PI Session: 2021.01.22_GRE_Radiology: Abdomen_Preparatory_Marcus John Julius, M.D.

Objectives: At the end of this session, students will be able to:
1. Describe the structures assessed on an abdominal series.
2. Compare and contrast single-contrast and double-contrast examinations of hollow viscera.
3. Discuss the physiologic processes visualized on both hepatobiliary and gastric emptying nuclear medicine scans.
4. Compare and contrast the echogenicity of solid abdominal viscera.
5. Differentiate the clinical scenarios appropriate for the use of either water-soluble or barium contrast media.
6. Explain the difference between 'positive', 'neutral', and 'negative' contrast media for CT imaging.

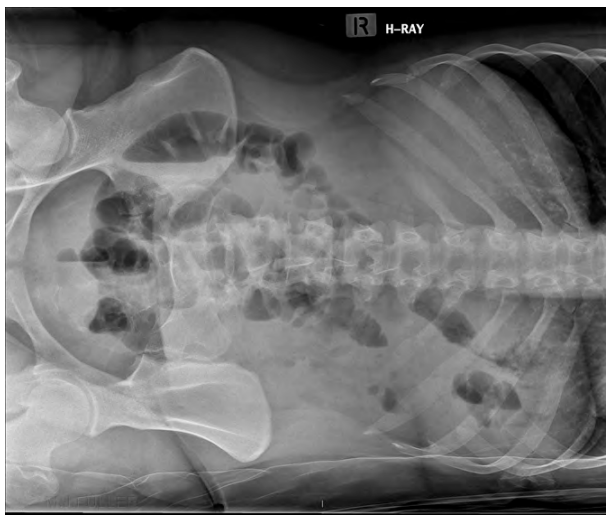
Note: There's good news and better news:
-*Good news* is that all of the imaging modalities in this PI session have already been reviewed in other PI sessions!
-*Better news* is, with all the background information under our belts, we can focus more of our attention on imaging examinations of the abdomen (tailored to the GI system).
-Please always keep well-versed on the physics, advantages/disadvantages, and terminology of what we've already covered in past PI sessions (i.e. general radiology, NM, US, and CT). This fund of knowledge will serve you well in future PI sessions, examinations, and clinical practice.

General radiology

IMAGING EXAMINATIONS

-*Abdominal series*
- -*KUB*: AP view of the abdomen and pelvis (from above the level of the diaphragm through the level of the symphysis pubis)
  - -'Kidneys-ureters-bladder'
  - -'Flat-plate' of the abdomen
- -A radiograph permitting assessment of pneumoperitoneum
  - -*Upright* AP view of the chest/upper abdomen
  - -*Left lateral decubitus* view of the abdomen
- -Assess:
  - -Free air (pneumoperitoneum)
  - -Bowel gas pattern
  - -Solid organ size
  - -Calcifications
  - -Osseous/soft tissues

Normal KUB



Normal left lateral decubitus image

Normal upright CXR

-Normal bowel caliber (in *maximum transverse* dimensions, in *cm*)
- -'3-6-9' rule
- -Small bowel: 3cm
- -Large bowel: 6cm
- -Cecum: 9cm

-Locate bowel based on location and bowel architecture
- -Small bowel in LUQ, central abdomen, and RLQ. Large bowel at periphery of abdomen
- -Small bowel possesses *valvulae conniventes*. Large bowel possesses *haustra*

-Normal liver length (upper limits of normal in adult)
- -16 cm at midclavicular line

-Splenic length (upper limits of normal in adult)
- -12 cm

-Urinary tract calculi
- -Radiopaque on radiographs: 75-80%

-Biliary tract (gallstones)
- -Radiopaque on radiographs: 20-25%

-Vascular calcifications (i.e. splenic artery, abdominal aorta, phleboliths/venous calcifications)

-Contrast administration (by mouth, *PO*; by rectum, *PR*) assist in radiographic assessment of hollow viscera

-Enteric contrast is either barium (inert) or water-soluble contrast (gastrografin, iodine-containing)

-Barium contrast is utilized orally if there is risk of aspiration

-Barium causes less irritation to the lungs than water soluble contrast (if aspirated into the lungs)

-Water-soluble contrast is utilized (PO and/or PR) if there is possibility of underlying hollow viscus perforation

-Water-soluble contrast lessen the chance of inflammation of the mediastinum (mediastinitis) or peritoneum (peritonitis)

-Water-soluble contrast draws water into the hollow viscus (and, as such, can cause fluid shifts). Excess water within hollow viscera may loosen stool consistency (i.e. may cause diarrhea; may help treat fecal impaction).

-Esophagram: Assessment of the esophagus

-Upper GI series: Assessment of the esophagus, stomach, and duodenum

- Single contrast: Opacification (with thin barium or gastrografin) allows for global assessment of course and caliber of hollow viscera.
- Double contrast: Opacification (with combination of thick barium and effervescence) allows for detailed mucosal assessment of distended hollow viscera.

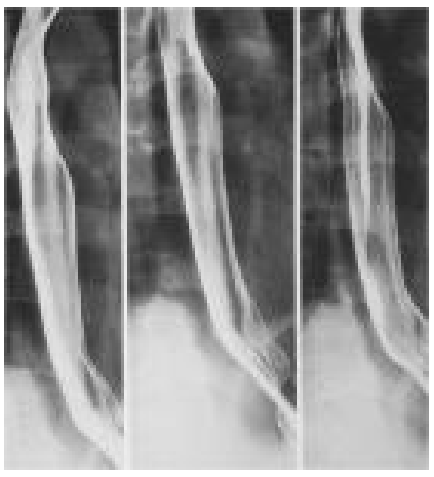
-Small bowel series (enterography): Assessment of the small bowel (from ligament of Treitz to the cecum), utilizing serial, timed images (tracking contrast throughout the small bowel)

-Assessment of bowel course, caliber, and mucosa

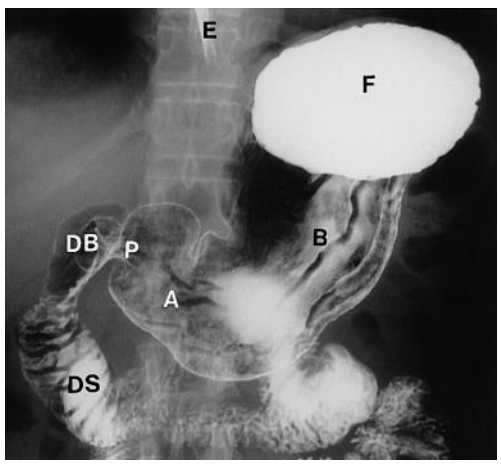
-Enterography may utilize barium or gastrografin, depending on the clinical scenario

-Barium will allow for more optimal small bowel mucosal assessment (but is *not* preferred if surgery is contemplated)

-Gastrografin will dilute as it passes through the bowel (i.e. water-soluble)



Double-contrast esophagram



Double-contrast upper GI series

Small bowel series

Note: The following is a link to a brief upper GI series

https://m.youtube.com/watch?v=LdPajRJWiDg

-Contrast enema: Assessment of the colon

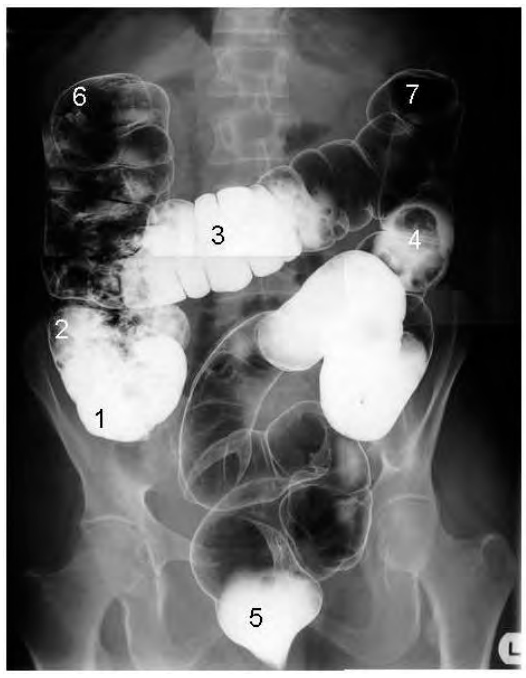
-Single contrast: Opacification (with thin barium or gastrografin) allows for global assessment of course and caliber of colon

-Double contrast: Opacification (with combination of thick barium and insufflated air) allows for detailed mucosal assessment of distended colon

-Barium is utilized if there is *no* possibility of underlying perforation

-Gastrografin is utilized if there is the possibility of underlying perforation

Single-contrast enema



Double-contrast enema (1: cecum; 2: ascending colon; 3: transverse colon; 4: descending colon; 5: rectum; 6: hepatic flexure; 7: splenic flexure)

Nuclear Medicine

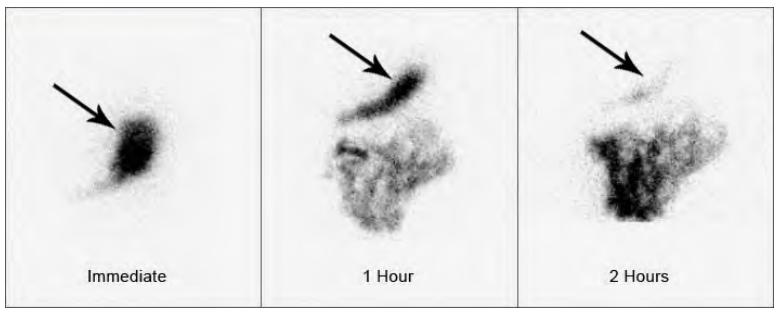
-**IMAGING EXAMINATIONS**

-Gastric emptying examination

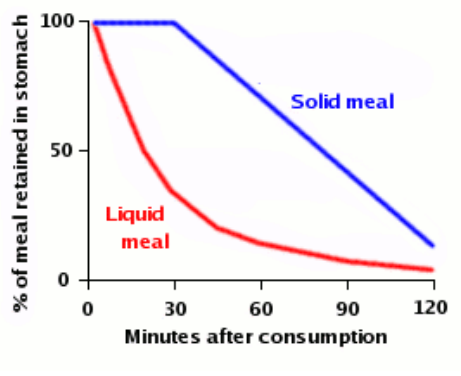
-Utilizes Tc-99m sulfur colloid (mixed with eggs)

-Generates images of gastric emptying (including images of potential GE reflux)

-Generates a gastric-emptying curve (to assess for gastric half-emptying time, normal range of 30min<x<90min)



Gastric emptying NM examination (arrow, stomach)



Gastric-emptying curve

-Hepatobiliary imaging

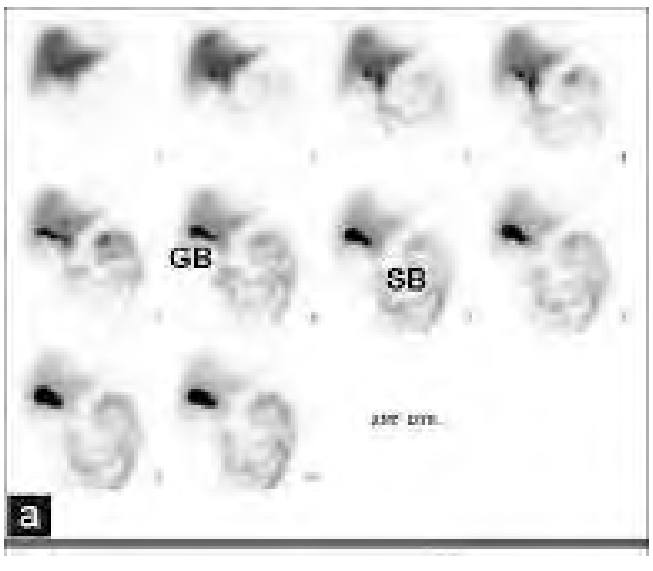
-Utilizes Tc-99m labelled radiopharmaceutical (i.e. mebrofenin) to visualize the liver

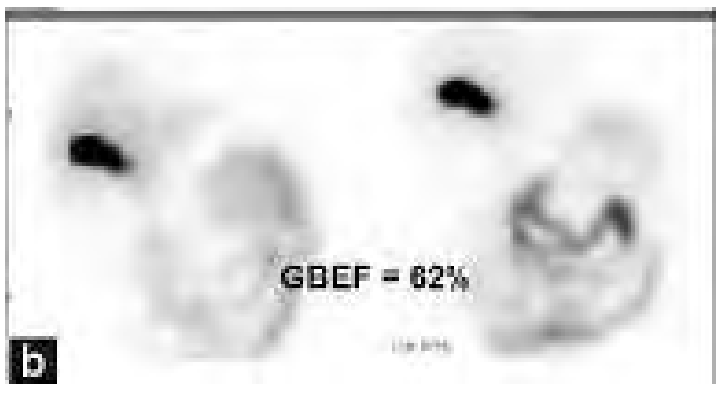
-After uptake by hepatocytes, radiopharmaceutical is excreted into the biliary tree

-Biliary tree and gallbladder become visualized (the latter normally within 60 mins, indicating cystic duct patency)

-Small bowel is normally visualized within 90 minutes (i.e. common bile duct patency)

-Cholecystokinin (CCK) can be administered to assess GB contraction (normally >50% gallbladder ejection fraction, GBEF)



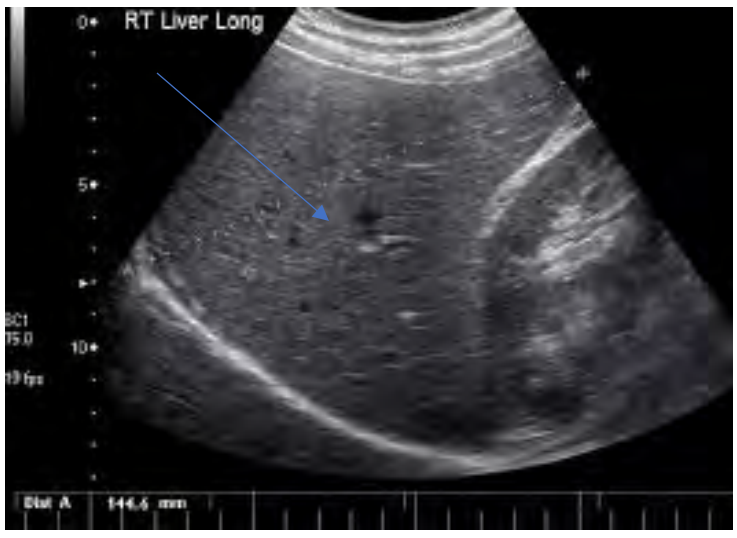


Normal hepatobiliary examination (a: first hour; b: after IV administration of CCK)

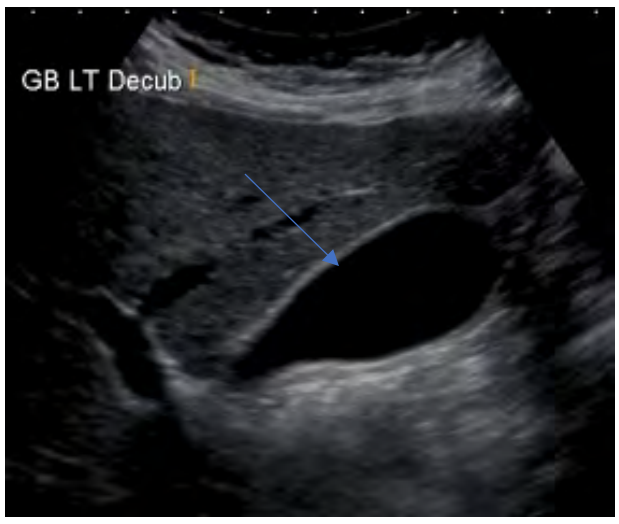
Ultrasonography

IMAGING EXAMINATION

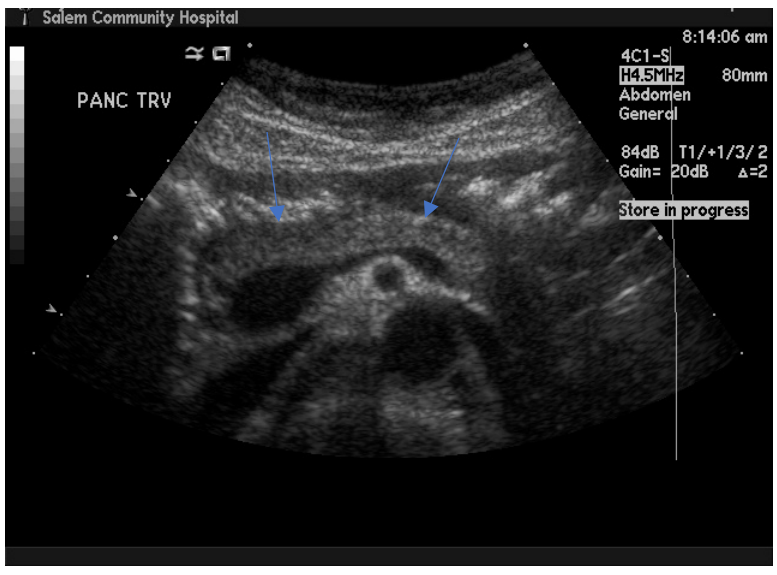
-Ultrasound allows for assessment of solid viscera of the abdomen (including liver, biliary tree, GB, spleen, kidneys, and pancreas)
  -Assessment of the pancreas may be slightly limited based on its location (surrounded by bowel in the C-loop of the duodenum)
  -Solid organ assessment includes organ size, shape, echogenicity
    -Normal echogenicity:
      -Renal sinus >pancreas
      -Pancreas > liver and spleen
      -Spleen > liver
      -Spleen > renal cortex
      -Liver >/= renal cortex
      -Renal cortex > renal medulla
    -Liver length: 16 cm in length at midclavicular line (upper limits of normal, adult)
    -Splenic length: 12 cm (upper limits of normal, adult)
-Ultrasound can also assess the stomach (i.e. pylorus) and appendix (children, women, in pregnancy)



Normal liver sonogram (sagittal image); arrow: liver



Normal gallbladder sonogram; arrow: gallbladder



Normal pancreas sonogram (transverse image); arrows: pancreas

Normal renal sonogram (sagittal image); arrow: kidney

Note: The following is a link to a normal, narrated ultrasound examination of the abdomen

https://m.youtube.com/watch?v=iJcIhyHs9TE

Computerized Axial Tomography

IMAGING EXAMINATIONS:

-The imaging field of view (FOV) of the abdomen is strictly from *above the diaphragm to the level of the iliac crests*. Because many organ systems extend from the abdomen into the pelvis (GI, GU, vascular), it is common to perform a pelvic CT in concert with an abdomen CT

-Abdominal CT imaging is enhanced with contrast media (enteric: by mouth, PO; by rectum, PR. Intravenous: IV)

-Water soluble contrast (i.e. gastrografin) is used if there is risk of hollow viscus perforation

-Barium enteric contrast may be used if there is no risk of hollow viscus perforation

-Barium and water-soluble contrast (i.e. gastrografin, iodine-containing) show up as increased density on CT ('high density or positive contrast')

-Water and mannitol are of intermediate density of CT ('neutral contrast')

-Gas (i.e. air or carbon dioxide) are of low density on CT ('low density or negative contrast')

-Examination protocols may be tailored to specific organs of interest:

-Solid organs

-Liver

-Pancreas

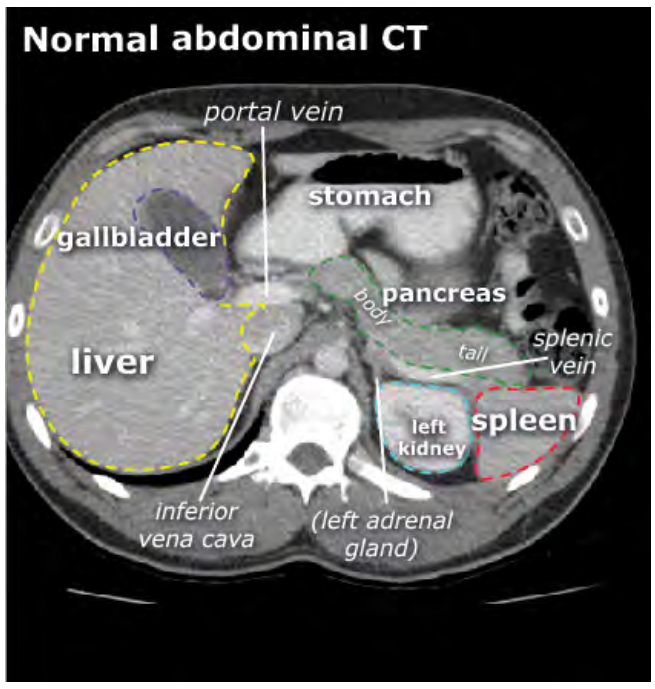
-Adrenal glands

-Kidneys

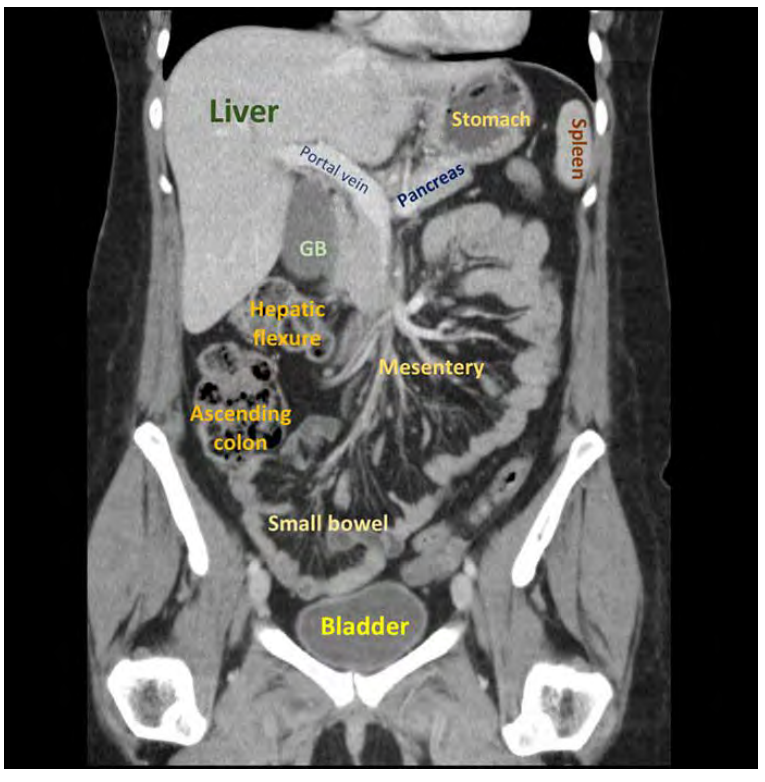
Hollow organs

-Small bowel

-Colon (including 'virtual colonoscopy')



Normal abdominal CT (axial)



Normal abdominal CT (coronal)

Tips for reviewing CTs

- Think of the anatomic location of any given structure (then extrapolate its location to the axial image). Remember the usual convention of the patient lying supine on the CT table, 'feet toward you'. (This will aid in your assessment of right, left, anterior, and posterior on the axial image.)
- Always think in continuity. Localize a structure on one image, then follow it to adjacent images in order to view it in its *entirety*. (Don't study every structure on a given image…instead, follow one structure across many images).
- Remember the different densities (gas<fat<water<soft tissue<bone<contrast/metal) so as to make sense of the composition of normal structures (and, eventually, pathologic processes).

Note: The following is a link to a brief overview of CT colonography (virtual colonoscopy)

https://www.youtube.com/watch?v=nJFdtxlJ-P4

References

-Clinical Radiology: The Essentials. Daffner et al. 4th ed. (Chapters 7 and 8).

-Primer of Diagnostic Imaging. Weissleder et al. 4th ed. (Chapter 3, 13, and 14).

-CT at a Glance. Seeram et al. (Chapters 11 and 12).

Note: Unless otherwise specified, all graphics are from Review of Radiologic Physics. Huda. Fourth edition.

Note: Medical images are from anonymized patient or online archives.

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