Hepatic Imaging: What Every Practitioner Should Know

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Disclosures

None
Learning Objectives

• Describe different liver imaging techniques
• Review imaging criteria for diagnosis of cirrhosis and portal hypertension
• Explain ACR LI-RADS and why it should be used in the patient at risk for HCC
Radiology Imaging Tools

Ultrasound  CT scan

MRI  Contrast or no contrast?
Ultrasound

- Inexpensive
- Portable
- Doppler evaluation
- Highest spatial resolution
- No ionizing radiation or nephrotoxic contrast
- Operator dependent
- Limited by body habitus, bowel gas
Computed Tomography (CT)

• Quick
• Well tolerated by patients
• High spatial resolution
• Options – single vs multi-phase
• *Ionizing radiation*
• *Less soft-tissue contrast*
• *Nephrotoxic contrast*
Magnetic Resonance Imaging

- High soft tissue contrast
- No ionizing radiation
- Functional and advanced techniques emerging
- *Time consuming*
- *Less spatial resolution*
- *Expensive, requires more expertise*
- *Limited by large body habitus, ascites, artifacts*
Hepatic Steatosis

Ultrasound

Noncontrast CT
Periportal Hypodensity?

Contrast enhanced CT

GRE In phase MRI  GRE Out of phase MRI

Diagnosis: Periportal Steatosis
What’s next?
Elastography
Elastography

• Why do we need it?

• US, CT, MRI low sensitivity for early fibrosis

• Need to identify patients with earlier stages of fibrosis
  • Risk stratification
  • Treatment management

• METAVIR Score : Fibrosis Staging F0-F4
Comparison of TE with 2D SWE

1D Transient Elastography
No correlative image

2D Shear Wave Elastography
Correlative image

Barr et al Radiology 2015
Shear Wave Stiffness for METAVIR Scores

Substantial overlap between stages of hepatic fibrosis especially lower stages

Friedrich-Rust M, J Viral Hepat 2012
Barr et al, Radiology 2015
Best Practice of US Elastography
SRU Consensus Statement

• Identify patients at **minimal risk** of having clinically significant fibrosis (METAVIR F0 and F1) and those at **high risk** of having clinically significant fibrosis (METAVIR score F3 and F4)

• Patients with **middle stages of fibrosis** (F2-F3)
  • blood tests
  • liver biopsy
  • MRE
  • clinical correlation

MR Elastography (MRE)

- Quantitative Imaging of Tissue Stiffness
  - Assess fibrosis
  - Normal is hepatic stiffness < 2.5 kPa
MR Elastography (MRE)
3 different patients

No increased stiffness
2 kPa
No evidence fibrosis

Increased stiffness
4 kPa
Significant fibrosis

Markedly increased stiffness
6 kPa
Cirrhosis

Barr et al Radiology 2015
What’s next?

Contrast Enhanced Ultrasound (CEUS)
How CEUS Works

Gas-filled microbubble < 7 µm

Outer shell stabilizer
Microbubbles vs Iodinated contrast/Gadolinium
CEUS Indications

66F, allergy to iodinated/gad contrast & 3 enlarging liver lesions

Dx: benign proteinaceous cyst

Dx: hemangioma

Dx: hemangioma
CEUS Cases
53 year old male with indeterminate liver mass – could not tolerate MRI

US Sag liver

US Trv liver
31 year old female with liver mass

Trv liver

Sag liver

Sag liver color doppler
Viable Tumor in Treated Lesion
Comparable to MRI – not seen B-mode

Case courtesy of David Fetzer, MD
66F with lung cancer, renal insufficiency

Diagnosis: metastasis
appears to be a possible, borderline, indeterminate, equivocal, suspected pixel, probably of questionable significance. Clinical correlation needed... maybe...
LI-RADS® developed & refined over many years …

- **2006**: Embryonic version of LI-RADS
- **2008**: ACR LI-RADS committee
- **2011**: v1.0 criteria & lexicon for CT, MRI-ECA
- **2013**: v2013: add algorithm & atlas for CT, MRI-ECA
- **2014**: v2014: add MRI-HBA, simplify algorithm
- **2017**: v2017: add US, CEUS, treatment response; further simplify algorithm
- **2018**: v2018: Unification with AASLD, minor modifications

4 contributors from 2 USA institutions

> 250 contributors
> 100 institutions
> 30 countries
LI-RADS “360”

US LI-RADS
Detect liver findings

CT/MRI/CEUS LI-RADS
Characterize liver findings

Multidisciplinary management plan
Einstein Liver US Protocol
Adapted from ACR US LI-RADS

Longitudinal images
- Left lobe
  - Left of midline
  - At midline with aorta
  - With IVC
  - With LPV
- Right lobe
  - With gallbladder
  - With right kidney
  - Include right hemidiaphragm and adjacent pleural space
  - Far lateral
  - MPV in B-mode, color and spectral Doppler
  - Common bile duct

Transverse images
- Dome with hepatic veins
- Right liver edge
- Left liver edge
- Left lobe
  - With left portal vein
  - Falciform ligament (assess for patent paraumbilical vein)
- Main portal vein bifurcation
- Right lobe
  - With right portal vein
  - With main portal vein
  - With gallbladder
  - With right kidney
  - Near liver tip

Additional views:
- Wide FOV of liver
- Liver/spleen comparison
- Spleen measurement
- High frequency R and L lobes for contour and parenchyma
- R and L lower quadrants to assess for ascites

Cine loops
- Sagittal left lobe midline to left liver edge
- Transverse subcostal through porta hepatis, superior to inferior
- Transverse right lobe superior to inferior
- High frequency linear transducer, left and right lobes
US LI-RADS
Value of falciform ligament view

2 years earlier

New portal hypertension
Benefit of low frequency and wide field of view for global contour abnormalities
Echogenic liver at low frequency
High frequency supports more specific diagnosis

1. Steatosis
   - echogenicity
   - sound attenuation
   - Smooth contour

2. Hepatitis and fibrosis
   - echogenicity
   - reticular echoes
   - Smooth contour

3. Cirrhosis
   - echogenicity
   - Regenerating nodules
   - Nodular contour

1 2 3

High frequency supports more specific diagnosis
Progression of cirrhosis on 12-5 MHz imaging

2013 US and CT
Smooth contour
Normal echogenicity

2014 US
Wavy contour
↑ Heterogeneity

Liver BX 4/2014:
Chronic hepatitis with Bridging fibrosis

Liver BX 10/2014:
Cirrhosis with Extensive fibrosis

2016 US and MR
Nodular contour
Tiny hypoechoic regenerating nodules on US with corresponding hypointense foci on MR

T1W portal venous phase
Other findings related to cirrhosis and portal hypertension

- Right pleural effusion
- Ascites with 3D surface rendering
- Splenomegaly
- 2 different patients
- Sag R colon
- Sag jejunum in LUQ
- Wall thickening of colon and jejunum
- Colopathy and enteropathy
- Nephromegaly
Paraumbilical

Spleno-renal

Cavernous transformation after chronic PV thrombosis

Gallbladder varices due to chronic PV thrombus

Coronary

T1W post contrast
Applying US LI-RADS in at-risk patient

1. Assign US category

<table>
<thead>
<tr>
<th>US-1</th>
<th>Negative</th>
</tr>
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<tbody>
<tr>
<td>US-2</td>
<td>Subthreshold</td>
</tr>
<tr>
<td>US-3</td>
<td>Positive</td>
</tr>
</tbody>
</table>

2. Assign US visualization score

<table>
<thead>
<tr>
<th>A</th>
<th>No or minimal limitations</th>
</tr>
</thead>
<tbody>
<tr>
<td>B</td>
<td>Moderate limitations</td>
</tr>
<tr>
<td>C</td>
<td>Severe limitations</td>
</tr>
</tbody>
</table>
Focal Observation $\geq 1\text{cm}$ at screening
Hepatitis C and Cirrhosis

CT/MRI LI-RADS 5: Classic HCC

US LI-RADS
Category 3

Cine: Couinaud segment and assess relationship to vessels and ducts

Arterial MRI

Recommend multiphase contrast study

Delayed MRI
Small observation on screening US

7 mm hypoechoic observation
US LI-RADS Category 2, Sub-threshold

Follow-up US (not MRI)
New 1.4 cm observation on surveillance US (US Category 3) not visible on MRI

CEUS LI-RADS 3
Resume US screening with CEUS
US LI-RADS Category 3

Transverse right lobe

Sagittal right lobe
Diagnosis: CEUS LI-RADS 5
Conclusion

• Advanced noninvasive hepatic imaging tools
• Contrast Enhanced Ultrasound is particularly helpful in setting of renal insufficiency
• ACR LI-RADS algorithm standardizes imaging from screening to diagnosis of HCC
• The radiologist is your friend!
Thank you!

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