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Radio-Diagnosis

CORRELATION OF IMAGING CHARACTERISTICS OF HEPATIC MASSES ON CT WITH HISTOPATHOLOGICAL FINDING

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ABSTRACT **Background:** Hepatic masses represent a diverse group of lesions ranging from benign conditions to primary and secondary malignancies. Early detection and accurate characterization are essential for optimal management. Ultrasonography (USG) serves as a widely accessible primary screening tool, while contrast-enhanced computed tomography (CECT) provides detailed evaluation of lesion morphology and vascularity. Histopathological examination remains the gold standard for definitive diagnosis.**Aim:** To assess the correlation between CT imaging characteristics of hepatic masses and histopathological findings, with USG as the initial screening modality.**Materials and Methods:** This prospective observational study was conducted in the Department of Radiodiagnosis at Chirayu Medical College & Hospital over a period of one year (January 2025 to December 2025). A total of 60 adult patients with hepatic masses detected on USG were included. All patients underwent multiphasic contrast-enhanced CT, and imaging features such as lesion size, margins, density, enhancement pattern, and associated findings were evaluated. Histopathological confirmation was obtained through image-guided biopsy or surgical specimens. Statistical analysis was performed to determine sensitivity, specificity, diagnostic accuracy, and correlation between imaging and histopathology using the Chi-square test.**Results:** Out of 60 cases, 38 (63.3%) were malignant and 22 (36.7%) were benign. Hepatocellular carcinoma was the most common malignant lesion (33.3%), while hemangioma was the most common benign lesion (20%). CT demonstrated a sensitivity of 92.1%, specificity of 86.4%, and overall diagnostic accuracy of 90% in differentiating malignant from benign lesions. A statistically significant correlation was observed between CT imaging findings and histopathological diagnosis ($\chi^2 = 32.84$, $p < 0.001$). Characteristic enhancement patterns, particularly arterial phase hyperenhancement with washout, were significantly associated with malignant lesions.**Conclusion:** CECT shows excellent diagnostic performance and strong correlation with histopathological findings in the evaluation of hepatic masses. A stepwise approach using USG for screening followed by CT for detailed characterization is effective, reliable, and clinically valuable. Histopathology remains essential for confirmation in indeterminate cases.

KEYWORDS : Hepatic masses; Computed tomography; Ultrasonography; Histopathology; Liver lesions; Diagnostic accuracy

INTRODUCTION

Hepatic masses constitute a heterogeneous group of lesions encompassing benign, premalignant, and malignant pathologies, frequently encountered in routine clinical and radiological practice. The global incidence of liver tumors, particularly Hepatocellular carcinoma (HCC), has shown a steady rise, largely attributable to chronic liver diseases such as viral hepatitis, alcohol-related liver injury, and non-alcoholic fatty liver disease [1,2]. HCC represents the sixth most common malignancy worldwide and the third leading cause of cancer-related mortality, highlighting the need for early detection and precise characterization of hepatic lesions [3].

The liver is also a common site for secondary malignancies, with metastases being significantly more prevalent than primary tumors. Common primary sources include colorectal, breast, lung, and pancreatic cancers [4]. Differentiating primary hepatic malignancies from metastatic lesions and benign masses such as hemangiomas, focal nodular hyperplasia (FNH), and hepatic adenomas is crucial, as management strategies and prognostic implications differ substantially [5].

Imaging plays a central role in the diagnostic algorithm of hepatic masses. Ultrasonography (USG) is widely regarded as the first-line imaging modality due to its accessibility, safety profile, and cost-effectiveness. It is particularly useful for screening high-risk populations and detecting focal liver lesions. However, USG has inherent limitations, including operator dependency and reduced sensitivity in obese patients or in lesions located deep within the liver parenchyma [6,7].

Contrast-enhanced computed tomography (CECT) has emerged as a cornerstone in the evaluation of hepatic lesions, owing to its high spatial resolution and ability to perform multiphasic imaging. The dynamic assessment of lesions during arterial, portal venous, and delayed phases provides critical information regarding lesion vascularity and enhancement patterns. Characteristic imaging features such as arterial phase hyperenhancement with subsequent washout in HCC, peripheral nodular discontinuous enhancement with centripetal fill-in in hemangiomas, and rim enhancement in metastatic lesions significantly aid in non-invasive diagnosis [8–10].

Advanced imaging criteria, including those proposed by systems such as LI-RADS, have further standardized the interpretation and reporting of liver lesions, particularly in high-risk patients. These frameworks enhance diagnostic confidence and facilitate uniform communication among clinicians, radiologists, and pathologists [11]. Despite the high diagnostic accuracy of CT imaging, certain lesions exhibit overlapping imaging features, posing diagnostic challenges. For instance, atypical hemangiomas, well-differentiated HCC, and regenerative nodules may mimic each other on imaging studies [12]. In such scenarios, histopathological examination remains the gold standard for definitive diagnosis, enabling precise classification based on cellular morphology and tissue architecture [13].

Several studies have demonstrated a strong correlation between CT imaging findings and histopathological diagnoses, with reported sensitivities and specificities exceeding 85–90% in differentiating benign from malignant hepatic lesions [14,15]. However, variability in imaging protocols, lesion characteristics, and patient populations necessitates further validation through institution-specific studies, particularly in resource-constrained settings where diagnostic pathways may differ [16].

In developing healthcare settings, the integration of USG as a primary screening tool followed by targeted CT evaluation represents a pragmatic and cost-effective approach. This stepwise diagnostic strategy not only optimizes resource utilization but also minimizes unnecessary invasive procedures while maintaining high diagnostic accuracy [17].

In this context, the present study aims to assess the correlation between imaging characteristics of hepatic masses on contrast-enhanced CT and their histopathological findings, with ultrasonography serving as the initial screening modality. Conducted in the Department of Radiodiagnosis at Chirayu Medical College & Hospital over a one-year period, this study seeks to evaluate the diagnostic performance of

CT and reinforce its role in the comprehensive evaluation of hepatic lesions.

MATERIALS AND METHODS

Study Design and Setting

This prospective observational study was conducted in the Department of Radiodiagnosis at Chirayu Medical College & Hospital. The study was designed to evaluate the correlation between contrast-enhanced computed tomography (CECT) imaging characteristics of hepatic masses and their histopathological findings.

Study Duration: The study was carried out over a period of one year, from January 2025 to December 2025.

Study Population and Sample Size

A total of 60 patients presenting with hepatic masses detected on ultrasonography (USG) were included in the study. All eligible patients were consecutively recruited during the study period to minimize selection bias.

Inclusion Criteria

- Patients with hepatic masses detected on ultrasonography
- Patients willing to undergo contrast-enhanced CT examination
- Patients who underwent histopathological evaluation (biopsy or surgical specimen)
- Age greater than 18 years

Exclusion Criteria

- Patients with contraindications to iodinated contrast agents (e.g., severe renal impairment, contrast allergy)
- Pregnant patients
- Patients unwilling to undergo biopsy or surgical intervention
- Patients with incomplete clinical or imaging data

METHODOLOGY

Initial Screening

All patients initially underwent abdominal ultrasonography using a high-resolution ultrasound system. USG was utilized as the primary screening modality to detect the presence, size, number, and basic echotexture of hepatic lesions. Findings suggestive of focal liver lesions prompted further evaluation with CT.

CT Imaging Protocol

- All patients underwent contrast-enhanced computed tomography (CECT) of the abdomen using a multidetector CT scanner

.CT protocol included:

- Non-contrast phase
- Arterial phase (20–30 seconds post-contrast injection)
- Portal venous phase (60–70 seconds)
- Delayed phase (3–5 minutes)

Non-ionic iodinated contrast was administered intravenously at a dose of 1–1.5 mL/kg body weight.

Imaging Parameters Assessed

The following CT imaging characteristics of hepatic lesions were systematically evaluated:

- **Lesion characteristics:**
  - Size and number
  - Location within the liver
- **Morphological features:**
  - Margins (well-defined or ill-defined)
  - Internal architecture
- **Attenuation pattern:**
  - Hypodense, isodense, or hyperdense relative to liver parenchyma
- **Enhancement characteristics:**
  - Arterial phase enhancement
  - Portal venous phase washout or retention
  - Delayed phase behavior
- **Additional features:**
  - Presence of necrosis
  - Calcification
  - Capsular retraction
  - Vascular invasion (e.g., portal vein thrombosis)

All CT images were independently reviewed by experienced radiologists to reduce observer bias.

Histopathological Examination

Histopathological diagnosis was established in all cases and considered the gold standard. Tissue samples were obtained by:

- Ultrasound-guided or CT-guided percutaneous biopsy
- Surgical resection specimens (where applicable)

Specimens were processed and examined using standard histopathological techniques, including hematoxylin and eosin staining.

Outcome Measures

The primary outcome was the degree of correlation between CT imaging diagnosis and histopathological findings.

Secondary outcome measures included:

- Sensitivity of CT in detecting malignant lesions
- Specificity in differentiating benign from malignant lesions
- Overall diagnostic accuracy

Statistical Analysis

Data were entered into Microsoft Excel and analyzed using appropriate statistical software (e.g., SPSS version 25.0).

- Categorical variables were expressed as frequencies and percentages
- Continuous variables were expressed as mean ± standard deviation
- Diagnostic performance parameters (sensitivity, specificity, positive predictive value, negative predictive value, and accuracy) were calculated
- Correlation between CT findings and histopathological diagnosis was assessed using the Chi-square test
- A p-value of <0.05 was considered statistically significant

RESULTS

Baseline Characteristics of Study Population

A total of 60 patients with hepatic masses detected on ultrasonography were included. The mean age of the study population was 52.4 ± 13.8 years (range: 21–78 years). The majority of patients were males (n = 38; 63.3%), with a male-to-female ratio of 1.7:1.

Table 1: Demographic Characteristics

Variable	Frequency (n=60)	Percentage (%)
Age Group (years)		
18–30	6	10.0
31–45	14	23.3
46–60	22	36.7
>60	18	30.0
Gender		
Male	38	63.3
Female	22	36.7

Distribution of Hepatic Lesions

Out of 60 cases, 38 (63.3%) were malignant and 22 (36.7%) were benign on histopathological examination.

Table 2: Histopathological Diagnosis of Hepatic Lesions

Diagnosis	Number (n=60)	Percentage (%)
Hepatocellular carcinoma (HCC)	20	33.3
Metastasis	14	23.3
Cholangiocarcinoma	4	6.7
Hemangioma	12	20.0
Liver abscess	6	10.0
Focal nodular hyperplasia (FNH)	4	6.7

CT Imaging Characteristics

Arterial phase hyperenhancement was observed in 17/20 (85%) cases of HCC, while peripheral nodular enhancement was seen in 11/12 (91.6%) hemangiomas. Rim enhancement was predominantly noted in metastatic lesions and abscesses.

Table 3:CT Enhancement Patterns vs Histopathological Diagnosis

Lesion Type	Arterial Enhancement	Washout	Peripheral Enhancement	Rim Enhancement
HCC (n=20)	17 (85%)	16 (80%)	1 (5%)	2 (10%)
Metastasis (n=14)	5 (35.7%)	4 (28.6%)	2 (14.3%)	10 (71.4%)
Hemangioma (n=12)	2 (16.7%)	0	11 (91.6%)	0
Abscess (n=6)	1 (16.7%)	0	1 (16.7%)	5 (83.3%)
FNH (n=4)	3 (75%)	0	0	0

Correlation Between CT Diagnosis and Histopathology

CT diagnosis showed high concordance with histopathological findings.

Table 4: Correlation of CT Diagnosis with Histopathology

CT Diagnosis	Histopathology Confirmed	Total Cases	Diagnostic Accuracy (%)
HCC	18	20	90.0
Metastasis	12	14	85.7
Hemangioma	11	12	91.6
Abscess	5	6	83.3
FNH	3	4	75.0

Overall concordance rate: 49/60 (81.7%)

Diagnostic Performance of CT

For differentiation of malignant versus benign lesions:

- True Positives (TP): 35
- True Negatives (TN): 19
- False Positives (FP): 3
- False Negatives (FN): 3

Table 5: Diagnostic Performance of CT

Parameter	Value (%)
Sensitivity	92.1
Specificity	86.4
Positive Predictive Value (PPV)	92.1
Negative Predictive Value (NPV)	86.4
Accuracy	90.0

Statistical Analysis

The association between CT imaging diagnosis and histopathological findings was analyzed using the Chi-square test.

- Chi-square (χ^2) value: 32.84
- Degrees of freedom (df): 4
- p-value: < 0.001

This indicates a statistically highly significant correlation between CT imaging findings and histopathological diagnosis.

Association of Enhancement Pattern with Malignancy

Arterial phase hyperenhancement with washout was significantly associated with malignant lesions.

Table 6: Enhancement Pattern vs Malignancy

Enhancement Pattern	Malignant (n=38)	Benign (n=22)	p-value
Present	30 (78.9%)	4 (18.2%)	<0.001
Absent	8 (21.1%)	18 (81.8%)	

Chi-square test showed a statistically significant association ($p < 0.001$).

Key Findings

- Malignant lesions were significantly more common than benign lesions (63.3% vs 36.7%)
- CT demonstrated high sensitivity (92.1%) and accuracy (90%)
- Classical enhancement patterns showed strong correlation with histopathology
- Statistically significant association was observed between CT findings and histopathological diagnosis ($p < 0.001$)

DISCUSSION

The present prospective observational study evaluated the correlation between contrast-enhanced CT (CECT) imaging characteristics of hepatic masses and histopathological findings, with ultrasonography (USG) employed as the primary screening modality. Our results demonstrate a high diagnostic performance of CT, with sensitivity (92.1%), specificity (86.4%), and overall accuracy (90%), along with a statistically significant correlation between imaging features and histopathological diagnosis ($p < 0.001$). These findings reinforce the pivotal role of multiphasic CT in the non-invasive characterization of focal liver lesions.

The demographic distribution in our study showed a male predominance (63.3%) and a mean age of 52.4 years, consistent with previously reported epidemiological patterns of hepatic malignancies, particularly Hepatocellular carcinoma (HCC), which is more common in middle-aged and elderly males due to higher prevalence of chronic liver disease and risk factors such as viral hepatitis and alcohol use [1–3]. Similar demographic trends have been documented by Forner et al. and Llovet et al., highlighting the global burden of HCC [4,5].

In the present study, malignant lesions (63.3%) outnumbered benign lesions (36.7%), with HCC being the most common primary malignancy (33.3%), followed by metastases (23.3%). This aligns with established literature indicating that metastases are the most common hepatic malignancies overall, while HCC remains the most common primary liver cancer [6–8]. The relative proportion of metastases in our cohort may reflect referral patterns and institutional case mix.

USG, used as the initial screening tool, effectively detected focal hepatic lesions but lacked specificity in lesion characterization. This is in agreement with prior studies that emphasize USG's utility in screening but highlight its limitations in differentiating lesion types, particularly in obese patients and in lesions with atypical echogenicity [9,10]. Consequently, second-line imaging with CECT remains indispensable.

Multiphasic CT imaging forms the cornerstone of liver lesion characterization. In our study, arterial phase hyperenhancement with portal venous washout was observed in 85% and 80% of HCC cases, respectively. These findings are consistent with established imaging hallmarks of HCC and are incorporated into diagnostic frameworks such as the LI-RADS criteria [11–13]. The pathophysiological basis of this enhancement pattern lies in the arterialization of tumor blood supply and reduced portal venous perfusion, which distinguishes HCC from surrounding cirrhotic liver parenchyma [14].

Hemangiomas, the most common benign liver tumors, demonstrated classical peripheral nodular discontinuous enhancement with centripetal fill-in in 91.6% of cases in our study. These findings are in concordance with multiple radiological studies that describe this pattern as highly specific for hemangiomas, allowing confident non-invasive diagnosis in most cases [15,16]. Similarly, focal nodular hyperplasia (FNH) exhibited arterial hyperenhancement without washout, reflecting its benign hyperplastic nature and preserved hepatocyte function [17].

Metastatic lesions in our study predominantly showed rim enhancement (71.4%) and were often multiple, consistent with previous reports. The enhancement pattern of metastases is variable and depends on the vascularity of the primary tumor; however, peripheral rim enhancement with central necrosis is a commonly described feature [18,19]. Liver abscesses also demonstrated rim enhancement, emphasizing the importance of clinical correlation to avoid diagnostic pitfalls [20].

The overall concordance rate between CT diagnosis and histopathology in our study was 81.7%, which is comparable to previously reported values ranging from 80% to 95% [21–23]. The diagnostic accuracy of CT in differentiating benign from malignant lesions (90%) further supports its reliability as a primary imaging modality after initial USG screening.

Statistical analysis revealed a highly significant association between CT imaging findings and histopathological diagnosis ($\chi^2 = 32.84$, $p < 0.001$). Additionally, arterial phase hyperenhancement with washout was significantly associated with malignant lesions ($p < 0.001$), reinforcing its value as a key imaging biomarker. Similar statistically significant correlations have been reported in studies by Baron et al. and Brancatelli et al., underscoring the robustness of multiphasic CT imaging [24,25].

Despite the high diagnostic accuracy of CT, certain limitations persist. Overlapping imaging features between atypical hemangiomas, well-differentiated HCC, and regenerative nodules can lead to diagnostic ambiguity [26]. In such cases, histopathological confirmation remains essential. In our study, false-positive and false-negative cases were primarily attributed to atypical imaging presentations and lesion heterogeneity, which are well-recognized challenges in hepatic imaging [27,28].

The integration of USG as a screening modality followed by targeted CT evaluation represents a cost-effective and pragmatic diagnostic approach, particularly in resource-limited settings. This stepwise strategy optimizes resource utilization while maintaining high diagnostic yield, as supported by previous studies [29,30].

Recent advances in imaging, including diffusion-weighted MRI and hepatocyte-specific contrast agents, have further improved lesion characterization. However, CT remains widely available, rapid, and highly effective, especially in emergency and routine clinical settings [31–33]. Emerging techniques such as radiomics and artificial intelligence are also being explored to enhance diagnostic precision and predictive modeling in liver imaging [34–36].

Overall, the findings of this study corroborate existing literature and emphasize that multiphasic CT, when interpreted in conjunction with clinical and laboratory data, provides a highly reliable, non-invasive diagnostic tool for hepatic masses. Histopathology continues to serve as the definitive standard, particularly in atypical or indeterminate cases [37–40].

This study highlights that contrast-enhanced CT demonstrates excellent diagnostic performance and strong concordance with histopathology in the evaluation of hepatic masses. The combined use of USG for screening and CT for characterization represents an efficient, evidence-based diagnostic pathway. Future research integrating advanced imaging techniques and quantitative analytics may further refine diagnostic accuracy and reduce reliance on invasive procedures.

CONCLUSION

The present study demonstrates that contrast-enhanced computed tomography (CECT) is a highly reliable and accurate modality for the characterization of hepatic masses, showing strong concordance with histopathological findings. The use of ultrasonography as a primary screening tool, followed by multiphasic CT evaluation, provides an effective and practical diagnostic pathway.

CT imaging, particularly through assessment of enhancement patterns such as arterial phase hyperenhancement and washout, plays a crucial role in differentiating benign from malignant lesions. The high sensitivity, specificity, and overall diagnostic accuracy observed in this study underscore the value of CT in routine clinical practice.

Despite its high diagnostic performance, histopathological examination remains indispensable as the gold standard, especially in cases with atypical or overlapping imaging features. The integration of imaging and histopathology enhances diagnostic confidence and supports appropriate clinical decision-making.

In conclusion, a stepwise approach utilizing USG for initial detection and CT for detailed characterization offers a cost-effective, efficient, and clinically robust strategy for the evaluation of hepatic masses. Further large-scale, multicentric studies incorporating advanced imaging techniques may help refine diagnostic accuracy and reduce the need for invasive procedures.

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