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ROLE OF TRIPLE-PHASE CT IN THE DETECTION AND CHARACTERIZATION OF FOCAL HEPATIC LESIONS: A SYSTEMATIC REVIEW

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ABSTRACT
Focal hepatic lesions comprise a broad spectrum of benign and malignant abnormalities that require accurate detection and characterization for appropriate clinical management. Triple-phase computed tomography (CT) provides phase-specific information through arterial, portal venous, and delayed imaging. To systematically evaluate the role of triple-phase CT in the detection, characterization, and differentiation of focal hepatic lesions. A systematic literature review was conducted according to PRISMA 2020 guidelines. PubMed, ScienceDirect, Google Scholar and DOAJ were searched for relevant studies published between 2017 and 2026. Ten eligible clinical studies were included. Methodological quality was assessed using QUADAS-2, and findings were synthesized narratively. Triple-phase CT consistently improved lesion assessment by combining complementary enhancement information. The arterial phase was most useful for hypervascular lesions, the portal venous phase improved visualization of hypovascular lesions and metastases, and the delayed phase aided evaluation of washout, capsule formation, progressive fill-in, and delayed enhancement. Diagnostic performance was generally favorable, although variability existed according to lesion type, CT protocol, and confirmation method. Triple-phase CT is a clinically useful and reliable modality for comprehensive evaluation of focal hepatic lesions and supports effective benign–malignant differentiation.

KEYWORDS: Triple-phase CT, focal hepatic lesions, hepatocellular carcinoma, liver metastases, diagnostic imaging

INTRODUCTION

The focal hepatic lesions are a heterogeneous group of localized abnormalities of the liver which may be benign, malignant, inflammatory or cystic in nature. The typical benign lesions are simple hepatic cysts, hemangiomas and focal nodular hyperplasia, whilst the hepatocellular carcinoma, intrahepatic cholangiocarcinoma and metastatic deposits are the dominant malignant lesions. Clinical significance of accurate differentiation is based on the fact that the management differs extensively between conservative surveillance and locoregional treatment, systemic treatment and surgical resection. In turn, imaging has become a key in determining the morphology, vascularity, internal structure, and the enhancement behavior of lesions, which helps to make further diagnostic and therapeutic decisions (Anichini et al., 2023). Routinely, ultrasonography, computed tomography (CT), and magnetic resonance imaging (MRI) are employed in the assessment of focal liver lesions. Ultrasonography is commonly considered the first modality due to its accessibility and non-ionizing radiation; but the characterization of the lesions may be constrained by the operator, body habitus, and location of the lesion. CT can offer quick image acquisition, extensive anatomical coverage and a high level of detail in the morphological appearance of lesions and vascularity enhancement, which can be of great use in routine clinical practice. Multidetector CT has also shown a significant role in detection and characterization of hepatic mass lesions particularly in cases that have contrast-enhanced phase information (Madhavi, 2020). The diagnostic significance of cross-sectional imaging in hepatocellular carcinoma has also been proven to be comparative evidence, and enhancement behavior is a significant element of non-invasive diagnosis (Chou et al., 2015). More recent clinical comparisons also indicated that triple-phase CT would be able to detect hypervascular liver metastases better than traditional ultrasonography (Azeem et al., 2026).

Triple-phase CT is a multiphase contrast-enhanced imaging, which assesses the liver at arterial, portal venous, and delayed or equilibrium phases. These vascular cycles offer complementary diagnostic data as focal lesions vary in terms of their arterial supply and portal perfusion, contrast washout and delayed retention (Chiorean et al., 2016). The arterial phase is especially helpful in the detection of hypervascular lesions and arterial hyperenhancement, and the portal venous phase enhances the visualization of most of the hypovascular lesions, such as metastatic deposits. The delayed stage gives more data on the washout, capsule formation, progressive enhancement and contrast retention. Research on dynamic contrast-enhanced CT has demonstrated that multiphase data can significantly enhance the classification of focal hepatic lesions in comparison to using a single phase (Cao et al., 2020).

Patterns of characteristic enhancement are essential to the characterization of lesions. Hepatocellular carcinoma often shows arterial-phase hyperenhancement with subsequent relative washout on subsequent phases, and hemangiomas tend to show peripheral nodular hyperenhancement with centripetal fill-in. Focal nodular hyperplasia is usually hypervascular at the arterial stage and could be comparatively homogeneous in the follow-up imaging. The features of arterial enhancement can also help to differentiate between hepatocellular carcinoma and focal nodular hyperplasia (Gatti et al., 2020). The use of multiphase CT has thus been explored to maximize the distinction between hepatocellular carcinoma and other focal lesions of the liver (Shi et al., 2020). However, more recently, radiomics has also been considered to distinguish between malignant and benign focal lesions by triphase-enhanced CT with a strong focus on the diagnostic richness of phase-specific image data (Wang et al., 2025).

The significance of enhancement behavior has also been shown in veterinary studies of hepatic lesions, but this evidence cannot be directly applied to human population. Triple-phase multidetector CT has already been proven useful in differentiating the various canine hepatic lesions (Stehlík et al., 2020) and systematic analysis of the CT features has revealed enhancement-related features of malignant and benign lesions in dogs (Burti et al., 2021). The same has done similar work that has indicated potential diagnostic use of triple-phase CT to differentiate benign lesions of the liver against hepatocellular carcinoma in dogs (Einwaller & Wennemuth, 2025). Meanwhile, artificial intelligence and computational image analysis are the increasingly explored directions of focal hepatic lesion detection and characterization, which can be attributed to the increasing complexity of quantitative imaging methods (Arribas Anta et al., 2025).

Regardless of these improvements, there remains much heterogeneity in CT acquisition protocols, phase timing, population of lesions, diagnostic confirmation, and reported diagnostic performance. Hence, the purpose of this systematic review was to integrate the existing evidence on the use of triple-phase CT in detecting and characterizing focal hepatic lesions, specifically phase-specific imaging results, enhancement patterns, distinction of benign and malignant lesions, as well as overall diagnostic performance.

2. METHODOLOGY

2.1 Study Design

This was a systematic literature review that aimed to determine the effectiveness of triple-phase computer tomography (CT) in the detection and characterization of focal hepatic lesions. The review concentrated on the diagnostic value of arterial, portal venous, and delayed/equilibrium phases in the detection of lesions, enhancement, and the differentiation of benign and malignant lesions. The PRISMA 2020 guidelines were used to conduct the review to provide systematic and transparent study identification, screening, and eligibility assessment, as well as reporting.

2.2 Literature Search Strategy

The extensive literature search included PubMed, ScienceDirect, Google Scholar and DOAJ to find the peer-reviewed articles published within 2017-2026 and focused on the topic of interest. English-language studies only were taken into consideration. The main search query was: ((triple-phase CT) or (triphasic CT)) and ((focal liver lesions) and (diagnostic accuracy) or (characterization). The search strategy was modified where it was needed based on the indexing needs of specific databases. Eligible articles reference lists were also manually screened to obtain more relevant studies that were not found in the electronic search.

2.3 Eligibility Criteria

The original clinical studies were included provided they measured triple phase or triphasic CT in adult patients with focal hepatic lesions and provided results on the subject of lesion detection, conspicuity, enhancement patterns, characterization, benign-malignant differentiation, or diagnostic performance. Arterial, portal venous and delayed/equilibrium phase studies were eligible. Triple-phase CT findings could also be extracted independently, thus, studies involving histopathology, biopsy, cytology, MRI, ultrasonography, surgical findings or imaging follow-up were also considered to confirm the diagnosis. Reviews, systematic reviews, meta-analyses, editorials, conference abstracts, case reports, duplicate publications, animal or in vitro studies, single- or biphasic CT studies, AI/deep-learning studies, and studies not related to focal hepatic lesions were omitted.

2.4 Study Selection

A literature search resulted in the identification of 335 records consisting of 325 in electronic databases and 10 by checking of the reference by hand. Following the elimination of 55 duplicates, 280 records were screened in terms of title and abstract where 220 were discarded. The rest of the 60 full-text articles were evaluated on their eligibility and 50 of them were ruled out of the study based on the predetermined criteria. Lastly, 10 studies were used in the qualitative synthesis. A PRISMA 2020 flow diagram was used to illustrate the entire selection process.

2.5 Data Extraction

Structured data-extraction format was used to extract data. The information extracted consisted of author and year of publication, the study design, sample size, the type and characteristics of lesions, diagnostic confirmation method, triple-phase CT acquisition protocol and phase timing, the lesion enhancement patterns and the key diagnostic findings. Diagnostic performance measures (sensitivity, specificity, positive predictive value, negative predictive value, diagnostic accuracy) were also measured where reported. The data extracted were systematically tabulated to make a comparison of

the study characteristic, phase-specific CT findings, lesion enhancement behavior and diagnostic performance in general across the studies that were included.

2.6 Quality Assessment

The Quality Assessment of Diagnostic Accuracy Studies-2 (QUADAS-2) tool was used to determine the methodological quality and risk of bias of the included studies. The evaluation included four areas, including patient selection, index test, reference standard, and flow and timing. The studies were systematically assessed with the aim of identifying the possible risk of bias factors that included the methods of participant recruitment, interpretation of triple-phase CT results, suitability of the diagnostic confirmation procedure, and diagnostic verification completeness and timing. Domain level judgments were divided into low risk, some concerns, or high risk of bias. The results were then summarized in a traffic-light plot to give a clear graphical representation of the risk-of-bias profile of the covered studies.

2.7 Data Synthesis

Due to the heterogeneity of the study designs, patient groups, the type of lesions, CT acquisition protocols, diagnostic confirmation techniques, and outcomes reported, a narrative synthesis was carried out. Results were categorized into large themes that included phase-wise acquisition of CT, lesion identification, patterns of characteristic enhancement, benign lesion v.s malignant lesion differentiation, and diagnostic performance. This methodology allowed conducting a systematic comparison of the existing evidence and taking into consideration methodological differences among the included studies.

3. RESULTS

3.1 Study Selection

A total of 335 records were identified during the literature search; 325 of the records were electronic databases and 10 were identified during manual reference screening. Having eliminated 55 duplicates, 280 records were identified by title and abstract, 220 of which were filtered out. The rest of the full texts were evaluated as eligible, and 50 were filtered out as not fitting the criteria set. In the end, the qualitative synthesis included 10 studies. The PRISMA 2020 flow diagram (Figure 1) summarizes the study-selection process.

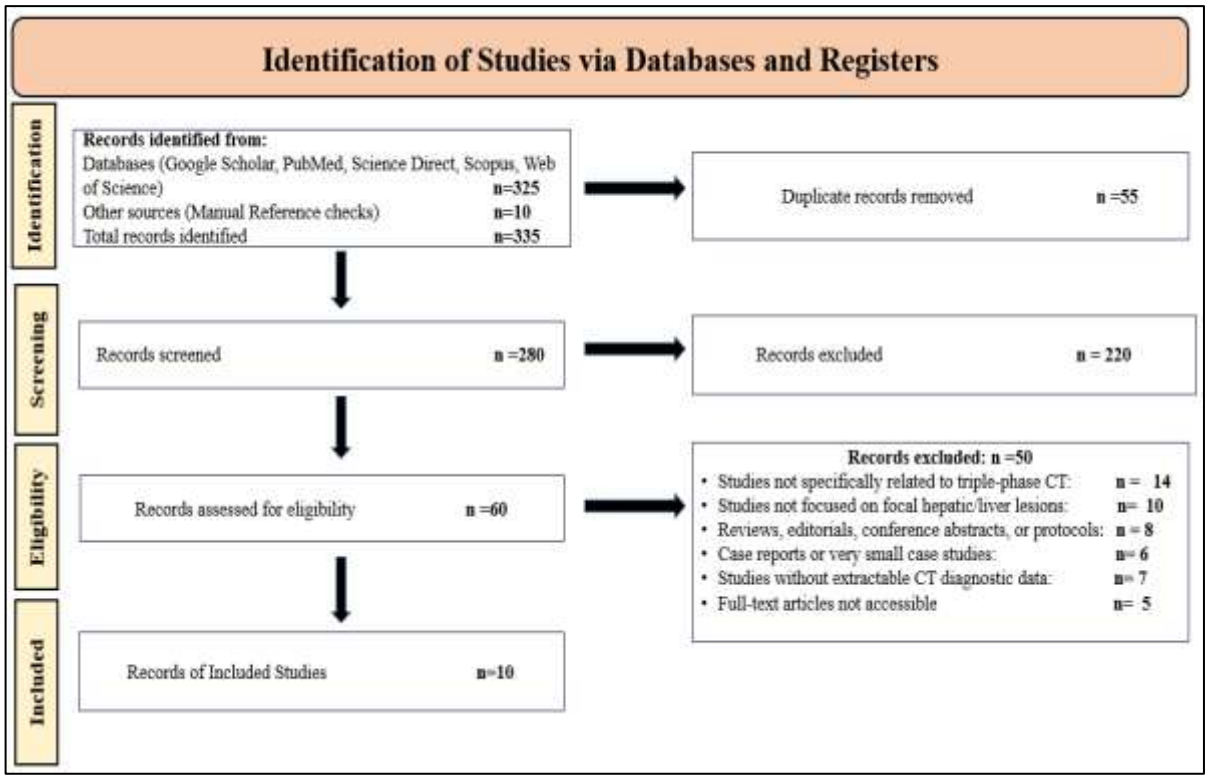

Figure 1. PRISMA Flow Diagram

3.2 Characteristics of Included Studies

The review had 10 studies that were published in the year 2017-2026 with designs which were prospective, retrospective, cross-sectional, and observational designs of diagnosis imaging. The sample size was between 50 and 190 patients with some of the studies also reporting lesion-level analyses. The studies included assessed a wide range of focal hepatic lesions, including hepatocellular carcinoma (HCC), metastases, hemangiomas, simple cysts, focal nodular hyperplasia (FNH), adenomas, abscesses, and intrahepatic cholangiocarcinoma. References criteria were different in different studies and encompassed histopathology, biopsy, cytology, MRI, ultrasonography, follow-up imaging and composite diagnostic criteria. Table 1 summarizes the main study characteristics and the main findings.

Table 1. Characteristics of the Included Studies

Author (Year)	Study Design	Sample Size	Lesion Types/Characteristics	Diagnostic Confirmation Method	Major Diagnostic Findings
Adhikari et al. (2024)	Prospective cross-sectional study	60 patients	HCC, hemangioma, intrahepatic cholangiocarcinoma, and other focal liver lesions	Histopathology	High diagnostic performance; sensitivity 93% and accuracy 95.5%.
Imbriaco et al. (2017)	Prospective comparative diagnostic study	73 patients; 125 lesions	74 HCC and 51 benign lesions	Pathology and/or 12-month CT/MRI follow-up	Good HCC detection performance with an overall AUC of 0.852.
Khurana et al. (2026)	Cross-sectional observational study	64 patients	Hemangioma, FNH, adenoma, cyst, abscess, HCC, metastasis, and cholangiocarcinoma	Histopathological and clinical-imaging correlation	Effective benign–malignant differentiation using enhancement and washout patterns.
Mittal & Kumbhar (2024)	Prospective observational study	80 patients; 299 lesions	154 benign and 145 malignant lesions; metastases and hemangiomas predominated	Biopsy and composite reference standard	High lesion-specific performance with 100% specificity across reported categories.
Musa et al. (2025)	Retrospective diagnostic study	190 patients	HCC, metastases, hemangioma, cyst, abscess, and other hepatic lesions	Histopathology	High accuracy for cysts, HCC, abscesses, and metastases.
Patil et al. (2024)	Cross-sectional study	50 patients	FNH, abscess, hemangioma, granuloma, HCC, and metastases	Triple-phase CT with sonoelastographic assessment	Characteristic enhancement patterns supported benign–malignant differentiation.
Pratap et al. (2025)	Cross-sectional observational study	135 patients	Benign and malignant hepatic lesions	Radiologist-based imaging assessment	Portal venous phase showed highest lesion conspicuity; arterial and delayed phases added complementary information.
Satyampet & Kumar (2021)	Prospective observational study	50 patients	Abscess, metastasis, HCC, hemangioma, cyst, hydatid, and other liver lesions	Histopathology/cytology and clinical-imaging correlation	High overall performance in differentiating benign and malignant lesions.
Tatikonda et al. (2021)	Longitudinal prospective study	60 patients; 200 lesions	141 malignant and 59 benign lesions, including metastases, HCC, hemangioma, cyst, abscess, FNH, and adenoma	Biopsy, USG, MRI, and follow-up	High sensitivity and specificity across hypervascular and hypovascular lesions.
Tyagi et al. (2026)	Prospective observational study	100 patients	HCC, hemangioma, metastases, and other focal liver lesions	CT-based final diagnosis following USG evaluation	Triple-phase CT refined or altered diagnosis in 22% of cases; washout, capsule, and vascular invasion supported malignancy.

3.3 Phase-Wise Triple-Phase CT Acquisition

The included studies had a three-phase strategy of acquisition that was largely consistent, with specific scanner configuration and timing varying across studies. Arterial phase was usually acquired in the range of about 20-40 seconds following contrast administration and was mostly utilized in examining lesion vascularity and detecting hypervascular lesions. The portal venous phase, which is usually obtained at a period of 60-75 seconds, enhanced lesion-to-liver contrast, and facilitated the visualization of hypovascular lesions. The delayed/equilibrium phase which was typically obtained between 180 seconds and several minutes was suitable in assessing washout, contrast retention, and delayed enhancement (Table 2). These phase-specific functions were consistently observed multidetector CT systems with varying acquirings in the studies (Adhikari et al., 2024; Khurana et al., 2026; Pratap et al., 2025).

Table 2. Phase-Wise Triple-Phase CT Acquisition and Diagnostic Role

Acquisition Component	Typical Timing/Approach	Main Diagnostic Purpose	Studies
Arterial phase	Approximately 20–40 s after contrast administration	Assessment of lesion vascularity and detection of hypervascular lesions	Adhikari et al. (2024); Pratap et al. (2025)
Portal venous phase	Approximately 60–75 s	Improved lesion-to-liver contrast and visualization of hypovascular lesions	Pratap et al. (2025); Tatikonda et al. (2021)
Delayed/equilibrium phase	Approximately 180 s to several minutes	Evaluation of washout, contrast retention, and delayed enhancement	Adhikari et al. (2024); Khurana et al. (2026)
Scanner configuration	Multidetector CT systems ranging from 16- to 192-slice scanners	Rapid multiphase acquisition with improved temporal and spatial resolution	Tatikonda et al. (2021); Khurana et al. (2026)
Contrast administration	Intravenous iodinated contrast followed by sequential phase acquisition	Demonstration of dynamic enhancement behavior of focal hepatic lesions	Khurana et al. (2026); Adhikari et al. (2024)
Protocol variation	Differences in scanner type and exact acquisition timing	Contributed to methodological heterogeneity across studies	Adhikari et al. (2024); Khurana et al. (2026); Pratap et al. (2025)

3.4 Role of Triple-Phase CT in Lesion Detection

Triple phase CT demonstrated a consistent benefit in lesion detection with supplementary information during the arterial, portal venous and delayed stages. Arterial phase was especially practical in identifying small hypervascular lesions, especially HCC, but the portal venous phase made visualization of hypovascular lesions and a large number of metastases easier, due to an increase in the lesion-to-liver contrast. Tatikonda et al. (2021) indicated specifically that the hepatic arterial phase was useful in detecting small hypervascular lesions, whereas the portal venous phase was more helpful in detecting small hypovascular lesions. As Pratap et al. (2025), the portal venous phase was identified as the most desirable one to offer the highest level of lesion conspicuity, and arterial and delayed phases provided additional diagnostic data. Tyagi et al. (2026) also demonstrated that triple phase CT refined or altered the original ultrasonographic diagnosis in 22% of cases, demonstrating the added value of triple phase CT in the characterization of the lesion once the initial diagnosis has been established.

All in all, the results showed that none of the phases alone was adequate to all types of lesions but the combination of all three phases enhanced the lesion visibility and diagnostic confidence in both hypervascular and hypovascular lesions of the liver.

3.5 Characterization of Focal Hepatic Lesions

A trio phase CT allowed the characterization of the focal hepatic lesions by showing lesion-specific enhancement patterns throughout the arterial, portal venous, and delayed stages. HCC was usually characterized by the arterial hyperenhancement and washout in portal venous or delayed imaging, capsule formation, and vascular invasion indicating malignancy (Adhikari et al., 2024; Tyagi et al., 2026). Peripheral nodular arterial enhancement with progressive centripetal fill-in was typically exhibited by hemangiomas, but hypovascular metastases were more prominent in the portal venous phase (Patil et al., 2024; Tatikonda et al., 2021). Other benign lesions such as simple cysts and FNH had the typical non-enhancing or homogeneous pattern of enhancement, whereas intrahepatic cholangiocarcinoma had progressive delayed enhancement (Table 3). This pattern variations based on the phase helped distinguish between benign and malignant focal hepatic lesion.

Table 3. Triple-Phase CT Enhancement Patterns of Focal Hepatic Lesions

Lesion	Arterial Phase	Portal Venous Phase	Delayed Phase	Diagnostic Interpretation	Studies

HCC	Hyperenhancement, often heterogeneous	Relative washout	Persistent washout ± capsule	Typical hypervascular malignant pattern	Adhikari et al. (2024); Tyagi et al. (2026)
Metastasis	Hypoenhancing or peripheral/rim enhancement	Increased conspicuity; commonly hypodense	Persistent hypoenhancement or variable washout	Malignant pattern dependent on vascularity	Tatikonda et al. (2021)
Hemangioma	Peripheral nodular enhancement	Progressive centripetal fill-in	Continued or complete fill-in	Characteristic benign vascular pattern	Patil et al. (2024)
Simple cyst	No enhancement	No enhancement	No enhancement	Benign fluid-containing lesion	Tatikonda et al. (2021)
FNH	Strong, usually homogeneous enhancement	Approaches isodensity	Possible delayed central scar enhancement	Typical benign hepatocellular pattern	Tatikonda et al. (2021)
Adenoma	Arterial hyperenhancement	Variable enhancement	Variable washout	May overlap with other hypervascular lesions	Tatikonda et al. (2021)
Abscess	Peripheral/rim enhancement	Persistent enhancing rim with hypodense center	Variable persistent rim enhancement	Suggestive of inflammatory lesion	Tatikonda et al. (2021)
Intrahepatic cholangiocarcinoma	Peripheral/incomplete enhancement	Progressive enhancement	Delayed enhancement	Fibrous malignant enhancement pattern	Adhikari et al. (2024)

3.6 Diagnostic Performance of Triple-Phase CT

The studies included tended to exhibit good diagnostic outcomes of triple-phase CT of distinguishing benign and malignant focal hepatic lesions. Adhikari et al. (2024) have provided a sensitivity of 93, specificity of 50, positive predictive value of 91 and a diagnostic accuracy of 95.5. The lesion-specific accuracy was also high in Musa et al. (2025) with 95.3% cysts, 92.0% metastases, 91.1% abscess, and 90.1% HCC, which was in good agreement with histopathological results.

Equally, Tatikonda et al. (2021) had a 100% sensitivity in abscesses, simple cysts, focal nodular hyperplasia, and intrahepatic cholangiocarcinoma, with sensitivity of 79.0, 92.3, and 91.1 in HCC, hemangioma, and metastases, respectively. Imbriaco et al. (2017) indicated that the detection of HCC had an overall CT accuracy of 81% and Khurana et al. (2026) reported an approximate overall diagnostic accuracy of about 92% to differentiate between benign and malignant lesions. In general, the results show that triple-phase CT is highly diagnostic in a variety of focal hepatic lesions, but the diagnostic performance differs depending on the type of the lesion, its enhancement pattern, and the reference standard.

3.7 Risk of Bias Assessment

The QUADAS-2 tool was used to determine the quality of methodology of the 10 included studies, addressing four areas: patient selection, index test, reference standard, and flow and timing. The evaluation revealed that a majority of the studies were of low risk of bias in selecting patients and evaluating index-tests. The primary methodological issues were associated with the reference standard, especially in the studies involving the use of composite diagnostic criteria, imaging follow-up, or unevenly pathologically confirmed. Fewer studies also expressed concerns about flow and timing since the interval or consistency between CT evaluation and diagnostic confirmation was not clearly indicated in all the studies. QUADAS-2 assessment revealed that the majority of studies were low-risk in the patient selection and index-test domains, but there were some concerns in the areas of reference standard and flow-and-timing domains as illustrated in Figure 2.

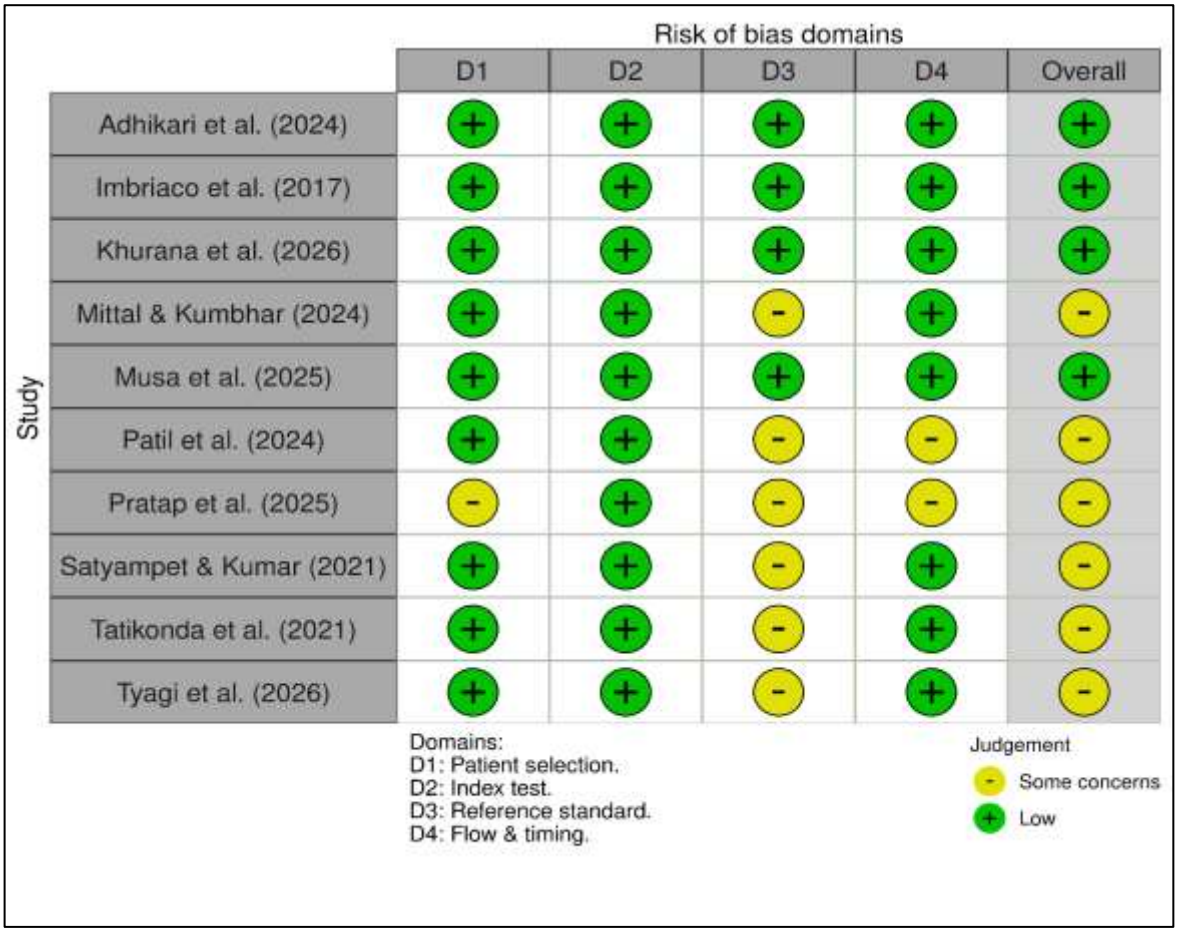

Figure 2. Traffic-light plot summarizing the QUADAS-2 risk-of-bias assessment of the included studies

All in all, the studies included were deemed to have acceptable methodological quality, but the reference-standard domain was the main source of possible bias, whereas patient selection and index-test assessment were mostly low-risk factors.

3.8 Overall Evidence Synthesis

In general, the findings had a consistent tendency to prove that triple-phase CT is valuable in the detection and characterization of focal hepatic lesions. The arterial phase proved especially useful in the detection of hypervascular lesions, the portal venous phase better conspicuity of most of the hypovascular lesions and metastases and the delayed phase was useful in the evaluation of washout, capsule formation, progressive fill-in, and delayed enhancement. These complementary phase-specific findings in the studies included supported differentiation between benign and malignant lesions and, in general, good diagnostic performance. Despite the fact that the types of lesions, CT acquisition protocols, sample sizes and diagnostic confirmation methods varied, the aggregate evidence indicates that triple-phase CT is a valuable and effective imaging technique that can provide an in-depth assessment of focal hepatic lesions.

4. DISCUSSION

The current systematic review indicates that triple-phase CT has a significant diagnostic value in the assessment of focal hepatic lesions through the integration of complementary data of the arterial phase, portal venous phase, and delayed phase. Throughout the incorporated articles, arterial phase was especially helpful to identify hypervascular lesions, the portal venous phase helped better visualize hypovascular lesions and metastases, and delayed phase helped to measure washout, capsule formation, contrast retention, and progressive enhancement. This stage-dependent behaviour justifies the fact that multiphasic measurement was always more informative as compared to relying on only one acquisition phase. The results are in accordance with the literature showing that multidetector CT is capable of characterizing hepatic masses by taking advantage of changes in vascularity and contrast enhancement through phases (Rehman et al., 2021).

The diagnostic performance of the evidence used was generally positive but differed depending on the type of lesion and the method of confirmation. In various studies sensitivity and accuracy were high and overall accuracy reported in some cases of benign and malignant differentiation was as high as 90 percent with their detection of HCC at approximately 81 percent. These findings are in line with the findings of Hasinuzzaman et al. (2026), who compared triple-phase MDCT with histopathology to detect HCC in patients with cirrhosis and proved that this method is a valuable diagnostic tool. Equally, Jain et al. (2019) found that MDCT could be applied in the characterization of lesions in addition to detection; the characterization was based on the enhancement morphology and vascular behavior. The present review can thus support the clinical significance of focusing on the overall multiphasic pattern of enhancement and not necessarily on lesion attenuation alone.

The patterns of lesion-specific enhancement were of specific significance in the differentiation between benign and malignant abnormalities. HCC tended to exhibit arterial hyperenhancement with subsequent washout, having hemangiomas tended to exhibit peripheral nodular enhancement with progressive centripetal fill-in and metastases tended to be more prominent at the portal venous phase. These observations are clinically significant as they may help to minimize diagnostic uncertainty by identification of normal enhancement features, which may be used to inform subsequent investigation. Ebeed et al. (2024) also highlighted the importance of multislice triphasic CT in the evaluation of metastatic hepatic lesions, especially in cases where lesion conspicuity can be altered as a result of treatment. Besides, Abba et al. (2024) reported a wide range of abnormalities observed on triphasic liver CT, which is why it is beneficial in the daily radiological practice.

The implications of the findings to the workflow and treatment planning are also important. Triple-phase CT has the potential to offer a quick and inexpensive way to characterize lesions, assist in deciding whether further MRI or biopsy is needed, and aid in staging and therapeutic decision-making. The new artificial-intelligence methods have the potential to improve interpretation. Nakai et al. (2021) showed that it is possible to combine triple-phase CT with tumor-marker data with convolutional neural networks to classify primary liver cancer, and Younger et al. (2026) emphasized the increased opportunities of AI-supported multiphase CT interpretation in HCC diagnosis. However, AI is supposed to be used as a complement to radiological evaluation and not to replace the expert interpretation.

Various restrictions must be noted. There was a great deal of heterogeneity in the sample size, lesion spectrum, CT scanner configuration, phase timing, and diagnostic confirmation methods. A few studies employed histopathology, but most studies employed imaging follow-up, composite criteria, or radiologist-based diagnosis, which might have led to variation in the diagnostic accuracy reported. The reference-standard domain was found to be the major methodological issue, as well, as the risk-of-bias assessment revealed. Standardized acquisition protocols and uniform timing of phases as well as larger multicenter populations and uniform histopathological validation should thus be used in future studies. Direct comparisons of MRI and prospective analysis of the lesion-specific diagnostic performance would further define the best clinical use of triple-phase CT.

5. CONCLUSION

This systematic review affirms that triple-phase CT is a useful imaging modality to detect and describe focal hepatic lesions. The integrated effect of arterial, portal venous and delayed phases give complementary data on the lesion vascularity, enhancement behavior, washout, capsule formation, progressive fill-in and delayed contrast retention. These phase-selective features enhance lesion conspicuity and differentiate between typical benign and malignant hepatic lesions, such as hepatocellular carcinoma, metastases, hemangiomas, cysts, focal nodular hyperplasia, abscesses, and intrahepatic cholangiocarcinoma. In the studies included, triple-phase CT had a generally good diagnostic performance, but the accuracy depended on the type of lesion, the study population, the acquisition protocol, and the method of diagnostic confirmation. The arterial phase was specifically helpful in hypervascular lesions and the portal venous phase was effective in improving the detection of most of the hypovascular lesions and metastases. The delayed stage also helped in characterization through showing washout or progressive improvement trends. Although there is methodological heterogeneity, the existing evidence confirms the clinical usefulness of triple phase CT as a fast, convenient, and dependable modality of overall assessment of liver lesions. To increase the strength of the evidence base, multicenter prospective studies with standardized phase timing, equal diagnostic criteria, and equal reference standards are required in the future to further establish its role compared to MRI and other advanced imaging modalities.

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