Clinical Applications of CT in the Abdomen and Pelvis




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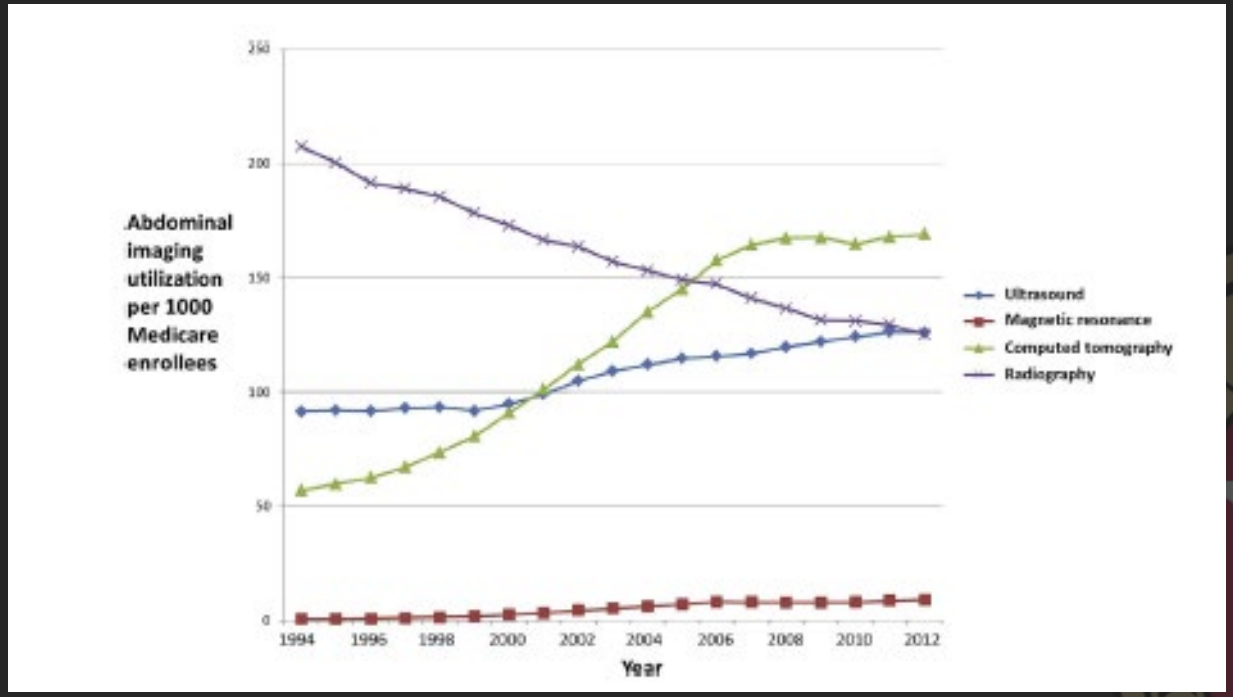
Objectives

- Discuss the utility of oral and intravenous contrast in ab/pel CT
- Review how the CT protocol can be tailored to the clinical question or indication with examples.

CT is a common exam



Moreno CC et al, JACR 2016

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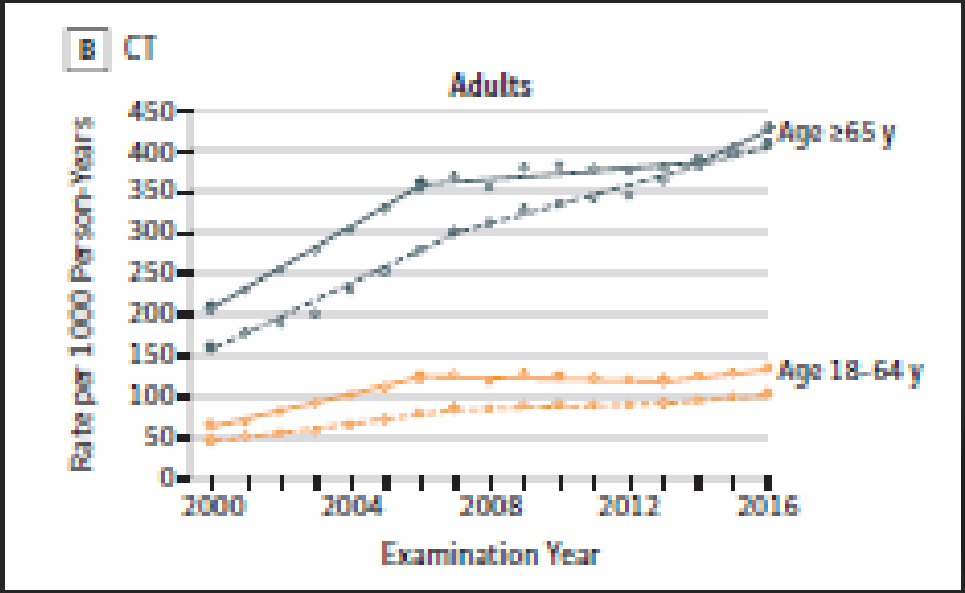
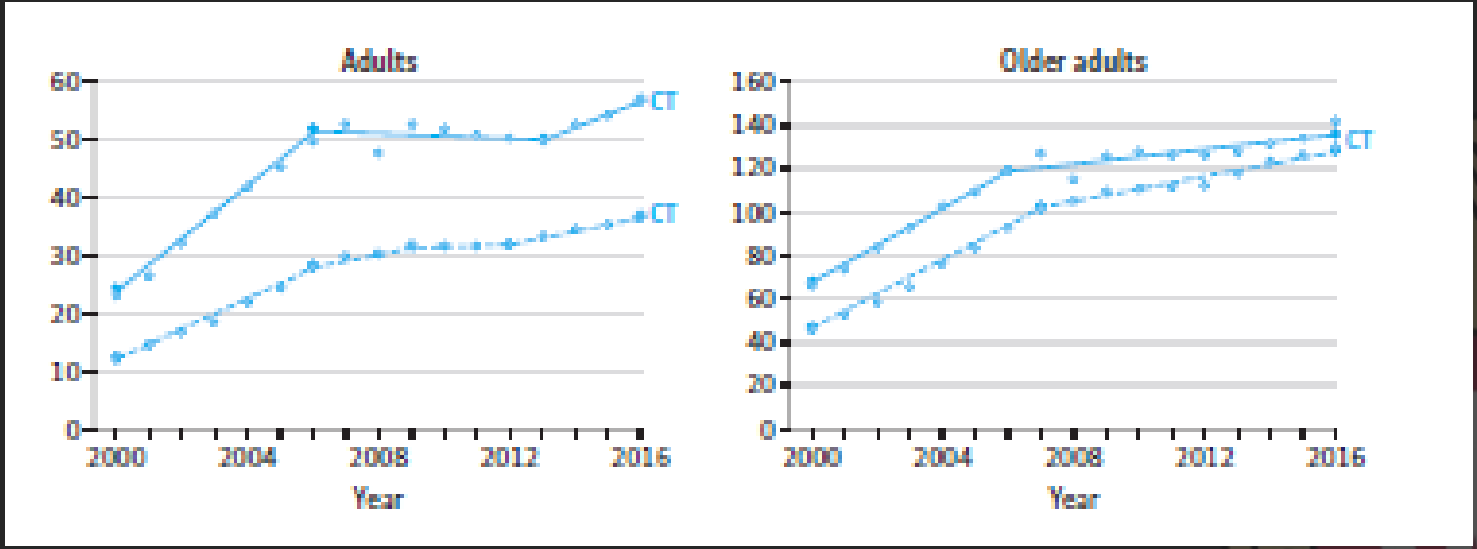


Smith-Bindman R et al, JAMA 2019

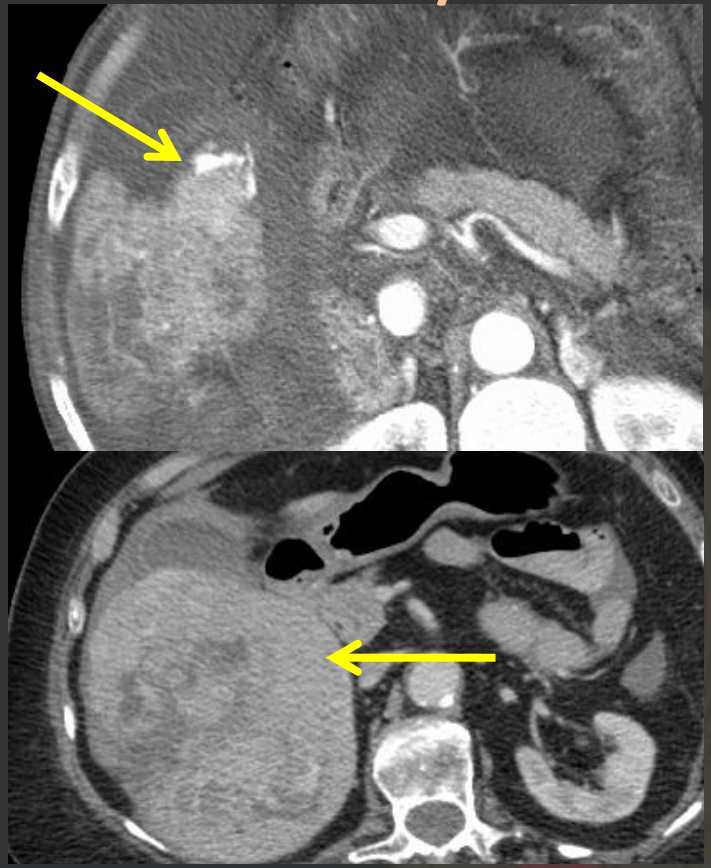
Abdominal CT



Smith-Bindman R et al, JAMA 2019

Clinical Uses of CT in the Abdomen/Pelvis

- Identification and staging of abdominal malignancies
- Inflammation, infection, or abscess
- Trauma
- Vascular abnormalities
- Transplant work-up
- Urinary tract stone disease/CT Urography
- CT Colonography



Types of iodinated contrast

- High-osmolar contrast media (HOCM)
  - Diatrizoate (Gastrografin) – ionic
- Low-osmolar contrast media (LOCM)
  - Iopamidol (Isoview) – non-ionic
  - Iohexol (Omnipaque) – non-ionic
- Iso-osmolar contrast media (IOMC)
  - Iodixanol (Visipaque) – non-ionic

Types of iodinated contrast

- Toxicity decreases as osmolality approaches serum – 290 mmol/kg
- HOCM
  - Diatrizoate (Gastrografin) – 1570 mmol/kg
- LOCM
  - Iopamidol (Isoview) – 796 mmol/kg
  - Iohexol (Omnipaque 300) – 672 mmol/kg
- IOMC
  - Iodixanol (Visipaque) – 290 mmol/kg

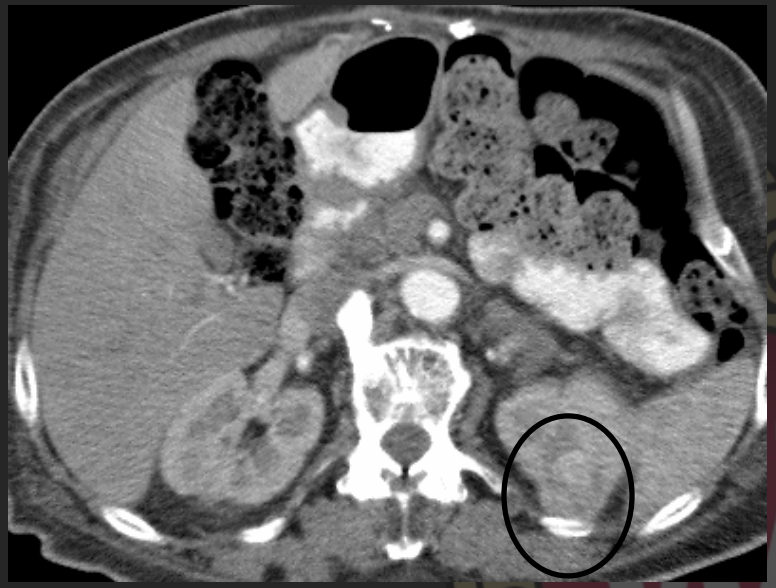
Intravenous contrast

Pros

- Improved tissue contrast in vessels, parenchymal organs
  - Better lesion characterization
- Can give information about physiologic function
  - Early vs late enhancement, vascular patency

Cons

- Allergic reactions
- Nephrotoxicity



Oral contrast media

- Adequate bowel distention
- Luminal, mural, extraluminal evaluation
- Palatable and tolerable
  - Positive: Ba based and I based (Omnipaque/Iohexol)
  - Neutral: Water, Volumen/Breeza
  - Negative: Air, Oil

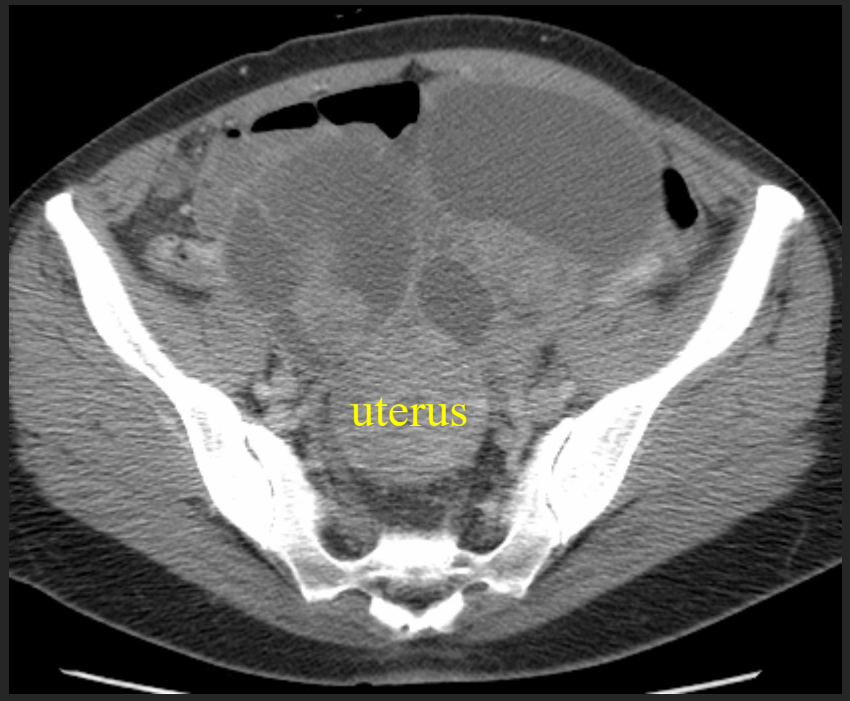
Oral contrast media

Pros

- Standard of care
- OCM is generally safe
- Radiologist comfort-higher confidence, quicker interpretation, fewer recommendations
- Bowel vs extra-enteric abnormalities
- Interpretation affected by visceral fat (may not directly correlate w BMI)

Cons

- Modern MDCT can differentiate bowel from mesenteric mass
- Intra-luminal pathology rare
- OCM not palatable, patients rarely consume large volumes
- Despite OCM, bowel inconsistently opacified
- TIME CONSUMING: delay in disposition and diagnosis in ED, impacts care in ED


uterus

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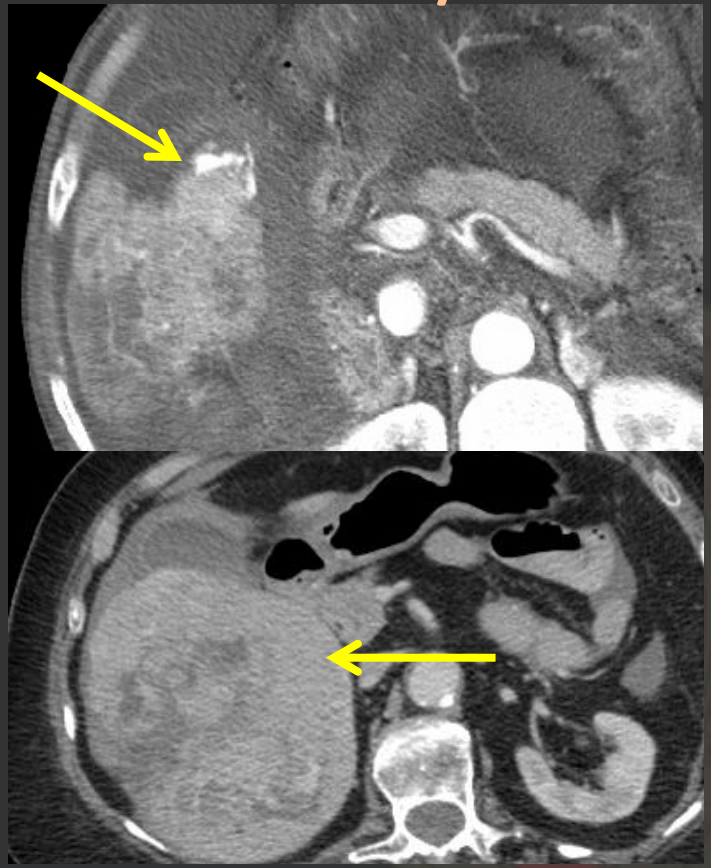
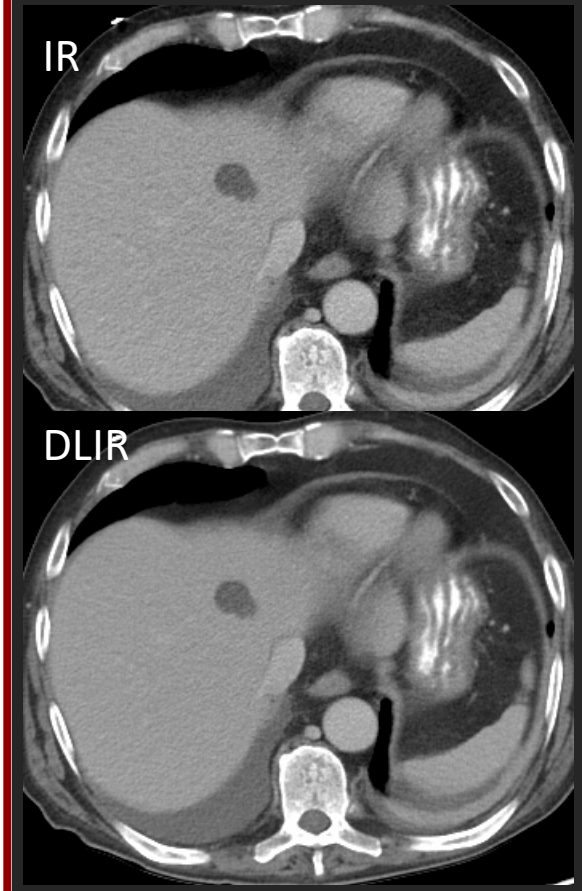


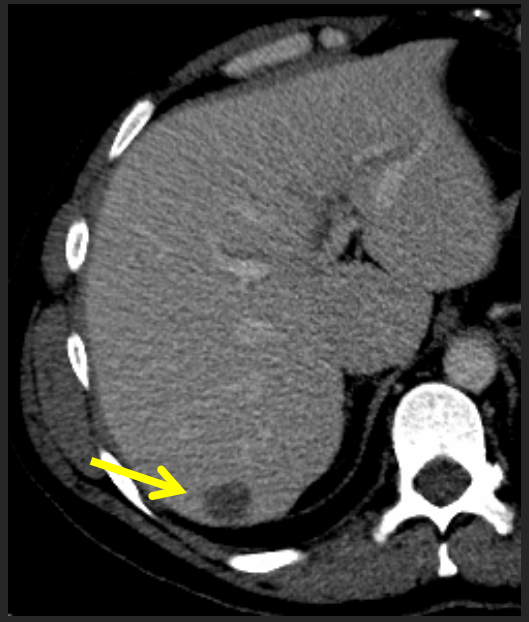
Surveillance of metastatic cancer



- CECT: Workhorse for oncologic staging and surveillance of metastatic disease
- May get repeated CT scans
  - Concerns around radiation dose
- Prioritization of radiation dose reduction, even in the setting of aggressive cancer
  - Iterative reconstruction algorithms
  - AI/DL based reconstruction algorithms

Hepatic metastatic disease

Low contrast liver lesions

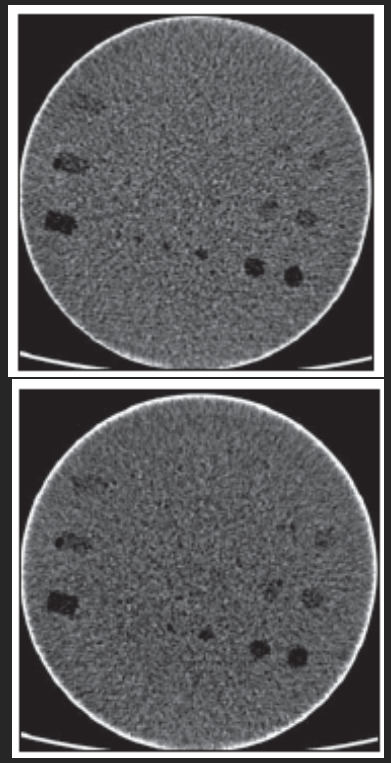


Met CRC

- Hepatic metastatic disease common
  - Low contrast to background liver parenchyma
  - Detection critical for staging, treatment
- Limited efficacy of advanced reconstruction algorithms
  - Effective for detection of liver lesion at modest dose reduction
  - Excessive dose reduction may compromise diagnostic image quality

Volders D et al Radiology 2013

Low contrast liver lesions

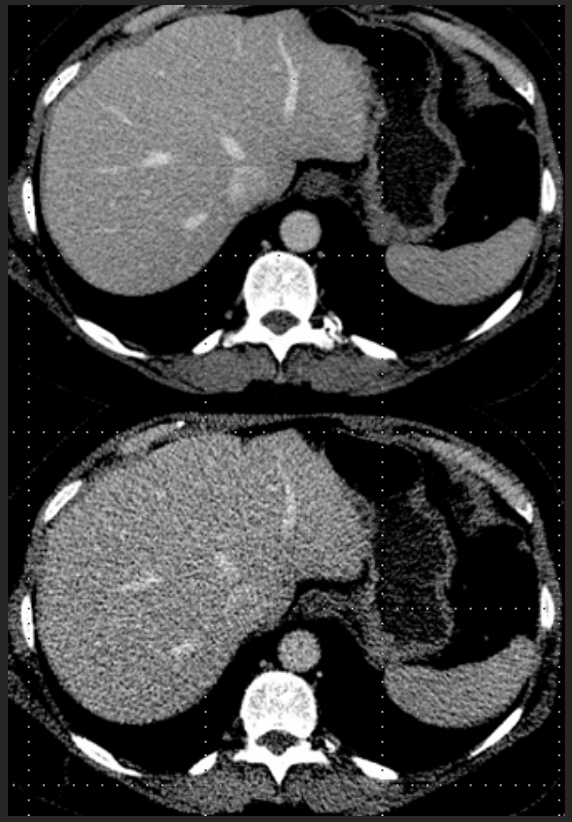


From Baker et al, AJR 2012

- Phantom studies
  - Low CT doses: IR does not preserve low contrast detectability
  - Low contrast object detection depends on dose
    - Invisible at low radiation doses regardless of recon technique
  - Superior diagnostic performance for hepatic lesion detection NOT seen with IR or smoothing techniques

Schindera ST et al, Radiology 2013; Baker ME et al AJR 2012; Dobeli K et al BJR 2013

Low contrast liver lesions



Pooler BD et al, Eur Radiol 2017

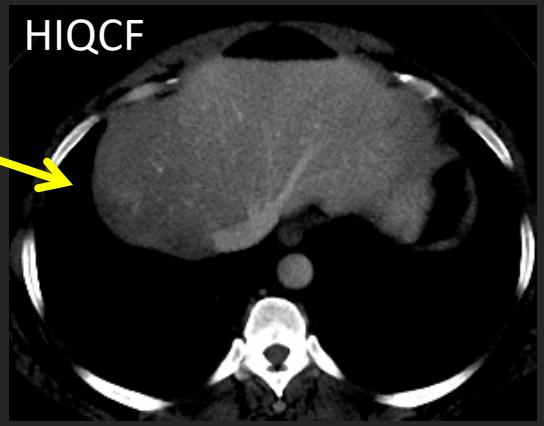
- Prospective human study
  - 70 pts, SD-CECT, 60-70% RD-CECT
  - FBP, ASIR, MBIR
  - 3 readers, liver lesions > 4 mm
- RD-CECT 2.0 mSV, 64% reduction
- Inferior diagnostic performance and reader confidence on all RD series

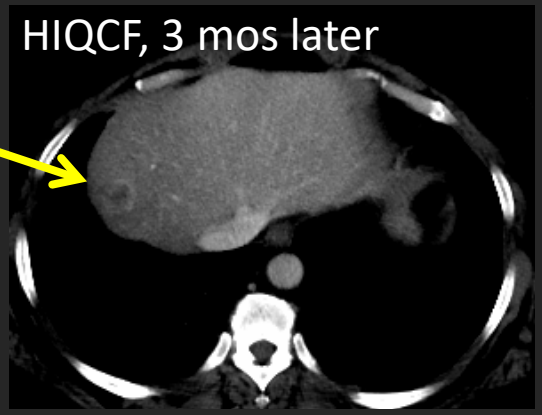
Pooler BD et al, Eur Radiol 2017

High Image Quality Cancer Follow up

- High image quality version of routine abdomen/pelvis CT protocol
- Meant for cancer follow up of colorectal, pancreas, esophagus, lung, breast cancer
- Not routinely used in lymphoma, testicular cancer

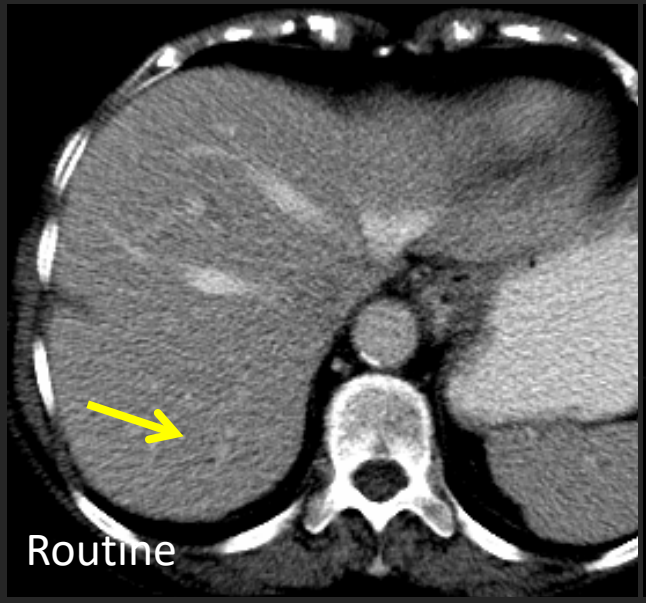
High Image Quality Cancer Follow up



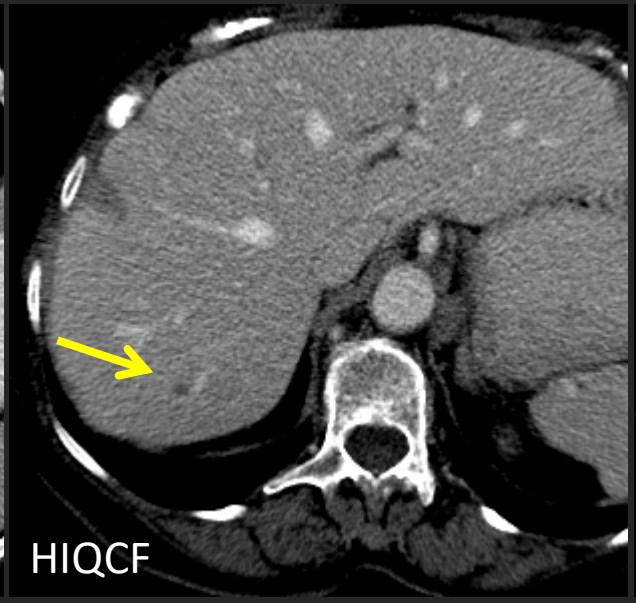


- Noise index 11.5, 14, 17 for sm, med, large
- Routine NI 15.5, 18.5, 23
- TURBO built into the protocol

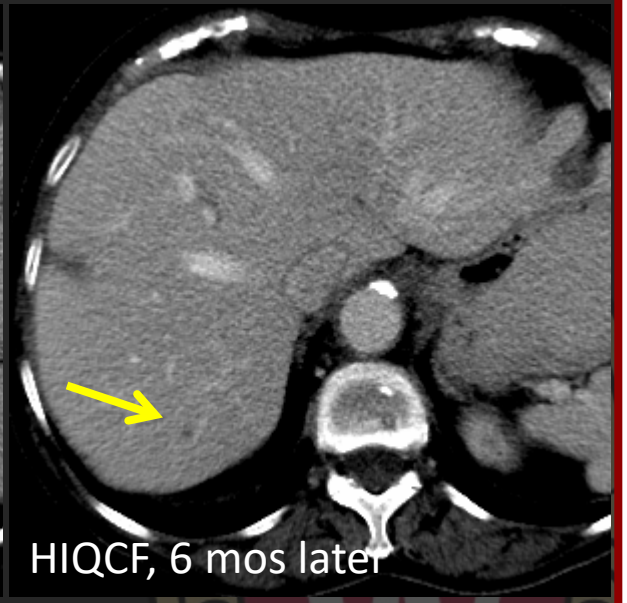
High Image Quality Cancer Follow up



DLP 399,
CTDIvol 6.6

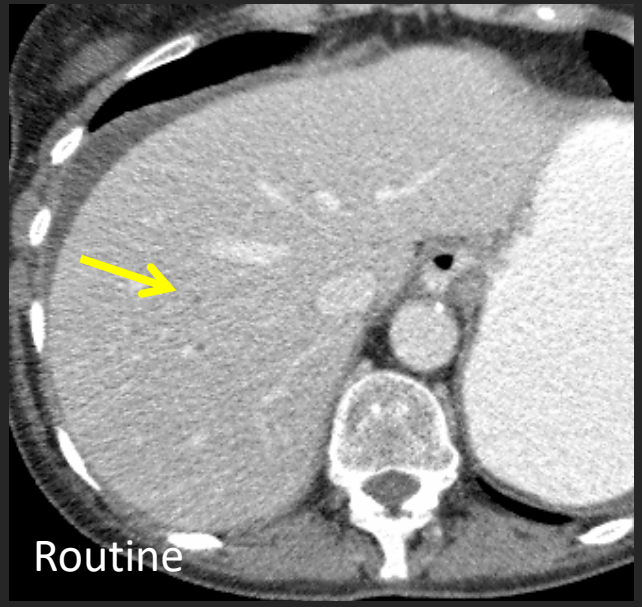


DLP 622,
CTDIvol 10.1

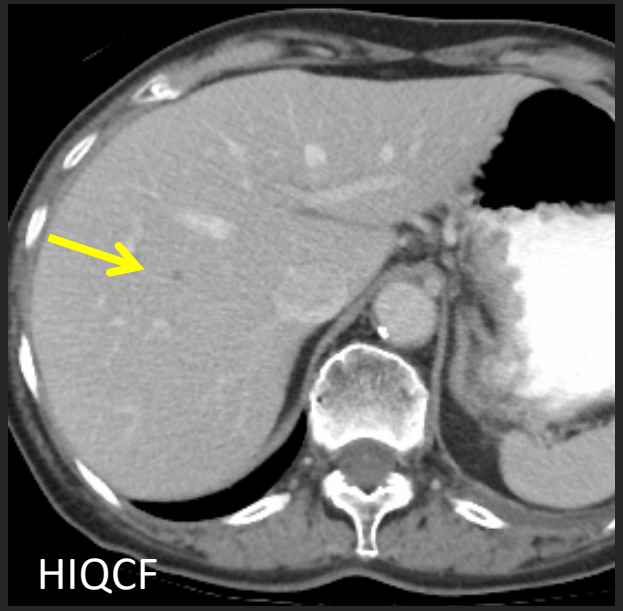


DLP 456,
CTDIvol 7.7

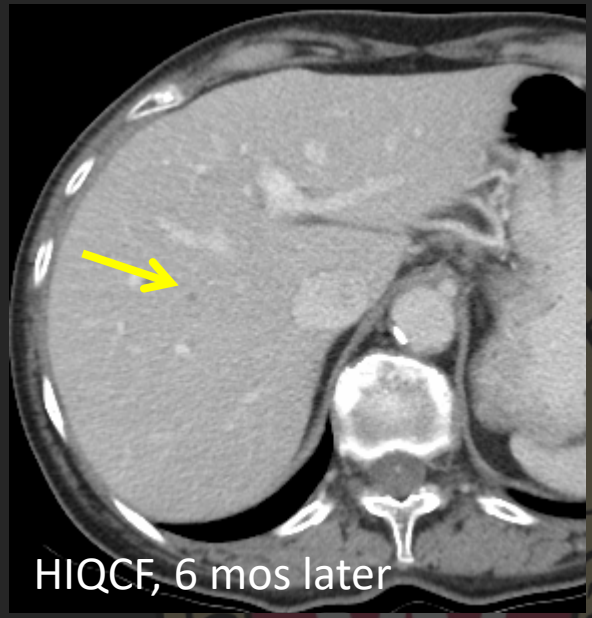
High Image Quality Cancer Follow up



DLP 471, CTDI vol 11.4



DLP 858, CTDI vol 14.5



DLP 766, CTDI vol 12.3

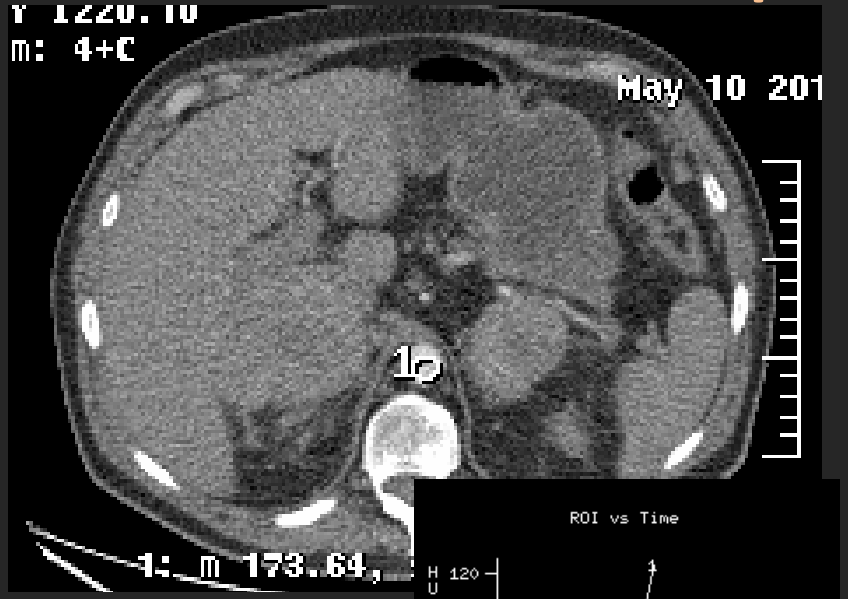
Lymphoma

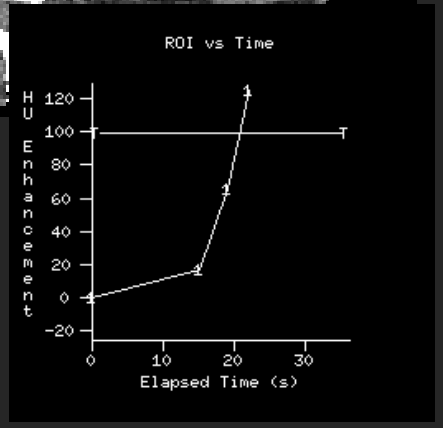
Low dose lymphoma follow up


Routine

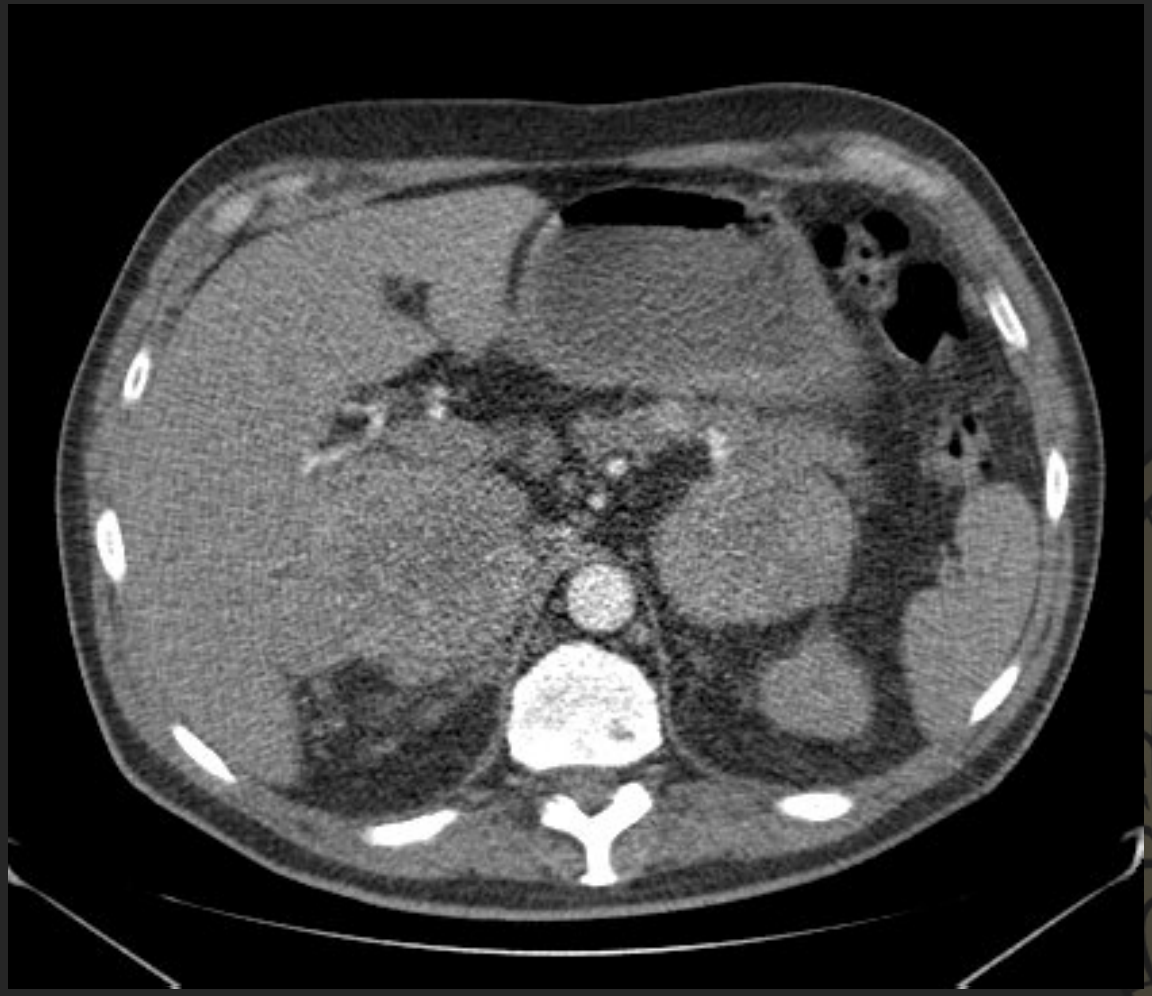

Low dose

Biphasic CT





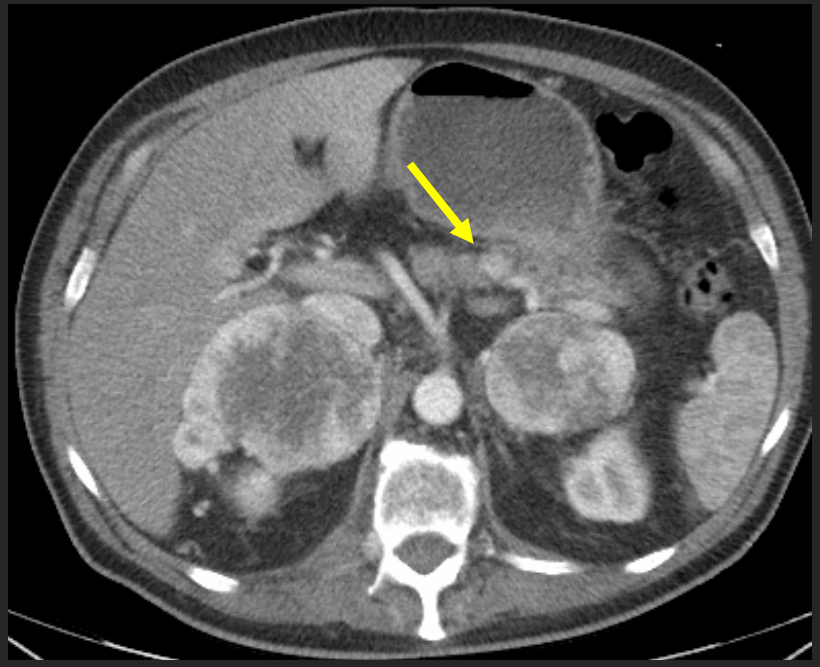
- Obtain late arterial and portal venous phases
  - Set empiric delay
  - Test bolus, automatic bolus tracking
- Low kV imaging
- DECT
  - Low keV datasets
  - IMD



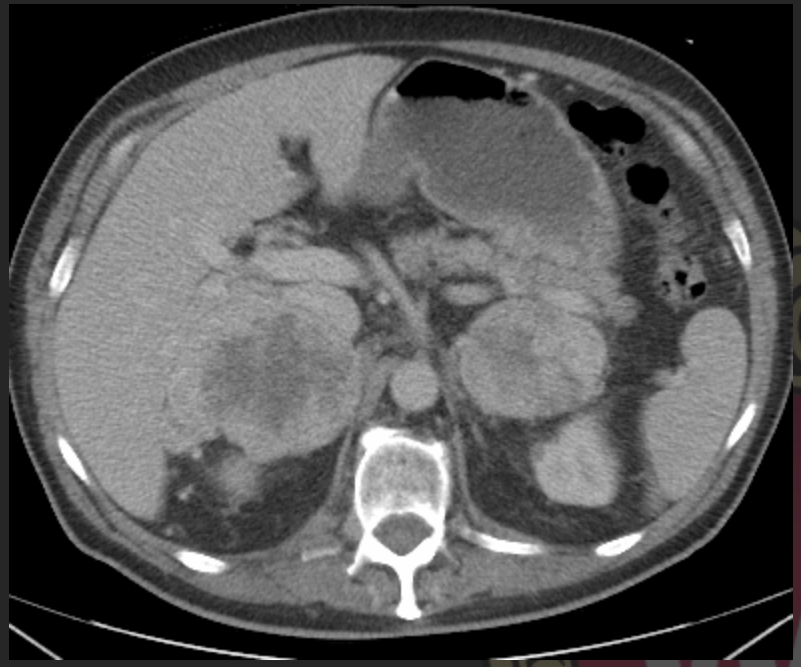
Biphasic CT in oncology

- RCC: pancreatic mets, renal mass
- NET: pancreas primary, hepatic mets
- Not Melanoma

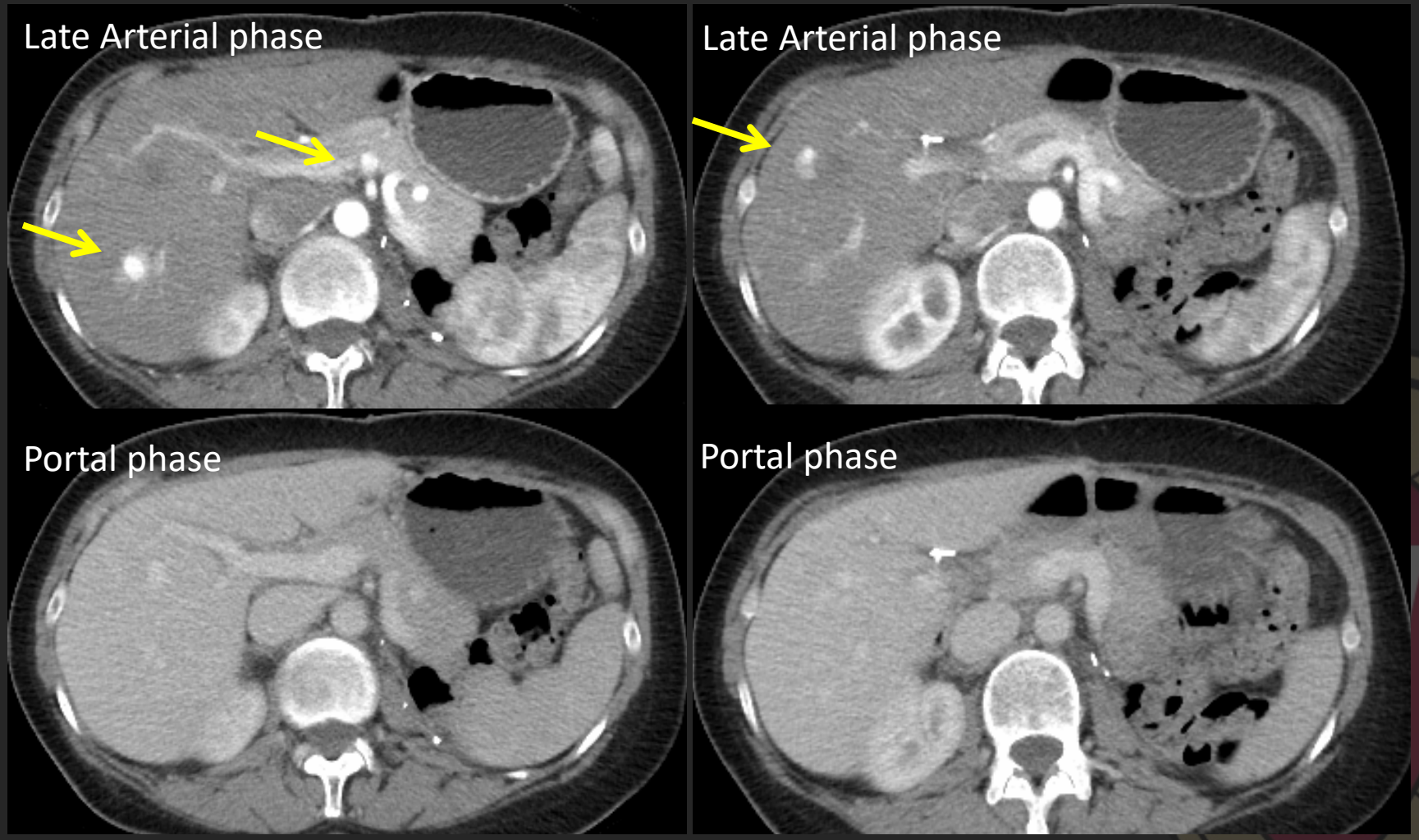
NG CS et al AJR 1999; Mecho S et al Abdominal Radiology 2009; Saguri K et al AJR 2014
Fidler JL et al AJR 2003; Paulson EK et al Radiology 1998
Blake SP et al Radiology 1999; Winkler N et al Eur J Radiol 2013



Late Arterial phase



Portal phase

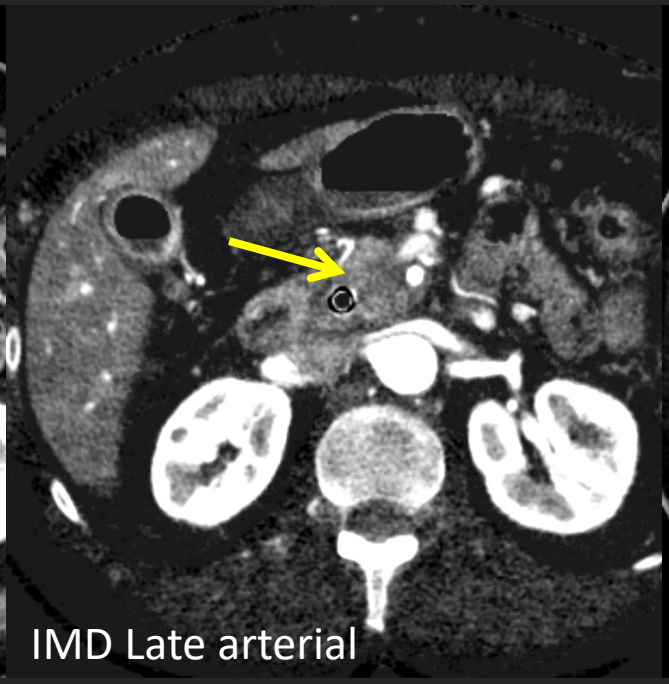

Late Arterial phase
Late Arterial phase
Portal phase
Portal phase

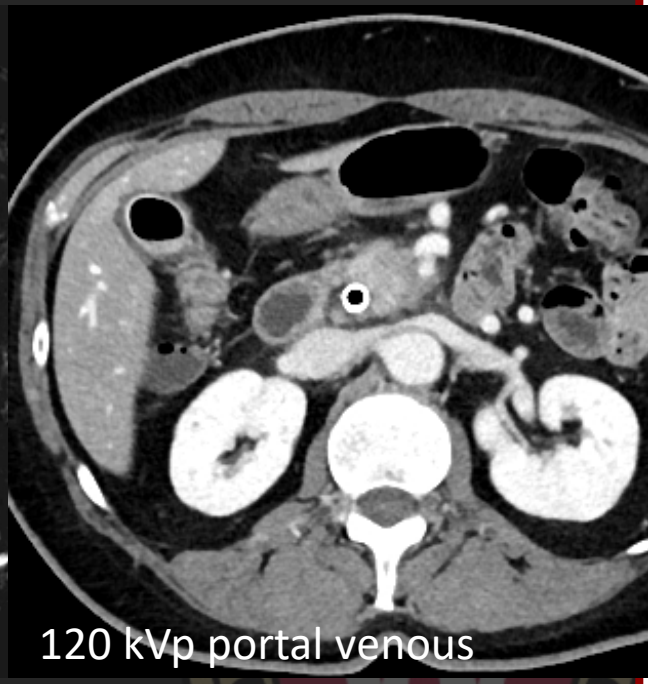
Biphasic CT in pancreas

- Late arterial: Pancreatic parenchymal phase
- Maximal enhancement of background pancreas parenchyma
- Increased conspicuity of non-enhancing lesions (panc adenoCa, panc cysts)
- Vascular enhancement, PNI
- DECT, low kVP, low monoenergetic, IMD datasets improve detection further
- Portal venous phase: Assess for mets

GW Boland et al AJR, 1998; Kulkarni NM et al Abdominal Radiology 2018; Patel BN et al Abdom Radiol 2018; Quiney B et al Abdominal Imaging 2015

Next





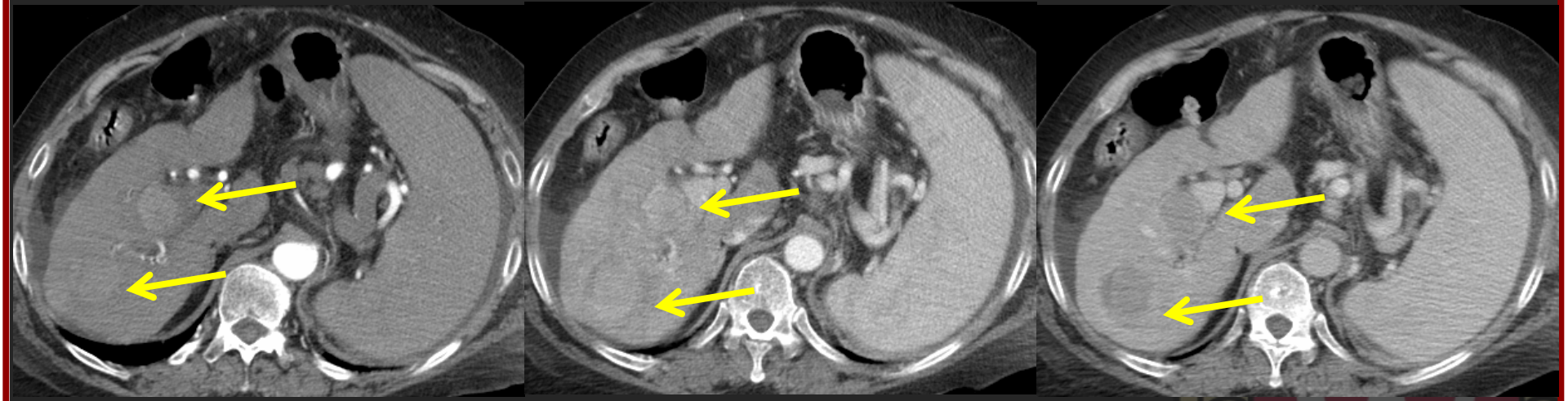
Case courtesy of Dr. Andrew Smith, UAB

Biphasic CT in HCC

- Value of arterial phase in HCC well established
  - Blood supply from hepatic artery
- OPTN/LIRADS require Arterial enh for diagnosis of HCC
- Low kV, DECT in late arterial
- Portal venous washout, pseudocapsule
- 3 minute delay required by UNOS
  - Washout needs to be unequivocal

Oliver JH et al, AJR 1996; HM Lee et al AJR 1997; Monzawa S et al AJR 2005; Shuman WP et al AJR 2014

Biphasic CT in HCC



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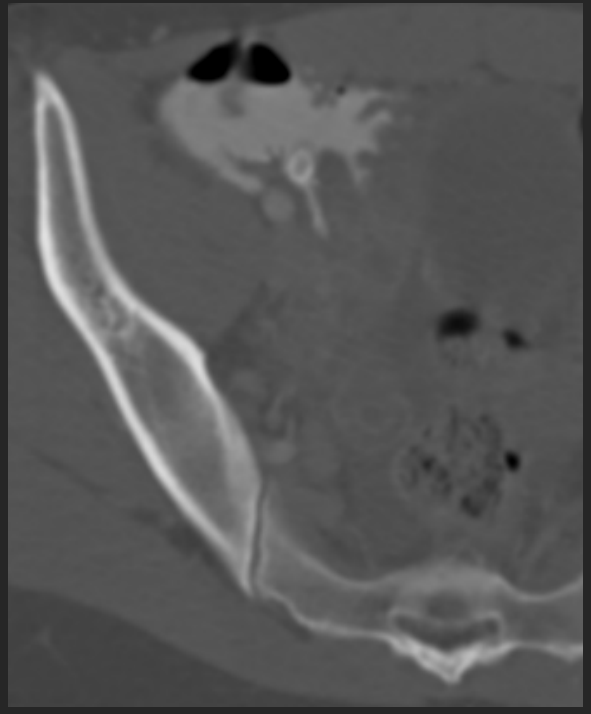
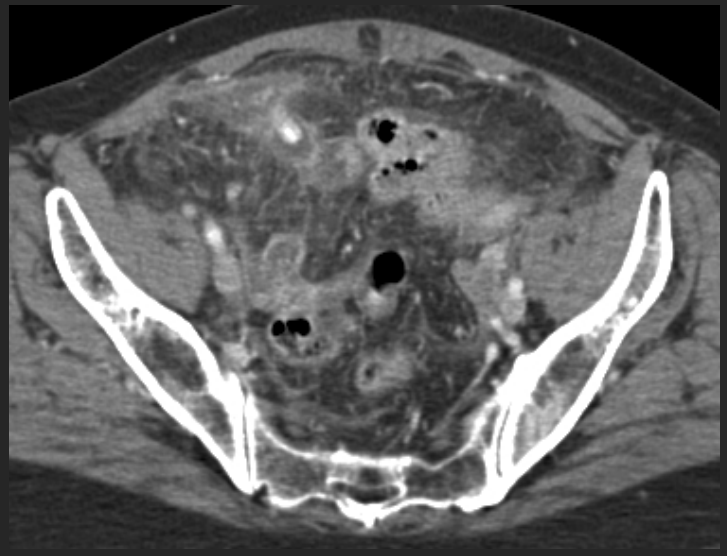
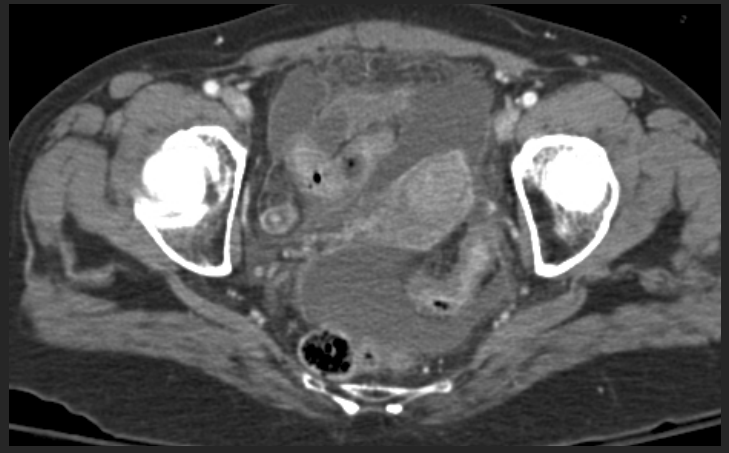
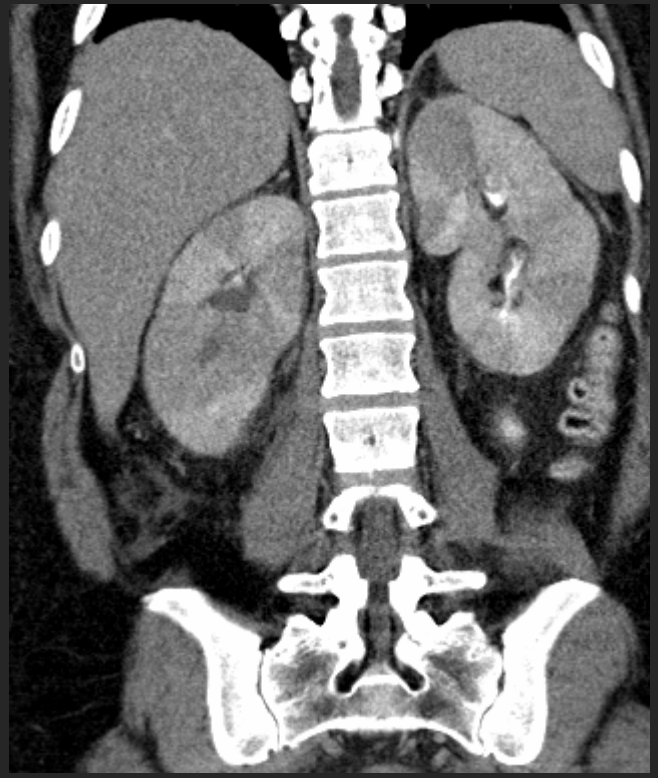
Appendicitis



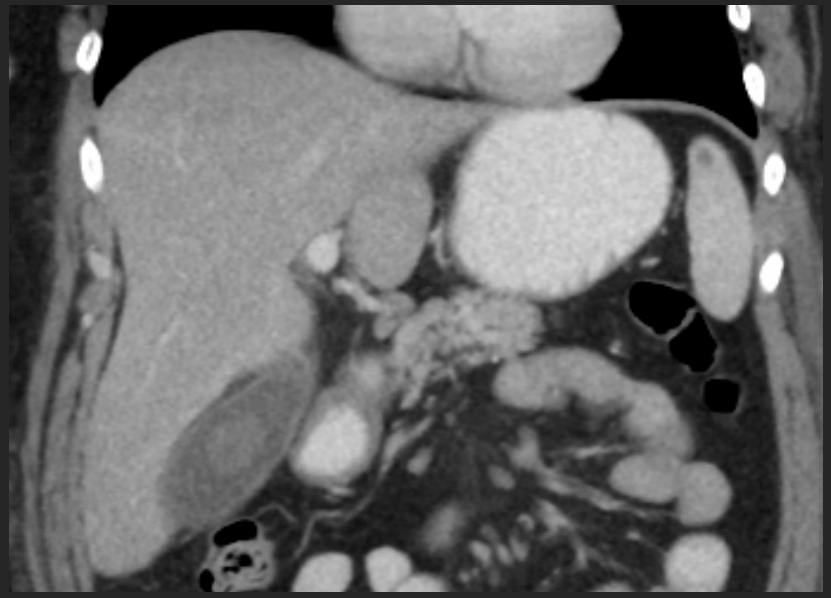


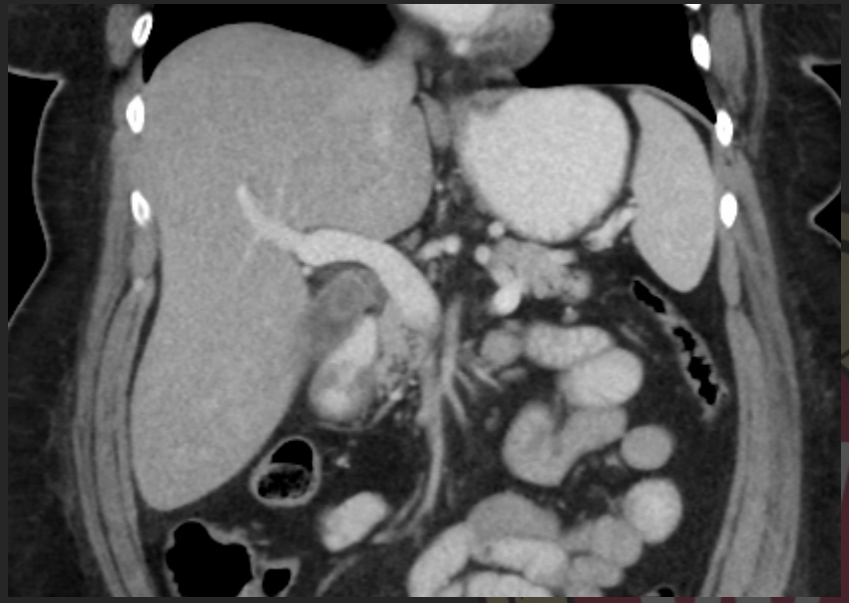


Pyelonephritis

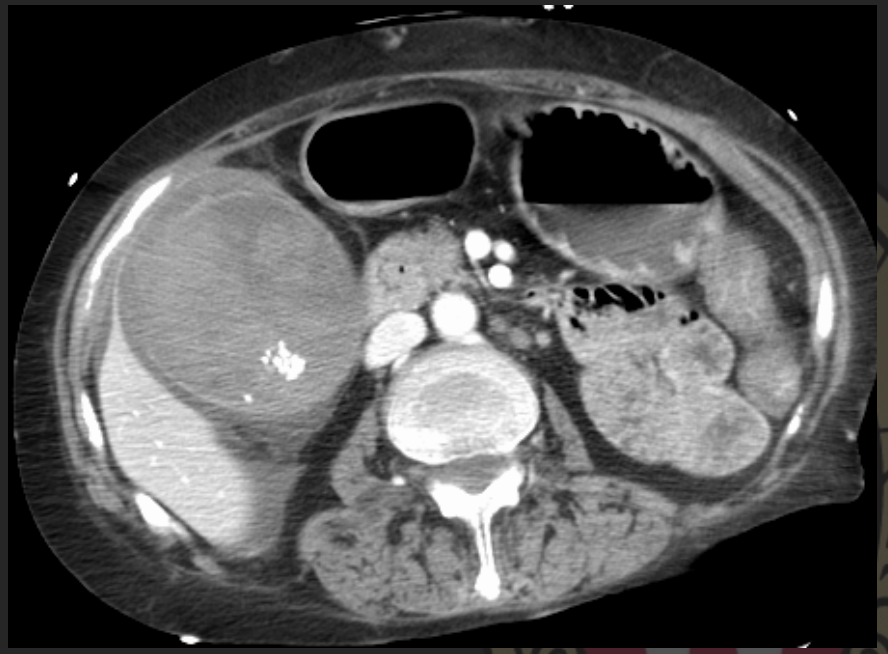


Cholecystitis

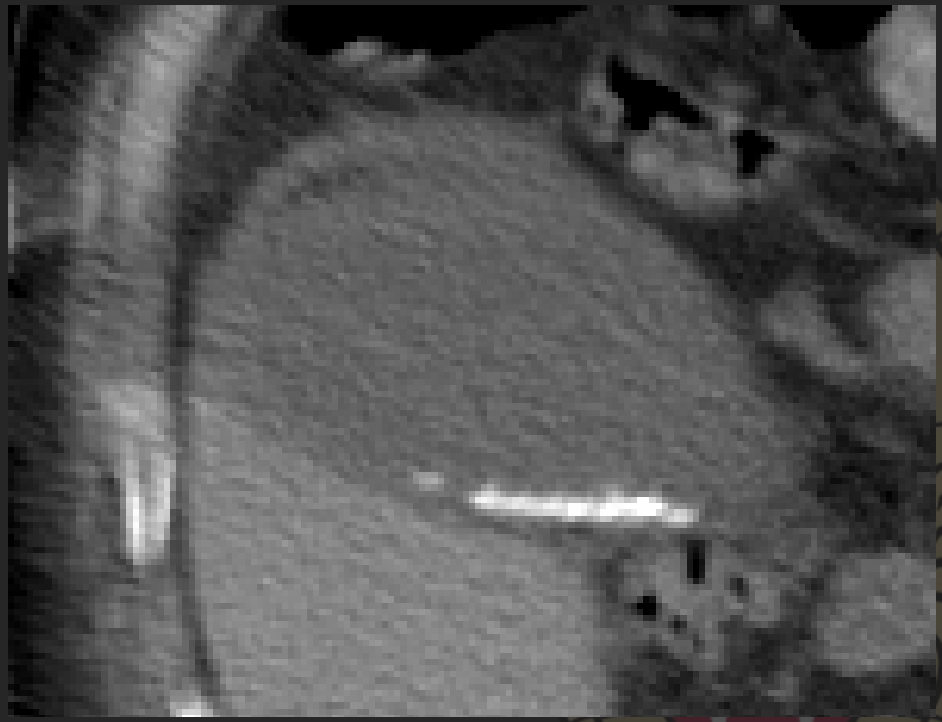




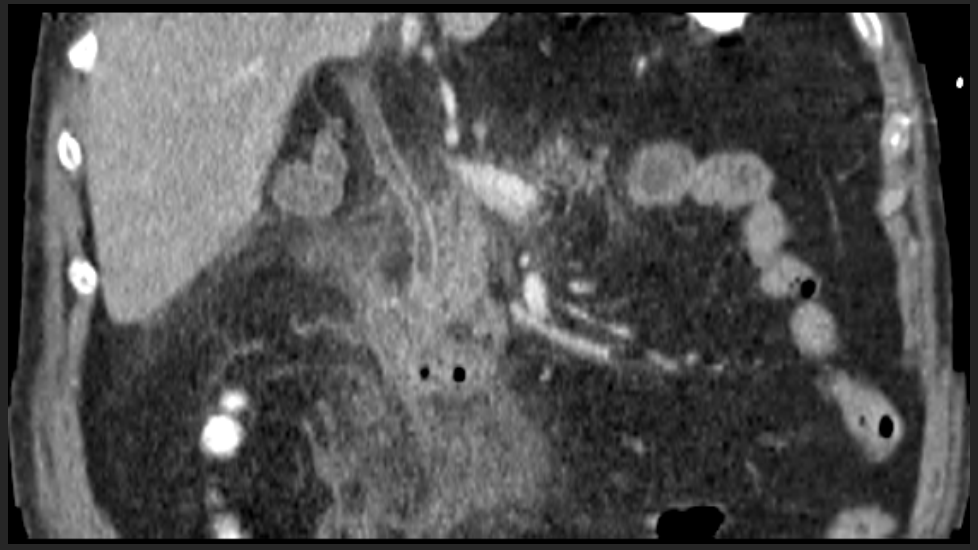
Hemorrhagic Cholecystitis



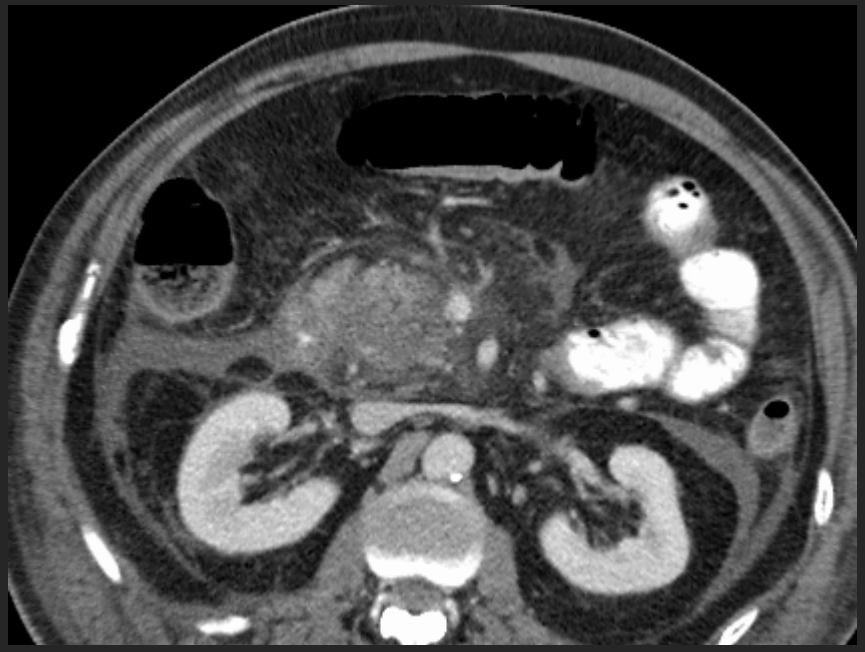
Emphysematous Cholecystitis

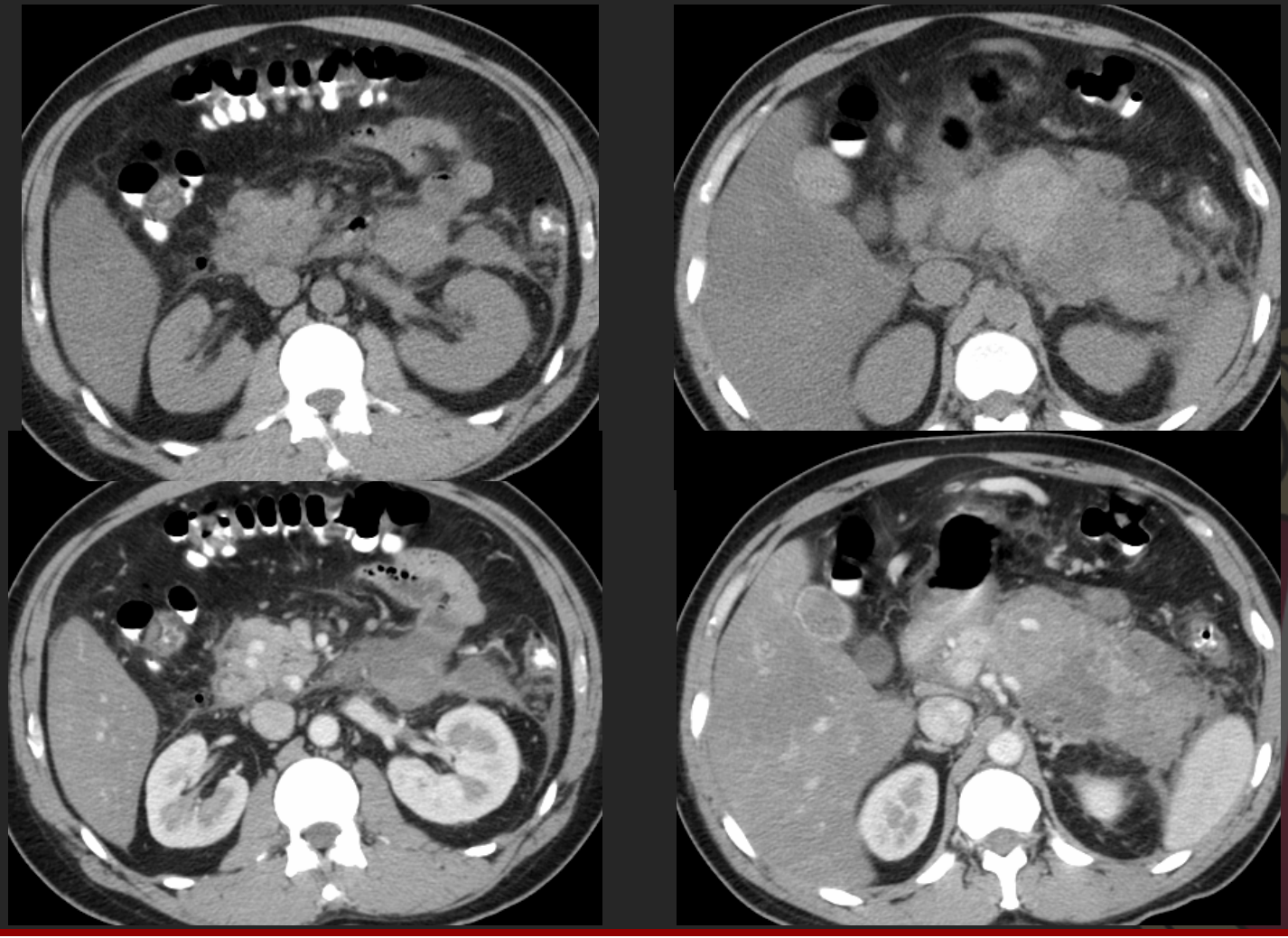


Pancreatitis



Necrotizing Pancreatitis





Pseudocyst/abscess formation

Diverticulitis

Hepatic abscess

Diverticular bleed

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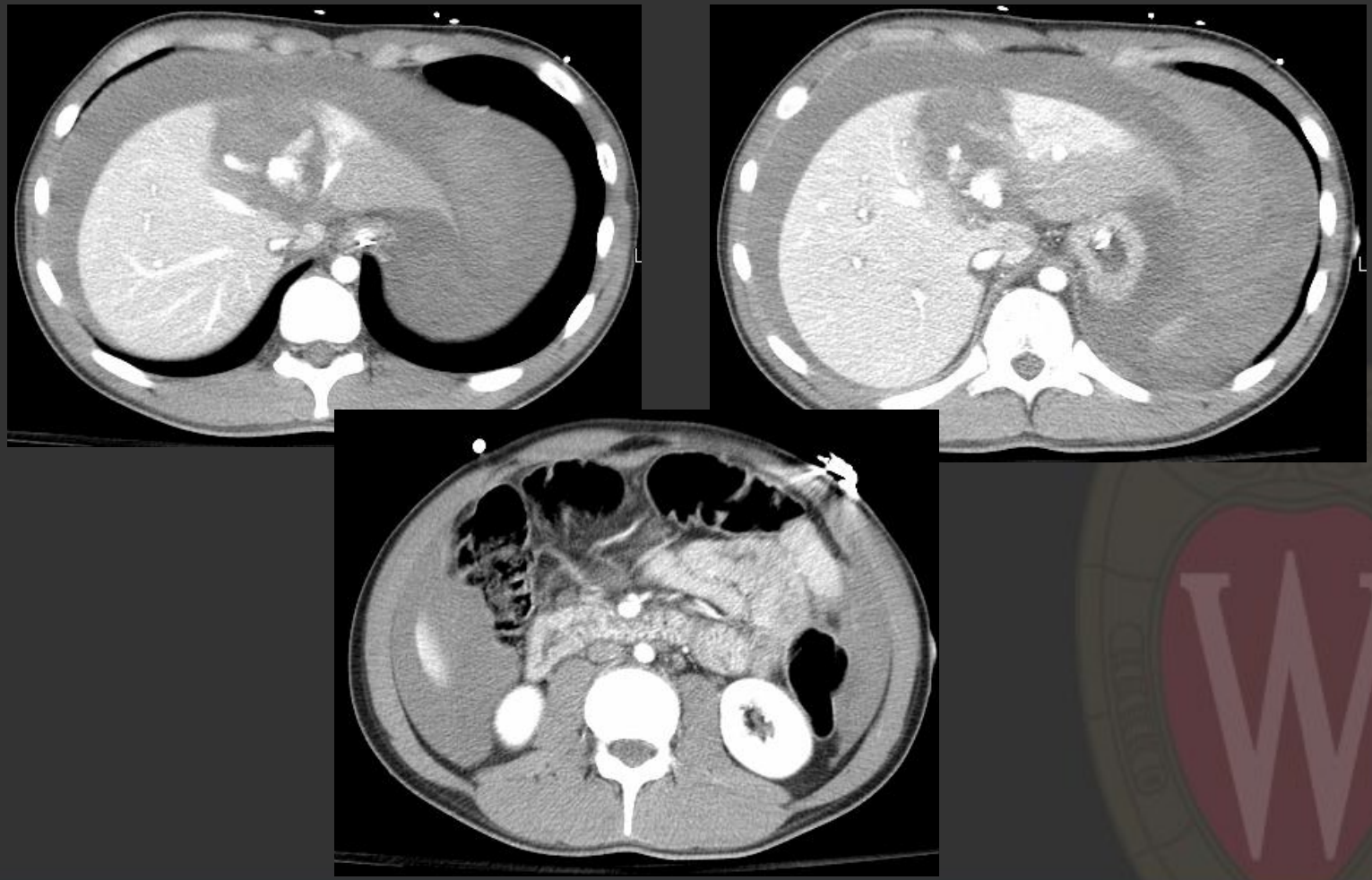
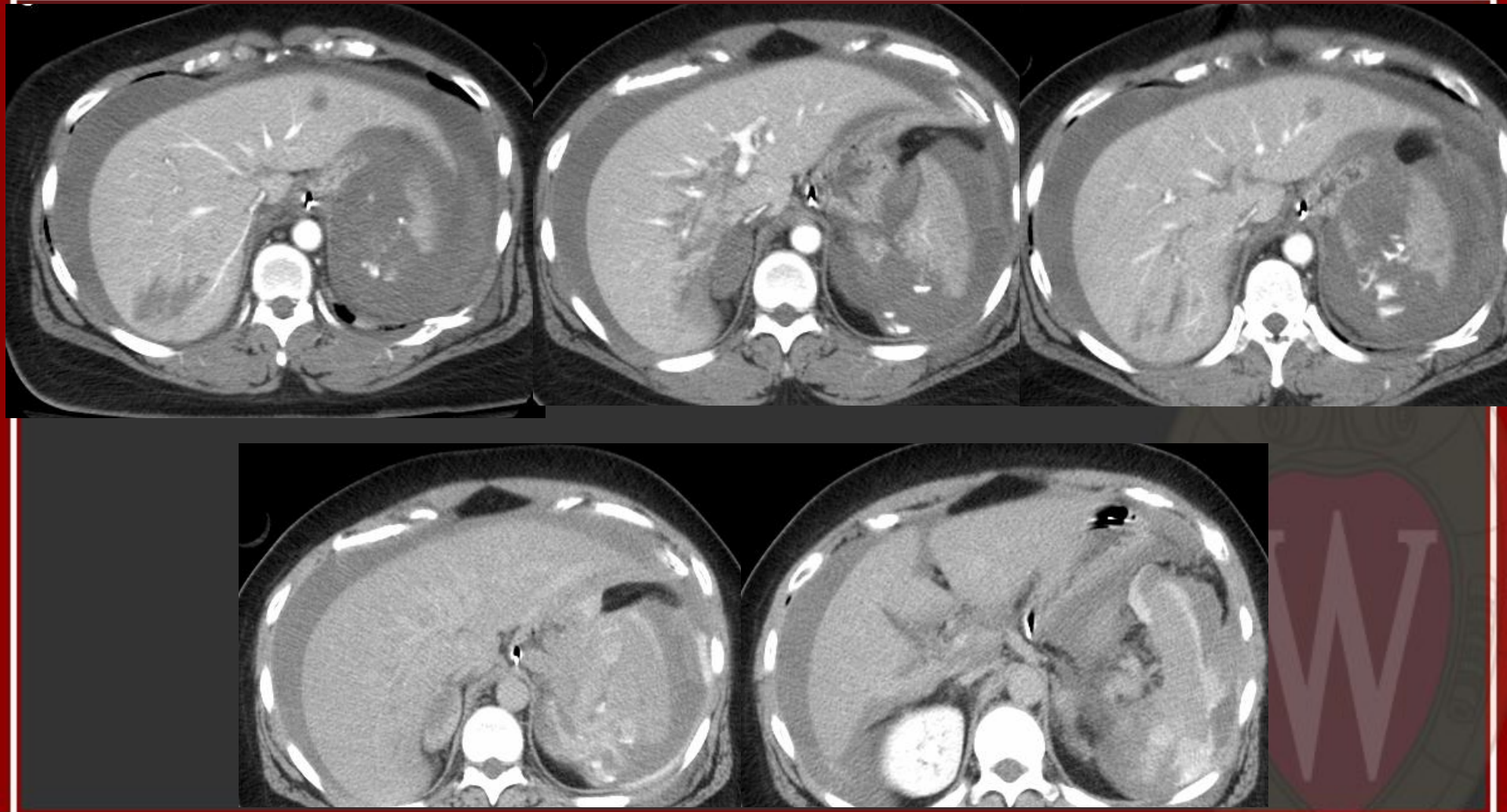
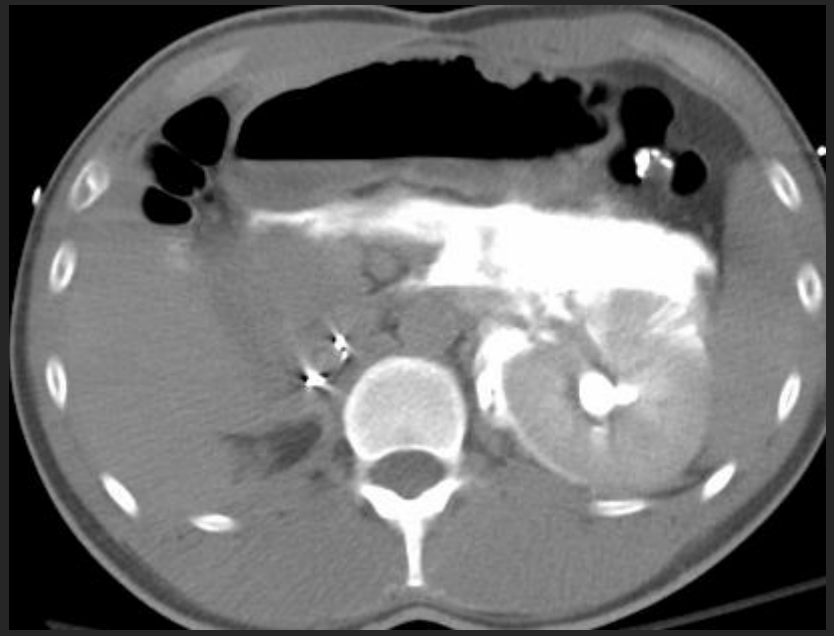
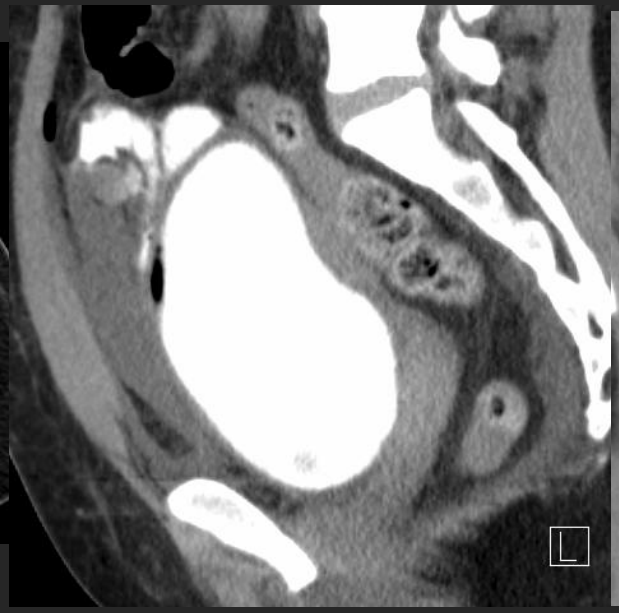
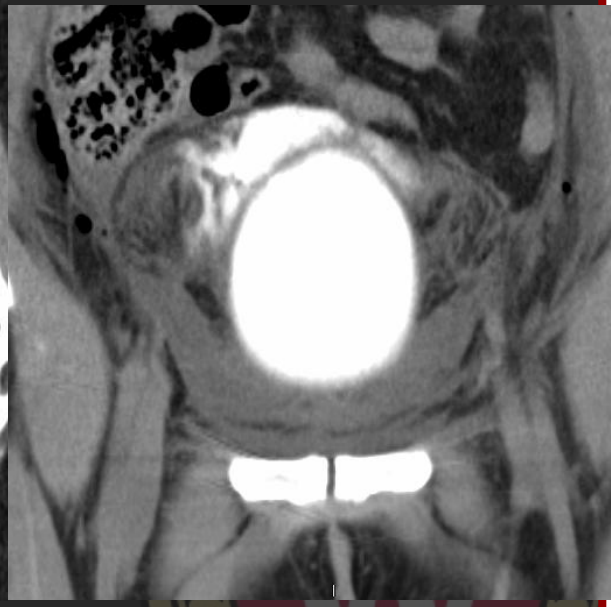


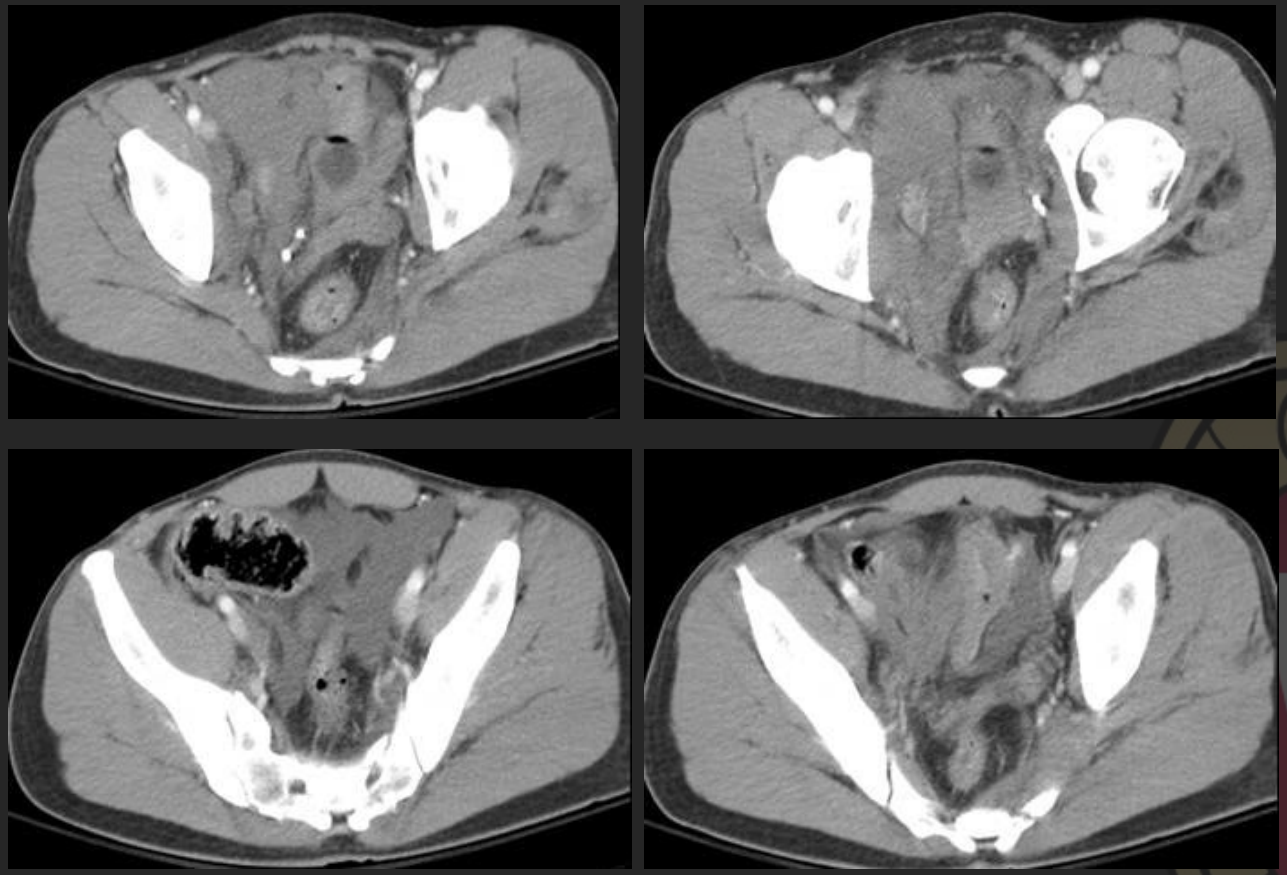




CT cystogram







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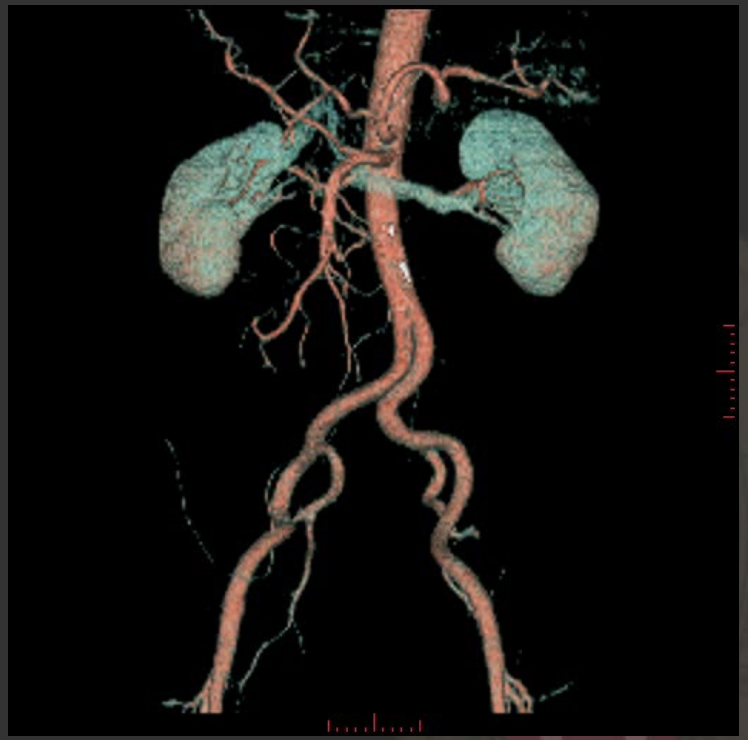
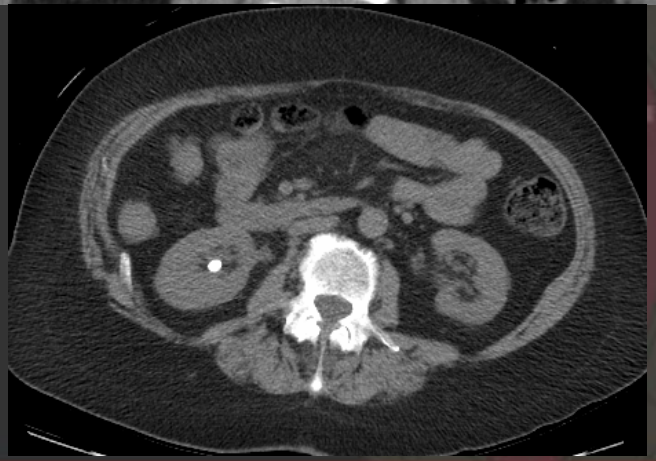
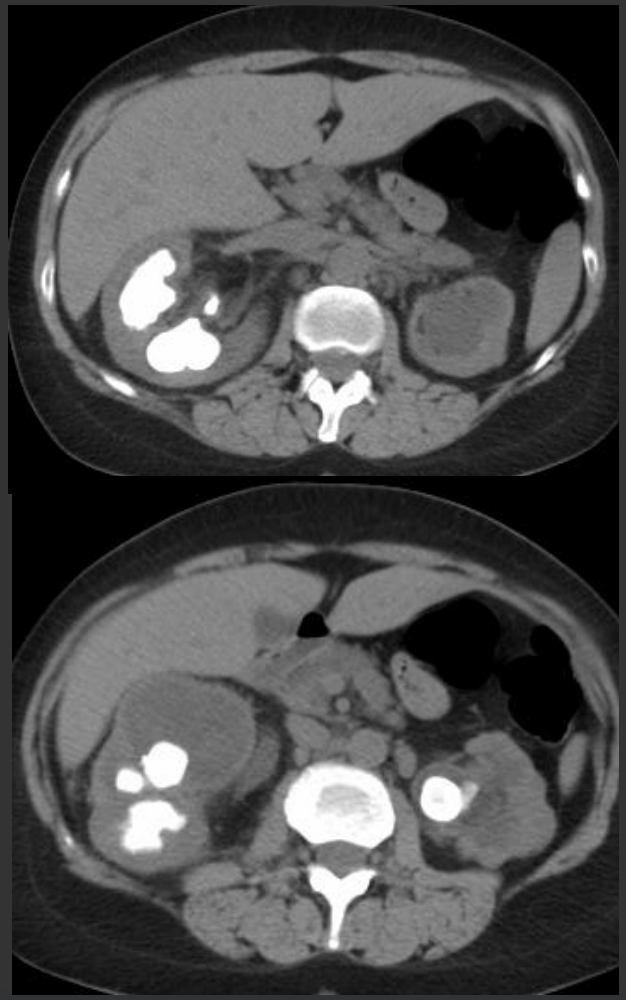


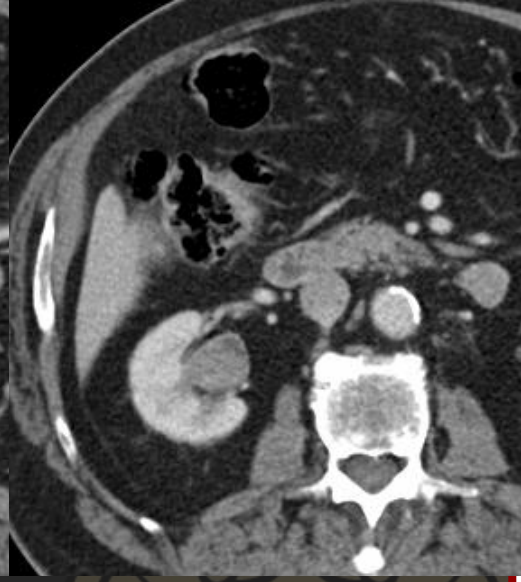
Clinical Uses of CT in the Abdomen/Pelvis

- Identification and staging of abdominal malignancies
- Inflammation, infection, or abscess
- Trauma
- Vascular abnormalities
- Transplant work-up
- Urinary tract stone disease/CT Urography
- CT Colonography









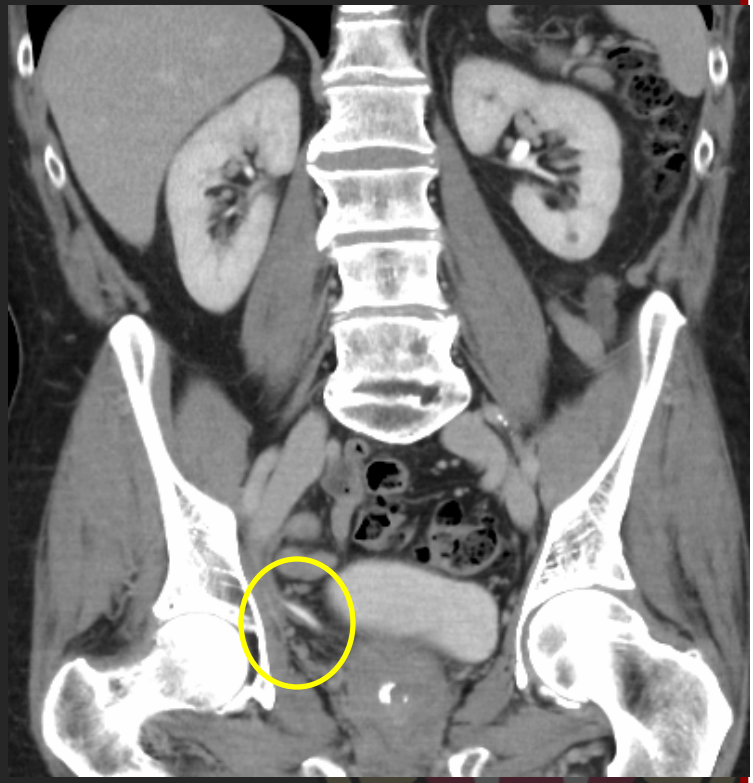


Split bolus CT

- Contrast bolus given in two+ separate injections
- Delay depends on clinical task
- Can capture some of the advantages of multiphase exam with single phase

Split bolus CT urography

- Non-contrast scan to evaluate for stones
- Initial injection smaller (50 ml)
- Wait 10 minutes, 2nd larger injection (100 ml)
- Use in younger patients, no history of TCC, post ablation
- Pre-hydration, no diuretic
- +/-DECT
- Separate single bolus scan for known high risk TCC
  - Non con, 60 sec del, 10 minute delay



Chow LC et al, AJR 2007; Shaish H, Newhouse JH. Abdom Radiol 2017

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Value: 270
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Summary

- CT is a common imaging exam for a variety of indications in the abdomen/pelvis.
- The CT protocol can be tailored to the clinical question.
- Protocols may encompass changes in radiation dose based on the clinical task.
- Oral and IV contrast can be added depending on the clinical scenario.
- Timing of contrast can be varied depending on the clinical question.

Thanks for your attention!

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