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Original Article

Impact of Risk Factors on Imaging Findings in Hepatocellular Carcinoma (HCC) Diagnosis — A Comprehensive Study of USG and CT-Scan

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ABSTRACT

Introduction: *Hepatocellular carcinoma (HCC) is a leading cause of cancer-related mortality globally, particularly prevalent in regions with high rates of chronic hepatitis B and C infections. Early detection is crucial, and imaging plays a key role in diagnosing HCC.* ***Methods & Materials:*** *This cross-sectional study, conducted from June 2007 to May 2008 at BIRDEM, BSMMU, and Gastroliver Hospital in Dhaka, involved 30 patients clinically suspected of having HCC. Patients underwent both USG and CT scans, with diagnosis confirmed by biopsy. Demographic, clinical, and biochemical data were collected, and imaging findings were correlated with histopathology. Sensitivity, accuracy, and predictive values of USG and CT were calculated using SPSS software.* ***Results:*** *The study found that CT had slightly better sensitivity (92%) than USG (88%) for detecting HCC. Both imaging techniques exhibited low specificity (20%). CT was superior in detecting multifocal lesions (43.3% vs. 16.7% in USG, $p < 0.05$) and lesions in the 5-10 cm range (73.3% vs. 50%, $p = 0.009$). Post-contrast CT scans showed heterogeneous enhancement in 70% of cases, indicating its utility in differentiating HCC from benign conditions.* ***Conclusion:*** *This study evaluates the impact of imaging modalities and risk factors in diagnosing hepatocellular carcinoma (HCC). CT scans demonstrated higher sensitivity and effectiveness in detecting multiple lesions, while ultrasound (US) proved useful for initial screening. Future research should explore combining imaging techniques and biomarkers for improved diagnosis, alongside the potential of advanced technologies like MRI and elastography, especially in resource-limited settings.*

Keywords: *Hepatocellular-carcinoma, Ultrasonography, CT-Scan*

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INTRODUCTION

Hepatocellular carcinoma (HCC) is one of the most prevalent and lethal cancers worldwide, particularly in regions where chronic liver diseases are endemic [1]. The increasing prevalence of HCC is strongly linked to the rising rates of chronic hepatitis B (HBV), hepatitis C (HCV), and cirrhosis, which significantly increase the risk of developing this malignancy [2]. Timely diagnosis and accurate staging of HCC are crucial to determine the most appropriate therapeutic interventions and to improve patient prognosis. Imaging techniques such as Ultrasonography (USG) and Computed Tomography (CT) are integral to the diagnostic workflow of HCC, offering non-invasive methods for lesion detection and characterization [3,4]. However, the diagnostic performance of these imaging modalities is influenced by a range of clinical factors, particularly the presence of underlying liver diseases. Chronic hepatitis and cirrhosis are two primary risk factors for HCC that have a direct impact on the liver's structure and function, subsequently affecting the imaging characteristics of the tumor. Hepatitis B and C infections lead to chronic inflammation of the liver, causing fibrosis and, over time, progression to cirrhosis, which is a known precursor to HCC [5]. The presence of cirrhosis can make tumor detection more challenging on imaging, as the liver's altered architecture can

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obscure or mimic lesions, especially small tumors. Additionally, cirrhosis can lead to complications such as portal hypertension and hepatomegaly, which may further complicate the interpretation of imaging studies [4,6]. USG is a commonly used tool for initial screening due to its non-invasive nature and accessibility. However, its ability to detect small lesions, particularly in cirrhotic livers, can be limited [7]. In contrast, CT scans, especially with contrast enhancement, provide a more detailed assessment of tumor size, location, and vascular involvement. Biphasic CT scans, which capture arterial and venous phases, are particularly valuable in detecting HCC, as tumors often demonstrate hypervascularity in the arterial phase [8]. The diagnostic accuracy of both USG and CT scans can vary based on the tumor's size, location, and vascular invasion, all of which are influenced by the underlying liver pathology. This study aimed to explore how specific risk factors, such as hepatitis and cirrhosis, influence the diagnostic performance of USG and CT in detecting HCC. By examining these relationships, the study seeks to provide insights into optimizing diagnostic strategies for early and accurate detection of HCC, which is critical for improving patient outcomes, particularly in regions with high incidences of chronic liver disease.

METHODS & MATERIALS

This cross-sectional study was conducted from June 2007 to May 2008 at BIRDEM, BSMMU, and Gastroliver Hospital, Dhaka, with 35 patients (20–85 years) suspected of having hepatocellular carcinoma (HCC). After excluding 5 patients (2 refused biopsy, 2 lacked biopsy results), 30 patients (26 male, 4 female) were included. Clinical assessments included a history of abdominal pain, jaundice, and weight loss, followed by routine investigations. Ultrasound (US) and CT scans were performed to confirm the diagnosis and assess tumor characteristics. The US was done with Siemens Antares or Medisone Sono Ace 8000 (3.5 MHz probes), and CT scans were conducted using a Somatom Emotion Duo (triple-phase protocol). The final HCC diagnosis was confirmed through biopsy and histopathology. Data were analyzed with SPSS, and the sensitivity, accuracy, and predictive values of US and CT were calculated, with a significance level of $p < 0.05$.

Inclusion Criteria:

- Clinically suspected hepatic neoplasm.
- Aged 20–85 years.
- Underwent both US and CT scans of the hepatobiliary system.

Exclusion Criteria:

- Refused biopsy.
- No histopathology results.
- Incomplete clinical or diagnostic data.

RESULTS

Table – I: Demographic and Clinical Features distribution of the study subjects (*n*=30)

Category	No. of Patients	Percentage
Age Group (years)		
< 20	1	3.3
21-30	2	6.7
31-40	9	29.9
41-50	4	13.3
51-60	7	23.3
61-70	6	20
> 70	1	3.3
Mean ± SE	-	50.89 ± 3.07
Range (Min, Max)	-	20-85
Sex		
Male	26	86.7
Female	4	13.3
Clinical Features		
Hepatomegaly	25	83
Upper Abdominal Pain	20	66.7
History of Weight Loss	18	60
Anorexia	17	56.7
Nausea/Vomiting	13	43.3
Jaundice	12	40
Ascitis	9	30

The findings indicate that the majority of patients are between 31-40 years old, with a mean age of 50.89 years. A significant gender disparity is observed, with 86.7% of patients being male. Hepatomegaly is the most common clinical symptom, seen in 83% of patients, followed by upper abdominal pain (66.7%), weight loss (60%), and anorexia (56.7%). Other symptoms such as nausea/vomiting, jaundice, and ascites are less prevalent, affecting 43.3%, 40%, and 30% of patients, respectively.

Table – II: Distribution of patients according to biochemical parameter (*n*=30)

Parameter	No. of patients (n=30)	Percentage
HBS Ag		
Positive	10	33.3
Negative	20	66.7
Alphafeto Protein (AFP)		
Increased	21	70
Normal	9	30

* Normal Range<20 ng/ml
* HCC: 400 ng/ml

The table highlights the presence of HBS Ag and the level of Alphafeto Protein (AFP). Out of 30 patients, 10 (33.3%) were positive for HBS Ag, while 20 (66.7%) were negative. Regarding AFP levels, 21 patients (70%) had increased AFP levels, while 9 patients (30%) had normal levels. The normal range for AFP is less than 20 ng/ml, while hepatocellular

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carcinoma (HCC) is considered when the AFP level is over 400 ng/ml.

Table – III: Assessment of liver size at USG and CT scan (*n*=30)

Liver size	USG		CT		P value
Enlarged	n	%	n	%	0.281^{NS}
Contracted	20	66.7	22	73.3	
Normal	6	20	2	6.7	
Total	30	100	30	100	

*Chi square=2.50, df=2, p=0.281, NS=Not significant
*Not significant (p> 0.05) with the chi-square test

The majority of patients had an enlarged liver, with 20 patients (66.7%) showing this result on USG and 22 patients (73.3%) on CT. In contrast, only 6 patients (20%) showed a normal liver size on USG, while 2 patients (6.7%) had normal liver size on CT. A chi-square test was conducted to determine the statistical significance of the differences between the two methods, yielding a p-value of 0.281, which is not significant, suggesting there was no notable difference between the two diagnostic methods.

Table – IV: Distribution of patients according to the number of lesions detected by USG and CT (*n*=-30)

Diagnosis	Single		Multifocal		Diffuse	
	n	%	n	%	n	%
USG	22	73.3	5	16.7	3	10
CT	15	50	13	43.3	2	6.7

*single Z=1.91, p>0.05 in Z-test
*Multi focal Z=2.35, p>0.005 in Z- test
*Diffuse Z=0.28, p>0.05 in Z-test

According to this table, the number of lesions detected by USG and CT was compared. On USG, 22 patients (73.3%) had a single lesion, 5 patients (16.7%) had multifocal lesions, and 3 patients (10%) had diffuse lesions. For CT, 15 patients (50%) had a single lesion, 13 patients (43.3%) had multifocal lesions, and 2 patients (6.7%) had diffuse lesions. Z-tests showed a significant difference for multifocal lesions (p<0.05).

Table – V: Assessment of size of lesion at USG and CT

Size of lesion	USG		CT		p-value
	n	%	n	%	
<5 cm	0	0	3	10	0.009
5-10 cm	15	50	22	73.3	
>10 cm	15	50	5	16.7	
Total	30	100	30	100	

*Chi square= 9.32, df=2, p=0.009, S=significant
*Significant (p<value) with chi-square text

In this table, the size of lesions was compared between USG and CT. For lesions between 5-10 cm, 22 patients (73.3%) were identified by CT, while 15 patients (50%) were identified by USG. For lesions larger than 10 cm, USG detected 15 patients (50%) while CT detected only 5 (16.7%). The chi-square test revealed a significant difference with a p-value of 0.009 for lesions between 5-10 cm.

Table – VI: Assessment of pre-contract and post-contrast study at CT scan (*n*=30)

Contrast	No. of patients	Percentage
Precontrast		
Isodense	4	13.3
Hyperdence	4	13.3
Hypodense	20	66.7
Mixed density	2	6.7
Post contrast		
Homogenous enhancement	5	16.7
Heterogeneous enhancement	21	70
Rim enhancing	1	3.3
Poorly enhancing	3	10

This table shows that the pre-contrast and post-contrast findings from CT were outlined. Pre-contrast, 20 patients (66.7%) had hypodense lesions, while 4 patients (13.3%) had isodense and hyperdense lesions, and 2 patients (6.7%) had mixed density. Post-contrast, 21 patients (70%) exhibited heterogeneous enhancement, 5 patients (16.7%) had homogeneous enhancement, 1 patient (3.3%) showed rim-enhancing lesions, and 3 patients (10%) had poorly enhancing lesions.

Table – VII: Comparison of USG and CT with Histopathological Correlation for the Diagnosis of Hepatocellular Carcinoma (HCC) (*n*=30)

Diagnosis Method	Histopathology (Positive for HCC)	Histopathology (Negative for HCC)
USG Positive for HCC	22	4
CT Positive for HCC	23	4
USG Negative for HCC	3	1
CT Negative for HCC	2	1

In this table, the comparison of USG and CT with histopathology for the diagnosis of HCC was presented. USG identified 22 positive cases of HCC, with 4 false positives, while CT identified 23 positive cases with 4 false positives. USG missed 3 cases, while CT missed 2.

Table – VIII: Sensitivity, Accuracy, Positive and Negative Predictive Values of USG and CT scan as Diagnostic Modalities in the Evaluation of HCC (*n*=30)

Validity Test	USG	CT Scan
Sensitivity	88%	92%
Specificity	20%	20%
Accuracy	76.7%	80%
Positive Predictive Value	84.6%	85.2%
Negative Predictive Value	25%	33.3%

This table shows that the diagnostic performance of USG and CT was shown. USG had a sensitivity of 88%, specificity of 20%, accuracy of 76.7%, positive predictive value of 84.6%, and negative predictive value of 25%. CT had a sensitivity of

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92%, specificity of 20%, accuracy of 80%, positive predictive value of 85.2%, and negative predictive value of 33.3%.

DISCUSSION

Hepatocellular carcinoma (HCC) remains one of the most common and lethal cancers worldwide. The diagnosis of HCC relies on various imaging modalities, including ultrasonography (USG) and computed tomography (CT), alongside histopathological confirmation [8]. This study aimed to evaluate the impact of risk factors on imaging findings in HCC diagnosis using these imaging techniques. The study involved 30 patients diagnosed with HCC, and the results highlight the importance of imaging in the early detection and monitoring of this malignancy. The demographic data from our study (Table I) revealed that the majority of patients were between the ages of 31 and 40, with a mean age of 50.89 years. This finding is consistent with the literature, which identifies HCC as more common in individuals aged 40 and above (McGlynn et al., 2021) [9]. Additionally, a significant gender disparity was noted, with a predominance of male patients (86.7%). Previous studies have similarly shown that HCC is more prevalent in males, likely due to higher exposure to risk factors such as hepatitis B and C infections, alcohol use, and smoking (Fa et al., 2013) [10]. Clinical features such as hepatomegaly, upper abdominal pain, weight loss, and anorexia were the most commonly observed symptoms, affecting over 50% of patients (Table I). These findings align with the known clinical manifestations of HCC, where hepatomegaly and abdominal pain are frequently reported in patients [11,12]. Although less common, other symptoms like jaundice, ascites, and nausea/vomiting were also noted, indicating more advanced stages of the disease at the time of diagnosis. Biochemical markers, including Hepatitis B surface antigen (HBS Ag) and Alphafeto Protein (AFP), were also assessed (Table II). The majority of patients had elevated AFP levels, with 70% showing an increase above the normal threshold of 20 ng/ml. AFP is a well-established biomarker for HCC and is often used in conjunction with imaging studies for diagnosis [13,14]. The increased AFP levels in our study support its diagnostic utility, although it is worth noting that some patients with normal AFP levels may still have HCC, emphasizing the need for multimodal diagnostic approaches. The evaluation of liver size using USG and CT (Table III) revealed that most patients had enlarged livers, a finding that is consistent with HCC. Interestingly, while USG detected liver enlargement in 66.7% of patients, CT showed a slightly higher percentage of patients with enlarged livers (73.3%). However, statistical analysis showed no significant difference between the two imaging modalities in detecting liver size ($p > 0.05$). This suggests that while both USG and CT are useful in identifying liver enlargement, neither modality is superior in this respect [15]. When examining the number of lesions detected by USG and CT (Table IV), it was found that USG identified more cases of single lesions (73.3%), while CT detected more multifocal lesions (43.3%). Z-tests indicated a significant difference for multifocal lesions ($p < 0.05$), suggesting that CT is more sensitive in detecting multiple lesions compared to USG. This finding is in line with previous studies that have highlighted CT's superior ability to identify multifocal HCC lesions [16]. The assessment of lesion size (Table 5) further revealed that CT detected more lesions in the 5-10 cm range, while USG was more effective in identifying lesions larger than 10 cm. This discrepancy could be due to CT's higher resolution and its ability to assess the full extent of lesions more accurately [17]. CT scans were also evaluated in pre-contrast and post-contrast phases (Table VI). The majority of lesions were hypodense in the pre-contrast phase, with 66.7% of patients showing this pattern. After contrast administration, heterogeneous enhancement was observed in 70% of cases, suggesting that contrast-enhanced CT is an important tool for differentiating HCC lesions from benign conditions, which often exhibit less enhancement [18]. The comparison of USG and CT with histopathological results (Table VII) demonstrated that both modalities performed well, with CT identifying 23 positive cases of HCC and USG detecting 22. Although both methods showed high sensitivity, there were some false positives and negatives. This emphasizes the complementary role of imaging and histopathological assessment in confirming HCC diagnosis. As expected, histopathology remains the gold standard in diagnosing HCC, and imaging techniques should be used as adjuncts for non-invasive screening. Finally, the sensitivity, specificity, accuracy, and predictive values of USG and CT were compared (Table VIII). The sensitivity of CT (92%) was slightly higher than that of USG (88%), indicating that CT is marginally more effective in detecting true positive cases of HCC. However, both imaging modalities had low specificity (20%), highlighting the challenge of differentiating HCC from other liver pathologies based solely on imaging. A similar study showed that while the sensitivity of CT was slightly superior to USG (93% vs. 85%), the specificity for both methods remained relatively low, around 18-22% [19]. The positive predictive value (PPV) for both methods was high, indicating that positive findings on imaging are likely to correspond to true HCC cases. However, the negative predictive value (NPV) was low for both modalities, suggesting that negative results on imaging should be followed by further diagnostic evaluation, including biopsy."

Limitation of the Study

The study was conducted across three hospitals, which may limit the generalizability of the findings to a wider population, and further research with a larger sample size from multiple centers is recommended.

CONCLUSION

This study shows that it is important to consider both the type of imaging used and the patient's risk factors when diagnosing hepatocellular carcinoma (HCC). CT scans are more sensitive and better at detecting multiple lesions, but ultrasound (US) is still a good option for initial screening. Future research should look into combining different imaging methods or adding biomarkers to improve diagnosis. We should also explore new imaging technologies, like MRI and elastography, to see how they can help detect HCC early, especially in areas with limited resources.

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RECOMMENDATION

When selecting an imaging modality for suspected hepatocellular carcinoma (HCC), it is essential to prioritize risk factors such as hepatitis and cirrhosis. These factors significantly affect the diagnostic performance of ultrasound (US) and computed tomography (CT). Future research should aim to improve the specificity of these methods, especially for high-risk patients, to facilitate early detection of HCC. Additionally, the incorporation of advanced imaging technologies like magnetic resonance imaging (MRI) and elastography is crucial for enhancing diagnosis. By integrating biomarkers with imaging techniques, we can improve diagnostic accuracy and strengthen clinical decision-making, providing a more effective strategy for managing HCC.

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