Radiology Update 2017

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Disclosures

• Financial: None
• Non FDA approved uses of drugs: None anticipated
• Views expressed do not necessarily represent the views of VA or of the United States
1. The accelerating pace of change...

Agricultural Revolution  →  8,000 years → Industrial Revolution  →  120 years → Light-bulb  →  90 years → Moon landing

2. ... and exponential growth in computing power...

Computer technology, shown here climbing dramatically by powers of 10, is now progressing more each hour than it did in its entire first 90 years.

COMPUTER RANKINGS
By calculations per second per $1,000

Analytical engine
Never fully built, Charles Babbage's invention was designed to solve computational and logical problems.

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Colossus
The electronic computer, with 1,500 vacuum tubes, helped the British crack German codes during WW II.

UNIVAC I
The first commercially marketed computer, used to tabulate the U.S. Census, occupied 943 cu. ft.

3. ... will lead to the Singularity

Apple II
At a price of $1,298, the compact machine was one of the first massively popular personal computers.

Power Mac G4
The first personal computer to deliver more than 1 billion floating-point operations per second.

Source: Time Magazine
Elastography

• Virtual palpation of organs
• Mapping the stiffness of tissue with imaging technology
• Stiff tissue more likely diseased
• Sono-elastography
• MR elastography
Elasticity

Stress = \( \frac{F}{A} \)

Strain = \( \frac{\text{Change in } L}{L} \)

\( E = \frac{\text{Stress}}{\text{Strain}} \)

“Harder” tissues have a higher \( E \)

Elastography quantitates and maps \( E \)
Shear Waves
• Elasticity (E) and shear wave propagation speed (c) are linked through the formula:

\[ E = 3\rho c^2 \]

(\(\rho\) = density of tissue in kg/m\(^3\) \(\sim\) 1000 kg/m\(^3\))

• Hence, if the shear wave propagation velocity (c) can be measured, the elasticity of the tissue can be determined.
Fibroscan® device

- Electronic platform
  - Ultrasonic signals acquisition
  - Numerical signal processing
- Integrated computer
  - Stiffness measurement
  - Examinations database
- Dedicated probes with unique technology

Fibroscan® (Echosens, Paris, France)
Cylinder of 1 cm wide & 4 cm long
From 25 mm to 65 mm below skin surface
This volume is at least 100 times bigger than a biopsy sample
Progression of Liver Disease

- Normal
- Fibrosis: Reversible, Silent
- Cirrhosis: Irreversible, High mortality
- Hepatocellular Ca
### QA and Limitations

#### QA program for Fibroscan
- Keep probe calibrated
- Positioning of patient
- Probe position
- Probe pressure
- Check the shear wave maps
- Avoid ribs
- Take at least 10 readings

#### Limitations
- Obese patients
- Narrow intercostal spaces
- LSM uninterpretable 1/5
- Acute viral hepatitis
- Extrahepatic cholestasis
- Increased CVP
- Ascites
2D Shear Wave Elastography
Leydig cell in the testis is shown using shear-wave elastography. Image courtesy of Toshiba.
2D Sono-elastography

- Integrated into a conventional machine
- Can perform HCC screen at same setting
- Larger ROI
- Ascites and obesity less of an issue
- Less well evaluated than Fibroscan
2D Sono-elastography Uses

- Liver
- Brain
- Thyroid
- Breast
- Scrotum
- Prostate
- Musculoskeletal
- Lymph nodes
MR Elastography (MRE)
Normal Volunteer

Normal vs Early Fibrosis

Cirrhosis with Ascites

Progression of Fibrosis

Rev Gastroenterol Mex 2017;82:32-45
Fatty liver vs Steatohepatitis

Diagnostic Performance: Fibroscan & MRE


Area under ROC Curve

Technical Success

Fibrosis Stage

F \geq 1 \quad F \geq 2 \quad F \geq 3 \quad F \geq 4

94%
84%
MRE samples MORE TISSUE

- Liver Bx – 1/10,000
- US – 1/2,000
- MRE – up to 100%
Which of the following is true regarding MRI Elastography?

- A. It uses relatively high dose radiation
- B. Can sample more liver than ultrasound elastography
- C. Requires contrast to be accurate
- D. Is contraindicated in cirrhosis
- E. Requires a 3 Tesla machine
Dual Energy CT (DECT)

- Two tubes or one tube rapidly changing kVp energy
- Scans volume at two different energies
- Materials show different attenuation at each energy
Total X-ray Attenuation

- Bone
- Iodine
- Water

μ (cm²/g) vs. E (keV)

Large difference
Small difference

Insights into Imaging · April 2011
Which of the following is true regarding Dual Energy CT?

• A. It delivers twice the radiation
• B. It can separate uric acid from calcium stones
• C. It requires the use of two separate X-ray tubes
• D. Offers no clinical advantage
• E. Is not yet FDA approved
High Kev chest / Low Kev Chest
One-shot Dual-energy Subtraction Imaging\textsuperscript{1}
Dual Energy Subtraction
Improved Detection of Small Lung Cancers with Dual-Energy Subtraction Chest Radiography

Feng Li
Roger Engelmann
Kunio Doi
Heber MacMahon

OBJECTIVE. The objective of our study was to retrospectively evaluate whether the use of dual-energy subtraction chest radiographs can improve radiologists' performance for the detection of small previously missed lung cancers.

MATERIALS AND METHODS. Dual-energy subtraction chest radiographs of 19 patients with previously missed nodular cancers, in which the radiology report did not mention a nodule that was visible in retrospect, were selected. Dual-energy subtraction radiographs of 19 patients with cancer and 16 patients without cancer were used for an observer study. Six radiologists indicated their confidence level regarding the presence of a lung cancer and, if they thought a cancer was present, also marked the most likely position for each lung, first using standard posteroanterior and lateral chest radiographs and then using both soft-tissue and bone dual-energy subtraction images along with standard radiographs. Receiver operating characteristic (ROC) curves were used to evaluate the observers' performance. The indicated locations of cancers and false-positives were also analyzed.

RESULTS. The average area under the ROC curve ($A_x$) value for the six radiologists was improved from 0.718 to 0.816, a statistically significant amount ($p = 0.004$), and the average sensitivity (correct localizations) for 19 previously missed cancers was also significantly improved from 40% to 59% ($p = 0.008$) with the aid of dual-energy subtraction images. The average number of false-positive (incorrect) localizations on 70 lungs was 10 without and nine with dual-energy subtraction images ($p = 0.785$).

CONCLUSION. Dual-energy subtraction chest radiography has the potential to improve radiologists’ performance for the detection of small missed lung cancers.
Benefits of DES Chest X-ray

- Increase detection of early lung cancer
- Confirmation of calcium in a nodule
- Evaluation of bone lesions
- Better demonstration of mediastinal, hilar and pleural disease
Nephrogenic Systemic Fibrosis (NSF)

AKA

Gadolinium-Associated Nephrogenic Systemic Fibrosis (GASF)
NSF

• 1997: Described among dialysis patients
• 2003: Systemic manifestations identified (eye, heart, lung, muscle, testes)
• 2006: Connection to Gd administration
• 2007: FDA issues “black box warning”
• 2012: Nearly all new cases have disappeared
### EMA Final Opinion on GBCM

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<th>Product</th>
<th>Type (formulation)</th>
<th>Recommendation</th>
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<tr>
<td>Artirem / Dotarem</td>
<td>macrocyclic (i.v.)</td>
<td>maintain</td>
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<tr>
<td>(gadoteric acid)</td>
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<td>Artirem / Dotarem</td>
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<td>Gadovist (gadobutrol)</td>
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<td>Magnevist (gadopentetic acid)</td>
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<tr>
<td>Multihance (gadobenic acid)</td>
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<td>restrict use to liver scans</td>
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MRI contrast agents are thought to cause what disease?

• A. Acute kidney injury
• B. Nephrogenic Diabetes Insipidus
• C. Nephrogenic Systemic Fibrosis
• D. Nephrogenic Pulmonary Edema
• E. Systemic Lupus Erythematosus
Best test to localize GI bleeding?
Localizing Acute Lower Gastrointestinal Hemorrhage: CT Angiography Versus Tagged RBC Scintigraphy

**Objective.** Lower gastrointestinal hemorrhage is a common cause of hospitalization and has substantial associated morbidity and financial cost. CT angiography (CTA) is emerging as an alternative to $^{99m}$Tc-labeled RBC scintigraphy (RBC scintigraphy) for the localization of acute lower gastrointestinal bleeding (LGIB); however, data on comparative efficacy are scant. The aim of this study was to assess the utility of CTA compared with RBC scintigraphy in the overall evaluation and management of acute LGIB.

**Materials and Methods.** We retrospectively reviewed images from all CTA examinations performed for suspected acute LGIB at our tertiary care hospital from January 2010 through November 2011. The comparison group was determined by retrospective review of twice the number of RBC scintigraphic scans consecutively obtained from June 2008 to November 2011 for the same indication. All CTA and RBC scintigraphic scans were reviewed for accurate localization of the site and source of suspected active LGIB.

**Results.** In total, 45 CTA and 90 RBC scintigraphic examinations were performed during the study period. Seventeen (38%) CTA scans showed active gastrointestinal bleeding compared with 34 (38%) RBC scintigraphic scans ($p = 1.000$). However, the site of bleeding was accurately localized on 24 (53%) CTA scans. This proportion was significantly greater than the proportion localized on RBC scintigraphic scans (27 [30%]) ($p = 0.008$). There were no significant differences between the two groups in average hospital length of stay, blood transfusion requirement, incidence of acute kidney injury, or in-hospital mortality.

**Conclusion.** Both CTA and RBC scintigraphy can be used to identify active bleeding in 38% of cases. However, the site of bleeding is localized with CTA in a significantly higher proportion of studies.