American College of Radiology
ACR Appropriateness Criteria®

Clinical Condition: **Liver Lesion Characterization**

Variant 1: **Typical benign on initial imaging, no history of malignancy.**

Radiologic Procedure	Rating	Comments	RRL*
No imaging procedure at this time	8	If classic hemangioma, simple cyst or FNH, no further imaging needed. Recommend follow-up imaging at appropriate time.	None
US abdomen	5	Particularly useful if follow-up is to be performed.	None
Tc-99m sulfur colloid or Tc-99m RBC	4		Med
CT abdomen	4	Helical with late arterial and portal venous phase imaging.	Med
MRI abdomen with contrast	4		None
MRI abdomen without contrast	4		None
Arteriography liver	2		High
Percutaneous biopsy liver	2		NS
Rating Scale: 1=Least appropriate, 9=Most appropriate			*Relative Radiation Level

Variant 2: **Typical benign on initial imaging, known history of extrahepatic malignancy.**

Radiologic Procedure	Rating	Comments	RRL*
No imaging procedure at this time	8	If classic hemangioma, simple cyst or FNH, no further imaging needed. Recommend follow-up imaging at appropriate time.	None
US abdomen	5		None
CT abdomen	5	Helical with late arterial and portal venous phase imaging.	Med
MRI abdomen with contrast	5		None
MRI abdomen without contrast	4		None
Tc-99m sulfur colloid or Tc-99m RBC	2		Med
Arteriography liver	2		High
Percutaneous biopsy liver	2		NS
Rating Scale: 1=Least appropriate, 9=Most appropriate			*Relative Radiation Level

Clinical Condition: **Liver Lesion Characterization**

Variant 3: **Typical malignant hepatic mass on initial imaging.**

Radiologic Procedure	Rating	Comments	RRL*
No imaging procedure at this time	7	Requires risk assessment and bio-chemical analysis for HCC. Recommend follow-up imaging at appropriate time.	None
Percutaneous biopsy liver	7	Requires risk assessment and bio-chemical analysis for HCC.	NS
CT abdomen	6	Helical with late arterial and portal venous phase imaging.	Med
MRI abdomen with contrast	6		None
US abdomen	4		None
MRI abdomen without contrast	4		None
Arteriography liver	2		High
Tc-99m sulfur colloid or Tc-99m RBC	2		Med
Rating Scale: 1=Least appropriate, 9=Most appropriate			*Relative Radiation Level

Variant 4: **Indeterminate on initial imaging, >1 cm, no suspicion or evidence of extrahepatic malignancy or liver disease.**

Radiologic Procedure	Rating	Comments	RRL*
MRI abdomen with contrast	8	Either MRI or CT, depending on availability and institutional preference.	None
CT abdomen	8	Either MRI or CT, depending on availability and institutional preference. Helical with late arterial and portal venous phase imaging.	Med
US abdomen	5		None
MRI abdomen without contrast	5		None
Percutaneous biopsy liver	5	Requires risk assessment and bio-chemical analysis for HCC.	NS
Tc-99m sulfur colloid or Tc-99m RBC	3	May be of use if classic hemangioma or focal nodular hyperplasia lesion suspected.	Med
Arteriography liver	2		High
Rating Scale: 1=Least appropriate, 9=Most appropriate			*Relative Radiation Level

Clinical Condition: **Liver Lesion Characterization**

Variant 5: **Indeterminate solitary mass on initial imaging, >1 cm, known history of extrahepatic malignancy.**

Radiologic Procedure	Rating	Comments	RRL*
Percutaneous biopsy liver	8		NS
CT abdomen	7	Helical with late arterial and portal venous phase imaging.	Med
FDG-PET whole body	7	Confirmation of metastatic disease if findings would influence patient management.	High
MRI abdomen with contrast	7		None
MRI abdomen without contrast	6		None
US abdomen	5		None
Tc-99m sulfur colloid or Tc-99m RBC	3		Med
Arteriography liver	2		High
Rating Scale: 1=Least appropriate, 9=Most appropriate			*Relative Radiation Level

Variant 6: **Indeterminate mass on initial imaging, >1 cm, known or suspected liver disease associated with a high risk of hepatocellular carcinoma (chronic hepatitis, cirrhosis, hemochromatosis, etc).**

Radiologic Procedure	Rating	Comments	RRL*
MRI abdomen with contrast	8	Either MRI or CT, depending on availability and institutional preference.	None
CT abdomen	8	Either MRI or CT, depending on availability and institutional preference. Helical with late arterial and portal venous phase imaging.	Med
Percutaneous biopsy liver	6	Depends on results of AFP.	NS
MRI abdomen without contrast	5		None
US abdomen	3		None
Tc-99m sulfur colloid or Tc-99m RBC	2		Med
Arteriography liver	2		High
Rating Scale: 1=Least appropriate, 9=Most appropriate			*Relative Radiation Level

Clinical Condition: **Liver Lesion Characterization**

Variant 7: **Small lesion on initial imaging, <1 cm.**

Radiologic Procedure	Rating	Comments	RRL*
No imaging procedure at this time	8	Recommend follow-up imaging at appropriate time.	None
US abdomen	7		None
MRI abdomen with contrast	5		None
CT abdomen	5	Helical with late arterial and portal venous phase imaging.	Med
MRI abdomen without contrast	4		None
Percutaneous biopsy liver	2		NS
Tc-99m sulfur colloid or Tc-99m RBC	2		Med
Arteriography liver	2		High
Rating Scale: 1=Least appropriate, 9=Most appropriate			*Relative Radiation Level

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Summary of Literature Review

Due to the high prevalence of benign focal hepatic lesions in adults, liver lesion characterization is an important objective of diagnostic imaging. For example, "incidental" liver masses discovered in healthy adults as well as liver lesions detected during staging of a known malignancy often need to be characterized.

Common benign liver masses include cysts and hemangiomas, and common malignant tumors are metastases and hepatocellular carcinoma (HCC). Less common liver tumors include focal nodular hyperplasia (FNH), liver cell adenoma (LCA), fibrolamellar HCC, intrahepatic cholangiocarcinoma, biliary cystadenoma and cystadenocarcinoma, lymphoma, hemangioendothelioma, hepatoblastoma in children, and a variety of sarcomas. On occasion, nontumorous masses seen as focal fat sparing, abscess, or hematoma may mimic liver tumors. Patients with cirrhosis are a special group in whom certain benign (regenerating nodules), premalignant (dysplastic nodules), malignant (HCC), and nontumorous (confluent hepatic fibrosis) masses are more prevalent.

The various variants in this document assume that state-of-the-art imaging studies have already been performed and that no prior imaging studies are available for comparison. For ultrasonography, this includes high-resolution sonography with color flow evaluation; for computed tomography (CT), it includes mechanically injected, intravenous (IV) contrast media–enhanced, dynamic helical, or multidetector helical CT; and, for magnetic resonance imaging (MRI), it includes T1- and T2-weighted imaging plus multiphase dynamic scanning with gadolinium chelate enhancement.

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Variant Development

"Liver lesion characterization" is undertaken for hepatic masses seen by ultrasound (US), CT, or MRI. For the variant analysis, one can consider the following clinical situations:

- *Typical Benign:* Incidental liver lesion whose US, CT, or MRI imaging appearance is highly suggestive of a benign mass (cyst, hemangioma, focal fat, or FNH). This may occur in a patient with or without a known history of malignancy.
- *Typical Malignant*: Incidental liver lesion whose US, CT, or MRI imaging appearance is highly suggestive of a malignant mass (HCC, cholangiocarcinoma, or metastases) in a patient who may or may not have a known malignancy.
- *Indeterminate:* Larger than 1 cm incidental liver lesion whose US, CT, or MRI imaging appearance is indeterminate. This may occur in a patient with a background of normal liver, chronic liver disease, or known extrahepatic primary malignancy.
- *Small*: Subcentimeter liver lesions whose US, CT, or MRI imaging appearance is indeterminate, regardless of clinical history.

Diagnostic Tests

For characterization of a liver lesion discovered by US, CT, or MRI, the following diagnostic studies may be considered:

- Dynamic contrast-enhanced CT (helical, or multidetector helical);
- MRI (including contrast enhancement with gadolinium chelates, iron oxide, and mangafodipir);
- Sonography;
- CT/PET;
- Nuclear scintigraphy (Tc-99m sulfur colloid or Tc-99m RBC);
- Angiography;
- Percutaneous biopsy;
- Follow-up imaging using the same test as the original study at an appropriate time interval.

Research on US contrast agents performed outside the United States has demonstrated high accuracy in characterizing liver lesions [1-3]. These agents have not been approved for hepatic imaging in the United States.

When considering possible studies for liver lesion characterization, it is assumed that a logical sequence will be followed. For example, if MRI and biopsy are considered appropriate tests, it is assumed that the biopsy will be done only if the MRI is nondiagnostic. In this case, both studies should be considered to be "indicated."

Recommendations

Typical Benign Mass: No History of Malignancy. Liver masses with typical imaging features of simple cyst, hemangioma, or FNH in patients who are not known to have, or are not suspected of having, a malignancy may be classified as benign [4-7]. Focal fat or focal spared areas in fatty livers can generally be diagnosed when typical features are seen on sonography, noncontrast CT, and, most reliably, MRI using in-phase and out-of-phase scanning.

Typical Benign Mass: Known History of Malignancy. Liver masses with typical imaging features of simple cyst, hemangioma, or FNH in patients who are known to have a malignancy may be considered benign [4-7]. However, if there is any doubt that the mass is benign; follow-up imaging (using the same test with which the lesion was initially detected) should be performed to make sure there is no change in the lesion appearance. Alternatively, MRI could be performed to help enable a definitive diagnosis. Presence of focal fat can be ascertained with MRI using in-phase and out-of-phase scanning.

Typical Malignant Mass: Lesions with typical sonographic, CT, or MRI features of a malignant mass do not require additional imaging, but confirmation with serum tumor markers (HCC) or percutaneous biopsy may be appropriate.

Indeterminate Mass: Normal Liver. For indeterminate masses, additional imaging may be required for tissue characterization. In these patients, follow-up imaging is not a practical option due to the need to initiate appropriate treatment. If the initial indeterminate imaging test is sonography or CT, then MRI may be considered for liver lesion characterization [8,9]. MRI would be preferred in pediatric and young adult patients due to lack of ionizing radiation. Nuclear scintigraphy is an option in patients with suspected FNH (technetium-labeled sulphur colloid) or possible neuroendocrine liver metastasis (somatostatin receptor scintigraphy).

Indeterminate Mass: Suspect Metastatic Disease. For indeterminate masses, additional imaging may be required for tissue characterization. In these patients, follow-up imaging is not a practical option due to the need to initiate appropriate treatment. In suspect metastatic disease, dynamic multidetector helical CT and contrast-enhanced multiphase MRI (gadolinium enhanced) [10,11] may be considered. CT/PET imaging is strongly suggested if the suspect metastasis will likely be FDG avid (eg, melanoma, colon and esophageal cancer, breast cancer, sarcoma) and a diagnosis of liver metastasis will influence patient management [12]. Nuclear scintigraphy is an option in patients with possible neuroendocrine liver metastasis (somatostatin receptor scintigraphy) [13,14].

Indeterminate Mass: Cirrhotic Liver. Characterization of liver lesions in a cirrhotic liver may be performed with either contrast-enhanced MRI (gadolinium) or dynamic multidetector helical CT, but that characterization is imperfect [15-18]. Characterization is more definitive for lesions larger than 2 cm in diameter. Although MRI may sometimes differentiate among regenerating nodules, dysplastic nodules, and HCC, MRI (like CT and US) is best used to follow up lesions to determine change in appearance. Percutaneous biopsy is often needed to make a final diagnosis [19].

Additional MRI contrast agents including mangafodipir and ferumoxide may be of value distinguishing benign and malignant primary hepatocellular tumor and detecting metastatic disease. However, experience with the use of these agents is mainly limited to Phase III clinical trials, and these agents are not widely available for clinical use [20-27].

For indeterminate liver lesions in all the categories considered above, a biopsy should be considered if the findings from the additional imaging tests are inconclusive.

Subcentimeter Lesion: These lesions are difficult to characterize. In patients with extrahepatic primary malignancy, these small lesions are best evaluated with follow-up imaging because most are benign [28].

Relative Radiation Level Information

Potential adverse health effects associated with radiation exposure are an important factor to consider when selecting the appropriate imaging procedure. Because there is a wide range of radiation exposures associated with different diagnostic procedures, a relative radiation level (RRL) indication has been included for each imaging examination. The RRLs are based on effective dose, which is a radiation dose quantity that is used to estimate population total radiation risk associated with an imaging procedure. Additional information regarding radiation dose assessment for imaging examinations can be found in the ACR Appropriateness Criteria® Radiation Dose Assessment Introduction document.

Relative Radiation Level Designations	
Relative Radiation Level*	**Effective Dose Estimate Range**
None	0
Minimal	< 0.1 mSv
Low	0.1-1 mSv
Medium	1-10 mSv
High	10-100 mSv
*The RRL assignments for some of the examinations cannot be made, because the actual patient doses in these procedures vary as a function of a number of factors (eg, the region of the body exposed to ionizing radiation, the imaging guidance that is used, etc). The RRLs for these examinations are designated as NS (not specified).	

Supporting Document(s)

- ACR Appropriateness Criteria® Overview
- Evidence table under review

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