HCC Imaging
Diagnostic Paradigms, Reporting, and New Tools

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Disclosures

• Bracco Diagnostics
  – Honoraria for CME program

• Bayer HealthCare Pharmaceuticals
  – Medicolegal Consultant
  – Honoraria for CME program
## Liver Disease: Diagnostic Imaging Paradigm

<table>
<thead>
<tr>
<th>Historical</th>
<th>New</th>
</tr>
</thead>
<tbody>
<tr>
<td>Morphologic/Anatomic</td>
<td>Quantitative imaging biomarkers</td>
</tr>
<tr>
<td>Non-standardized reporting</td>
<td>Standardized reporting</td>
</tr>
</tbody>
</table>

- **Historical**
  - Identify morphologic changes in anatomic structures that correlate with gross and/or microscopic histopathologic observations

- **New**
  - Use objective image–derived indicators of normal biological processes, pathogenic processes, or response to therapeutic interventions that provide interpretive value beyond gross anatomic appearances
Quantitative Imaging Biomarkers

International collaboration of academia, clinical medicine, industry and regulators to improve the value and practicality of quantitative imaging biomarkers by reducing variability across devices, patients and time through use of standardized test objects, standardized protocols and readouts

- Quantitative Imaging Biomarkers Alliance (QIBA)
- Quantitative Imaging Network (QIN)
- European Imaging Biomarkers Alliance (EIBALL)
- American College of Radiology Imaging Network (ACRIN)
- European Society of Radiology (ESR)
- European Organization for Research and Treatment in Cancer (EORTC)
- International Society for Magnetic Resonance in Medicine (ISMRM)
- Cancer Research UK

Hepatic Venous Pressure Gradient for CSPH

- Portal hypertension is the main cause for severe complications of cirrhosis, including hepatic encephalopathy, ascites, and gastroesophageal variceal bleeding.

- **Hepatic venous pressure gradient (HVPG)** measurement by means of catheterization of the right hepatic vein, a well-established method of estimating portal venous pressure, is calculated by subtracting the free hepatic venous pressure from the wedged hepatic venous pressure.

- An HVPG of 10 mm Hg or greater is considered “clinically significant portal hypertension” (CSPH) and is a criterion used to predict clinical outcomes in patients with portal hypertension.

- The current reference standard for measuring HVPG is invasive, difficult to reproduce, and not widely available.

- Are there noninvasive methods for assessing portal pressure in cirrhosis?
Semiautomated Software to Quantify Liver Surface Nodularity (LSN) on CT scans

The LSN score is the average distance between each pixel of the detected surface of the liver and a mathematically smoothed line derived from the detected surface that is designed to mimic a normal smooth liver surface.

a. 61-year-old woman with alcoholic cirrhosis and HVPG of 6 mm Hg

b. 58-year-old woman with alcoholic cirrhosis and HVPG of 13 mm Hg.
Multi-institutional European trial
189 patients
  102 with CSPH
LSN was correlated with HVPG

CONCLUSIONS
LSN score correlated strongly with HVPG
LSN score demonstrated high diagnostic performance for detecting CSPH and outperformed other noninvasive tests
• Used main portal vein velocity obtained from venous Doppler US combined with calculated CT angiographic images obtained using two methods;
  • **Finite element analysis**: measures the distribution of the field variables such as pressure or displacement in small elements of a three-dimensional model
  • **Computational fluid dynamics**: uses mathematical models to define the interactions of fluid with adjacent structures.
• Prospective multicenter trial with 102 consecutive subjects
CONCLUSIONS
Virtual HVPG with CTA correlates well with invasive HVPG and shows good performance in diagnosing clinically significant portal hypertension in patients with cirrhosis.
CT Quantitative Imaging Biomarkers for Diffuse Liver Disease
Liver MRI Tool Box

- Motion resistant MRI
- Volumetric quantification of the whole tumor and necrotic component
- Fat and iron quantification
- Hepatocyte function with GBCAs
- Diffusion (DWI)
- Perfusion (PWI)
- Radiogenomic venous invasion (RVI)
- MR spectroscopy (MRSI)
- MR elastography (MRE)
- Chemical exchange saturation transfer (CEST)
  - Amide proton transfer imaging (APT)
- MR thermometry (necrosis)
- MR pH measurement
- Apoptosis imaging
- Susceptibility (SWI)
- Oxygen-sensitive MRI (hypoxia)
- MR fingerprinting (MRF)
MRI Fat and Iron Quantification

- Direct measurements of T2* and R2* mapping
  - A fundamental tissue property \([R_2^* = (1 / T2^*)]\) is independent of acquisition parameters
  - Linear correspondence between R2* and iron concentration (field strength dependent)
  - Can be obtained in single breath-hold
  - T2* corrected methods used for fat quantification can simultaneously quantify iron

## Selected Quantitative Hepatic Iron Deposition MRI Studies in Humans

<table>
<thead>
<tr>
<th>Study</th>
<th>No. of Subjects</th>
<th>Model</th>
<th>Standard of Reference</th>
<th>Performance</th>
<th>Notes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gandon et al (7)</td>
<td>174</td>
<td>Decision algorithm</td>
<td>Histologic examination</td>
<td>Mean difference from Bland-Altman analysis: 0.8 μmol/g (LOAs: −6.3 to 7.9 μmol/g)</td>
<td>Multisequence method using decision algorithm rather than an explicit parameterized model fitting</td>
</tr>
<tr>
<td>Wood et al (8)</td>
<td>22</td>
<td>Monoexponential model of T2* and T2 decay</td>
<td>Histologic examination</td>
<td>Mean difference from Bland-Altman analysis: 1% (LOAs: −23%, 23%)</td>
<td>R2* results listed here; all 22 patients underwent biopsy</td>
</tr>
<tr>
<td>Kühn et al (20)</td>
<td>95</td>
<td>Single and multipeak multiecho Dixon</td>
<td>Histologic examination</td>
<td>AUC: 0.99</td>
<td>Multiple thresholds and models evaluated for both fat and iron quantification</td>
</tr>
<tr>
<td>St Pierre et al (9)</td>
<td>233</td>
<td>Monoexponential model of T2 decay</td>
<td>Histologic examination</td>
<td>Mean difference from Bland-Altman analysis: 1.9% (LOAs: −71%, 74%)</td>
<td>Validation study of methods from Wood et al (8); provides basis for FerriScan</td>
</tr>
</tbody>
</table>
### Selected Quantitative Hepatic Fat Fraction MRI Studies in Humans

<table>
<thead>
<tr>
<th>Study</th>
<th>No. of Subjects</th>
<th>Model</th>
<th>Standard of Reference</th>
<th>Performance</th>
<th>Notes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Idilman et al (21)</td>
<td>70</td>
<td>Six-point GRE with IDEAL reconstruction</td>
<td>Histologic examination</td>
<td>AUC: 0.95</td>
<td>AUC is for detecting moderate-to-severe steatosis; optimal fat fraction cutoff = 15%</td>
</tr>
<tr>
<td>Deng et al (17)</td>
<td>10</td>
<td>Multipeak multiecho Dixon</td>
<td>Histologic examination</td>
<td>Mean difference from Bland-Altman analysis: −0.35% (LOAs: −2.2%, 2.1%)</td>
<td>Six-point Dixon, five-spectral-peak fat model</td>
</tr>
<tr>
<td>Kühn et al (20)</td>
<td>95</td>
<td>Single and multipeak multiecho Dixon</td>
<td>Histologic examination</td>
<td>AUC: 0.93–0.95</td>
<td>Multiple thresholds and models evaluated for both fat and iron quantification</td>
</tr>
<tr>
<td>Mashhoodi et al (15)</td>
<td>10</td>
<td>Single and multipeak multiecho Dixon</td>
<td>…</td>
<td>COV: 10%–18%; SD: 0.78%–0.84%</td>
<td>Multicenter, multimagnet, multivendor reproducibility study for dual and multipeak fat fraction</td>
</tr>
<tr>
<td>Kang et al (5)</td>
<td>21</td>
<td>Multipeak multiecho Dixon</td>
<td>MRS</td>
<td>Mean difference from Bland-Altman analysis: approximately 1.2%</td>
<td>Also evaluated reproducibility of multiecho technique</td>
</tr>
<tr>
<td>Hamilton et al (16)</td>
<td>121</td>
<td>Multipeak multiecho</td>
<td>MRS</td>
<td>…</td>
<td>Measured in vivo fat peaks in steatotic liver with method validated in phantom</td>
</tr>
<tr>
<td>Hines et al (22)</td>
<td>42</td>
<td>Multipeak multiecho Dixon</td>
<td>MRS</td>
<td>Sensitivity, specificity: 91%, 93%</td>
<td>Sensitivity and specificity for detecting &gt; 5% fat fraction</td>
</tr>
<tr>
<td>Lee et al (6)</td>
<td>161</td>
<td>Dual-peak Dixon and MRS PDFF</td>
<td>MRS/histologic examination</td>
<td>Sensitivity, specificity: MRS = 80.0%, 80.2%; dual-peak Dixon = 76.7%, 87.1%</td>
<td>Sensitivity and specificity for detecting &gt; 5% fat fraction; used single fat peak but did correct for T2* effects</td>
</tr>
<tr>
<td>Yelko et al (23)</td>
<td>163</td>
<td>Multipeak multiecho Dixon</td>
<td>MRS</td>
<td>Accuracy range: 86%–96%</td>
<td>Compared single and multipeak models using multiple numbers of echoes; accuracy in diagnosing fat fraction &gt;6%</td>
</tr>
<tr>
<td>Kühn et al (24)</td>
<td>50</td>
<td>Multipeak multiecho Dixon</td>
<td>MRS</td>
<td>Mean difference from Bland-Altman analysis: 0.49% (LOAs: −3.26%, 4.25%)</td>
<td>Evaluated effect of correcting for T2*, T1, and multipeak model</td>
</tr>
<tr>
<td>Noureddin et al (19)</td>
<td>50</td>
<td>Multipeak multiecho Dixon</td>
<td>MRS/histologic examination</td>
<td>Dixon/MRS correlation: r² = 0.98; P &lt; .0001</td>
<td>Compared multiecho PDFF; MRS PDFF; and histologic examination longitudinally and with clinical parameters</td>
</tr>
<tr>
<td>Sarkunasingham et al (14)</td>
<td>217</td>
<td>Two-point and three-point multiecho Dixon</td>
<td>MRS</td>
<td>Mean difference from Bland-Altman analysis: −0.5% (LOAs: −5.1%, 4.2%)</td>
<td>Three-point Dixon results shown (superior to two-point results)</td>
</tr>
</tbody>
</table>
MRI Fat and Iron Quantification
Quantitative MRI for Hepatic Fibrosis

Elastography
- Elastogram
- Tissue stiffness

DWI
- ADC
- $D^*$ using IVIM
- Kurtosis value

T1
- $T1\rho$
- T1 mapping / T1 value

Contrast enhanced MRI
- Extracellular Volume Fraction
- Hepatocyte Fraction (HeF)

T2 and T2*
- T2 value
- $\Delta R2^*$ using BOLD MRI

Strain Imaging
- Strain map using cine tagging

ADC: apparent diffusion coefficient. IVIM: intravoxel incoherent motion.
BOLD MRI: Blood Oxygen Level Dependent MRI

Guo Y, et al. Radiology 2018
MR Elastography (MRE)

- Stiffness of liver tissue is strongly correlated with degree of fibrosis
- MRE assesses images of an acoustic wave generated by a sound source (low-frequency mechanical waves) as it passes through the liver to determine hepatic stiffness (i.e., elastic properties of tissue)
- Requires modest software and hardware upgrades to conventional MR scanners
- Acquisition approx 15 seconds (one breath-hold)
2.5cm

Conventional MR Image

Gel phantom with stiff inclusions

1. Driver (30-500 Hz)

2. MRE Sequence

3. Inversion

10

0

+10

-10

Displacement (µm)

0

40

80

Shear Stiffness (kPa)

Wave Images ➔ Elastogram
MR Elastography (MRE)

\[ \mu = 1.98 \text{ kPa} \]

\[ \mu = 6.95 \text{ kPa} \]

Bx: Grade 3 Fibrosis

\[ \mu = 1.98 \text{ kPa} \]

\[ \mu = 6.95 \text{ kPa} \]
MR Elastography (MRE)

- Mean liver stiffness measurements increase with greater degrees of liver fibrosis
- With upper limit of normal set at 2.93 kPa, achieve 98%/99% sensitivity/specificity
- 97% negative predictive value for excluding liver fibrosis
- Fatty infiltration does not affect results

kPa=kiloPascals
Magnetic Resonance Elastography for Staging Liver Fibrosis in Non-alcoholic Fatty Liver Disease: A Diagnostic Accuracy Systematic Review and Individual Participant Data Pooled Analysis

Pooled analysis of the diagnostic performance of magnetic resonance elastography for diagnosis and staging of liver fibrosis, based on 232 patients from 9 studies (6 independent cohorts).

<table>
<thead>
<tr>
<th>Fibrosis Stage</th>
<th>Optimal cut-off (kPa)</th>
<th>AUROC (95% CI)</th>
<th>Sensitivity (95% CI)</th>
<th>Specificity</th>
<th>Positive LR</th>
<th>Negative LR</th>
</tr>
</thead>
<tbody>
<tr>
<td>Any Fibrosis (≥Stage 1)</td>
<td>2.88</td>
<td>0.86 (0.82–0.90)</td>
<td>0.75 (0.68–0.87)</td>
<td>0.77 (0.65–0.88)</td>
<td>3.24</td>
<td>0.33</td>
</tr>
<tr>
<td>Significant Fibrosis (≥Stage 2)</td>
<td>3.54</td>
<td>0.87 (0.82–0.93)</td>
<td>0.79 (0.76–0.90)</td>
<td>0.81 (0.72–0.91)</td>
<td>4.14</td>
<td>0.27</td>
</tr>
<tr>
<td>Advanced Fibrosis (≥Stage 3)</td>
<td>3.77</td>
<td>0.90 (0.84–0.94)</td>
<td>0.83 (0.53–0.90)</td>
<td>0.86 (0.81–0.96)</td>
<td>5.93</td>
<td>0.19</td>
</tr>
<tr>
<td>Cirrhosis (Stage 4)</td>
<td>4.09</td>
<td>0.91 (0.76–0.95)</td>
<td>0.88 (0.82–1.00)</td>
<td>0.87 (0.77–0.97)</td>
<td>6.50</td>
<td>0.14</td>
</tr>
</tbody>
</table>

Repeatability
True change if values differ more than 22% on the follow up exam
MR Elastography
Azygos vein flow greater than 0.1 L/min (P=.034; 100% sensitivity/62% specificity) and portal venous flow less than the sum of splenic and superior mesenteric vein flow (P<.001;100% sensitivity/94% specificity) measured at 4D flow MRI are useful markers to stratify the risk of bleeding in gastroesophageal varices in patients with liver cirrhosis.
Quantitative MRI for Hepatic Fibrosis
Multiparametric estimation using machine learning

Elastography
- Elastogram
- Tissue stiffness

DWI
- ADC
- D* using IVIM
- Kurtosis value

T1
- T1ρ
- T1 mapping / T1 value

Contrast enhanced MRI
- Extracellular Volume Fraction
- Hepatocyte Fraction (HeF)

T2 and T2*
- T2 value
- ΔR2* using BOLD MRI

Strain Imaging
- Strain map using cine tagging

ADC: apparent diffusion coefficient. IVIM: intravoxel incoherent motion.
BOLD MRI: Blood Oxygen Level Dependent MRI

Guo Y, et al. Radiology 2018
Overt HCCs usually have elevated arterial flow with reduced or absent portal flow, which makes the diagnostic hallmark of HCC, “arterial enhancement and washout”
The Liver Imaging Reporting and Data System (LI-RADS®)

Provides a standardized lexicon, strict diagnostic criteria, an easy-to-follow diagnostic algorithm, and reporting guidelines to improve the consistency and clarity of radiologist interpretation and reporting.
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 and AASLD achieved unification in 2018
CT/MRI LI-RADS® v2018 CORE

Untreated observation without pathologic proof in **patient at high risk for HCC**

- If cannot be categorized due to image degradation or omission → LR-NC
- If definite **TIV** → LR-TIV
- If definitely benign → LR-1
- If probably benign → LR-2
- If probably or definitely malignant but not HCC specific (e.g., if **targetoid**) → LR-M

Otherwise, use CT/MRI diagnostic table below

- If intermediate probability of malignancy → LR-3
- If probably HCC → LR-4
- If definitely HCC → LR-5
<table>
<thead>
<tr>
<th>Arterial phase hyperenhancement (APHE)</th>
<th>No APHE</th>
<th>Nonrim APHE</th>
</tr>
</thead>
<tbody>
<tr>
<td>Observation size (mm)</td>
<td>&lt; 20</td>
<td>≥ 20</td>
</tr>
<tr>
<td>Count additional major features:</td>
<td>None</td>
<td>LR-3</td>
</tr>
<tr>
<td>• Nonperipheral “washout”</td>
<td>LR-3</td>
<td>LR-4</td>
</tr>
<tr>
<td>• Enhancing “capsule”</td>
<td>LR-4</td>
<td>LR-4</td>
</tr>
<tr>
<td>• Threshold growth</td>
<td>LR-4</td>
<td>LR-4</td>
</tr>
</tbody>
</table>

Observations in this cell are categorized based on one additional major feature:
- LR-4 – if enhancing “capsule”
- LR-5 – if nonperipheral “washout” OR threshold growth
### 2018 AASLD/LI-RADS Unified Guidance Uses LR-5 criteria…

<table>
<thead>
<tr>
<th>Size</th>
<th>Criteria</th>
<th>Comments</th>
<th>Table Cell</th>
</tr>
</thead>
<tbody>
<tr>
<td>10-19 mm</td>
<td>APHE (nonrim) &lt;br&gt;• AND “washout” (nonperipheral)</td>
<td>Equivalent to AASLD 2010 criteria</td>
<td></td>
</tr>
<tr>
<td></td>
<td>APHE (nonrim) &lt;br&gt;• AND threshold growth</td>
<td>Equivalent to OPTN 5A-g</td>
<td></td>
</tr>
<tr>
<td>≥ 20 mm</td>
<td>APHE (nonrim) &lt;br&gt;• AND both of the following: &lt;br&gt;• “Washout” (nonperipheral) &lt;br&gt;• Enhancing “capsule”</td>
<td>Equivalent to OPTN 5A</td>
<td></td>
</tr>
<tr>
<td></td>
<td>APHE (nonrim) &lt;br&gt;• AND one or more of following: &lt;br&gt;• “Washout” (nonperipheral) &lt;br&gt;• Enhancing “capsule” &lt;br&gt;• Threshold growth</td>
<td>Equivalent to OPTN 5B or 5X</td>
<td></td>
</tr>
<tr>
<td>Major Feature</td>
<td>Definition</td>
<td>Examples</td>
<td></td>
</tr>
<tr>
<td>---------------------------------------------------</td>
<td>---------------------------------------------------------------------------</td>
<td>-------------------------------------------------</td>
<td></td>
</tr>
</tbody>
</table>
| Nonrim arterial phase hyperenhancement (APHE)     | Nonrim-like enhancement in arterial phase unequivocally greater in whole or in part than liver. Enhancing part must be higher in attenuation or intensity than liver in arterial phase. 
*Comment:* Nonrim APHE is required for LR-5 categorization. | ![CT Arterial phase](image1.png) | ![MRI-ECA Arterial phase](image2.png) | ![MRI-Gadoxetate Arterial phase](image3.png) |
| Nonperipheral washout appearance ("washout")     | Nonperipheral visually assessed temporal reduction in enhancement in whole or in part relative to composite liver tissue from earlier to later phase resulting in hypoenhancement in the extracellular phase: 
- portal venous or delayed phase with ECA or gadobenate 
- portal venous phase with gadoxetate | ![CT Portal or delayed phase](image4.png) | ![MRI-ECA Portal or delayed phase](image5.png) | ![MRI-Gadoxetate Portal phase only](image6.png) |
| Enhancing capsule appearance ("capsule")         | Smooth, uniform, sharp border around most or all of an observation, unequivocally thicker or more conspicuous than fibrotic tissue around background nodules, and visible as an enhancing rim in portal venous phase, delayed phase, or transitional phase. | ![CT Portal or delayed phase](image7.png) | ![MRI-ECA Portal or delayed phase](image8.png) | ![MRI-Gadoxetate Portal or transitional](image9.png) |
| Size                                              | Largest outer-edge-to-outer-edge dimension of an observation 
*Comment:* Do not measure in arterial phase or DWI if margins are clearly visible on different phase or sequence (size may be overestimated in arterial phase due to summation with peributter enhancement and is not measured reliably on DWI due to anatomic distortion). | ![CT Pick phase, sequence, plane in which margins are clearest](image10.png) | ![MRI-ECA Include "capsule" in measurement](image11.png) |
| Threshold growth                                  | Size increase of a mass by ≥ 50% in ≤ 6 months 
*Comments:* 
- Measure on same phase, sequence, and plane if possible. 
- Apply threshold growth only if there is a prior CT or MRI exam. Do not assess threshold growth by comparing to prior US or CEUS exams. | ![CT 50% size increase in 4 months](image12.png) |
<table>
<thead>
<tr>
<th>LR-M Imaging Feature</th>
<th>Definition</th>
<th>Examples</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Targetoid dynamic enhancement</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Rim arterial phase hyperenhancement (APHE)</td>
<td>Spatially defined subtype of APHE in which arterial phase enhancement is most pronounced in observation periphery</td>
<td></td>
</tr>
<tr>
<td>Peripheral washout appearance</td>
<td>Spatially defined subtype of “washout” in which apparent washout is most pronounced in observation periphery</td>
<td></td>
</tr>
<tr>
<td>Delayed central enhancement</td>
<td>Central area of progressive postarterial phase enhancement</td>
<td></td>
</tr>
<tr>
<td><strong>Targetoid appearance on diffusion-weighted imaging (DWI) or transitional phase (TP)/hepatobiliary phase (HBP)</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Targetoid restriction</td>
<td>Concentric pattern on DWI characterized by restricted diffusion in observation periphery with less restricted diffusion in observation center</td>
<td></td>
</tr>
<tr>
<td>Targetoid TP or HBP appearance</td>
<td>Concentric pattern in TP or HBP characterized by moderate-to-marked hypointensity in observation periphery with milder hypointensity in center</td>
<td></td>
</tr>
</tbody>
</table>
# Treatment Response Features

<table>
<thead>
<tr>
<th>LR-Treatment Response Assessment Feature</th>
<th>Definition</th>
<th>Examples</th>
</tr>
</thead>
<tbody>
<tr>
<td>Treatment-specific expected enhancement</td>
<td>Expected temporal and spatial pattern of posttreatment enhancement attributable to treatment-related changes in parenchymal perfusion.</td>
<td><img src="image1.png" alt="CT" /> <img src="image2.png" alt="MRI" /></td>
</tr>
<tr>
<td>No lesional enhancement</td>
<td>Absence of enhancement within or along the margin of a treated lesion. <strong>Comment:</strong> Complete disappearance after locoregional treatment is considered equivalent to absence of enhancement.</td>
<td><img src="image3.png" alt="CT" /> <img src="image4.png" alt="MRI" /></td>
</tr>
<tr>
<td>Posttreatment Arterial phase hyperenhancement (APHE)</td>
<td>Nodular, masslike, or thick and irregular APHE contained within or along the margin of a treated lesion suggests posttreatment tumor viability. <strong>Comment:</strong> Subtraction imaging on MRI can help assess APHE posttreatment, if there are hyperintense areas on precontrast T1-W sequences.</td>
<td><img src="image5.png" alt="CT" /> <img src="image6.png" alt="MRI" /></td>
</tr>
<tr>
<td>Posttreatment “washout”</td>
<td>Nodular, masslike, or thick and irregular washout appearance contained within or along the margin of a treated lesion suggests posttreatment tumor viability.</td>
<td><img src="image7.png" alt="CT" /> <img src="image8.png" alt="MRI" /></td>
</tr>
<tr>
<td>Posttreatment enhancement similar to pretreatment</td>
<td>Nodular, masslike, or thick and irregular enhancement similar to pretreatment enhancement in all postcontrast phases contained within or along the margin of a treated lesion suggests posttreatment tumor viability, even in the absence of APHE or washout appearance.</td>
<td><img src="image9.png" alt="CT" /> <img src="image10.png" alt="MRI" /></td>
</tr>
<tr>
<td>Size of equivocally, probably, or definitely viable tumor</td>
<td>Longest dimension through enhancing area of treated lesion, not traversing nonenhancing area</td>
<td><img src="image11.png" alt="CT" /> <img src="image12.png" alt="MRI" /></td>
</tr>
</tbody>
</table>
## HCC & Overall Malignancy per LI-RADS Category

<table>
<thead>
<tr>
<th>LI-RADS Category</th>
<th>HCC (%)</th>
<th>Overall Malignancy (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>LR-1</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>LR-2</td>
<td>13 (8, 22)</td>
<td>14 (9, 21)</td>
</tr>
<tr>
<td>LR-3</td>
<td>38 (31, 45)</td>
<td>40 (31, 50)</td>
</tr>
<tr>
<td>LR-4</td>
<td>74 (67, 80)</td>
<td>80 (75, 85)</td>
</tr>
<tr>
<td>LR-5</td>
<td>94 (92, 96)</td>
<td>97 (95, 99)</td>
</tr>
<tr>
<td>LR-M</td>
<td>36 (26, 48)</td>
<td>93 (87, 97)</td>
</tr>
</tbody>
</table>

Van der Pol CBLC, et al. ILCA 2018
LI-RADS v2018

Available Soon
Summary

ROADMAP FOR MEDICAL IMAGING RESEARCH AND DEVELOPMENT

A Report by the
Interagency Working Group on Medical Imaging Committee on Science
NATIONAL SCIENCE AND TECHNOLOGY COUNCIL

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Figure 1. Four Objectives for Advancing High-Value Imaging
Diagnostic performance of DLS for CT-based staging of liver fibrosis was compared with radiologist’s assessment, aminotransferase-to-platelet ratio index (APRI), and fibrosis-4 index using receiver operating characteristic curve (AOROC) and Obuchowski index.

RESULTS

- DLS had staging accuracy of 79.4% and an AUROC of 0.96, 0.97, and 0.95 for diagnosing significant fibrosis (F2-4), advanced fibrosis (F3-4) and cirrhosis (F4), resp.
- DLS outperformed the radiologist, APRI, and fibrosis-4 index for staging liver fibrosis.