Liver Imaging Reporting and Data System LI-RADS v2014 - A Pictorial Review of the Categories on CT and MRI

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Learning objectives

• Overview of the changes between LI-RADs v2013 and LI-RADS v2014
• Provide an overview and examples of different of the LI-RADS categories on CT and MRI
• Review similarities and differences between AASLD 2010, OPTN 2014 and LI-RADS v2014 classifications
Background

- HCC is the fifth most common cancer in the world and is the third most common cause of cancer-related death. HCC is the fastest growing cause of cancer death in the USA with incidence that has tripled in the last two decades. Numbers are expected to continue to rise given the obesity epidemic. Risk factors include cirrhosis from any cause 80-90% of the cases. The most common cause of cirrhosis is now Hepatitis C virus (HCV); however, it is expected that by 2030 Nonalcoholic steatohepatitis (NASH) will become the most common cause of cirrhosis. Other risk factors include: Hepatitis B virus (HBV), ethanol abuse, diabetes, smoking, male sex, and genetic liver diseases. The annual incidence of HCC in patients with cirrhosis is 2-8%.

- Early detection has become more important with advances in treatment. Imaging plays a crucial role in hepatocellular carcinoma surveillance in high risk patients.

- The need for standardization stems from the differences in techniques of performing the radiologic exam and the different terms that radiologists inconsistently use.

- LI-RADS is not the first effort to standardize imaging criteria for HCC. Multiple groups have published practice guidelines since 2001 including: European Association for the study of the Liver, American Association for the study of Liver Diseases (AASLD), Asian Pacific Association for the study of Liver (APASL), Japanese Society of Hepatology (JSH) and United Network of Organ Sharing (UNOS) / Organ Procurement and Transplantation Network (OPTN).
Findings and procedure details

- LI-RADS was developed by radiologists in collaboration with hepatologists, pathologists and surgeons with input from AASLD and OPTN as an attempt to standardize reporting and provide consistency among providers in patients with an increased risk for HCC. It is endorsed by the American College of Radiology (ACR). LI-RADS provides a lexicon of precisely defined terms, an illustrative atlas that is easily accessible online, establishes minimum acceptable CT and MRI techniques and creates a data collection to facilitate outcome monitoring, quality assurance and research. All this helps enhance communication among radiologists, hepatologists, surgeons and pathologists. LI-RADS also offers guidance about the management of the findings.

- LI-RADS version 1.0 was released in March 2011, followed by LI-RADS v2013 and LI-RADS v.2014 for CT and MR. LI-RADS v 2014 was expanded to apply to hepatobiliary contrast agents. An update on Contrast Enhanced Ultrasound CEUS LI-RADS 2016 was approved by the ACR LI-RADS Steering Committee in June 2016 which is beyond the scope of our discussion.

- LI-RADS is a dynamic document with advancing knowledge, feedback and imaging techniques. Stepwise progression of carcinogenesis and altered vascular dynamics help in identifying suspicious lesions on imaging. LI-RADS may be used by community and academic radiologists.

- LI-RADS has 8 categories represented in table 1.

- Figures 2 through 13 provide pictorial examples of the various LI-RADS categories.

- LI-RADS v2013 versus LI-RADS v2014 (Figure 1). The decision algorithm became simplified and more intuitive. The beginning point which is an observation in imaging was changed to an observation in a high risk patient for HCC (red circle), which was stated in LI-RADS v2013 syllabus but now added to the algorithm to highlight the fact that this is not an incidental finding in a routine patient. The Category LR-Treated was moved to the beginning of the algorithm (yellow circle) because this is usually known at the time of interpretation of the images. The 3rd main change is in the lesions that are 10-19 mm in diameter with arterial phase hyperenhancement and demonstrate one of the three features (Washout, capsule or threshold growth) which was previously classified LR-4 (blue circle) now can be classified as LR-5g, if there is # 50% diameter increase in # 6 months (equivalent to OPTN 5A-g) or LR-5us, if there is both "washout" and visibility as discrete nodules at antecedent surveillance ultrasound, per AASLD HCC criteria.
Ancillary features that favor HCC as specified (table 2) can be used to upgrade the category up to LR4. Hence, an ancillary feature favoring HCC cannot be used to upgrade an LR-4 to LR-5. Ancillary features that favor benignity can also be used to downgrade lesion LR category.

Table 3 summarizes the differences between AASLD, OPTN, and LI-RADS. The main limitation of the OPTN is that it is designed for specialized liver transplant centers in the US, while that of the AASLD system is the limited categorization of observations into HCC, intermediate or benign. The main limitation of LI-RADS is the need for prospective validation of this system after application on a large scale.
<table>
<thead>
<tr>
<th>LI-RADS Categories</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>LR-1</td>
<td>Definitely Benign 100% certainty observation is benign.</td>
</tr>
<tr>
<td>LR-2</td>
<td>Probably Benign High probability observation is benign.</td>
</tr>
<tr>
<td>LR-3</td>
<td>Intermediate probability for HCC Both HCC and benign entity have moderate probability.</td>
</tr>
<tr>
<td>LR-4</td>
<td>Probably HCC High probability observation is HCC but there is not 100% certainty.</td>
</tr>
<tr>
<td>LR-5</td>
<td>Definitely HCC 100% certainty observation is HCC.</td>
</tr>
<tr>
<td>LR-5V</td>
<td>Definitely HCC with Tumor in Vein 100% certainty that observation is HCC invading vein.</td>
</tr>
<tr>
<td>LR-M</td>
<td>Probably Malignant, not specific for HCC Observation is probably malignant, but imaging features are not specific for HCC.</td>
</tr>
<tr>
<td>LR-Treated</td>
<td>Treated Observation A loco-regionally treated observation.</td>
</tr>
</tbody>
</table>

Table 1: LI-RADS Categories

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Fig. 1: LI-RADS v2013 versus LI-RADS v2014

© ACR LI-RADS
<table>
<thead>
<tr>
<th>Ancillary features that favor HCC</th>
<th>Ancillary features that favor benignity</th>
</tr>
</thead>
<tbody>
<tr>
<td>Undistorted vessels</td>
<td>Restricted diffusion</td>
</tr>
<tr>
<td>Homogeneous marked T2 hyper- or hypo-intensity</td>
<td>Mild-moderate T2 hyper-intensity</td>
</tr>
<tr>
<td>Parallels blood pool enhancement</td>
<td>Corona enhancement</td>
</tr>
<tr>
<td>Diameter reduction</td>
<td>Mosaic architecture</td>
</tr>
<tr>
<td>Diameter stability ≥ 2 years</td>
<td>Nodule-in-nodule architecture</td>
</tr>
<tr>
<td>Hepatobiliary phase isointensity</td>
<td>Intralesional fat</td>
</tr>
<tr>
<td>Lesional iron sparing</td>
<td></td>
</tr>
<tr>
<td>Lesional fat sparing</td>
<td></td>
</tr>
<tr>
<td>Blood products</td>
<td></td>
</tr>
<tr>
<td>Diameter increase less than threshold growth</td>
<td></td>
</tr>
<tr>
<td>Distinctive rim</td>
<td></td>
</tr>
<tr>
<td>Hepatobiliary phase hypo-intense rim</td>
<td></td>
</tr>
<tr>
<td>Hepatobiliary phase hypo-intensity</td>
<td></td>
</tr>
</tbody>
</table>

**Table 2: Ancillary features**

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<table>
<thead>
<tr>
<th></th>
<th>AASLD 2011</th>
<th>OPTN 2014</th>
<th>LI-RADS 2014</th>
</tr>
</thead>
<tbody>
<tr>
<td>Overview</td>
<td>Comprehensive management system for HCC</td>
<td>OPTN policy for Liver Transplant candidates with HCC (in USA)</td>
<td>Comprehensive imaging diagnosis-system for HCC</td>
</tr>
<tr>
<td>Target population</td>
<td>Patients at risk for HCC in a surveillance program</td>
<td>Patients with HCC considered for Liver Transplant</td>
<td>All patients at risk for HCC</td>
</tr>
<tr>
<td>Intended users</td>
<td>Radiologists with expertise in liver imaging</td>
<td>Radiologists at Liver Transplant centers</td>
<td>All radiologists</td>
</tr>
<tr>
<td>Categorization of observations</td>
<td>HCC; Indeterminate; Benign</td>
<td>Untreated definite HCC (Class 5A, 5B, 5X); Treated definite HCC; Class 5T (treated); Nondiagnostic exam</td>
<td>LR-1 through 5 LR-5V; LR-M; LR treated</td>
</tr>
<tr>
<td>Imaging methods addressed</td>
<td>US for surveillance; CT and MRI with extracellular agents for diagnosis</td>
<td>CT and MRI with extracellular agents</td>
<td>CT and MRI with extracellular agents; (provides guidance for use of MRI with hepatobiliary) and CEUS</td>
</tr>
<tr>
<td>Lexicon and atlas</td>
<td>No</td>
<td>No</td>
<td>Yes</td>
</tr>
<tr>
<td>Reporting templates</td>
<td>No</td>
<td>No</td>
<td>Yes</td>
</tr>
<tr>
<td>Prospective validation</td>
<td>Prospective single-center European studies</td>
<td>Large, prospective, multicenter study in progress</td>
<td>Pending</td>
</tr>
</tbody>
</table>

**Table 3:** Differences Between AASLD, OPTN, and LI-RADS

© Adapted from LI-RADS Summary, Discussion, and Consensus of the LI-RADS Management Working Group and Future Directions HEPATOLOGY, Vol. 61, No. 3, 2015
**Fig. 2:** LI-RADS 1 Lesion

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Fig. 3: LI-RADS 1 Lesion

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**Fig. 4:** LI-RADS 2 Lesion

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LI-RADS 2 Lesion: cirrhosis associated nodules - Regenerative Nodules

Diameter < 20mm AND
Homogeneous AND
Iso-enhancement to background cirrhotic nodules in all phases

Fig. 5: LI-RADS 2 Lesion

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LI-RADS 3 Lesion: Regenerative Nodule

- Large lesion > 20 mm
- Arterial phase isoenhancement
- No washout, no capsule, no threshold growth on follow-up

**Fig. 6:** LI-RADS 3 Lesion

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Fig. 7: LI-RADS 4 Lesion

Right hepatic lobe lesion
- Arterial phase isoenhancement
- Size < 20mm
- Washout AND Capsule

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**Fig. 8:** LI-RADS 5 Lesion

Right hepatic lobe lesion
- Arterial phase hyperenhancement
- Size > 20mm
- Washout AND Capsule

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**Fig. 9:** LI-RADS 5V Lesion

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LI-RADS 5 Lesion on CT: Definite HCC

Left hepatic lobe lesion
- Arterial phase hyperenhancement
- Size > 20mm
- Capsule

**Fig. 10:** LI-RADS 5 Lesion

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**Fig. 11:** LI-RADS T Lesion

Patient with history of HCC treated with partial hepatectomy showing local recurrence.

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LI-RADS M: Hepatic Angiosarcoma

LI-RADS M: probably malignant, but imaging features are not specific for HCC.

A nonspecific right hepatic lobe mass with bizarre heterogeneous enhancement and features suggestive of non HCC malignancy proved to be hepatic angiosarcoma.

**Fig. 12:** LI-RADS M Lesion

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Fig. 13: Ancillary feature that favors HCC
Conclusion

- HCC is a global health problem. Imaging plays a critical role in diagnosis, staging, treatment planning and follow-up.

- Radiologists should be familiar with LI-RADS which has been developed in an attempt to standardize reporting and facilitate communication with clinicians.
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References


