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POSITIVE PREDICTIVE VALUE OF ULTRASOUND LIVER IMAGING AND DATA SYSTEM IN DETECTING HEPATOCELLULAR CARCINOMA IN AT-RISK POPULATION, KEEPING CT SCAN AS GOLD STANDARD

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Abstract

OBJECTIVE: *To evaluate the positive predictive value of ultrasound-based Liver Imaging Reporting and Data System (LI-RADS) category 3 in identifying hepatocellular carcinoma among individuals with liver cirrhosis, using triphasic computed tomography (CT) as the diagnostic benchmark.*

METHODOLOGY: *This cross-sectional validation study was executed at The Indus Hospital, Karachi, encompassing 91 individuals diagnosed with liver cirrhosis (ages 18–70, either gender). The ultrasound examinations were done using the standardized Liver Imaging Reporting and Data System (LIRADS). Patients falling into ultrasound LIRADS 3 category that is having observation greater than 1 cm or portal vein thrombosis, were advised to undergo tri-phasic CT of the abdomen. Data was subjected to statistical analysis utilizing SPSS version 26, with statistical significance established at $p \leq 0.05$.*

RESULTS: *This study included 91 Patients with a mean age of 52.34 ± 11.91 years. Males constituted 42.9% and females comprised 57.1% of patients. The findings revealed a true positive rate of 8.8% and a false positive rate of 11.0%. The positive predictive value (PPV) of ultrasound LI-RADS-3 in identifying HCC was calculated to be 44.44%, indicating that less than half of the Patients classified under LI-RADS-3 were correctly diagnosed with HCC.*

CONCLUSION: *Ultrasound LI-RADS category 3 demonstrates a constrained capacity to accurately identify hepatocellular carcinoma in patients with cirrhosis, as evidenced by its true and false positive rates. Although it may facilitate initial identification, the risk of misclassification underscores the necessity for further validation via triphasic computed tomography. These observations advocate for the sustained application of ultrasound as a preliminary screening modality, augmented by conclusive imaging techniques within populations at elevated risk.*

INTRODUCTION

Hepatocellular carcinoma is the most common type of primary liver cancer and the sixth most common cancer in the world. It also ranks as the third cancer type with the highest mortality rate [1]. The prevalence of hepatocellular carcinoma in Pakistan, the tenth most populous country in the world, is as high as 7.46/100000 in males and 2.8/100000 in females [2]. Whether viral or non-viral, liver cirrhosis is the most prevalent risk factor. Hepatitis C is the most prevalent virus among them, followed by hepatitis B [3]. Although the exact pathophysiology of hepatocellular carcinoma is still unknown, one theory is that the liver's defence mechanism to deal with it is based on repeated damage to the hepatocytes, regardless of the underlying cause, since regeneration would cause genetic instability, which
would then lead to the formation of hyperplastic and dysplastic nodules and ultimately hepatocellular carcinoma [4]. Unlike other DNA viruses, the hepatitis B virus is unique in that its ability to integrate viral DNA into the hepatocyte genome enables hepatitis B virus to cause hepatocellular carcinoma without a prerequisite step of cirrhosis [5]. Because of its excellent prognosis and the availability of curative modalities such as percutaneous ethanol ablation, trans-arterial chemoembolization, surgical resection, and even liver transplant, early detection of HCC is critical. Although these treatments are curative for hepatocellular carcinoma, they still have a recurrence rate of 15% [6].

Ultrasound is one of the major screening instruments in hepatocellular carcinoma identification with a professional sensitivity of 60–80% and a specificity greater than 90% [7]. According to existing data from several nations, semiannual follow-up is advised for patients who are at risk since it has been shown to have the advantage of early diagnosis [8].

One of the recently suggested systems is the ultrasound liver imaging and data system, which categorizes ultrasound limitations based on visualization and includes standard ultrasound testing techniques, reporting, and referral. Depending on the extent of the observation (lesion) and whether portal vein thrombosis is present, ultrasound LIRADS 1, 2, and 3 are the suggested categories. Ultrasound LIRADS 3 has nearly one in five chances of having HCC. Only 50% of the liver parenchyma can be seen in the ultrasound LIIRAD C investigation, which is quite limiting [9–11]. Imaging methods such as tri-phasic multi-detector computed tomography, magnetic resonance imaging, and contrast enhanced ultrasound are useful and have nearly entirely replaced biopsy in the diagnosis of hepatocellular carcinoma [12]. Liver nodules with distinctive increase in enhancement on the arterial phase, portal venous washout, and liver cirrhosis are diagnostic criteria for hepatocellular carcinoma [13]. Abduljabbar et al.'s study found that the ultrasonography liver imaging reporting and data system (LI-RADS) category 3 had a 46.4%positvepredictve value [14]. A different study found that ultrasonography LI-RADS category 3 had a 29% positive predictive value [15]. Ultrasound is a crucial screening technique for hepatocellular carcinoma, one of the most prevalent cancers in Pakistan that is typically undetected until symptoms appear. However, it has limitations of its own and lacks a standardized reporting system. Although it has not yet been implemented, ultrasound LIRADS is one of the suggested standardized reporting systems. To the best of my knowledge, no study has been conducted in Pakistan, hence the only goal of this research is to ascertain the positive predictive value of ultrasonography LIRADS from the limited data that is currently available.

METHODOLOGY

This cross-sectional validation study was carried out in the Radiology Department of the Indus Hospital, Karachi. Using a non-probability, consecutive sampling technique, we recruited 91 participants. Participants referred for the screening ultrasound and meeting the eligibility criteria were included in the data collection. We included participants aged 18 to 70 years with liver cirrhosis found on screening ultrasound having findings consistent with Ultrasound Liver Imaging Reporting and Data System (LIRADS) category 3. Individuals meeting the following criteria were excluded; abnormal renal function test, known malignancy (HCC or other primary cancers), Child-Pugh Class C liver disease.

Cirrhosis was identified on ultrasound by the presence of an irregular nodular liver margin along with coarse, altered, or heterogeneous parenchymal echotexture. LIRADS category 3 was considered the

threshold requiring further evaluation with tri-phasic CT. This category was defined by the detection of an observation (lesion) measuring more than 1 cm or the presence of portal vein thrombosis in a patent with cirrhosis or positive Hepatitis B surface antigen (HBsAg). Portal vein thrombosis was diagnosed based on the presence of echogenic material within the portal vein lumen, along with the absence of flow on color Doppler imaging and the absence of waves on spectral analysis. Eligible patients who visited the radiology department and provided informed consent were included. The ultrasound examinations were done using the standardized LIRADS technique for reproducibility of imaging techniques. Ultrasound examinations were performed by a dedicated radiology resident with updates and evaluations conducted by a dedicated radiologist. For Patients falling in LIRADS 3 category that is having observation greater than 1 cm or portal vein thrombosis, tri-phasic CT of the abdomen was recommended. Histopathological assessment was the gold standard for diagnosis and exclusion of HCC within the interval CT findings. A CT scan was considered positive for HCC if an enhancing lesion was detected in the arterial phase, accompanied by washout in the portal venous or delayed phase. A difference in Hounsfield Unit (HU) of more than 60 between the arterial and portal venous/delayed phase was used to confirm washout.

Data was analyzed and interpreted using SPSS version 26. Mean ± standard deviation was computed for continuous variables while frequencies and percentages were calculated for categorical variables.

RESULTS

A total of 91 participants were enrolled in the study. The demographic and clinical characteristics of the study population consisted of 39 males (42.9%) and 52 females (57.1%).

The mean age was 52.34 ± 11.91 years, with 19 individuals (20.9%) aged between 25-40 years and 72 individuals (79.1%) over 40 years of age. Regarding comorbidities, 41 participants (45.1%) had comorbid conditions, while 50 (54.9%) did not. In terms of lesion size, 34 individuals (37.4%) had lesions smaller than 2 cm, and 57 (62.6%) had lesions equal to or larger than 2 cm. For echogenicity, 37 participants (40.7%) had hypoechoic lesions, 9 (9.9%) had isoechoic lesions, and 45 (49.5%) had hyperechoic lesions. Finally, portal vein thrombosis was present in 29 participants (31.9%) and absent in 62 (68.1%) (TABLE 1).

The findings revealed a true positive rate of 8.8% and a false positive rate of 11.0%. The positive predictive value (PPV) of ultrasound LI-RADS-3 in identifying HCC was calculated to be 44.44%, indicating that less than half of the patients classified under LI-RADS-3 were correctly diagnosed with HCC (TABLE 2).

DISCUSSION

This study aimed to evaluate the positive predictive value (PPV) of the ultrasound-based Liver Imaging Reporting and Data System (LI-RADS) category 3 for identifying hepatocellular carcinoma (HCC) in patients with liver cirrhosis, using triphasic computed tomography (CT) as the reference standard. The findings indicated a PPV of 44.44%, suggesting that fewer than half of the lesions classified as LI-RADS 3 were subsequently validated as HCC through CT imaging. This underscores the moderate diagnostic efficacy associated with this classification system. Analysis also revealed an 8.8% true positive rate and an 11.0% false positive rate, meaning many lesions originally thought to be malignant were later found to be benign. These statistical measures reflect the diagnostic ambiguity associated with LI-RADS category 3 and underscore the necessity for subsequent imaging to ascertain malignancy.

Our results are consistent with previous investigations conducted by Abduljabbar et al., who reported a PPV of 46.4% for ultrasound LI-RADS category 3, and Son et al., who noted a 29% PPV, with both studies documenting significant false positive rates within high-risk cohorts [14,15]. Such discrepancies highlight the limitations inherent in diagnostic consistency and accentuate the need for supplementary imaging modalities to achieve accurate categorization. The observed variation in PPV across different studies may be attributable to heterogeneous lesion characteristics, disparate levels of operator expertise, differences in equipment, and patient-specific variables. Musa et al. showed that triphasic CT can give higher

diagnostic ability and is therefore beneficial to advance imaging methods [16]. Furthermore, Arian et al. highlighted the differences in methodology and

population that addressed a large portion of the variance in outcomes [17]. Although ultrasound LI-RADS functions as a pragmatic and non-invasive approach for initial lesion evaluation—particularly within resource-limited environments—its moderate predictive capability and relatively high false positive rates necessitate judicious application.

These considerations suggest that lesions classified as LI-RADS 3 should be subjected to follow-up with contrast-enhanced CT or MRI to ensure precise diagnosis and to mitigate the risks of both overtreatment and deferred care. In the current investigation, the reported positive predictive value of 44.44%, accompanied by true positive and false positive rates of 8.8% and 11.0% respectively, underscores the constrained predictive validity of ultrasound LI-RADS category 3 in the identification of hepatocellular carcinoma (HCC) within cirrhotic patent population. These results advocate for its application in preliminary screening while emphasizing the necessity for corroborative imaging to guarantee precise diagnostic and therapeutic approaches.

CONCLUSION

Ultrasound LI-RADS category 3 demonstrates a constrained capacity to accurately identify hepatocellular carcinoma in patients with cirrhosis, as evidenced by its true and false positive rates. Although it may facilitate initial identification, the risk of misclassification underscores the necessity for further validation via triphasic computed tomography. These observations advocate for the sustained application of ultrasound as a preliminary screening modality, augmented by conclusive imaging techniques within population at elevated risk.

Table I: Demographic and Clinical Data of the Study Population (n=91)

Variable	Frequency (%)
Gender	
Male	39 (42.9)
Female	52 (57.1)
Age (Mean ± SD) = 52.34 ± 11.91 years	
25-40 years	19 (20.9)
>40 years	72 (79.1)
Comorbidities	
Yes	41 (45.1)
No	50 (54.9)
Size of Lesions	
< 2 cm	34 (37.4)
≥ 2 cm	57 (62.6)
Observations	
Hypoechoic	37 (40.7)
Isoechoic	9 (9.9)
Hyperechoic	45 (49.5)
Portal Vein Thrombosis	
Present	29 (31.9)
Absent	62 (68.1)

Table II: Diagnostic Outcomes of Ultrasound LI-RADS Category 3 in Detecting Hepatocellular Carcinoma in Cirrhotic Patients

Diagnostic Variables	Ultrasound (LIRADS-3)
True Positive	8.8%
False Positive	11.0%
Positive Predictive Value	44.44%

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