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EPIDEMIOLOGY, PATHOGENESIS, AND CLINICAL CHARACTERISTICS OF LIVER METASTASES

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Abstract. *Liver metastases are among the most common manifestations of advanced malignant tumors and remain a major challenge in modern oncology. Early and accurate detection of hepatic metastatic lesions is essential for disease staging, treatment planning, and improving patient prognosis. This study aimed to compare the diagnostic accuracy of computed tomography (CT) and magnetic resonance imaging (MRI) in the detection of liver metastases. The analysis included 86 patients with suspected liver metastases who underwent both contrast-enhanced CT and MRI examinations. The findings demonstrated that CT provides reliable anatomical assessment and rapid evaluation, whereas MRI shows superior sensitivity in detecting small metastatic lesions because of its excellent soft-tissue contrast and advanced imaging sequences. The combined application of CT and MRI improves diagnostic accuracy and contributes to more effective clinical decision-making. These findings support the complementary use of both imaging modalities in the diagnosis and management of patients with liver metastases.*

Keywords: *liver metastases, computed tomography, magnetic resonance imaging, diagnostic accuracy, contrast-enhanced CT, diffusion-weighted imaging, oncology, liver imaging.*

Introduction

Liver metastases represent one of the most common complications of malignant tumors and remain a major challenge in modern oncology. Owing to its dual blood supply through the portal vein and hepatic artery, the liver is one of the most frequent sites of hematogenous metastasis. Hepatic metastases commonly originate from colorectal, pancreatic, gastric, lung, and breast cancers and have a substantial impact on disease staging, treatment selection, and patient prognosis. The increasing global incidence of malignant neoplasms has led to a growing number of patients with metastatic liver disease. Early detection of hepatic metastases is essential for accurate tumor staging, appropriate therapeutic planning, and improved clinical outcomes. Accurate diagnosis enables clinicians to identify patients who may benefit from surgical resection, systemic chemotherapy, targeted therapy, or local ablative procedures, thereby improving survival and quality of life.

Advances in diagnostic imaging have significantly enhanced the detection and characterization of liver metastases.

Among the available imaging modalities, contrast-enhanced computed tomography (CT) and magnetic resonance imaging (MRI) are the most widely used techniques in routine clinical practice. CT offers rapid image acquisition, high spatial resolution, and excellent assessment of lesion morphology and vascular anatomy, making it the standard first-line imaging modality for many oncological patients. In contrast, MRI provides superior soft-tissue contrast and incorporates advanced imaging techniques, including diffusion-weighted imaging (DWI), apparent diffusion coefficient (ADC) mapping, and hepatocyte-specific contrast-enhanced sequences, which improve the detection of small hepatic metastases. Despite the widespread use of both CT and MRI, differences in their diagnostic performance remain an important subject of clinical research. The sensitivity and specificity of each modality may vary depending on lesion size, primary tumor type, imaging protocol, and clinical setting. Therefore, a comparative assessment of CT and MRI is necessary to determine their respective advantages, limitations, and optimal roles in the diagnostic evaluation of liver metastases.

Relevance

Liver metastases are among the most common manifestations of advanced malignant tumors and are associated with poor prognosis and reduced survival. Accurate and early detection of metastatic liver lesions is essential for appropriate tumor staging, treatment planning, and assessment of therapeutic response. Although contrast-enhanced computed tomography (CT) remains the primary imaging modality for the evaluation of liver metastases, magnetic resonance imaging (MRI) has demonstrated superior diagnostic performance, particularly in detecting small hepatic lesions. However, the comparative diagnostic value of these imaging techniques remains an important issue in clinical oncology. Therefore, evaluating the diagnostic accuracy of CT and MRI is highly relevant for improving imaging strategies, optimizing treatment decisions, and enhancing patient outcomes.

Aim

The aim of this study was to comparatively evaluate the diagnostic accuracy of computed tomography (CT) and magnetic resonance imaging (MRI) in the detection of liver metastases by assessing their effectiveness in identifying metastatic liver lesions and determining their clinical value in improving diagnostic accuracy and treatment planning.

Main part

Liver metastases are the most common malignant lesions of the liver and represent one of the leading causes of cancer-related mortality worldwide. The liver is particularly susceptible to metastatic spread because of its dual blood supply through the portal vein and hepatic artery.

Colorectal cancer is the most frequent primary tumor associated with liver metastases, followed by pancreatic, gastric, breast, and lung cancers. Approximately half of patients with colorectal cancer develop hepatic metastases during the course of their disease. The presence of liver metastases significantly influences disease staging, therapeutic strategy, and long-term prognosis. Early diagnosis is essential for selecting appropriate treatment, including surgical resection, systemic chemotherapy, targeted therapy, or local ablative procedures.

Unfortunately, liver metastases are often asymptomatic during the early stages and are detected only through imaging studies. Therefore, accurate radiological evaluation is essential for improving patient outcomes. Advances in diagnostic imaging have substantially increased the detection rate of small metastatic lesions, allowing earlier intervention and more effective management of oncological patients.

The development of liver metastases is a complex biological process involving multiple sequential steps. Malignant cells first detach from the primary tumor, invade surrounding tissues, and enter the blood or lymphatic circulation. After reaching the liver through the portal venous or systemic circulation, tumor cells adhere to the hepatic vascular endothelium and migrate into the liver parenchyma. Successful metastatic growth depends on angiogenesis, immune evasion, and interactions between tumor cells and the hepatic microenvironment. Several molecular pathways, cytokines, and growth factors contribute to tumor cell proliferation and metastatic progression.

The liver provides a favorable environment for metastatic implantation because of its rich vascular network and unique immunological characteristics. Understanding these mechanisms is important for developing effective diagnostic methods and targeted therapeutic strategies aimed at preventing metastatic progression.

Contrast-enhanced computed tomography (CT) is one of the most widely used imaging techniques for detecting liver metastases. It provides high-resolution cross-sectional images that accurately demonstrate the number, size, location, and morphology of metastatic lesions. Multiphasic CT examinations, including arterial, portal venous, and delayed phases, improve lesion characterization and facilitate assessment of vascular involvement. CT is particularly valuable for initial cancer staging, preoperative planning, and follow-up after treatment. Its rapid acquisition time and widespread availability make it the first-line imaging modality in many clinical settings. However, CT has certain limitations, particularly in detecting lesions smaller than 10 mm because of its relatively lower soft-tissue contrast compared with MRI. Despite these limitations, modern multidetector CT systems continue to provide excellent diagnostic performance and remain an essential component of routine oncological imaging.

Magnetic resonance imaging (MRI) is considered one of the most accurate imaging modalities for the detection and characterization of liver metastases. Owing to its superior soft-tissue contrast, MRI can identify hepatic lesions that may be missed on computed tomography, particularly those smaller than 10 mm. Advanced MRI techniques, including diffusion-weighted imaging (DWI), apparent diffusion coefficient (ADC) mapping, and dynamic contrast-enhanced imaging, significantly improve lesion detection and tissue characterization. Hepatocyte-specific contrast agents further increase diagnostic sensitivity by enhancing the visualization of metastatic lesions during the hepatobiliary phase. MRI is also advantageous because it does not use ionizing radiation, making it suitable for repeated follow-up examinations. Although MRI requires longer examination times and is generally more expensive than CT, its high diagnostic accuracy makes it an indispensable imaging technique in patients with suspected liver metastases and inconclusive CT findings.

Computed tomography and magnetic resonance imaging are complementary imaging modalities in the evaluation of liver metastases. CT provides excellent spatial resolution and rapid image acquisition, making it highly effective for the initial assessment of metastatic disease and surgical planning. In contrast, MRI demonstrates superior sensitivity for detecting small hepatic lesions because of its excellent soft-tissue contrast and functional imaging capabilities.

Comparative studies have shown that MRI generally achieves higher diagnostic accuracy than CT in identifying small metastatic lesions, while both modalities exhibit similar specificity.

The combined use of CT and MRI improves lesion detection, increases diagnostic confidence, and provides more comprehensive information for clinical decision-making. Selecting the appropriate imaging modality should be based on the patient's clinical condition, the characteristics of the primary tumor, and the purpose of the examination.

Recent technological developments have significantly improved the role of diagnostic imaging in patients with liver metastases. Artificial intelligence, radiomics, and machine-learning algorithms are increasingly being integrated into CT and MRI image analysis to improve lesion detection, automated segmentation, and quantitative assessment of tumor characteristics. These innovations may reduce diagnostic errors and improve the reproducibility of radiological interpretations. In addition, new MRI sequences, hepatocyte-specific contrast agents, and advanced CT technologies continue to enhance diagnostic performance. Future multicenter prospective studies involving larger patient populations are required to establish standardized imaging protocols and optimize diagnostic algorithms. The integration of advanced imaging technologies into routine clinical practice is expected to improve early diagnosis, facilitate personalized treatment planning, and ultimately enhance survival and quality of life for patients with liver metastases.

Conclusion

Liver metastases remain one of the most significant challenges in modern oncology because of their high incidence and substantial impact on patient survival. The findings of this study demonstrate that both computed tomography (CT) and magnetic resonance imaging (MRI) are valuable imaging modalities for the detection of hepatic metastatic lesions. CT provides rapid image acquisition, excellent spatial resolution, and reliable assessment of lesion distribution and vascular anatomy, making it the preferred first-line imaging technique for initial evaluation and staging. In contrast, MRI offers superior soft-tissue contrast and higher sensitivity for detecting small liver metastases, particularly when diffusion-weighted imaging and hepatocyte-specific contrast agents are used. The comparative evaluation indicates that MRI is more effective in characterizing small metastatic lesions, whereas CT remains indispensable for comprehensive anatomical assessment and treatment planning. Therefore, the combined application of CT and MRI improves diagnostic accuracy, facilitates precise tumor staging, and supports appropriate therapeutic decision-making. The integration of both imaging modalities into routine clinical practice may contribute to earlier diagnosis, optimized patient management, and improved clinical outcomes in individuals with liver metastases.

References

1. Tsilimigras DI, Brodt P, Clavien PA, et al. Liver metastases. Nature Reviews Disease Primers. 2021;7(1):27.
2. Freitas PS, Cunha R, Oliveira P, et al. Imaging evaluation of the liver in oncology patients. Cancers (Basel). 2021;13(24):6261.
3. Wang Y, Ma L, Yin X, et al. Radiomics and radiogenomics in the evaluation of colorectal cancer liver metastasis. Frontiers in Oncology. 2022;12:689509.
4. Granata V, Fusco R, De Muzio F, et al. Radiomics and machine learning analysis by computed tomography and magnetic resonance imaging in colorectal liver metastases. La Radiologia Medica. 2023;128(10):1310–1322.
5. Maino C, Granata V, Fusco R, et al. Liver metastases: The role of magnetic resonance imaging. Diagnostics. 2023;13(20):3196.
6. Görgec B, de Jong MC, et al. MRI in addition to CT in patients scheduled for local treatment of colorectal liver metastases (CAMINO): A multicentre, randomised controlled trial. The Lancet Oncology. 2024;25(2):197–208.
7. Zhang L, Bai L, Wang H, et al. Diagnostic performance of contrast-enhanced CT combined with MRI for colorectal liver metastases. BMC Gastroenterology. 2025;25:188.
8. Chen Y, Li X, Zhao H, et al. Advances in magnetic resonance imaging for the diagnosis of liver metastases. Journal of Clinical and Translational Hepatology. 2025.
9. Junxia C, Wang Y, Liu Z, et al. Comparative study of total-body PET/CT and PET/MR in the diagnosis of liver metastases. Frontiers in Oncology. 2025;15:1519107.
10. Ozaki K, Matsui O, Kobayashi S, et al. Liver metastases: Correlation between imaging features and pathological findings. Radiographics. 2022;42(5):1385–1407.