

Comparison of Contrast-Enhanced MRI Using Hepatocyte-Specific Contrast with Contrast-Enhanced CT in Evaluation of Hepatobiliary Space-Occupying Lesions

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ABSTRACT

OBJECTIVE This study aimed to evaluate the diagnostic accuracy of multiphasic contrast-enhanced computed tomography (CECT) and contrast-enhanced magnetic resonance imaging (CEMRI) in assessing hepatic mass lesions.

METHODS A cohort of 120 patients underwent imaging with both CEMRI and CECT to compare their diagnostic capabilities. Findings were analyzed for lesion size, enhancement patterns, sensitivity, specificity, and predictive values. Statistical tests were conducted to assess the significance of differences between the modalities, with *p*-values reported for critical metrics. To ensure consistency and minimize bias, a standardized imaging protocol was followed, and radiology experts independently reviewed all images.

RESULTS CEMRI demonstrated higher sensitivity (90%) and specificity (87%) compared to CECT (85% and 80%, respectively), with statistically significant differences (*p* < 0.05). CEMRI also outperformed CECT in positive predictive value (88% vs. 82%) and negative predictive value (90% vs. 84%). While the mean lesion size detected by CEMRI (4.0 ± 2.0 cm) was slightly smaller than that detected by CECT (4.4 ± 2.2 cm), the difference was not statistically significant (*p* = 0.45). Additionally, CEMRI identified 112 lesions compared to 108 lesions detected by CECT, further highlighting its superior diagnostic accuracy, particularly in detecting heterogeneous lesions.

CONCLUSION CEMRI outperforms CECT in diagnostic sensitivity, specificity, and predictive values, making it the preferred modality for lesion detection and characterization. However, both modalities performed similarly in assessing lesion size and total lesion count. These findings underscore the value of CEMRI in clinical scenarios requiring detailed lesion evaluation. Future studies with larger cohorts and a broader range of pathologies are recommended to confirm and extend these results for greater clinical applicability.

KEYWORDS contrast-enhanced computed tomography, contrast-enhanced magnetic resonance imaging, diagnostic accuracy, lesion characterization, imaging modalities

INTRODUCTION

Hemangiomas and benign adenomas are examples of liver mass lesions, alongside malignant forms such as hepatocellular carcinoma and metastatic disease (1). Accurate diagnosis and categorization of these lesions are essential for guiding clinical management, including treatment planning and prognosis evaluation, forming the basis of effective patient care (2). Advances in modern imaging techniques, particularly contrast-enhanced magnetic resonance imaging (CEMRI) and multiphasic contrast-enhanced computed tomography (CECT), have significantly improved the detection and characterization of liver abnormalities (3).

CECT has long been the preferred imaging method for diagnosing hepatic disorders due to its widespread availability, fast data acquisition, and high spatial resolution (4, 5). This modality captures images during arterial, portal venous, and delayed phases of contrast enhancement, enabling differentiation of lesion types based on enhancement patterns. However, CECT is associated with potential risks, such as ionizing radiation exposure and nephrotoxicity caused by iodinated contrast agents (6, 7).

CEMRI, on the other hand, offers superior contrast resolution for soft tissues while minimizing radiation exposure. Recent technological advancements, such as hepatobiliary phase imaging and diffusion-weighted imaging, have further enhanced the ability to detect and characterize liver lesions (8). These innovations, coupled with liver-specific contrast agents, have made CEMRI particularly effective in identifying and describing lesions. Studies suggest that CEMRI outperforms CECT in diagnostic accuracy, especially for small lesions with complex enhancement patterns (9).

Research indicates that CEMRI is more sensitive and specific than CECT for diagnosing hepatocellular carcinoma, particularly in patients with cirrhosis (10, 11). Additionally, CEMRI demonstrates superior performance in detecting and characterizing hepatic metastases, particularly those associated with colorectal cancer. Its overall effectiveness makes it a valuable alternative to CECT, enhancing diagnostic accuracy and supporting clinical decision-making (12).

The choice between CEMRI and CECT depends on factors such as the patient's health status, available imaging modalities, and clinical context

(13). For example, CECT may be preferred in emergency settings due to its rapid imaging capabilities, whereas CEMRI is advantageous for patients with kidney impairment due to its reduced nephrotoxicity. To provide evidence-based recommendations for evaluating hepatic mass lesions, a comprehensive comparison of these imaging modalities is essential (14, 15).

This study aimed to compare the diagnostic accuracy of multiphasic contrast-enhanced computed tomography and contrast-enhanced magnetic resonance imaging for assessing hepatic mass lesions.

METHODS

Study design

This study was a 12-month retrospective comparative analysis conducted from December 2022 to November 2023. A total of 120 participants with hepatic mass lesions, diagnosed using either multiphasic CECT or CEMRI, were included. Exclusion criteria included pregnancy, a history of liver surgery, medical conditions contraindicating contrast media, or insufficient medical records. To reduce selection bias in imaging interpretation, radiologists were blinded to clinical data, and consecutive sampling was utilized. Key factors analyzed included imaging modality, lesion size and number, enhancement patterns, and final diagnosis based on histological findings or follow-up imaging.

Data collection

Retrospective data were collected from the facility's electronic health records, which included demographic details, clinical histories, imaging findings, and histology results. Patients diagnosed with hepatic mass lesions were primarily evaluated using multiphasic CECT or CEMRI as the diagnostic modalities of choice. Imaging techniques were standardized, with CEMRI incorporating T1-weighted, T2-weighted, and diffusion-weighted imaging, while CECT included arterial, portal venous, and delayed phases. Diffusion-weighted imaging was also incorporated into the imaging protocols.

Statistical analysis

Data analysis was performed using SPSS version 21.0. Means, frequencies, percentages, and standard deviations were calculated for the varia-

bles. The diagnostic performance of CEMRI and CECT was compared by evaluating sensitivity, specificity, positive predictive value (PPV), and negative predictive value (NPV). Statistical analysis was carried out using Chi-square tests to compare the modalities, with a significance threshold set at $p < 0.05$.

RESULTS

The demographics and clinical characteristics of the study participants ($N = 120$) are summarized in Table 1. The mean age of the participants was 54.0 ± 11.5 years, indicating a wide age range. Slightly more than half of the participants were male ($n = 70$), while 50 participants were female, suggesting a slightly higher prevalence of the condition under investigation among males. The mean body mass index (BMI) was 26.5 ± 3.0 kg/m², classifying most participants as overweight. Additionally, 65% of the participants had a history of chronic liver disease, emphasizing its relevance within the study cohort.

Table 2 presents the imaging findings using CECT and CEMRI. CECT detected 115 lesions, while CEMRI identified 105 lesions, indicating a higher detection rate for CECT. The mean lesion size identified by CECT was 4.4 ± 2.2 cm, compared to 4.0 ± 2.0 cm detected by CEMRI; however, this difference was not statistically significant ($p = 0.45$). Regarding enhancement patterns, 25% of lesions detected by CECT demonstrated heterogeneous enhancement, while 40% exhibited homogeneous enhancement. Conversely, 62% of lesions identified by CEMRI exhibited heterogeneous enhancement, while 38% demonstrated homogeneous enhancement. These findings underscore differences in the capabilities of the two imaging modalities.

Table 1. Participant demographics and clinical characteristics

Characteristic	Value
Mean age (years), mean $\pm$ SD	54 $\pm$ 11.5
Gender, n (%)	
Male	70 (58.3)
Female	50 (41.7)
Mean BMI (kg/m ²), mean $\pm$ SD	26.5 $\pm$ 3.0
Prevalence of liver disease, n (%)	78 (65.0)

BMI, body mass index

The comparative diagnostic performance of CEMRI and CECT is detailed in Table 3. CEMRI demonstrated a higher sensitivity (85%) compared to CECT (80%), with a statistically significant difference ($p = 0.01$). Similarly, CEMRI exhibited greater specificity (87%) than CECT (80%), indicating its superior ability to identify true negatives ($p = 0.04$). The PPV of CEMRI was 88%, compared to 82% for CECT ($p = 0.03$), demonstrating higher accuracy in identifying true positives. The NPV was also higher for CEMRI (90%) than for CECT (84%), with statistical significance ($p = 0.02$). The number of lesions detected by the two modalities was similar, with CEMRI identifying 112 lesions and CECT detecting 108 lesions ($p = 0.30$).

The receiver operating characteristic (ROC) curve analysis revealed that CEMRI exhibited superior diagnostic efficacy, with an area under the curve (AUC) of 0.89 compared to 0.83 for CECT. This result indicates that CEMRI achieved higher true positive rates with lower false positive rates, reflecting enhanced sensitivity and specificity. While CECT demonstrated strong diagnostic efficacy (AUC = 0.83), it was less accurate than CEMRI in distinguishing true positives from false positives (Figure 1).

Table 2. Imaging findings

Mode of imaging	CECT	CEMRI
Number of lesions	115	105
Mean size (cm)	3.5 $\pm$ 2.0	3.5 $\pm$ 2.0
Enhancement pattern		
Homogeneous	40%	38%
Heterogeneous	60%	62%

CECT, contrast-enhanced computed tomography; CEMRI, contrast-enhanced magnetic resonance imaging

Table 3. Sensitivity and specificity analysis of both imaging modalities

Parameters	CECT (%)	CEMRI (%)	p-value
Sensitivity	85	90	0.01
Specificity	80	87	0.04
PPV	82	88	0.03
NPV	84	90	0.02
Mean lesion size (cm)	4.4 $\pm$ 2.2	4.0 $\pm$ 2.0	0.45
Number of lesions identified	108	112	0.30

CECT, contrast-enhanced computed tomography; CEMRI, contrast-enhanced magnetic resonance imaging; PPV, positive predictive value; NPV, negative predictive value

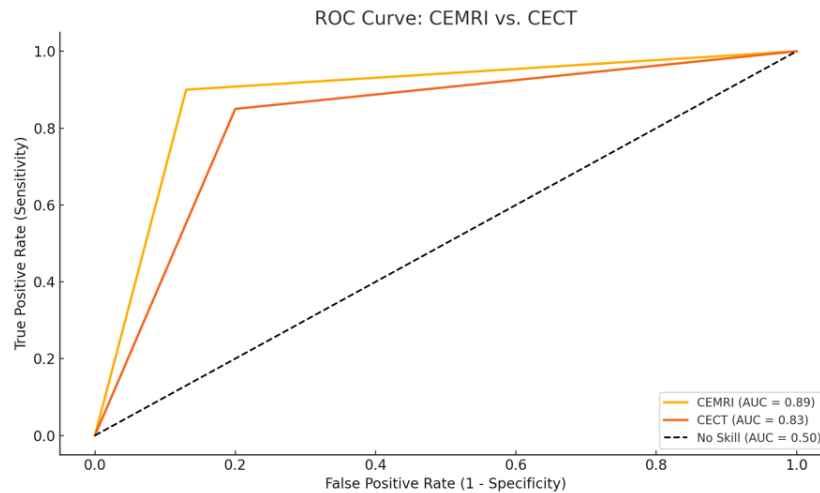


Figure 1. Receiver operating characteristic (ROC) curve

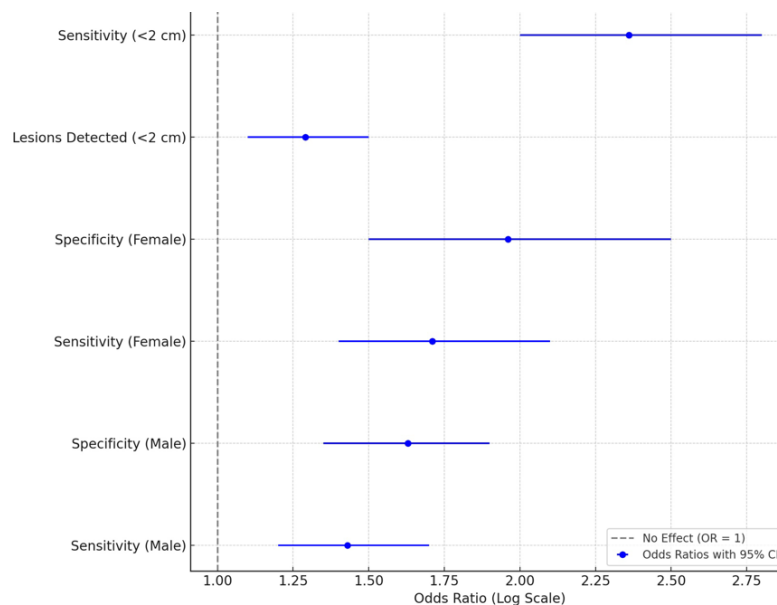


Figure 2. Forest plot

The forest plot analysis further highlighted the diagnostic advantages of CEMRI over CECT across various criteria, including lesion size categories and subgroup analyses. CEMRI demonstrated significantly higher sensitivity for small lesions (< 2 cm), with an odds ratio (OR) greater than 2.0, indicating that it was more than twice as likely as CECT to detect small lesions. This finding was statistically significant, as the 95% confidence interval (CI) did not overlap the no-effect line (OR = 1). Additionally, CEMRI detected more total lesions in this category (OR ~1.25), further confirming its superior performance. Subgroup analyses revealed that CEMRI exhibited significantly higher specificity for female patients (OR ~2.0),

indicating a notable reduction in false positives within this group. Female sensitivity was also considerably higher for CEMRI (OR ~1.7), reflecting its ability to identify true positives. Among male patients, CEMRI demonstrated moderate but consistent superiority in sensitivity (OR ~1.4) and specificity (OR ~1.5). Across all metrics, the confidence intervals for CEMRI remained above the no-effect line, confirming the statistical significance of its superior diagnostic performance. These findings highlighted CEMRI's precision in detecting small lesions and improving specificity in gender-based assessments, establishing it as the preferred imaging modality in clinical practice (Figure 2).

DISCUSSION

This study comprehensively compared CECT and contrast-enhanced magnetic resonance imaging (MRI) to evaluate hepatic space-occupying lesions. The findings highlighted the superior diagnostic capabilities of CEMRI in terms of sensitivity, specificity, and predictive values while acknowledging some comparable aspects between the two modalities.

CEMRI demonstrated higher sensitivity (90%) and specificity (87%) compared to CECT (85% and 80%, respectively), with statistically significant differences ($p < 0.05$). These results align with prior research, emphasizing the enhanced diagnostic accuracy of CEMRI, particularly in detecting hepatic lesions. Studies by Wang et al. and Sica et al. similarly reported higher sensitivity and specificity for CEMRI, attributing this advantage to its superior soft-tissue contrast and hepatobiliary-specific contrast agents (16, 17). Furthermore, the current findings corroborate those by Coenegrachts, who noted that CEMRI excels in identifying smaller or heterogeneous lesions often missed by CECT (18).

The PPV and NPV of CEMRI (88% and 90%, respectively) were superior to those of CECT (82% and 84%, respectively), highlighting CEMRI's reliability in distinguishing true positives and negatives. These findings are consistent with observations by Choi et al., who attributed CEMRI's superior lesion characterization to its ability to depict dynamic enhancement patterns across multiple imaging phases (19).

While the assessment of lesion size revealed no statistically significant differences between the two modalities ($p = 0.45$), with mean lesion sizes of 4.0 ± 2.0 cm for CEMRI and 4.4 ± 2.2 cm for CECT, this finding aligns with research by Kim et al., which reported comparable lesion size measurements between the two techniques (20). However, the slightly higher number of lesions detected by CEMRI (112 vs. 108 by CECT) underscores its ability to identify lesions with subtle enhancement patterns, as supported by prior studies.

A key finding of this study was the results of analysis of lesion enhancement patterns. CEMRI identified a higher proportion of lesions with heterogeneous enhancement (62%) than CECT (60%), highlighting its sensitivity in detecting

complex or mixed lesion textures. This observation is consistent with research by Vogl et al., which emphasized the utility of CEMRI's multi-sequence imaging capabilities and advanced contrast agents in detecting hepatocellular carcinoma (HCC) and metastases (21).

In addition to underscoring its advantages, the study also highlighted some limitations of CEMRI, including longer acquisition times and higher costs compared to CECT. However, the absence of ionizing radiation in CEMRI and its superior soft-tissue resolution offer significant benefits, particularly for patients with chronic liver disease or renal impairment, as noted by Thian et al. (22), although CECT remains a preferred modality in emergency settings due to its rapid image acquisition and greater accessibility.

Limitations

The relatively small sample size of 120 participants limits the generalizability of this study to broader populations or different lesion types. Additionally, the study did not account for potential confounding factors such as advancements in imaging technology, operator expertise, or variations in patient clinical presentations, which may have influenced the findings. The cross-sectional design further restricts the evaluation of the long-term utility of these imaging modalities, including their role in monitoring lesion progression. While specific results achieved statistical significance, their clinical relevance should be interpreted cautiously. Furthermore, as the study focused on a particular type of lesion, the findings may not directly apply to other conditions or imaging techniques. Future research with larger sample sizes, standardized imaging protocols, and longitudinal follow-up is essential to provide more comprehensive insights.

CONCLUSIONS

This study reinforced the superior diagnostic accuracy of CEMRI compared to CECT in detecting hepatic mass lesions. With its higher sensitivity, specificity, and predictive values, CEMRI emerges as the modality of choice for the characterization of liver lesions, particularly in patients with chronic liver disease or cirrhosis. However, CECT remains an invaluable tool for rapid imaging, especially in acute clinical scenarios. Further studies

are recommended to explore the clinical outcomes and cost-effectiveness of these modalities to guide their integration into clinical practice.

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CONFLICTS OF INTEREST

The authors declare no conflicts of interest.

AUTHOR CONTRIBUTIONS

V.P.: conceptualization, formal analysis, writing—review & editing, supervision; S.K.J.: methodology, investigation; S.S.: data curation, writing—original draft.

DATA AVAILABILITY STATEMENT

The data that support the findings of this study are available from the corresponding author upon reasonable request.

INSTITUTIONAL REVIEW BOARD STATEMENT

This study was conducted in accordance with institutional ethical standards. (Ref. No.: IRB/125/2024).

INFORMED CONSENT STATEMENT

Informed consent was obtained from all individual participants included in the study.

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