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:
- M. Robert De Jong, RDMS, RVT, FAIUM, FSDMS – Johns Hopkins
- and
- Dr. Leslie Scoutt, Yale University, School of Medicine

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 ligamentum teres and left hepatic vein (LHV)
- Caudate lobe (smallest)
  - Delineated by the fissure for the ligamentum venosum

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

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Falciform Ligament

Surface Anatomy

Segmental Anatomy- Ligamentum teres

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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

Medial | Lateral
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, H₂O permitted
- Supine: longitudinal & transverse views
- Decubitus: Right side up views
- Erect views
- Identify local tenderness

Gallbladder

Normal Gallbladder

<table>
<thead>
<tr>
<th>Sagittal</th>
<th>Transverse</th>
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<tbody>
<tr>
<td><img src="image1.png" alt="Sagittal View" /></td>
<td><img src="image2.png" alt="Transverse View" /></td>
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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)

Gallstone

- They are mobile

Supine

Right side up decubitus
Gallstones: Shadowing

- Size dependent
  - \( \geq 3 \text{ mm} \)
- 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, \( \geq 3 \text{ mm} \)
- 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

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

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)

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)
1. **Cortex** (the outer c-shaped thick rim)
2. **Medulla** (the renal pyramids)
3. **Sinus** (central area)
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
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- Interlobar artery
- Arcuate artery
Blood Supply

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Renal Vasculature

- Color Doppler US
- 3D 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

Hydronephrosis

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

Hydronephrosis
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

- Left lobe liver

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)
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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