MUSC
MEDICAL UNIVERSITY of SOUTH CAROLINA

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

The Dual Energy Duel

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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

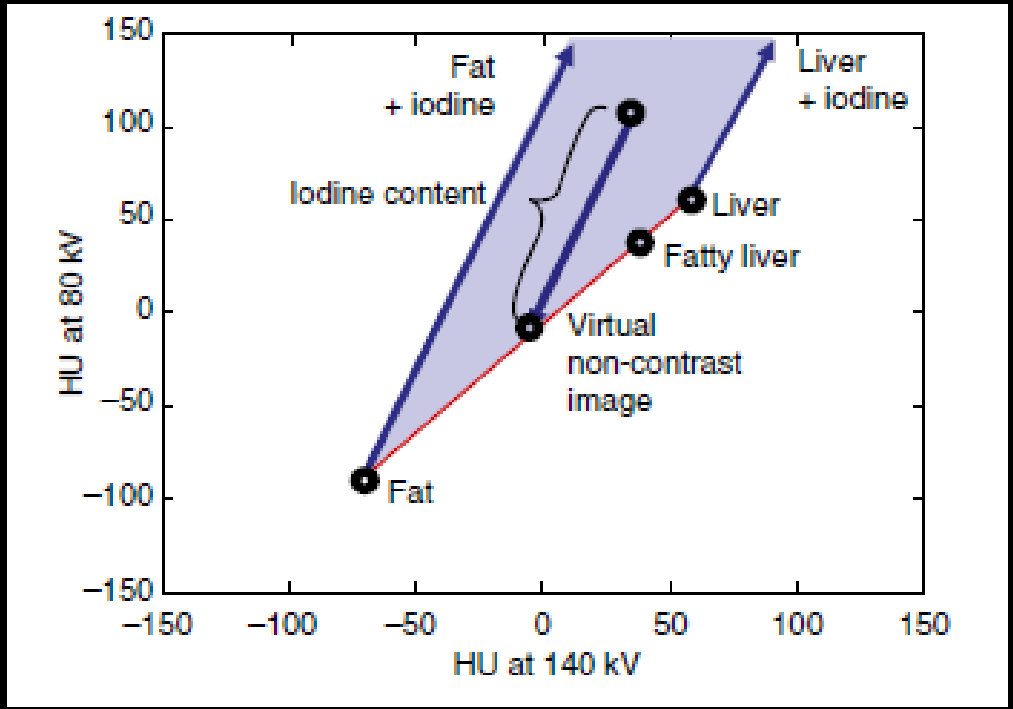
Problems with traditional CT

- 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)

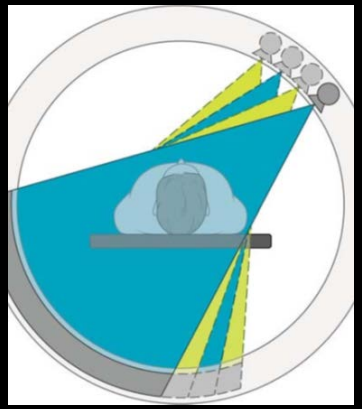


How to scan with 2 different energy levels?

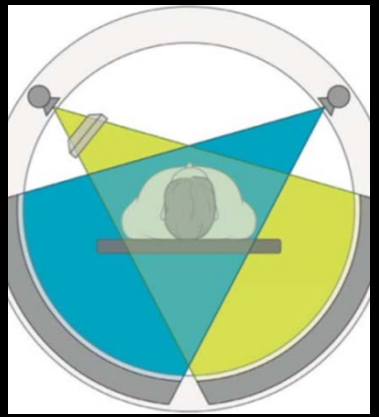
- Requires hardware that is part of the CT scanner
  - can’t be done on regular CT scanners
- Each manufacturer has different techniques (different scanner designs) to achieve this
  - Some differences need to be understood

DECT- 5 Different Approaches

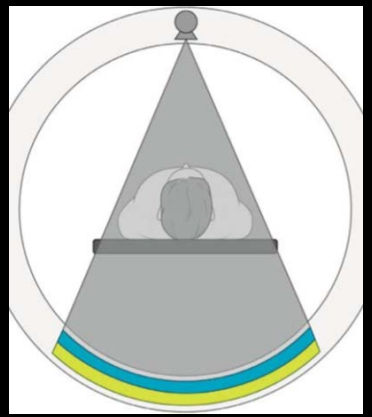
Single-Source Rapid Switching DECT (GE)



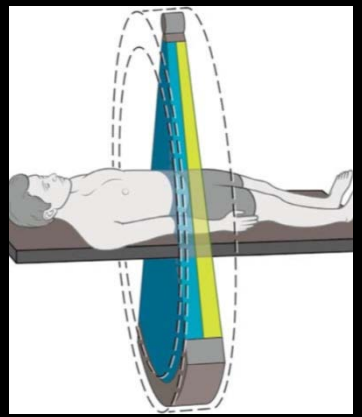
Dual-Source DECT (Siemens)



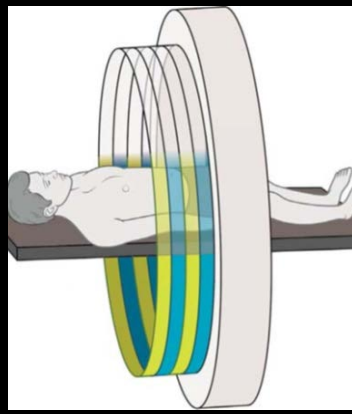
Dual Layer Detector DECT (Philips)



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

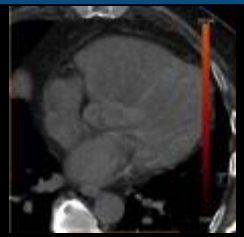
Sn 150 kVp

90 kVp

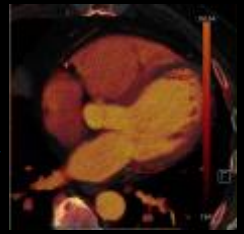
Mixed 120 kVp

60% of 90kVp

40% of 150kVp



Virtual Unenhanced



Iodine Map

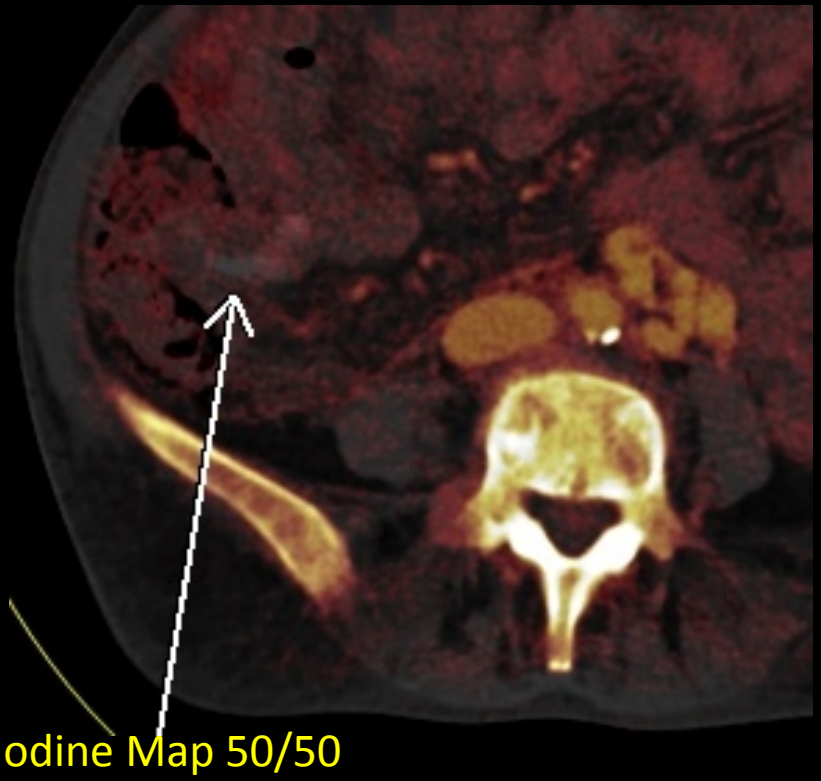
Virtual Monoenergetic

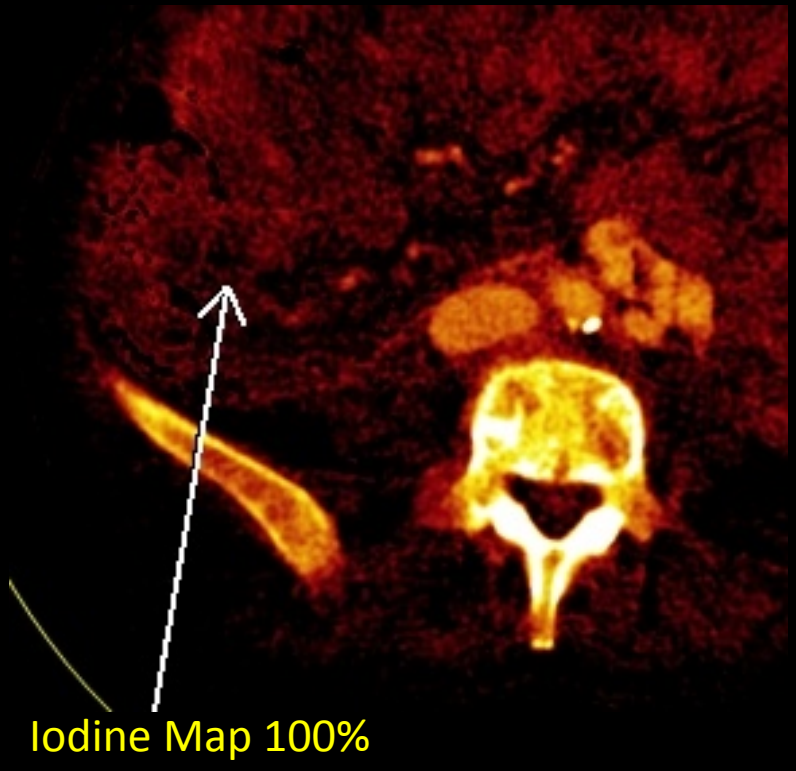
FOE

- 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

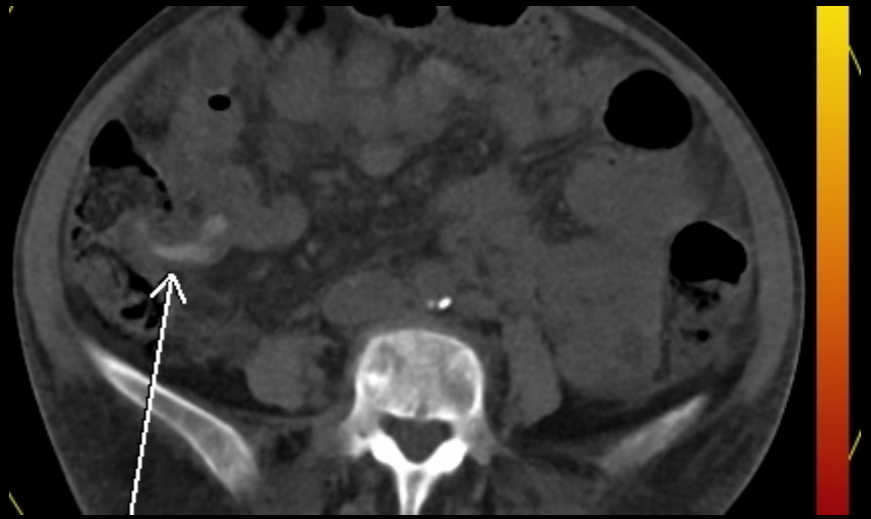
Case # 1

- 62 year old Female
- Low H/H, r/o bleed



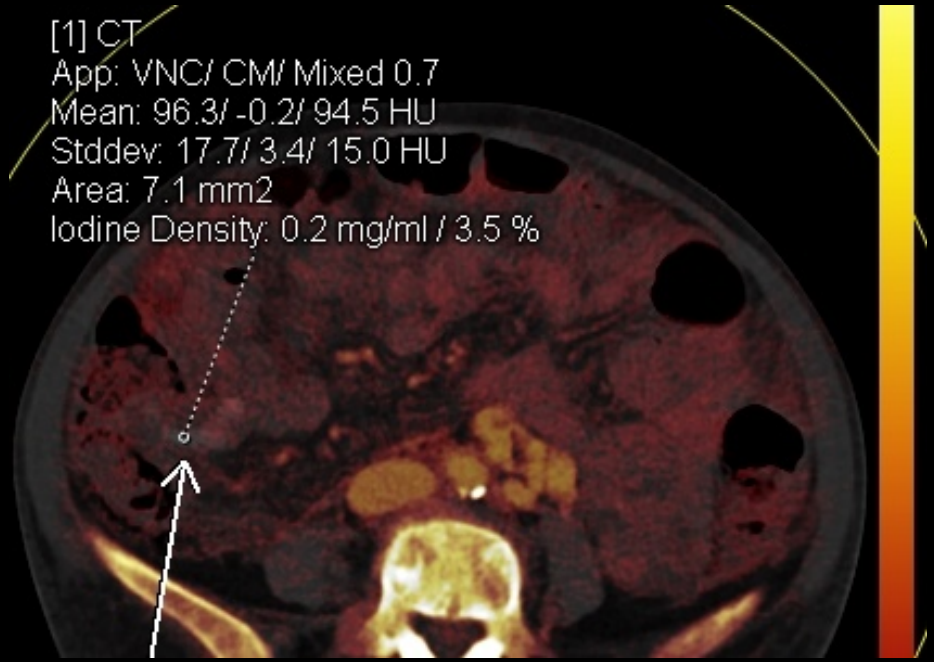


See it doesn’t contain IODINE!



Virtual noncontrast (VNC)

- Virtual Noncontrast (VNC)
  - Intrinsically dense
  - Suggests not contrast / active bleeding



Iodine Density = 0.2 mg/mL

- Iodine Density
  - < 0.3 mg/mL → very unlikely to contain iodine
  - > 1.0 mg/mL → likely contains iodine
- Diagnosis:
  - Ingested material
- Followup
  - No evidence of bowel bleeding
    - No BRBPR
    - No Melena
    - H/H low but stable

Case # 2

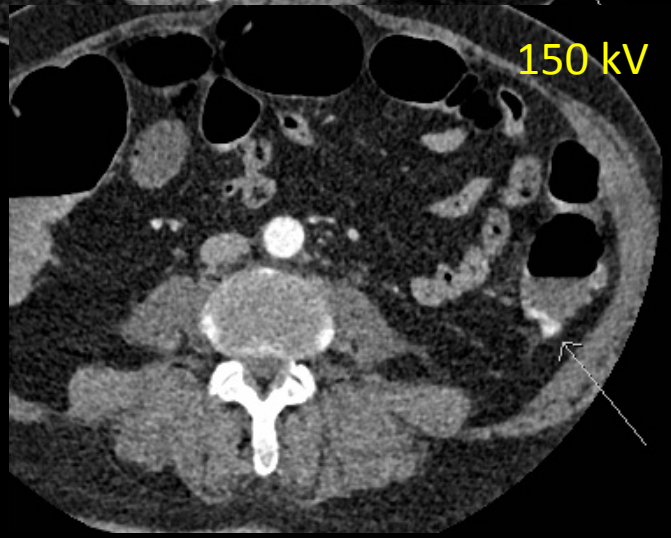
- 66 yo M
- 3 days BRBPR
- OSH EGD negative
- Transferred to MUSC

- 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

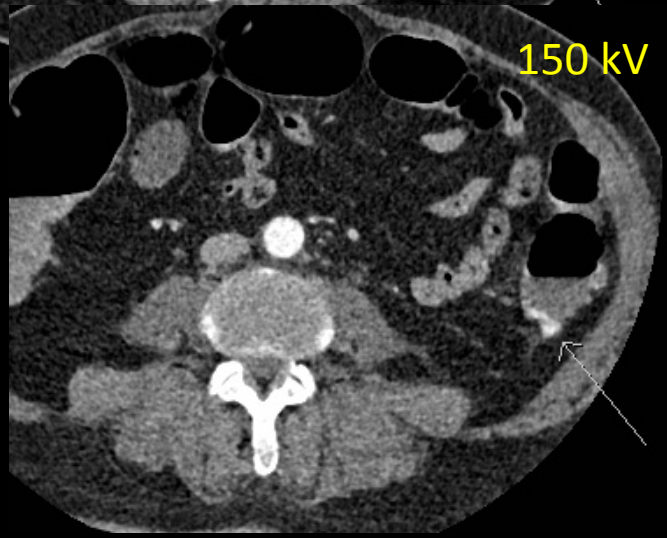
Original (0.7 blended)

100 kV



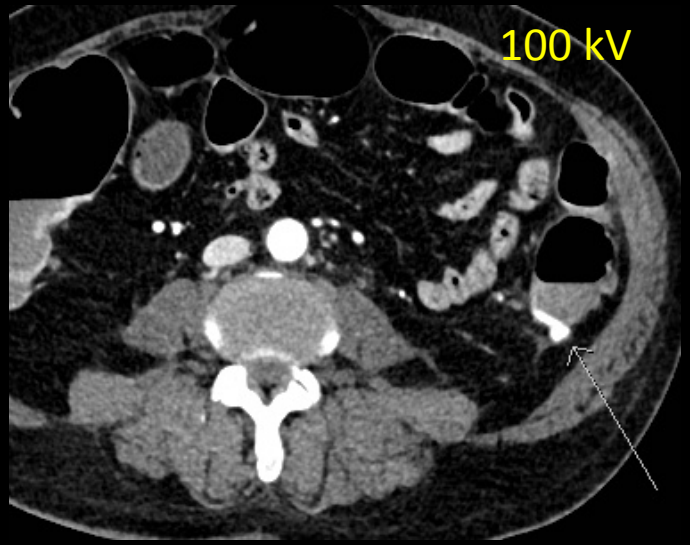
150 kV

Original (0.7 blended)



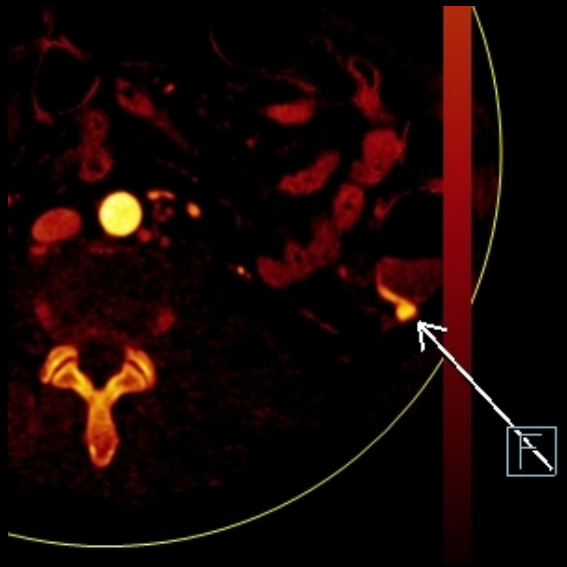
Assuming this is active bleed, which energy SHOULD attenuate more?

Original (0.7 blended)

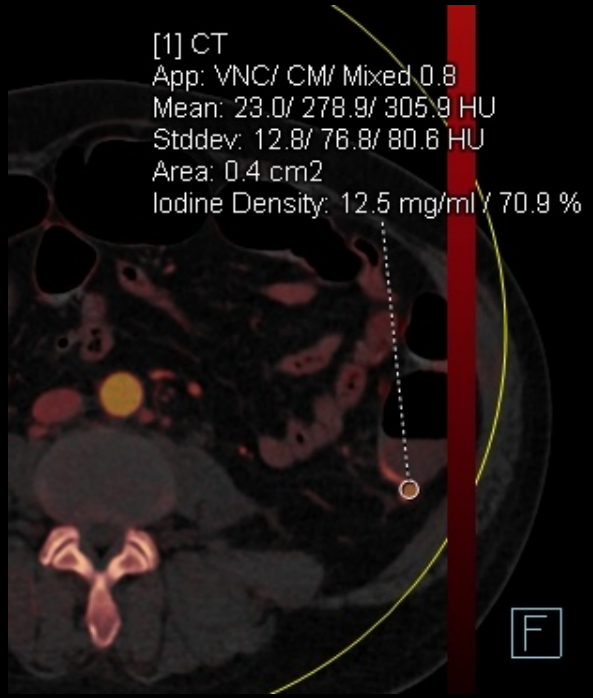


Assuming this is active bleed, which energy SHOULD attenuate more?

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



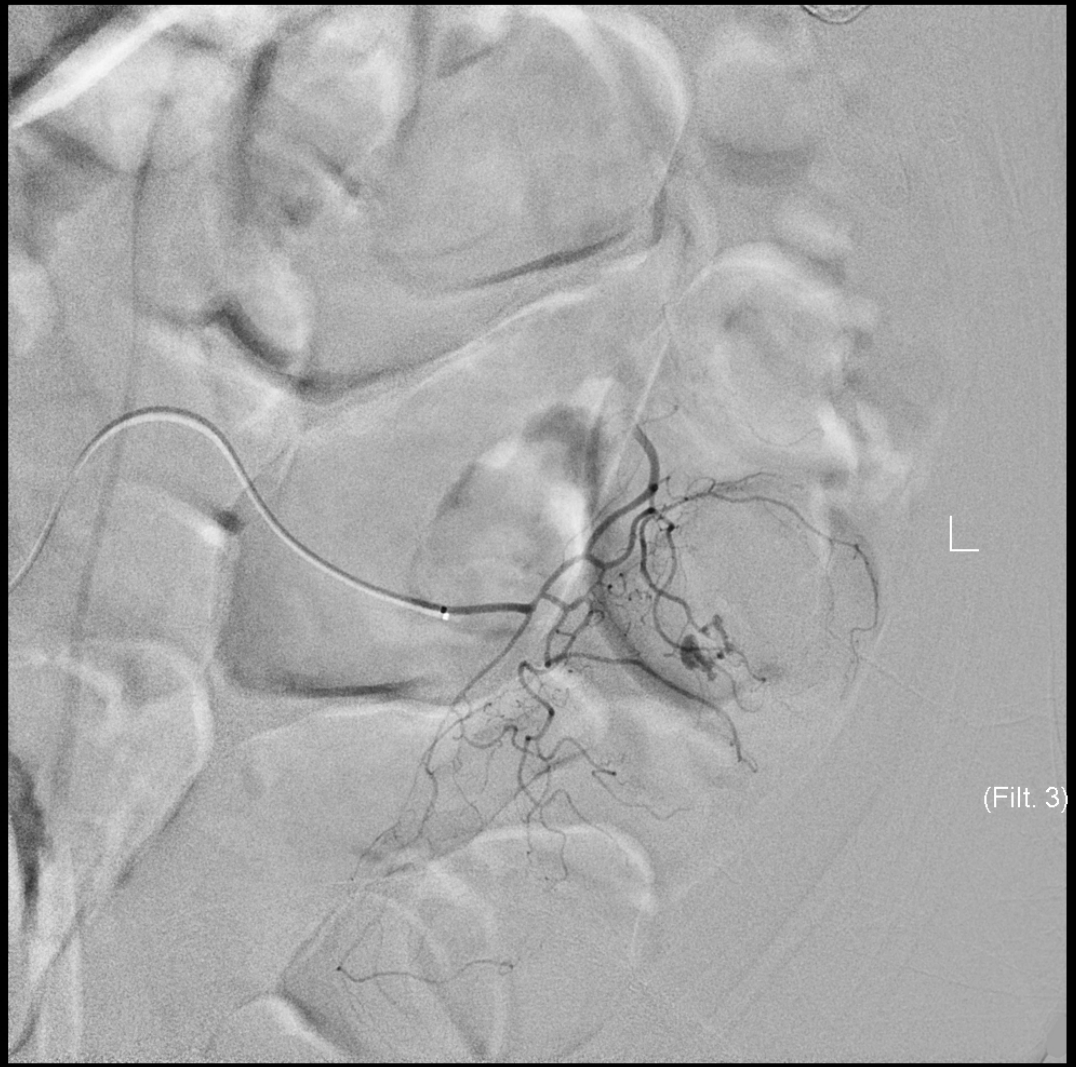
Iodine Map



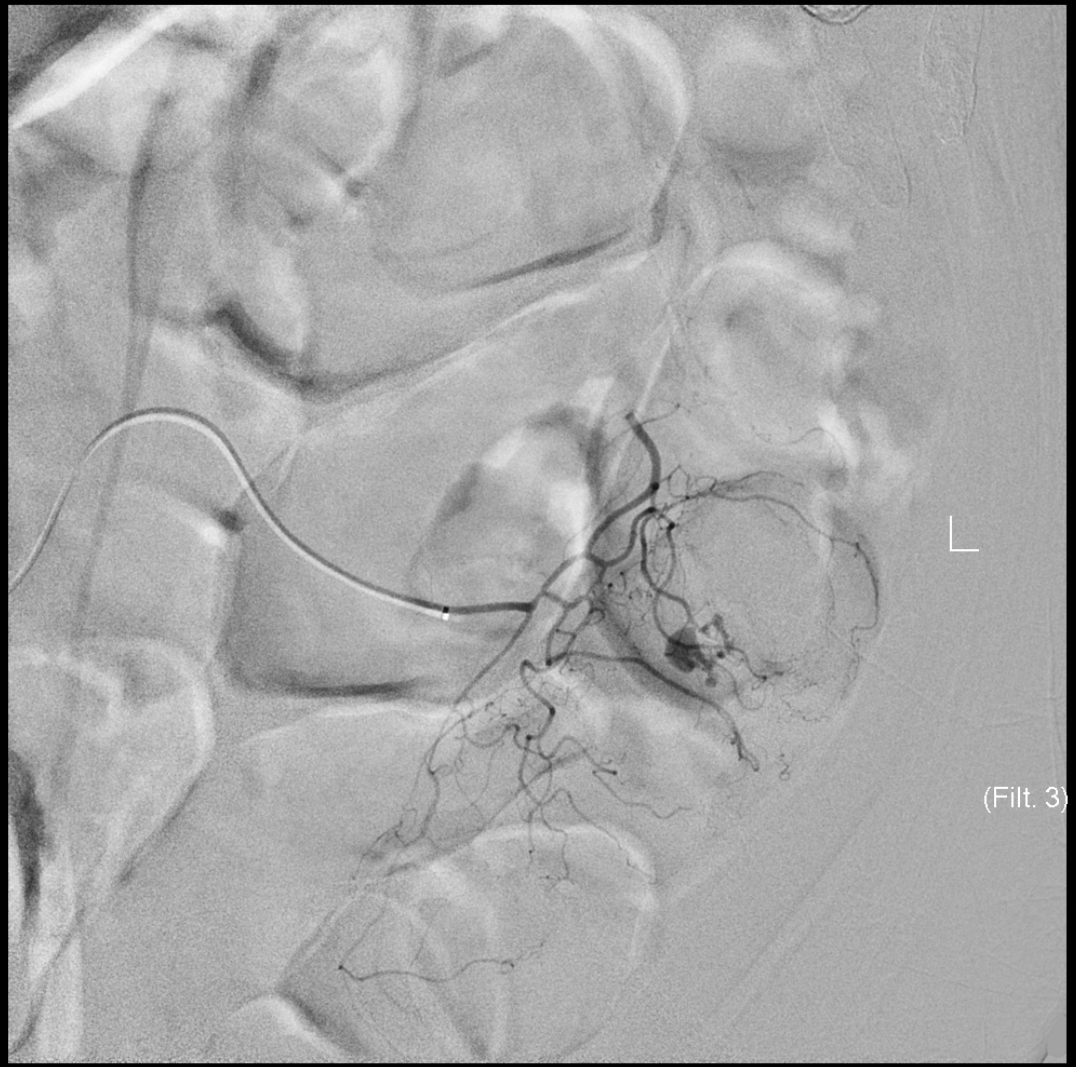
Iodine density = 12.5 mg/mL

VNC

Conventional angiogram performed


(Filt. 3)


L
(Filt. 3)


L
(Filt. 3)


L
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L
(Filt. 3)


L
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L
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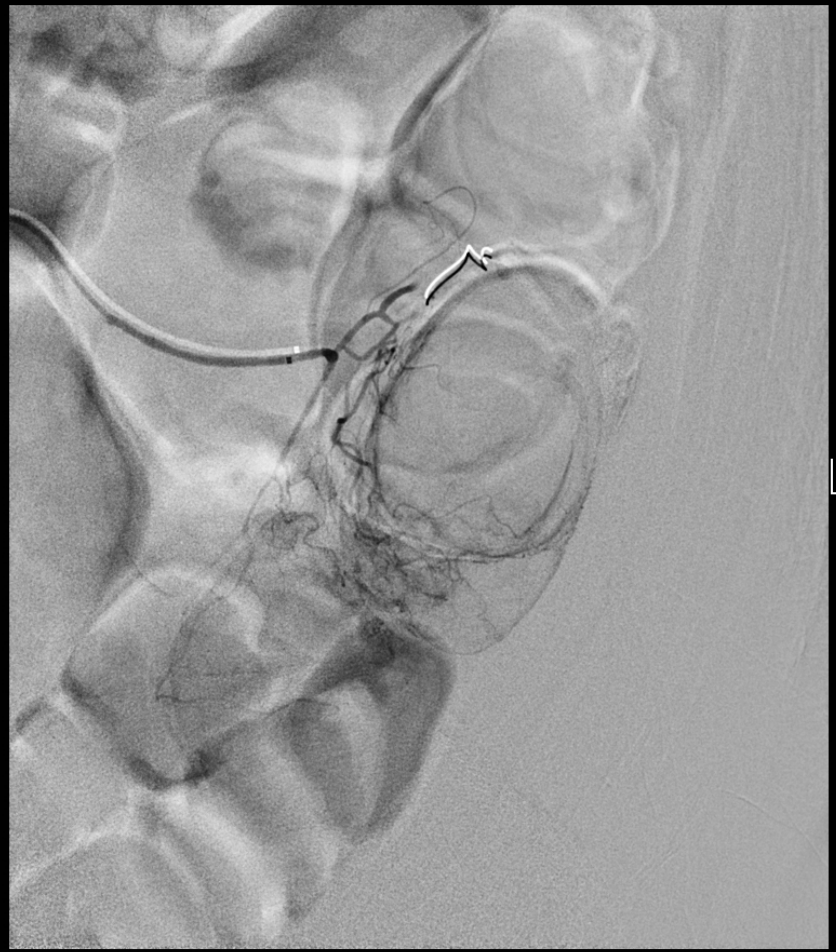
L
(Filt. 3)

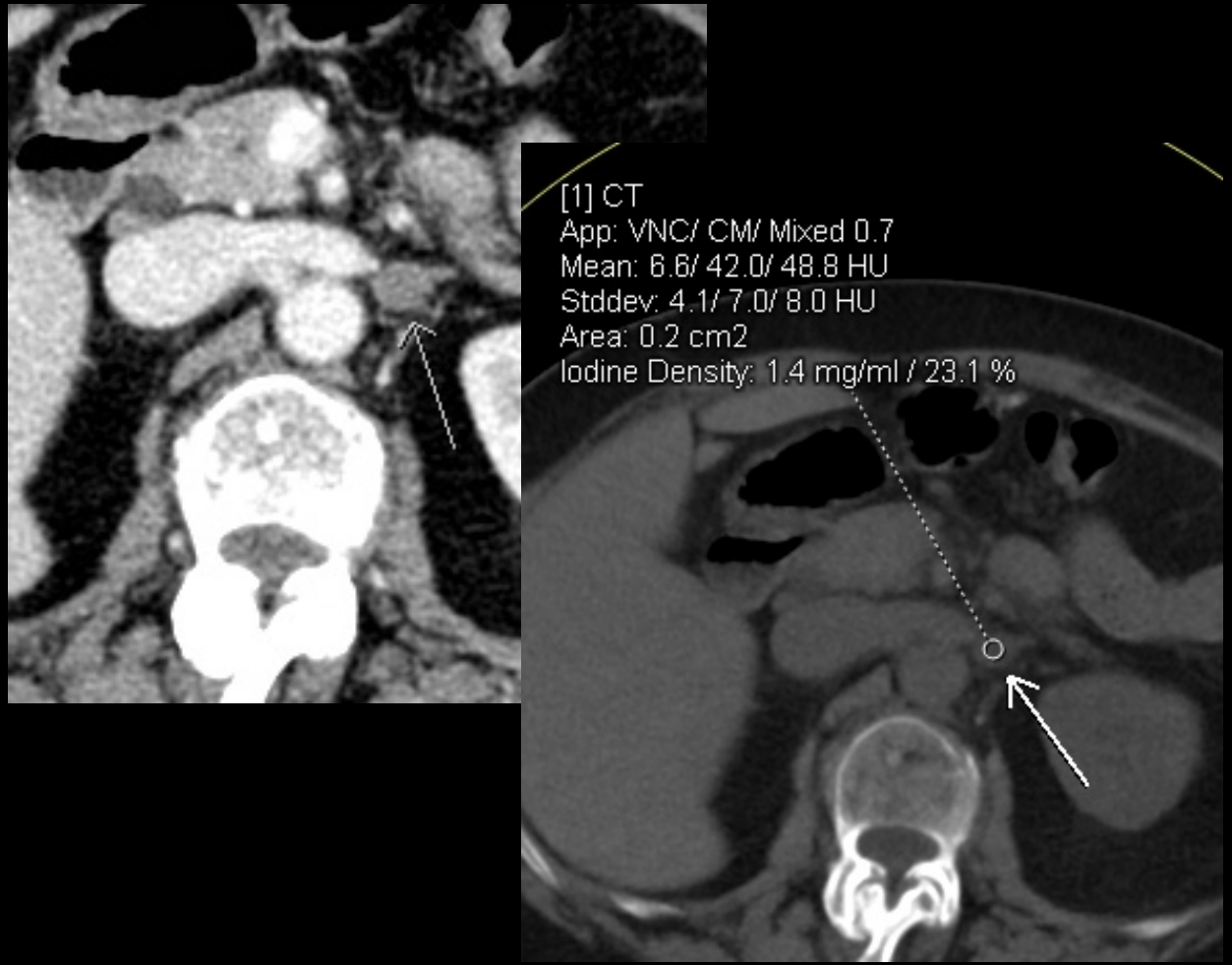
Coiled


L
(Filt. 3)

Case # 3

- 66 yo F
- Scan done for abdominal pain
- Incidental adrenal nodule

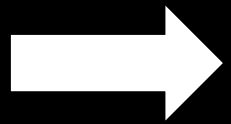
- Single phase scan
- HU > 10 on PV
- Can DECT help?

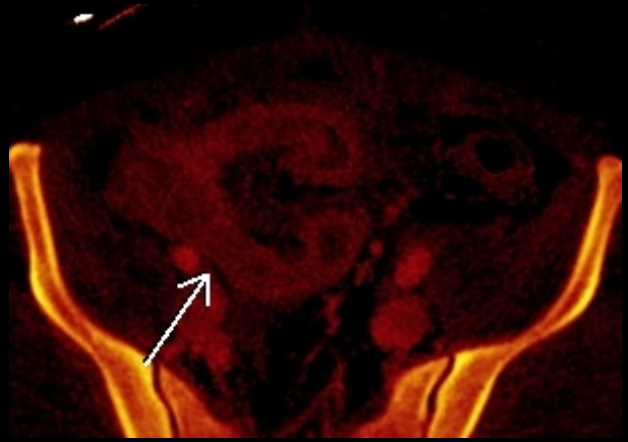


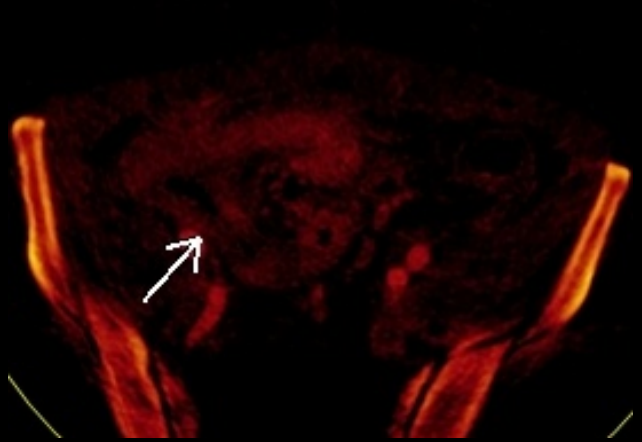
- Single phase scan
- HU > 10 on PV
- Can DECT help?
  - VNC
  - HU = 7
- Diagnosis: Adenoma

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

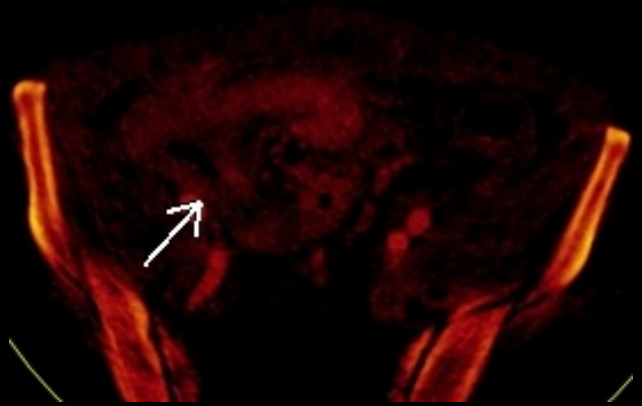






1 week post-surgery

1 week + 4 days

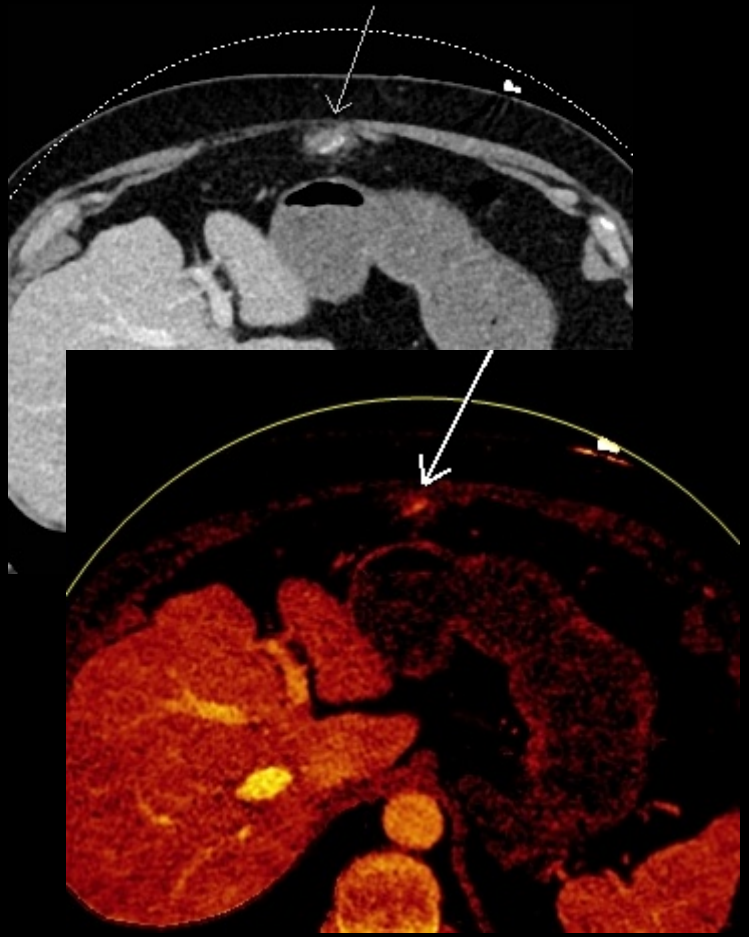


- Decreased iodine uptake
- In distal ileum
- Diagnosis: Bowel Ischemia

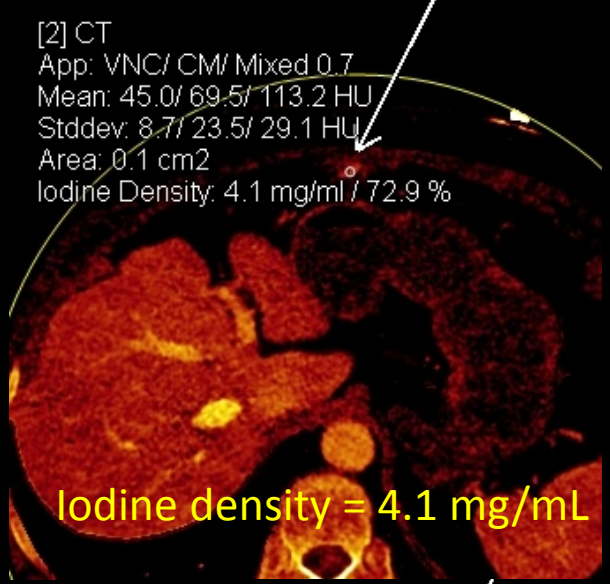
Case # 5

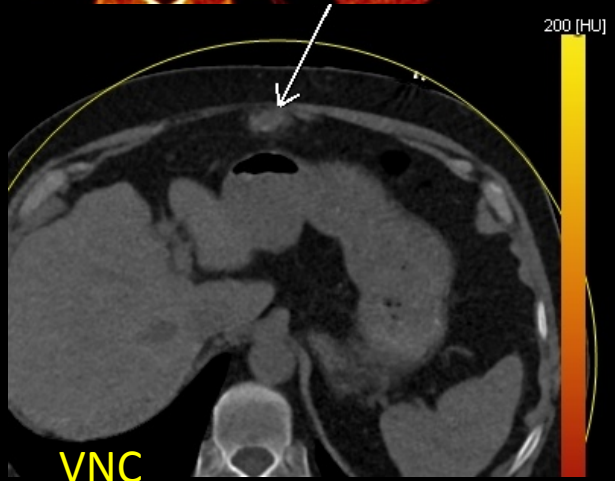
- 72 yo M – MVC Trauma

- 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!





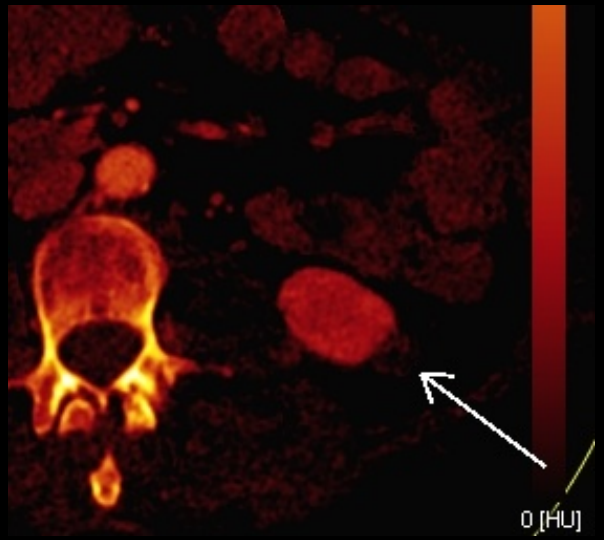
- Diagnosis:
  - Falciform Ligament Avulsion
  - With Active Bleeding

Case # 6

- 66 yo F, “fell”, trauma CT

- Incidental renal lesion
- Prelim resident impression:
  - “solid renal mass”

Original (0.7 blended)

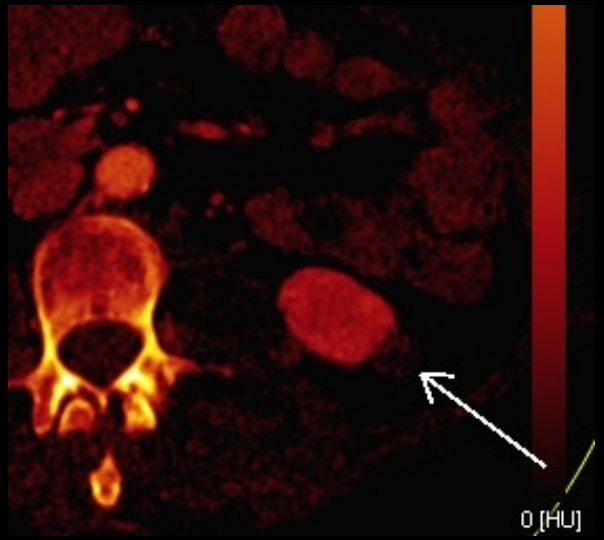


Iodine map

VNC

Diagnosis: Hemorrhagic cyst

Original (0.7 blended)

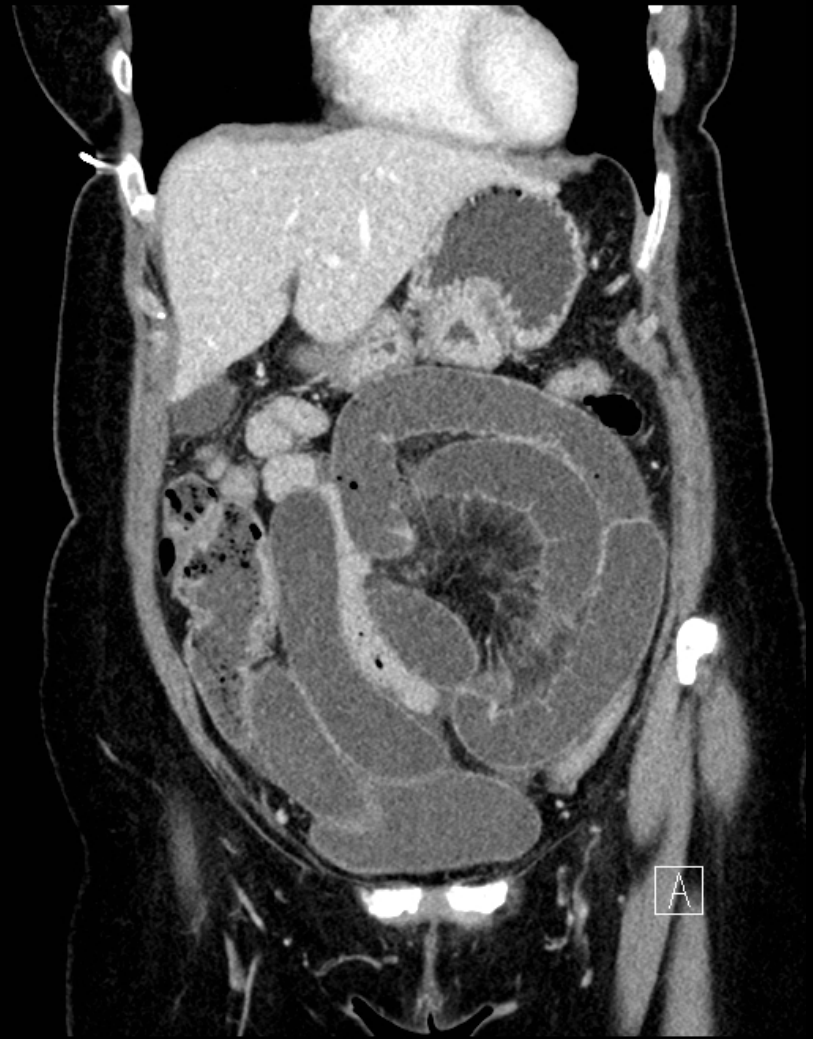


Iodine map

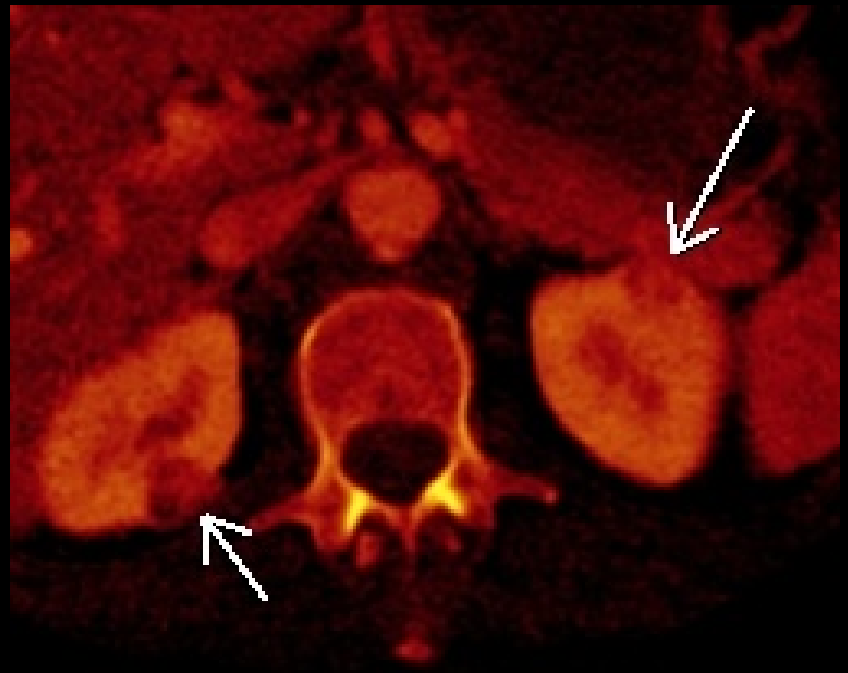
VNC

Corollary (Case #7)

- 68 yo F, abdominal pain, suspected SBO

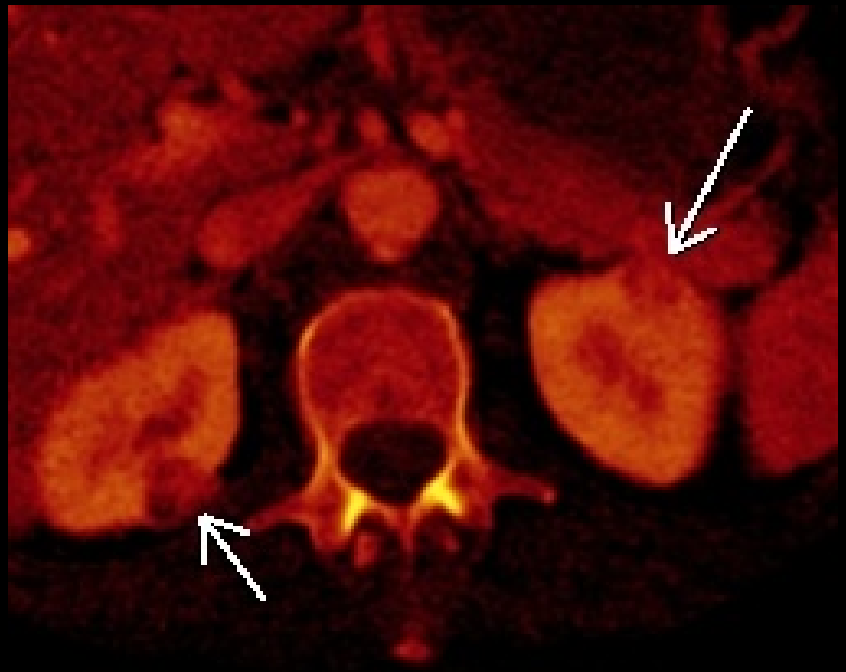


- SBO present
- But also…



Iodine map

Diagnosis: bilateral renal neoplasms

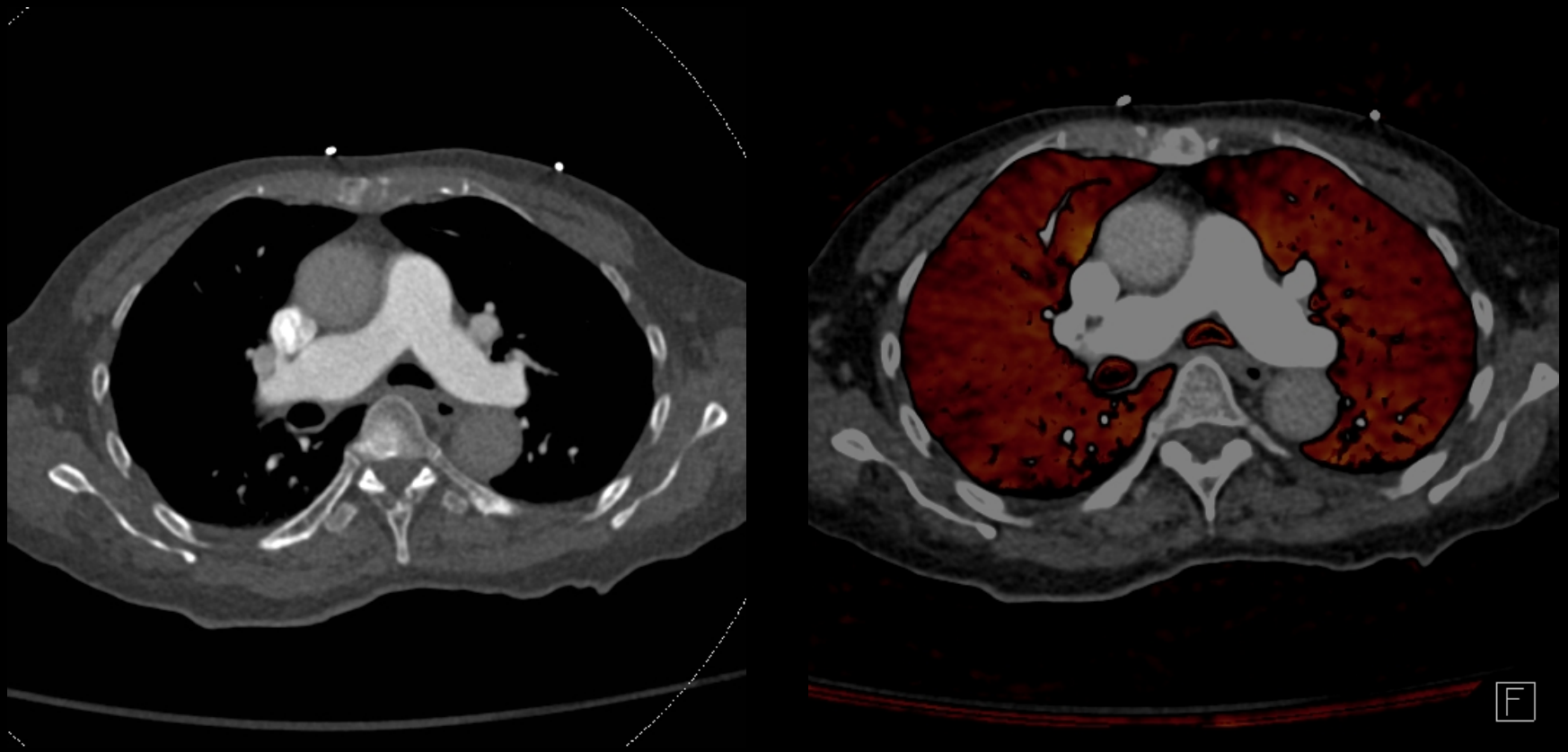


Iodine map

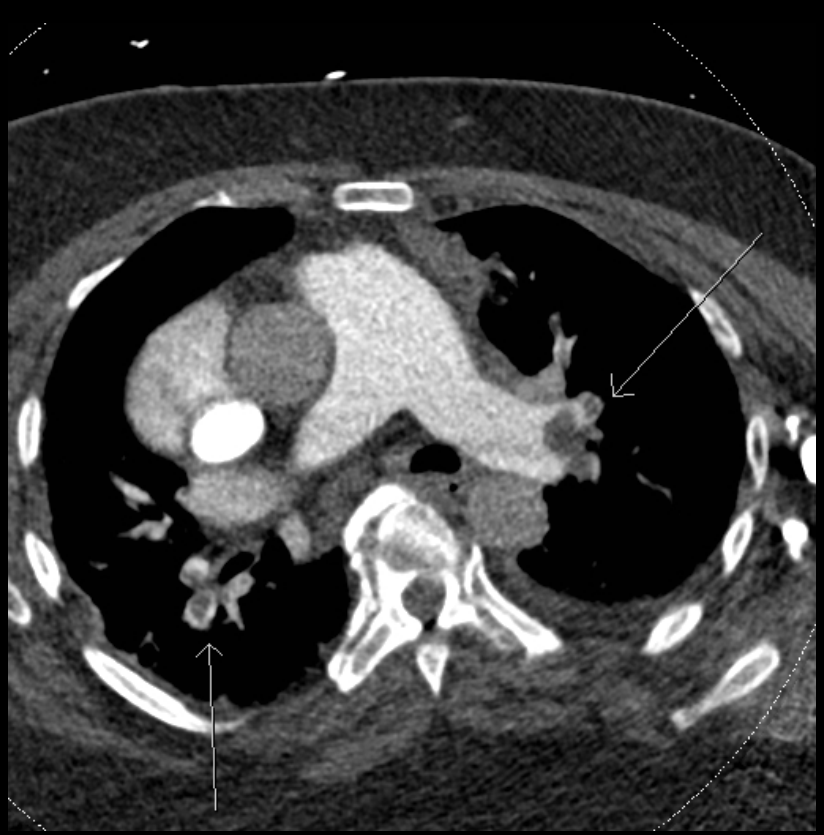
DECT for Pulmonary Emboli

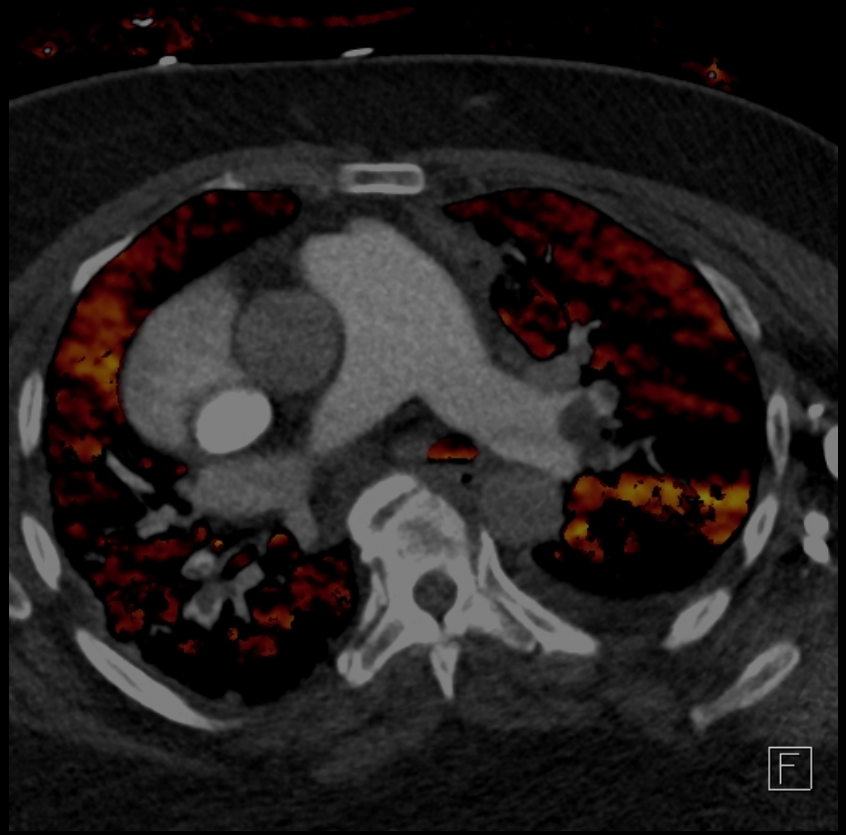
- PE in Abdomen CT Lung Bases?
- Can DECT help?

Normal DECT Lung Perfusion



Case #8

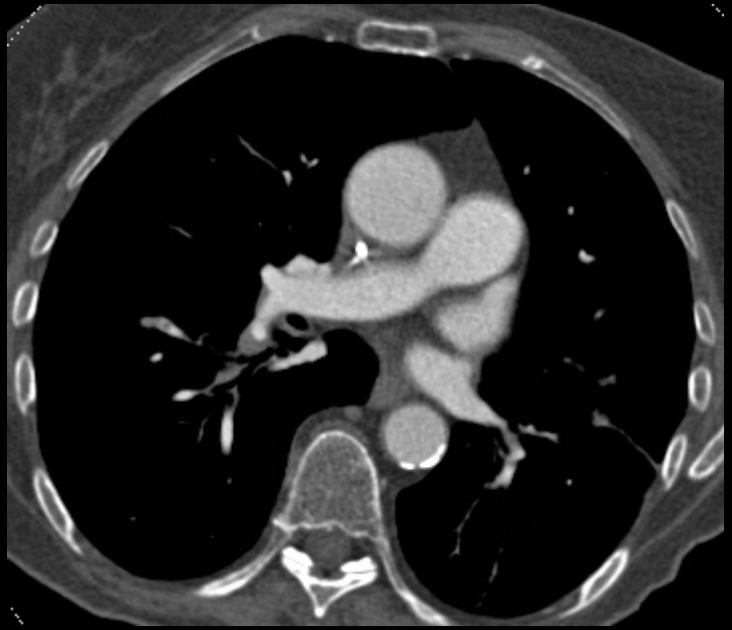




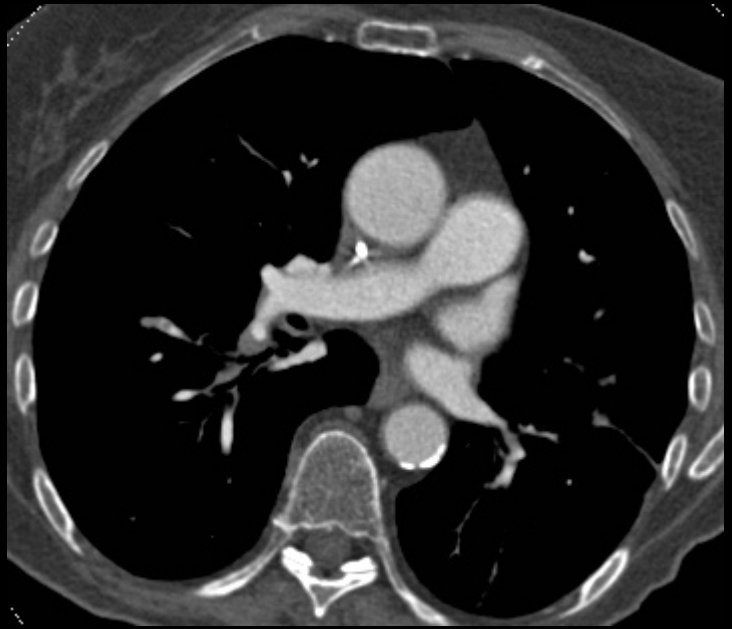
Case #9 (Subtler)

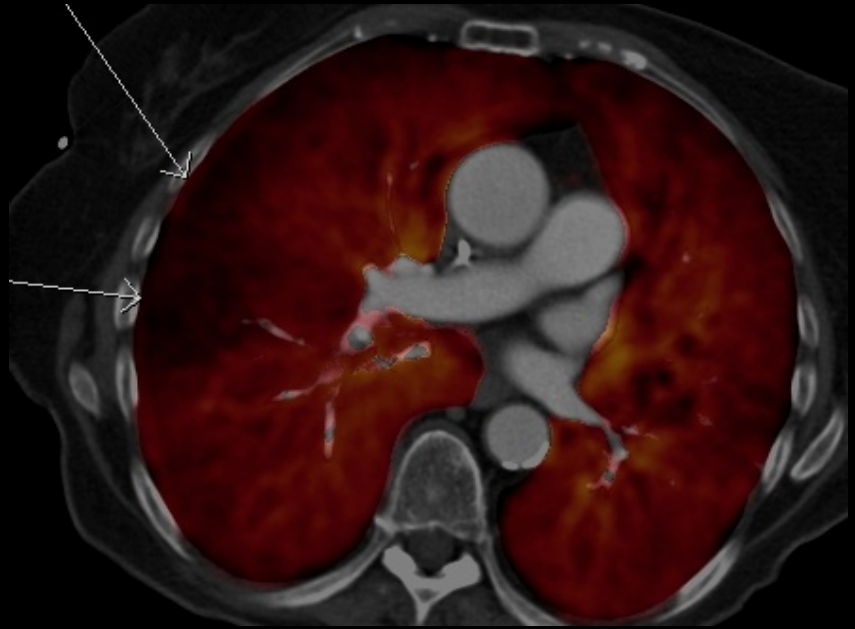
- 80 yo F, Hx bladder cancer
- Presents acutely with shortness of breath

See a PE??

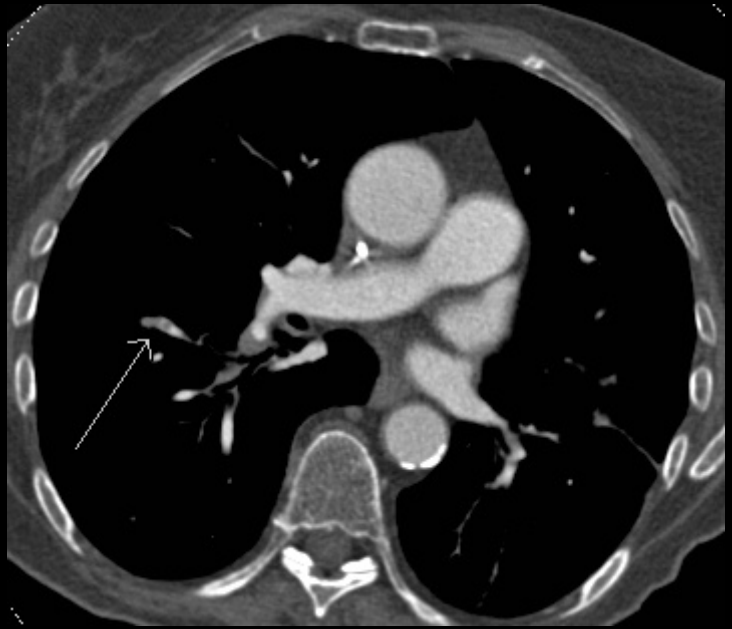


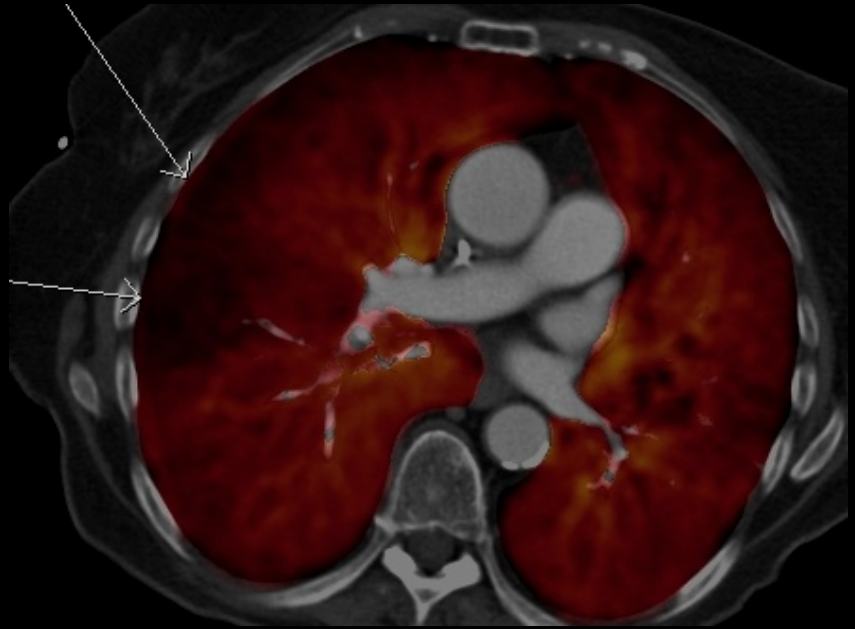
See how perfusion helps





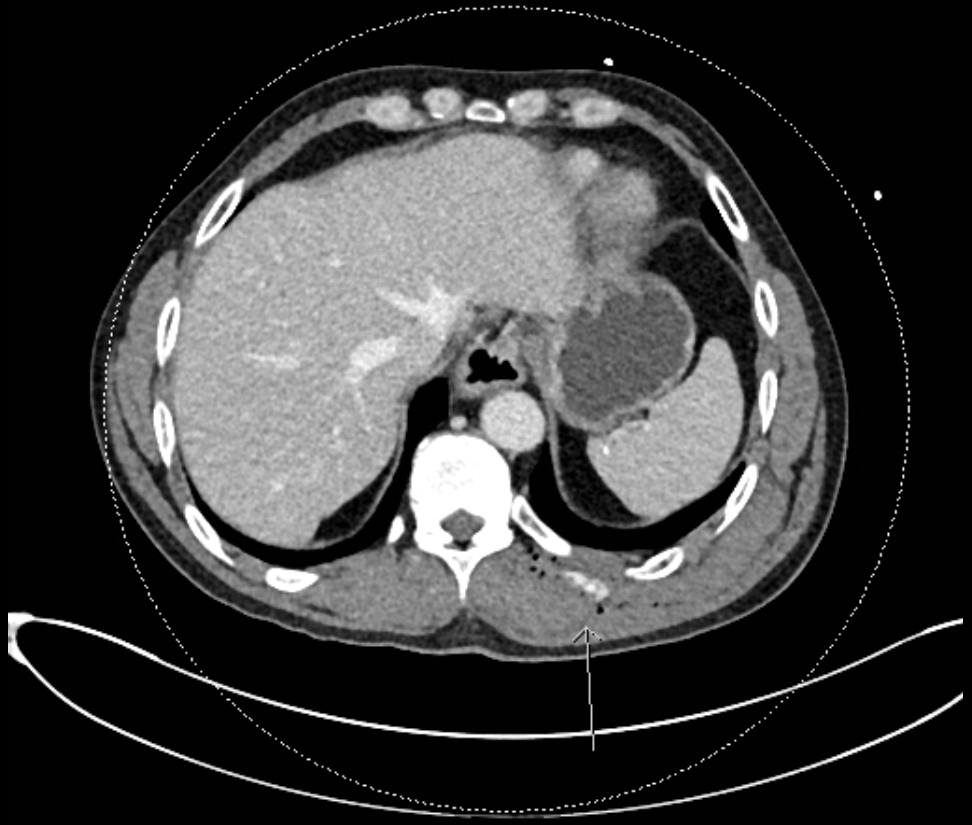
See how perfusion helps

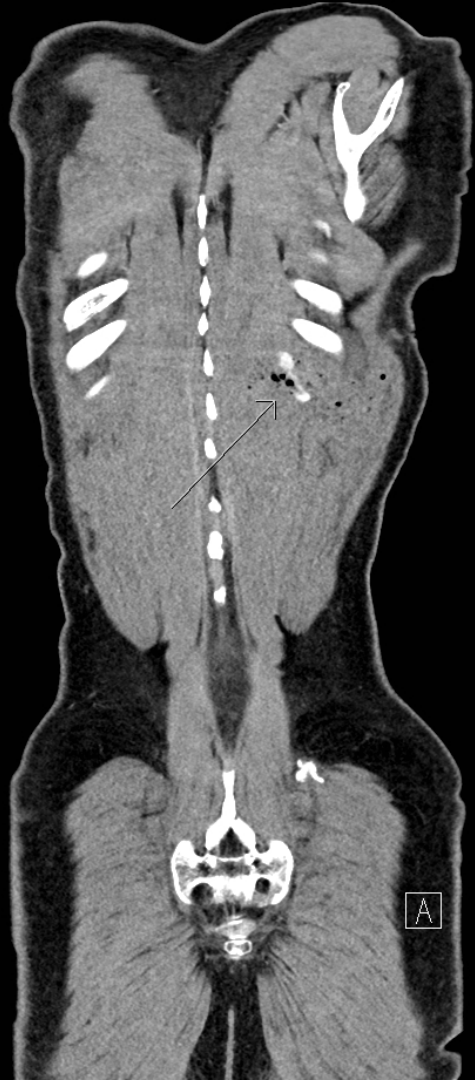




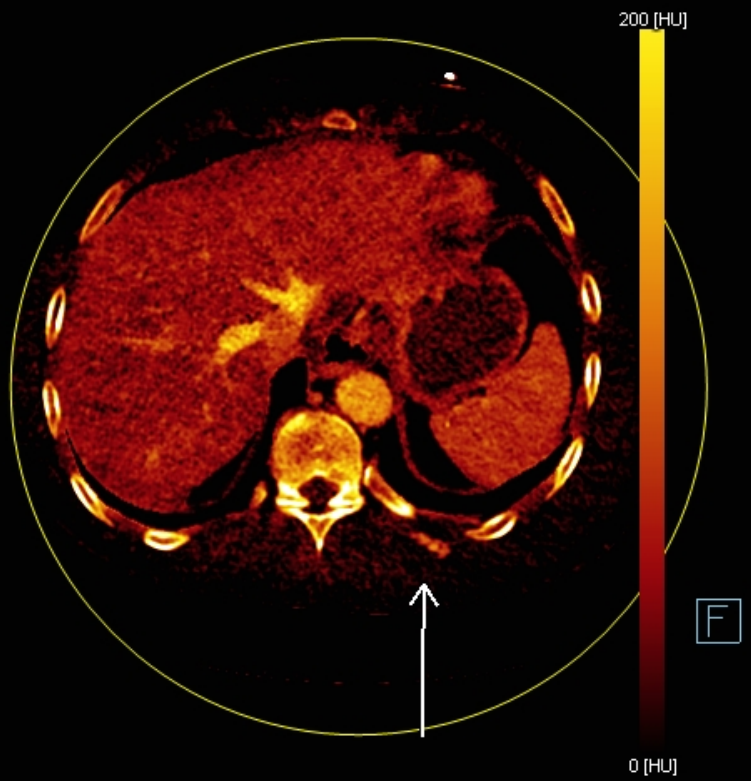
Case #10

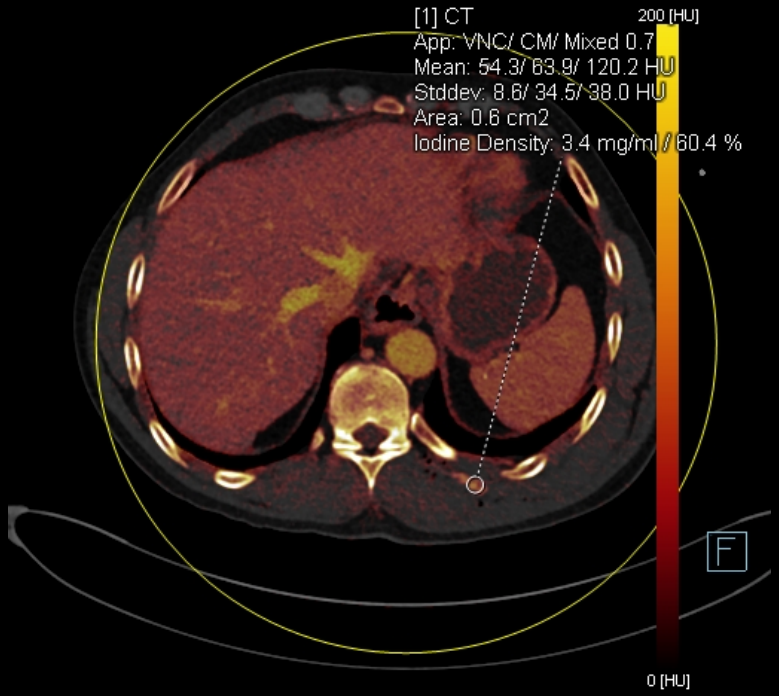
- 51 yo M
- Stabbed in the back





Is this active hemorrhage?



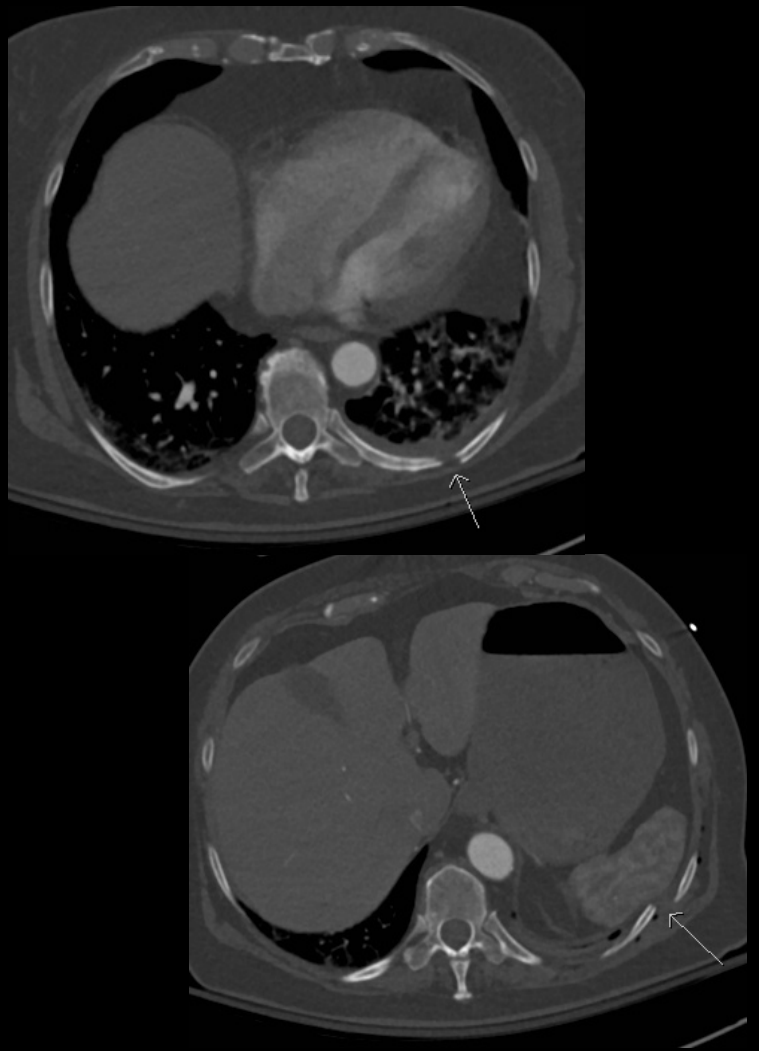


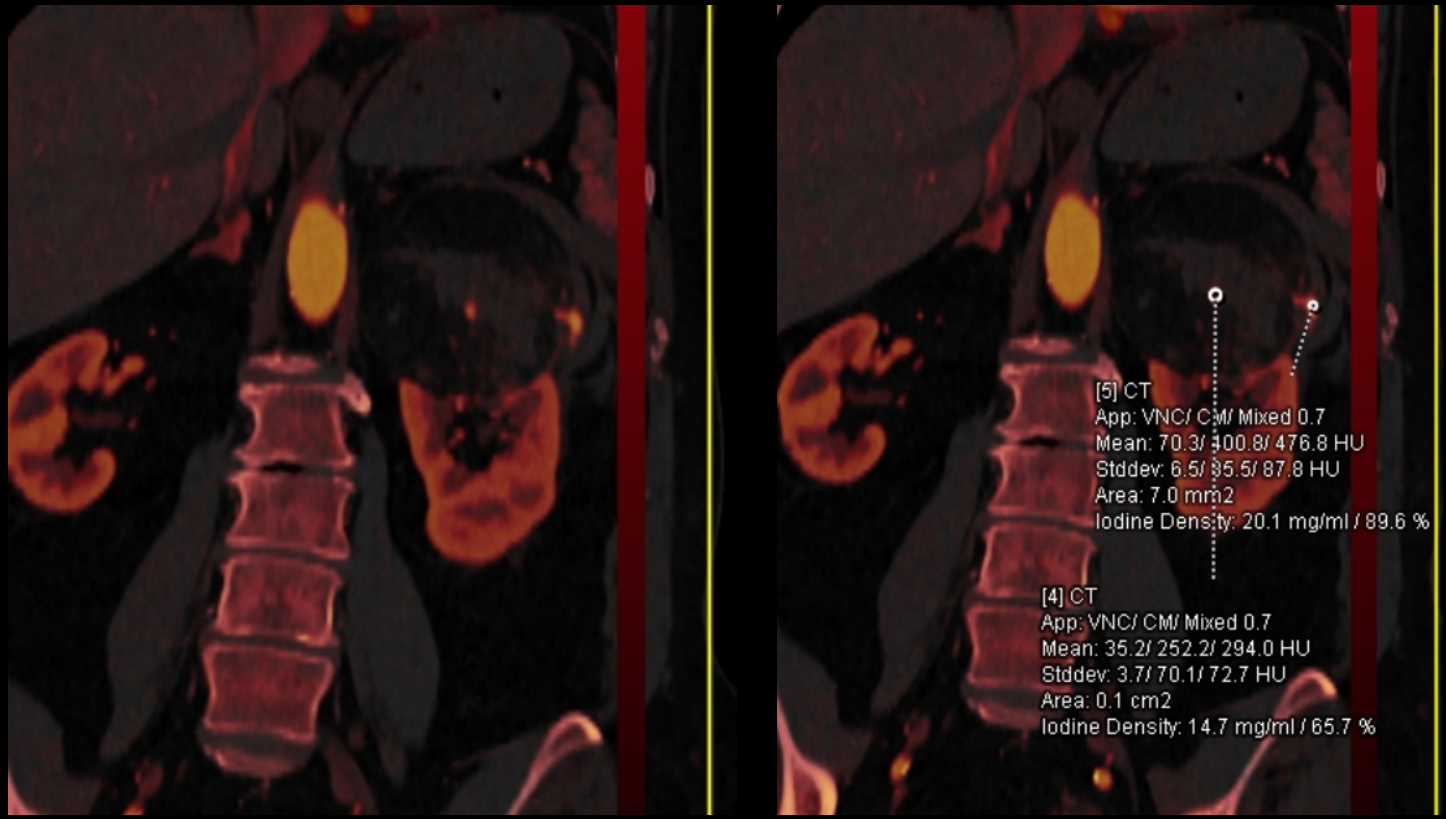
Iodine density = 3.4 mg/mL

Diagnosis = Active hemorrhage!

Case #11

- 73 yo F
- Restrained driver in high-speed rollover MVC


Pix 289.5
Perim 4.72 cm
Area 1.77 cm^2
Avg -89.37 HU
Dev 14.80
HU=-90

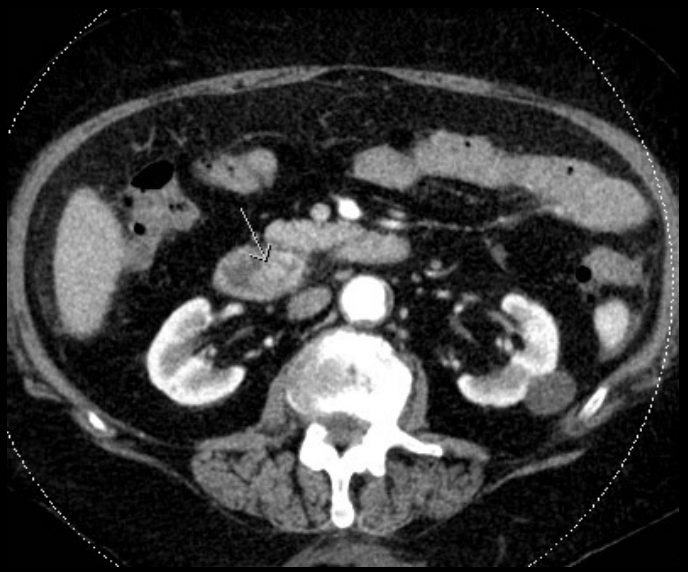


Iodine Density > 15 mg/mL

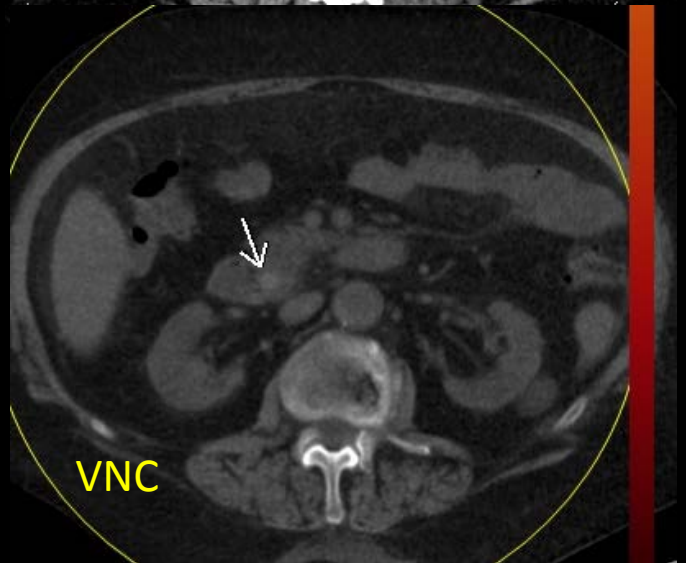
Diagnosis = AML with active bleeding

Case #12

- 82 yo M
- Abdominal pain



-CBD dilated
-Hyperdensity in distal duct / ampulla (arrow)
-Mass? Stone?
-Can DECT help?



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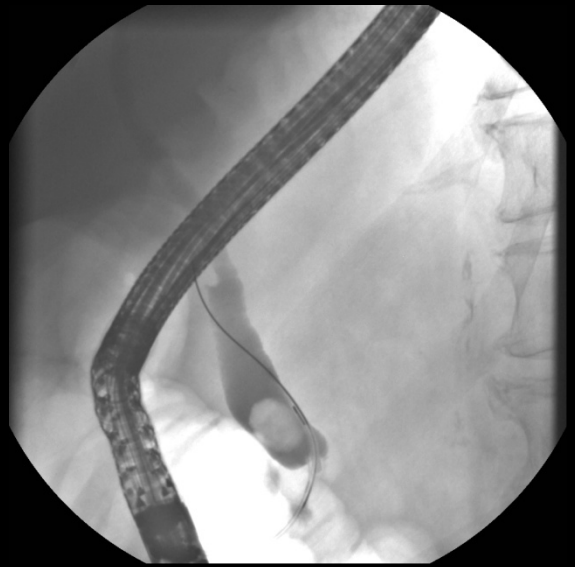
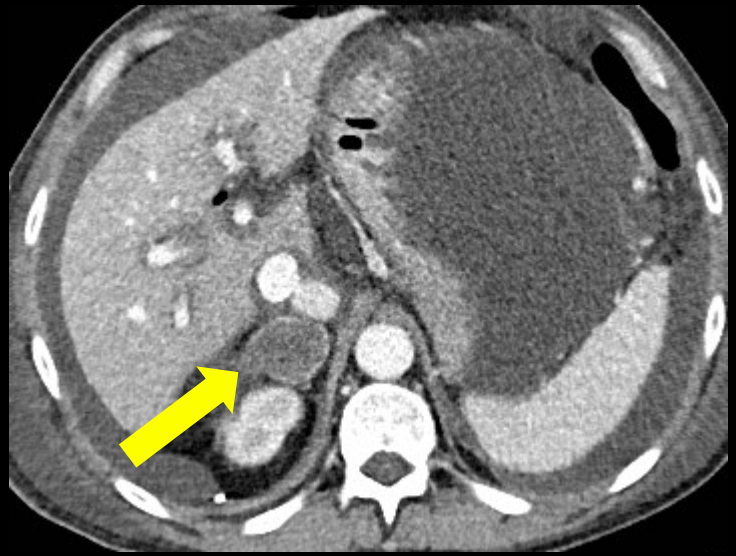
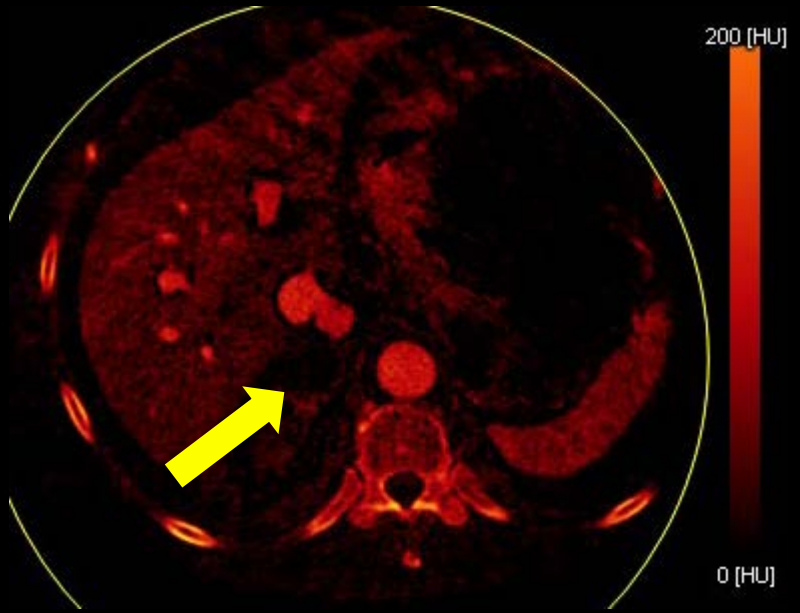


Diagnosis: CBD stone (removed via ERCP)

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!

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