Abdominal Ultrasound


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Abdominal Ultrasound: Objectives

- Review normal sonographic anatomy of abdominal organs
- Review vascular anatomy where indicated
- Present some common and basic pathological condition
- Live scanning portion afterwards

Acknowledgements:

Thanks to:

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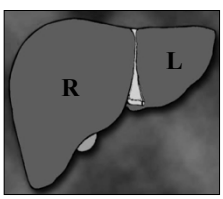
for supplying some of the images

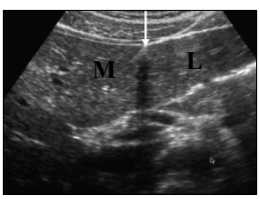
Liver

- Largest solid organ in normal abdomen
- Occupies most of the right upper quadrant
- Right lobe (largest)
  - anterior and posterior segment- delineated by interlobar fissure, gallbladder, middle hepatic vein (MHV)
- Left lobe
  - Medial and lateral segment- delineated by ligametum teres and left hepatic vein (LHV)
- Caudate lobe (smallest)
  - Delineated by the fissure for the ligametum venosum

Falciform Ligament



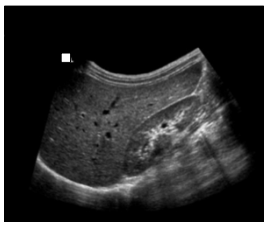
Surface Anatomy



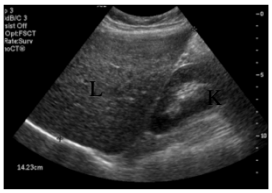
Segmental Anatomy- Ligamentum teres

Liver Sonography

- Fasting 6-8 hours prior to exam
- Transducer dependent on patient body habitus
- Technique
  - Normal liver brighter than the renal cortex
- Measures 13-17cm in length
  - Right mid-clavicular line



Liver Anatomy - Right Lobe

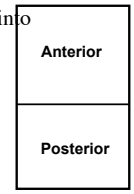


Sagittal

Transverse

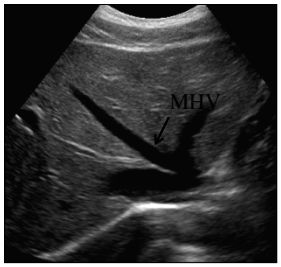
Right Lobe Divisions

- Right Hepatic Vein
  - Divides right lobe into segments
    - Anterior
    - Posterior



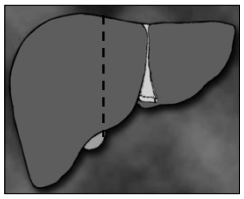
Liver - Left Lobe

- Right/left separation
  - Middle hepatic vein
  - (MHV)
  - Main lobar fissure



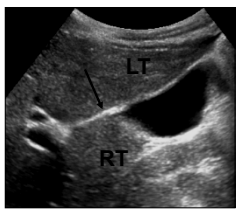
Main Lobar Fissure

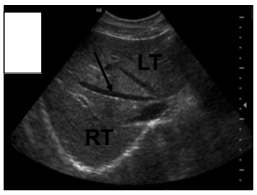
- One of the main dividers of the liver into fairly equal right & left lobes
- Seen as a white line extending from the portal hepatis to the gallbladder neck



Division Right and Left Lobe

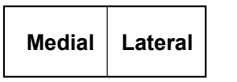
- Main lobar fissure (yellow arrow)
- Middle hepatic (turquoise arrow)





Liver- Left Lobe

- Divided into medial and lateral segments
  - Left hepatic vein
  - Ligamentum teres
    - Echogenic round structure

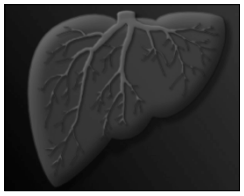


Liver - Caudate Lobe

- Sagittal Borders
  - Inferior
    - Main portal vein (MPV)
  - Posterior
    - Inferior vena cava (IVC)
  - Anterior
    - Ligamentum Venosum (arrow)

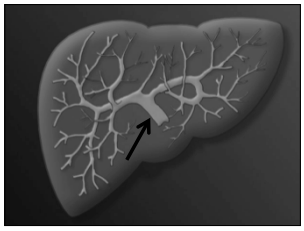
Hepatic Veins

- Right hepatic vein
- Middle hepatic vein
- Left hepatic vein



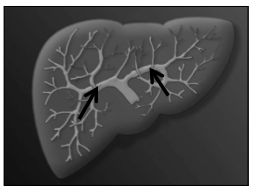
Hepatic Veins

Main Portal Vein



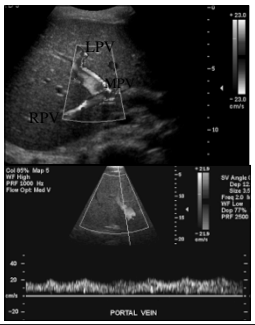
Portal Vein Division

- MPV divides within the liver into
  - Right portal vein-short
  - Left portal vein-longer



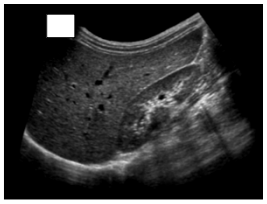
Portal Vein

- Portal vein
  - Hepatopetal flow
  - Flow into liver
- Branches course within hepatic segments
- Doppler signal
  - Continuous flow



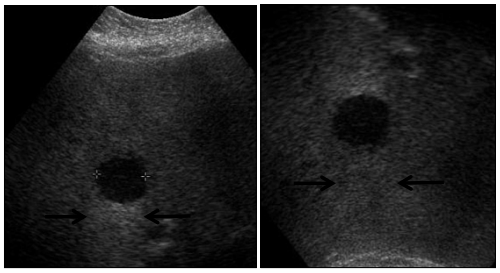
Riedel's Lobe - Normal Variant

- More common in women
- Presents clinically as
  - Hepatomegaly
  - Right upper quadrant (RUQ) mass
- Normal echotexture
- Elongation of right inferior lobe
  - Tongue like projection
  - Finger like projection

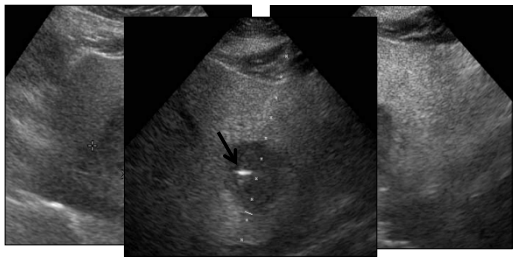


Liver Cyst- Benign Mass

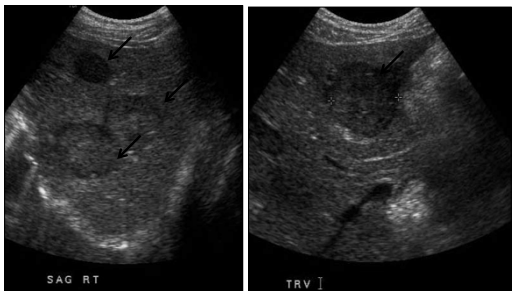
- Anechoic, posterior acoustic enhancement



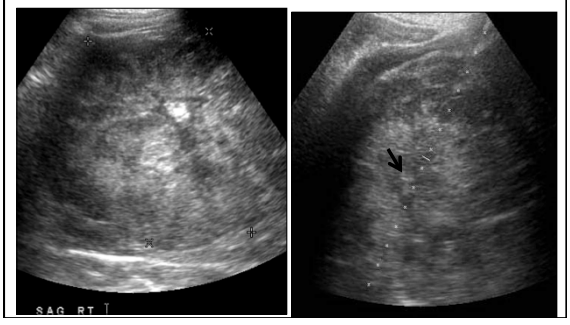
Metastatic Breast Cancer



Liver Metastases from Lung Cancer

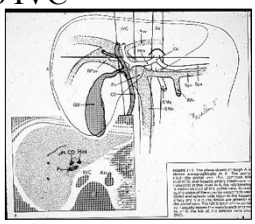


Hepatocellular Carcinoma



Gallbladder-Anatomic Location

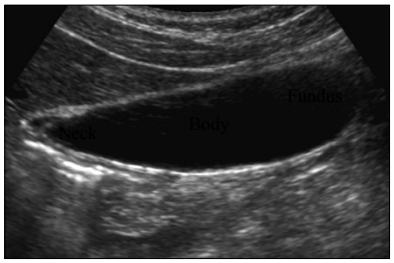
- Inferior aspect of the liver
- Medial and anterior to right kidney
- Lateral and anterior to IVC
- Fundus, body, neck
- Junctional fold - kink near neck
- Phrygian cap – kink near fundus



Sonographic Technique

- Patient fasting, H_2O permitted
- Supine: longitudinal & transverse views
- Decubitus: Right side up views
- Erect views
- Identify local tenderness

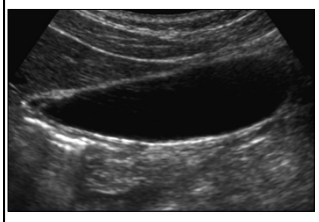
Gallbladder

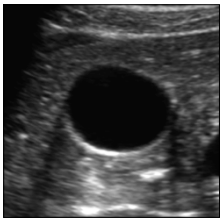


Normal Gallbladder

Sagittal

Transverse

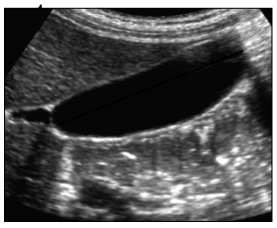


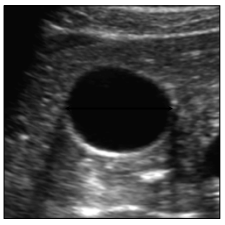


← Superior Inferior → ← Lateral Medial →

Gallbladder Measurements

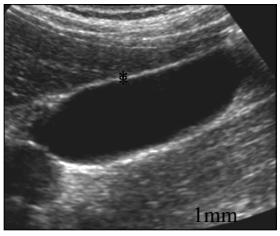
- 10 cm length
- 4 cm transverse

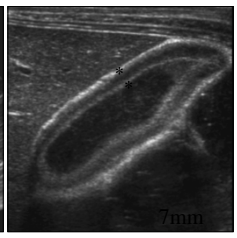




Gallbladder Measurements

- Wall thickness < 3 mm

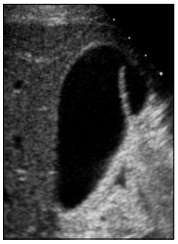


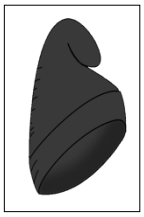


Gallbladder- Junctional Folds

Gallbladder – Fundal Fold

- Folds
  - Phrygian cap: fundus folds on itself





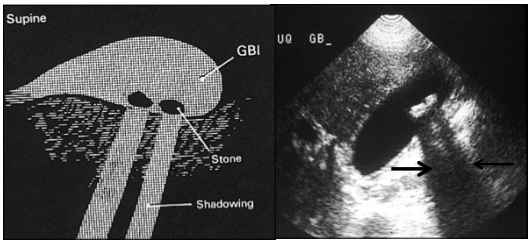
Gallstones

- Often found in asymptomatic patients (10% of US population)
- Acute or chronic cholecystitis
- Dense echogenic structure
- > 2-3 mm - posterior acoustic shadowing

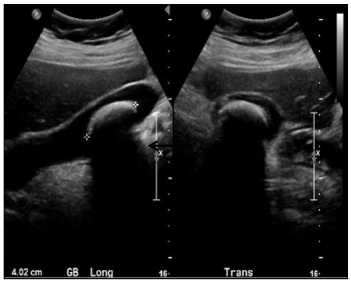
Gallstones

- Movement on RSU or erect view
- Stone filled GB - no surrounding echo-free bile
- Floating gallstones
- Adherent gallstones (DDX: polyp, tumor)

Gallstones



Gallstone



Gallstones

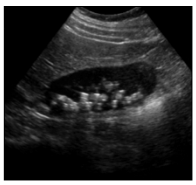
- They are mobile

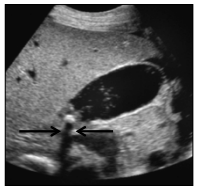
Supine

Right side up decubitus

Gallstones: Shadowing

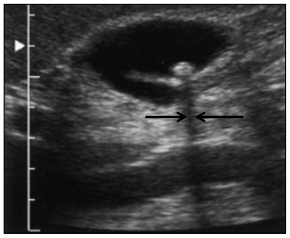
- Size dependent
  - > 3 mm
- Independent of the composition



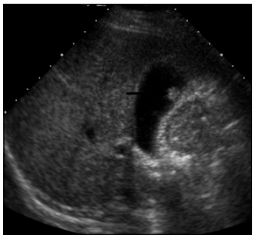


Gallstone versus Polyp

Gallstone with acoustic shadow



Polyp - no shadow-non-mobile



Acute Cholecystitis

- Most common cause of RUQ pain
- > 90% of cases due to obstruction of the cystic duct or neck of gallbladder
- Leads to:
  - distension
  - ischemia
  - inflammation
  - superinfection
  - necrosis
  - perforation

Acute Cholecystitis : US Findings

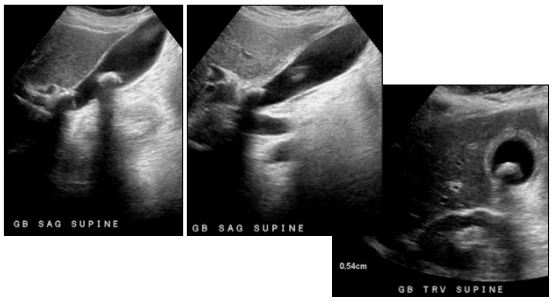
- Gallstones
- Acute, focal pain
- GB wall thickening, > 3 mm
- Peri GB - fluid collections

Gallstones
Positive sonographic Murphy sign

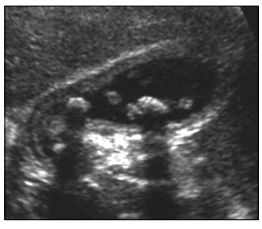
- Combination of findings
  - PPV: 92%
  - NPV: 95%

Ralls, Radiology: 1985

ACUTE CHOLECYSTITIS



Acute Cholecystitis



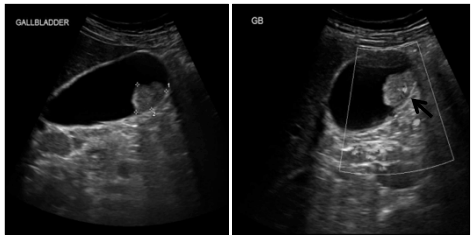
Stone in neck

Gallbladder Carcinoma

- Thick gallbladder walls
- Projection of cancerous mass into lumen - like polyps or stones
- Ill-defined large mass in gallbladder bed

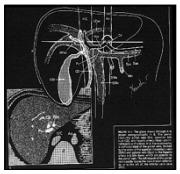
Gallbladder Carcinoma

- Focal mass near gallbladder fundus
- Central vascularity on CDUS



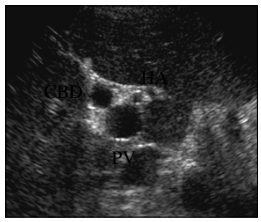
Biliary Tree

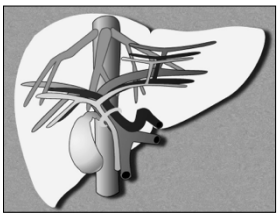
- Only a small portion seen within liver
- Common bile duct (CBD):
  - anterior to portal vein
  - anterior and to the right of hepatic artery
- Occasionally small portion of biliary tree outside of porta hepatis visible
- CBD: 6 - 7 mm upper limits of normal
  - ↑ w/ age, s/p cholecystectomy – debatable



Extrahepatic Bile Ducts

- Bile duct lies anterior & lateral to the MPV
- Lateral (to right) of Hepatic artery (HA)

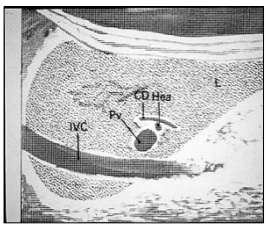


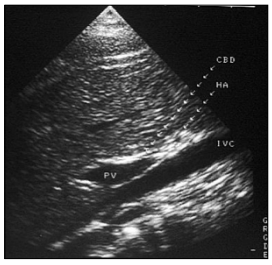


Extrahepatic Bile Ducts

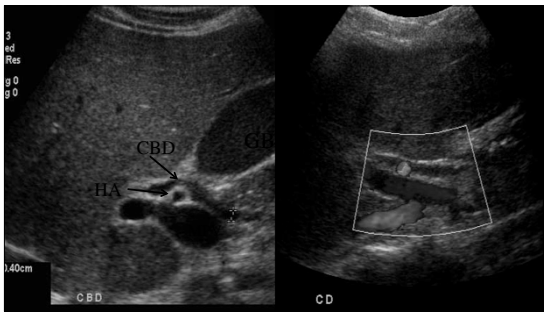
- Common hepatic duct
  - above cystic duct insertion
- Common bile duct
  - Below cystic duct insertion
- We usually do not see the cystic duct

Normal Porta Hepatis Anatomy





Normal Porta Hepatis Anatomy

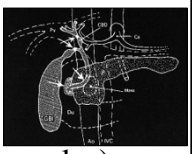


Intrahepatic Bile Ducts

- Right and left hepatic ducts run anterior to portal veins
- Peripheral ducts variable

Biliary Obstruction

- "Double barrel shotgun"
- "Parallel channel" sign
- Stones in CBD
- Mass within bile ducts
- Mass porta hepatis (ca or nodes)



Biliary Obstruction

- Dilated CBD and intrahepatic ducts
- Large stone in distal CBD (arrow)

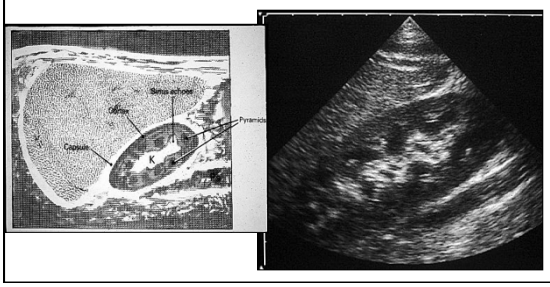
Renal Anatomy

- Adult Size
  - 9 - 13 cm length
  - 4 -5 cm wide
  - 2.5 -3 cm AP
- Neonate
  - 4.5 -5 cm long

Renal Ultrasound

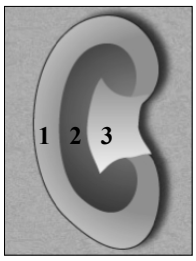
- Normal renal parenchyma:
  - < echogenic than liver
  - Dense central sinus echoes (fat)
  - Medullary zone (pyramids)
  - < echogenic than cortex
  - Echogenic capsule
- NORMAL SIZE: 8 -13 cm (adult)
  4.5 - 5 cm (birth)

Normal Kidney - Sagittal View



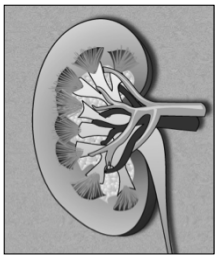
Normal Renal Anatomy

1. Cortex (rim)
2. Medulla (the renal pyramids)
3. Sinus (central area)



Normal Renal Anatomy

- Sinus
  - Major & minor calyces
  - Pelvis
  - Artery & vein
  - Fat
  - Nerves & lymphatics



Normal Renal Anatomy

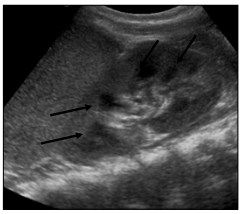
- Sinus (hyperechoic)
- Medulla (almost anechoic)
- Cortex (hypoechoic)
- Capsule (usu not seen)
- Perirenal fat (variable echogenicity)

Renal Cortex

Hypo- or isoechoic to the liver or spleen

Renal Pyramids

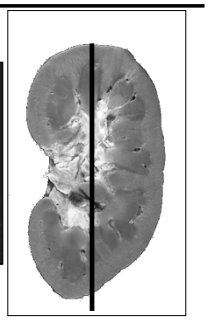
- Triangular or pyramidal hypoechoic areas



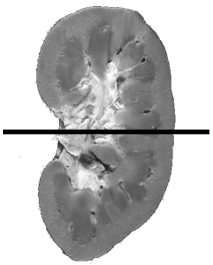
Renal Sinus

- Echogenic central portion of kidney
  - Due to multiple reflections
  - Collecting ducts
  - Fat
  - Lymphatics

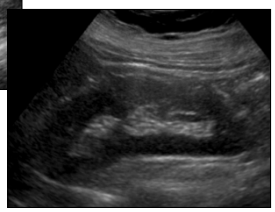
Scanning Technique- Sagittal



Scanning Technique - Transverse



Normal Kidney



Renal Measurements

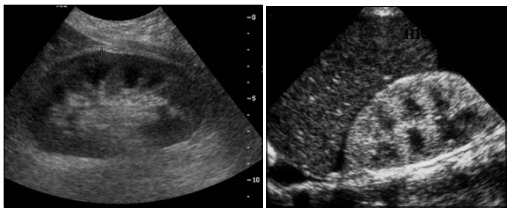
- Vary with age, height, weight, sex
- Renal lengths: 9-13 cm
- Right and left kidney should be within 2 cm in length
  - Left kidney usually slightly bigger than right
- Size decreases with age
- Compensatory hypertrophy- if renal agenesis

Renal Cortical Echogenicity

- Renal medulla < cortex < liver/spleen

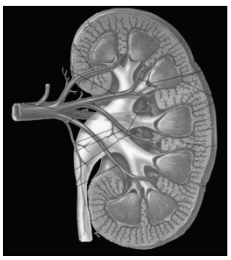
Renal Cortical Echogenicity

- Increased
  - ↑ corticomedullary differentiation
  - ↑ relative to liver/spleen



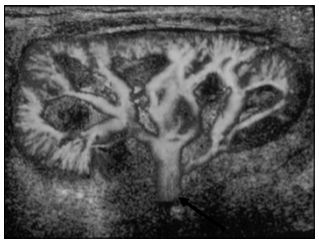
Renal Blood Supply

- Renal artery
- Segmental artery
- Interlobar artery
- Arcuate artery
- Interlobular artery



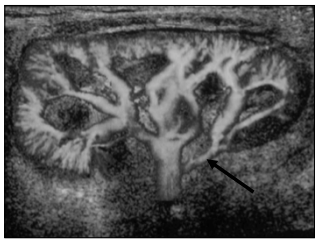
Blood Supply

- Main Renal artery



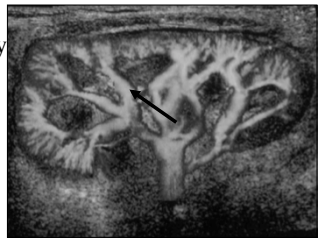
Renal Blood Supply

- Renal artery
- Segmental artery



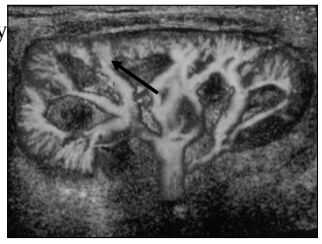
Blood Supply

- Renal artery
- Segmental artery
- Interlobar artery



Blood Supply

- Renal artery
- Segmental artery
- Interlobar artery
- Arcuate artery



Blood Supply

- Renal artery
- Segmental artery
- Interlobar artery
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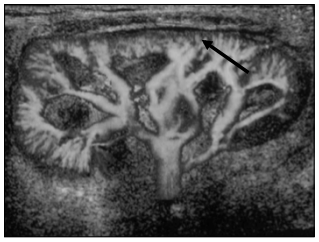
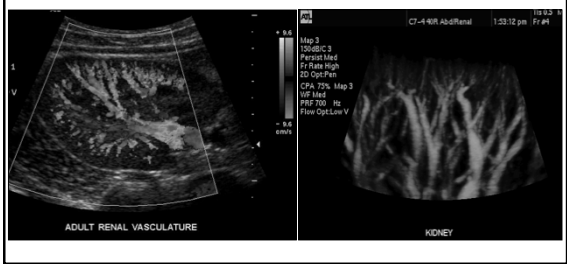


Renal Vasculature

Color Doppler US

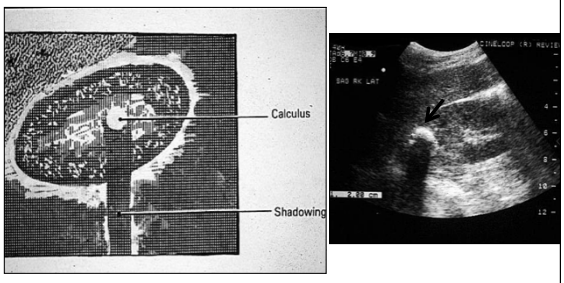
3- D US



Renal Calculi

- Bright echogenic focus with acoustic shadowing
- Shadowing independent of composition, dependent on size
- 3 mm should shadow
- Try higher or lower frequency transducer

Renal Calculus



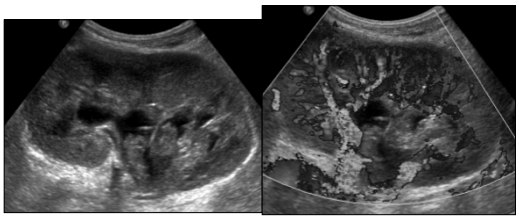
Hydronephorosis

- Obstructions at ureteropelvic junction (UPJ), ureterovescicle junction (UVJ, ladder outlet
- Dilated pelvocalyceal system
- Dilated ureter
- Cortical atrophy

Hydronephrosis

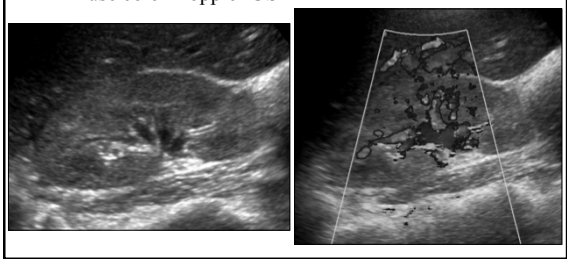
Hydronephrosis

- Do not confuse with vessels
  - use color Doppler US



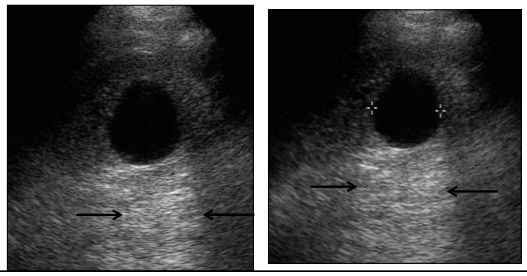
Hydronephrosis

- Do not confuse with vessels
  - use color Doppler US



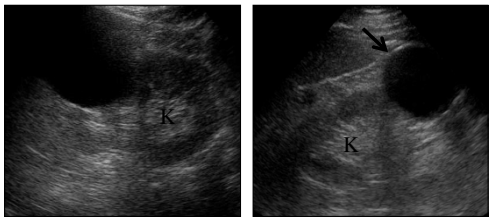
Benign Mass - Simple Renal Cyst

- Anechoic, fluid filled, posterior enhancement



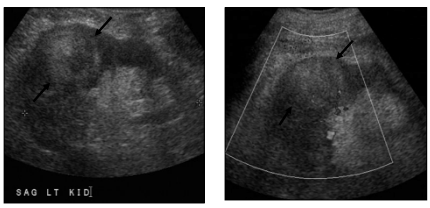
Benign Mass - Renal Cyst

- Anechoic sharply defined renal mass (C)
- Arising from the kidney (K)



Renal Cell Carcinoma

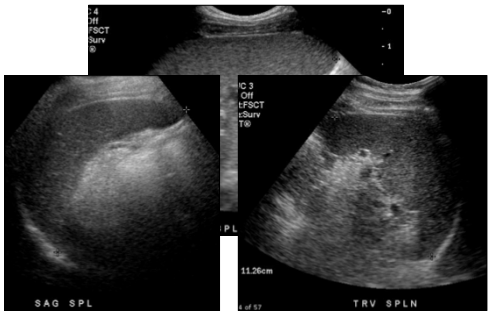
- Mildly echogenic left renal mass
- Minimal vascularity on CDUS



Spleen

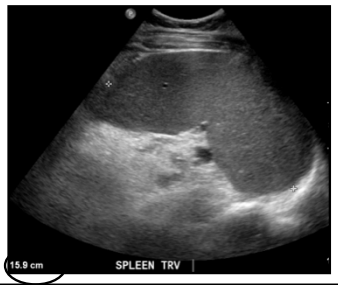
- Intraperitoneal organ in the left upper quadrant
- In continuity with the diaphragm, left kidney, splenic flexure, stomach and tail of the pancreas
- Homogenous echotexture on US
- More echogenic than the liver or the left kidney
- Normal measurements: 12 x 6 x 4cm

Spleen

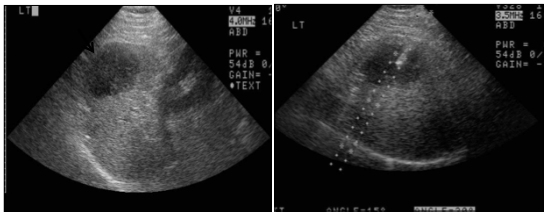


Splenomegaly

- > 12 cm in adults

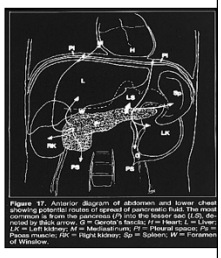


Focal Splenic Mass - Lymphoma

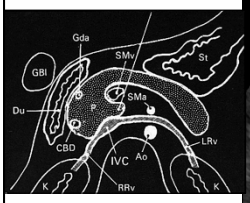


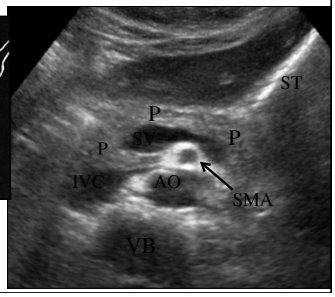
Pancreas

- Slightly more echogenic than liver
- Size:
  Head- 2.7 +/- 0.7 cm
  Body- 2.2 +/- 0.7 cm
  Tail- 2.4 +/- 0.7 cm



Normal Pancreas





Pancreas US- Technique

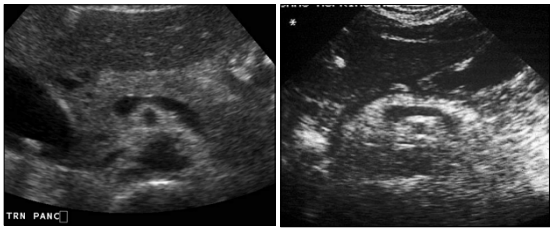
- Fast 6-8 hours to reduce bowel gas
- 3.5 - 5 MHz curved array transducer
- Pancreatic tissue brighter and coarser
- than liver tissue
- Scan on deep inspiration
- Left lobe as acoustic window
- Oral contrast / water or other fluid to distend stomach and displace gas

Pancreas

Normal Pancreas

30 year old

60 year old - more echogenic



Chronic Pancreatitis

Calcifications

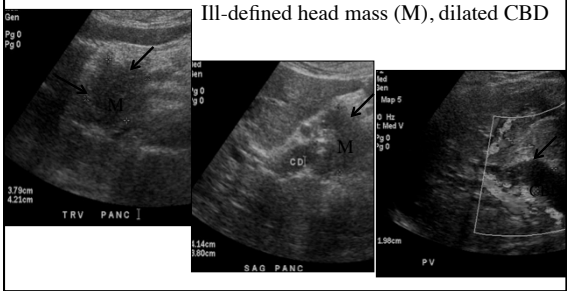
Dilated pancreatic duct

Pancreatic Carcinoma

- Head
  > body or tail
- Mass:
  - usually hypoechoic
  - dilated pancreatic duct
  - dilated common bile duct (CBD)
  - Liver metastases
  - Lymphadenopathy

Pancreas Head Carcinoma

Ill-defined head mass (M), dilated CBD

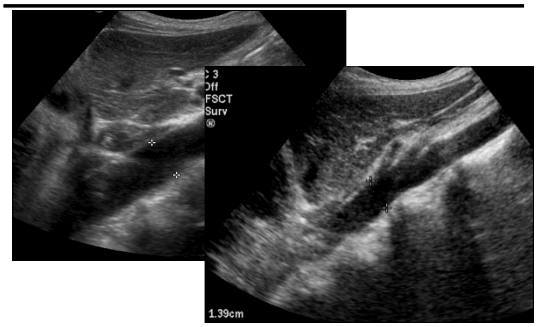


Aorta

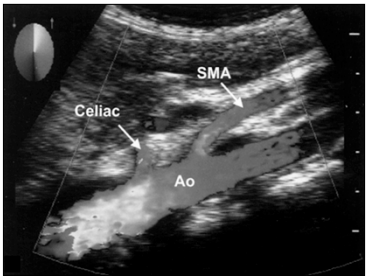
- Major blood source for abdominal organs and peripheral musculature
- Triphasic, high resistance waveform

- Major branches
  - Celiac artery (CA)
  - Superior mesenteric artery (SMA)
  - Inferior mesenteric artery (IMA)

Aorta and Branches

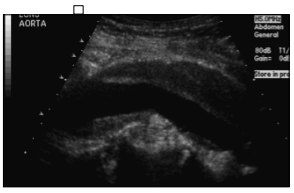


Aorta and Branches



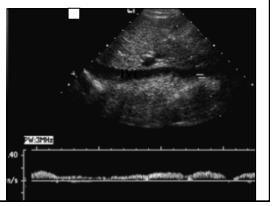
Abdominal Aortic Aneurysm

- Clinical symptoms
  - Asymptomatic
  - Abdominal pain
  - Back pain
  - Leg pain
  - Pulsatile abdominal mass

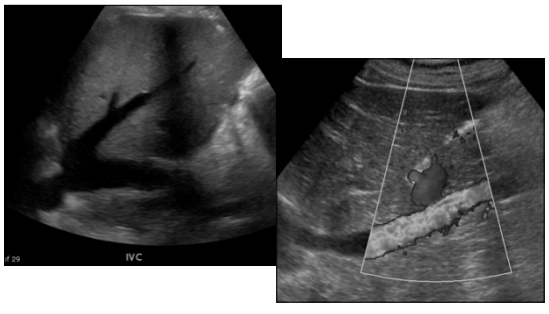


Inferior Vena Cava (IVC)

- Runs anterior to spine and to the right of the aorta
- Empties into the right atrium
- Divided into 2 parts by ultrasound
  - Extrahepatic portion
  - Intrahepatic portion
- Phasic venous waveform



IVC and Hepatic Veins



Conclusion

- Ultrasound is after plain X-ray the most commonly used imaging modality worldwide
- It is user dependent, requires a thorough knowledge of physics, normal anatomy, pathology and physiology and in experienced hands should be the first imaging modality employed in most patients

Thank You
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