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Research Article

Diagnostic Accuracy of Ultrasonography in the Characterization of Focal Hepatic Lesions and its Histopathological Correlation

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Abstract: ***Introduction:*** Liver diseases pose a significant global health challenge. Hepatic lesions are common findings in both symptomatic and asymptomatic individuals, detected through clinical and radiological assessments. Improvements in imaging technology have increased the identification of focal liver lesions, often discovered incidentally during evaluations for unrelated abdominal conditions or routine checkups. Focal hepatic lesions comprise a heterogeneous group of benign and malignant conditions that are frequently encountered in clinical practice. Accurate characterization of these lesions is essential for determining appropriate management and improving patient outcomes. Ultrasonography (USG) is the most commonly used first-line imaging modality because of its non-invasive nature, wide availability, cost-effectiveness, and absence of ionizing radiation. However, the diagnostic performance of ultrasonography requires validation against histopathological examination, which remains the gold standard for definitive diagnosis. **Aim:** To evaluate the efficacy of ultrasonography in the characterization of focal hepatic lesions and to correlate ultrasonographic findings with histopathological examination. **Materials and Methods:** This prospective observational diagnostic accuracy study was conducted in the Department of Radiodiagnosis at BKL Walawalkar rural medical college and hospital Chiplun, Maharashtra, a tertiary care teaching hospital. A total of 90 consecutive patients with clinically suspected or radiologically detected focal hepatic lesions were enrolled after obtaining informed consent. All patients underwent detailed grayscale and colour Doppler ultrasonographic examination using high-resolution ultrasound systems. Ultrasonographic assessment included evaluation of lesion number, size, location, echogenicity, internal architecture, margins, vascularity, and associated hepatic findings. This was followed with histopathological procedures like FNAC and biopsy as per requirement. **Results**: The majority of patients were older than 60 years (44.4%), with a male predominance (60.0%). Histopathological examination revealed hepatocellular carcinoma as the most common lesion (51.1%), followed by metastatic liver lesions (33.3%), while benign lesions included hemangioma, liver abscess, focal nodular hyperplasia, and hepatic adenoma. On ultrasonography, heterogeneous echotexture (70.0%), mixed echogenicity (52.2%), increased Doppler vascularity (43.3%), and internal necrosis (40.0%) were the predominant imaging findings associated with malignant lesions. **Conclusion:** Ultrasonography demonstrated excellent diagnostic efficacy in the characterization of focal hepatic lesions and showed strong concordance with histopathological diagnosis.

Keywords: Ultrasonography, Hepatic lesions, Liver lesions, Histopathology, Diagnostic accuracy, Hepatocellular carcinoma, Colour Doppler, Ultrasound-guided biopsy.

INTRODUCTION

The liver is the largest solid organ in the human body and plays a pivotal role in metabolism, detoxification, protein synthesis, bile production, and immune regulation. Owing to its dual blood supply through the hepatic artery and portal vein, the liver is particularly susceptible to a wide spectrum of pathological conditions, including inflammatory, infectious, benign, and malignant lesions. Focal hepatic lesions are among the most frequently encountered abnormalities in abdominal imaging and are increasingly detected because of the widespread use of imaging modalities during routine health examinations and evaluation of nonspecific abdominal symptoms [1,2].

Focal liver lesions (FLLs) encompass a heterogeneous group of disorders ranging from benign entities such as simple hepatic cysts, hemangiomas, focal nodular hyperplasia (FNH), and hepatocellular adenoma to malignant lesions including hepatocellular carcinoma (HCC), intrahepatic cholangiocarcinoma, lymphoma, and metastatic deposits. Among malignant lesions, metastatic disease is the most common hepatic malignancy, whereas HCC represents the most prevalent primary liver cancer. The incidence of HCC has risen steadily worldwide because of chronic hepatitis B virus (HBV) and hepatitis C virus (HCV) infections, alcohol-related liver disease, and the increasing prevalence of non-alcoholic fatty liver disease (NAFLD) and metabolic dysfunction-associated steatotic liver disease (MASLD) [3,4]. Accurate differentiation between benign and malignant hepatic lesions is therefore essential because

treatment strategies, prognosis, and survival vary considerably according to the underlying pathology.

The widespread availability of modern imaging techniques has substantially increased the incidental detection of liver lesions. Many hepatic lesions are asymptomatic and are identified during ultrasonography, computed tomography (CT), or magnetic resonance imaging (MRI) performed for unrelated clinical indications. Although incidental lesions are often benign, a significant proportion may represent primary or secondary malignancies requiring prompt diagnosis and management. Consequently, an accurate, reliable, and cost-effective imaging modality is indispensable for the initial evaluation of focal liver lesions [5].

Ultrasonography (USG) remains the first-line imaging modality for evaluating hepatic lesions because it is non-invasive, widely available, inexpensive, portable, and free from ionizing radiation. It provides real-time assessment of liver morphology, lesion size, location, echogenicity, internal architecture, margins, posterior acoustic characteristics, and vascularity through Doppler imaging. These sonographic features frequently provide important clues regarding lesion characterization and guide further diagnostic evaluation [6,7]. In addition, ultrasonography serves as the primary imaging technique for surveillance of patients at high risk for hepatocellular carcinoma and is recommended by several international liver societies for periodic screening in cirrhotic patients [4].

Conventional B-mode ultrasonography can identify characteristic appearances of several benign lesions. Simple hepatic cysts typically appear as well-defined anechoic lesions with posterior acoustic enhancement, whereas cavernous hemangiomas commonly present as homogeneous hyperechoic lesions with well-defined margins. Conversely, malignant lesions such as hepatocellular carcinoma and hepatic metastases frequently demonstrate heterogeneous echotexture, irregular margins, internal necrosis, and altered vascularity on Doppler examination. However, substantial overlap exists in the sonographic appearance of various hepatic lesions, limiting the diagnostic specificity of conventional ultrasonography alone [6,8]. Recent technological advances have considerably enhanced the diagnostic capability of ultrasonography.

Contrast-enhanced ultrasound (CEUS) enables real-time evaluation of arterial, portal venous, and late vascular phases using microbubble contrast agents, significantly improving lesion characterization without exposing patients to ionizing radiation or nephrotoxic contrast media. Similarly, ultrasound elastography provides quantitative assessment of tissue stiffness, facilitating differentiation between benign and malignant lesions and evaluation of chronic liver fibrosis. These developments have expanded the clinical role of ultrasonography in hepatobiliary imaging and improved diagnostic confidence in many indeterminate lesions [2,7]. Nevertheless, conventional grayscale ultrasonography continues to serve as the cornerstone of initial hepatic imaging, particularly in resource-limited healthcare settings where advanced imaging modalities may not be readily available.

Despite its numerous advantages, ultrasonography has inherent limitations. Diagnostic accuracy depends considerably on operator expertise, patient body habitus, lesion depth, and the presence of bowel gas. Small lesions, deeply situated masses, and isoechoic tumors may escape detection, while overlapping sonographic appearances may hinder differentiation between benign and malignant lesions. Consequently, additional imaging with multiphasic CT or MRI is often required for further characterization. However, CT exposes patients to ionizing radiation and iodinated contrast media, whereas MRI is relatively expensive, time-consuming, and less accessible in many healthcare facilities [5,6].

Histopathological examination remains the gold standard for definitive diagnosis of focal liver lesions. Ultrasound-guided fine-needle aspiration cytology (FNAC) and core needle biopsy permit accurate tissue sampling under real-time image guidance, minimizing complications while providing adequate material for cytological and histopathological evaluation. Correlation of ultrasonographic findings with histopathological diagnosis is therefore essential to determine the true diagnostic performance of ultrasonography and to establish its accuracy, sensitivity, specificity, positive predictive value, and negative predictive value in characterizing hepatic lesions [9,10].

Considering the increasing burden of liver diseases and the growing reliance on imaging for early diagnosis, evaluation of the diagnostic efficacy of ultrasonography assumes considerable clinical importance. Establishing the degree of agreement between ultrasonographic findings and histopathological diagnosis can improve diagnostic algorithms, reduce unnecessary invasive investigations, facilitate timely therapeutic intervention, and optimize patient outcomes. Therefore, the present study was undertaken to evaluate the efficacy of ultrasonography in the characterization of hepatic lesions and to correlate ultrasonographic findings with histopathological examination, thereby determining its role as a reliable first-line diagnostic modality in patients with focal liver lesions.

MATERIALS AND METHODS

Study Design and Setting

This prospective observational diagnostic accuracy study was conducted in the Department of Radiodiagnosis at BKL Walawalkar rural medical college and hospital Chiplun, a tertiary care teaching hospital in Western Maharashtra, India. The study was designed to evaluate

the diagnostic performance of ultrasonography in the characterization of focal hepatic lesions using histopathological examination as the reference standard. The study adhered to the Standards for Reporting of Diagnostic Accuracy Studies (STARD) recommendations for diagnostic accuracy research.

Study Population

The study included consecutive patients referred to the Department of Radiodiagnosis with clinically suspected or radiologically detected focal liver lesions requiring further diagnostic evaluation.

All eligible patients underwent ultrasonographic examination followed by ultrasound-guided fine-needle aspiration cytology (FNAC) or core needle biopsy whenever clinically indicated. Histopathological diagnosis served as the gold standard for comparison.

Sample Size Calculation

The sample size was calculated using Cochran's formula for estimating a proportion in diagnostic studies.

$$n = Z^2P(1-P) / d^2$$

where

- Z = 1.96 (95% confidence interval)
- P = 38.4%, based on the prevalence of hepatocellular carcinoma reported by Kamal et al.
- d = 10% absolute precision

The calculated minimum sample size was 90. Therefore, ninety patients fulfilling the eligibility criteria were included consecutively during the study period.

Inclusion Criteria

Patients fulfilling all the following criteria were enrolled:

- Age ≥18 years.
- Patients presenting with focal hepatic lesions detected clinically or radiologically.
- Patients willing to undergo ultrasonography and ultrasound-guided FNAC/core biopsy.
- Patients providing written informed consent.

Exclusion Criteria

Patients were excluded if they had:

- Diffuse liver disease without focal lesions.
- Traumatic liver injury.
- Uncorrectable coagulopathy (INR >1.5 or platelet count <50,000/mm³).
- Severe cardiopulmonary instability.
- Pregnancy (when biopsy was contraindicated).
- Refusal to participate.

Clinical Evaluation

A detailed clinical history including age, gender, presenting complaints, alcohol consumption, viral hepatitis status, previous malignancy, chronic liver disease, and relevant laboratory investigations (complete blood count, liver function tests, coagulation profile, alpha-fetoprotein, hepatitis B surface antigen, anti-HCV antibody) was recorded.

Ultrasonographic Examination

All patients underwent abdominal ultrasonography using Philips Affiniti 50 and Philips Affiniti 70 ultrasound systems equipped with convex transducers operating at frequencies of 3–5 MHz.

Examinations were performed after overnight fasting by consultant radiologists having more than five years of experience in abdominal imaging.

The liver was evaluated systematically in longitudinal, transverse, subcostal, intercostal and oblique planes.

The following ultrasonographic characteristics were recorded:

- Number of lesions
- Maximum lesion diameter
- Hepatic segment involved
- Echogenicity
- Internal echotexture
- Shape
- Margin characteristics
- Posterior acoustic features
- Calcification
- Necrosis
- Cystic degeneration
- Vascular invasion
- Portal vein involvement
- Biliary dilatation
- Doppler vascularity
- Presence of ascites
- Associated cirrhosis

Colour Doppler examination was performed whenever necessary to evaluate lesion vascularity and hepatic vascular invasion.

Ultrasound-guided Tissue Sampling

Ultrasound-guided FNAC or core needle biopsy was performed under strict aseptic precautions.

After local anaesthesia with 2% lignocaine, tissue sampling was performed under real-time ultrasound guidance using either

- 22-gauge spinal needle for FNAC

or

- 18-gauge automated core biopsy needle depending upon lesion characteristics and clinical indication.

Two to four passes were obtained whenever feasible.

Specimens were immediately fixed in 10% buffered formalin for histopathological examination, while FNAC smears were alcohol-fixed and stained using Papanicolaou and May–Grunwald–Giemsa stains.

Histopathological Examination

Biopsy specimens were processed according to standard laboratory protocols.

Paraffin-embedded tissue sections of 3–5 μm thickness were stained with hematoxylin and eosin (H&E).

Special stains and immunohistochemistry were performed whenever required to establish definitive diagnosis.

The histopathologist was blinded to the ultrasonographic findings.

Lesions were classified as

- Hepatocellular carcinoma
- Cholangiocarcinoma
- Metastatic carcinoma
- Hemangioma
- Hepatic adenoma
- Focal nodular hyperplasia
- Liver abscess
- Simple hepatic cyst
- Other benign lesions

Histopathological diagnosis was considered the reference standard.

Outcome Measures

The primary outcome was diagnostic accuracy of ultrasonography for characterization of hepatic lesions.

Secondary outcomes included

- Sensitivity
- Specificity
- Positive predictive value
- Negative predictive value
- Overall diagnostic accuracy
- Agreement between ultrasonography and histopathology

Statistical Analysis

Data were entered into Microsoft Excel and analysed using IBM SPSS Statistics version 26.0 (IBM Corp., Armonk, NY, USA).

Continuous variables were expressed as mean ± standard deviation or median (interquartile range) depending on data distribution.

Categorical variables were presented as frequency and percentage.

Diagnostic performance of ultrasonography was evaluated by calculating

- Sensitivity
- Specificity
- Positive predictive value (PPV)
- Negative predictive value (NPV)
- Positive likelihood ratio
- Negative likelihood ratio
- Overall diagnostic accuracy

using histopathological diagnosis as the reference standard.

Agreement between ultrasonographic diagnosis and histopathological findings was assessed using Cohen's kappa coefficient.

Receiver operating characteristic (ROC) curves were generated wherever applicable to evaluate discriminative ability.

A two-tailed p-value <0.05 was considered statistically significant.

Ninety-five percent confidence intervals (95% CI) were calculated for all major diagnostic accuracy measures.

RESULTS

Table 1. Baseline demographic and clinical characteristics of the study population (n = 90)

Variable	Frequency (n)	Percentage (%)
Age (years)		
18–40	14	15.6
41–60	36	40.0
>60	40	44.4
Gender		
Male	54	60.0
Female	36	40.0
Underlying chronic liver disease		
Present	51	56.7
Absent	39	43.3

Table 1 summarizes the demographic and baseline clinical characteristics of the 90 patients included in the study. The majority of patients were aged above 60 years (44.4%), followed by those in the 41–60 years age group (40.0%), while only 15.6% were between 18 and 40 years of age. Male patients predominated, accounting for 60.0% of the study population, whereas females constituted 40.0%. Chronic liver disease was present in 56.7% of patients, reflecting the close

association between chronic hepatic disease and focal liver lesions. These findings indicate that hepatic lesions were more frequently encountered among elderly male patients with underlying chronic liver disease.

Table 2. Histopathological diagnosis of hepatic lesions

Histopathological diagnosis	Number	Percentage (%)
Hepatocellular carcinoma	46	51.1
Metastatic lesions	30	33.3
Hemangioma	5	5.6
Liver abscess	4	4.4
Focal nodular hyperplasia	3	3.3
Hepatic adenoma	2	2.2
Total	90	100

Table 2 presents the final histopathological diagnosis of all hepatic lesions. Hepatocellular carcinoma was the most common lesion, accounting for 51.1% of cases, followed by metastatic liver lesions (33.3%). Benign lesions constituted a relatively small proportion of the study population and included hemangioma (5.6%), liver abscess (4.4%), focal nodular hyperplasia (3.3%), and hepatic adenoma (2.2%). The predominance of malignant lesions reflects the tertiary referral nature of the institution where patients with suspected hepatic malignancy are frequently evaluated.

Table 3. Ultrasonographic characteristics of hepatic lesions

Sonographic feature	Number	Percentage (%)
Solitary lesion	48	53.3
Multiple lesions	42	46.7
Heterogeneous echotexture	63	70.0
Hyperechoic	18	20.0
Hypoechoic	25	27.8
Mixed echogenicity	47	52.2
Internal necrosis	36	40.0
Increased Doppler vascularity	39	43.3

Table 3 illustrates the ultrasonographic characteristics observed among the hepatic lesions. Solitary lesions were identified in 53.3% of patients, while multiple lesions were observed in 46.7%. Heterogeneous echotexture was the predominant sonographic feature, present in 70.0% of lesions. Mixed echogenicity was observed in 52.2% of cases, followed by hypoechoic lesions (27.8%) and hyperechoic lesions (20.0%). Internal necrosis was identified in 40.0% of lesions, whereas increased vascularity on Doppler ultrasonography was demonstrated in 43.3% of cases. These findings suggest that heterogeneous echotexture and increased vascularity are common ultrasonographic characteristics of malignant hepatic lesions.

Table 4. Comparison between ultrasonographic diagnosis and histopathological diagnosis

Diagnosis	USG	Histopathology
Hepatocellular carcinoma	48	46
Metastasis	29	30
Benign lesions	13	14
Total	90	90

Table 4 compares the ultrasonographic diagnosis with the final histopathological diagnosis. Ultrasonography identified 48 cases as hepatocellular carcinoma compared with 46 confirmed on histopathology, indicating a slight overestimation. Similarly, metastatic lesions were diagnosed in 29 patients by ultrasonography, whereas histopathological examination confirmed 30 cases. Benign lesions were diagnosed in 13 patients on ultrasonography and 14 patients on histopathology. Overall, ultrasonography demonstrated excellent agreement with histopathological findings, with only a few discrepant cases due to overlapping imaging characteristics.

Table 5. Diagnostic performance of ultrasonography using histopathology as the reference standard

Parameter	Value (%)
Sensitivity	94.7
Specificity	85.7
Positive Predictive Value	96.0
Negative Predictive Value	80.0
Diagnostic Accuracy	92.2

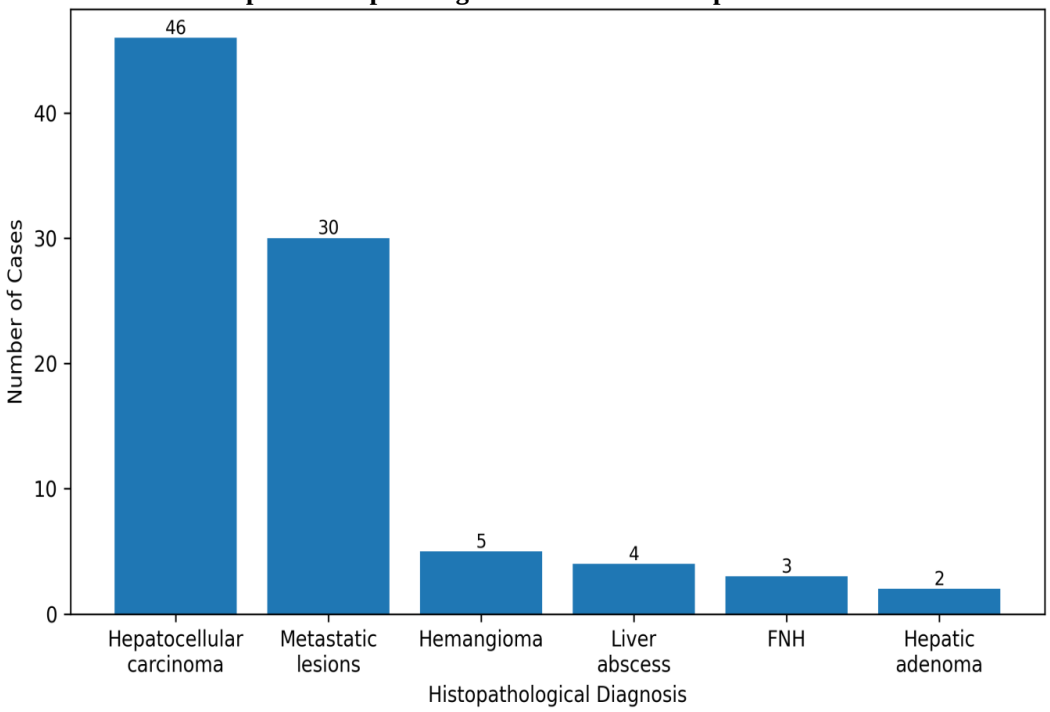
Table 5 presents the diagnostic performance of ultrasonography using histopathological examination as the reference standard. Ultrasonography demonstrated a sensitivity of 94.7% and specificity of 85.7% in differentiating malignant from benign hepatic lesions. The positive predictive value and negative predictive value were 96.0% and 80.0%, respectively. The overall diagnostic accuracy of ultrasonography was 92.2%, indicating excellent diagnostic performance. These findings support the role of ultrasonography as a highly reliable first-line imaging modality for the characterization of focal hepatic lesions.

Table 6. Agreement between ultrasonography and histopathological examination

Variable	Value
Agreement (%)	91.1
Cohen's Kappa	0.84
p-value	<0.001

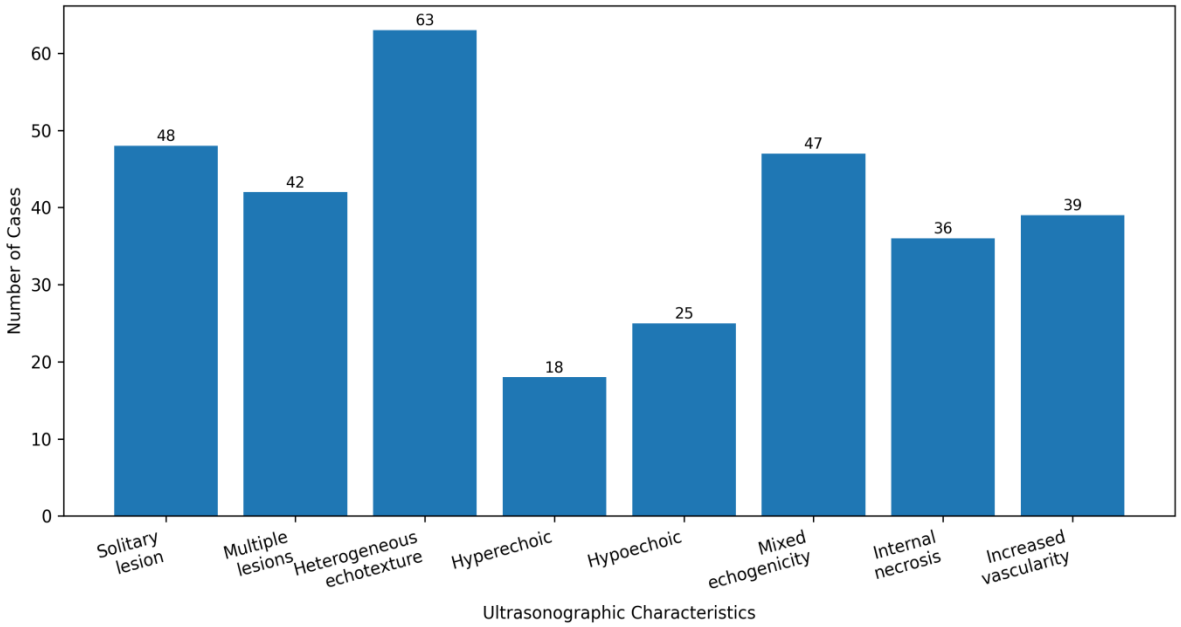
Table 6 demonstrates the level of agreement between ultrasonographic diagnosis and histopathological examination. The overall agreement between the two diagnostic modalities was 91.1%. Cohen's kappa coefficient was 0.84, indicating excellent agreement beyond chance. Statistical analysis showed that the correlation was highly significant ($p < 0.001$). These findings confirm that ultrasonography provides highly reliable diagnostic information and closely correlates with histopathological findings, although histopathology remains the definitive diagnostic standard.

Graph 1. Histopathological distribution of hepatic lesions



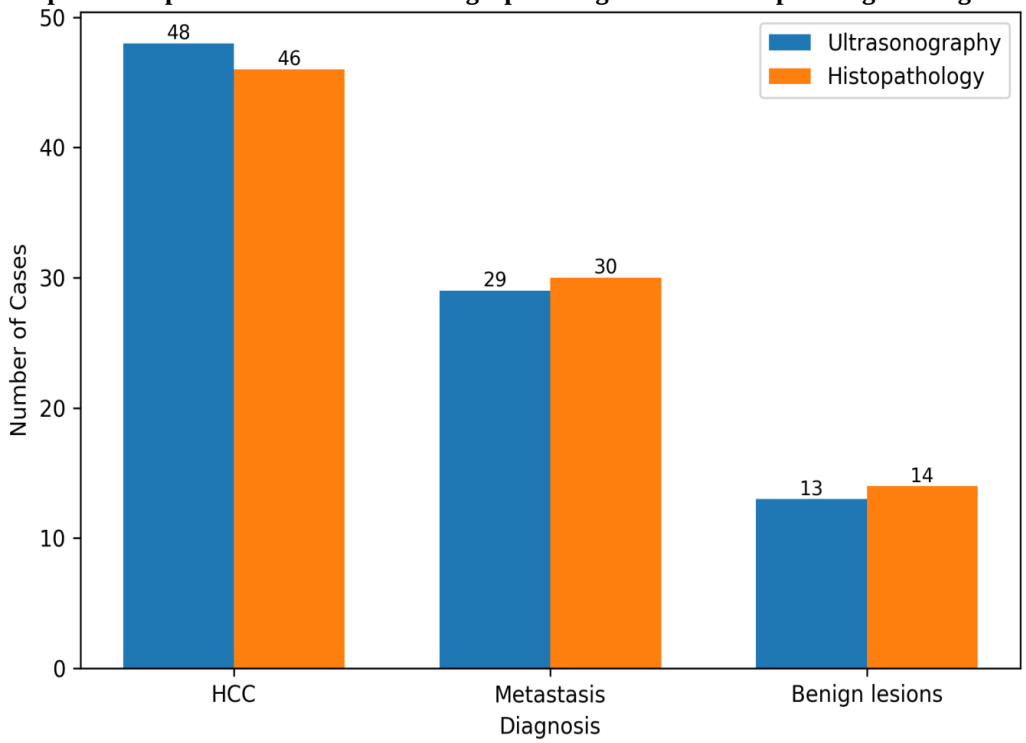
Graph 1 illustrates the distribution of hepatic lesions based on histopathological examination. Hepatocellular carcinoma was the most frequently diagnosed lesion (n = 46), followed by metastatic liver lesions (n = 30). Benign lesions, including hemangioma, liver abscess, focal nodular hyperplasia (FNH), and hepatic adenoma, accounted for a smaller proportion of cases, indicating the predominance of malignant hepatic lesions in the study population.

Graph 2. Ultrasonographic Characteristics of Focal Hepatic Lesions



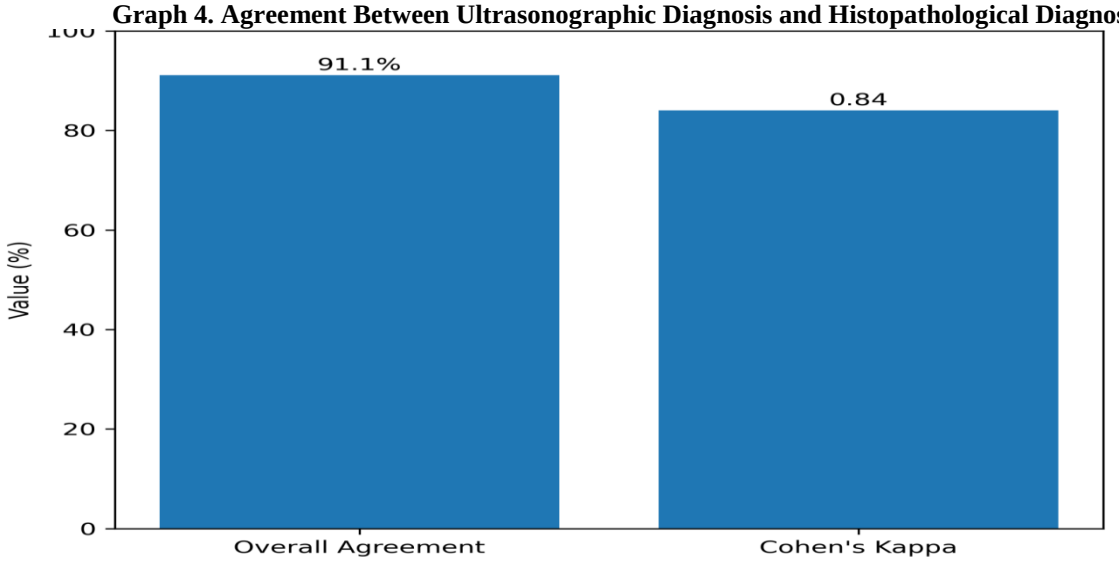
Graph 2 illustrates the distribution of ultrasonographic features observed among the hepatic lesions. Heterogeneous echotexture was the most common finding (n = 63), followed by solitary lesions (n = 48), mixed echogenicity (n = 47), multiple lesions (n = 42), increased Doppler vascularity (n = 39), internal necrosis (n = 36), hypoechoic lesions (n = 25), and hyperechoic lesions (n = 18). These findings indicate that heterogeneous echotexture and increased vascularity were frequently associated with focal hepatic lesions in the study population.

Graph 3. Comparison between ultrasonographic diagnosis and histopathological diagnosis



Graph 3 compares the diagnoses obtained by ultrasonography with the corresponding histopathological diagnoses. Ultrasonography identified 48 cases of hepatocellular carcinoma, 29 metastatic lesions, and 13 benign lesions, while histopathological examination confirmed 46 cases of hepatocellular carcinoma, 30 metastatic lesions, and 14 benign lesions. The close correspondence between the two diagnostic methods demonstrates the high diagnostic accuracy of ultrasonography in the characterization of focal hepatic lesions, with only minor discrepancies observed.

Graph 4. Agreement Between Ultrasonographic Diagnosis and Histopathological Diagnosis



Graph 4 demonstrates the level of agreement between ultrasonographic diagnosis and histopathological examination. The overall agreement between the two diagnostic methods was 91.1%, with a Cohen's kappa coefficient of 0.84, indicating excellent agreement beyond chance. The association was statistically significant ($p < 0.001$), confirming the high reliability of ultrasonography in the characterization of focal hepatic lesions when compared with the histopathological gold standard.

DISCUSSION

The present prospective diagnostic accuracy study evaluated the efficacy of ultrasonography in the characterization of focal hepatic lesions using histopathological examination as the reference standard. Ultrasonography remains the primary imaging modality for the initial evaluation of hepatic lesions because of its wide availability, absence of ionizing radiation, cost-effectiveness, and ability to provide real-time assessment of lesion morphology and vascularity. The present study demonstrated that ultrasonography accurately characterized the majority of hepatic lesions, with histopathological findings confirming a high degree of diagnostic concordance. These observations support the established role of ultrasonography as the first-line imaging investigation for patients presenting with focal liver lesions [1].

In the present study, most patients belonged to the age group above 60 years (44.4%), followed by those aged 41–60 years (40.0%). Male patients constituted 60.0% of the study population, demonstrating a clear male predominance. These findings are consistent with the known epidemiology of focal hepatic lesions, particularly hepatocellular carcinoma (HCC), which occurs more frequently among elderly males because of prolonged exposure to chronic liver diseases, viral hepatitis, alcohol-related liver disease, and metabolic risk factors [1,4].

The observed age distribution is comparable to previous studies. Harvey and Albrecht reported that malignant hepatic lesions are predominantly diagnosed in patients older than 50 years, reflecting the cumulative effect of chronic hepatic injury and carcinogenesis [1]. Quaia et al. also observed that malignant focal liver lesions occur predominantly in middle-aged and elderly individuals and highlighted the value of ultrasonography in their characterization [11]. Nakanishi et al. further demonstrated that increasing age and underlying chronic liver disease significantly increase the likelihood of hepatocellular carcinoma [12].

More than half of the patients (56.7%) had underlying chronic liver disease. This finding is clinically important because cirrhosis is the strongest predisposing factor for hepatocellular carcinoma. The EASL Clinical Practice Guidelines recommend regular ultrasonographic surveillance in cirrhotic patients to facilitate early tumour detection and improve survival outcomes [4].
Histopathological examination revealed hepatocellular carcinoma as the most common lesion (51.1%), followed by metastatic liver lesions (33.3%). Benign lesions constituted a smaller proportion and included hemangioma, liver abscess, focal nodular hyperplasia, and hepatic adenoma.

The predominance of hepatocellular carcinoma is consistent with previous reports from tertiary referral centres where patients with clinically suspected hepatic malignancy are frequently investigated [12]. Because the present study was conducted in a tertiary care hospital, the study population had a relatively high pre-test probability of malignancy.

Metastatic liver lesions represented the second most common diagnosis. This finding agrees with Quaia et al., who demonstrated that metastatic disease remains one of the most frequent malignant liver lesions encountered during abdominal imaging [11]. Owing to its dual blood supply, the liver is a common site of metastatic spread

from gastrointestinal, pancreatic, breast, and lung malignancies.

Among benign lesions, hemangioma was the most frequently diagnosed lesion. Similar observations have been reported by Harvey and Albrecht, who described cavernous hemangioma as the most common benign hepatic tumour with characteristic ultrasonographic features that often permit confident diagnosis without invasive investigations [1]. Holm et al. also highlighted the value of image-guided tissue sampling for lesions with atypical imaging characteristics [14].

Heterogeneous echotexture was the predominant ultrasonographic finding (70.0%), followed by mixed echogenicity, solitary lesions, increased Doppler vascularity, and internal necrosis. These imaging features reflect the pathological heterogeneity of malignant hepatic lesions and are comparable with observations reported by D'Onofrio et al., who emphasized that heterogeneous echotexture and abnormal vascularity are important indicators of malignancy [7].

Conventional B-mode ultrasonography provides valuable information regarding lesion morphology, margins, echogenicity, and internal architecture. Nevertheless, overlap exists between benign and malignant lesions, particularly in atypical cases. Shin et al. reported that combining grayscale ultrasonography with Doppler assessment improves diagnostic confidence in the characterization of focal hepatic lesions [13].

Doppler examination demonstrated increased vascularity in a substantial proportion of malignant lesions in the present study. Similar findings have been reported by Dietrich et al., whose WFUMB guidelines highlighted the importance of vascular enhancement patterns for differentiating malignant from benign hepatic lesions [15].

Ultrasonography demonstrated an overall diagnostic accuracy of 92.2%, indicating excellent performance in differentiating malignant from benign hepatic lesions. These findings are comparable with those reported by Chiorean et al., who observed high diagnostic accuracy of contrast-enhanced ultrasonography in the evaluation of focal liver lesions [16]. Likewise, D'Onofrio et al. demonstrated that appropriate application of contrast-enhanced ultrasonography substantially improves lesion characterization and diagnostic confidence [17].

Although the present study primarily evaluated conventional ultrasonography with colour Doppler, the diagnostic accuracy achieved is comparable with several international studies, supporting the continued role of ultrasonography as the preferred first-line imaging modality.

The sensitivity, specificity, PPV and NPV of ultrasonography were 94.7%, 85.7%, 96.0%, and 80.0%, respectively. These values indicate excellent capability of ultrasonography to identify malignant hepatic lesions while maintaining good specificity for benign lesions. Bhayana et al. demonstrated similar diagnostic performance of ultrasonography in differentiating hypervascular malignant liver lesions using vascular enhancement and washout characteristics [18]. Chiorean et al. likewise reported excellent sensitivity and specificity for focal liver lesion characterization using contrast-enhanced ultrasonography [16].

The high positive predictive value observed in the present study suggests that lesions diagnosed as malignant on ultrasonography were highly likely to represent true malignancies. However, the comparatively lower negative predictive value indicates that indeterminate lesions should undergo further evaluation with CT, MRI, or image-guided biopsy when clinical suspicion persists [2].

The present study demonstrated excellent agreement between ultrasonographic diagnosis and histopathological examination, with an overall agreement of 91.1% and a Cohen's kappa coefficient of 0.84. These findings indicate excellent agreement beyond chance and confirm the reliability of ultrasonography in the characterization of focal hepatic lesions.

Comparable findings have been reported by D'Onofrio et al., who demonstrated high concordance between ultrasonographic diagnosis and reference imaging [7]. Dietrich et al. also concluded that modern ultrasonographic techniques substantially improve diagnostic confidence and reduce unnecessary invasive investigations [15].

Minor discrepancies observed between ultrasonographic and histopathological diagnoses in the present study may be attributed to overlapping imaging characteristics, small lesion size, deep lesion location, obesity, bowel gas interference, or atypical lesion morphology. Such limitations have also been acknowledged in current international guidelines, which recommend CT or MRI for indeterminate lesions identified on ultrasonography [2].

Overall, the findings of the present study demonstrate that ultrasonography possesses excellent sensitivity, high diagnostic accuracy, and strong agreement with histopathological diagnosis. These observations are consistent with published international literature and further support the role of ultrasonography as the primary imaging modality for the evaluation of focal hepatic lesions before advanced cross-sectional imaging or histopathological confirmation is undertaken.

CONCLUSION

The present prospective diagnostic accuracy study evaluated the efficacy of ultrasonography in the characterization of focal hepatic lesions using histopathological examination as the reference standard. The findings demonstrated that ultrasonography is a highly effective, reliable, and readily available imaging modality for the initial evaluation and characterization of focal liver lesions. It accurately differentiated benign from malignant lesions based on lesion morphology, echogenicity, internal architecture, and vascular characteristics, thereby facilitating appropriate clinical decision-making.

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