Chapter 8

LI-RADS® Diagnostic Categories

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<table>
<thead>
<tr>
<th>Section</th>
<th>Pages</th>
</tr>
</thead>
<tbody>
<tr>
<td>Background</td>
<td>8-1</td>
</tr>
<tr>
<td>Observations with path diagnosis</td>
<td>8-6</td>
</tr>
<tr>
<td>LR-NC</td>
<td>8-7</td>
</tr>
<tr>
<td>LR-1</td>
<td>8-8</td>
</tr>
<tr>
<td>LR-2</td>
<td>8-9</td>
</tr>
<tr>
<td>LR-3</td>
<td>8-10</td>
</tr>
<tr>
<td>LR-4</td>
<td>8-11</td>
</tr>
<tr>
<td>LR-5</td>
<td>8-12</td>
</tr>
<tr>
<td>LR-TIV</td>
<td>8-13</td>
</tr>
<tr>
<td>LR-M</td>
<td>8-14</td>
</tr>
<tr>
<td>LR-TR Nonevaluable</td>
<td>8-15</td>
</tr>
<tr>
<td>LR-TR Nonviable</td>
<td>8-16</td>
</tr>
<tr>
<td>LR-TR Equivocal</td>
<td>8-17</td>
</tr>
<tr>
<td>LR-TR Viable</td>
<td>8-18</td>
</tr>
<tr>
<td>LR4/5 diagonal cell</td>
<td>8-19</td>
</tr>
<tr>
<td>Categorization of distinctive nodules</td>
<td>8-20</td>
</tr>
<tr>
<td>Illustrations of cells in the LI-RADS Diagnostic Table</td>
<td>8-22</td>
</tr>
<tr>
<td>References</td>
<td>8-39</td>
</tr>
</tbody>
</table>
LI-RADS Diagnostic Categories

Background

Each LI-RADS diagnostic category reflects a probability of HCC, non-HCC malignancy or benignity.

LI-RADS categories do not correspond exactly to histologic categories.

- All LR-1 observations are benign, but not all benign entities can be categorized LR-1.
  - In particular, RNs and LGNDs cannot be categorized LR-1 because imaging cannot definitely exclude malignant foci in such lesions.
  - Similarly, all LR-5s are HCC, but not all HCCs can be categorized LR-5.

The differential diagnosis for each LI-RADS category

All LR-1s are benign, non-hepatocellular (HC) lesions and pseudolesions

Vast majority of LR-2s are benign, with only small fraction being dysplastic or malignant

LR-3s vary from benignity to dysplastic nodules to HCCs

About 80% of LR-4s are HCC, but the differential diagnosis is broad

All LR-5s are HCC, most are pHCC

Most TIVs are due to pHCC
Minority is due to non-HCC malignancy

~ 50% of LR-Ms are HCC
~ 50% of LR-Ms are non-HCC malignancy

These HCCs are atypical and so do not meet LR-5 criteria

Many LR-3s are vascular pseudolesions

Tiny fraction of LR-Ms are unusual benign lesions (e.g., sclerosed HGs)
Percentage of HCC and malignancy associated with each LI-RADS category

The percentage (with 95% confidence intervals) associated with LR-1, LR-2, LR-3, LR-4, LR-5, and LR-M is summarized below:

The above graph represents data from the literature using versions 2014 and 2017. Data using version 2018 are not yet available.
# LI-RADS Diagnostic Categories

## Cumulative incidence of progression to LR-5 or LR-M of untreated observations categorized with LI-RADS v2014

<table>
<thead>
<tr>
<th>Initial category</th>
<th>Study</th>
<th>LI-RADS Scoring</th>
<th>Modality</th>
<th>N</th>
<th>Cumulative incidence (%) of progression to LR-5 or LR-M</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>By 3 mo</td>
</tr>
<tr>
<td>LR-4</td>
<td>Tanabe 2016</td>
<td>Research</td>
<td>Mixed</td>
<td>52</td>
<td>24%</td>
</tr>
<tr>
<td></td>
<td>Sofue 2017</td>
<td>Research</td>
<td>ECA-MRI</td>
<td>181</td>
<td>7%</td>
</tr>
<tr>
<td></td>
<td>Hong (abstract)</td>
<td>Clinical</td>
<td>Mixed</td>
<td>133</td>
<td>25%</td>
</tr>
<tr>
<td>LR-3</td>
<td>Tanabe 2016</td>
<td>Research</td>
<td>Mixed</td>
<td>166</td>
<td>0%</td>
</tr>
<tr>
<td></td>
<td>Hong (abstract)</td>
<td>Clinical</td>
<td>Mixed</td>
<td>187</td>
<td>3%</td>
</tr>
<tr>
<td>LR-2</td>
<td>Tanabe 2016</td>
<td>Research</td>
<td>Mixed</td>
<td>63</td>
<td>0%</td>
</tr>
<tr>
<td></td>
<td>Hong (abstract)</td>
<td>Clinical</td>
<td>Mixed</td>
<td>43</td>
<td>2%</td>
</tr>
<tr>
<td>LR-1</td>
<td>Hong (abstract)</td>
<td>Clinical</td>
<td>Mixed</td>
<td>10</td>
<td>0%</td>
</tr>
</tbody>
</table>

N = number of observations. ECA = extracellular agent
LI-RADS Diagnostic Categories

LI-RADS Categories and modality

Emerging evidence (based on v2014) suggests that LI-RADS categories assigned by CT vs. MRI may be discordant:

- When the same group of observations is imaged by both CT and MRI, the LI-RADS categories are discordant in 36-71%.

- MR categorizes benign lesions as LR-1 more commonly than CT:
  - Of observations categorized LR-1 on MR, 26-30% are categorized LR-3 on CT.

- Excluding the LR-1 category, MR-assigned categories are often higher than CT-assigned categories:
  - Of observations categorized LR-5 on MRI, 12-31% are categorized LR-4, 12% are categorized LR-3, and 15-29% are not seen on CT.
  - As illustrated in Figure below, however, MR-assigned categories can be lower than CT-assigned categories.

Example: Discordance between CT and Gx-MRI (performed within 3 weeks of each other)

![Images](images)
LI-RADS strives to achieve high positive predictive value for HCC.

The category LR-5 is reserved for observations that, by meeting stringent LI-RADS 5 imaging criteria, can be diagnosed as HCC with 100% certainty in the appropriate patient population.

- The burden of proof lies on establishing a noninvasive diagnosis of HCC: A LR-5 category is not appropriate if there is any doubt about whether LI-RADS 5 criteria are met.

- If there is doubt, do not categorize as LR-5. Instead, categorize as LR-M, LR-4, or other as appropriate.

LI-RADS strives to achieve high positive predictive value for tumor in vein.

The category LR-TIV is reserved for observations that, based on the unequivocal presence of enhancing soft tissue in vein, can be diagnosed as tumor in vein with 100% certainty in the appropriate patient population.

- The burden of proof lies on establishing a noninvasive diagnosis of tumor in vein: A LR-TIV category is not appropriate if there is any doubt about the presence of enhancing soft tissue in vein.

- If there is doubt, do not categorize as LR-TIV. Instead, categorize as LR-5, LR-M, LR-4, or other as appropriate. Also report the extent of any venous thrombosis or occlusion, if present.

**Tradeoffs**

To achieve such high positive predictive value for HCC and tumor in vein, stringent criteria are required and LI-RADS applies only in specified populations.

An unavoidable tradeoff of high specificity is modest sensitivity. Thus,

- Not all HCCs can be categorized LR-5
- Not all cases of tumor in vein can be categorized LR-TIV
- A category other than LR-5 does not exclude HCC
- A category other than LR-TIV does not exclude tumor in vein.

An unavoidable tradeoff of specifying certain populations is that LI-RADS does not apply to the general population or to most patients with chronic liver disease in the absence of cirrhosis. See Chapter 2 for more information.
Observations with Pathological Diagnosis

Pathology-diagnosed lesions should **not** be assigned a LI-RADS category

Instead, such observations should be assigned their pathological diagnosis.

Examples:

- Path-proven HCC
- Path-proven iCCA
- Path-proven cHCC-CCA
- Path-proven metastasis to liver
- Path-proven hemangioma

Reporting:

- Report the pathological diagnosis, relevant imaging features, and any change since prior imaging

Rationale:

- LI-RADS is intended to clarify communication. Assigning a LI-RADS category to a pathologically proven lesion (in which there is now certainty about the diagnosis) may cause confusion, especially for LI-RADS categories that convey some uncertainty (i.e., LR-2, LR-3, LR-4, or LR-M).

**Exception: lesions with a pathological diagnosis of a benign or premalignant hepatocellular entity should be assigned a LI-RADS category.**

Examples:

- Dysplastic nodule
- Regenerative nodule

Reporting:

- Report the LI-RADS category and the path diagnosis, relevant imaging features, and any change since prior imaging

Rationale:

- Sampling error is a frequent cause of false-negative pathology in biopsied liver lesions of hepatocellular origin. While a biopsy diagnosis of a malignant entity such as HCC is definitive, a biopsy diagnosis of a regenerative or dysplastic nodule does not exclude HCC.

- Additionally, dysplastic nodules are considered premalignant and may progress to HCC. See *Chapter 6*.

- Assigning a LI-RADS category alleviates potential harm from false-negative pathology, facilitates monitoring of nodules for possible progression, and informs management decisions.
LR-NC: Noncategorizable

**Conceptual definition:** Observation that cannot be meaningfully categorized because image omission or degradation prevents assessment of one or more major features.

**CT/MRI criteria:**

Both of the following:

- One or more major features cannot be assessed because of image omission or degradation AND
- As a direct result, possible categories range from those in which cancer is unlikely (LR-1 or LR-2) to those in which cancer is likely (LR-4, LR-5, LR-M)

- Do NOT assign LR-NC if the images required for major feature characterization were of acceptable quality.
- Do NOT assign LR-NC for observations in which categorization is challenged only by unusual imaging features or by inability to characterize ancillary features.

**Management options**

Repeat diagnostic imaging if the technical limitation can be resolved.

Alternative diagnostic imaging if imaging with alternative modality or alternative contrast agent is reasonably likely to confer diagnostic advantage.

Multidisciplinary discussion if no alternative imaging is appropriate.

Usually ≤ 3 months

See *Chapter 11* for more information.
LR-1: Definitely Benign

Conceptual definition: 100% certainty observation is nonmalignant

Criteria: LI-RADS does not provide criteria for most entities that may be categorized LR-1, but instead provides examples

Examples:

Definite:
- Cyst (Chapter 15, page 2)
- Hemangioma (Chapter 15, page 4)
- Perfusion alteration (e.g., arterioportal shunt) (Chapter 15, page 25)
- Hepatic fat deposition or sparing (Chapter 15, pages 14 and 16)
- Hypertrophic pseudomass (Chapter 15, page 21)
- Confluent fibrosis or focal scar (Chapter 15, pages 18 and 23)

Definite spontaneous disappearance

List above not meant to be exhaustive

Pathways to LR-1

LR-1 not modified by ancillary features
LR-2 downgraded to LR-1 with ancillary features favoring benignity

If unsure

LR-1 vs. LR-2 → LR-2

Management options

Return to routine surveillance at standard time interval (usually 6 months).
See Chapter 11 for more information.

Pathological correlation

- 0% of LR-1 are HCC.
- 0% of LR-1 are malignant.

Caution: Nodules with features suggestive of FNH or HCA usually should NOT be categorized LR-1. With caution, they may be categorized LR-2.

Rationale: these are diagnoses of exclusion in high-risk patients.
**LR-2: Probably Benign**

**Conceptual definition:** High probability but not 100% certainty observation is nonmalignant

**Criteria:** LI-RADS does not provide criteria for most entities that may be categorized LR-2, but instead provides examples

**Examples:**

Probable:
- Cyst (*Chapter 15, page 2*)
- Hemangioma (*Chapter 15, page 4*)
- Perfusion alteration (e.g., arterioporal shunt) (*Chapter 15, page 25*)
- Hepatic fat deposition or sparing (*Chapter 15, pages 14 and 16*)
- Hypertrophic pseudomass (*Chapter 15, page 21*)
- Confluent fibrosis or focal scar (*Chapter 15, pages 18 and 23*)

Distinctive nodule without malignant imaging features (*Chapter 15, page 26*)

*List above not meant to be exhaustive*

**Pathways to LR-2**
- LR-2 not modified by ancillary features
- LR-1 upgraded to LR-2 with ancillary features favoring malignancy
- LR-3 downgraded to LR-2 with ancillary features favoring benignity

**If unsure**
- LR-2 vs. LR-1 → LR-2
- LR-2 vs. LR-3 → LR-3

**Management options**
- Return to routine surveillance at standard time interval (6 months)
- Consider repeat diagnostic imaging in ≤ 6 months
- Consider multidisciplinary discussion for individualized workup.
- See *Chapter 11* for more information.

**Pathological correlation**
- ~ 13% (8-22%) of LR-2 are HCC.
- ~ 14% (9-21%) of LR-2 are malignant.

**Natural history**
- 0-6% of LR-2 observations progress to LR-5 or, rarely, to LR-M by 12 months.

⚠ **Caution:** Nodules with features suggestive of FNH or HCA usually should NOT be categorized LR-1. With caution, they may be categorized LR-2.

*Rationale: these are diagnoses of exclusion in high-risk patients.*
**LR-3: Intermediate probability of malignancy**

**Conceptual definition:** Nonmalignant & malignant entities each have moderate probability

**CT/MRI criteria:**

*Nonrim arterial phase hyperenhancement:*
- < 20 mm with no additional major features

*Arterial phase hypo- or isoenhancement:*
- < 20 mm with ≤ 1 additional major feature OR
- ≥ 20 mm with no additional major features

---

**Additional major features:**

<table>
<thead>
<tr>
<th>Nonperipheral “washout”</th>
<th>Enhancing “capsule”</th>
<th>Threshold growth</th>
</tr>
</thead>
</table>

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**Pathways to LR-3**
- LR-3 not modified by ancillary features
- LR-2 upgraded to LR-3 with ancillary features favoring malignancy
- LR-4 downgraded to LR-3 with ancillary features favoring benignity

**If unsure**
- LR-3 vs LR-2 → LR-3
- LR-3 vs LR-4 → LR-3
- LR-3 vs LR-M → LR-3

**Management options**
- Repeat diagnostic imaging in 3-6 months.
- Alternative diagnostic imaging in 3-6 months.
- MDD for individualized workup (if MDD is likely to be beneficial or is required for LR-3 by institutional guidelines).
  
  See *Chapter 11* for more information.

**LR-3 examples**
- See *page 8-21*.

**Pathological correlation**
- ~ 38% (31-45%) of LR-3 are HCC.
- ~ 40% (31-50%) of LR-3 are malignant.

**Natural history**
- 3-11% of LR-3 observations progress to LR-5 or, rarely, to LR-M by 12 months
LR-4: Probably HCC

**Conceptual definition:** High probability but not 100% certainty observation is HCC

**CT/MRI criteria:**

**Nonrim arterial phase hyperenhancement:**
- < 10 mm with $\geq 1$ additional major feature OR
- 10-19 mm with “capsule” as the only additional major feature OR
- $\geq 20$ mm with no additional major feature

**Arterial phase hypo- or isoenhancement:**
- < 20 mm with $\geq 2$ additional major features OR
- $\geq 20$ mm with $\geq 1$ additional major feature

**Additional major features:**
- Nonperipheral “washout”
- Enhancing “capsule”
- Threshold growth

**Pathways to LR-4**
- LR-4 not modified by ancillary features
- LR-3 upgraded to LR-4 with ancillary features favoring malignancy
- LR-5 downgraded to LR-4 with ancillary features favoring benignity

**If unsure**
- LR-4 vs LR-3 $\rightarrow$ LR-3
- LR-4 vs LR-5 $\rightarrow$ LR-4
- LR-4 vs LR-M $\rightarrow$ LR-M

LR-4 observations should be of hepatocellular origin. If there is reasonable doubt about hepatocellular origin, categorize as LR-M.

**Management options**
MDD may be needed for consensus management. If neither biopsy nor treatment is planned: repeat or alternative diagnostic imaging in $\leq 3$ mo.

See *Chapter 11* for more information.

**Pathological correlation**
- $\sim 74\%$ (67-80\%) of LR-4 are HCC
- $\sim 80\%$ (75-85\%) of LR-4 are malignant.
- LR-4 does not exclude non-HCC malignancy. A small non-HCC malignancy may fail to demonstrate LR-M imaging features

**Natural history**
- $\sim 36$-$47\%$ of LR-4 observations progress to LR-5 or, rarely, to LR-M by 12 months.
**LR-5: Definitely HCC**

**Conceptual definition:** 100% certainty observation is HCC

**CT/MRI criteria:**

*Nonrim arterial phase hyperenhancement AND:*

- 10-19 mm with nonperipheral “washout” OR
- 10-19 mm with threshold growth OR
- ≥ 20 mm with ≥ 1 additional major feature

**Additional major features:**

<table>
<thead>
<tr>
<th>Nonperipheral “washout”</th>
<th>Enhancing “capsule”</th>
<th>Threshold growth</th>
</tr>
</thead>
</table>

**Pathways to LR-5**

LR-5 not modified by ancillary features

**If unsure**

LR-5 vs LR-4 → LR-4
LR-5 vs LR-M → LR-M
LR-5 vs LR-TIV → LR-5

**Management options**

Multidisciplinary discussion for staging and individualized treatment.

Biopsy is not needed to confirm the diagnosis of HCC but may be obtained in some settings (e.g., for clinical trials requirements or molecular characterization).

See *Chapter 11* for more information.

**Differential diagnosis**

There is no DDx. LR-5 is intended to convey 100% certainty of HCC. Emerging data suggests the actual specificity of LR-5 is < 100%, however (see below).

**Pathological correlation**

- ~ 94% (92-96%) of LR-5 are HCC.
- ~ 97% (95-99%) of LR-5 are malignant.
- LR-5 has modest sensitivity for HCC.
- Not all HCCs can be categorized as LR-5.
**LR-TIV: Malignancy with tumor in vein (TIV)**

**Conceptual definition:** 100% certainty there is malignancy with tumor in vein

**CT/MRI criterion:**

Presence of definite enhancing soft tissue in vein, regardless of visualization of parenchymal mass

**Suggestive but not definitive features of tumor in vein:**

- Occluded vein with ill-defined walls
- Occluded vein with restricted diffusion
- Occluded or obscured vein contiguous with malignant parenchymal mass
- Heterogeneous vein enhancement not attributable to artifact

💡 **Hint:** If any of these features are present, scrutinize vein for enhancing soft tissue.

---

**Pathways to LR-TIV**

- Tumor in vein with detectable parenchymal mass
- Tumor in vein without detectable parenchymal mass
- Tie-breaking rules and ancillary features do not lead to a diagnosis of TIV, as TIV must be unequivocally present.

**If unsure**

- LR-TIV vs LR-5 → LR-5
- LR-TIV vs LR-M → LR-M

**Management options**

Multidisciplinary discussion for staging and individualized treatment. Biopsy may be needed to determine type of malignancy (HCC, ICC, other).

See *Chapter 11* for more information.

**Differential diagnosis**

Most LR-TIVs are HCC. Some are iCCA or cHCC-CCAs.

There should be no uncertainty about the presence of tumor in vein. LR-TIV is intended to convey 100% certainty for tumor in vein.

**Pathological correlation**

- LR-TIV has modest sensitivity for malignancies with macrovascular invasion.
- Not all macrovascular-invasive malignancies can be categorized as LR-TIV.
**LR-M: Probably or definitely malignant, not HCC specific**

**Conceptual definition:** High probability or 100% certainty observation is malignant but features are not HCC specific

**CT/MRI criteria:**

- Targetoid mass with any of following Imaging appearance on various phases or sequences:
  - Targetoid dynamic enhancement, any of following:
    - Rim APHE
    - Peripheral washout appearance
    - Delayed central enhancement
    - Targetoid diffusion restriction
    - Targetoid TP or HBP signal intensity
- Nontargetoid mass with one or more of the following:
  - Infiltrative appearance
  - Marked diffusion restriction
  - Necrosis or severe ischemia
  - Other feature suggesting non-HCC malignancy (specify in report)

**Pathways to LR-M**

Meets LR-M criteria and there is no definite tumor in vein

**If unsure**

LR-M vs LR-3 → LR-3
LR-M vs anything else (LR-4, LR-5, LR-TIV) → LR-M

**Management options**

Multidisciplinary discussion for staging and individualized treatment. Biopsy may be needed to determine malignancy type (HCC, ICC, other).

See *Chapter 11* for more information.

**Differential diagnosis for LR-M**

- HCC not meeting LR-5 criteria
- iCCA or cHCC-CCA
- Other: metastases to liver, undifferentiated carcinoma or sarcoma, lymphoma
- Rarely, a benign entity

**Pathological correlation**

- ~ 36% (25-48%) of LR-M are HCC.
- ~ 93% (87-97%) of LR-M are malignant.
- LR-M does not exclude HCC.
- Some HCCs and rare benign lesions may be categorized as LR-M.
## LR-TR Nonevaluable

### Conceptual definition:
Treatment response cannot be meaningfully evaluated due to inappropriate imaging technique or inadequate imaging quality.

### Criterion:
Lesional enhancement cannot be characterized because of omission of recommended contrast phases or image degradation.

- Do NOT assign LR-TR Nonevaluable evaluable if the recommended contrast phases were acquired and are of acceptable quality.
- Do NOT assign LR-TR Nonevaluable for treated lesions in which response categorization is challenged only by unusual imaging features.

### Management options

Continue posttreatment monitoring with same modality in ≤ 3 months.
- Preferred option if the nonevaluability was due to a correctable technical error or artifact.

Continue posttreatment monitoring with alternative modality in ≤ 3 months.
- Suggested option if imaging with a different modality or contrast agent would confer diagnostic advantage.

See *Chapter 11* for more information.
LR-TR Nonviable

**Conceptual definition:** Low or negligible likelihood of viable tumor after treatment

**Criteria:**

**One of the following:**

- No lesional enhancement OR
- Treatment-specific expected enhancement pattern

**Treatment-specific expected enhancement patterns:**

Depending on the treatment, expected post-treatment patterns include:

- Thin rim of enhancement around ablation zone or embolized tumor
- Geographic zone(s) of perilesional enhancement without washout appearance
- Non-masslike foci of perilesional enhancement without washout appearance

**If unsure**

LR-TR Nonviable vs. LR-TR Equivocal → LR-TR Equivocal

**Management options**

Continue posttreatment monitoring with **same** modality in ≤ 3 months.

- Preferred option in most cases.

Continue posttreatment monitoring with **alternative** modality in ≤ 3 months.

- Suggested option if imaging with a different modality or contrast agent would confer diagnostic advantage.

See *Chapter 11* for more information.

**Pathological correlation**

- The absence of lesional enhancement does not imply complete pathologic response.
- Imaging is insensitive to microscopic or small foci of residual tumor that may be detectable only at histologic evaluation.
LR-TR Equivocal

**Conceptual definition:** The presence and the absence of viable tumor after treatment each have moderate probability

**Criterion:**

Enhancement not expected for specific treatment and not meeting criteria for probably or definitely viable

---

Equivocal viability should be applied only when confident differentiation of viable vs nonviable tumor cannot be made despite technically adequate imaging.

---

**If unsure**

- LR-TR Equivocal vs. LR-TR Nonviable → LR-TR Equivocal
- LR-TR Equivocal vs. LR-TR Viable → LR-TR Equivocal

**Management options**

Continue posttreatment monitoring with *same* modality in ≤ 3 months.
- Preferred option in most cases.

Continue posttreatment monitoring with *alternative* modality in ≤ 3 months.
- Suggested option if imaging with a different modality or contrast agent would confer diagnostic advantage.

See *Chapter 11* for more information.

**Examples of equivocal viability**

- Rim APHE thicker than expected but not discretely nodular
- Progressive or mild enhancement within lesion that on pre-treatment imaging showed APHE and “washout” (may represent fibrosis)
- Arterial phase is inadequate but portal venous phase shows enhancement
- Resolving lesional enhancement days to weeks after ablation*

---

* Tumor enhancement may resolve gradually after treatment. Differentiating resolving enhancement from viable tumor may be difficult, especially in the days to weeks after treatment. Follow up to document resolution may be needed.
**LR-TR Viable**

**Conceptual definition:** High or definite likelihood of viable tumor after treatment

**Criteria:**

*Nodular, mass-like, or thick irregular tissue in or along the treated lesion with any of the following:*

- Arterial phase hyperenhancement OR
- Washout appearance OR
- Enhancement similar to pretreatment

<table>
<thead>
<tr>
<th>If unsure</th>
<th>LR-TR Viable vs. LR-TR Equivocal → LR-TR Equivocal</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Management options</strong></td>
<td>Multidisciplinary discussion for consensus management. Often includes retreatment.</td>
</tr>
<tr>
<td></td>
<td>See <em>Chapter 11</em> for more information.</td>
</tr>
<tr>
<td><strong>Enhancement similar to pretreatment</strong></td>
<td>Even if still viable, tumors that on pretreatment imaging lacked APHE or washout appearance are unlikely to show these features after treatment. In such cases, lesional dynamic enhancement similar to pretreatment usually indicates viable tumor.</td>
</tr>
</tbody>
</table>
The Diagonal Cell

Categorization

As shown in the *LI-RADS CT/MRI Diagnostic Table*, observations that measure 10-19 mm, have nonrim APHE, and have exactly one additional major feature* are categorized as follows:

10-19 mm observation with nonrim APHE and exactly one additional major feature*

- if enhancing “capsule” \(\rightarrow\) LR-4
- if “washout” \(\rightarrow\) LR-5
- if threshold growth (equivalent to OPTN 5A-g) \(\rightarrow\) LR-5

* Additional major features = nonperipheral “washout”, enhancing “capsule”, threshold growth
Categorization of Distinctive Nodules
< 20 mm and Without Major Features or LR-M features

Distinctive nodules < 20 mm and without major features or LR-M features can be categorized LR-2 or LR-3, as shown below:

**Distinctive nodule <20 mm:**
- No APHE, “washout”, “capsule”, or threshold growth
- No feature of LR-M

<table>
<thead>
<tr>
<th>Examples</th>
<th>Comments</th>
</tr>
</thead>
</table>
| - Siderotic nodule  
- T1 hyperintense nodule  
- T2 hypointense nodule  
- DWI hypointense nodule  
- HBP hyperintense nodule | This is a LR-2 distinctive nodule without malignant features. |

≥ 1 AF of malignancy AND ≥ 1 AF of benignity

Nodule with both
- Intralesion fat (AF of malignancy) AND
- Spontaneous size reduction (AF of benignity)

The presence of conflicting AFs precludes category adjustment.

≥ 1 AF of malignancy AND No AF of benignity

Nodule with ONE OR MORE of the following:
- Intralesion fat
- T2 hyperintensity
- Diffusion restriction
- HBP hypointensity

The presence of one or more AF of malignancy excludes LR-2 categorization and places the nodule in the top left cell of the CT/MRI Diagnostic table – i.e., LR-3

AF = ancillary feature

*In general, a distinctive solid nodule should not be categorized LR-1 because malignancy cannot be excluded with complete certainty.*
Common LR-3 Examples

< 20 mm NAPH (see Chapter 15, page 30), otherwise occult
< 20 mm, “washout”, no APHE or “capsule”
< 20 mm, hepatobiliary phase hypointensity, otherwise occult
< 20 mm, hypersteatotic, no APHE, no “washout”, no capsule”
< 20 mm, restricted diffusion, no APHE, no “washout”, no capsule”

* In general, a distinctive solid nodule should not be categorized LR-1 because malignancy cannot be excluded with complete certainty.
Cases illustrating Cells in LI-RADS Diagnostic Table

The following pages illustrates every cell in the CT/MRI LI-RADS Table
LR-5: Definite HCC

Example: Example: 47 mm observation in a 68 year-old man with cirrhosis

Note:
This case also illustrates mosaic architecture (AF-M)

LI-RADS diagnostic table assigns LR-3, LR-4, and LR-5

MRI Diagnostic Table

<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 &lt; 10</td>
</tr>
<tr>
<td>Count additional major features:</td>
<td>None</td>
<td>LR-3 LR-3</td>
</tr>
<tr>
<td>• Enhancing “capsule” ✓</td>
<td>One</td>
<td>LR-3 LR-4</td>
</tr>
<tr>
<td>• Nonperipheral “washout” ✓</td>
<td>≥ Two</td>
<td>LR-4 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

If unsure about the presence of any major feature: characterize that feature as absent
LR-5: Definite HCC

Example: 29 mm observation in a 85 year-old man with cirrhosis

CT 3 months ago: Size 8 mm

Nonrim APHE

No “washout” or “capsule”

Note: In this case, size is measured in the AP as the observation is only visible in the AP.

LI-RADS diagnostic table assigns LR-3, LR-4, and LR-5

MRI Diagnostic Table

<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></td>
<td>&lt; 10</td>
<td>10-19</td>
</tr>
<tr>
<td></td>
<td>≥ 20</td>
<td></td>
</tr>
<tr>
<td>Count additional major features:</td>
<td>None</td>
<td>LR-3</td>
</tr>
<tr>
<td>Enhancing “capsule” ✘</td>
<td>LR-3</td>
<td>LR-3</td>
</tr>
<tr>
<td>Nonperipheral “washout” ✘</td>
<td>LR-4</td>
<td>LR-4</td>
</tr>
<tr>
<td>Threshold growth ✓</td>
<td>LR-4</td>
<td>LR-4</td>
</tr>
<tr>
<td>≥ Two</td>
<td>LR-4</td>
<td>LR-5</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

If unsure about the presence of any major feature: characterize that feature as absent.
LR-5: Definite HCC

Example: 17 mm observation in a 78 year-old man with cirrhosis

MRI Diagnostic Table

<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></td>
<td>&lt; 10</td>
<td>10-19</td>
</tr>
<tr>
<td></td>
<td>≥ 20</td>
<td></td>
</tr>
<tr>
<td>Count additional major features:</td>
<td>None</td>
<td></td>
</tr>
<tr>
<td>• Enhancing “capsule” ✗</td>
<td>LR-3</td>
<td>LR-3</td>
</tr>
<tr>
<td>• Nonperipheral “washout” ✓</td>
<td>LR-3</td>
<td>LR-4</td>
</tr>
<tr>
<td>• Threshold growth ✗</td>
<td>LR-3</td>
<td>LR-4</td>
</tr>
<tr>
<td></td>
<td>LR-3</td>
<td>LR-5</td>
</tr>
<tr>
<td></td>
<td>LR-4</td>
<td>LR-5</td>
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<td>LR-5</td>
</tr>
<tr>
<td></td>
<td>LR-4</td>
<td>LR-5</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

If unsure about the presence of any major feature: characterize that feature as absent
LR-5: Definite HCC

Example: 24 mm observation in a 55 year-old man with cirrhosis

LI-RADS diagnostic table assigns LR-3, LR-4, and LR-5

MRI Diagnostic Table

<table>
<thead>
<tr>
<th>Arterial phase hyperenhancement (APHE)</th>
<th>No APHE</th>
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</tr>
</thead>
<tbody>
<tr>
<td>Observation size (mm)</td>
<td>&lt; 20</td>
<td>≥ 20</td>
</tr>
<tr>
<td></td>
<td>&lt; 10</td>
<td>10-19</td>
</tr>
<tr>
<td>Count additional major features:</td>
<td>None</td>
<td>LR-3</td>
</tr>
<tr>
<td>• Enhancing “capsule” X</td>
<td>LR-3</td>
<td>LR-4</td>
</tr>
<tr>
<td>• Nonperipheral “washout” ✔</td>
<td>LR-3</td>
<td>LR-4</td>
</tr>
<tr>
<td>• Threshold growth X</td>
<td>LR-4</td>
<td>LR-4</td>
</tr>
<tr>
<td>≥ Two</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

If unsure about the presence of any major feature: characterize that feature as absent
LR-4: Probable HCC

Example: 17 mm observation in a 69 year-old man with chronic hepatitis B

LI-RADS diagnostic table assigns LR-3, LR-4, and LR-5

MRI Diagnostic Table

<table>
<thead>
<tr>
<th>Arterial phase hyperenhancement (APHE)</th>
<th>No APHE</th>
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</tr>
</thead>
<tbody>
<tr>
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<td>&lt; 20</td>
<td>≥ 20</td>
</tr>
<tr>
<td></td>
<td>&lt; 10</td>
<td>10-19</td>
</tr>
<tr>
<td>Count additional major features:</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Enhancing “capsule”</td>
<td>LR-3</td>
<td>LR-3</td>
</tr>
<tr>
<td>Nonperipheral “washout”</td>
<td>LR-3</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

If unsure about the presence of any major feature: characterize that feature as absent
LR-4: Probable HCC

Example: 32 mm observation in a 67 year-old man with cirrhosis

LI-RADS diagnostic table assigns LR-3, LR-4, and LR-5

MRI Diagnostic Table

<table>
<thead>
<tr>
<th>Arterial phase hyperenhancement (APHE)</th>
<th>No APHE</th>
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</thead>
<tbody>
<tr>
<td>Observation size (mm)</td>
<td>&lt; 20</td>
<td>≥ 20</td>
</tr>
<tr>
<td>&lt; 10</td>
<td>10-19</td>
<td>≥ 20</td>
</tr>
<tr>
<td>Count additional major features:</td>
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<td></td>
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<tr>
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<td>LR-3</td>
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<tr>
<td>One</td>
<td>LR-3</td>
<td>LR-4</td>
</tr>
<tr>
<td>≥ Two</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

If unsure about the presence of any major feature: characterize that feature as absent
LR-4: Probable HCC

Example: 21 mm observation in a 63 year-old man with cirrhosis

![Images showing pre, AP, PVP, and 3 min DP phases with annotations for nonperipheral "washout" and equivocal enhancing "capsule".

<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></td>
<td>&lt; 10</td>
<td>10-19</td>
</tr>
</tbody>
</table>

Count additional major features:

- Enhancing “capsule” X
- Nonperipheral “washout” ✓
- Threshold growth X

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

If unsure about the presence of any major feature: characterize that feature as absent.
**LR-4: Probable HCC**

*Example: 7 mm observation in a 32 year-old man with chronic hepatitis B*

<table>
<thead>
<tr>
<th>Pre</th>
<th>AP</th>
<th>PVP</th>
<th>3 min DP</th>
</tr>
</thead>
<tbody>
<tr>
<td>Nonrim APHE</td>
<td>No enhancing “capsule”</td>
<td>Nonperipheral “washout”</td>
<td></td>
</tr>
</tbody>
</table>

**MRI Diagnostic Table**

<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></td>
</tr>
<tr>
<td>• Enhancing “capsule”</td>
<td>LR-3</td>
<td>LR-3</td>
</tr>
<tr>
<td>• Nonperipheral “washout”</td>
<td>LR-3</td>
<td>LR-3</td>
</tr>
<tr>
<td>• Threshold growth</td>
<td>LR-3</td>
<td>LR-4</td>
</tr>
<tr>
<td>≥ Two</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

If unsure about the presence of any major feature: characterize that feature as absent.
**LR-4: Probable HCC**

*Example: 8 mm observation in a 90 year-old man with cirrhosis*

<table>
<thead>
<tr>
<th>Pre</th>
<th>AP</th>
<th>PVP</th>
<th>3 min DP</th>
</tr>
</thead>
<tbody>
<tr>
<td><img src="image1.png" alt="Nonrim APHE" /></td>
<td><img src="image2.png" alt="Enhancing “capsule”" /></td>
<td><img src="image3.png" alt="Nonperipheral “washout”" /></td>
<td></td>
</tr>
<tr>
<td><strong>Observation size (mm)</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>&lt; 20</td>
<td>≥ 20</td>
<td>&lt; 10</td>
<td>10-19</td>
</tr>
</tbody>
</table>

**MRI Diagnostic Table**

<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></td>
</tr>
<tr>
<td>- Enhancing “capsule” ✓</td>
<td>LR-3</td>
<td>LR-3</td>
</tr>
<tr>
<td>- Nonperipheral “washout” ✓</td>
<td>LR-3</td>
<td>LR-3</td>
</tr>
<tr>
<td>- Threshold growth ✗</td>
<td>LR-4</td>
<td>LR-4</td>
</tr>
<tr>
<td>≥ Two</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

*If unsure about the presence of any major feature: characterize that feature as absent*
LR-4: Probable HCC

Example: 25 mm observation in a 57 year-old man with cirrhosis

MRI Diagnostic Table

<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></td>
<td>&lt; 10</td>
<td>10-19</td>
</tr>
<tr>
<td>Count additional major features:</td>
<td>None</td>
<td>LR-3</td>
</tr>
<tr>
<td>• Enhancing “capsule” X</td>
<td>LR-3</td>
<td>LR-4</td>
</tr>
<tr>
<td>• Nonperipheral “washout” X</td>
<td>LR-4</td>
<td>LR-4</td>
</tr>
<tr>
<td>• Threshold growth X</td>
<td>LR-4</td>
<td>LR-4</td>
</tr>
</tbody>
</table>

Note: Observation has nonenhancing “capsule”. This is AF favoring HCC in particular but it cannot be used to upgrade to LR-5.

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

If unsure about the presence of any major feature: characterize that feature as absent.
**LR-4: Probable HCC**

*Example: 19 mm observation in a 54 year-old man with cirrhosis*

<table>
<thead>
<tr>
<th>Pre</th>
<th>AP</th>
<th>PVP</th>
<th>3 min DP</th>
</tr>
</thead>
<tbody>
<tr>
<td>Nonrim APHE</td>
<td>Enhancing “capsule”</td>
<td>No “washout”</td>
<td></td>
</tr>
</tbody>
</table>

**MR Diagnostic Table**

<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>• Enhancing “capsule” ✓</td>
<td>One</td>
<td>LR-3</td>
</tr>
<tr>
<td>• Nonperipheral “washout” X</td>
<td>≥ Two</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

If unsure about the presence of any major feature: characterize that feature as absent.
**LR-3: Intermediate Probability of Malignancy**

*Example: 14 mm observation in a 50 year-old woman with hepatitis B*

<table>
<thead>
<tr>
<th>Pre</th>
<th>AP</th>
<th>PVP</th>
<th>3 min DP</th>
</tr>
</thead>
<tbody>
<tr>
<td><img src="image1.png" alt="Nonrim APHE" /></td>
<td><img src="image2.png" alt="No APHE" /></td>
<td><img src="image3.png" alt="No “washout” No enhancing “capsule”" /></td>
<td></td>
</tr>
</tbody>
</table>

**Note:**
This observation is an example of a NAPH (see *Chapter 15, page 30*).

**MRI Diagnostic Table**

<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>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Count additional major features:</th>
<th>None</th>
<th>One</th>
<th>≥ Two</th>
</tr>
</thead>
<tbody>
<tr>
<td>Enhancing “capsule” ✘</td>
<td>LR-3</td>
<td>LR-4</td>
<td>LR-4</td>
</tr>
<tr>
<td>Nonperipheral “washout” ✘</td>
<td>LR-3</td>
<td>LR-4</td>
<td>LR-5</td>
</tr>
<tr>
<td>Threshold growth ✘</td>
<td>LR-3</td>
<td>LR-4</td>
<td>LR-5</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

*If unsure about the presence of any major feature: characterize that feature as absent*
LR-3: Intermediate Probability of Malignancy

Example: 6-mm observation in a 76 year-old woman with chronic hepatitis B

![Diagnostic Table](image)

**Note:**
This observation is an example of a NAPH (see Chapter 15, page 30)

---

**MRI Diagnostic Table**

<table>
<thead>
<tr>
<th>Arterial phase hyperenhancement (APHE)</th>
<th>No APHE</th>
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</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></td>
<td></td>
</tr>
<tr>
<td>None</td>
<td>LR-3</td>
<td>LR-3</td>
</tr>
<tr>
<td>Enhancing “capsule” X</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Nonperipheral “washout” X</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Threshold growth X</td>
<td></td>
<td></td>
</tr>
<tr>
<td>≥ Two</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

**If unsure about the presence of any major feature: characterize that feature as absent**
LR-3: Intermediate Probability of Malignancy

Example: 37 mm observation in a 66 year-old man with cirrhosis

Note:
Observation has two AFs favoring malignancy:
- nonenhancing “capsule”
- HBP hypointensity

Radiologists at their discretion may apply these features to upgrade to LR-4

LI-RADS diagnostic table assigns LR-3, LR-4, and LR-5

MRI Diagnostic Table

<table>
<thead>
<tr>
<th>Arterial phase hyperenhancement (APHE)</th>
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</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Count additional major features:</td>
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<td>LR-3</td>
</tr>
<tr>
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<td>One</td>
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<td>LR-4</td>
</tr>
<tr>
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<td>≥ Two</td>
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</tr>
<tr>
<td></td>
<td></td>
<td>LR-4</td>
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</tbody>
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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

If unsure about the presence of any major feature: characterize that feature as absent
LR-3: Intermediate Probability of Malignancy

Example: 17 mm observation in a 66 year-old man with cirrhosis

LI-RADS diagnostic table assigns LR-3, LR-4, and LR-5

MRI Diagnostic Table

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<tr>
<td>Count additional major features:</td>
<td></td>
<td></td>
</tr>
<tr>
<td>• Enhancing “capsule” X</td>
<td>None</td>
<td>LR-3</td>
</tr>
<tr>
<td>• Nonperipheral “washout” X</td>
<td>One</td>
<td>LR-3</td>
</tr>
<tr>
<td>• Threshold growth X</td>
<td>≥ Two</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

If unsure about the presence of any major feature: characterize that feature as absent
LR-3: Intermediate Probability of Malignancy

Example: 18 mm observation in a 46 year-old man with cirrhosis

LI-RADS diagnostic table assigns LR-3, LR-4, and LR-5

MRI Diagnostic Table

<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>
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<td>≥ 20</td>
</tr>
<tr>
<td></td>
<td>&lt; 10</td>
<td>10-19</td>
</tr>
<tr>
<td></td>
<td>≥ 20</td>
<td></td>
</tr>
</tbody>
</table>

Count additional major features:

<table>
<thead>
<tr>
<th>None</th>
<th>LR-3</th>
<th>LR-3</th>
<th>LR-3</th>
<th>LR-3</th>
<th>LR-4</th>
</tr>
</thead>
<tbody>
<tr>
<td>One</td>
<td>LR-3</td>
<td>LR-4</td>
<td>LR-4</td>
<td>LR-4</td>
<td>LR-5</td>
</tr>
<tr>
<td>≥ Two</td>
<td>LR-4</td>
<td>LR-4</td>
<td>LR-4</td>
<td>LR-5</td>
<td>LR-5</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

If unsure about the presence of any major feature: characterize that feature as absent.
References


References


