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COMPARATIVE EVALUATION OF THE DIAGNOSTIC ACCURACY OF CT AND MRI IN THE DETECTION OF LIVER METASTASES

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Abstract: Liver metastases are among the most common complications of malignant tumors and play a critical role in determining disease stage, treatment strategy, and 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. A total of 86 patients with suspected liver metastases underwent both contrast-enhanced CT and MRI examinations. The findings demonstrated that MRI was more effective in detecting small metastatic lesions, whereas CT provided reliable evaluation of lesion distribution and anatomical structures. The combined use of CT and MRI improved diagnostic accuracy and contributed to more effective clinical decision-making. These findings support the complementary role of both imaging modalities in the diagnosis of liver metastases.

Keywords: Liver metastases, computed tomography, magnetic resonance imaging, diagnostic accuracy, oncology, liver imaging, CT, MRI.

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СРАВНИТЕЛЬНАЯ ОЦЕНКА ДИАГНОСТИЧЕСКОЙ ТОЧНОСТИ КТ И МРТ ПРИ ВЫЯВЛЕНИИ МЕТАСТАЗОВ ПЕЧЕНИ

Аннотация: Метастазы печени являются одним из наиболее распространённых осложнений злокачественных новообразований и играют важную роль в определении стадии заболевания, выборе тактики лечения и прогнозе пациентов. Целью настоящего исследования являлась сравнительная оценка диагностической точности компьютерной томографии (КТ) и магнитно-резонансной томографии (МРТ) при выявлении метастазов печени. В исследование были включены 86 пациентов с подозрением на метастатическое поражение печени, которым были выполнены контрастно-усиленные КТ и МРТ. Полученные результаты показали, что МРТ обладает более высокой эффективностью при выявлении небольших метастатических очагов, тогда как КТ обеспечивает надёжную оценку распространённости поражения и анатомических структур. Комплексное применение КТ и МРТ позволило повысить диагностическую точность и улучшить принятие клинических решений. Полученные данные подтверждают взаимодополняющую роль обеих методов визуализации в диагностике метастазов печени.

Ключевые слова: метастазы печени, компьютерная томография, магнитно-резонансная томография, диагностическая точность, онкология, визуализация печени, КТ, МРТ.

JIGAR METASTAZLARINI ANIQLASHDA KT VA MRTNING DIAGNOSTIK ANIQLIGINI SOLISHTIRMA BAHOLASH

Annotatsiya: Jigar metastazlari xavfli o‘smalarning eng ko‘p uchraydigan asoratlaridan biri bo‘lib, kasallik bosqichini aniqlash, davolash strategiyasini tanlash va bemor prognozini belgilashda muhim ahamiyat kasb etadi. Ushbu tadqiqotning maqsadi jigar metastazlarini aniqlashda kompyuter tomografiyasi (KT) va magnit-rezonans tomografiyaning (MRT) diagnostik aniqligini qiyosiy baholashdan iborat. Tadqiqotga jigar metastazlariga shubha qilingan 86 nafar bemor jalb qilindi va ularda kontrast kuchaytirilgan KT hamda MRT tekshiruvlari o‘tkazildi. Natijalar MRT kichik metastatik o‘choqlarni aniqlashda yuqori samaradorlikka ega ekanligini, KT esa metastazlarning tarqalishi va anatomik tuzilmalarni baholashda ishonchli usul ekanligini ko‘rsatdi. KT va MRTni kompleks qo‘llash diagnostik aniqlikni oshirdi hamda klinik qaror qabul qilish samaradorligini yaxshiladi. Olingan natijalar jigar metastazlarini tashxislashda ushbu ikki usulning bir-birini to‘ldiruvchi ahamiyatga ega ekanligini tasdiqlaydi.

Kalit so‘zlar: jigar metastazlari, kompyuter tomografiyasi, magnit-rezonans tomografiya, diagnostik aniqlik, onkologiya, jigar tasvirlash, KT, MRT.

Introduction

Cancer remains one of the leading causes of morbidity and mortality worldwide, with metastatic disease representing the primary cause of cancer-related deaths. The liver is one of the most common sites of distant metastasis due to its dual blood supply and unique vascular anatomy. Liver metastases are frequently observed in patients with colorectal, pancreatic, gastric, lung, and breast cancers, significantly affecting treatment strategies and patient prognosis. Early and accurate detection of liver metastases is essential for disease staging, therapeutic planning, surgical decision-making, and evaluation of treatment response. Advances in diagnostic imaging have substantially improved the ability to identify hepatic metastatic lesions at an early stage. Among the available imaging modalities, computed tomography (CT) and magnetic resonance imaging (MRI) are considered the most valuable techniques for detecting and characterizing liver metastases in clinical practice.

Contrast-enhanced CT is widely used because of its rapid acquisition time, high spatial resolution, and ability to evaluate lesion morphology and vascular enhancement patterns. However, its diagnostic performance may be limited in detecting small lesions, particularly those measuring less than 10 mm. In contrast, MRI provides superior soft-tissue contrast and offers advanced imaging sequences, including diffusion-weighted imaging (DWI), apparent diffusion coefficient (ADC) mapping, and hepatocyte-specific contrast-enhanced imaging, which improve the detection and characterization of small metastatic lesions. Recent studies have demonstrated that both CT and MRI play important roles in the diagnosis of liver metastases; however, differences in their sensitivity, specificity, and overall diagnostic accuracy remain a subject of ongoing research. A comparative evaluation of these imaging modalities is therefore essential to determine their respective advantages, limitations, and optimal clinical applications. Such evidence may contribute to improving diagnostic algorithms and selecting the most appropriate imaging strategy for patients with suspected hepatic metastases.

Relevance

Liver metastases represent one of the most frequent manifestations of advanced malignant tumors and are associated with reduced survival and poor clinical outcomes. Accurate detection of metastatic liver lesions is crucial for tumor staging, treatment planning, surgical decision-making, and assessment of therapeutic response. Although contrast-enhanced computed tomography (CT) is widely used as the first-line imaging modality, magnetic resonance imaging (MRI) has demonstrated superior sensitivity for detecting small hepatic metastases due to its excellent soft-tissue contrast and advanced functional imaging techniques. However, the diagnostic performance of these modalities may vary depending on lesion size, primary tumor type, and imaging protocols. Therefore, a comparative evaluation of the diagnostic accuracy of CT and MRI remains highly relevant for optimizing imaging strategies and improving the clinical management of patients with suspected liver metastases.

Aim

The aim of this study was to comparatively evaluate the diagnostic accuracy of computed tomography (CT) and magnetic resonance imaging (MRI) in detecting liver metastases by assessing their sensitivity, specificity, and overall diagnostic performance, as well as to determine their clinical value in the diagnosis of metastatic liver lesions.

Main part

Liver metastasis is one of the most common manifestations of advanced malignant disease and represents a major cause of cancer-related mortality worldwide. Because of its dual blood supply through the hepatic artery and portal vein, the liver is particularly susceptible to hematogenous dissemination of tumor cells from primary malignancies. The highest incidence of hepatic metastases is observed in patients with colorectal cancer, although metastases frequently originate from pancreatic, gastric, breast, lung, and neuroendocrine tumors. The development of liver metastases significantly influences tumor staging, therapeutic planning, and long-term patient survival. In many cases, hepatic involvement is associated with advanced disease and limits the possibility of curative treatment. Consequently, early detection of metastatic lesions is essential for selecting the most appropriate therapeutic strategy, including surgical resection, systemic chemotherapy, targeted therapy, immunotherapy, or local ablative techniques. The increasing global incidence of malignant tumors has resulted in a growing number of patients with hepatic metastatic disease. Advances in oncological treatment have prolonged patient survival, making accurate imaging evaluation even more important during both initial staging and follow-up.

Contrast-enhanced computed tomography (CT) remains one of the primary imaging modalities for evaluating patients with suspected liver metastases. Owing to its high spatial resolution, rapid image acquisition, and widespread availability, CT is routinely used for cancer staging and treatment monitoring. Multiphasic contrast-enhanced CT, including arterial, portal venous, and

delayed phases, provides detailed information regarding lesion morphology, vascularity, and enhancement characteristics. These features enable radiologists to identify metastatic lesions, evaluate their size and distribution, and assess their relationship with adjacent vascular structures. CT also plays an important role in determining the resectability of liver metastases and planning surgical or interventional procedures. Despite these advantages, CT has several limitations. Small metastatic lesions, particularly those measuring less than 10 mm, may remain undetected because of limited soft-tissue contrast. In addition, exposure to ionizing radiation and the potential adverse effects of iodinated contrast agents should be considered, especially in patients requiring repeated imaging examinations. Recent technological advances, including multidetector CT and improved reconstruction algorithms, have significantly enhanced diagnostic performance.

Magnetic resonance imaging (MRI) is widely recognized as one of the most accurate imaging techniques for the detection and characterization of liver metastases. Compared with CT, MRI provides superior soft-tissue contrast, allowing more precise visualization of focal hepatic lesions. Modern MRI protocols combine conventional T1- and T2-weighted sequences with diffusion-weighted imaging (DWI), apparent diffusion coefficient (ADC) mapping, and dynamic contrast-enhanced imaging. These advanced techniques improve lesion detection, facilitate tissue characterization, and increase diagnostic confidence, particularly in patients with small or equivocal lesions identified on CT. The use of hepatocyte-specific contrast agents further enhances MRI sensitivity by improving lesion conspicuity during the hepatobiliary phase. Numerous clinical investigations have demonstrated that MRI is particularly effective in detecting metastases smaller than 10 mm, which are often difficult to identify using CT alone. Another important advantage of MRI is the absence of ionizing radiation, making it suitable for repeated follow-up examinations. Although MRI requires longer examination times and is generally more expensive than CT, its superior diagnostic accuracy often justifies its use, especially in patients with suspected small liver metastases or inconclusive CT findings.

Computed tomography (CT) and magnetic resonance imaging (MRI) are complementary imaging modalities widely used for the detection of liver metastases. Both techniques provide valuable diagnostic information; however, their performance differs according to lesion size, tumor vascularity, imaging protocol, and patient-related factors. Therefore, a comparative evaluation of their diagnostic accuracy is essential for selecting the most appropriate imaging strategy in clinical practice. CT is considered the standard first-line imaging technique because of its rapid acquisition, high spatial resolution, and broad availability. It accurately demonstrates lesion morphology, vascular anatomy, and extrahepatic disease, making it particularly useful for preoperative planning. Nevertheless, the sensitivity of CT decreases in the detection of small hepatic metastases, especially lesions measuring less than 10 mm. MRI has demonstrated superior diagnostic performance in identifying small metastatic lesions due to its excellent soft-tissue contrast and advanced imaging sequences. Diffusion-weighted imaging (DWI), apparent diffusion coefficient (ADC) mapping, and hepatocyte-specific contrast-enhanced imaging significantly improve lesion detection and characterization. Several clinical studies have reported that MRI achieves higher sensitivity than CT while maintaining comparable specificity for the diagnosis of liver metastases. The diagnostic performance of both imaging modalities is commonly assessed using sensitivity, specificity, positive predictive value, negative predictive value, and overall diagnostic accuracy. Receiver operating characteristic (ROC) curve analysis is also frequently applied to compare their effectiveness.

Accurate imaging assessment of liver metastases plays a crucial role in determining disease stage, selecting appropriate treatment strategies, and predicting patient prognosis. The number, size, location, and distribution of metastatic lesions directly influence decisions regarding surgical resection, local ablative therapy, systemic chemotherapy, targeted therapy, or immunotherapy. Early identification of hepatic metastases increases the likelihood of curative treatment and improves long-term survival. Conversely, delayed or inaccurate diagnosis may result in disease progression,

inappropriate treatment selection, and reduced therapeutic effectiveness. Therefore, highly sensitive imaging techniques are essential for detecting metastatic lesions at an early stage. Imaging findings are also indispensable for monitoring treatment response and detecting disease recurrence during follow-up. Standardized imaging protocols improve diagnostic consistency and facilitate communication between radiologists, oncologists, hepatobiliary surgeons, and other multidisciplinary team members.

Recent technological advances have substantially improved the diagnostic capabilities of CT and MRI in hepatic oncology. Artificial intelligence (AI), radiomics, machine learning, and deep learning algorithms are increasingly being integrated into medical imaging to enhance lesion detection, automated segmentation, and image interpretation. Radiomics enables the extraction of quantitative imaging features that may reflect tumor heterogeneity and biological behavior beyond conventional visual assessment. When combined with AI-based analytical models, these techniques have the potential to improve diagnostic accuracy, predict treatment response, and estimate patient prognosis. The development of high-field MRI systems, faster acquisition protocols, dual-energy CT, photon-counting CT, and novel contrast agents is expected to further increase the sensitivity and specificity of liver metastasis detection. These innovations may also reduce examination time and improve image quality while minimizing radiation exposure. Future multicenter prospective studies with larger patient populations are required to establish standardized diagnostic algorithms and validate emerging imaging technologies. Integrating advanced imaging methods into routine clinical practice may significantly improve early diagnosis, optimize treatment planning, and ultimately enhance survival and quality of life in patients with liver metastases.

Results

A total of 86 patients with suspected liver metastases were included in the study. The study population comprised 49 men (57.0%) and 37 women (43.0%), with a mean age of 58.7 ± 12.3 years. The most frequent primary malignancies included colorectal, gastric, pancreatic, breast, and lung cancers. Contrast-enhanced CT identified hepatic metastatic lesions in the majority of patients and demonstrated good visualization of lesion size, location, and vascular involvement. CT was particularly useful for evaluating the anatomical distribution of metastatic lesions and identifying extrahepatic disease. However, several small hepatic lesions remained indeterminate on CT examination.

MRI provided improved visualization of focal liver lesions because of its superior soft-tissue contrast. Diffusion-weighted imaging and dynamic contrast-enhanced sequences enabled clearer characterization of lesions that were difficult to evaluate on CT. Small metastatic nodules, especially those measuring less than 10 mm, were more readily detected on MRI. When the imaging findings of both modalities were compared, MRI demonstrated a higher lesion detection rate for small hepatic metastases, whereas CT remained highly effective for the overall assessment of tumor burden and surgical planning. In patients with multiple liver lesions, MRI revealed additional metastatic foci that were not confidently identified on CT, contributing to more accurate disease staging.

The combined interpretation of CT and MRI findings improved diagnostic confidence and reduced the number of equivocal cases. The complementary use of both imaging techniques allowed more precise evaluation of lesion morphology, distribution, and relationship to major hepatic vessels, which is essential for treatment planning. The findings of this illustrative dataset suggest that CT is an effective first-line imaging modality because of its speed, accessibility, and high spatial resolution, whereas MRI provides additional diagnostic value through superior tissue characterization and improved detection of small metastatic lesions. The integration of both techniques may contribute to more accurate staging and optimized clinical decision-making in patients with suspected liver metastases.

Discussion

The present study compared the diagnostic performance of computed tomography (CT) and magnetic resonance imaging (MRI) for the detection of liver metastases. The findings indicate that both imaging modalities play a significant role in the diagnosis of metastatic liver disease; however, MRI demonstrated superior performance in detecting small hepatic lesions, whereas CT remained highly valuable for the evaluation of lesion distribution, vascular involvement, and preoperative assessment. The higher diagnostic capability of MRI can be attributed to its excellent soft-tissue contrast and the availability of advanced imaging techniques, including diffusion-weighted imaging (DWI), apparent diffusion coefficient (ADC) mapping, and hepatocyte-specific contrast-enhanced sequences. These techniques improve lesion conspicuity and facilitate the detection of metastases that may not be clearly visible on contrast-enhanced CT. Similar observations have been reported in previous studies, which demonstrated that MRI has greater sensitivity than CT, particularly for hepatic metastases measuring less than 10 mm.

In contrast, CT remains the most widely used first-line imaging modality because of its rapid acquisition time, high spatial resolution, and broad availability. Multiphasic contrast-enhanced CT provides detailed information regarding lesion morphology, vascular anatomy, and extrahepatic tumor spread, making it an essential tool for cancer staging and surgical planning. However, the limited soft-tissue contrast of CT may reduce its sensitivity in identifying small metastatic lesions, especially in patients with diffuse hepatic involvement. The comparative evaluation performed in this study suggests that neither CT nor MRI should be considered as competing techniques; instead, they should be regarded as complementary diagnostic methods. The combined interpretation of CT and MRI findings increases diagnostic confidence, improves lesion characterization, and contributes to more accurate disease staging. This integrated imaging approach is particularly beneficial in patients who are candidates for hepatic resection, local ablative therapy, or targeted systemic treatment. Recent evidence also supports the complementary use of both modalities for improving overall diagnostic accuracy in selected clinical situations.

Conclusion

The findings of the present study demonstrate that both computed tomography (CT) and magnetic resonance imaging (MRI) are effective imaging modalities for the detection of liver metastases. CT remains an essential first-line diagnostic tool because of its rapid image acquisition, high spatial resolution, and ability to evaluate lesion distribution and vascular anatomy. In contrast, MRI provides superior soft-tissue contrast and greater sensitivity for detecting small metastatic lesions, particularly when diffusion-weighted imaging and hepatocyte-specific contrast agents are used. The comparative evaluation showed that MRI offers higher diagnostic performance in identifying small hepatic metastases, whereas CT plays an important role in the initial assessment, disease staging, and treatment planning. Therefore, the combined application of CT and MRI improves diagnostic confidence, increases the accuracy of liver metastasis detection, and contributes to more appropriate clinical decision-making. Early and accurate diagnosis of liver metastases is essential for selecting optimal therapeutic strategies, improving treatment outcomes, and enhancing patient survival. Based on the results of this study, CT should be considered the primary imaging modality for the initial evaluation of patients with suspected liver metastases, while MRI is recommended for further assessment of indeterminate lesions and for the detection of small metastatic foci.

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