Innovations in Chest Radiography

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Disclosures

- Consultant for Riverain Medical
- Minor stockholder in Hologic, Inc.
- License and royalty fees from University of Chicago (UCtech)

Advances in Detectors and Software

- CR versus DR
- Dual Energy Subtraction
- Bone Suppression Imaging
- Temporal Subtraction
- Tomosynthesis
- Dynamic Radiography
- Computer-aided Detection

Advances in Detector Technology

- CR (Computed Radiography): Powder phosphors
  Dual reading CR
  Needle phosphors
- DR (Direct Digital Radiography): CSI-photodiode/TFT detectors
  Amorphous selenium detectors

Schaefer-Prokop, C et al, European Radiology 2008 18:1818-1830

Advantages of Newer Detectors

CR Portable CXR
DR Portable CXR

Subtle Pneumothorax

CR Portable CXR
DR Portable CXR
Advantages of Newer Detectors

- Increased Dose Efficiency
- Improved Image Quality
- Improved Scatter Rejection

Advances in Detectors and Software

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Dual Energy CXR - Single Exposure Technique

- Copper filter
- 1st CR plate
- 2nd CR plate
- Single exposure ES uses two detectors separated by a filter

Dual Energy Chest Radiography
Dual Energy Chest Radiography

Sequential Exposure ES

Detector Plate

First exposure at 60 Kv for calcium detection

Second exposure at 120 Kv for standard image and soft tissue

Weighted subtraction gives soft tissue and bone images

Cardiac Motion Artifact with Two-Shot Dual Energy Technique

Soft Tissue Image

Bone Image

Respiratory Motion Artifact with Two-Shot Dual Energy Technique

Soft Tissue Image

Bone Image

Standard CXR

Standard CXR

Dual Energy CXR
Clinical Advantages of Dual Energy Radiography

- Improved detection of pulmonary nodules
- Improved rejection of false positives
- Improved detection/characterization of calcified pleural/cardiac lesions
- Improved detection of bone metastases

Enhancement and CADe for CXR

- Dual Energy Subtraction
- Bone Suppression Imaging
- Temporal Subtraction
- Tomosynthesis
- Dynamic Radiography
- Computer-aided Detection
Bone Suppression Imaging

- Provides many of the benefits of Dual Energy CXRs except calcium detection.
- Provides a software-only solution that can be applied to all digital CXRs, including bedside exams without specialized equipment.
Enhancement and CADe for CXR

- Dual Energy Subtraction
- Bone Suppression Imaging
- Temporal Subtraction
- Tomosynthesis
- Dynamic Radiography
- Computer-aided Detection
Temporal Subtraction

Benefits
- Improved detection for pulmonary, pleural, mediastinal disease

Limitations
- Misregistration artifacts can be confusing

Enhancement and CADe for CXR

- Dual Energy Subtraction
- Bone Suppression Imaging
- Temporal Subtraction
- Tomosynthesis
- Dynamic Radiography
- Computer-aided Detection

Bullous Emphysema

- Can detect abnormal regional ventilation
- Has potential to show abnormal regional perfusion
- Non-invasive and simple to perform

Dynamic Chest Radiography with a Flat-Panel Detector (FPD)

Rie Tanaka, PhD, S. Sanada, PhD, M. Fujimura, MD, N. Okazaki, MD, T. Kobayashi, MD, T. Matsui, O. Matsui, MD
Graduate School of Medicine, Kanazawa University, JAPAN

Dynamic Chest Radiography

- Evaluation of Regional Pulmonary Airflow with a Dynamic Flat-Panel Detector R. Tanaka et al. RSNA 2006
Enhancement and CADe for CXR

- Dual Energy Subtraction
- Bone Suppression Imaging
- Temporal Subtraction
- Tomosynthesis
- Dynamic Radiography
- Computer-aided Detection

Improvement in CAD Accuracy since 2006: Results with a 50-Case Database

<table>
<thead>
<tr>
<th>Year</th>
<th>CAD</th>
<th>Sensitivity</th>
<th>Average False Marks</th>
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<tbody>
<tr>
<td>2006</td>
<td>V 1.0</td>
<td>54%</td>
<td>5.6</td>
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<tr>
<td>2006</td>
<td>V 3.0</td>
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<td>V 5.0</td>
<td>67%</td>
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<td>2013</td>
<td>V 5.2</td>
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</tbody>
</table>

CADe Evaluations 2013

- Kligerman et al. (JIT 2013)
  - 81 cases of missed lung cancer
  - CAD marked 49%
  - Average False Positives: 1.8 per case
  - Observer accuracy improved significantly

- Li et al. RSNA 2013
  - 608 consecutive CXRs
  - Overall FP rate 1.3
  - FP rate for normal CXRs 0.7
  - FP rate for abnormal CXRs 1.5
Recent Improvements in CXR CAD

- Increased sensitivity
- Greatly reduced false positive rate

Conclusions

- Enhanced Radiography and CADe can improve diagnostic accuracy, even for experienced radiologists
- Because most CXRs are negative, these methods can also potentially increase productivity