Adding Dual Energy CT to Routine Emergency Department Workflow: Friend or Foe?

The Dual Energy Duel

Andrew D. Hardie, M.D.
Mark D. Kovacs, M.D.
Disclosures

• Both authors have nothing to disclose
Why bother doing DECT?

• Traditional CT is really just a map of pixel densities
  – Inherent tissue density
    • attenuation of x-ray beam by the tissue
  – Density of iodine
    • administered contrast agents
Traditional CT

- Use of pre and post contrast imaging
  - Contribution of iodine can be better determined
    - Still some limitations but overall useful
  - Still not much information about tissue other than density
    - Things that are the same density cannot be delineated
Problems with traditional CT

• Most CT has transitioned to single phase post-contrast imaging
  – faster, cheaper, less radiation
    • But, iodine and inherent tissue density cannot be readily differentiated

• Clinicians are used to the powerful capabilities of MRI and other advanced techniques and expect more of CT
  – Improved differentiation can reduce need to order additional studies
How can Dual Energy CT help?

• Different materials may have similar density on traditional CT (at a single energy), but have different density at low and high energy.

• Further, how much a material changes between low and high energy beams is specific to each material.
Assessment of the slope of density change at low (80) and high (140) energy (kV)
How to scan with 2 different energy levels?

• Requires hardware that is part of the CT scanner
  – can’t be done on regular CT scanners

• Each manufacturer has different techniques (different scanner designs) to achieve this
  – Some differences need to be understood
DECT - 5 Different Approaches

- Single-Source Rapid Switching DECT (GE)
- Dual-Source DECT (Siemens)
- Dual Layer Detector DECT (Philips)
- Single Source Twin Beam (Siemens)
- Single-Source Sequential DECT (Toshiba)

Siegel MJ et al., JCAT 2017
Friend vs. Foe

- Audience?
- Who uses it?
- What are perceived advantages and disadvantages?
FRIEND

• **Materials** (instead of density) can be ascertained
  – Iodine (contrast) vs. blood

• Attain Virtual **Non-contrast** data
  – Rarely scan w/ and w/o in ED (time and radiation)

• Improve **visualization** thru post-processing
  – “Rescue” a poor IV contrast bolus
  – Metal artifact reduction
Dual Source DECT – Post Processing

Sn 150 kVp

90 kVp

Mixed 120 kVp
60% of 90kVp
40% of 150kVp

Virtual Unenhanced

Iodine Map

Virtual Monoenergetic
FOE

- Increased **quantity** of information
  - Easy to be overwhelmed (initially)
  - Can take more time (initially)

- Increased **expertise** in interpreting
  - Could lead to mistakes

- More difficult to **acquire**
  - Depends on the system used
Case # 1

- 62 year old Female
- Low H/H, r/o bleed
See it doesn’t contain IODINE!
Virtual Noncontrast (VNC)

- Intrinsically dense
- Suggests not contrast / active bleeding
Iodine Density = 0.2 mg/mL

- Iodine Density
  
  $< 0.3 \text{ mg/mL} \rightarrow$ very unlikely to contain iodine
  
  $> 1.0 \text{ mg/mL} \rightarrow$ likely contains iodine

- Diagnosis:
  - Ingested material

- Followup
  - No evidence of bowel bleeding
    - No BRBPR
    - No Melena
    - H/H low but stable
Case # 2

- 66 yo M
- 3 days BRBPR
- OSH EGD negative
- Transferred to MUSC
• Assume no oral contrast given
• Looks like active bleed, right?
• How can DECT help?
• Number of ways
• At MUSC
• Can view low and high energy images
• Separately
Assuming this is active bleed, which energy SHOULD attenuate more?
Assuming this is active bleed, which energy SHOULD attenuate more?

ANSWER: 100 kV attenuates more = appears brighter
B/C closer to K edge of IODINE
Iodine Map

Iodine density = 12.5 mg/mL

[1] CT
App: VNC/ CM/ Mixed 0.8
Mean: 23.0/ 278.9/ 305.9 HU
Stddev: 12.8/ 76.8/ 80.8 HU
Area: 0.4 cm²
Iodine Density: 12.5 mg/mL / 70.9 %
Conventional angiogram performed
Coiled
Case # 3

- 66 yo F
- Scan done for abdominal pain
- Incidental adrenal nodule
• Single phase scan
• HU > 10 on PV
• Can DECT help?
• Single phase scan
• HU > 10 on PV
• Can DECT help?
  – VNC
  – HU = 7
• Diagnosis: Adenoma
Case # 4

• 28 yo M -- ATV Trauma
• Ran into chain along midabdomen
• Initial CT showed mesenteric injury
• 52 cm small bowel resected
• Post-surg, progressive severe pain over days
• Decreased iodine uptake
• In distal ileum
• Diagnosis: Bowel Ischemia
Case # 5

- 72 yo M – MVC Trauma
• Fat stranding anterior abdomen
• Linear high density (arrow)
• Is this active bleeding?
• Fat stranding anterior abdomen
• Linear high density (arrow)
• Is this active bleeding?
  • YES!
• Diagnosis:
  • Falciform Ligament Avulsion
  • With Active Bleeding
Case # 6

- 66 yo F, “fell”, trauma CT
• Incidental renal lesion

• Prelim resident impression:
  – “solid renal mass”
Diagnosis: Hemorrhagic cyst
Corollary (Case #7)

- 68 yo F, abdominal pain, suspected SBO
• SBO present
• But also...
Diagnosis: bilateral renal neoplasms
DECT for Pulmonary Emboli

• PE in Abdomen CT Lung Bases?
• Can DECT help?
Normal DECT Lung Perfusion
Case #9 (Subtler)

• 80 yo F, Hx bladder cancer
• Presents acutely with shortness of breath
See a PE??
See how perfusion helps
See how perfusion helps
Case #10

- 51 yo M
- Stabbed in the back
Iodine density = 3.4 mg/mL
Diagnosis = Active hemorrhage!
Case #11

• 73 yo F
• Restrained driver in high-speed rollover MVC
Iodine Density > 15 mg/mL
Diagnosis = AML with active bleeding
Case #12

• 82 yo M
• Abdominal pain
- CBD dilated
- Hyperdensity in distal duct / ampulla (arrow)
- Mass? Stone?
- Can DECT help?
- CBD dilated
- Hyperdensity in distal duct / ampulla (arrow)
- Mass? Stone?
- Can DECT help?

Diagnosis: CBD stone (removed via ERCP)
Case #13

- 60 yo M Hx HCC s/p transplant
- p/w Abdominal Pain
- CT performed (1st scan post transplant)
No Iodine present on Iodine Map
Diagnosis = Adrenal hematoma
Thanks for your attention!

Andrew D. Hardie, M.D.  hardie@musc.edu  
Mark D. Kovacs, M.D.  kovacsm@musc.edu