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Recent updates in Liver Imaging Reporting and Data System (LI-RADS) in high-risk patients for developing hepatocellular carcinoma

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Abstract

Hepatocellular carcinoma represents the prevailing primary malignancy that affects the liver. HCC is unlike the majority of solid malignancies in that patients with cirrhosis can have the disease diagnosed without biopsy confirmation using contrast-enhanced CT or MRI. The aim of the study is to determine the diagnostic accuracy & utility of both LI-RADS as well as the conventional criteria-free approach in patients who have been diagnosed with liver lesions. This prospective research was conducted on 103 high-risk patients for HCC and presented to the National Cancer Institute by a suspected hepatic lesion either by elevated serum alfa-fetoprotein (AFP) or by previous cross-sectional imaging research (US, CT, or MRI) to perform a triphasic CT study or dynamic MRI on the liver from March 2020 to March 2023.In contrast to Likert Scale (LS) method, LI-RADS generated comparatively greater specificity (89.83 percent vs. 64.4 percent), a lesser sensitivity (84.3 percent vs. 98 percent), & a relatively greater accuracy (87.3 percent vs. 80 percent). LI-RADS method exhibited a comparatively greater positive likelihood ratio (+LR: 8.29 vs. 2.75) & positive predictive value (Ppv: 87.8 percent vs. 70.42 percent) with respect to LS approach. LI-RADS has a better prediction of malignancy in at-risk individuals for HCC as it produces higher accuracy, specificity, and +LR compared to LS. We advise using it as it allows the radiologist to standardize the reporting of CT & MRI of liver lesions, which leads to clear communication and better patient care.

Keywords: LI-RADS, Likert Scale, Hepatocellular carcinoma.

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1. Introduction

HCC is considered the most prevalent malignancy that originates from within the liver. Hepatitis ranks as the 4th most common reason for cancer-related mortality on a global scale and is the primary reason for mortality due to cancer in numerous regions where it is endemic [1]. Cirrhosis, chronic viral hepatitis infection caused by HBV, alcoholic steatohepatitis, & nonalcoholic steatohepatitis are all well-established risk factors for HCC [3-2]. In contrast to the majority of solid malignancies, HCC can be identified without biopsy confirmation in cases of cirrhosis using contrast-enhanced CT or MRI [5-4]. For the evaluation of CT & MRI scans for individuals undergoing HCC surveillance, LI-RADS was designed as a structured reporting & data collection system [6]. LI-RADS purposes are to attain near-perfect specificity for HCC diagnosis (LR-5; definite HCC) in order to obviate the need for biopsy for definitive treatment [8-7].

The objective of this research endeavor was to assess the diagnostic precision & utility of both LI-RADS & the conventional criteria-free approach in individuals who had established liver lesions.

2. Patient & methods

This prospective research was conducted on 103 high-risk patients for HCC and presented to the National Cancer Institute as a suspected hepatic lesion either by elevated serum alfa-fetoprotein (AFP) or by previous cross-sectional imaging research (US, MRI, or CT) to perform a triphasic CT study or dynamic MRI on the liver from March 2020 to March 2023.

2.1 Ethical consideration

Ethical committees endorsed the study and obtained informed consent from all participants.

2.2 Inclusion Criteria

High-risk cases for HCC (as with a history of chronic viral hepatitis or cirrhosis) who were suspected either clinically or by previous cross-sectional imaging research (US, CT, and MRI) to have a hepatic lesion.

2.3 Exclusion Criteria

Patients having a contraindication to MRI or IV contrast agents; cases who underwent locoregional therapy with trans-catheter arterial chemoembolization or radiofrequency ablation; & cases of hepatic metastasis, cholangiocarcinoma, or hepatic sarcoma proven by surgery or biopsy.

3. Methods

3.1 Design of a CT examination protocol

The CECT examinations of the liver were performed utilizing a GE light-speed VCT 64 multislice CT scanner.

3.2 Design of an MRI examination protocol

Were conducted on a 1.5 Tesla scanner.

3.3 CT and MRI images interpretation

Two hepatic imaging-experienced readers evaluated the CT or MRI data without knowledge of the results.

3.3.1 First reader

Utilizing LI-RADS to assess six imaging characteristics for each liver lesion: tumor diameter, capsule, arterial phase hyper-enhancement, washout appearance, tumor embolus within a venous lumen, &, if possible, tumor growth rate. The reader then assigned a final LI-RADS score between one and five.

3.3.2 Second reader

Utilized the standard, criterion-free reporting model Likert scale. Then, on a 5-point Likert scale, a likelihood score for HCC was assigned: LS-1 indicated certain benignity, LS-2 probable benignity, LS-3 indeterminacy, LS-4 likely HCC, & LS-5 certain HCC. We categorized the lesions into two groups HCC group and non-HCC group. The malignant lesions were identified through histologic findings following biopsy or surgery. In patients who did not undergo biopsy or surgery, the diagnosis of hepatocellular carcinomas (HCCs) was determined using integrative evaluation criteria. These criteria comprised the following: previous diagnosis of cirrhosis &/or chronic viral hepatitis; elevated concentrations of alpha-fetoprotein in the serum (>11 ng/mL); & consistent results on CT/MR images or digital subtraction angiography in conjunction with TACE therapy; these factors were considered in the diagnostic process. Following that, these lesions were classified as HCCs.

Benign lesions were diagnosed by: lesions showing typical benign imaging features; cross-sectional imaging modality (i.e., US, CT, or MRI) follow-up; and cases with pathologically proven benign lesions. Then these lesions were inserted into the non-HCC group.

3.4 Analytical statistics

A thorough as well as precise review was conducted on every piece of collected data.

Utilizing version 21 of the statistical package for social science software program (SPSS), pre-coded data were inputted onto the computer in preparation for statistical analysis. Quantitative variables were summarized using mean, SD, median, & IQR; qualitative variables were presented using number & percentage. These tests were the Chi-square test, Fisher exact test, unpaired t-test, Mann-Whitney test, Fleiss kappa and interclass correlation coefficient (ICC), ROC (receiver operator characteristic curve), and a P value less than 0.05 was regarded as having statistical significance.

4. Results and Discussion

4.1 Case presentation

4.1.1 Clinical history

A sixty-seven-year-old man with liver cirrhosis & elevated AFP was referred for assessment of a liver mass detected by US. A dynamic MRI study of the liver was done.

4.2 Reader 1 using LI-RADS system

Consistent with a tumor in the vein, dynamic MRI reveals enhancing soft tissue in right main portal vein that extends into and enlarges the right intrahepatic portal branches. Following arterial phase hyperenhancement, the branching intraluminal tumor exhibited "washout" in portal venous & delayed stages. This is associated with a 60-mm LR-5 parenchymal observation involving segment VIII, with nonrim arterial phase hyperenhancement, washout appearance, and no capsule appearance.

This mass is contiguous with the tumor in the vein. This finding was classified as LR-TIV, definitely attributable to HCC.

The 2018 report, as endorsed by LI-RADS

First observation: The site is Segment VIII. Particulars: 60 x 60 mm Yes, the tumor encompasses the complete length of the right portal vein. Features of LR-M: None, Nonrim APH: Indeed, Enhancing capsule appearance: no; non-peripheral discharge appearance: yes Growth threshold: N/A, Auxiliary characteristics: Preferring benignity: null, Preferring malignancy: negative

LI-RADS v2018 Classification: LR-TIV (tumor in vein), unquestionably attributable to HCC.

4.3 Reader 2 using criteria free LIKERT SCALE

Dynamic MRI revealed cirrhotic liver, showing an ill-defined right lobe infiltrative mass lesion mainly located in segment VIII. It measures 6x6 cm at its maximum axial dimensions. The lesion showed early arterial enhancement, rapid washout in the portal vein, & delayed stage. The lesion is invading the right portal vein with malignant thrombosis, having the same contrast behavior as the malignant liver mass. The thrombosed vein has a maximum caliber of 2.8 cm. A portal vein thrombus abuts the tumor.

This lesion was assigned LS-5.

4.4 Final Diagnosis

In this case, diagnoses of HCC depended on integrative evaluation criteria: history of cirrhosis, high levels of serum alfa-fetoprotein (above 11 ng/mL), &

consistent results (regarding HCC) at MRI images (HCC group).

We found that arterial phase hyper-enhancement was the most common major criterion, washout appearance was the second most common major criterion, and capsule appearance was the least common major criterion. There was almost perfect agreement between LI-RADS and LS readers in our evaluation of the major imaging features of the involved lesions as judged by the reader. In addition, The overall interreader agreement concerning the final score was exceptional. This is comparable to the results obtained by Ehman et al., who assessed the inter-observer agreement and rate of observation for the main LI-RADS features at CT & MRI in 184 HCC confirmed by pathology. In their investigation, arterial phase hyper-enhancement was identified as the most commonly observed main feature, followed by washout appearance. In contrast, inter-observer reliability for arterial hyper-enhancement & washout was found to be statistically significant, while inter-observer reliability for capsule appearance was found to be infrequent in the overall LI-RADS category [9].

The results of our research revealed significant discrepancies in liver observations as recorded by LI-RADS & Likert scale methodologies. While both scales effectively categorized lesions as definitely benign, probably benign, and definitely malignant, they did not align in their classification of lesions intermediately to probably harboring hepatocellular carcinoma (HCC). In particular, the two methodologies do not concur regarding the classification of intermediate & probable HCC. Our observations revealed that the majority of the inconsistencies occurred in the identification of lesions with scores 3 & 4, which corresponded to intermediately probable HCC. This finding aligns with the research conducted by Zhang et al., which similarly observed significant differences in liver observation between LI-RADS & Likert scale methods: Both systems demonstrated high levels of consistency in classifying lesions as definitely benign or probably benign, moderate agreement in classifying intermediate & certain malignancies, but low agreement in classifying lesions as probable malignancies. Moreover, the discrepancies among the two scoring systems were most pronounced in classifying lesions as intermediate to probably HCC [10]. The frequencies of Likert scale & LI-RADS scores stratified by our readers were as follows: Scores 1 and 2 were assigned more or less similarly between both scoring systems, with score 1 being a little bit more assigned on the Likert scale than LI-RADS, scores 3 and 5 being much more frequently assigned by LI-RADS than Likert scale, and on the contrary, score 4 was much more frequently assigned on the Likert scale than LI-RADS. In contrast to LI-RADS, the LS method yielded the following results: lesions with LR-3 were overscored by 36% as well as underscored by 16%; lesions with LR-4 were overscored by 44.4% as well as underscored by 33%.A study done by Barth et al., demonstrated some variation in the distribution of scores stratified by both scoring systems (LI-RADS and Likert Scale) as follows: Score 1 was assigned more frequently with the Likert scale than with LI-RADS. Score 3 was less often assigned with the Likert scale than with LI-RADS. Scores 4 and 5 were assigned with similar frequencies with both Likert Scale & LI-RADS [11]. In our study, we compared the ability of two algorithms to distinguish HCC from non-HCC for diagnostic purposes & observed that radiologists who utilized LI-RADS produced better diagnostic accuracy than LS (87.3% vs. 80%). Also, the LS approach produced significantly less specificity than LI-RADS (64.41 percent vs. 89.83 percent). In the assessment of at-risk cases with a mass-forming lesion suspected of HCC, maximizing specificity is more important than ensuring high diagnostic sensitivity. Similar research was done by Buscarino et al., which contrasted the LI-RADS & Likert scales in the characterization of 44 liver nodules in 39 cases of chronic liver disease by MRI and demonstrated that the readers of the LI-RADS scale revealed the following consequences: Accuracy equals 80 percent, and sensitivity equals 72 percent. Specificity equals 93 percent, PPV equals 93 percent, and NPV equals 70%. As for the Likert, the outcomes were: Accuracy equals 79 percent. Sensitivity equals 73 percent. Specificity equals 87%, PPV equals 89%, and NPV equals 70% [12].

Table 1: Cases demographics

	Mean ± SD	**Median (IQR)**	**Range**
Age	59.3±12.3	63(57:69)	15:80
sex	**N**	**%**	
Man	62	60.2	
Woman	41	39.8	

Table 2: Inter reader agreement regarding the major diagnostic features of HCC

	k Coefficient
Tumor size in mm	0.981 (0.972,0.987)
Arterial enhancement	0.705 (0.831,0.579)
Venous wash out	0.763 (0.885,0.641)
Capsule	0.771 (0.917,0.625)
Tumor in vein	0.927 (1.029,0.825)
Overall	0.898 (0.852,0.93)

Table 3: Summary of major features using LI-RADS in HCC & non-HCC groups

Major features in LIRADS		**Total lesions N=110**	**Non HCC group N=59**	**HCC group N=51**	**P value**
		No (%)	No (%)	No (%)	
Arterial enhancement	No enhancement	17/110(15.45%)	17/59(28.2%)	0/51(0%)	<0.001
	Hypo or Iso-enhancement	26/110(23.6%)	13/59(22%)	13/51(25.5%)	
	Hyper - enhancement	67/110(60.9%)	29/59(49.2%)	38/51(74.5%)	
Venous washout	No washout	65/110(59%)	55/59(93.2%)	10/51(19.6%)	<0.001
	washout	45/110(40.6%)	4/59(6.8%)	41/51(80.4%)	
Capsule	No capsule	86/110(78.2%)	56/59(94.9%)	30/51(58.8%)	<0.001
	capsule	24/110(21.8%)	3/59(5.10%)	21/51(41.2%)	
Tumor in Veins	Yes	93/110(84.54%)	58/59(98.3%)	35/51(68.6%)	<0.001
	No	17/110(15.45%)	1/59(1.7%)	16/51(31.4%)	
Threshold Growth	No	106/110(96.4%)	58/59(98.3%)	48/51(96%)	0.592
	Yes	4/110(3.6%)	1/59(1.7%)	3/51(5.9%)	
Size in mm	mean± SD		49.45± 38.1	28.27± 26.26	<0.001

Table 4: Comparison of the scoring results for 110 hepatic lesions by the LI-RADS & LS approaches

Scoring level	**LR**		**LS**		**Overscored**		**Underscored**		**Cohen K**
	N	**%**	**N**	**%**	**N**	**%**	**N**	**%**	
Score 1	21	19.1 %	27	24.5 %	3/21	14.29 %	0/21	0 %	0.682 (0.514 , 0.85)
Score 2	15	13.6 %	12	10.9 %	1/15	6.67 %	8/15	53 %	0.368 (0.108 , 0.628)
Score 3	25	22.7 %	13	11.8 %	9/25	36 %	4/25	16 %	-0.059 (-0.215 , 0.97)
Score 4	9	8.2 %	29	26.4 %	4/9	44.44 %	3/9	33 %	-0.022 (-0.166 , 0.122)
Score 5	40	36.4 %	29	26.4 %	0/40	0 %	17/40	43 %	-0.52 (-0.35 , 0.69)
Total	110	100 %	110	100 %	17/110	15.45 %	32/110	29 %	-0.324 (-0.21 , 0.43)

Table 5: Performance for detection of HCCs stratified by LI-RADS & LS scale

Diagnostic variable	Scoring system	
	LI-RADS	**LIKERT**
Threshold value	≥ LR 3	≥ LS 2
Accuracy	87.3%	80.0%
Sensitivity	84.31%	98.04%
Specificity	89.83%	64.41%
+ LR	8.29	2.75
- LR	0.17	0.03
Ppv	87.8%	70.4%
Npv	86.9%	97.4 %

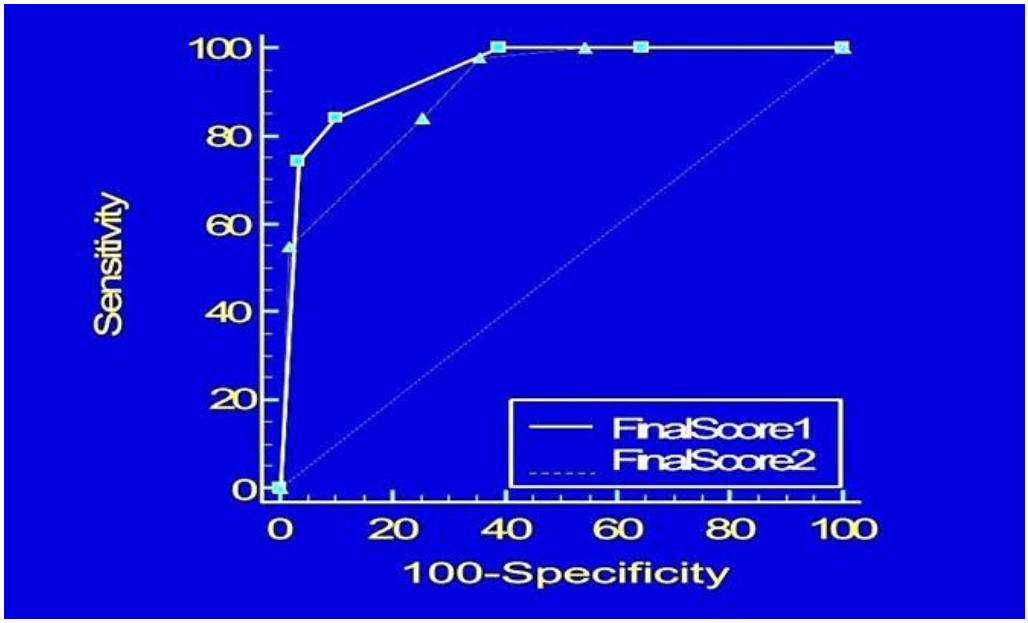

Figure 1: ROC curve of both LI-RADS (final score 1) and LIKERT SCALE (final score 2)

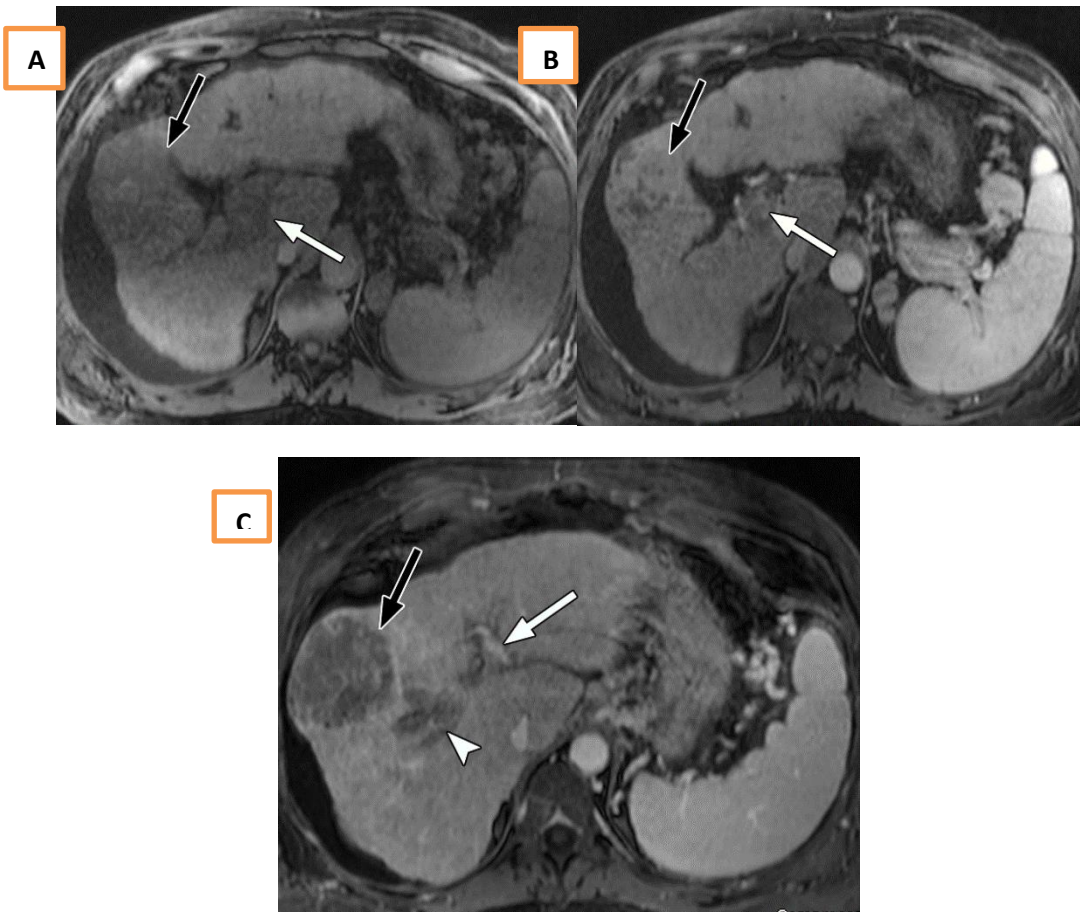

Figure 2: Dynamic MRI study of a 67-year-old male patient with liver cirrhosis showing HCC with malignant portal vein thrombosis

A: pre-contrast, B: porto-venous phase, and C: porto-venous phase at a higher level than A & B reveal tumors (black arrows) & multiple thrombosed right portal vein branches (arrowheads). The left portal vein (white arrow) is patent.

The optimization of the LI-RADS scale criterion was determined to be a score of three or greater, according to ROC analysis. The LS required a score of two or more as the optimal criterion. Table 1 showed that the average age was 59.3±12.3 SD, 62 cases were men (60.2 %) & 41 patients were women (39.8 %). Table 2 showed that almost complete interreader agreement was observed for the measured diameter. (k equals 0.981), interreader agreement was good for detection of arterial phase enhancement (k equals 0.705), porto-venous phase washout (k equals 0.763), & capsule appearance (k equals 0.771), & was excellent for detection of tumor embolus within the vein (k equals 0.927). The overall interreader agreement for the final score was also excellent (k equals 0.898). Table 3 showed that this research revealed statistically significant variance (p value < **0.05)** among the HCC group and non-HCC group using LI-RADS regarding arterial phase enhancement, venous washout, tumor in the vein**,** capsule appearance, and difference in the measured diameter in mm.

In this study, the overall k agreement between the two methods for classifying 110 hepatic lesions was 0.32, which can be considered as fair agreement. Both scoring methods exhibited a high degree of concurrence at score one (k = 0.682). A moderate level of agreement was observed between the two assessment methods at score 5 (k = 0.52), whereas acceptable agreement was observed at score 2 (k = 0.36). A discrepancy arose between the two scoring methods regarding the third (k = -0.059) and fourth (k = -0.022) scores. When comparing LI-RADS and the LS approach, it was observed that the LS method led to overscoring by 33.3 percent (9/25) and underscoring by 16 percent (4/25) for lesions with LR-3, and underscoring by 33.3 percent (3/9) for lesions with LR-4. Notably, inconsistencies emerged predominantly in the identification of lesions receiving scores of three and four (Table 4). When compared to the LS approach, LI-RADS yielded a comparatively greater accuracy (87.3 percent vs. 80 percent), a reduced sensitivity (84.3 percent vs. 98 percent), & a significantly greater specificity (89.83 percent vs. 64.4 percent). Additionally, the LI-RADS method exhibited a comparatively greater positive likelihood ratio (+LR: 8.29 vs. 2.75) & positive predictive value (Ppv equals 87.8 percent vs. 70.42 percent) in comparison to the LS approach (Table 5).

5. Conclusions

We concluded that LI-RADS has a better prediction of malignancy in at-risk cases for HCC as it produced higher accuracy, specificity, and +LR compared to LS. We advise using LI-RADS in cases at risk for HCC as it allows the radiologist to: apply consistent terminology; standardize the reporting of CT & MRI of liver lesions; improve the comprehensiveness of the report; reduce variability in imaging interpretation; facilitate quality assurance and investigation; & improve communication

with referring clinicians through the use of standardized terminology.

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