HOSPITAL MEDICINE 101 PRE-COURSE: DO YOU HAVE THE GUTS? INTRODUCTION INTO ABDOMINAL IMAGING FOR HOSPITALISTS

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FINANCIAL DISCLOSURES

- Dr. Amith Skandhan, has no actual or potential conflicts of interest to disclose regarding this presentation

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Discuss	Discuss abdominal x ray interpretation including identification of free air, ileus/small bowel obstruction, large bowel obstruction
Interpret	Interpret common acute abdominal CT scan findings
Recognize	Recognize common hospital medicine related disease processes which require abdominal imaging
Review	Review specific studies for specific disease processes and organ systems

BY THE END OF THIS PRESENTATION, PARTICIPANTS SHOULD BE ABLE TO

ABDOMINAL X RAY

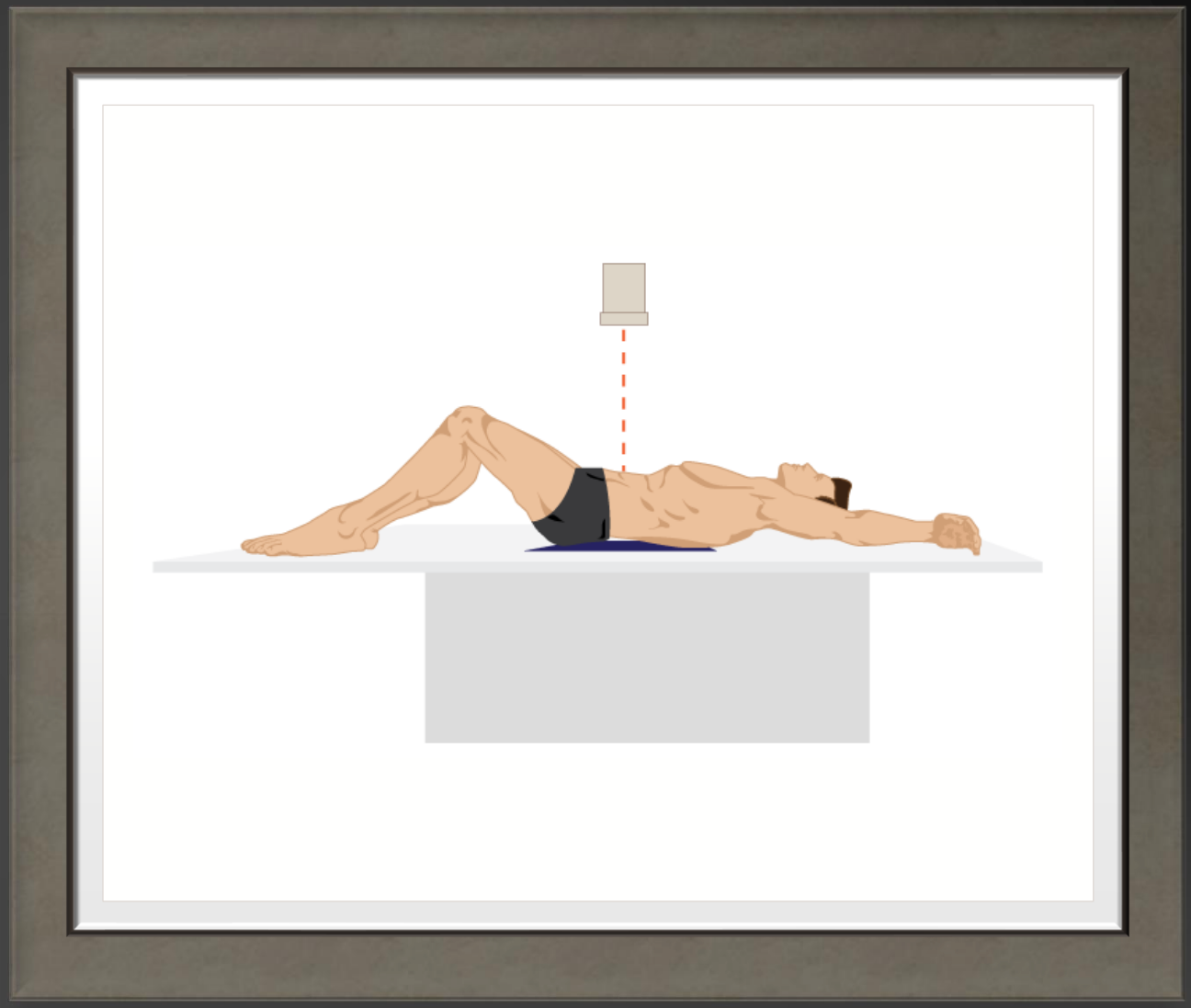
HOW WILL YOU ASSESS IMAGE TYPE AND QUALITY

- **Projection:** Supine, Upright, Decubitus, Other
- **Rotation:** The spinous processes of the vertebrae should be equidistant between the pedicles
- **Exposure:** The bones of the spine should be discernible

- Case courtesy of Dr Jeremy Jones, Radiopaedia.org, rID: 34068
- Undergraduate Diagnostic Imaging Fundamentals

SUPINE POSITIONING

- The patient lies on their back and the x-ray beam enters anteriorly.
- There will be **no discernible air-fluid levels in the intestine on this view.**
- *Undergraduate Diagnostic Imaging Fundamentals*

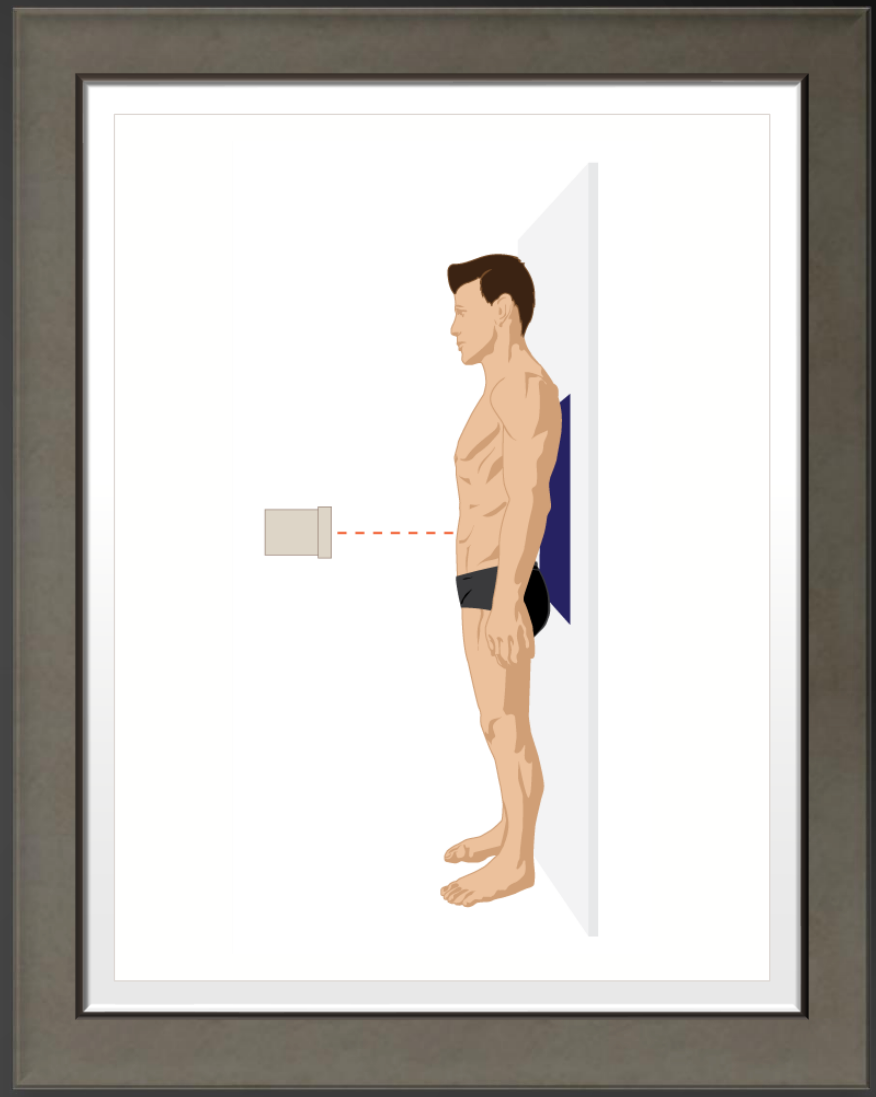


UPRIGHT POSITIONING

- The table is oriented in a vertical orientation and the x-ray beam enters from the anterior abdomen.

- **This image optimally visualizes air-fluid levels and free, intraperitoneal gas.**

- *Undergraduate Diagnostic Imaging Fundamentals*



DECUBITUS POSITIONING

- The patient lies with their side down to the table and the x-ray beam enters anteriorly.
- Time should be allocated to allow for any gas to rise to the non-dependent region of the abdomen. **This is a view commonly used to detect free, intraperitoneal, gas.**

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HOW TO READ AN ABDOMINAL X RAY

- **White:** Bone and calcification
- **Grey:** Soft tissue
- **Black:** Air

- **BBC APPROACH:**
  - Bowel & other organs
  - Bones
  - Calcification & artifact

- *Radiology of the abdomen – Abdulaziz Almaine MD*

- *Undergraduate Diagnostic Imaging Fundamentals*

WHY ARE ABDOMINAL X-RAYS SO VARIABLE?

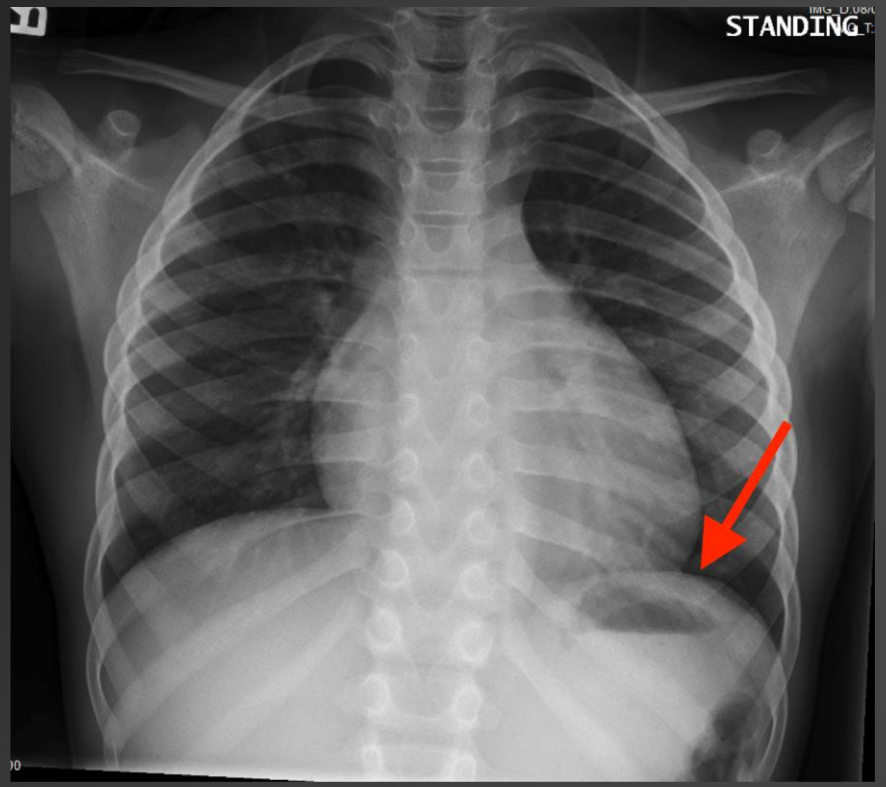
- The conspicuity of an anatomic structure depends upon whether it contains gas or is surrounded by fat.
- Therefore, intestine not filled with gas that does not have fat at its margins, will not be seen on x-ray.

- *Undergraduate Diagnostic Imaging Fundamentals*

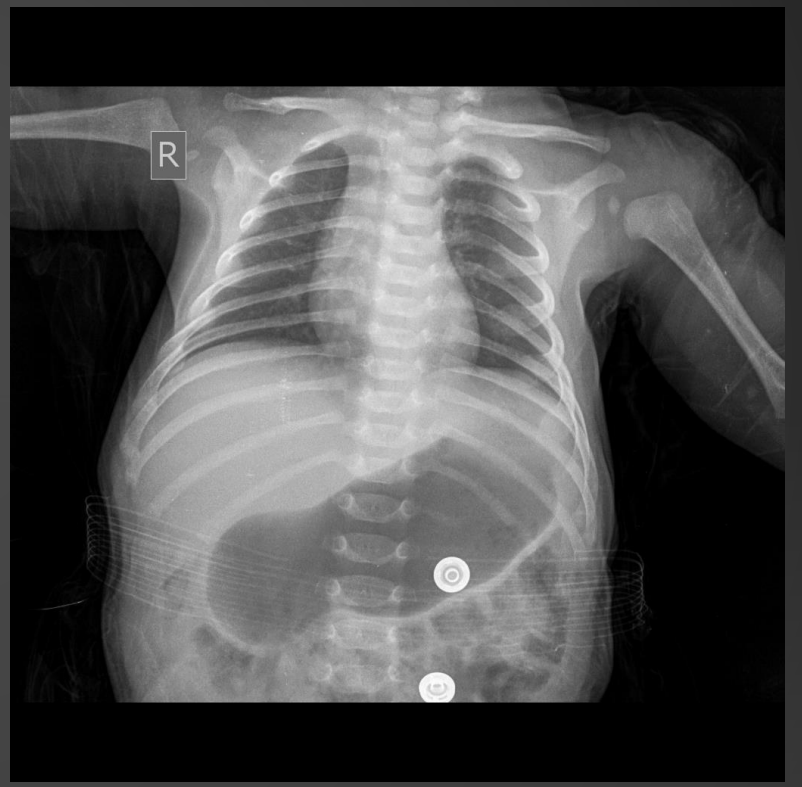
The stomach is in the left upper quadrant and usually has gas within it.

An air-fluid level can be seen in the stomach on the upright and decubitus views.

NORMAL GASTRIC BUBBLE



GASTRIC DISTENTION

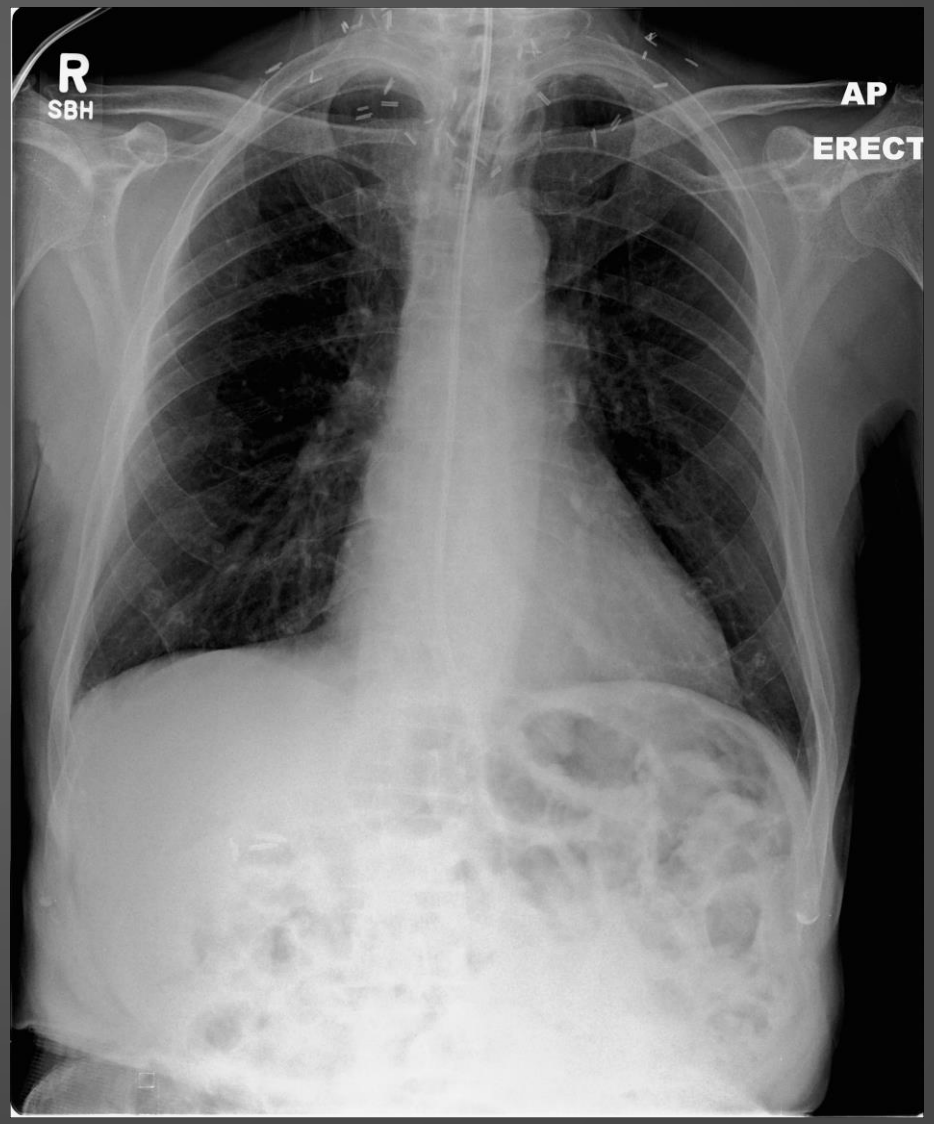


Case courtesy of Dr Fadi Ali, Radiopaedia.org, rID: 84718

NASOGASTRIC TUBE (NGT):

- This is a case where the NGT is likely to be in the GI tract, but is not properly placed in the stomach.
- If advanced slightly, the tip will be in the stomach and either aspirate will be gained, or can be checked again by x-ray.

- *Case courtesy of Dr Derek Smith, Radiopaedia.org, rID: 35554*



CASE:

- 33-year-old female who had an EGD with biopsy was brought in when she developed sudden onset of severe upper abdominal pain with associated nausea, fever and diaphoresis.

- Extensive free subdiaphragmatic gas.

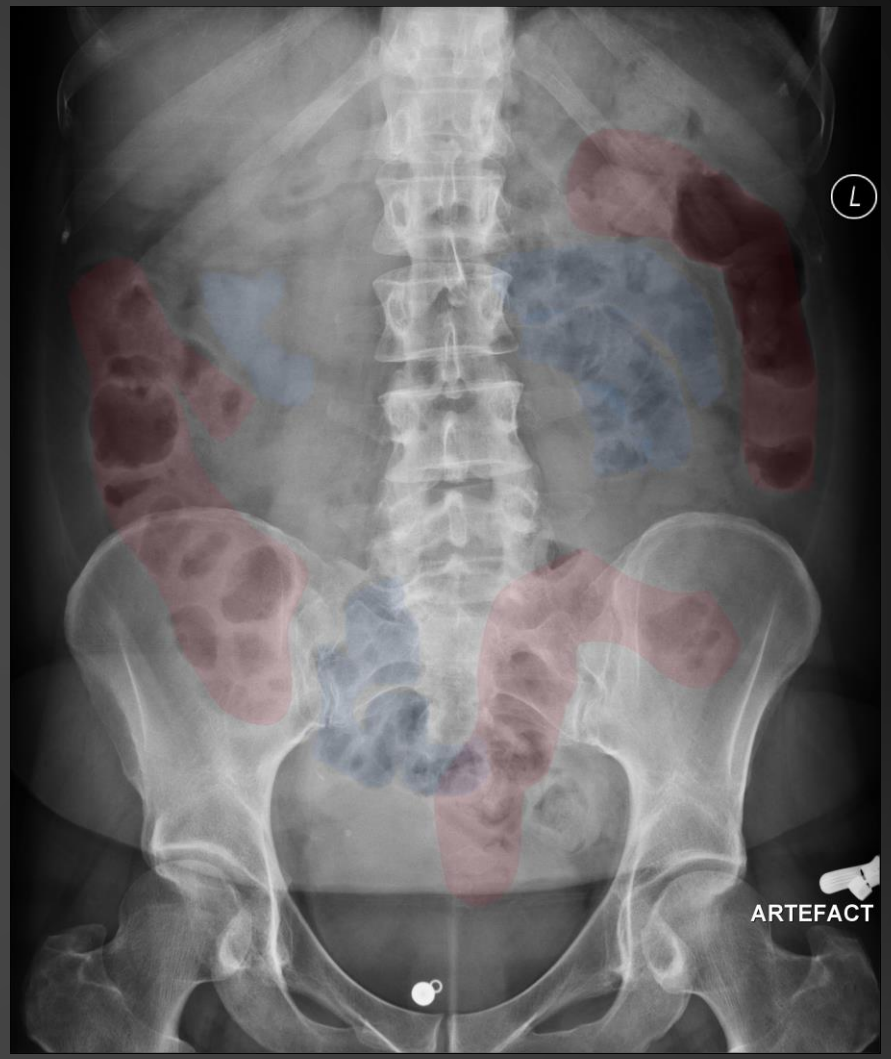
- Case courtesy of Dr Henry Knipe, Radiopaedia.org, rID: 35354

HOW TO DIFFERENTIATE BETWEEN SMALL AND LARGE BOWELS ON AN ABDOMINAL XRAY?

- The **small bowel** usually lies more centrally, with the large bowel framing it around the periphery.
- The small bowel's mucosal folds are called valvulae conniventes and are usually seen across the full width of the bowel.

- *Undergraduate Diagnostic Imaging Fundamentals*

- The **large bowel** wall features pouches or sacculations
call *haustra* (*pl*), *haustrum* (*sing*).
- Between the haustra are bridges of soft tissue that project into the colonic lumen, known as the plicae semilunares coli.
- The fold pattern created by the plicae are thicker than the valvulae conniventes of the small bowel and usually do not completely traverse the lumen of the colon.

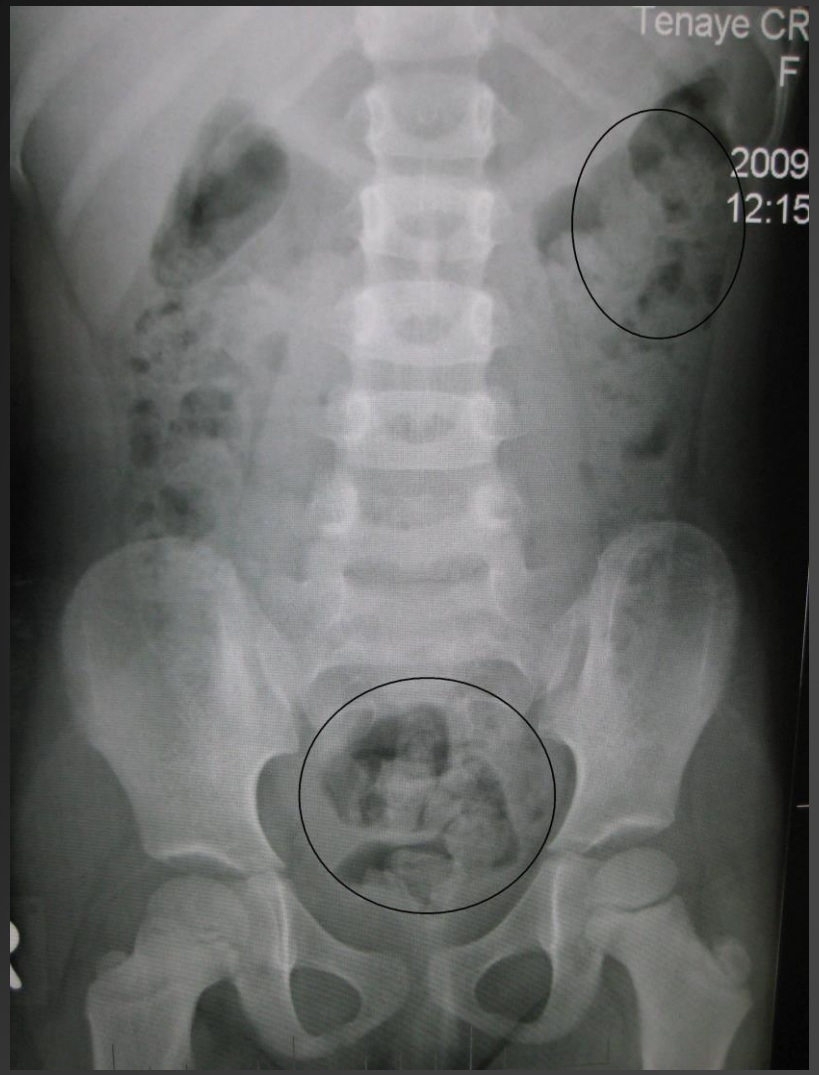


Case courtesy of Dr Jeremy Jones, Radiopaedia.org, rID: 34068

HOW DOES FECES LOOK ON XRAY?

- **Feces** has a mottled appearance and are most often seen in the colon, due to trapped gas within solid feces.
- There is considerable normal variation in the distribution of bowel gas and fecal material.

- *Undergraduate Diagnostic Imaging Fundamentals*



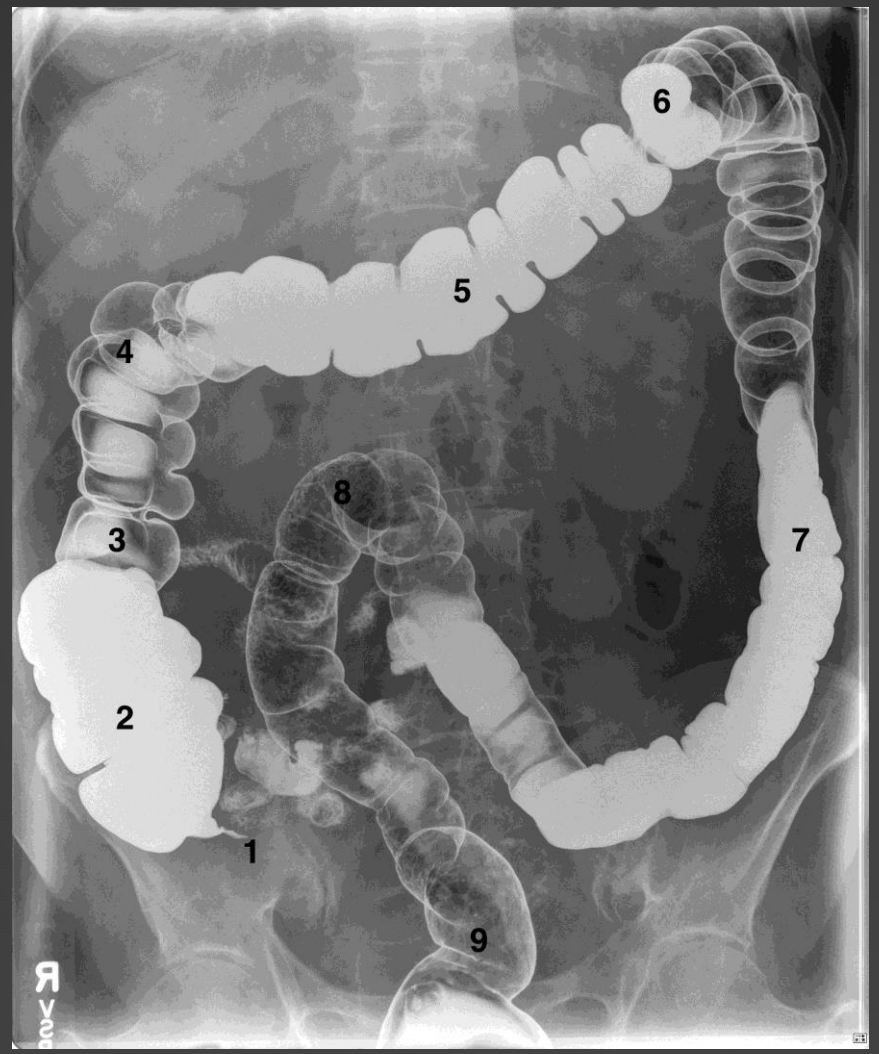
BY JAMES HEILMAN, MD - HTTPS://IASOTEA10.COM/PERDIDA-DE-PESO/IASO-TEA/, CC BY 3.0, HTTPS://COMMONS.WIKIMEDIA.ORG/W/INDEX.PHP?CURID=6876565

CASE COURTESY OF DR IAN BICKLE, RADIOPAEDIA.ORG, RID: 75114

3/6/9 RULE

- The upper limit of normal diameter of the intestines should not exceed:
  - 3cm - Small bowel
  - 6cm - Colon, except for Cecum
  - 9cm - Cecum

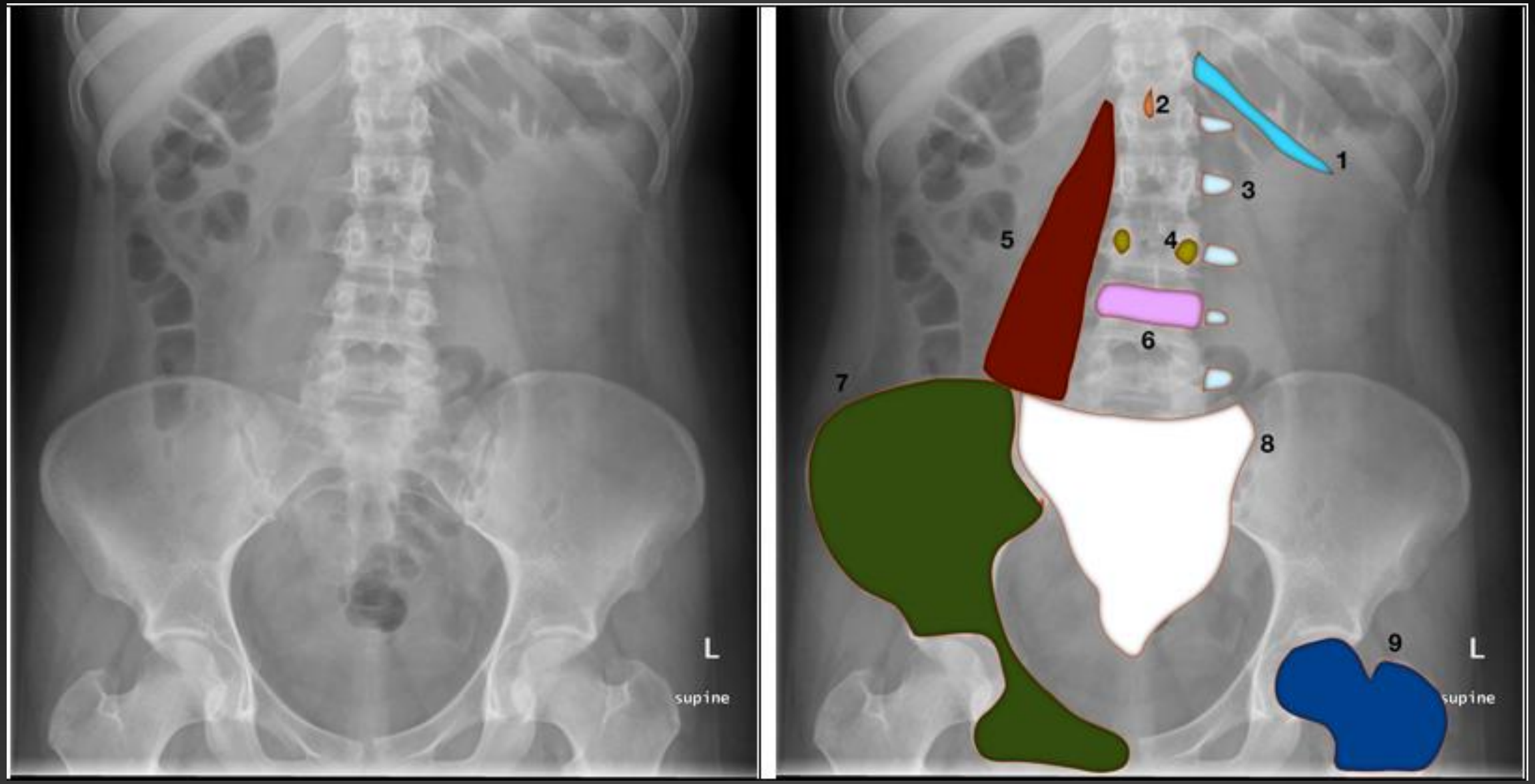
BARIUM STUDY



OTHER ORGANS AND STRUCTURES IN ABDOMINAL X RAY

Lungs	Check the lung bases, if visible, for abnormalities (e.g. consolidation, pleural fluid), as abdominal pain can sometimes be caused by chest abnormalities (referred pain)
Liver	Large right upper quadrant (RUQ) structure
Gallbladder	Rarely seen. Look for calcified gallstones or cholecystectomy clips
Stomach	Left Upper Quadrant to midline structure. Often contains visible gas. **Air-fluid level will change with the projection obtained i.e. not seen on AP, transverse on upright, longitudinal on decubitus.**

Psoas muscles	The lateral margin is seen as an oblique, low density, line on either side of the vertebral column.
Kidneys	Often visible, right kidney lower than left
Spleen	Left Upper Quadrant (LUQ), superior to the kidney
Bladder	Variable appearance based upon the degree of fullness. It is outlined by a low density line of fat.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supine
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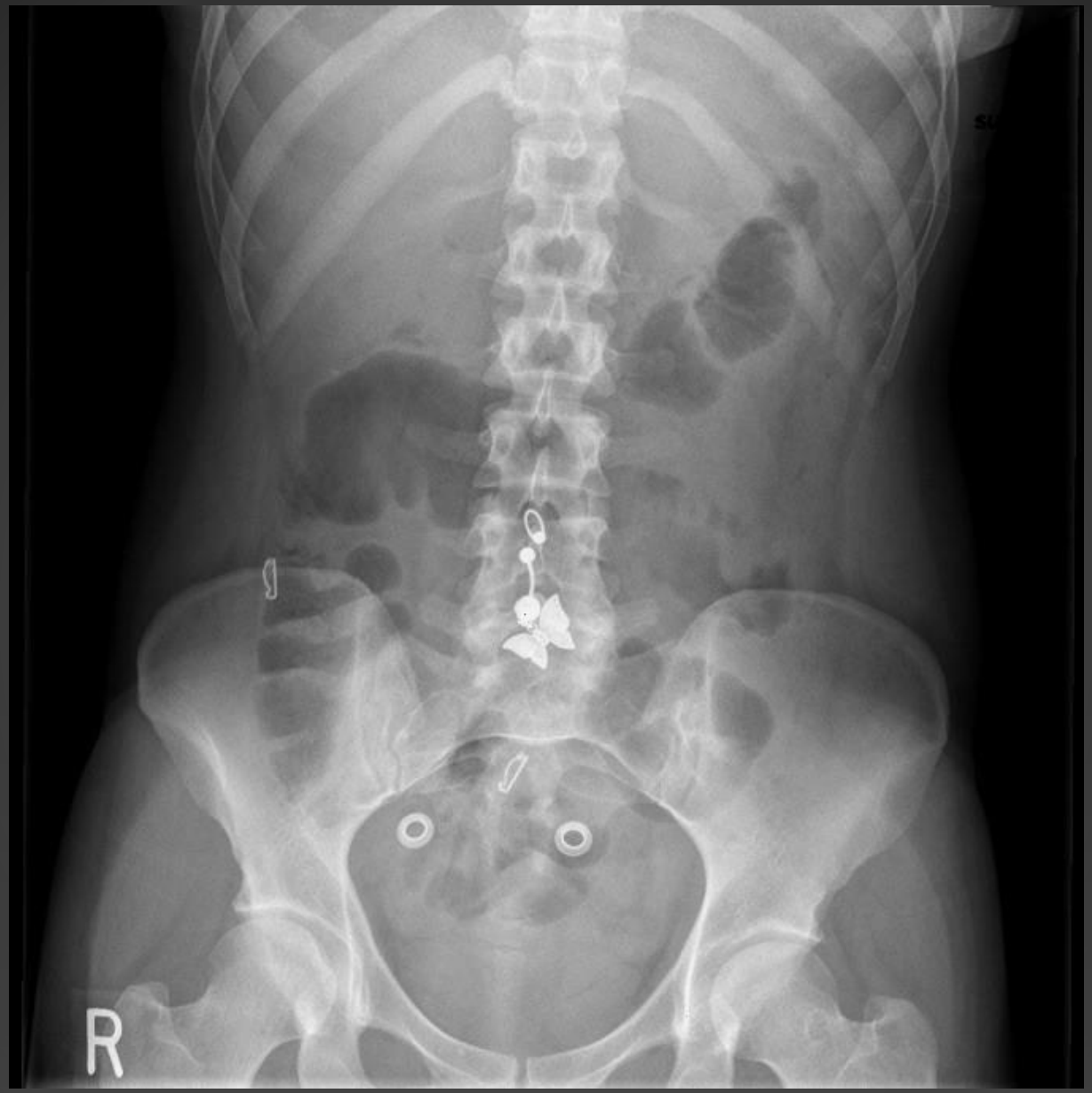
CALCIFICATION AND ARTIFACTS

- Various high density (white) areas of calcification or artifacts may be seen
- Examples include:
  - Calcified gallstones in the RUQ
  - Renal calculi
  - Pancreatic calcification
  - Vascular calcification
  - Costochondral cartilage calcification
  - Contrast (e.g. following barium administration)
  - Surgical clips
  - Metallic umbilical jewelry, artifact over the approximate location of the umbilicus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A CASE OF KIDNEY STONE

- A KUB was performed in this patient as part of her evaluation for UTI. The finding of a round laminated opacity at the right renal hilum raised the suspicion of nephrolithiasis.
- *Case courtesy of Dr Saeed Soltany Hosn, Radiopaedia.org, rID: 20050*

CT SCAN OF ABDOMEN/PELVIS

CT SCANS OF ABDOMEN-PELVIS: WHEN DO YOU NEED CONTRAST

- PO contrast
- Oral contrast is used to visualize bowel pathology

- IV contrast
- IV contrast is used to visualize the vasculature and internal organs of abdomen-pelvis

CONTRAINDICATIONS TO CONTRAST

- Metformin use
- Pregnancy
- Renal failure
- Allergic reaction

INDICATIONS

NON-CONTRASTED CT SCAN

- **Renal stone**

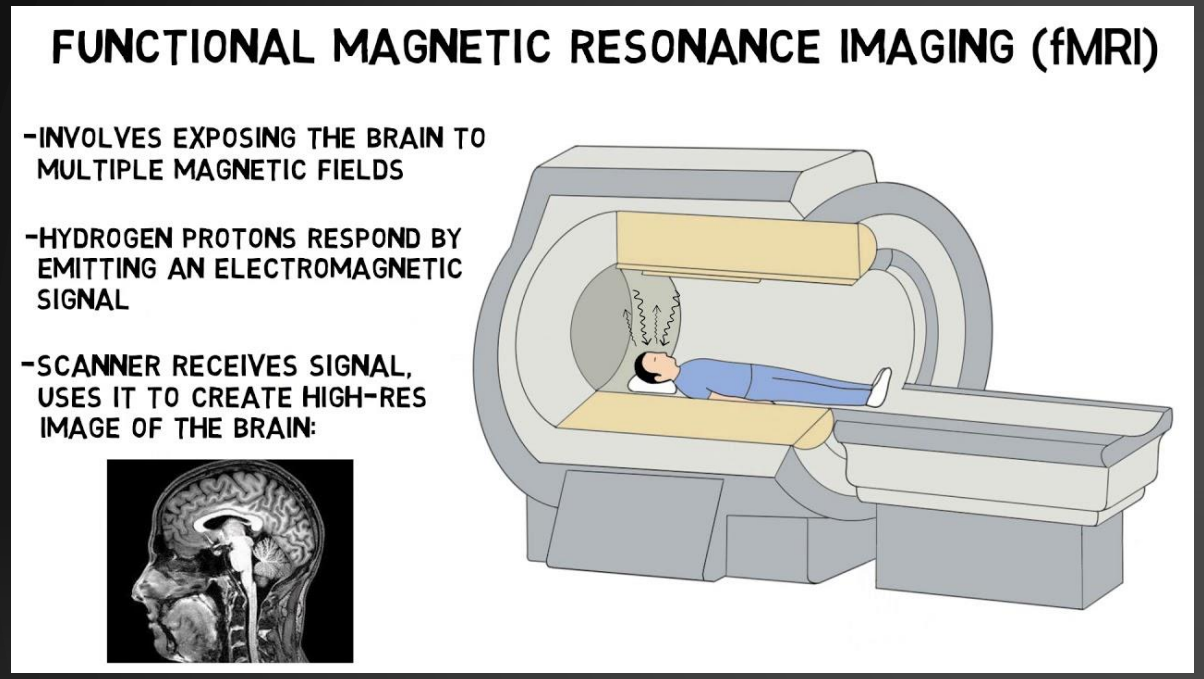
CONTRAST CT SCAN

- Pain
- Colitis
- Crohn's
- Appendicitis
- Tumor, cancer, mass

CT ANGIOGRAM (CTA)

- CT Angiography, or CTA, is a type of contrasted CT scan used to evaluate the blood vessels.
- Abdominal Aorta (CTA Abdomen) – Aneurysm, dissection, post stent grafting, renal artery stenosis, metastatic stenosis

MRI ABDOMEN-PELVIS

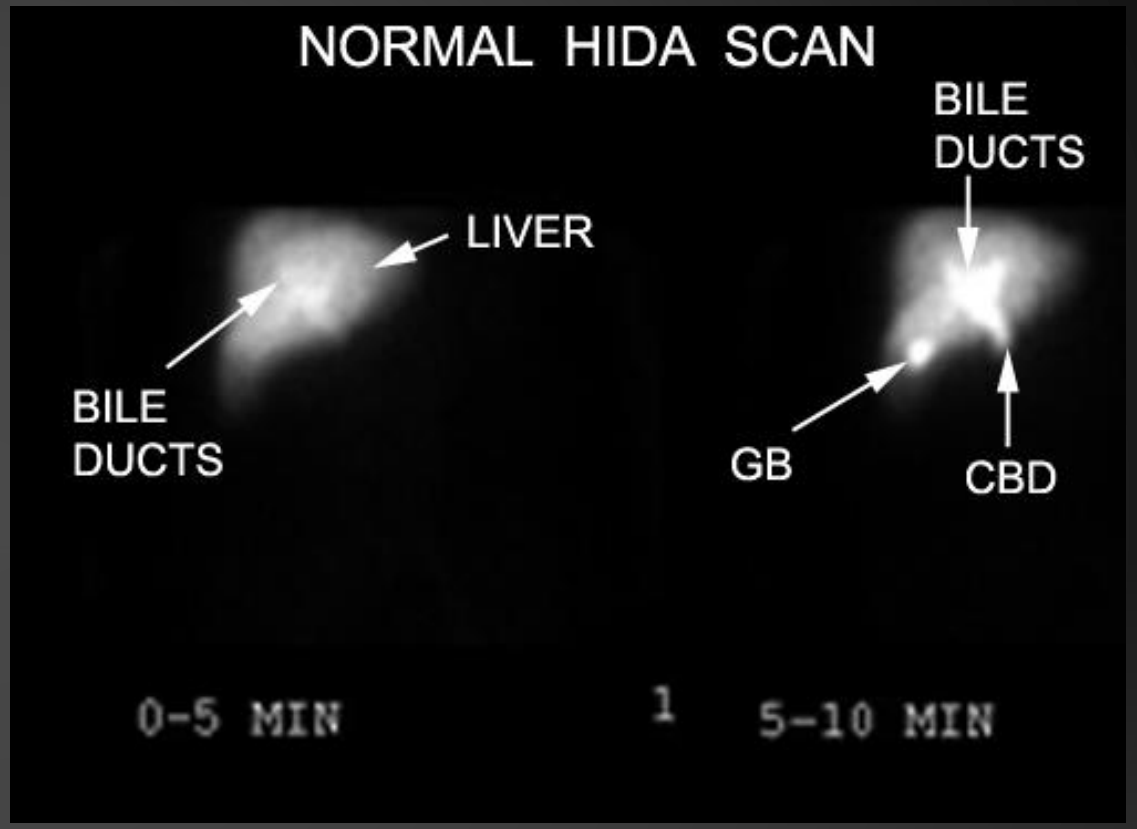


- MRI does **NOT** involve radiation
- IV Contrast in MRI is Gadolinium Based
- Gadolinium based contrast can cause Nephrogenic systemic fibrosis (NSF). NSF is a rare disease that occurs mainly in people with advanced kidney failure with or without dialysis

- IV Contrast or Not?
- MRCP?

HEPATOBILIARY IMINODIACETIC ACID SCAN (HIDA)

- A radiotracer used is iminodiacetic acid (IDA), is administered intravenously, bound to albumin, transported to the liver, and excreted into the biliary system.
- In some patients, when you want a stimulant to check for gallbladder emptying.
- DO NOT use a stimulated HIDA scan study on a patient who has gallstones
- On a bile leak patient use a non-stimulated HIDA scan



SMALL BOWEL OBSTRUCTION

- Small-bowel obstruction (SBO) is responsible for up to 16% of hospital admissions for abdominal pain with mortality ranging between 2% to 8% overall, and as high as 25% when associated with bowel ischemia.
- Imaging not only diagnoses the presence of SBO but also can aid in the differentiation of high-grade (needing surgical intervention) from low-grade obstruction (needing conservative management with enteric tube decompression).

- The typical acute presentation of a patient suspected of having SBO includes intermittent crampy central abdominal pain, distension, nausea, and vomiting.
- Physical examination findings include abdominal distension with either absent or high-pitched bowel sounds.
- Abnormal laboratory findings such as an elevated white blood cell count, elevated lactic acid, or elevated serum amylase raise the suspicion for a complication such as ischemia.
- However, **physical examination and laboratory tests are neither sufficiently sensitive nor specific to determine which patients with SBO have coexistent strangulation or ischemia.**

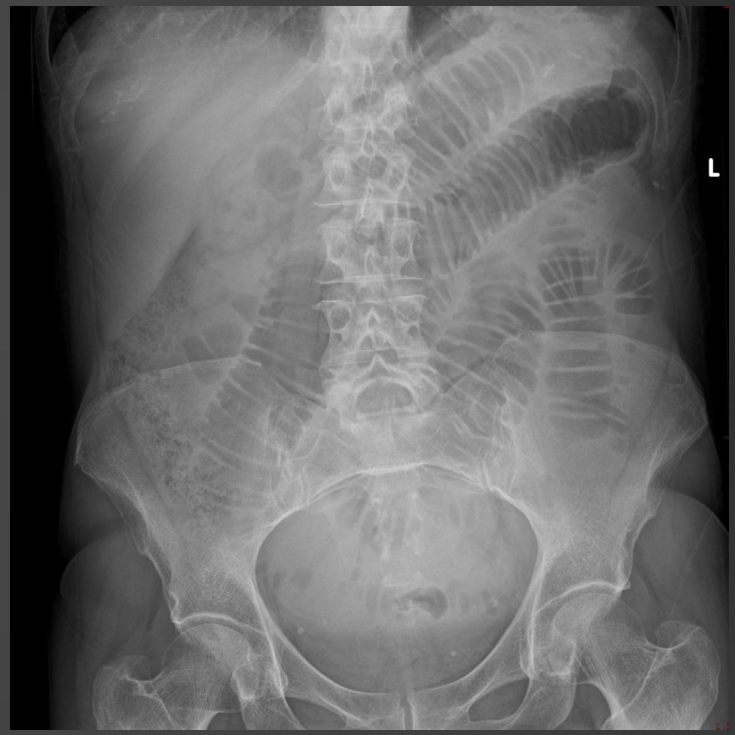
ABDOMINAL X RAY IN SMALL BOWEL OBSTRUCTION (SBO)

- In SBO, you have dilation of small bowel > 3 cm
- The valvulae conniventes are much more visible and have what is referred to as a "*coiled spring appearance*".

- The most common cause (75%) of small bowel obstruction is adhesions (related to previous abdominal surgery).

A CASE OF SMALL BOWEL OBSTRUCTION

- Multiple features to indicate a high grade small bowel obstruction.
  - a. Dilated bowel in the central abdomen
  - b. The valvulae connivente are beautifully illustrated indicating it is small bowel.
  - c. The large bowel is collapsed.
- At laparotomy, this was an adhesional obstruction of the distal small bowel.
- *Case courtesy of Dr Ian Bickle, Radiopaedia.org, rID: 75101*

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LARGE BOWEL OBSTRUCTION

- Large bowel obstruction is most often due to colorectal *carcinoma* and diverticular related *strictures*.
- Less common causes are hernias or a volvulus.

A CASE OF LARGE BOWEL OBSTRUCTION

- The large bowel is gas filled and distended down to the level of the distal descending colon-sigmoid.
- Small bowel collapsed.
- No free gas.

- *Case courtesy of Dr Ian Bickle, Radiopaedia.org, rID: 50391*


R
XR ABDOMEN

AMERICAN COLLEGE OF RADIOLOGY ACR APPROPRIATENESS CRITERIA SUSPECTED SMALL-BOWEL OBSTRUCTION

Variant 1: **Suspected small-bowel obstruction. Acute presentation. Initial imaging.**

Procedure	Appropriateness Category	Relative Radiation Level
CT abdomen and pelvis with IV contrast	Usually Appropriate	☢☢☢
CT abdomen and pelvis without IV contrast	May Be Appropriate	☢☢☢
MRI abdomen and pelvis without and with IV contrast	May Be Appropriate	O
Radiography abdomen and pelvis	May Be Appropriate (Disagreement)	☢☢☢
Fluoroscopy small bowel follow-through	May Be Appropriate	☢☢☢
MRI abdomen and pelvis without IV contrast	May Be Appropriate	O
CT abdomen and pelvis without and with IV contrast	Usually Not Appropriate	☢☢☢☢
CT enteroclysis	Usually Not Appropriate	☢☢☢☢
CT enterography	Usually Not Appropriate	☢☢☢☢
MR enterography	Usually Not Appropriate	O
US abdomen and pelvis	Usually Not Appropriate	O
Fluoroscopy small bowel enteroclysis	Usually Not Appropriate	☢☢☢
MR enteroclysis	Usually Not Appropriate	O

Variant 2: **Suspected intermittent or low-grade small-bowel obstruction. Indolent presentation.**

Procedure	Appropriateness Category	Relative Radiation Level
CT abdomen and pelvis with IV contrast	Usually Appropriate	☢☢☢
CT enterography	Usually Appropriate	☢☢☢☢
CT enteroclysis	May Be Appropriate	☢☢☢☢
MR enterography	May Be Appropriate	O
CT abdomen and pelvis without IV contrast	May Be Appropriate	☢☢☢
Fluoroscopy small bowel enteroclysis	May Be Appropriate	☢☢☢
Fluoroscopy small bowel follow-through	May Be Appropriate	☢☢☢
MRI abdomen and pelvis without and with IV contrast	May Be Appropriate	O
MR enteroclysis	May Be Appropriate	O
MRI abdomen and pelvis without IV contrast	May Be Appropriate	O
CT abdomen and pelvis without and with IV contrast	Usually Not Appropriate	☢☢☢☢
Radiography abdomen and pelvis	Usually Not Appropriate	☢☢☢
US abdomen and pelvis	Usually Not Appropriate	O

CASE

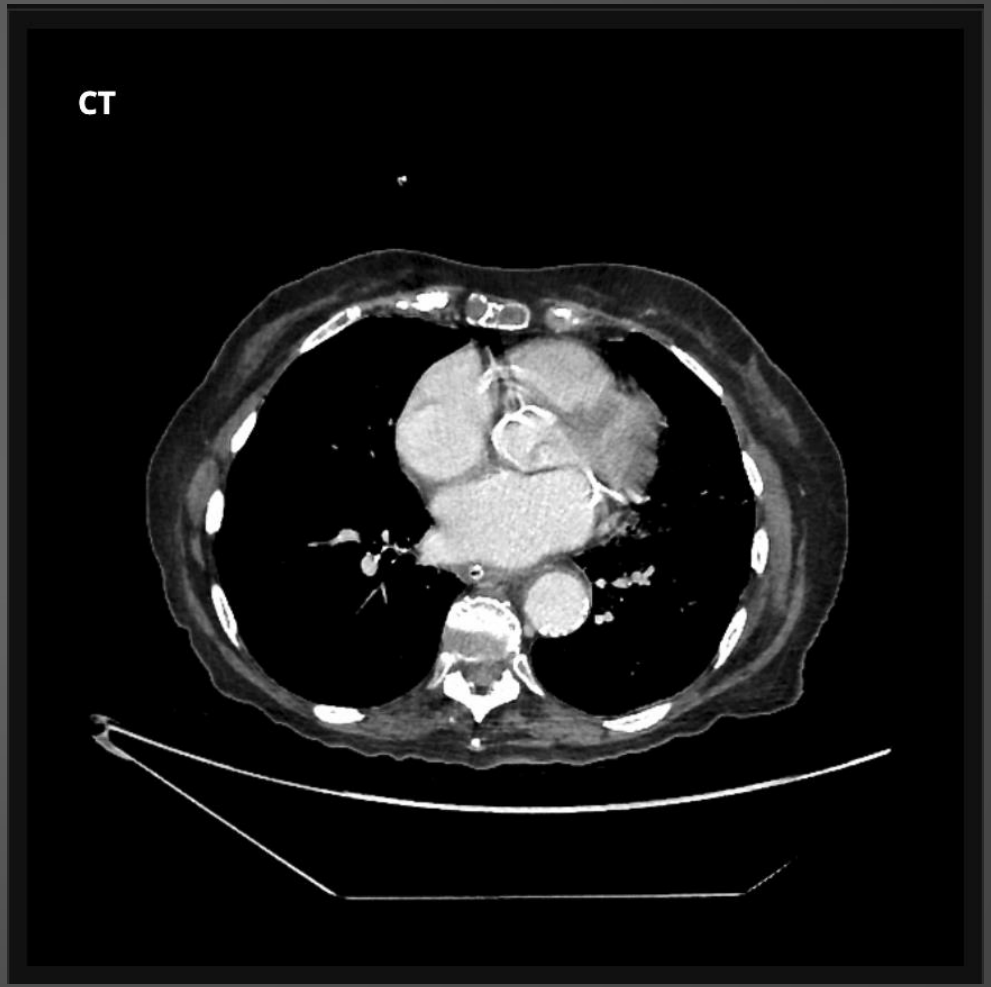
- 90-year-old female with past medical history of surgery for small bowel obstruction with abdominal pain & distention, with no signs of fever and shock.

- *Case courtesy of Dr Tom O'Graphy, Radiopaedia.org, rID: 36878*

- Abdominal radiograph showing dilated bowel in the lower abdomen.

- *Case courtesy of Dr Tom O'Graphy, Radiopaedia.org, rID: 36878*

- Marked dilatation of the stomach and small bowel loops. Bowel wall thickening in left lower quadrant, at the transition area of dilated and collapsed small bowel.
- Mesenteric hyperemia and fluid infiltration of surrounding fat.
- Small foci of gas around the bladder, and also under peritoneum inside the bladder. This is not typical for gastrointestinal perforation.
- No abnormalities in the pancreas, spleen, kidneys, adrenal glands or liver. No peritoneal effusion. The large bowel is not dilated. There is uncomplicated diverticulosis of the ascending and sigmoid colon.
- *Case courtesy of Dr Tom O'Graphy, Radiopaedia.org, rID: 36878*



ACUTE PANCREATITIS

- Acute pancreatitis (AP), an inflammatory process affecting the pancreas, is the **third most frequent gastrointestinal cause of hospital admissions in the United States.**
- AP results in approximately 300,000 hospital admissions each year, with associated costs of approximately $2.6 billion.
- The incidence of AP is increasing and is estimated at 40 per 100,000 people.

- **The clinical diagnosis of AP requires 2 of the following 3 features:**
  - 1) abdominal pain consistent with AP (acute onset of persistent, severe, epigastric pain often radiating to the back)
  - 2) serum lipase or amylase levels at least 3 times the upper limits of normal
  - 3) characteristic findings of AP on contrast-enhanced CT, MRI, or transabdominal ultrasound (US)

  - Imaging is also performed in AP to investigate the etiology, complications, and extent of disease. Imaging AP requires an understanding of the disease subtypes, evolution, and associated complications.

AMERICAN COLLEGE OF RADIOLOGY ACR APPROPRIATENESS CRITERIA ACUTE PANCREATITIS

Variant 1: **Suspected acute pancreatitis. First-time presentation. Epigastric pain and increased amylase and lipase. Less than 48 to 72 hours after symptom onset. Initial imaging.**

Procedure	Appropriateness Category	Relative Radiation Level
US abdomen	Usually Appropriate	O
CT abdomen and pelvis with IV contrast	May Be Appropriate	☢☢☢
MRI abdomen without and with IV contrast with MRCP	May Be Appropriate	O
MRI abdomen without IV contrast with MRCP	May Be Appropriate	O
US duplex Doppler abdomen	May Be Appropriate	O
CT abdomen and pelvis without and with IV contrast	Usually Not Appropriate	☢☢☢☢
CT abdomen and pelvis without IV contrast	Usually Not Appropriate	☢☢☢
US abdomen with IV contrast	Usually Not Appropriate	O

Variant 2: **Suspected acute pancreatitis. Initial presentation with atypical signs and symptoms; including equivocal amylase and lipase values (possibly confounded by acute kidney injury or chronic kidney disease) and when diagnoses other than pancreatitis may be possible (bowel perforation, bowel ischemia, etc). Initial imaging.**

Procedure	Appropriateness Category	Relative Radiation Level
CT abdomen and pelvis with IV contrast	Usually Appropriate	☢☢☢
MRI abdomen without and with IV contrast with MRCP	Usually Appropriate	O
CT abdomen and pelvis without IV contrast	May Be Appropriate	☢☢☢
MRI abdomen without IV contrast with MRCP	May Be Appropriate	O
US abdomen	May Be Appropriate	O
US duplex Doppler abdomen	May Be Appropriate	O
CT abdomen and pelvis without and with IV contrast	Usually Not Appropriate	☢☢☢☢
US abdomen with IV contrast	Usually Not Appropriate	O

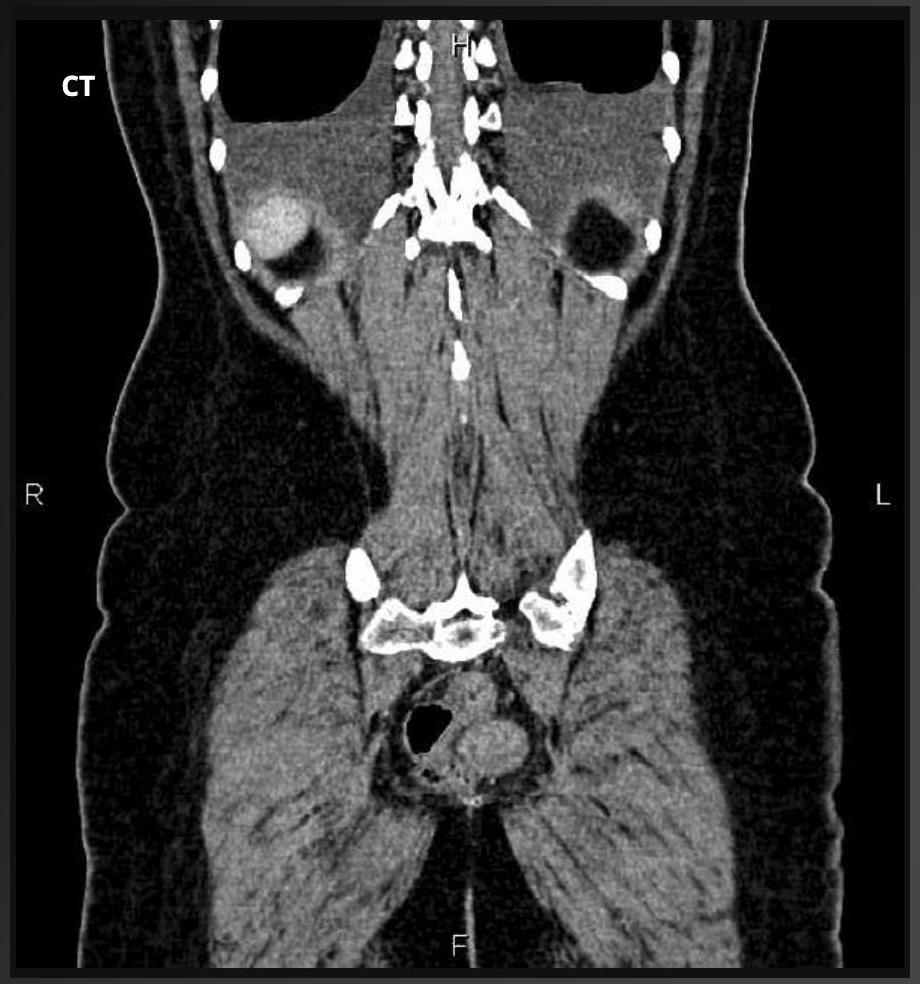
Variant 3: **Acute pancreatitis. Critically ill, systemic inflammatory response syndrome (SIRS), severe clinical scores (eg, Acute Physiology, Age, and Chronic Health Evaluation [APACHE]-II, Bedside Index for Severity in AP [BISAP], or Marshall). Greater than 48 to 72 hours after onset of symptoms.**

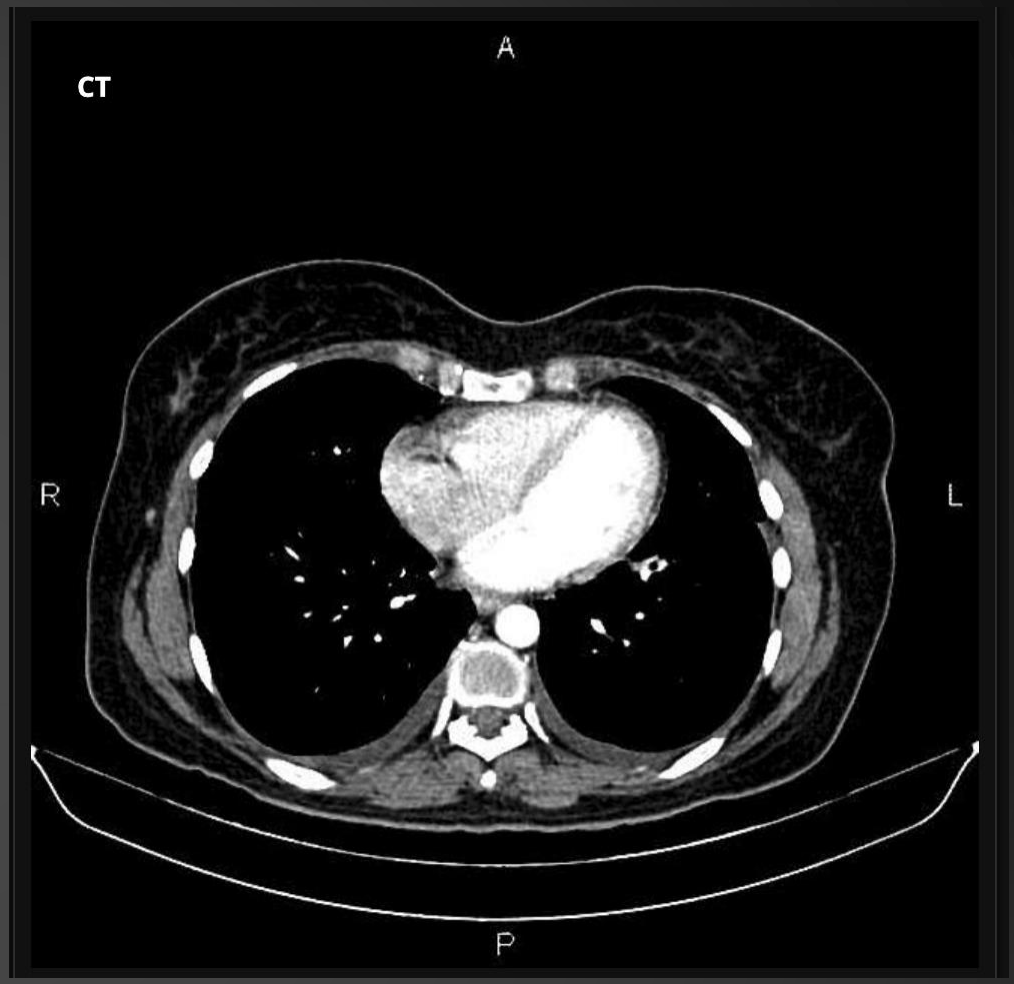
Procedure	Appropriateness Category	Relative Radiation Level
CT abdomen and pelvis with IV contrast	Usually Appropriate	☢☢☢
MRI abdomen without and with IV contrast with MRCP	Usually Appropriate	O
MRI abdomen without IV contrast with MRCP	May Be Appropriate	O
CT abdomen and pelvis without IV contrast	May Be Appropriate	☢☢☢
US duplex Doppler abdomen	May Be Appropriate	O
CT abdomen and pelvis without and with IV contrast	Usually Not Appropriate	☢☢☢☢
US abdomen	Usually Not Appropriate	O
US abdomen with IV contrast	Usually Not Appropriate	O

CASE OF ACUTE PANCREATITIS

- 50-year-old alcoholic presented with severe upper abdominal pain and is found to be tachycardiac, with systolic blood pressures in 90's.
- The important role of CT scan in the context of acute pancreatitis is to evaluate for possible complications such as
  - Necrosis
  - Hemorrhage
  - Infection
  - Vascular complications (such as pseudoaneurysm)
  - Intra- or peripancreatic collections

- Case courtesy of Dr Mohammad Taghi Niknejad, Radiopaedia.org, rID: 89473





The pancreas is enlarged particularly at distal portion accompanied by peripancreatic fluid accumulation and fat stranding.
Some pleural effusion is present bilaterally accompanied by bilateral lower lobe sub segmental collapse.

ACUTE NON LOCALIZED ABDOMINAL PAIN

- The impact of imaging underscores the difficulty in making an accurate clinical diagnosis when patients present with non-localizing abdominal pain.
- Associated fever with abdominal pain constitutes an even more challenging clinical situation.
- **Fever** raises clinical suspicion of an intra-abdominal infection, abscess, or other condition that may need immediate surgical or medical attention.

AMERICAN COLLEGE OF RADIOLOGY ACR APPROPRIATENESS CRITERIA ACUTE NONLOCALIZED ABDOMINAL PAIN

Variant 1: **Acute nonlocalized abdominal pain and fever. No recent surgery. Initial imaging.**

Procedure	Appropriateness Category	Relative Radiation Level
CT abdomen and pelvis with IV contrast	Usually Appropriate	☢☢☢
MRI abdomen and pelvis without and with IV contrast	May Be Appropriate	O
US abdomen	May Be Appropriate	O
CT abdomen and pelvis without IV contrast	May Be Appropriate	☢☢☢
MRI abdomen and pelvis without IV contrast	May Be Appropriate	O
CT abdomen and pelvis without and with IV contrast	May Be Appropriate	☢☢☢☢
Radiography abdomen	May Be Appropriate	☢☢
FDG-PET/CT skull base to mid-thigh	Usually Not Appropriate	☢☢☢☢
WBC scan abdomen and pelvis	Usually Not Appropriate	☢☢☢☢
Nuclear medicine scan gallbladder	Usually Not Appropriate	☢☢
Fluoroscopy contrast enema	Usually Not Appropriate	☢☢☢
Fluoroscopy upper GI series with small bowel follow-through	Usually Not Appropriate	☢☢☢

Variant 2: **Acute nonlocalized abdominal pain and fever. Postoperative patient. Initial imaging.**

Procedure	Appropriateness Category	Relative Radiation Level
CT abdomen and pelvis with IV contrast	Usually Appropriate	☢☢☢
MRI abdomen and pelvis without and with IV contrast	May Be Appropriate	O
US abdomen	May Be Appropriate	O
CT abdomen and pelvis without IV contrast	May Be Appropriate	☢☢☢
MRI abdomen and pelvis without IV contrast	May Be Appropriate	O
CT abdomen and pelvis without and with IV contrast	May Be Appropriate	☢☢☢☢
Radiography abdomen	May Be Appropriate	☢☢
Fluoroscopy contrast enema	May Be Appropriate	☢☢☢
Fluoroscopy upper GI series with small bowel follow-through	May Be Appropriate	☢☢☢
FDG-PET/CT skull base to mid-thigh	Usually Not Appropriate	☢☢☢☢
WBC scan abdomen and pelvis	Usually Not Appropriate	☢☢☢☢
Nuclear medicine scan gallbladder	Usually Not Appropriate	☢☢

Variant 3: **Acute nonlocalized abdominal pain. Neutropenic patient. Initial imaging.**

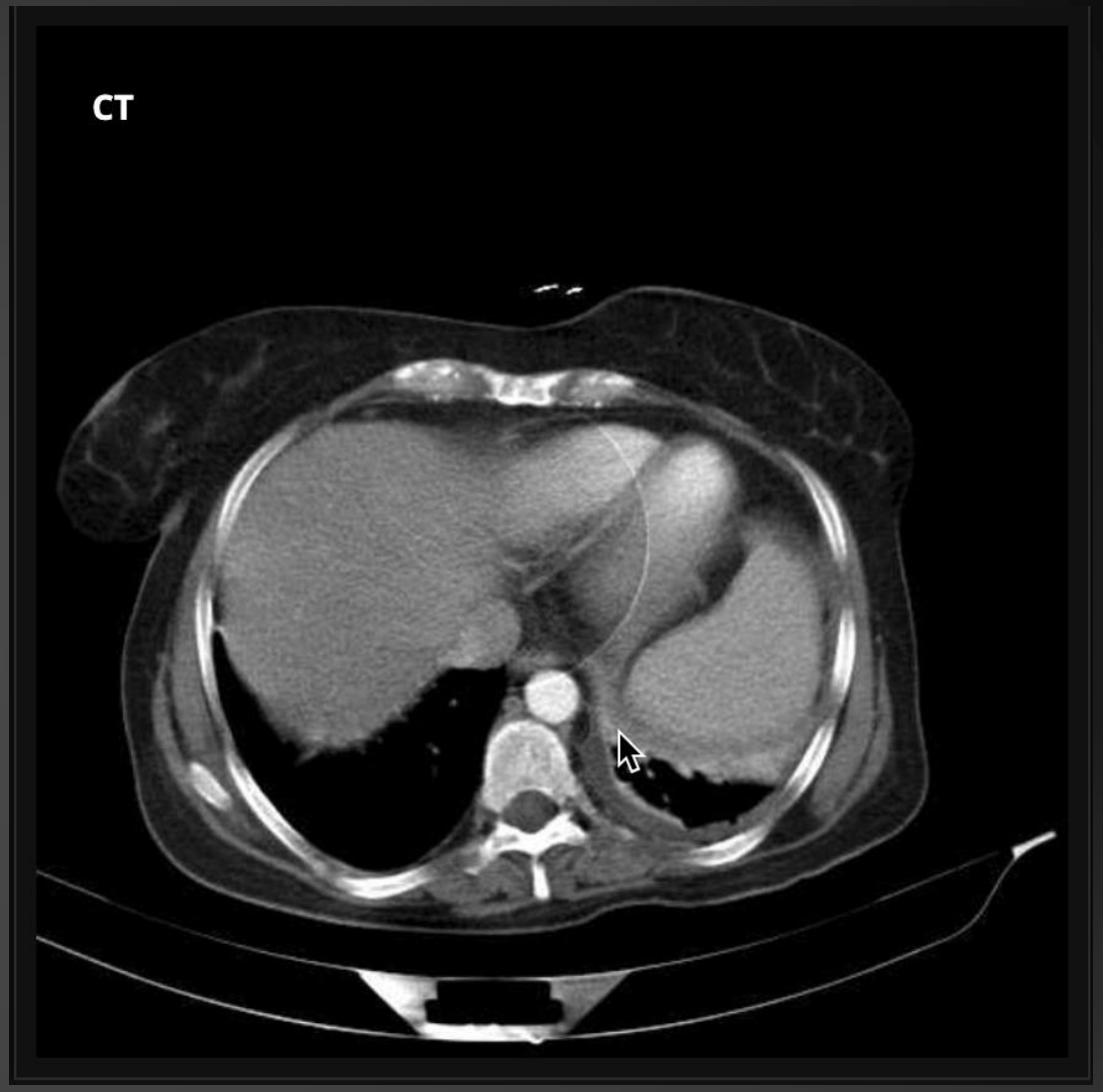
Procedure	Appropriateness Category	Relative Radiation Level
CT abdomen and pelvis with IV contrast	Usually Appropriate	☢☢☢
CT abdomen and pelvis without IV contrast	May Be Appropriate	☢☢☢
MRI abdomen and pelvis without and with IV contrast	May Be Appropriate	O
US abdomen	May Be Appropriate	O
MRI abdomen and pelvis without IV contrast	May Be Appropriate	O
CT abdomen and pelvis without and with IV contrast	May Be Appropriate	☢☢☢☢
FDG-PET/CT skull base to mid-thigh	Usually Not Appropriate	☢☢☢☢
WBC scan abdomen and pelvis	Usually Not Appropriate	☢☢☢☢
Radiography abdomen	Usually Not Appropriate	☢☢
Nuclear medicine scan gallbladder	Usually Not Appropriate	☢☢
Fluoroscopy contrast enema	Usually Not Appropriate	☢☢☢
Fluoroscopy upper GI series with small bowel follow-through	Usually Not Appropriate	☢☢☢

CASE

- A 60-year-old female who underwent left adrenalectomy for left adrenal carcinoma, presented with fever and left flank pain.

- Case courtesy of Dr Mohammad Taghi Niknejad, Radiopaedia.org, rID: 20859

- Collections with internal gas and surrounding fat stranding and fluid are seen at left perirenal and pararenal spaces (site of left adrenalectomy)
- Findings are consistent with retroperitoneal abscess



RIGHT UPPER QUADRANT PAIN

- We will go over the diagnostic accuracy of imaging studies to evaluate for acute cholecystitis, the primary diagnostic concern in the setting of acute right upper quadrant pain.

- Jaundice is an important clinical finding that suggests a different subset of conditions.

- Acute cholecystitis is the most frequent complication of gallstone disease, a common entity, but can be life threatening; therefore, timely diagnosis is essential for proper treatment.
- Although most patients with acute cholecystitis experience right upper quadrant abdominal pain, nausea, vomiting, anorexia, and fever.
- The information derived only from clinical history, physical examination, and routine laboratory tests has not yielded acceptable likelihood ratios sufficient to predict the presence or absence of acute cholecystitis.

AMERICAN COLLEGE OF RADIOLOGY
ACR APPROPRIATENESS CRITERIA
RIGHT UPPER QUADRANT PAIN

Variant 1: **Right upper quadrant pain. Suspected biliary disease. Initial imaging.**

Procedure	Appropriateness Category	Relative Radiation Level
US abdomen	Usually Appropriate	O
CT abdomen with IV contrast	May Be Appropriate	☢☢☢
MRI abdomen without and with IV contrast with MRCP	May Be Appropriate	O
MRI abdomen without IV contrast with MRCP	May Be Appropriate	O
Nuclear medicine scan gallbladder	May Be Appropriate	☢☢
CT abdomen without IV contrast	May Be Appropriate	☢☢☢
CT abdomen without and with IV contrast	Usually Not Appropriate	☢☢☢☢

Variant 2: **Right upper quadrant pain. No fever or high white blood cell (WBC) count. Suspected biliary disease. Negative or equivocal ultrasound.**

Procedure	Appropriateness Category	Relative Radiation Level
MRI abdomen without and with IV contrast with MRCP	Usually Appropriate	O
CT abdomen with IV contrast	Usually Appropriate	☢☢☢
MRI abdomen without IV contrast with MRCP	Usually Appropriate	O
Nuclear medicine scan gallbladder	May Be Appropriate	☢☢
CT abdomen without IV contrast	May Be Appropriate	☢☢☢
CT abdomen without and with IV contrast	Usually Not Appropriate	☢☢☢☢

Variant 3: **Right upper quadrant pain. Fever, elevated WBC count. Suspected biliary disease. Negative or equivocal ultrasound.**

Procedure	Appropriateness Category	Relative Radiation Level
MRI abdomen without and with IV contrast with MRCP	Usually Appropriate	O
CT abdomen with IV contrast	Usually Appropriate	☢☢☢
Nuclear medicine scan gallbladder	Usually Appropriate	☢☢
MRI abdomen without IV contrast with MRCP	May Be Appropriate	O
CT abdomen without IV contrast	May Be Appropriate	☢☢☢
CT abdomen without and with IV contrast	Usually Not Appropriate	☢☢☢☢

Variant 4: **Right upper quadrant pain. Suspected acalculous cholecystitis. Negative or equivocal ultrasound.**

Procedure	Appropriateness Category	Relative Radiation Level
Nuclear medicine scan gallbladder	Usually Appropriate	☢☢
CT abdomen with IV contrast	May Be Appropriate	☢☢☢
MRI abdomen without and with IV contrast with MRCP	May Be Appropriate	O
Percutaneous cholecystostomy	May Be Appropriate	Varies
MRI abdomen without IV contrast with MRCP	May Be Appropriate	O
CT abdomen without IV contrast	May Be Appropriate	☢☢☢
CT abdomen without and with IV contrast	Usually Not Appropriate	☢☢☢☢

AMERICAN COLLEGE OF RADIOLOGY ACR APPROPRIATENESS CRITERIA JAUNDICE

Variant 1: **Jaundice. No known predisposing conditions. Initial imaging.**

Procedure	Appropriateness Category	Relative Radiation Level
US abdomen	Usually Appropriate	O
CT abdomen with IV contrast	Usually Appropriate	☢☢☢
MRI abdomen without and with IV contrast with MRCP	Usually Appropriate	O
MRI abdomen without IV contrast with MRCP	May Be Appropriate	O
CT abdomen without and with IV contrast	Usually Not Appropriate	☢☢☢☢
CT abdomen without IV contrast	Usually Not Appropriate	☢☢☢
ERCP	Usually Not Appropriate	☢☢☢
US abdomen endoscopic	Usually Not Appropriate	O

Variant 2: **Jaundice. Suspected mechanical obstruction based on initial imaging, clinical condition, or laboratory values.**

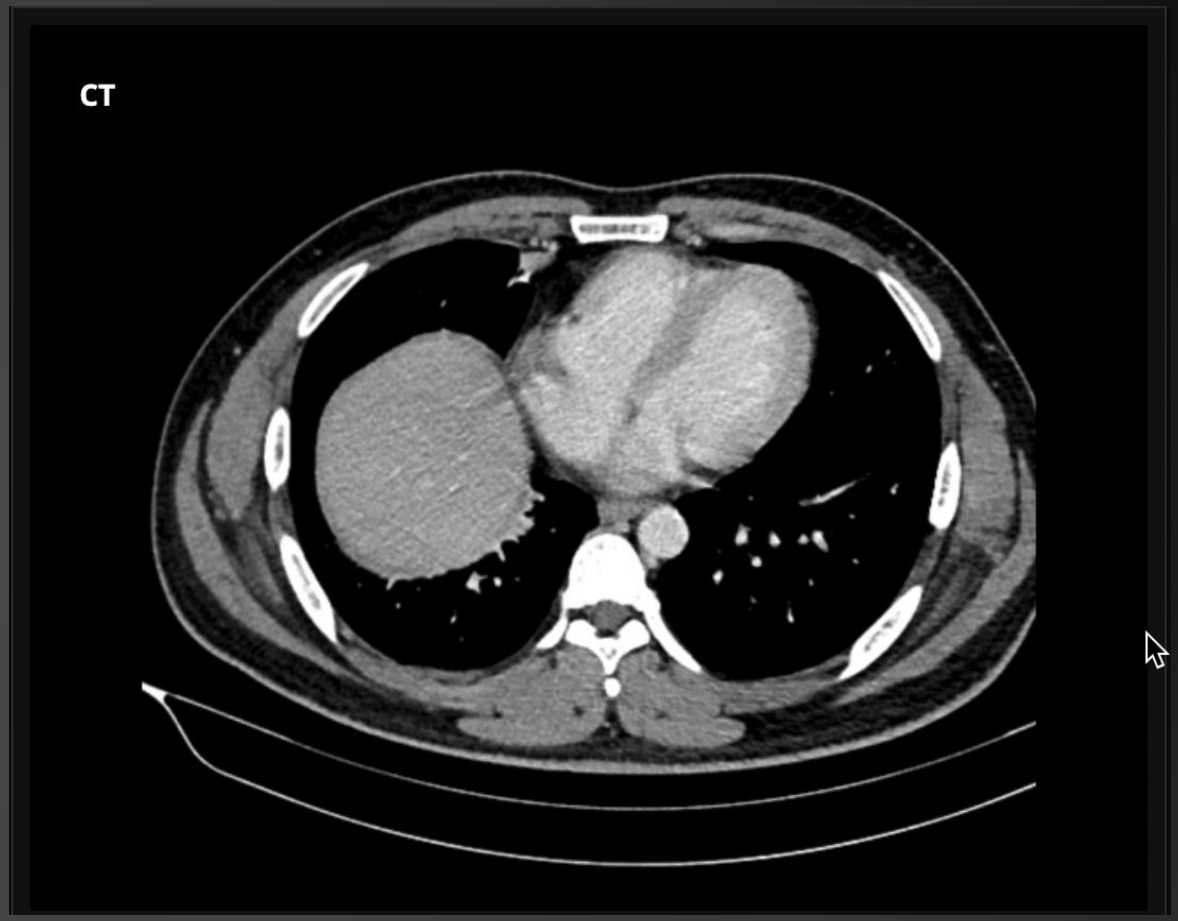
Procedure	Appropriateness Category	Relative Radiation Level
CT abdomen with IV contrast	Usually Appropriate	☢☢☢
MRI abdomen without and with IV contrast with MRCP	Usually Appropriate	O
MRI abdomen without IV contrast with MRCP	Usually Appropriate	O
US abdomen	Usually Appropriate	O
ERCP	May Be Appropriate	☢☢☢
US abdomen endoscopic	May Be Appropriate	O
CT abdomen without and with IV contrast	Usually Not Appropriate	☢☢☢☢
CT abdomen without IV contrast	Usually Not Appropriate	☢☢☢

CASE

- 40 year old obese female came in with worsening right upper quadrant pain with associated nausea. Patient is found to have a temperature of 101.4 F, SBP in 90's, HR in 110's and RR in 20's.

- *Case courtesy of Dr Hidayatullah Hamidi, Radiopaedia.org, rID: 53216*

- Acute cholecystitis is the primary complication of cholelithiasis and the most common cause of right upper quadrant pain.
- CT Scan features of acute cholelithiasis seen here include
  - Gall bladder overdistension (11 x 5 cm)
  - Diffuse wall thickening
  - Pericholecystic collection and fat stranding
  - Lithiasis in gallbladder neck.



RIGHT LOWER QUADRANT PAIN

- **Appendicitis is the most common surgical pathology responsible for right lower quadrant (RLQ) abdominal pain** presenting to emergency departments in the United States, where the incidence continues to increase despite reports of decreases in Europe and Canada .
- Historically, the clinical determination of appendicitis has been poor, particularly in special patient populations, such as those at the extremes of age and pregnant women.

AMERICAN COLLEGE OF RADIOLOGY ACR APPROPRIATENESS CRITERIA RIGHT LOWER QUADRANT PAIN-SUSPECTED APPENDICITIS

Variant 1: **Right lower quadrant pain, fever, leukocytosis. Suspected appendicitis. Initial imaging.**

Procedure	Appropriateness Category	Relative Radiation Level
CT abdomen and pelvis with IV contrast	Usually Appropriate	☢☢☢
CT abdomen and pelvis without IV contrast	May Be Appropriate	☢☢☢
US abdomen	May Be Appropriate	O
MRI abdomen and pelvis without and with IV contrast	May Be Appropriate	O
US pelvis	May Be Appropriate	O
MRI abdomen and pelvis without IV contrast	May Be Appropriate	O
CT abdomen and pelvis without and with IV contrast	Usually Not Appropriate	☢☢☢☢
Radiography abdomen	Usually Not Appropriate	☢☢
Fluoroscopy contrast enema	Usually Not Appropriate	☢☢☢
WBC scan abdomen and pelvis	Usually Not Appropriate	☢☢☢☢

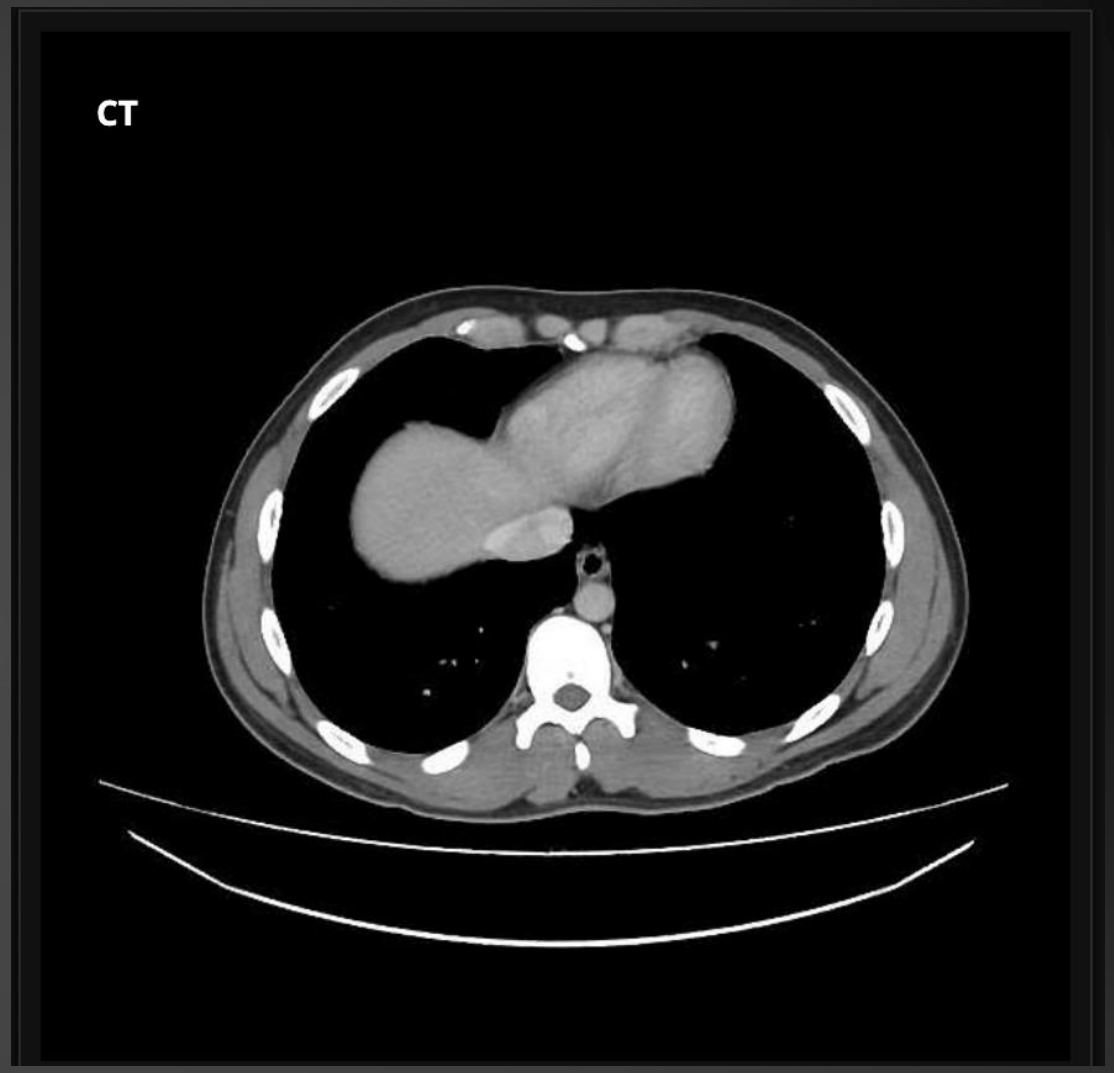
Variant 3: **Pregnant woman. Right lower quadrant pain, fever, leukocytosis. Suspected appendicitis. Initial imaging.**

Procedure	Appropriateness Category	Relative Radiation Level
US abdomen	Usually Appropriate	O
MRI abdomen and pelvis without IV contrast	Usually Appropriate	O
US pelvis	May Be Appropriate	O
CT abdomen and pelvis with IV contrast	May Be Appropriate	☢☢☢
CT abdomen and pelvis without IV contrast	May Be Appropriate	☢☢☢
CT abdomen and pelvis without and with IV contrast	Usually Not Appropriate	☢☢☢☢
MRI abdomen and pelvis without and with IV contrast	Usually Not Appropriate	O
WBC scan abdomen and pelvis	Usually Not Appropriate	☢☢☢☢
Radiography abdomen	Usually Not Appropriate	☢☢
Fluoroscopy contrast enema	Usually Not Appropriate	☢☢☢

CASE

- 36-year-old male comes into the emergency room with complaints of sudden onset of severe right lower quadrant pain. He has associated symptoms of fever of 102 F, nausea and vomiting. His laboratory results reveal a WBC count of 24, 000

- There is a long pelvic fluid-filled appendix (11 cm) with a thick enhanced wall (2 cm), containing an appendicolth (1.8 cm) obstructing the ostium with no evidence of wall defect.
- Peri appendiceal fat stranding with thickening of the peritoneal reflections and free intraperitoneal fluid in the pelvis and ileus.



LEFT LOWER QUADRANT ABDOMINAL PAIN

- The most common cause of left lower quadrant pain in adults is acute sigmoid or descending colonic diverticulitis.
- It has been estimated that between 10% and 25% of patients with diverticulosis will ultimately develop diverticulitis .
- Appropriate imaging triage for patients with suspected diverticulitis (ie, left lower quadrant pain) should address the differential diagnostic possibilities and what information is necessary to make a definitive management decision.

- Some patients with acute diverticulitis may not require any imaging, notably those with **typical symptoms of diverticulitis without suspected complications** or those with **a previous history of diverticulitis who present with clinical symptoms of recurrent disease .**

- Patients with diverticulitis may require surgery or interventional radiology procedures because of associated complications, including abscesses, fistulas, obstruction, or perforation.
- As a result, there has been a trend toward greater use of imaging to confirm the diagnosis of diverticulitis, evaluate the extent of disease, and detect complications before deciding on appropriate treatment .

AMERICAN COLLEGE OF RADIOLOGY ACR APPROPRIATENESS CRITERIA LEFT LOWER QUADRANT PAIN-SUSPECTED DIVERTICULITIS

Variant 1: **Left lower quadrant pain. Suspected diverticulitis. Initial imaging.**

Procedure	Appropriateness Category	Relative Radiation Level
CT abdomen and pelvis with IV contrast	Usually Appropriate	☢☢☢
CT abdomen and pelvis without IV contrast	May Be Appropriate	☢☢☢
MRI abdomen and pelvis without and with IV contrast	May Be Appropriate	O
MRI abdomen and pelvis without IV contrast	May Be Appropriate	O
US abdomen transabdominal	May Be Appropriate	O
CT abdomen and pelvis without and with IV contrast	Usually Not Appropriate	☢☢☢☢
Fluoroscopy contrast enema	Usually Not Appropriate	☢☢☢
Radiography abdomen and pelvis	Usually Not Appropriate	☢☢☢
US pelvis transvaginal	Usually Not Appropriate	O

Variant 2: **Left lower quadrant pain. Suspected complications of diverticulitis.**

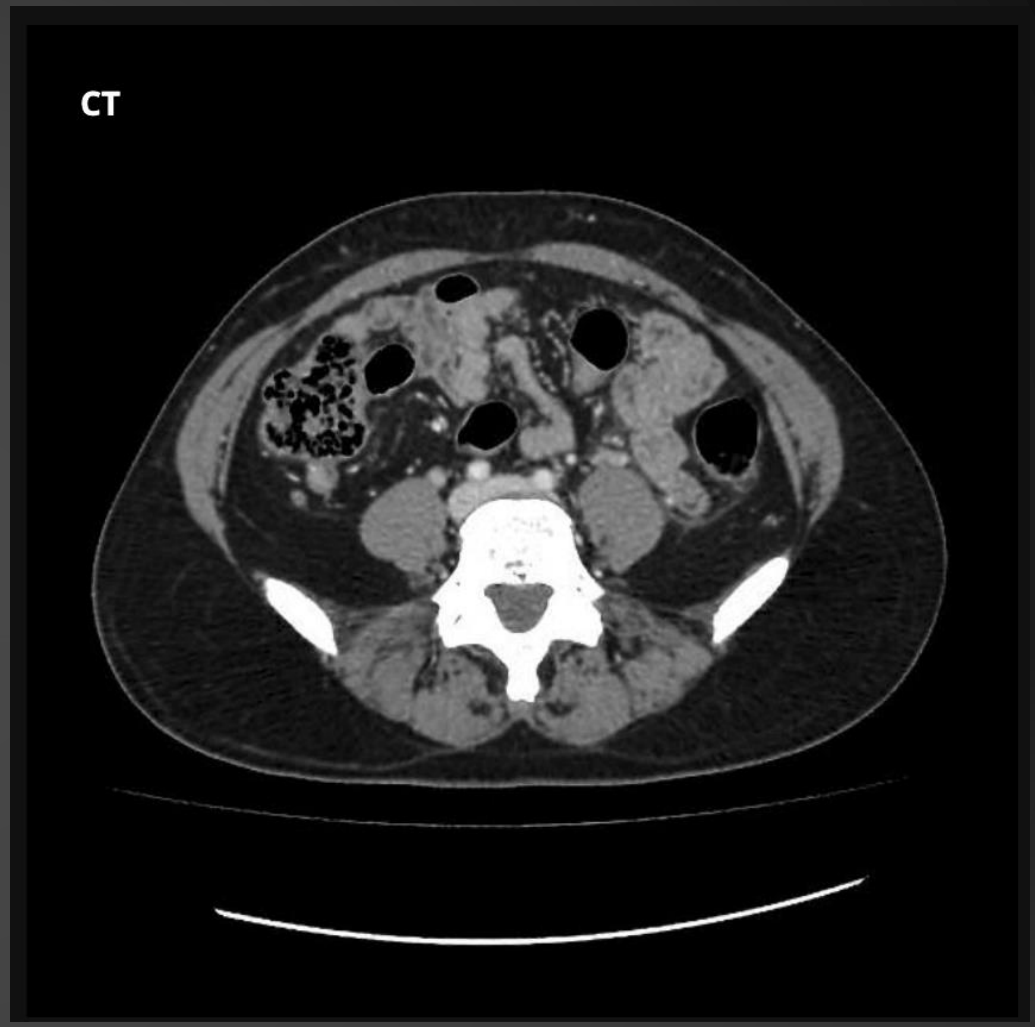
Procedure	Appropriateness Category	Relative Radiation Level
CT abdomen and pelvis with IV contrast	Usually Appropriate	☢☢☢
CT abdomen and pelvis without IV contrast	May Be Appropriate	☢☢☢
CT pelvis with bladder contrast (CT cystography)	May Be Appropriate	☢☢☢☢
MRI abdomen and pelvis without and with IV contrast	May Be Appropriate	O
Fluoroscopy contrast enema	May Be Appropriate	☢☢☢
Fluoroscopy cystography	May Be Appropriate	☢☢☢
MRI abdomen and pelvis without IV contrast	May Be Appropriate	O
US abdomen transabdominal	May Be Appropriate	O
CT abdomen and pelvis without and with IV contrast	Usually Not Appropriate	☢☢☢☢
Radiography abdomen and pelvis	Usually Not Appropriate	☢☢☢
US pelvis transvaginal	Usually Not Appropriate	O

CASE

- 45-year-old female patient, came in with pain in the left lower quadrant for 1 day. She describes the pain as a continuous, , moderate intensity, aggravated when walking and has relief with rest. Denies nausea, vomiting, fever, or change in bowel habits.

- *Case courtesy of Dr Abraão Kupske, Radiopaedia.org, rID: 42245*

- There is in the left iliac fossa a segmental wall thickening of the descending colon, associated with thickening of the adjacent fat planes, with heterogeneous enhancement after contrast agent, suggesting edema.
- No evidence of mechanical obstruction, adjacent collections or other signs of complications.



MESENTERIC ISCHEMIA

- Mesenteric ischemia is an uncommon disease affecting the small and large bowel resulting from a reduction of intestinal blood flow.
- Although the disease is responsible for fewer than 1 in 1,000 hospital admissions, the mortality rate remains high, ranging between 30% to 90% in acute settings despite advances in treatment options.

- The etiology of acute mesenteric ischemia may vary from
  - Arterial occlusion
  - Venous thrombosis
  - Vasoconstriction
- In the chronic setting, mesenteric ischemia is almost always caused by severe atherosclerotic disease
- Higher prevalence in the elderly population and nonspecific clinical presentation leading to delayed diagnosis contribute to the high mortality rate.

AMERICAN COLLEGE OF RADIOLOGY ACR APPROPRIATENESS CRITERIA IMAGING OF MESENTERIC ISCHEMIA

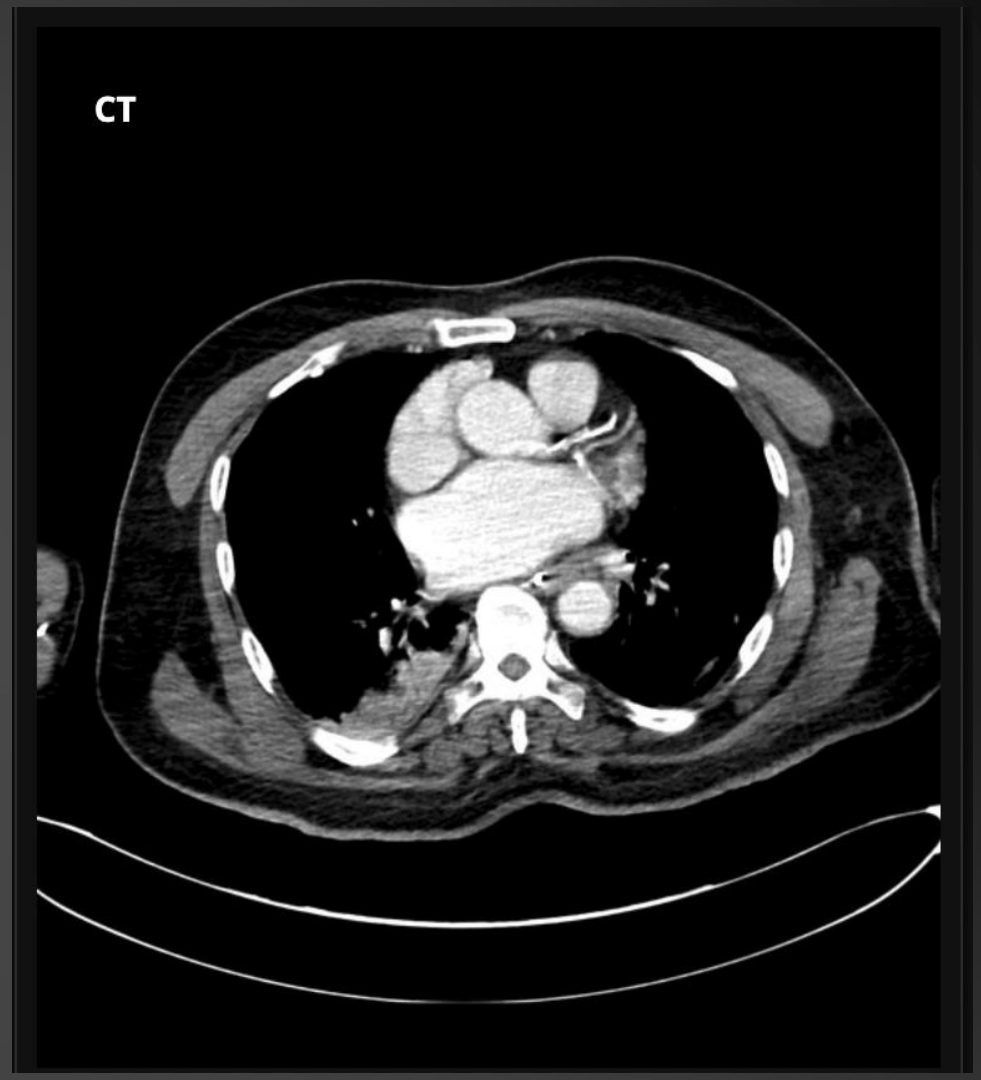
Variant 1: **Suspected acute mesenteric ischemia. Initial imaging.**

Procedure	Appropriateness Category	Relative Radiation Level
CTA abdomen and pelvis with IV contrast	Usually Appropriate	☢☢☢☢
CT abdomen and pelvis with IV contrast	May Be Appropriate	☢☢☢
Arteriography abdomen	May Be Appropriate (Disagreement)	☢☢☢
MRA abdomen and pelvis without and with IV contrast	May Be Appropriate (Disagreement)	O
Radiography abdomen	May Be Appropriate	☢☢
US duplex Doppler abdomen	May Be Appropriate	O
CT abdomen and pelvis without and with IV contrast	Usually Not Appropriate	☢☢☢☢
CT abdomen and pelvis without IV contrast	Usually Not Appropriate	☢☢☢
MRA abdomen and pelvis without IV contrast	Usually Not Appropriate	O

CASE

- 75-year-old male with past medical history of atrial fibrillation came in with cerebral ischemic stroke then developed acute abdominal pain

- There is decreased wall enhancement of distal small bowel loops compared to the proximal loops, with total occlusion of the distal superior mesenteric artery. No pneumatosis intestinale, portal venous gas or pneumoperitoneum.
- There is also total occlusion of the left renal artery, with delayed global parenchymal enhancement of the left kidney and also demonstrates multifocal wedge-areas of no enhancement indicative of left renal ischemia. Absent contrast excretion by the left kidney as well in the delayed phase.



TOXIC MEGACOLON

CASE

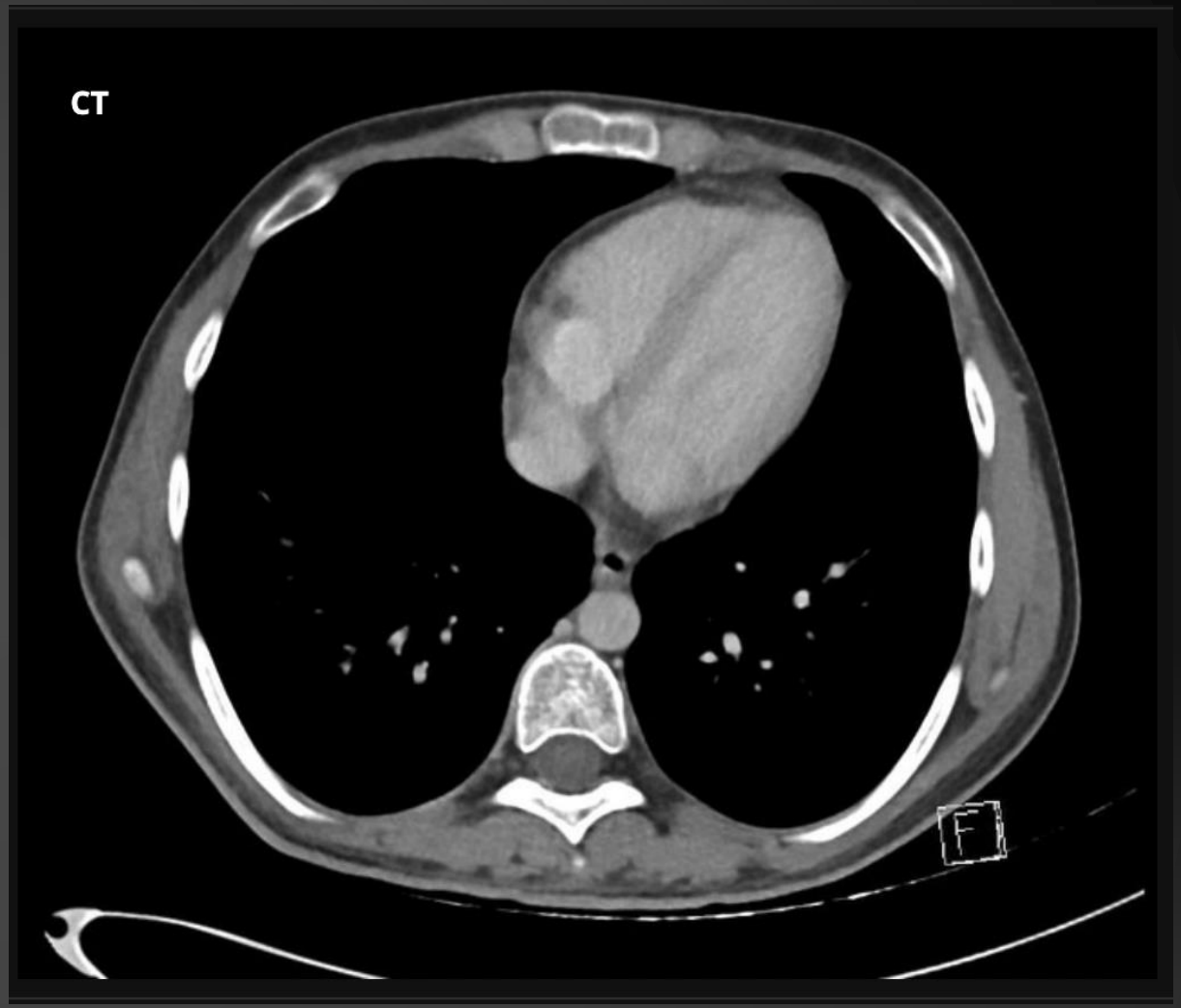
- 59 year old male who was on a prolonged antibiotic course for right arm osteomyelitis, came in with 3 days of worsening abdominal pain, diarrhea and vomiting.
- He is found to be confused, with dry mucous membranes.
- Temp 103.4 F, HR 130, SBP 90/60
- WBC 22,000, Hb 8.1, Na 128, Cl 97, CO2 33, BUN 50, Cr 3.9

- *Case courtesy of Dr Vu Tran, Radiopaedia.org, rID: 79504*

DIAGNOSTIC CRITERIA FOR TOXIC MEGACOLON

- Radiographic evidence of colonic dilation (diameter >6 cm)
- PLUS at least three of the following:
  - •Fever >38°C
  - •Heart rate >120 beats/min
  - •Neutrophilic leukocytosis >10,500/microL
  - •Anemia
- PLUS at least one of the following:
  - •Dehydration
  - •Altered sensorium
  - •Electrolyte disturbances
  - •Hypotension

- Long segment colitis from the rectum to the splenic flexure, with marked gaseous distension.
- The possibilities include infective and inflammatory colitides.
- In that context the dilated appearance may be in keeping with toxic megacolon.



POINTERS

- Always review the images before you look at the radiologist's report
- Compare the current images with patient's prior images
- Have a good relationship with the radiologist and other sub-specialists
- Use resources like **Radiopedia** and **American College of Radiology (ACR)** to learn more
- Know that you are not a radiologist and may not know everything in the scans.
- What you should know is what to order, when to order and also what might be abnormal

QUESTIONS?

THANK YOU!