SSR Institute of International Journal of Life Sciences
ISSN (O): 2581-8740 | ISSN (P): 2581-8732
Adhikari *et al*., 2024
DOI: 10.21276/SSR-IIJLS.2024.10.6.10

Original Article

open access

Triple Phase CT scan in Focal Liver Lesion with Histopathology Correlation

Kamal Adhikari[1*], Mamata Bhattarai[1], Ramendra Kumar Raman[2], Subaj Bhattarai[1], Hensen Khadka[1], Bikash Bikram Adhikari[1], Sagar Dahal[3], Sadhana Dahal[4]

[1]Department of Radiodiagnosis, NAMS (Bir Hospital), Kathmandu, Nepal
[2]Department of Anatomy, Kantipur Dental College Teaching Hospital, Kathmandu, Nepal
[3]Department of Anaesthesiology, Nepal Medical College, Nepal
[4]National Medicine Laboratory, Kathmandu, Nepal

***Address for Correspondence:** Dr. Kamal Adhikari, Department of Radiodiagnosis, NAMS (Bir Hospital), Kathmandu, Nepal
E-mail: radionams@gmail.com

Received: 23 Jun 2024/ Revised: 24 Aug 2024/ Accepted: 26 Oct 2024

ABSTRACT

Background: The diagnostic evaluation of liver lesions is critical for accurate clinical management, and imaging plays a pivotal role in this process. This study focuses on assessing the diagnostic performance of triple-phase computed tomography (CT) in characterizing liver lesions, with its findings validated against histopathological results to ensure accuracy and reliability. This study evaluates the diagnostic performance of triple-phase computed tomography (CT) in the assessment of liver lesions, correlating its findings with histopathological results.

Methods: This prospective cross-sectional study was conducted as a prospective cross-sectional study from December 2019 to September 2020, the research involved 60 patients who underwent triple-phase CT with subsequent histopathology for comparison.

Results: The study found hepatocellular carcinoma (HCC) as the most common malignancy. Three enhancement patterns were observed: homogeneous, abnormal internal vessels, and heterogeneous enhancement, with the abnormal internal vessel pattern showing the highest specificity (90.6%) and positive predictive value (PPV) (78.6%). Rapid washout yielded a specificity of 87.5% and PPV of 72.2% for HCC diagnosis. Dynamic contrast CT demonstrated an overall sensitivity of 93%, specificity of 50%, PPV of 91%, and a diagnostic accuracy of 95.5% in distinguishing benign from malignant lesions.

Conclusion: This study highlights the value of triple-phase CT for liver lesion characterization, supporting its use as a diagnostic tool to guide therapeutic decisions.

Key-words: Focal liver lesion, Histopathology correlation, Hepatocellular carcinoma, Positive predictive value, Triple phase CT scan

INTRODUCTION

The liver, due to its dual blood supply and vital metabolic functions, is prone to a wide range of pathologies, from benign cysts to malignant tumors such as hepatocellular carcinoma (HCC) and metastatic disease [1].

How to cite this article
Adhikari K, Bhattarai M, Raman RK, Bhattarai S, Khadka H, et al. Triple Phase CT scan in Focal Liver Lesion with Histopathology Correlation. SSR Inst Int J Life Sci., 2024; 10(6): 6417-6421.

Access this article online
https://iijls.com/

Differentiating benign from malignant liver lesions is essential for optimal patient management, as treatment varies significantly based on lesion type [2]. Ultrasound, often used as an initial imaging tool, has limited specificity, while magnetic resonance imaging (MRI) is highly effective but less accessible, reserved mainly for inconclusive cases [3].

Triple-phase computed tomography (CT) has become a preferred modality for liver imaging, as it captures arterial, portal venous, and equilibrium phases, which reveal distinct enhancement patterns that aid in lesion characterization. For instance, hypervascular lesions like HCC typically show arterial enhancement with rapid

DOI: 10.21276/SSR-IIJLS.2024.10.6.10

washout, while benign hemangiomas display peripheral nodular enhancement [4,5]. The Liver Imaging Reporting and Data System (LI-RADS) further enhances diagnostic consistency by categorizing liver lesions based on risk, aiding interdisciplinary diagnosis and management [2].

Given the increasing incidence of liver malignancies, this study evaluates the diagnostic accuracy of triple-phase CT in characterizing liver lesions. By comparing CT findings with histopathological results, this research aims to validate triple-phase CT as a non-invasive, first-line diagnostic tool for distinguishing between benign and malignant hepatic lesions, enhancing diagnostic standards and early detection rates.

MATERIALS AND METHODS

Study Design and Setting- This prospective cross-sectional study was conducted in the Radiology Department at the National Academy of Medical Sciences, where 60 adult patients with suspected liver pathology were enrolled. The sample size was calculated based on the prevalence of liver disease, providing a representative cohort of patients.

Inclusion and Exclusion Criteria- Patients included were those aged 18 or older with suspected liver pathology based on clinical or preliminary imaging findings, such as ultrasound. Exclusion criteria involved patients with known liver pathology, contrast agent allergies, inconclusive biopsy results, or other contraindications to contrast-enhanced CT [3].

CT Imaging Protocol- Triple-phase CT imaging was performed using a Philips Ingenuity 128-slice CT scanner with the following phases:

- **Arterial Phase (30-40 seconds):** Enhances hypervascular lesions, essential for identifying tumors such as HCC.
- **Portal Venous Phase (70 seconds):** Highlights both hypervascular and hypovascular lesions, improving lesion contrast.
- **Equilibrium Phase (180 seconds):** Depicts contrast retention differences between benign and malignant lesions.

Radiological findings were classified based on the Liver Imaging Reporting and Data System (LI-RADS) and later compared with histopathology.

Statistical Analysis- Data were analyzed using SPSS version 20.0, with sensitivity, specificity, PPV, and diagnostic accuracy calculated. Statistical significance was set at $p<0.05$.

RESULTS

Table 1 presents a comprehensive summary of the demographic and clinical characteristics of the patient cohort, highlighting key variables such as age, gender distribution, medical history, and relevant clinical parameters.

Table 1: demographic and clinical characteristics of the patient cohort

Characteristic	Total Patients (n=60)
Mean Age (years)	54 ± 12
Male (%)	65%
Female (%)	35%
Malignant Lesions	82.9%
Benign Lesions	17.1%

Performance of Triple-Phase CT in Lesion Characterization- The triple-phase CT scan was effective in detecting significant malignant lesions and accurately distinguishing between benign and malignant liver lesions.

Table 2: Performance of Triple-Phase CT in Lesion Characterization

Lesion Type	Enhancement Pattern	Se	Sp	Pp	DA
HCC	Abnormal internal vessels	90.6	78.6	72.2	95.5
HH	Peripheral nodular	93	50	91	95.5
IC	Delayed enhancement	81.3	50	75	90.2

Se= Sensitivity (%); Sp= Specificity (%); Pp= PPV (%); DA= Diagnostic Accuracy (%)
HH= Hepatic Hemangiomas; IC= Intrahepatic Cholangiocarcinoma

Hepatocellular Carcinoma (HCC)- HCC was the most diagnosed malignancy, with three enhancement patterns observed: homogeneous, abnormal internal vessels, and heterogeneous. The abnormal internal vessel pattern

DOI: 10.21276/SSR-IIJLS.2024.10.6.10

yielded the highest specificity (90.6%) and PPV (78.6%), correlating with previous studies indicating that vascular abnormalities are predictive of malignancy.

Table 3: Hepatocellular Carcinoma (HCC)

Enhancement Pattern	Specificity (%)	PPV (%)
Abnormal internal vessels	90.6	78.6
Rapid washout	87.5	72.2

Benign Lesions: Hemangiomas, Abscesses, and Adenomas- Among benign lesions, hemangiomas demonstrated characteristic peripheral nodular enhancement, with a diagnostic accuracy of 95.5%, consistent with Leslie et al.'s findings that peripheral nodular enhancement is indicative of benignity. Liver abscesses and hepatic adenomas presented with hypodense regions and peripheral rim enhancements, respectively, matching descriptions in Kim *et al.* study on adenoma presentations.

Comparison with Histopathology Findings- Histopathology confirmed the accuracy of triple-phase CT in detecting focal liver lesions, with an overall sensitivity of 93%, specificity of 50%, and PPV of 91%. The study demonstrated a high diagnostic accuracy (95.5%) for triple-phase CT in distinguishing malignant from benign liver lesions, comparable to biopsy findings and prior research.

DISCUSSION

The findings of this study highlight the significant diagnostic accuracy of triple-phase computed tomography (CT) in differentiating benign from malignant liver lesions, supporting its continued use as a primary imaging modality in hepatic lesion assessment. This study's high specificity and positive predictive value (PPV) for hepatocellular carcinoma (HCC) in cases with abnormal internal vessel patterns align with existing literature, which demonstrates that such vascular characteristics are highly indicative of malignancy. Previous studies have similarly reported that the presence of internal vessels and rapid washout patterns in arterial and venous phases are reliable indicators of HCC, given the lesion's typical reliance on arterial blood supply [5].

The utility of triple-phase CT, particularly in detecting early-stage HCC, is critical in a clinical landscape where timely diagnosis can substantially impact patient outcomes. Studies by Van Leeuwen *et al.* [4] also found triple-phase CT to be especially effective in identifying hypervascular liver tumors during the arterial phase, an observation that aligns with our study's results showing high sensitivity for malignant lesions with rapid arterial enhancement. Further, the liver-specific enhancement pattern of hemangiomas, often characterized by peripheral nodular enhancement on triple-phase CT, showed high diagnostic accuracy in distinguishing these benign lesions, corroborating findings by Leslie *et al.* [6], who highlighted peripheral nodular enhancement as a key diagnostic feature.

Benign lesions, such as hemangiomas, displayed characteristic peripheral nodular enhancement with a diagnostic accuracy of 95.5%, corroborating Leslie et al.'s observation that this feature is a reliable indicator of benignity [6,8]. Similarly, liver abscesses appeared as hypodense regions, while hepatic adenomas demonstrated peripheral rim enhancement, in agreement with the imaging characteristics described by Kim *et al.* [9].

A notable finding in our study was the specificity and diagnostic accuracy of LI-RADS category 5 in diagnosing HCC, which aligns with the American College of Radiology's recommendations for using LI-RADS as a standardized reporting tool for liver lesions (Hafeez *et al.* [2]. In practice, these structured reporting systems can facilitate communication among radiologists, hepatologists, and oncologists, fostering an interdisciplinary approach to liver lesion management [10-13]. Additionally, the non-invasive nature of triple-phase CT makes it particularly useful for high-risk patients or those for whom biopsy poses a significant risk due to coagulopathy or other complications [14-16].

CLINICAL IMPLICATIONS

The findings underscore the value of triple-phase CT in clinical practice, especially for patients at high risk of HCC, including those with chronic liver disease or cirrhosis. Given the high diagnostic accuracy, incorporating triple-phase CT as part of a regular screening protocol in high-risk populations could enhance early detection rates of HCC, potentially improving prognosis through earlier intervention.

DOI: 10.21276/SSR-IIJLS.2024.10.6.10

Furthermore, for benign lesions such as hemangiomas or hepatic adenomas, triple-phase CT can reduce the need for biopsy by providing characteristic imaging patterns that are often sufficient for diagnosis, reducing both patient discomfort and procedural risks [1].

FUTURE DIRECTIONS

While the results of this study are promising, further research is necessary to refine and enhance the diagnostic protocols associated with triple-phase CT. Future studies should involve larger, multi-center cohorts to validate these findings across diverse populations and explore the role of advanced imaging techniques, such as contrast-enhanced ultrasound (CEUS) and magnetic resonance imaging (MRI), in combination with triple-phase CT. Such multimodal imaging approaches may improve diagnostic accuracy, particularly for complex cases where the lesion's vascularity is not visualized on CT alone.

Additionally, research should focus on optimizing the timing and contrast protocols within the three-phase CT technique to minimize false-negative results and improve specificity for challenging cases. For example, adjusting the timing of the arterial phase to capture rapid arterial enhancement could improve the detection of smaller, hypervascular lesions, an area that holds potential for improving early HCC diagnosis [7]. Integrating artificial intelligence and machine learning algorithms into CT image analysis may also help standardize and enhance lesion characterization, potentially providing automated insights into subtle changes in enhancement patterns that might be difficult to detect visually.

Lastly, prospective longitudinal studies are needed to evaluate the outcomes of patients diagnosed with liver lesions through triple-phase CT versus those diagnosed through other imaging modalities or biopsy alone. This could provide valuable data on the long-term benefits of using non-invasive imaging for early diagnosis and monitoring in patients with liver disease, potentially leading to a revision of clinical guidelines for liver cancer screening and management.

CONCLUSIONS

In conclusion, triple-phase CT emerges as a powerful diagnostic tool for liver lesion characterization, providing clinicians with reliable data to make informed decisions about patient management. The study's findings affirm the clinical value of specific enhancement patterns, which aid in differentiating between benign and malignant lesions. Further research on timing protocols, combined imaging approaches, and AI integration will enhance the role of triple-phase CT in hepatology, paving the way for even more precise, non-invasive diagnostic strategies.

CONTRIBUTION OF AUTHORS

Research concept-Kamal Adhikari
Research design- Dr Ramendra Kumar Raman
Supervision-Kamal Adhikari
Materials-Bikash Bikram Adhikari, Sagar Dahal, Sadhana Dahal
Data collection-Subaj bhattarai, Hensen Khadka
Data analysis and Interpretation- Kamal Adhikari
Literature search- Bikash Bikram Adhikari, Sagar Dahal, Sadhana Dahal
Writing article-Mamata Bhattarai
Critical review-Kamal Adhikari
Article editing-Subaj bhattarai, Hensen Khadka
Final approval-Kamal Adhikari

REFERENCES

[1] Ahirwar CP, Patil A, Soni N. Role of triple-phase computed tomography findings for evaluation of hepatic lesions. Int J Res Med Sci., 2016; 4(8): 3576-81. doi: 10.18203/2320-6012.ijrms20162332.

[2] Hafeez S, Alam MS, Sajjad Z, Khan ZA, Akhter W, Mubarak F. Triphasic computed tomography (CT) scan in focal tumoral liver lesions. J Pak Medical Assoc., 2011; 61(6): 571-74.

[3] Mishra AK, Shrestha P, Bista NR, Bhurtel P, Bhattarai S, Thakali K, Pathak SR. Pattern of liver diseases. J Nepal Health Res Council., 2009; 7(1): 14-18.

[4] Van Leeuwen MS, Noordzij J, Feldberg MA, Hennipman AH, Doornewaard H. Focal liver lesions: characterization with triphasic spiral CT. Radiol., 1996; 201(2): 327-36. doi: 10.1148/radiology.201.2.8888219.

[5] Oliva MR, Saini S. Liver cancer imaging: role of CT, MRI, US, and PET. Cancer Imaging. 2004; 4(Spec No A). doi: 10.1102/1470-7330.2004.0011.

[6] Leslie DF, Johnson CD, Ilstrup DM, Harmsen WS. Distinction between cavernous hemangiomas of the liver and hepatic metastases on CT: value of contrast

DOI: 10.21276/SSR-IIJLS.2024.10.6.10

enhancement patterns. AJR Am J Roentgenol., 1995; 164(3): 625-29. doi: 10.2214/ajr.164.3.7863883.

[7] Karahan OI, Yikilmaz A, Isin S, Orhan S. Characterization of hepatocellular carcinomas with triphasic CT and correlation with histopathologic findings. Acta Radiologica., 2003; 44(6): 566-71. doi: 10.1046/j.1600-0455.2003.00148.x.

[8] Gazelle GS, Lee MJ, Mueller PR. Cholangiographic segmental anatomy of the liver. Radiographics. 1994 Sep; 14(5): 1005-13. doi: 10.1148/radiographics. 14.5.7991810.

[9] Kim KW, Kim TK, Han JK, Kim AY, Lee HJ, Choi BI. Hepatic hemangiomas with arterioportal shunt: findings at two-phase CT. Radiol., 2001; 219(3): 707-11. doi: 10.1148/radiology.219.3.r01ma05707.

[10] Grazioli L, Zech CJ, Breuer J, Reiser MF, Schoenberg SO. Diagnostic performance and description of morphological features of focal nodular hyperplasia in Gd-EOB-DTPA-enhanced liver magnetic resonance imaging: results of a multicenter trial. Investig Radiol., 2008; 43(7): 504-11. doi: 10.1097/RLI.0b0 13e3181705cd1.

[11] Javan R, Herrin D, Tangestanipoor A. Understanding spatially complex segmental and branch anatomy using 3D printing: liver, lung, prostate, coronary arteries, and circle of Willis. Academic Radiol., 2016 Sep; 23(9): 1183-89. doi: 10.1016/j.acra.2016. 04.010.

[12] Rockey DC, Caldwell SH, Goodman ZD, Nelson RC, Smith AD. Liver biopsy. Hepatol., 2009; 49(3): 1017-44. doi: 10.1002/hep.22742.

[13] Strunk H, Stuckmann G, Textor J, Willinek W. Limitations and pitfalls of Couinaud's segmentation of the liver in transaxial imaging. Eur Radiol., 2003 Nov; 13(11): 2472-82.

[14] Soyer P. Segmental anatomy of the liver: utility of a nomenclature accepted worldwide. AJR Am J Roentgenol., 1993 Sep; 161(3): 572-73. doi: 10.2214/ajr.161.3.8352107.

[15] Guiney MJ, Kruskal JB, Sosna J, Hanto DW, Goldberg SN, Raptopoulos V. Multi-detector row CT of relevant vascular anatomy of the surgical plane in split-liver transplantation. Radiol. 2003; 229(2): 401-407. doi: 10.1148/radiol.2292021437.

[16] Marrero JA, Ahn J, Reddy KR. ACG clinical guideline: The diagnosis and management of focal liver lesions. Am J Gastroenterol., 2014; 109(9): 1328-47. doi: 10.1038/ajg.2014.213.