and dilation with advancing age → enlargement of mediastinal contours
- Atheroma calcifications: most commonly seen in the aortic arch and in the descending thoracic aorta

Chest radiograph in a 71-year-old man shows a bulging soft tissue opacity in right paratracheal area (arrow) corresponding to a tortuous right brachiocephalic to subclavian artery on CT.
Excessive Fat Deposition

- Superior mediastinum, Paravertebral regions, Cardiophrenic angles, Extrapleural space

Chest radiographs in 72-year-old woman show mass opacity in left cardiophrenic angle area which is classic appearance of prominent paracardiac fat pad. This is confirmed on CT. Prominent paracardiac fat pads are usually mistaken for mass, atelectasis, or pneumonia on chest radiographs.
Changes in the Chest Wall

Decreased chest wall compliance with increasing age

**Muscle**
- Aging-related muscle mass loss → one of the major causes of increased pulmonary transparency on chest X-rays in the elderly

**Rib**
- Costal cartilage calcification: mistaken for pulmonary nodules

**Thoracic spines**
- Osteoporosis
- Degenerative changes: reduced intervertebral space, bone sclerosis adjacent to the intervertebral discs, marginal vertebral osteophytes
- Barrel chest
Barrel chest: increased thoracic AP diameter relating to osteoporosis and partial or complete vertebral fractures.

★ A manifestation of COPD/Emphysema, but typically seen in the elderly.
Chest PA radiograph in a 75-year-old woman shows a nodular opacity in left paraspinal area (arrow), which is corresponding to bridging osteophytes on CT.
Changes in the Diaphragm

Diaphragmatic Bulging

- Diaphragmatic atrophy, weakness and dyskinesia
  → Elevation and bulging of the hemidiaphragm

Esophageal Hiatal Hernia

- *Increases with age, women > men*
- Enlargement of the anterior-posterior distance of the thorax → stretching of the diaphragm in the anterior direction → widen the esophageal hiatus → increased hiatal hernia.

<table>
<thead>
<tr>
<th>TABLE 1. Age-related and Sex-related Incidence of HH</th>
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<tbody>
<tr>
<td>Age Group</td>
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<tr>
<td>-------------</td>
</tr>
<tr>
<td>Group 1 (&lt;70)</td>
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<tr>
<td>Group 2 (≥70 to &lt;80)</td>
</tr>
<tr>
<td>Group 3 (≥80 to &lt;90)</td>
</tr>
<tr>
<td>Group 4 (≥90)</td>
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<tr>
<td>Total</td>
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</table>

Chest PA radiograph in an 80-year-old woman shows a large mass opacity with internal air density in left retrocardiac area (arrows). Chest CT confirms **esophageal hiatal hernia**. Increased anterior-posterior distance of the thorax causes stretching of the diaphragm, and results in widening of the esophageal hiatus.
<table>
<thead>
<tr>
<th><strong>AGING CHEST</strong></th>
<th><strong>Normal Structural Changes in Radiologic Images</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Lung</strong></td>
<td>Age-related alveolar hyperinflation&lt;br&gt;Ground-glass opacity, basal dependent&lt;br&gt;Mosaic attenuation pattern&lt;br&gt;Reticular densities, subpleural and basal&lt;br&gt;Incidental lung nodules&lt;br&gt;Air cysts</td>
</tr>
<tr>
<td><strong>Airway</strong></td>
<td>Cartilage calcifications&lt;br&gt;Increased AP diameter of trachea&lt;br&gt;Increased CT bronchoarterial ratio&lt;br&gt;Increased bronchial wall thickness</td>
</tr>
<tr>
<td><strong>Mediastinum</strong></td>
<td>Cardiac enlargement&lt;br&gt;Coronary and cardiac valve/annulus calcification&lt;br&gt;Vessel lengthening, dilation, and calcification&lt;br&gt;Excessive fat deposition</td>
</tr>
<tr>
<td><strong>Chest Wall</strong></td>
<td>Osteoporosis&lt;br&gt;Decreased muscle mass&lt;br&gt;Rib cartilage calcifications&lt;br&gt;Increased thoracic AP diameter</td>
</tr>
<tr>
<td><strong>Diaphragm</strong></td>
<td>Bulging contour&lt;br&gt;Hiatal hernia</td>
</tr>
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And Annual Delegate Meeting of
The Korean Society of Radiology

**2017.10.25 Wed – 2017.10.28 Sat**

Coex, Seoul, Korea

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<th>Event</th>
<th>Date</th>
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<tbody>
<tr>
<td>Deadline for Abstract Submission</td>
<td>May 31 (Wed)</td>
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<tr>
<td>Abstract Acceptance Notice</td>
<td>July 5 (Wed)</td>
</tr>
<tr>
<td>Deadline for Presenter Registration</td>
<td>July 31 (Mon)</td>
</tr>
<tr>
<td>Deadline for Early Registration</td>
<td>August 31 (Thu)</td>
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<tr>
<td>Deadline for Pre-registration</td>
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