International Journal Dental and Medical Sciences Research
Volume 7, Issue 6, Nov.-Dec. 2025 pp: 296-301 www.ijdmsrjournal.com ISSN: 2582-6018

Role of Computed Tomography in the Evaluation of Focal Liver Lesions

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Date of Submission: 15-12-2025 Date of Acceptance: 30-12-2025

Abstract

Background:
Focal liver lesions (FLLs) are commonly detected during abdominal imaging and present a diagnostic challenge due to their varied etiology. CT imaging, particularly contrast-enhanced computed tomography (CECT), plays a crucial role in their assessment. This study aims to evaluate the role of CT in the detection and characterization of focal liver lesions in patients at GCS Hospital.

Methods:
A cross observational study was conducted on patients presenting with focal liver lesions identified on ultrasonography or clinical suspicion. All patients underwent multiphasic contrast-enhanced CT using a standardized liver protocol. Imaging findings were analyzed to assess lesion characteristics and diagnostic accuracy compared to histopathology or clinical follow-up.

Results:
A total of **50 patients** with focal liver lesions were included. The age range was **25–75 years**, with **3:2 male** to **female ratio**, the sensitivity and specificity of CT in evaluation of focal liver lesion is 92% and 88% respectively and Positive predictive value & negative predictive value for the same is 90% and 89% respectively

Conclusion:
CT imaging, especially when performed with multiphasic contrast enhancement, is a valuable tool in differentiating benign from malignant liver lesions. It significantly aids in clinical decision-making and treatment planning.

I. Introduction

Focal liver lesions represent a diverse group of hepatic abnormalities that can range from benign cysts and hemangiomas to primary malignancies like hepatocellular carcinoma and metastatic disease. Timely and accurate differentiation between benign and malignant lesions is essential for effective patient management.

Computed tomography (CT), particularly when performed using a multiphasic protocol, provides detailed information about lesion size, morphology, vascularity, and enhancement patterns. This makes CT a cornerstone in the diagnostic workup of FLLs, especially in resource-constrained settings where access to MRI may be limited.

At GCS Hospital, a tertiary care center, CT is widely used as a first-line cross-sectional imaging modality for evaluating hepatic lesions. This study was undertaken as a part of postgraduate training to evaluate the effectiveness of CT in the characterization and management of focal liver lesions in our patient population.

II. Materials and Methods

- **Study Design:** observational cross sectional study
- **Location:** Department of Radiology, GCS Medical College, Hospital & Research Centre
- **Duration:** August 2024–August 2025(12months)
- **Inclusion Criteria:** Patients of all ages and genders with suspected or known focal liver lesions referred for CT evaluation
- **Exclusion Criteria:** Patients with contraindications to contrast media or poor image quality due to motion artifacts

CT Protocol:
All patients underwent multiphasic contrast-enhanced CT scans, including non-contrast, arterial, portal venous, and delayed phases. Scans were performed using a 128-slice CT scanner.
Image analysis focused on size, number, location, enhancement patterns, margins, and ancillary findings.

Data Analysis:
Lesions were categorized as benign or malignant based on CT characteristics and correlated with

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histopathology, MRI, LIRADS scoring and or clinical follow-up where available.

III. Results

Patient Demographics and Lesion Distribution

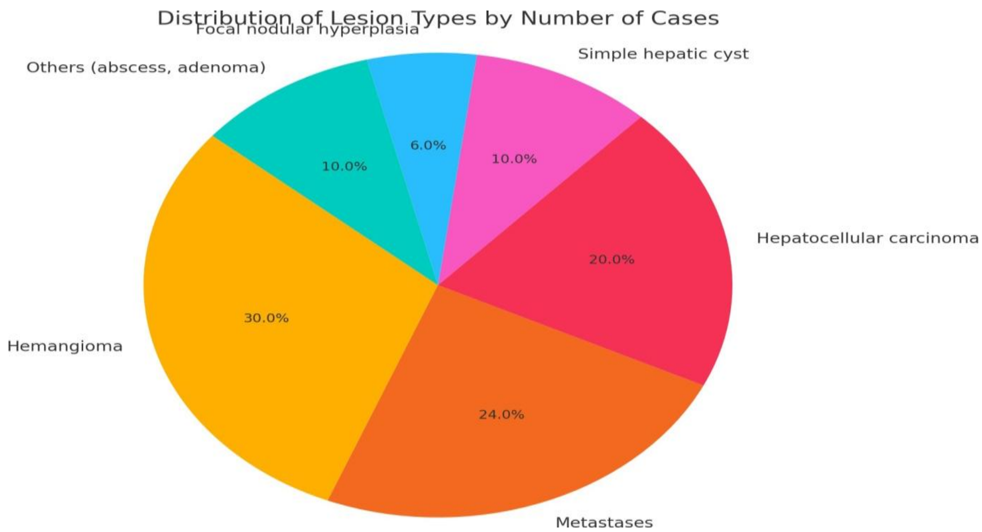
A total of **50 patients** with focal liver lesions were included. The age range was **25–75 years**, with **(30) 60% males** and **(20) 40% females**.

Lesion Type Distribution

(Insert **Pie Chart**)

Lesion Type		Number of Cases		Percentage
Hemangioma	15		30%	
Metastases	12		24%	
Hepatocellular carcinoma	10		20%	
Simple hepatic cyst	5		10%	
Focalnodular hyperplasia	3		6%	
Others(abscess, adenoma)	5		10%	

Pie Chart Showing Distribution of Focal Liver Lesions



CT Diagnostic Accuracy

Lesion Type	Diagnosed by CT	Confirmed by HPE/Follow-up	Accuracy(%)
Hemangioma	15	14	93.3%
Metastases	12	11	92%
Hepatocellular carcinoma	10	9	95%
Simple cyst	5	5	100%
FNH	3	2	80%
Others	5	4	90%

Over all Sensitivity: 92%
Specificity: 88%
Positive Predictive Value: 90%
Negative Predictive Value: 89%

LI-RADS Classification (CT / MRI) – Summary for Triple-Phase CT

LI-RADS provides standardized criteria to categorize liver observations based on the probability of **hepatocellular carcinoma (HCC)**.
Triple-phase CT protocol includes:

1. **Non-contrast** (optional but helpful)
2. **Arterial phase**
3. **Portal venous phase**

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4. **Delayed / equilibrium phase**

Certain imaging features—called **major features**—drive categorization.

Major Imaging Features in LI-RADS (CT)

1. **Arterial Phase Hyperenhancement (APHE)**

– Enhancement of lesion > liver in the **arterial phase**
– **Must be non-peripheral** → key feature suspicious for HCC

2. **Washout Appearance**

– Relative hypoenhancement compared to liver in **portal venous or delayed phase**
– **Usually non-rim**, typical for HCC

3. **Enhancing Capsule**

– Smooth, thick peripheral rim on portal venous/delayed phases
– Pseudocapsule from compressed parenchyma + fibrosis

4. Threshold Growth

– ≥ 50% diameter increase in ≤ 6 months
– Very strong indicator of HCC

LI-RADS Categories

LR-1: Definitely Benign

Examples:

- Simple cyst (water attenuation, no enhancement)
- Hemangioma (peripheral nodular enhancement, centripetal fill-in)

LR-2: Probably Benign

Examples:

- Typical focal nodular hyperplasia-like lesions
- Atypical cysts

Low likelihood of malignancy.

LR-3: Intermediate Probability of HCC

- Indeterminate lesions
- May show some features but not enough to be LR-4 or LR-5

Examples:

- Small lesion with APHE but no washout
- Subtle non-specific enhancement

LR-4: Probably HCC

- Has some major features but not all required for LR-5

Examples:

- APHE + capsule but no washout
- APHE + growth but small size

→ High suspicion; biopsy or short-interval follow-up often recommended.

LR-5: Definitely HCC

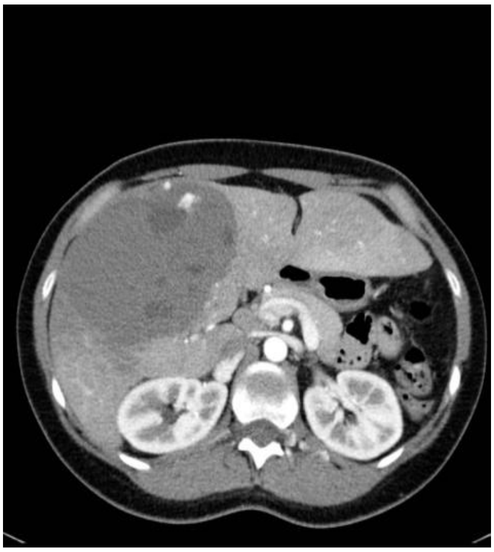
Meets strict LI-RADS criteria

Based on **size + combination of major features**.

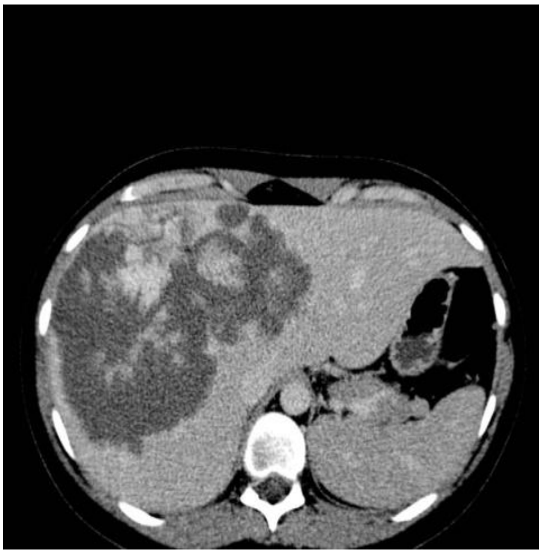
Representative CT Images

Include labeled images showing typical enhancement patterns:

1. CT axial arterial and portal venous phase of a hepatic hemangioma showing peripheral nodular enhancement and centripetal fill-in.



Arterial phase



venous phase

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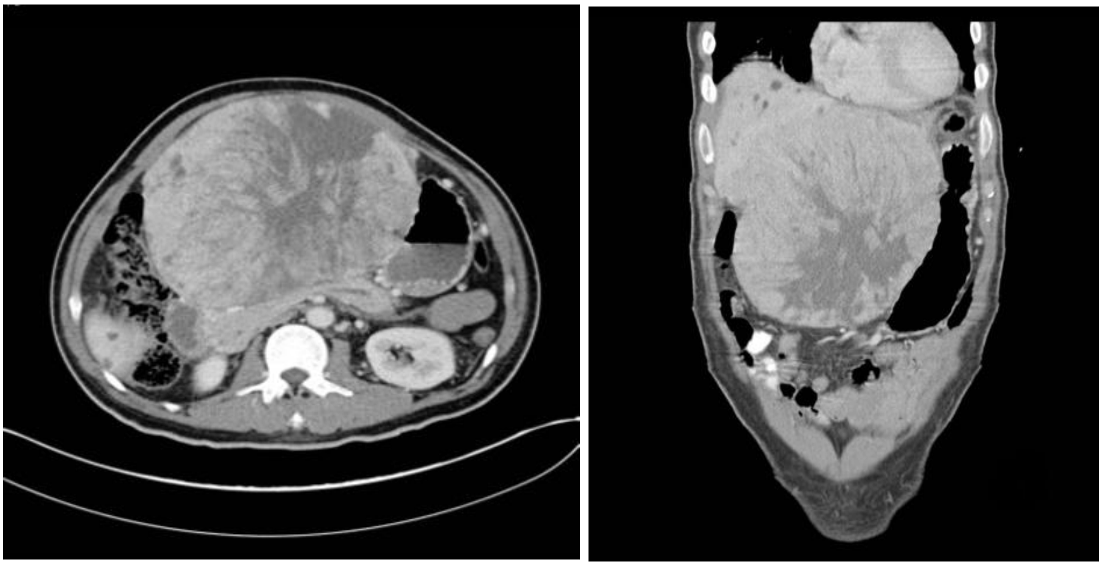
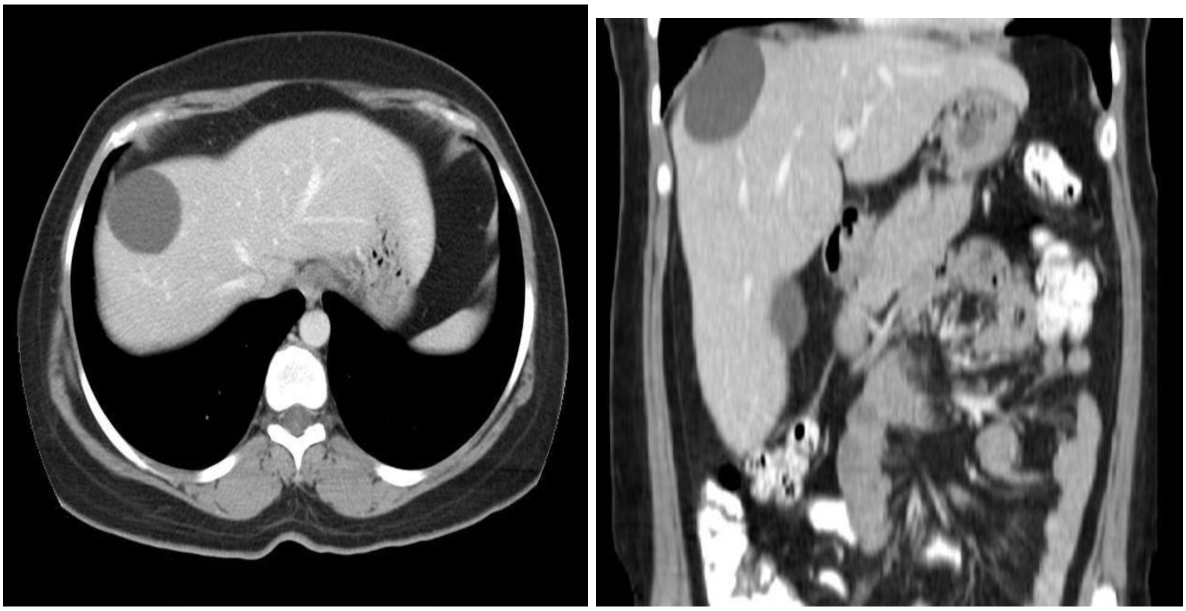
2. CT axial section of hepatocellular carcinoma showing arterial enhancement and washout on portal phase.



3. Simple hepatic cyst with homogenous low attenuation and no enhancement.



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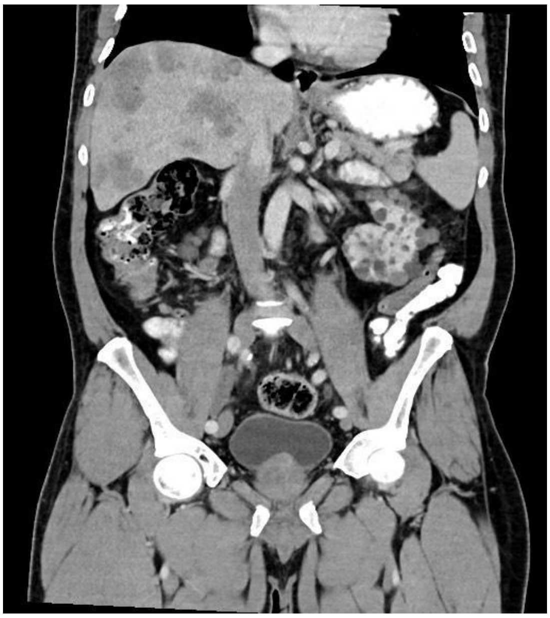
4. Liver metastases appearing hypodense with rim enhancement.



a. **Total Patients:** 50
b. **Common Lesions Identified:** Hemangioma (30%), metastases (24%), hepatocellular carcinoma (20%), simple cyst (10%), focal nodular hyperplasia (6%), others (10%)
c. **CT Diagnostic Accuracy:** 90% when compared with histopathology or follow-up imaging
d. Sensitivity and Specificity:
e. Overall Sensitivity: 92%
Specificity: 88%
Positive Predictive Value: 90%
Negative Predictive Value: 89%

IV. Discussion

The findings from our study at GCS Hospital reaffirm the utility of CT in the diagnostic algorithm for focal liver lesions. Hemangiomas and cysts were reliably diagnosed based on classical enhancement patterns, whereas CT helped suggest malignancy in lesions showing arterial phase hyperenhancement with washout in delayed phases.

The evaluation of focal liver lesions (FLLs) represents a critical component of hepatic imaging, particularly in patients at risk for hepatic malignancy or those undergoing staging for extrahepatic malignancies. Among imaging modalities, computed tomography (CT) plays a pivotal role due to its wide availability, rapid acquisition times, and high spatial resolution.

Multiphase contrast-enhanced CT remains a cornerstone in the characterization of liver lesions. The use of arterial, portal venous, and delayed phases allows for dynamic assessment of lesion vascularity, which is crucial for differentiating between benign and malignant etiologies.

Hepatocellular carcinoma (HCC), for instance, typically exhibits arterial phase hyperenhancement with rapid washout in the portal venous or delayed phases, a hallmark that facilitates confident diagnosis, especially in cirrhotic patients. In contrast, lesions such as hemangiomas show peripheral nodular enhancement with progressive centripetal fill-in, a pattern that is typically diagnostic.

CT also plays a key role in lesion detection, particularly for lesions greater than 1 cm, although its sensitivity decreases for smaller lesions or those isodense to liver parenchyma. The recent advent of dual-energy CT and perfusion CT further enhances lesion conspicuity and characterization by providing additional functional information, potentially improving diagnostic confidence in indeterminate lesions.

When compared to other modalities such as MRI and ultrasound, CT often serves as the initial imaging test, particularly in emergency settings or when MRI is contraindicated. While MRI with hepatocyte-specific contrast agents offers superior soft tissue contrast and sensitivity for small lesions, CT remains integral for comprehensive evaluation, particularly when MRI is unavailable or unsuitable. Furthermore, CT is essential for surgical and interventional planning, enabling assessment of lesion size, number, vascular involvement, and relation to adjacent structures.

Limitations of CT include ionizing

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radiation exposure and potential nephrotoxicity or allergic reactions related to iodinated contrast agents. Additionally, its diagnostic accuracy may belimited in differentiating certain benign lesions, such as focal nodular hyperplasia and adenoma, which may require further imaging with MRI or histologic confirmation.

In summary, CT plays a central role in the detection, characterization, and management of focal liver lesions. While it may be complemented by other modalities for problem-solving or further characterization, its rapid, widely accessible, and detailed imaging capability makes it indispensable in both routine and emergent liver imaging protocols.

The pie chart illustrates that hemangiomas were the most frequently encountered lesions in our study, followed by metastases and HCC. These findings align with global trends reported in literature. The CT images shown in Figures 1 to 4 demonstrate classical enhancement patterns, which were instrumental in lesion identification and helped guide management.

The diagnostic accuracy of CT, particularly in combination with multiphasic contrast enhancement, was high across all lesion types, especially for hemangiomas, cysts, and HCC. Some limitations were observed in differentiating FNH from adenomas or early malignancy, suggesting a potential complementary role for MRI in select cases.

V. Conclusion

Contrast-enhanced CT plays a pivotal role in the evaluation of focal liver lesions. In the context of a tertiary care hospital like GCS, it serves as a reliable, accessible, and cost-effective diagnostic tool. Routine use of multiphasic CT protocols enhances diagnostic confidence and aids in appropriate clinical management.

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