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Original Article

Role of Triphasic Computed Tomography in Evaluation of Hepatic Lesions: Comparative Cross-Sectional Study

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ABSTRACT

Focal hepatic lesions may be benign or malignant and can be difficult to characterize with ultrasound alone. Multiphase contrast-enhanced computed tomography provides dynamic information about lesion vascularity and enhancement, which can improve lesion characterization and guide further management. **Objectives:** To determine the diagnostic accuracy of triphasic computed tomography (TPCT) in differentiating benign from malignant hepatic lesions using fine-needle aspiration cytology (FNAC) as the reference standard. **Methods:** A comparative cross-sectional study was conducted among 136 patients with focal hepatic lesions. All patients underwent triphasic computed tomography (TPCT), and fine-needle aspiration cytology (FNAC) was used as the reference standard. TPCT findings were compared with FNAC results to determine sensitivity, specificity, positive predictive value, negative predictive value, and overall diagnostic accuracy. **Results:** Out of 140 enrolled patients, 136 had complete data available for the final analysis. TPCT classified 31 (22.8%) lesions as benign and 105 (77.2%) as malignant, whereas FNAC classified 29 (21.3%) as benign and 107 (78.7%) as malignant. The contingency table showed 104 true positives, 28 true negatives, 1 false positive, and 3 false negatives. Overall diagnostic accuracy was 97.1%. **Conclusions:** In this single-centre cohort, TPCT demonstrated high diagnostic accuracy for distinguishing benign from malignant focal hepatic lesions. Its high sensitivity and specificity support its value as a non-invasive diagnostic modality, although findings should be validated in larger multi-centre studies.

INTRODUCTION

Focal liver lesions (FLLs) are localized abnormalities that differ from the surrounding hepatic parenchyma and include a broad spectrum of benign and malignant entities. With the increasing use of abdominal imaging, FLLs are being detected frequently, making accurate characterization clinically important because management differs substantially between benign lesions and malignant disease. Current guidance emphasizes assessment using clinical history, laboratory findings, and appropriate imaging rather than reliance on a single imaging feature [1–4]. The differential diagnosis of FLLs includes common benign lesions such as hemangioma, focal nodular hyperplasia, hepatocellular adenoma, and hepatic cysts, as well as primary and secondary malignant lesions. Although many benign lesions can be characterized confidently on imaging, atypical enhancement patterns may overlap with malignant disease and can create diagnostic uncertainty. Appropriate characterization is therefore important to reduce unnecessary invasive procedures while avoiding missed malignancy [3, 5]. Ultrasonography (US) is commonly used as an initial and accessible examination for focal liver abnormalities; however, its ability to characterize lesions may be limited. Dynamic contrast-enhanced computed

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tomography (CT) provides information about lesion vascularity and enhancement during arterial, portal venous, and delayed phases. These dynamic enhancement characteristics are important in differentiating hepatocellular carcinoma (HCC), metastases, hemangioma, focal nodular hyperplasia, and other focal hepatic abnormalities [6, 7]. For patients at risk of HCC, multiphasic CT and magnetic resonance imaging (MRI) have established roles in non-invasive diagnosis. The 2023 American Association for the Study of Liver Diseases (AASLD) guidance supports multiphasic contrast-enhanced CT or MRI for diagnostic evaluation of suspicious liver lesions in appropriate at-risk patients. The 2025 European Association for the Study of the Liver (EASL) guideline similarly emphasizes appropriate cross-sectional imaging, while the Liver Imaging Reporting and Data System (LI-RADS) provides standardized terminology and diagnostic categories for liver observations [8–11]. MRI provides excellent tissue characterization and may be particularly useful when lesions remain indeterminate following US or CT. Nevertheless, multiphasic CT remains an important cross-sectional modality because of its rapid acquisition, wide availability, and ability to demonstrate characteristic enhancement patterns. Recent studies have also investigated spectral CT, radiomics, and artificial-intelligence approaches for improving characterization of benign and malignant FLLs [12–15].

Evidence from local clinical settings regarding triphasic CT performance against cytological or tissue-based reference standards remains limited, providing a rationale for the present investigation. This study finds the diagnostic performance of triphasic CT in differentiating benign from malignant focal hepatic lesions in a local clinical cohort. The study aimed to evaluate TPCT findings against the study reference diagnosis and reports sensitivity, specificity, positive predictive value, negative predictive value, and overall diagnostic accuracy.

METHODS

The comparative cross-sectional study was conducted in the Department of Radiology, Gujranwala Teaching Hospital, Gujranwala. Data collection was done for six months from July 2025 to December 2025 following formal approval of the research synopsis vide no. IRB.87/GMC dated 18th June 2025. Patients visiting the Medical Outpatient Department (OPD) with a suspicion of focal hepatic lesions made up the primary data source. This study calculated the sample size using a 5% margin of error and a 95% confidence interval, with an expected prevalence of 10% for focal liver lesions. The following formula was used: $n = Z^2 \times P (1 - P) / m^2$. Here, n is the required sample size, Z is the standard value at a 95% confidence level (1.96), P is the estimated prevalence of focal liver lesions (0.10), and m is the margin of error (0.05). This calculation gives: $n = (1.96)^2 \times 0.1(1 - 0.1) / (0.05)^2$, $n = 3.8416 \times 0.09 / 0.0025$, $n = 0.3457 / 0.0025$, $n \approx 138$. Therefore, a minimum of 138 cases was required. The current study found 140 patients, out of whom 4 refused to participate, and the study ended up with 136 cases. The sample size was initially calculated using a prevalence-based formula, yielding a minimum of 138 participants. However, as this was a diagnostic-accuracy study, an ideal sample-size calculation was based on the anticipated sensitivity and specificity of TPCT, the expected prevalence of malignant lesions, and the desired precision. Since the study had already been completed using the prespecified prevalence-based calculation, the final sample of 136 participants was retained. This is acknowledged as a methodological limitation, and future prospective studies should use a diagnostic-accuracy-based sample-size calculation. The sampling method used was purposive non-probabilistic sampling. All patients of any age or gender with clinical suspicion of liver disease were included, as well as patients with lesions already identified by ultrasound, conventional CT, or FNAC. Patients who were pregnant, had abnormal renal function tests, abnormal bleeding or clotting profiles, known sensitivity to CT contrast, or had a liver transplant were excluded. Finally, 136 patients with suspected focal liver lesions who fulfilled the inclusion/exclusion criteria were enrolled. They were sent for further evaluation to the Department of Radiology. Before starting the study, this study obtained formal approval from the Institutional Ethical Review Committee. The current study also obtained informed consent in writing from every patient. Triphasic CT of the liver was performed in the Department of Radiology. The entire liver was scanned sequentially across three distinct phases: the portal venous phase, the arterial phase, and the equilibrium phase. A collimation of 5 mm and a table speed of 5 mm/second were used throughout the examination. All scans were acquired in the craniocaudal direction during a single breath-hold to minimize motion artifact. A baseline unenhanced scan of the liver was obtained by following the acquisition of an initial digital scout view. Subsequently, approximately 80 to 90 mL of non-ionic contrast material was administered intravenously at a controlled rate of about 2 to 3 mL per second to enable dynamic phase imaging. The entire liver was scanned in the arterial phase. 25 seconds after the end of the arterial phase, after 25 or 30 seconds, the liver was scanned in the portal venous phase. The 25-second interscan delay allows the patient to rebreathe and reposition the scan plane cephalad to the liver. After these two phases, the third scan was performed in the equilibrium phase, 8 minutes after injection of non-ionic contrast. The acquired images in different phases were

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evaluated in detail to identify lesions and classify them according to age, clinical background, and other imaging findings. Further, the findings were classified as benign or malignant by correlating them with histopathological findings. In all patients of the study, hepatic lesion FNAC was conducted, which was followed by the reports of FNAC in the Department of Pathology, KEMU, in the Department of Radiology. For patients with multifocal lesions, FNAC was done from the most accessible and largest lesion. With informed consent, under aseptic measures with the help of 22/23 G LP needle Fine needle aspiration cytology was performed from targeted hepatic lesion. The traditional demographic info is reflected in this research work like name, sex, age, and address, was collected using a proforma. The brief history presenting illness with relevant history was noted down. Before examination, Ultrasound finding was recorded. The collected pictures were reported by a senior radiologist with strong real-time experience in CT reporting. The TPCT findings were independently assessed by three radiologists. In cases of disagreement between the radiologists, the findings were discussed jointly, and a final diagnosis was reached by consensus agreement among the three radiologists. This final consensus interpretation was considered the provisional TPCT diagnosis and was subsequently compared with the reference-standard diagnosis. All the data used in this study were in hard copy and console form.

Collected data were entered into SPSS version 25.0. Quantitative data fields, such as age, were calculated with statistical tools: mean and standard deviation. While the Qualitative variables, such as gender, presentation, number of focal liver lesions, and enhancement pattern of lesions, were presented as n (%). The accuracy of the diagnosis of malignant or benign hepatic lesions was determined by the Triphasic Computed Tomography, and a 2x2 table was used for this calculation.

RESULTS

A total of 136 participants were included in this study. After age stratification, most (40.4%) patients were in the age range of 51 – 60 years, followed by 35.3% that lied in the age range of 41-50 years. Gender distribution revealed that 69 (50.7%) were males and 67 (49.2%) were females. Out of 136 patients, 16 (11.8%) were recorded as Hepatitis B reactive, whereas 70 (51.5%) were recorded as Hepatitis C reactive (Table 1).

Table 1: Baseline and Demographic Characteristics of the Participants (n=136)

Variables	n (%)
Age	
≤ 21	8 (5.9%)
22–30	0 (0.0%)
31–40	10 (7.4%)
41–50	48 (35.3%)
51–60	55 (40.4%)
>60	15 (11.0%)
Gender	
Male	69 (50.7%)
Female	67 (49.2%)
Others	
Hepatitis B Reactive	16 (11.8%)
Hepatitis C Reactive	70 (51.5%)
No. of Solid Focal Lesions (Mean ± S.D)	3.85 ± 3.40

The largest lesion echogenicity examination revealed 10 (7.4%) patients as isoechoic, 65 (47.8%) as hypoechoic, and 61 (44.9%) as hyperechoic. Moreover, lesions in 94 (69.1%) patients were observed to be enhanced on the arterial phase, and in 22 (16.2%) patients, lesions were enhanced on the portal venous phase (Table 2).

Table 2: Imaging Characteristics of Lesions (n=136)

Variables	n (%)
Echogenicity of Largest Lesion	
Isoechoic	10 (7.4%)
Hypoechoic	65 (47.8%)
Hyperechoic	61 (44.9%)
Arterial Enhancement	94 (69.1%)
Portal Venous Enhancement	22 (16.2%)

Radiologist A, radiologist B, and radiologist C declared 31 (22.8%), 32 (23.5%), and 24 (17.6%) as benign lesions, respectively, whereas 105 (77.2%), 104 (76.5%), and 112 (82.4%) were declared as malignant (Table 3).

Table 3: Characterization of Lesion as Benign or Malignant Based on TPCT Scan Findings of Three Different Radiologists

Lesion Characterization	Reader A, n (%)	Reader B, n (%)	Reader C, n (%)
Benign	31 (22.8%)	32 (23.5%)	24 (17.6%)
Malignant	105 (77.2%)	104 (76.5%)	112 (82.4%)

Based on the consensus of all three reports of the patients, 31 (22.8%) patients were reported to have benign lesions and 105 (77.2%) patients were reported to have malignant lesions based on TPCT scan findings, which were taken as the provisional diagnosis. After biopsy (FNAC), benign and malignant lesions were recorded in 29 (21.3%) and 107 (78.7%) patients, respectively (Table 4).

Table 4: The Provisional (TPCT) and Final Diagnosis (FNAC) of the Patients

Variables	n (%)
Provisional Diagnosis	
Benign	31 (22.8%)
Malignant	105 (77.2%)
FNAC (Final Diagnosis)	
Benign	29 (21.3%)

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Malignant	107 (78.7%)

Using the 2 x 2 table, considering FNAC as the gold standard diagnosis, by applying the respective calculation formulae, the sensitivity of the TPCT scan was observed as 97.2%, specificity 96.6%, PPV 99%, NPV 90.3%. The diagnostic accuracy of 97.1% was observed (Table 5).

Table 5: 2 X 2 Table Based on TPCT as Provisional Diagnosis and FNAC as Final Diagnosis

Diagnostic Measure	Estimate (%)	95% CI
Sensitivity	97.2%	92.1–99.0
Specificity	96.6%	82.8–99.4
PPV	99.0%	94.8–99.8
NPV	90.3%	75.1–96.7
Overall Diagnostic Accuracy	97.1%	92.7–98.9

Sensitivity: 104/104 + 3= 97.2%, Specificity: 28/28+1= 96.6%, Positive Predictive Value: 104/104+1=99%, Negative Predictive Value: 28/28+3 = 90.3%, Diagnostic Accuracy: 104+28/104+28+1+3=97.1%

DISCUSSION

In the present study, TPCT demonstrated high diagnostic performance for differentiating benign from malignant focal hepatic lesions, with sensitivity of 97.2%, specificity of 96.6%, positive predictive value of 99.0%, negative predictive value of 90.3%, and overall diagnostic accuracy of 97.1%. These findings support the usefulness of multiphasic CT for focal liver lesion characterization in the studied clinical setting and are broadly consistent with recent literature describing dynamic contrast-enhanced CT as an important imaging modality for liver lesion assessment [16, 17]. The performance observed in this study can be explained by the ability of multiphasic CT to characterize lesion vascularity and enhancement over different phases. Arterial-phase hyperenhancement, washout, capsule appearance, and other enhancement characteristics are important components of contemporary liver imaging, particularly for HCC. AASLD and EASL guidance support multiphasic contrast-enhanced CT or MRI in appropriate patients, while LI-RADS provides a standardized framework for interpretation and communication of imaging findings [8–11]. The three-reader assessment in the present study showed some variation in lesion classification, although a final interpretation was reached by consensus. Reader variability is clinically relevant because interpretation may be influenced by lesion size, background liver disease, enhancement pattern, and reader experience. LI-RADS was developed to improve standardized interpretation and communication, and recent evidence indicates that ancillary imaging features can provide additional diagnostic information when major imaging features alone are insufficient for confident characterization [11, 18]. The high proportion of malignant lesions in this cohort should also be considered when interpreting the predictive values. Predictive values are influenced by disease prevalence, and therefore the high positive predictive value observed here should not automatically be generalized to populations with a lower prevalence of malignancy. Comparative literature also indicates that diagnostic performance depends on patient population, lesion spectrum, imaging technique, and reference standard. MRI may provide additional sensitivity for selected diagnostic tasks, whereas CT remains a practical and widely available modality for many clinical pathways [19, 20].

There are some limitations of this study. It was conducted at a single center with non-probability sampling, making it difficult to extrapolate the findings to other centers and patient populations. Second, only 136 of 140 patients enrolled were included in the final analysis, and the disposition of the four records not included should be verified from the source dataset. Thirdly, FNAC was the reference standard, and cytology may not be as informative in terms of architectural information as core histopathology for all lesions. Fourth, the exact method of achieving the consensus of radiologists is not described in the manuscript supplied and should be confirmed. Lastly, the original sample size calculation was based on prevalence instead of explicitly on expected diagnostic sensitivity/specificity and desired precision. Histopathology would be a stronger reference standard than FNAC, because cytology lacks architectural information and can misclassify benign versus malignant hepatic lesions, especially HCC and some benign entities. In addition, the study population had a high prevalence of malignancy (78.7%), which is atypical and indicates spectrum bias; this distorts the predictive values and limits generalizability to lower-prevalence settings. Purposive non-probabilistic sampling further worsens this limitation. No subgroup analyses were performed by lesion type, lesion size, or cirrhosis status, so diagnostic accuracy in these clinically important subgroups remains unknown. Sample-size calculations for diagnostic accuracy should be prospectively specified, CT acquisition and reporting should be standardized, interobserver agreement in the prospective setting should be performed, and the reference standard procedures should be clearly documented for future studies. Multicenter studies with prespecified sample-size calculations for diagnostic accuracy or consecutive sampling, standardized acquisition and reporting criteria for the CT, formal interobserver agreement analysis, and well-documented acquisition procedures for the reference standard are recommended. Indeterminate and discordant lesions should be analyzed separately in prospective studies, and the results of TPCT should be compared to MRI or contrast-enhanced ultrasound (CEUS) if clinically indicated.

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CONCLUSIONS

In this single-centre cohort, triphasic computed tomography (TPCT) demonstrated high diagnostic accuracy for differentiating benign from malignant focal hepatic lesions when compared with FNAC. TPCT is a practical, non-invasive imaging modality that may support lesion characterization and guide further management.

Authors' Contribution

Conceptualization: MWA
Methodology: MF
Formal analysis: MWA
Writing and Drafting: SG, MA, ZRS
Review and Editing: MWA, SG, MA, MF, ZRS

All authors approved the final manuscript and take responsibility for the integrity of the work

Conflict of Interest

All the authors declare no conflict of interest.

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