EE017 - A Case Based Pictorial Review of Liver Lesions Using the LI-RADS Classification System

D.Ferguson, M.Mohammed, C. Healy, A.C. Harris, S Chang.
Disclosure Statement

I have no disclosures regarding affiliation with medical, pharmaceutical or communication companies. I will not discuss regarding ‘off label’ use of medical device, product or pharmaceutical.

Aims

1. To become familiar with the Liver Imaging Reporting and Data Systems (LI-RADS) classification and its updated version v2014.

2. To use a stepwise approach to the classification of liver lesions using the LI-RADS classification system.

3. To demonstrate specific CT/MRI cross sectional images and classify appropriately.
Introduction

• Imaging plays a key role in the diagnosis, surveillance and management of patients with increased risk of developing liver cancer. These include patients with a background of hepatitis or underlying cirrhosis.

• During this process, imaging will demonstrate a wide spectrum of lesions from the definitely benign to the definitely malignant. This wide variety increases the potential for both misinterpretation and also miscommunication of findings between medical specialties.

• The LI-RADS classification system was launched in 2011 to formalize and standardize the radiology reporting system. Subsequent reviews and enhancements have been performed with the latest version released in 2014.

Methods

• We present the LIRADS algorithm with ancillary features and tie-breaker table adapted from the American College of Radiology.

• Images of patients with known risk factors for HCC were reviewed on the local PACS. Examples for each LIRADS category were obtained.

• Hyperlinks are incorporated into the algorithm table and at the top of each slide to allow easy transformation to the relevant examples.
LIRADS Major Algorithm

**Diameter (mm)**
- <20
- ≥20
- <10
- 10-19
- ≥20

**Washout**
- None
- One
- ≥2

**Capsule**
- LR3
- LR4
- LR5

**Threshold growth**
- LR3
- LR4
- LR5

*Within this cell, LR4 unless:
- There is ≥50% diameter increase in ≤6 months (LR5g).
- There is both “washout” and visibility as discrete nodules at antecedent surveillance ultrasound (LR-5us).
Ancillary features of imaging may be used to supplement the major features and allow for upgrading or downgrading of category. Of note, the presence of ancillary features favouring malignancy may only upgrade to a highest category of LR4. Ancillary features favouring benignity may downgrade from any of the categories inclusive of category LR5.
If there is persistent doubt regarding the final categorization, following application of the ancillary features, the tie-breaking rules are used as outlined in the diagram above.
Ancillary Features favouring HCC (1)

**Restricted Diffusion:**
Mildly T2 hyperintense lesion demonstrated within segment 6 of the liver centrally. This demonstrates diffusion restriction (B-value: 1000)

**Corona enhancement:**
Segment 6 lesion demonstrates marked arterial phase hyperenhancement with perilesional rim enhancement apparent on late arterial phase which fades to isodensity on delayed phase.

**Blood products:**
T1 weighted opposed phase image demonstrates lesion within segment 7/8 that remains hyperintense. On diffusion weighted imaging, this demonstrates central hyperintense signal with a hypointense low signal rim. These features are consistent with the presence of blood products.
Ancillary Features favouring HCC (2)

Nodule-in-nodule appearance:
Non contrast T1 image demonstrates a T1 hyperintense lesion within the dome. This demonstrates arterial enhancement and portal venous phase washout within an internal nodule giving a nodule-in-nodule appearance.

Lesional fat sparing:
Lesion in right lobe of liver is hypointense on in phase images but is hyperintense on opposed phase sequence consistent with lesional fat sparing. While this favours HCC, this is also associated with haemangiomas.

Intralesional fat:
Mildly hyperintense lesion noted adjacent to the IVC on in phase sequence. On opposed phase sequence, this demonstrates signal drop-out consistent with the presence of intralesional fat.
Ancillary Features favouring HCC (3)

**Mosaic Architecture:**
This refers to a mixed pattern of varied enhancement/attenuation/signal intensity within a lesion. CT (arterial and portal venous phases) demonstrates a lesion within segment 4B with mosaic architecture.

**Distinctive Rim:**
Lesion within the dome of the liver demonstrates a circumferential rim that is of differing intensity to the lesion and surrounding liver consistent with a distinctive rim.

**Mild-Moderate T2 Hyper-intensity:**
Adjacent to the IVC, there is a mildly T2 hyperintense lesion which demonstrates other major and ancillary features to favour HCC. Of note, this does not demonstrate marked T2 hyperintensity as would be seen in more benign lesions.

Further ancillary features favouring malignancy include:
- Diameter ↑ < threshold growth
- Lesional iron sparing
- Hepatobiliary phase hypointensity
Ancillary Features favouring benignity

Marked Homogeneous T2 Hyperintensity/Hypointensity:  
9mm lesion demonstrates marked T2 hyperintense signal. Further sequences confirmed this to be a simple cyst.

Undistorted vessels:  
Vessels abut and pass within the wedge shaped lesion in the left lobe of liver. No evidence of deformity or displacement of the vessels suggesting benignity.

Parallels blood pool enhancement:  
Attenuation of the lesion within the dome of the liver follows that of blood pool on post contrast images. This is a sign of benignity and is consistent with an haemangioma.

Further ancillary features favouring benignity include:  
- Hepatobiliary phase isoointensity  
- Diameter stability > 2 years  
- Diameter reduction
**LR1 lesion:** Lesion characteristic of haemangioma within the right lobe of liver with discontinuous peripheral nodular enhancement with fill in on delayed imaging. Ancillary features of benignity inclusive of marked T2 hyperintensity, enhancement pattern paralleling blood-pool with no distortion of the vessels.

**LR1 lesion:** Lesion in keeping with a transient hepatic attenuation difference (THAD). This demonstrates hyper-enhancement on arterial phase imaging which becomes isodense on portal venous and delayed phases.
**LIRADS Category Examples (LR2)**

**LR2 lesion:** 3cm wedge shaped area within segment 2 of the liver demonstrates isointense signal on in-phase T1 sequence with hyperintense signal on opposed phase sequence. Of note, the background liver demonstrates marked signal loss on opposed phase consistent with a markedly fatty liver. On T2 weighted imaging this area is hypointense with respect to background liver and is isointense on T2 fat-saturation sequence. On arterial phase this is hyperenhancing on arterial phase that persists on portal venous phase. This is in keeping with a geographic area of fat sparing within a markedly fatty liver.

**LR1 lesions** are classified as definitely benign while LR2 lesions are classified as probably benign. Given this, there is cross-over between the type of lesion within these categories. These include haemangioma, THAD, cyst, focal fat sparing, hypertrophic pseudomass and confluent fibrosis.
LR3 lesion: Triphasic CT liver demonstrates a single LR3 lesion. 14mm segment 6 lesion demonstrates isointense enhancement on arterial phase imaging with washout present on portal venous and delayed phases. No associated capsule or threshold interval growth.

LR3 lesion: MRI demonstrates an 18mm hyper-enhancing lesion on arterial phase within the caudate lobe without associated washout on delayed phases, capsule or threshold growth increase. No ancillary features to favour malignancy with lesion seen to be mildly T2 hypointense, with no restricted diffusion or intraltesional fat.
LIRADS Category Examples (LR4)

LR4 lesion: Two lesions demonstrated within the dome of the liver. The larger lesion (-cat) measures 2.4 cm and demonstrates washout consistent with a LR4 lesion. The smaller lesion ( ) measures 16 mm and is hypovascular on arterial phase with washout consistent with a LR3 lesion on major criteria. However, intralesional fat is noted on out of phase imaging (an ancillary feature favouring malignancy) and therefore this is categorized also as LR4.

LR4 lesion: 17 mm lesion in segment 2 of the liver demonstrates arterial hyperenhancement with washout compatible with a LR4 lesion. Ancillary feature favouring HCC of restricted diffusion present. However, this remains a LR4 lesion as ancillary features cannot upgrade into the LR5 category.
**LIRADS Category Examples (LR5)**

**LR5 lesion:** Triphasic CT liver demonstrates two LR5 lesions.
1. 24mm lesion in right lobe of liver demonstrates hyperenhancement on arterial phase with washout on delayed phase. By size and presence of a single major feature, this meets LR5 criteria. Note also the presence of intralesional fat.
2. 15mm lesion in the left lobe of liver demonstrates arterial phase hyper-enhancement with portal venous washout with an enhancing capsule. Despite being smaller than the first lesion, this has two major features and therefore is also a LR5 lesion.

**LR5 lesion:**
MRI demonstrates a 3.2cm lesion within segment 8 of the liver with hyperenhancement on arterial phase with washout. There is associated mild T2 hyperintensity, mild restricted diffusion with a distinctive rim. This is consistent with a LR5 lesion.
LIRADS Category Examples (LR treated/LRV)

**LR treated:** Non contrast CT demonstrates post treatment features within the liver inclusive of surgical clips post partial hepatectomy ( ), lipiodol deposition ( ) post Transarterial ChemoEmbolisation (TACE) and focal area of hypoattenuation ( ) within an hypertrophied left lobe of liver following Radiofrequency Ablation (RFA).

**LRV:** Portal venous phase CT demonstrates a filling defect within the anterior branch of the right portal vein consistent with tumoural soft tissue extension into the vein. This is a contraindication to liver transplantation.
LIRADS Category Examples (LRM)

**LRM:** Coronal CT images (arterial and portal venous phase) demonstrates background cirrhotic liver with a hypovascular hypo-attenuating lesion within segment 6 of the liver. Given the patient’s background history of colorectal metastasis, this is in keeping with a metastasis with no suspicion of HCC.
Acknowledgements

American College of Radiology: http://nrdr.acr.org/Lirads/lirads.aspx