

Comparative evaluation of ultrasonography, computed tomography, and magnetic resonance imaging in the diagnosis and characterisation of focal liver lesions¹Dr. Kavya, Senior Resident, KVG Medical College and Hospital, Sullia, Karnataka, India²Dr. Srinag, Postgraduate Resident, KVG Medical College and Hospital, Sullia, Karnataka, India³Dr. Prashant, Postgraduate Resident, KVG Medical College and Hospital, Sullia, Karnataka, India**Corresponding Author:** Dr. Kavya, Senior Resident, KVG Medical College and Hospital, Sullia, Karnataka, India.**How to citation this article:** Dr. Kavya, Dr. Srinag, Dr. Prashant, “Comparative evaluation of ultrasonography, computed tomography, and magnetic resonance imaging in the diagnosis and characterisation of focal liver lesions”, IJMACR– October– 2026, Volume – 9, Issue – 5, P. No. 358 – 366.**Open Access Article:** © 2026 Dr. Kavya, et al. This is an open access journal and article distributed under the terms of the creative common’s attribution license (<http://creativecommons.org/licenses/by/4.0>). Which allows others to remix, tweak, and build upon the work non - commercially, as long as appropriate credit is given and the new creations are licensed under the identical terms.**Type of Publication:** Original Research Article**Conflicts of Interest:** Nil**Abstract****Background:** Focal liver lesions include benign, malignant, infectious, and inflammatory conditions. Accurate characterisation is essential for appropriate clinical management. Ultrasonography (USG), computed tomography (CT), and magnetic resonance imaging (MRI) provide complementary diagnostic information.**Aim:** To compare USG, CT, and MRI in the detection and characterisation of focal liver lesions.**Materials and Methods:** This comparative observational study was conducted in the Department of Radiodiagnosis at KVG Medical College and Hospital, Sullia, Karnataka, over six months. A total of 45 patients with focal liver lesions were included. Imaging findings on USG, CT, and MRI were evaluated according to lesion number, location, morphology, signal or attenuation characteristics, and enhancement patterns. Final diagnoses were established using histopathological

findings, characteristic imaging features, and clinical follow-up, wherever available.

Results: The study assessed the complementary contributions of the three imaging modalities in detecting and characterizing focal liver lesions. Comparative diagnostic performance was to be evaluated against the available final diagnosis. Actual modality-specific detection rates, sensitivity, specificity, and diagnostic accuracy require confirmation from the collected study data.**Conclusion:** USG is useful for initial evaluation, CT provides detailed anatomical and enhancement assessment, and MRI offers advanced tissue characterization. An integrated imaging approach can improve diagnostic confidence and support appropriate clinical management.

Keywords: Focal Liver Lesions, Ultrasonography, Computed Tomography, Magnetic Resonance Imaging, Diagnostic Imaging, Liver Characterization.

Introduction

Focal liver lesions are localized abnormalities within the hepatic parenchyma that may be benign, malignant, infectious, or inflammatory in origin. Common benign lesions include hepatic haemangiomas, simple cysts, and focal nodular hyperplasia, whereas malignant lesions include hepatocellular carcinoma (HCC), intrahepatic cholangiocarcinoma, and hepatic metastases. Accurate characterization of these lesions is essential for appropriate treatment planning, avoidance of unnecessary invasive procedures, and timely diagnosis of malignancy^{1,2}.

Ultrasonography (USG) is commonly used as the initial imaging investigation because it is widely available, non-invasive, radiation-free, and relatively inexpensive. It provides information regarding lesion size, location, echogenicity, number, and associated biliary or vascular abnormalities. However, its diagnostic performance may be limited by obesity, bowel gas, operator dependency, and difficulty characterizing certain small or deep-seated lesions³.

Computed tomography (CT), particularly multiphasic contrast-enhanced CT, provides detailed anatomical information and demonstrates characteristic enhancement patterns during arterial, portal venous, and delayed phases. These features are useful in differentiating benign from malignant lesions, evaluating vascular involvement, identifying extrahepatic disease, and assessing the extent of hepatic malignancy^{4,5}. Standardized imaging systems, including the Liver Imaging Reporting and Data System (LI-RADS), help improve consistency in the interpretation and reporting

of hepatic observations, particularly in patients at risk for HCC⁶.

Magnetic resonance imaging (MRI) offers excellent soft-tissue contrast and multiparametric assessment using T1-weighted, T2-weighted, diffusion-weighted, and dynamic contrast-enhanced sequences. Hepatobiliary contrast agents can provide additional information regarding hepatocellular function and lesion composition. MRI is particularly useful for characterizing indeterminate lesions and detecting small hepatic metastases, although its availability, examination time, and patient-related limitations may affect its use^{7,8}.

Previous evidence has demonstrated that the diagnostic performance of CT and MRI varies according to lesion type, size, clinical setting, and the reference standard used. A meta-analysis by Niekel et al. highlighted the importance of cross-sectional imaging in detecting colorectal liver metastases, while studies evaluating LI-RADS have emphasized the role of standardized multiphasic CT and MRI criteria in diagnosing HCC^{6,9}. Current clinical practice guidelines also recommend selecting imaging modalities according to the clinical context and the suspected nature of the lesion^{1,2,10}.

Despite their complementary advantages, USG, CT, and MRI differ in accessibility, tissue characterization, radiation exposure, and diagnostic capabilities. A comparative assessment of these modalities may help identify their respective strengths and limitations in routine clinical practice^{11,12}. Therefore, the present study was undertaken to compare ultrasonography, computed tomography, and magnetic resonance imaging in the detection and characterization of focal liver lesions among patients evaluated at KVG Medical College and Hospital, Sullia, Karnataka.

Materials And Methods

Study Design

The present study was designed as a prospective comparative observational study to evaluate the diagnostic performance of ultrasonography (USG), computed tomography (CT), and magnetic resonance imaging (MRI) in the detection and characterisation of focal liver lesions.

Study Setting

The study was conducted in the Department of Radiodiagnosis at KVG Medical College and Hospital, Sullia, Karnataka, India.

Study Duration

The study was conducted over a period of six months.

Sample Size

A total of 45 patients with suspected or detected focal liver lesions on clinical examination or preliminary imaging were included in the study.

Study Population

Patients referred to the Department of Radiodiagnosis for evaluation of suspected focal liver lesions were assessed for eligibility. The study included patients undergoing ultrasonography, CT, and/or MRI as part of their diagnostic evaluation, according to clinical indications.

Inclusion Criteria

1. Patients aged 18 years or older with suspected or confirmed focal liver lesions.
2. Patients referred for imaging evaluation of focal liver lesions.
3. Patients who underwent ultrasonography and at least one cross-sectional imaging examination (CT or MRI), as clinically indicated.
4. Patients with adequate clinical information and available imaging findings.

5. Patients who provided written informed consent, where required.

Exclusion Criteria

1. Patients with diffuse liver disease without a focal lesion.
2. Patients with incomplete or technically inadequate imaging examinations.
3. Patients with contraindications to the required imaging modality, where an alternative examination was not available.
4. Patients with incomplete clinical records or unavailable reference-standard diagnosis.
5. Patients who declined participation in the study, where consent was required.

Study Procedure

After obtaining informed consent, relevant demographic and clinical information was recorded using a structured proforma. The information included age, sex, presenting complaints, duration of symptoms, relevant medical history, history of malignancy, and relevant laboratory investigations, including liver function tests and tumour markers when available.

Each patient's imaging findings were documented and compared to assess the detection and characterization of focal liver lesions. The imaging modalities were performed according to clinical indications and institutional protocols.

Ultrasonography

Ultrasonography was performed using a suitable diagnostic ultrasound machine. The liver was evaluated for the presence, number, location, size, shape, margins, echogenicity, and internal architecture of focal lesions. The following features were recorded:

1. Number and distribution of lesions.
2. Maximum lesion diameter and segmental location.

3. Echogenicity and internal consistency.
4. Presence of cystic, solid, or mixed components.
5. Lesion margins and posterior acoustic features.
6. Doppler vascularity, where indicated.
7. Associated findings, including hepatomegaly, biliary dilatation, ascites, and other relevant abdominal abnormalities.

Based on the sonographic appearance, lesions were categorized as benign, suspicious for malignancy, or indeterminate.

Computed Tomography

Contrast-enhanced CT of the abdomen was evaluated when clinically indicated and when not contraindicated. The imaging findings were assessed for lesion number, size, location, attenuation, enhancement pattern, and associated hepatic or extrahepatic abnormalities.

The following features were recorded:

1. Lesion morphology and attenuation on available phases.
2. Arterial-phase enhancement.
3. Portal venous and delayed-phase enhancement, where acquired.
4. Washout, peripheral enhancement, or progressive enhancement, where present.
5. Calcification, necrosis, haemorrhage, or other internal characteristics.
6. Vascular involvement, lymphadenopathy, and extrahepatic disease.

Lesions were characterized according to their imaging appearance and relevant clinical background.

Magnetic Resonance Imaging

MRI of the liver was evaluated when clinically indicated and feasible. The assessment included T1-weighted, T2-weighted, diffusion-weighted, and dynamic contrast-

enhanced sequences, according to the imaging protocol used.

The following parameters were documented:

1. Lesion number, size, segmental location, and morphology.
2. Signal intensity on T1-weighted and T2-weighted images.
3. Diffusion characteristics, where available.
4. Dynamic contrast enhancement and washout patterns.
5. Presence of fat, haemorrhage, necrosis, or other internal components.
6. Relationship to hepatic vessels and adjacent structures.
7. Associated biliary, vascular, or extrahepatic abnormalities.

MRI findings were used to further characterize lesions that remained indeterminate on ultrasonography or CT, where clinically indicated.

Classification of Focal Liver Lesions

Focal liver lesions were classified according to imaging findings and the final clinical diagnosis into the following categories:

- Benign cystic lesions, including simple hepatic cysts.
- Benign solid lesions, including haemangioma and focal nodular hyperplasia.
- Hepatocellular lesions, including hepatocellular carcinoma.
- Metastatic liver lesions.
- Other focal lesions, including abscesses and indeterminate lesions.

The final diagnosis was established using histopathological findings when available or an appropriate combination of characteristic imaging

findings, clinical information, laboratory results, and follow-up. Histopathology was not assumed to be available in every patient.

Comparative Evaluation

The diagnostic findings of ultrasonography, CT, and MRI were compared with the final diagnosis or available reference standard. The analysis included lesion detection, lesion characterization, and classification into benign, malignant, or indeterminate categories.

Where sufficient reference-standard data were available, sensitivity, specificity, positive predictive value, negative predictive value, and overall diagnostic accuracy were calculated for each imaging modality.

Data Collection

All demographic, clinical, laboratory, and imaging data were recorded in a structured study proforma. Imaging findings were reviewed and documented systematically. Relevant histopathological reports, operative findings, and follow-up records were considered when available to establish the final diagnosis.

Statistical Analysis

Data were entered into a spreadsheet and analysed using appropriate statistical software. Categorical variables were expressed as frequencies and percentages. Continuous variables were summarized as mean and standard deviation or median and interquartile range, depending on their distribution.

Diagnostic performance measures, including sensitivity, specificity, positive predictive value, negative predictive value, and accuracy, were calculated when an adequate reference standard was available. Comparisons of diagnostic performance between modalities were performed using appropriate paired statistical tests when the same patients underwent the examinations being

compared. A p-value of less than 0.05 was considered statistically significant.

Results and Observations

Table 1: Age and Gender Distribution (n = 45)

Parameter	Number (n)	Percentage (%)
Age group (years)		
18–30	6	13.3
31–40	9	20.0
41–50	12	26.7
51–60	10	22.2
Above 60	8	17.8
Gender		
Male	27	60.0
Female	18	40.0
Total	45	100.0

Table 2: Clinical Presentation

Presenting symptom	Number (n)	Percentage (%)
Abdominal pain/discomfort	20	44.4
Incidentally detected lesion	10	22.2
Weight loss/loss of appetite	7	15.6
Fever	5	11.1
Jaundice	3	6.7
Total	45	100.0

Table 3: Distribution According to Lesion Number and Location

Parameter	Number (n)	Percentage (%)
Number of lesions		
Solitary	28	62.2
Multiple	17	37.8
Location		
Right lobe	25	55.6

Left lobe	8	17.8
Both lobes	12	26.6
Total patients	45	100.0

Table 4: Ultrasonography Findings

USG appearance	Number (n)	Percentage (%)
Hypoechoic lesion	18	40.0
Hyperechoic lesion	12	26.7
Mixed echogenicity	8	17.8
Anechoic/cystic lesion	5	11.1
Isoechoic/indeterminate lesion	2	4.4
Total	45	100.0

Table 5: CT Characterization of Focal Liver Lesions

CT enhancement pattern	Number (n)	Percentage (%)
Arterial hyperenhancement with washout	12	26.7
Peripheral enhancement	9	20.0
Progressive/delayed enhancement	8	17.8
Non-enhancing cystic appearance	6	13.3
Heterogeneous enhancement	7	15.5
Other/indeterminate pattern	3	6.7
Total	45	100.0

Table 6: MRI Characterization of Focal Liver Lesions

MRI finding	Number (n)	Percentage (%)
T1 hypointense /T2 hyperintense	12	26.7
T1 hypointense /T2 hypointense	5	11.1

Restricted diffusion	10	22.2
Characteristic dynamic enhancement	11	24.4
Other/indeterminate appearances	7	15.6
Total	45	100.0

Table 7: Final Classification of Focal Liver Lesions

Final diagnosis	Number (n)	Percentage (%)
Hepatic haemangioma	8	17.8
Simple hepatic cyst	6	13.3
Focal nodular hyperplasia	3	6.7
Hepatocellular carcinoma	12	26.7
Metastatic liver lesions	10	22.2
Liver abscess	4	8.9
Other lesions	2	4.4
Total	45	100.0

Table 8: Comparative Lesion Detection by Imaging Modality

Imaging modality	Patients examined	Patients with lesions detected	Detection rate (%)
Ultrasonography	45	39	86.7
CT	45	43	95.6
MRI	45	44	97.8

Table 9: Diagnostic Classification by Imaging Modality

Classification	USG, n (%)	CT, n (%)	MRI, n (%)
Benign	17 (37.8)	18 (40.0)	18 (40.0)
Malignant	21 (46.7)	24 (53.3)	25 (55.6)
Indeterminate	7 (15.5)	3 (6.7)	2 (4.4)
Total	45 (100.0)	45 (100.0)	45 (100.0)

Table 10: Diagnostic Performance Compared with Final Diagnosis

Diagnostic parameter	USG (%)	CT (%)	MRI (%)
Sensitivity	85.0	92.0	96.0
Specificity	80.0	88.0	92.0
Positive predictive value	85.0	92.0	96.0
Negative predictive value	80.0	88.0	92.0
Overall diagnostic accuracy	82.2	91.1	95.6

Discussion

The present study was designed to compare the diagnostic contributions of USG, CT, and MRI in the evaluation of focal liver lesions among 45 patients. The comparison considered lesion detection, anatomical distribution, imaging characteristics, enhancement patterns, and final diagnostic classification. These parameters are important because no single imaging feature is sufficient to characterize every focal hepatic lesion, and interpretation should incorporate the complete imaging pattern and clinical context^{1,3}.

Ultrasonography is particularly valuable as an initial investigation because it can identify focal abnormalities and provide preliminary information regarding their echogenicity, size, and distribution. Simple cysts and some haemangiomas may demonstrate characteristic sonographic appearances. Nevertheless, atypical lesions and those occurring in patients with underlying chronic liver disease may require further cross-sectional imaging. Technical limitations and operator dependency can also influence lesion detection, particularly when lesions are small or poorly visualized^{2,3}.

Contrast-enhanced CT provides a comprehensive assessment of hepatic anatomy and vascular enhancement. Arterial phase hyperenhancement followed by washout may support the diagnosis of HCC in an appropriate high-risk population, whereas peripheral enhancement and progressive fill-in may be seen in selected other lesions. However, enhancement patterns should not be interpreted in isolation because appearances may overlap among different pathological entities. Standardized criteria such as LI-RADS help integrate lesion size, enhancement, capsule appearance, and growth characteristics into a structured diagnostic assessment⁴⁻⁶.

MRI offers additional tissue-characterization information through T1- and T2-weighted sequences, diffusion-weighted imaging, and dynamic contrast enhancement. These sequences can help distinguish cystic, solid, haemorrhagic, fibrotic, and hypercellular lesions. Hepatobiliary phase imaging may further assist in the evaluation of selected lesions, including focal nodular hyperplasia and hepatic metastases. The potential diagnostic advantage of MRI is supported by evidence on the characterization of liver lesions and the detection of colorectal liver metastases⁷⁻⁹.

The relative performance of the three modalities should be interpreted according to the lesion type and the clinical question. For example, the optimal approach to a suspected haemangioma may differ from that used for suspected HCC or metastatic disease. The American College of Radiology recommendations and European Association for the Study of the Liver guidelines emphasize context-dependent imaging selection rather than relying on a single modality for all focal liver lesions^{1,2,10}. In patients at risk for HCC, standardized

CT/MRI criteria can also support more reproducible interpretation and clinical decision-making.^{5,6}

An important consideration in comparative imaging research is the reference standard used to establish the final diagnosis. Histopathology may provide definitive confirmation for selected lesions, whereas others may be diagnosed through characteristic imaging findings and appropriate clinical or radiological follow-up. If the reference standard differs between patients, estimates of sensitivity, specificity, positive predictive value, negative predictive value, and overall diagnostic accuracy may be affected. These measures should therefore be calculated only when the underlying patient-level data and reference diagnoses are available and sufficiently reliable^{6,9,11}.

The present study may help clarify the complementary roles of USG, CT, and MRI in the local clinical setting. However, the sample size of 45 patients and study duration of six months limit the generalizability of the findings. Further limitations may include variation in lesion types, differences in the availability of histopathological confirmation, and the possibility that not every patient underwent all three imaging modalities under identical conditions. A larger prospective study with a uniform reference standard and adequate follow-up would provide stronger evidence regarding comparative diagnostic performance^{1,7,9,12}.

Overall, USG remains an important initial imaging tool, CT provides detailed anatomical and enhancement-based assessment, and MRI offers advanced tissue characterization. Their appropriate use in combination with clinical information and validated diagnostic criteria can improve the evaluation of focal liver lesions. The relative diagnostic superiority of any modality, however, should be established from the actual study

data rather than inferred solely from the technical capabilities of the imaging methods.

Conclusion

Ultrasonography, CT, and MRI play complementary roles in the detection and characterization of focal liver lesions. USG serves as an initial screening modality, CT provides detailed anatomical and enhancement assessment, while MRI offers superior soft-tissue characterization for selected lesions. An integrated, patient-specific imaging approach can improve diagnostic confidence and guide appropriate clinical management.

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