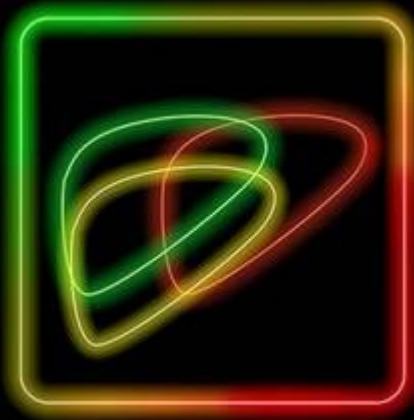




American College  
of Radiology™

# LI-RADS® CEUS Nonradiation TRA v2024 Core



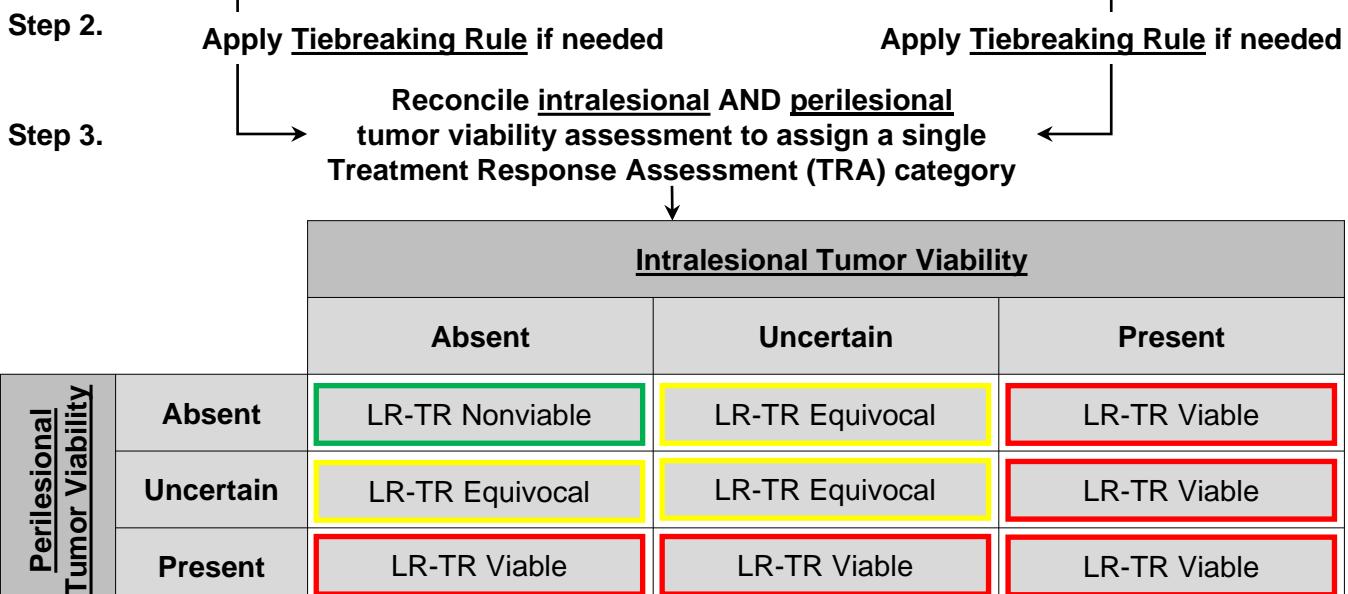


# LI-RADS® CEUS NONRADIATION TRA v2024

Observation treated by nonradiation-based Locoregional Therapy (TACE, TAE, RFA, MWA or PEA), or at surgical margin after resection, imaged with CEUS in at-risk patient.

**Step 1. Assess both intralesional AND perilesional tumor viability using CEUS Imaging Criteria. If not evaluable, assign LR-TR Nonevaluable and proceed to Step 4.**

Intralesional Tumor Viability	CEUS Imaging Criteria	Perilesional Tumor Viability	CEUS Imaging Criteria
Absent	No intralesional enhancement	Absent	Enhancement identical to surrounding liver
Uncertain	Arterial phase hypoenhancement (with or without washout)	Uncertain	Arterial phase hyperenhancement without washout <b>OR</b> Arterial phase isoenhancement with washout <b>OR</b> Arterial phase hypoenhancement
Present	Arterial phase hyperenhancement (with or without washout) <b>OR</b> Arterial phase isoenhancement (with or without washout)	Present	Arterial phase hyperenhancement with washout



## Step 4. Final check.

After steps 1, 2, and 3 – Ask yourself if the assigned TRA category is reasonable and appropriate.

If YES: You are done, move on to the next Treated Lesion (if any).

If NO: Re-evaluate.

- New distinct nodule(s) separate from Treated Lesion should be categorized using CEUS Diagnostic Algorithm instead of CEUS TRA Algorithm.
- In patients after partial hepatectomy the entire resection margin should be evaluated using Perilesional Tumor Viability criteria. In patients without surgical cavity visible on B-mode ultrasound Intralesional Tumor Viability should be labeled as “Absent”.



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# What is LI-RADS® CEUS Treatment Response Assessment?

## LI-RADS CEUS Treatment Response Assessment (TRA) is:

- A comprehensive system for standardizing Contrast-Enhanced Ultrasound (CEUS) acquisition, interpretation, reporting, and data collection for HCC and select cases of non-HCC malignancies (iCCA and cHCC-CCA), treated with locoregional therapy (LRT) or surgical resection.
- A dynamic document, to be expanded and refined as knowledge accrues and in response to user feedback.
- Designed to improve communication, patient care, education, and research.
- Supported and endorsed by the American College of Radiology (ACR).
- Developed by a multidisciplinary, international consortium of diagnostic and interventional radiologists, hepatobiliary surgeons, hepatologists, hepatopathologists, and radiation oncologists through literature review and expert consensus. Contributors include academic and community physicians as well as members in training.
- Complementary to other LI-RADS algorithms including LI-RADS CT/MRI TRA.

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## LI-RADS CEUS TRA may be used for clinical care, education, or research by:

- Community and academic radiologists
- Radiologists in training
- Other health care professionals providing care to patients with liver disease
- Researchers

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## Why is LI-RADS CEUS TRA important?

- Enables clear communication between radiologists and other specialists caring for patients after locoregional therapy and surgical resection.
- Provides standardized terminology to facilitate data collection, quality assurance, and research.
- Provides a simple, practical system suitable for routine clinical practice for assessing treatment response in individual lesions. This is particularly relevant in patients with liver-limited disease and to inform patient management including the need for retreatment.
- Prior systems (see below) were developed for clinical trials, emphasize overall patient response, and do not provide lesion-level treatment response assessment for each treated observation.

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## What are other treatment response systems?

- Response Evaluation Criteria in Solid Tumors (RECIST), modified RECIST (mRECIST), and European Association for the Study of Liver Disease (EASL) provide criteria to assess overall patient response in clinical trials and retrospective studies assessing treatment response for HCC patients, rather than to assess individual tumors or to inform clinical management.
- LI-RADS CT/MRI TRA uses concepts from mRECIST for assessment of viability following treatment. It uses imaging criteria of tumor viability different from LI-RADS CEUS TRA.



# LI-RADS® CEUS NONRADIATION TRA v2024

**Apply in high-risk patients to assess response for path-proven or presumed HCC (LR-3, LR-4, LR-5, LR-M) after locoregional treatment including surgical resection**



High-risk patients are those with cirrhosis **OR** Chronic hepatitis B viral infection even in absence of cirrhosis **OR** current or prior HCC, including adult liver transplant candidates and recipients of liver transplant.



**Apply to treated lesions imaged with contrast-enhanced ultrasound.**

**Apply nonradiation TRA algorithm after nonradiation-based LRT:**



- Radiofrequency ablation (RFA)
- Microwave ablation (MWA)
- Percutaneous ethanol ablation (PEA)
- Transarterial embolization (TAE)
- Conventional transarterial chemoembolization (cTACE)
- Drug-eluting bead transarterial chemoembolization (DEB-TACE)



**Apply to Treated Lesions:**

- Visible on post-treatment B-mode ultrasound



**Apply in postsurgical patients when assessing recurrence at the surgical margin, when surgical cavity or surgical margin is visible on ultrasound.**



**Apply with caution in select cases of non-HCC malignancies, such as iCCA and chHCC-CCA.**



**Do NOT apply in patients with Treated Lesion not visible on B-mode ultrasound.**



**Do NOT apply in new or untreated lesions outside treatment zone.**



**Do NOT apply in lesions treated with radiation-based therapies, or in patients on systemic therapy.**



# LI-RADS® CEUS NONRADIATION TRA v2024

## Key Concepts

### Tumor response to ablation and nonradiation-based intra-arterial embolization

Ablation and nonradiation-based intra-arterial embolization cause both tumor death and reactive changes in surrounding liver parenchyma. Surgical resection can produce reactive and granulation tissue development at the resection site. Hence, enhancement in treated lesion and along its margin might have different enhancement patterns, especially within first 4 weeks after treatment.

- Due to extremely high sensitivity of CEUS to vascular flow, post-treatment reactive changes are common and may manifest as areas of abnormal perilesional enhancement, especially during the first 3 months after treatment.
- **Treated Lesions:**
  - Treated lesions typically demonstrate no intralesional enhancement after successful treatment.
  - Arterial phase hyperenhancement or isoenhancement (with or without washout) within the Treated Lesion indicate persistent tumor viability.
  - Arterial phase hypoenhancement (with or without washout) within the Treated Lesion could be observed in incompletely treated lesions, but also in reactive/granulation tissue replacing successfully treated lesion.
- **Perilesional liver parenchyma:**
  - Locoregional treatments, especially percutaneous ablation, can lead to development of substantial hyperemia around the ablated area, typically seen within 1 month after treatment. This can result in false-positive cases by misdiagnosing the hyperenhancement along the borders of treatment cavity, as viable tumor as well as false-negative cases by failure to distinguish post-procedure inflammation from a true residual viable tumor.
  - Liver parenchyma surrounding Treated Lesion expected to return to normal enhancement after successful treatment within 3 months after treatment.
  - Abnormal enhancement in liver parenchyma surrounding Treated Lesion that persist for >6 month is concerning and should be further evaluated with an alternative imaging modality.

### Surgical resection

The appearance of Treated Lesion depends on the amount of surgically removed liver.

- In patients after focal segmental or wedge resection it is common to see a surgical cavity or surface defect on B-mode ultrasound, which might appear “mass-like”. Tumor viability in this cavity (outside the liver) should be evaluated using [Intralesional Tumor Viability](#) criteria. It should demonstrate no internal enhancement in patients with no viable disease.
- In patients after partial hepatectomy the entire resection margin (inside the liver) is considered perilesional tissue and should be evaluated using [Perilesional Tumor Viability](#) criteria.
- In patients without surgical cavity visible on B-mode ultrasound [Intralesional Tumor Viability](#) should be labeled as “Absent”.



# LI-RADS® CEUS NONRADIATION TRA v2024

## Treated Lesion and TRA Categories

After catheter-based treatments (TAE, cTACE, DEB-TACE):

- Treated observation visible on B-mode US

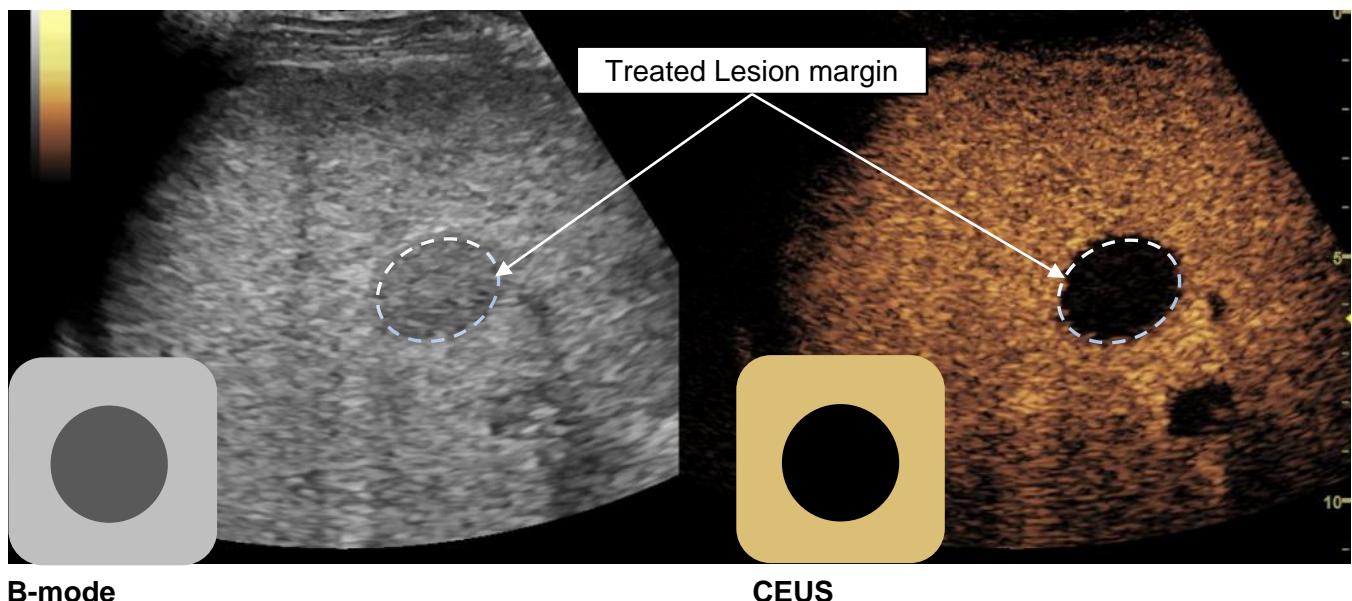
After percutaneous treatments (RFA, MWA, PEA):

- Treated Lesion**
- Combination of observation and parenchymal changes related to ablation procedure visible on B-mode US

After surgical resection:

- Surgical cavity after segmental or wedge resection visible on B-mode US

- CEUS LI-RADS Treatment Response Assessment leverages the unique ability of CEUS to visualize both anatomical (B-mode) and contrast-enhanced ultrasound images simultaneously and in real time.
- Using B-mode images as anatomical reference allows separate evaluation of contrast enhancement patterns inside and outside of the Treated Lesion.



B-mode

CEUS

### TRA Categories

#### LR-TR Nonevaluable

Treated by nonradiation-based therapy, response not evaluable due to image omission or degradation

#### LR-TR Nonviable

Treated by nonradiation-based therapy, probably or definitely not viable

#### LR-TR Equivocal

Treated by nonradiation-based therapy, equivocally viable

#### LR-TR Viable

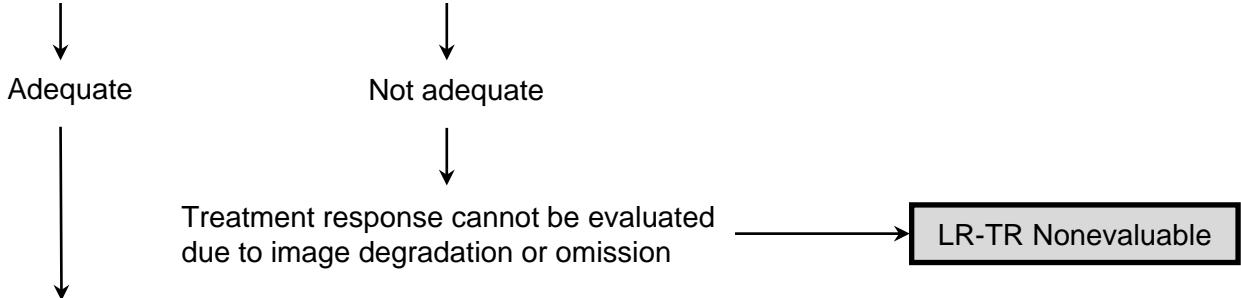
Treated by nonradiation-based therapy, probably or definitely viable



# LI-RADS® CEUS NONRADIATION TRA v2024 ALGORITHM

Treated Lesion OR margin of surgical resection visible on B-mode ultrasound

CEUS examination is technically adequate?



Define margins of Treated Lesion on B-mode US

Assess both intralesional AND perilesional tumor viability on CEUS

Use intralesional tumor viability table

Apply Tiebreaking Rule if needed

Use perilesional tumor viability table

Apply Tiebreaking Rule if needed

Reconcile intralesional AND perilesional tumor viability

LR-TR Nonviable

LR-TR Equivocal

LR-TR Viable

New distinct nodule(s) separate from Treated Lesion, visible on ultrasound

CEUS Diagnostic Algorithm



## Step 1.

### Assess both intralesional AND perilesional tumor viability using CEUS Imaging Criteria

If not evaluable, assign LR-TR Nonevaluable and proceed to Step 4.

#### Intralesional Tumor Viability

	Conceptual definition	CEUS Imaging Criteria
<b>Absent</b>	Low or negligible likelihood of viable tumor within the margins of the Treated Lesion	No intralesional enhancement
<b>Uncertain</b>	The presence and the absence of viable tumor within the margins of Treated Lesion each have similar probability	Arterial phase hypoenhancement (with or without washout)
<b>Present</b>	Definite or high likelihood of viable tumor within the margins of Treated Lesion	Arterial phase hyperenhancement (with or without washout) <b>OR</b> Arterial phase isoenhancement (with or without washout)

#### Perilesional Tumor Viability

	Conceptual definition	CEUS Imaging Criteria
<b>Absent</b>	Low or negligible likelihood of viable tumor in close proximity to the outer margins of Treated Lesion	Enhancement identical to surrounding liver
<b>Uncertain</b>	The presence and the absence of viable tumor in close proximity to the outer margins of Treated Lesion each have similar probability	Arterial phase hyperenhancement without washout <b>OR</b> Arterial phase isoenhancement with washout <b>OR</b> Arterial phase hypoenhancement
<b>Present</b>	Definite or high likelihood of viable tumor in close proximity to the outer margins of Treated Lesion	Arterial phase hyperenhancement with washout



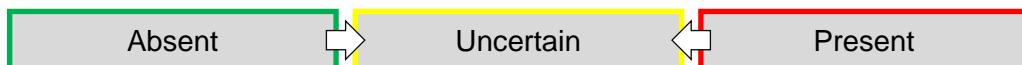
- New distinct nodule(s) separate from Treated Lesion should be categorized using CEUS Diagnostic Algorithm instead of CEUS TRA Algorithm.
- In patients after partial hepatectomy the entire resection margin should be evaluated using Perilesional Tumor Viability criteria. In patients without surgical cavity visible on B-mode ultrasound Intralesional Tumor Viability should be labeled as "Absent".



## Step 2.

### Apply Tiebreaking Rule if Needed

If unsure between two Intralesional or Perilesional tumor viability categories, choose each category reflecting lower certainty, as follows:



## Step 3.

### Reconcile Intralesional AND Perilesional Tumor Viability

To reconcile **perilesional** AND **intralesional** Tumor Viability, use the higher category of the two.

- If one or both are Present -> Final category **LR-TR Viable**
- If one is Uncertain and one is Absent -> Final category **LR-TR Equivocal**
- If both are Absent -> Final category **LR-TR Nonviable**

		<u>Intralesional Tumor Viability</u>		
		Absent	Uncertain	Present
Perilesional Tumor Viability	Absent	LR-TR Nonviable	LR-TR Equivocal	LR-TR Viable
	Uncertain	LR-TR Equivocal	LR-TR Equivocal	LR-TR Viable
	Present	LR-TR Viable	LR-TR Viable	LR-TR Viable

## Step 4.

### Final check.

After steps 1, 2, 3 and 4 – Ask yourself if the assigned TRA category is reasonable and appropriate.

**If YES:** You are done, move on to the next treated lesion (if any)

**If NO:** Re-evaluate

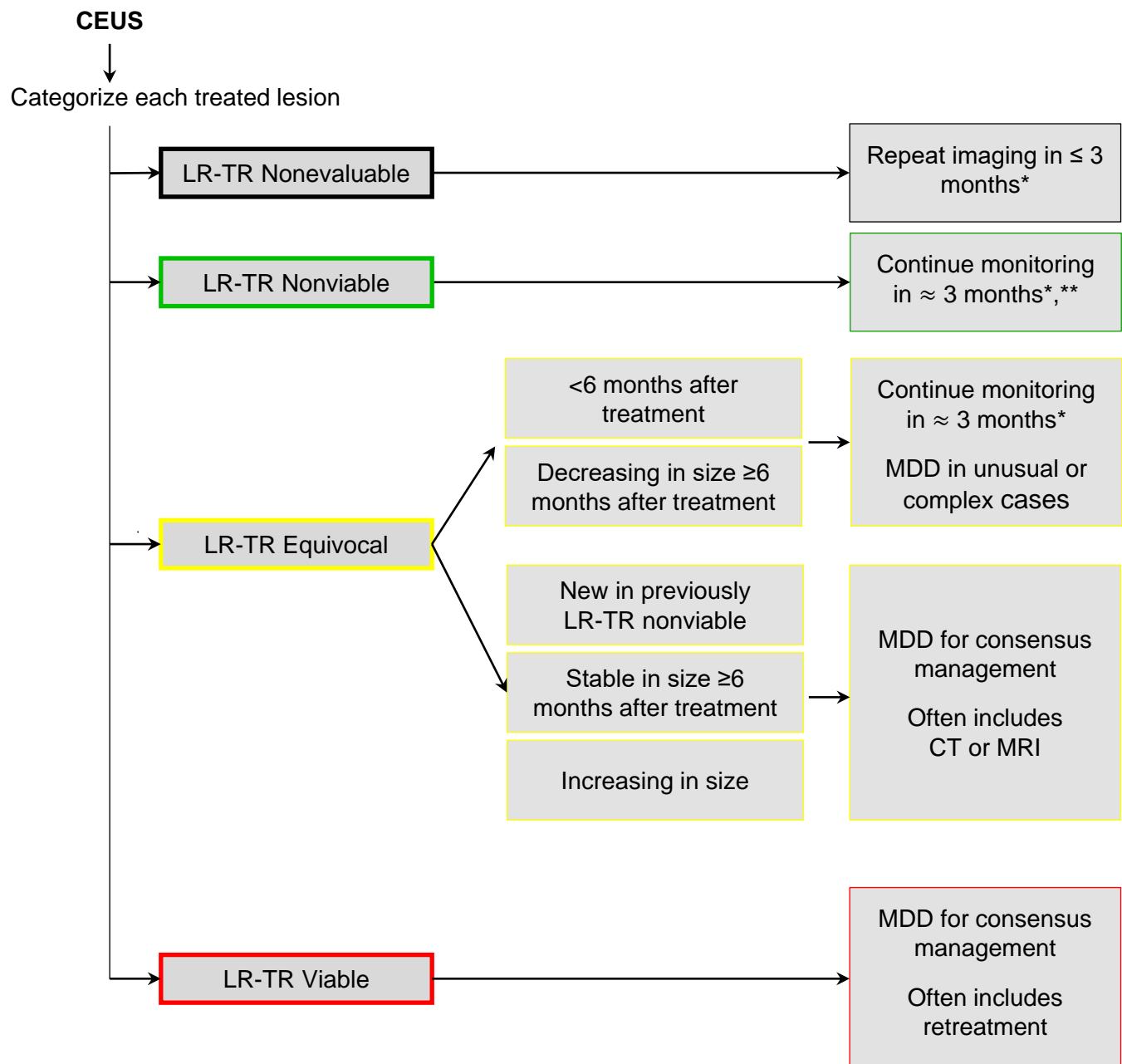


# LI-RADS® CEUS NONRADIATION TRA v2024

## Management: Suggested Imaging Workup Options & Time Intervals

### Timing of CEUS imaging after LRT

- CEUS Nonradiation TRA LI-RADS does not include any specific guidelines on timing of CEUS imaging after LRT.
- Decisions regarding most appropriate timing and imaging modality to evaluate HCC treatment response after LRT should be deferred to regional guidelines and MDD.



\* Using same modality or different modality as appropriate.

\*\* If stable after 1-2 years, follow-up interval may be extended to 6 months.



# LI-RADS® CEUS NONRADIATION TRA v2024

## Reporting Template

Sample report: template A

**Treated lesion [#]** – A lesion in segment [Couinaud segment] (series [#], image [#]), pretreatment category LR [category from preprocedure diagnostic report] [dated], was treated with [treatment type: RFA/MWA/PEA/TAE/DEB-TACE/cTACE/focal resection/segmentectomy/partial hepatectomy]. The posttreatment follow-up shows a [size] [mm/cm] treated lesion [with/without/uncertain/ intralesional tumor viability]. Surrounding liver parenchyma enhancement consistent with [present/uncertain/absent tumor viability]. [Additional comments/descriptions]. After reconciling intralesional and perilesional tumor viability, LR-TR category (v2024) is established as: [Nonevaluable/Nonviable/Equivocal/Viable].

Sample report: template B

<b>Treated lesion #:</b>	1/2/3
<b>Location:</b>	Segment I/II/III/IVa/IVb/V/VI/VII/VIII
<b>Pretreatment category</b>	[Uncertain/Not seen/Remote treatment/LR-5/LR-4/LR-3/TIV/LR-M/Biopsy HCC]
<b>Type of most recent treatment:</b>	[RFA/MWA/PEA/TAE/DEB-TACE/cTACE/Unknown]
<b>Date of most recent treatment:</b>	[MM-DD-YYYY/Unknown]
<b>Intralesional tumor viability:</b>	[Present/Absent/Uncertain/Nonevaluable]
<b>Perilesional tumor viability:</b>	[Present/Absent/Uncertain/Nonevaluable]
<b>LR-TR category:</b>	[Nonevaluable/Nonviable/Equivocal/Viable]

### Notes:

- The above sample reports are meant as guidance. The report elements, order of report elements, terminology, and other details should be customized to match institutional preference.
- LI-RADS measurements are given in mm, but each institution should utilize units according to local standards and use them consistently.
- Observations may be treated sequentially by different types of therapies. Use your judgment to select the appropriate TRA algorithm in such cases. You may not know which therapy was used. If the type of therapy can be inferred from imaging features, apply the appropriate TRA algorithm.
- If multiple therapies have been used on a single lesion, generally the TRA associated with the most recent LRT should be applied.

Reference: [Roudenko A et al, J Vasc Interv Radiol 2023](#)



# LI-RADS® CEUS NONRADIATION TRA v2024

## Abbreviations

ACR	American College of Radiology
AP	Arterial phase
APHE	Arterial phase hyperenhancement
CEUS	Contrast-enhanced ultrasound
cTACE	Transarterial chemo-embolization
cHCC-CCA	Combined hepatocellular-cholangiocarcinoma
DEB-TACE	Drug-eluting beads TACE
EASL	European Association for the Study of Liver Disease
HCC	Hepatocellular carcinoma
iCCA	Intrahepatic cholangiocarcinoma
LI-RADS	Liver Imaging Reporting and Data System
LRT	Locoregional therapy
mRECIST	Modified RECIST
MDD	Multidisciplinary discussion
MWA	Microwave ablation
Non-RT	Nonradiation
PEA	Percutaneous ethanol ablation
RECIST	Response Evaluation Criteria in Solid Tumors
RFA	Radiofrequency ablation
SBRT	Stereotactic body radiation therapy
TAE	Transarterial (bland) embolization
TARE	$^{90}\text{Y}$ Transarterial radioembolization
TR	Treatment response
TRA	Treatment response assessment
US	Ultrasound



# LI-RADS® CEUS NONRADIATION TRA v2024

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# LI-RADS® CEUS NONRADIATION TRA v2024

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