CT/MRI LI-RADSv2018: inter-reader agreement and correlation with pathology

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Authors:	A. Borgheresi, A. Agostini, D. Nicolini, R. Montalti, M. Vivarelli, A. Lorenzoni, A. Giovagnoni; Ancona/IT
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Aims and objectives

The diagnosis of Hepatocellular Carcinoma (HCC) strongly relies on cross-sectional imaging according to the 2018 European Association for the Study of the Liver (EASL) Guidelines [1].

Conversely, the most important prognostic factors in terms of recurrence are the Edmondson-Steiner Grade (E-S) [2,3] and Microvascular Invasion (MVI) [2,4] evaluated on the pathological specimen. Unfortunately, the preoperative biopsy is not considered a reliable tool [5].

Several studies have correlated different radiological findings to post-surgical or post-transplant recurrence of HCC [6-10], but at now their definition is not completely standardized and reproducible. Therefore, the most important prognostic information is still obtained from the surgical specimen or explanted liver. A radiological marker predicting pathological features would allow for more accurate patient stratification and treatment selection [11,12].

Liver Imaging - Reporting and Data Systems (LI-RADS) have been developed with the main purpose of standardization of liver imaging in patients with chronic liver disease at risk of HCC. This algorithm is still under construction; the last version has been released recently [13]. The key feature of LI-RADS is the defined lexicon and the exact definition of the lesion pattern, aiming to an unequivocal characterization of the observations with improved reproducibility [14].

The purpose of this study was to evaluate the inter-reader agreement (IRA) between readers with different experience and to determine the correlation of CT/MRI LI-RADSv2018 standardized imaging observations with pathological features of HCC on the surgical specimen in cirrhotic patients.

Methods and materials

Patient Population

In this retrospective study, we included patients with chronic liver disease who underwent surgical resection for focal liver lesion between June 2015 and June 2018 at Hepatobiliary and Transplant Surgery of University Hospital of Ancona. All the lesions included were HCC at the surgical specimen. All the patients had at least one triphasic contrast-enhanced CT or MRI within a month prior to surgery. Patients with lack of clinical, radiological or pathological data were excluded.

Imaging Protocol

Pre-surgical examinations were performed with a 64-slices TC (LightSpeed VCT, GE Healthcare, Milwaukee, WI) or a 1.5 Tesla MRI (Signa HdXt, GE Healthcare, Milwaukee, WI) with a triphasic post-contrastographic study.

MRI protocol included axial FSE T2w images with and without fat suppression, a coronal T2w SSFSE sequence, an axial T1w in- and out-of-phase GRE, a DWI (b=0, b=800 s/ mm^2). The contrastographic study was obtained with administration of Gd-DOTA (0.1 mmol/Kg, 2 ml/s; Dotarem, Guerbet, Roissy CdG Cedex, France) or Gd-EOB-DTPA (0.025 mmol/Kg, 1 ml/s; Primovist, Bayer, Berlin, Germany). 3D spoiled, fat-suppressed T1w GRE (LAVA) were used to acquire pre-contrast, arterial, portal venous, late venous/ transitional and eventual hepatobiliary phase.

CT examinations were performed with pre-contrast and post-contrastographic acquisitions of arterial (with bolus tracking), portal venous and late venous phases with the following parameters: 120 kV, modulated mA, pitch 0.984:1, iterative reconstruction (ASiR, GE Healthcare, Milwaukee, WI), reconstruction kernel Standard, slice thickness/ spacing 2.5/2.5 mm.

Image revision

Three readers with different experience rated in blind the presurgical imaging using LI-RADSv2018. Reader 1 was a resident in radiology with 5 years of experience, reader 2 had 10 years of experience and reader 3 had 30 years of experience. LI-RADS Major and Ancillary Features were assigned for each lesion as in LI-RADSv2018 [13].

Statistical Analysis

Statistical analysis was performed with MedCalc v12.5 (MedCalc Software, Ostend, Belgium). IRA was calculated using the Intraclass Correlation Coefficient (ICC). For

pathological correlation, discordant LI-RADS Major or Ancillary Features were reviewed in consensus, and Chi-square Test was used. Significant p was set at $p<0.05$.

Results

Patient Demographics and Lesion characteristics

Ninety-two patients (median age: 64 y.o.; interquartile range: 56-72 y.o.) were included. Among the 92 patients, chronic liver etiology was due to HCV in 33 patients (pts), to HBV in 14 pts, to Alcohol in 14 pts and related to miscellaneous etiology in 31 patients.

A total of 112 lesions (median diameter: 22 mm; interquartile range: 10-43 mm) were evaluated respectively in 63 CT and 49 MRI. At pathological evaluation, 44 lesions had E-S Grade 1 (G1), 48 lesions had G2, and 20 were G3. MVI was detected in 35 lesions (Table 1 on page 6).

At radiological revision LI-RADSv2018 categories of LR-3, LR-4, LR-5, and LR-M were assigned. Imaging and pathological findings are summarized in Table 2 on page 6.

Pathological correlation

Significant correlations were demonstrated between LR-5 and G2 and for LR-M with G3 and MIV (Table 3 on page 7).

Table 4 summarizes significant correlation between LI-RADSv2018 Major and Ancillary Features with pathology. Tumor size, Corona enhancement, Mosaic architecture, Targetoid mass and Rim Arterial Phase Enhancement (APHE) were significantly related to the presence of MIV. Targetoid Mass, Rim APHE, and infiltrative appearance were significantly correlated to G3 (Table 4 on page 7).

Inter-reader agreement

LI-RADS score built on Major Features only showed a moderate IRA in CT (ICC=0.594) and in MRI (ICC=0.578); IRA for the final LI-RADS category was moderate in CT (ICC=0.723) and in MRI (ICC=0.689) (Table 5 on page 8).

Images for this section:

Table 1. Demographics, Pathology and Radiology of study population and lesions.

	Parameters	N
Population	Patients included	92
	Age; median (25-75p)	64 (56-72)
	Gender, M/F	69/23
Cirrhosis, Etiology	HCV; N (%)	33 (36)
	HBV; N (%)	14 (15)
	Alcohol; N (%)	14 (15)
	Miscellaneous; N (%)	31 (34)
Pathology	Lesion, N	112
	Diameter [mm]. Median (25-75p)	22 (10-43)
	Edmondson-Steiner Grade	
	G1, N (%)	44 (39)
	G2, N (%)	48 (43)
	G3, N (%)	20 (18)
	Microvascular Invasion, N (%)	35 (31)
Radiology	CT, N	63
	MRI, N	49

Table 1: Demographics, Pathology and Radiology of study population and lesions.

Table 2. CT/MRI LI-RADSv2018 categories, Edmondson-Steiner pathological grade and Microvascular Invasion (MVI) for each lesion.

LR-M	(11§) (12*)	1§ 3*	3§ 3*	7§ 6*	6§ 3*
LR-5	(43§) (21*)	12§ 4*	25§ 15*	6§ 2*	13§ 6*
LR-4	(13§) (13*)	4§ 3*	6§ 8*	2§ 2*	3§ 3*
LR-3	(11§) (10*)	4§ 7*	6§ 3*	1§ 0*	1§ 0*
	(n)	G1 (44)	G2 (48)	G3 (20)	MVI (35)

Legend. §: CT/LI-RADS. *: MRI/LI-RADS.

Table 2: CT/MRI LI-RADSv2018 categories, Edmondson-Steiner pathological grade and Microvascular Invasion (MVI) for each lesion.

Table 3. Correlation of LI-RADSv2018 categories with Edmondson-Steiner grade, and with Microvascular Invasion (MVI).

LI-RADS category	LR-M	-	-	0.002§ 0.041*	0.038§
	LR-5	-	0.028§ 0.019*	-	-
	LR-4	-	-	-	-
	LR-3	0.021§ 0.001*	0.012*	-	-
Pathology	Edmondson-Steiner Grade	G1	G2	G3	MVI

Legend. *Chi-Square Test; p.* §: CT/LI-RADS. *: MRI/LI-RADS.

Table 3: Correlation of LI-RADSv2018 categories with Edmondson-Steiner grade, and with Microvascular Invasion (MVI).

Table 4. Significant correlations of LI-RADSv2018 Major and Ancillary Features with pathology, in particular with Edmondson-Steiner grade 3 (G3) and Microvascular Invasion (MVI).			
LI-RADS category		**G3**	**MVI**
LR-M Criteria	*Targetoid mass*	0.003§ 0.024*	0.002§
	Rim APHE	0.041§	0.003§
	Infiltrative appearance	0.019§	-
Major Features	*Size ≥20 mm*	-	0.009§
Ancillary Features, Malignancy	*Corona Enhancement*	-	0.031§
Ancillary Features, HCC specific	*Mosaic architecture*	-	0.022§
Ancillary Features, Benignity	-	-	-
Legend. *Chi-square Test, p.* §: CT/LI-RADS. *: MRI/LI-RADS. APHE: Arterial phase enhancement; MVI: Microvascular Invasion; HCC: Hepatocellular Carcinoma.			

Table 4: Significant correlations of LI-RADSv2018 Major and Ancillary Features with pathology, in particular with Edmondson-Steiner grade 3 (G3) and Microvascular Invasion (MVI).

Table 5. Inter-reader agreement for LI-RADS categories including Major or Ancillary Features. Intraclass Correlation Coefficient (ICC).

Parameters		CT	MRI
Major Features	APHE (95%CI)	0.765 (0.577-0.928)	0.805 (0.689-0.968)
	WO (95%CI)	0.737 (0.581-0.894)	0.694 (0.512-0.882)
	Enhancing "Capsule" (95%CI)	0.753 (0.618-0.897)	0.784 (0.591-0.887)
	Diameter (95%CI)	0.989 (0.982-0.993)	0.987 (0.977-0.992)
LI-RADS Category assigned by Major features only (95%CI)		0.594 (0.469-0.748)	0.578 (0.416-0.753)
LI-RADS Category assigned including Ancillary features (95%CI)		0.723 (0.598-0.831)	0.689 (0.493-0.795)

Legend. *ICC: Intraclass Correlation Coefficient. 95% CI: 95% Confidence Interval. APHE: Arterial Phase Enhancement. WO: "Wash out" not peripheral.*

Table 5: Inter-reader agreement for LI-RADS categories including Major or Ancillary Features. Intraclass Correlation Coefficient (ICC).

Conclusion

Application of LI-RADSv2018 score allowed for a moderate to good IRA between readers with different experience. Significant correlations between some LI-RADSv2018 features and pathological features were found.

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