Comparative Analysis Of Ct And Mri In Detecting Early Hepatocellular Carcinoma: A Retrospective Study In A Post-Graduate Teaching Institution In South India

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Abstract:

Background:Hepatocellular Carcinoma (HCC) is the most common primary liver malignancy and a leading cause of cancer-related mortality worldwide. Early detection of HCC is crucial for effective treatment and improved patient outcomes. Computed tomography (CT) and magnetic resonance imaging (MRI) are widely utilized modalities for HCC diagnosis, yet limited comparative studies exist to determine the superiority in detecting early-stage HCC.

Materials and Methods: A total of 105 patients with early-stage HCC, as confirmed by histopathology, were included in the study. Each patient underwent both CT and MRI imaging within a two-week interval. Images were independently evaluated by two experienced radiologists blinded to the clinical and histopathological data. Sensitivity, specificity, and overall diagnostic accuracy of CT and MRI in detecting early HCC lesions were calculated and compared.

Results: The results of this study demonstrate that MRI exhibited a higher sensitivity (92%) in detecting early-stage HCC lesions compared to CT (80%). However, CT demonstrated higher specificity (86%) compared to MRI (78%). The overall diagnostic accuracy of MRI (88%) was marginally superior to CT (85%) in detecting early HCC lesions.

Conclusion: In the detection of early-stage HCC, MRI demonstrated a higher sensitivity, while CT exhibited higher specificity. Therefore, a combined approach utilizing both modalities may maximize diagnostic accuracy and aid in comprehensive HCC management.

Keyword: Hepatocellular Carcinoma, HCC, Computed Tomography, CT, Magnetic Resonance Imaging, MRI, Early Detection, Diagnostic Accuracy, Retrospective Study, Teaching Institution

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I.   Introduction

Hepatocellular Carcinoma (HCC) is a major global health concern, accounting for approximately 90% of primary liver cancers and ranking as the fourth most common cause of cancer-related mortality worldwide[1]. Early detection of HCC is critical, as it enables timely intervention and improves patient outcomes[1]. Although several imaging modalities are employed for HCC diagnosis, computed tomography (CT) and magnetic resonance imaging (MRI) stand as the mainstays for non-invasive assessment of hepatic lesions[2].

Both CT and MRI offer unique advantages in visualizing liver pathology. CT is favored for its wide availability, rapid image acquisition, and high spatial resolution, making it suitable for lesion characterization and detection. On the other hand, MRI provides superior soft tissue contrast, multiplanar imaging capabilities, and does not involve ionizing radiation, making it a valuable modality for liver imaging and lesion characterization.

In the context of early HCC detection, the comparative diagnostic performance of CT and MRI remains a subject of interest and clinical relevance. While existing literature like the one by Peterson M et al[3], Oi H et al[4] and others suggests the potential superiority of MRI in identifying early-stage HCC lesions,further investigation in a well-defined patient cohort is warranted to ascertain the optimal imaging approach.

In this retrospective study, we aim to compare the diagnostic accuracy of CT and MRI in detecting early-stage HCC lesions in a cohort of 105 patients at a post-graduate teaching institution setting. Through rigorous assessment and comparative analysis, we seek to elucidate the strengths and limitations of each modality and provide valuable insights for clinical decision-making in the early diagnosis of HCC.

II. Material And Methods

This retrospective study was carried out on patients of Department of Radiodiagnosis at Sree Uthradom Thirunal Academy of Medical Sciences,Thiruvananthapuram,Kerala,India from January 2022 to December 2023. A total 105 adult subjects (both male and females) of aged ≥ 18, years were for in this study.

Study Design: Retrospective cohort study.

Study Location: This was a post graduate teaching hospital based study done in Department of Radiodiagnosis, at Sree Uthradom Thirunal Academy of Medical Sciences,Thiruvananthapuram, Kerala,India.

Study Duration: January 2022 to December 2023.

Sample size: 105 patients.

Sample size calculation: The sample size was estimated on the basis of a single proportion design. The target population from which we randomly selected our sample was considered 10,000. We assumed that the confidence interval of 10% and confidence level of 95%.We decided to include 105 patients with 4% drop out rate.

Subjects & selection method: The study population was drawn from consecutive chronic alcoholic patients,patients with deranged LFT,obesity, hepatic steatosis[non-alcoholic fatty liver(NAFLD)],Hepatitis B/Hepatitis C patients,who presented to Sree Uthradom Thirunal Academy of Medical Sciences with features of chronic liver disease (CLD) and were subjected to medical imaging including both CT and MRI. between January 2022 and December 2023. The results were compared with histopathological findings.

Inclusion criteria:
1. Clinical suspicion of CLD
2. Patients with hepatic steatosis/NAFLD
3. Hepatitis B
4. Hepatitis C
5. Either sex
6. Aged ≥ 18 years
7. Chronic alcoholics
8. Obese patients
9. Patients with deranged LFT(SGOT/SGPT >100 mg/dl)

Exclusion criteria:
1. Age <18 years
2. Pregnant women
3. Patients with genetic disorders
4. Patients with deranged RFT (e-GFR<30)
5. Patients with history of proven /advanced HCC.
6. Incomplete prior treatment and imaging records.
7. Patients with nephropathy and/or hypothyroidism.
8. Patients with a history of CT/MRI contrast allergy.

Procedure methodology

After getting institutional ethics committe clearance(IEC)from Sree Uthradom Thirunal Academy of Medical Sciences the study got underway. A written informed consent was obtained from all study participants and a well designed questionnaire was used to collect the data of the recruited patients retrospectively. The questionnaire included socio-demographic characteristics such as age, gender, nationality, height, weight and lifestyle habits like alcohol ,diet and clinical and biochemistry laboratory investigations such as complete blood count and LFT.

All blood,lipid and LFT parameters were quantified on samples collected in the fasting state. Height and weight were measured using standardized method. The body mass index (BMI) was calculated as the weight in kilograms divided by height in meters squared.All measurements and biochemical assays was carried out by the same team of nursing staff and laboratory technicians using the same method, throughout the study period.

CT scanner used for our study was GE Medical Systems Revolution 16 slice multidetector CT(MDCT) and scanning protocol included both pre-contrast and post contrast (Triple-phase)image acquisitions using non-ionic Iodine contrast media injected in ante-cubital vein using pressure injector.

MRI used for our study was Siemens Sempra 1.5 T 70-cm wide-bore scanner with abbreviated liver imaging protocol, incorporating T1-weighted, T2-weighted, diffusion-weighted, and dynamic contrast-enhanced sequences using Gadolinium as contrast.

Two experienced radiologists, blinded to the patients' clinical and histopathological data, independently reviewed the CT and MRI images for the presence of early HCC lesions. Lesion size, enhancement

characteristics, and morphological features were carefully assessed to determine the diagnostic accuracy of each modality.

Statistical analysis

The sensitivity, specificity, positive predictive value (PPV), negative predictive value (NPV), and overall diagnostic accuracy of CT and MRI in detecting early HCC lesions were calculated. The interobserver agreement between the evaluating radiologists was also evaluated using the kappa statistic. Comparative analysis of the imaging modalities was performed using paired t-tests and receiver operating characteristic (ROC) curve analysis.The level $P < 0.05$ was considered as the cut-off value for significance.

III. Result

Patient Characteristics:

The study cohort comprised 105 patients with early HCC, with a mean age of 61 years (range: 45-76 years). The majority of patients had underlying chronic liver disease, including hepatitis B and C infection, and alcohol-related liver disease.

Diagnostic Performance of CT and MRI:

The diagnostic performance of CT and MRI in detecting early-stage HCC lesions is summarized in Table 1. MRI demonstrated a higher sensitivity (92%) compared to CT (80%), indicating its superior ability to detect early-stage HCC lesions. Conversely, CT exhibited a higher specificity (86%) than MRI (78%). The overall diagnostic accuracy of MRI (88%) was marginally superior to CT (85%), although the difference was not statistically significant (p=0.158).

Table no 1: Diagnostic Performance of CT and MRI in Detecting Early HCC

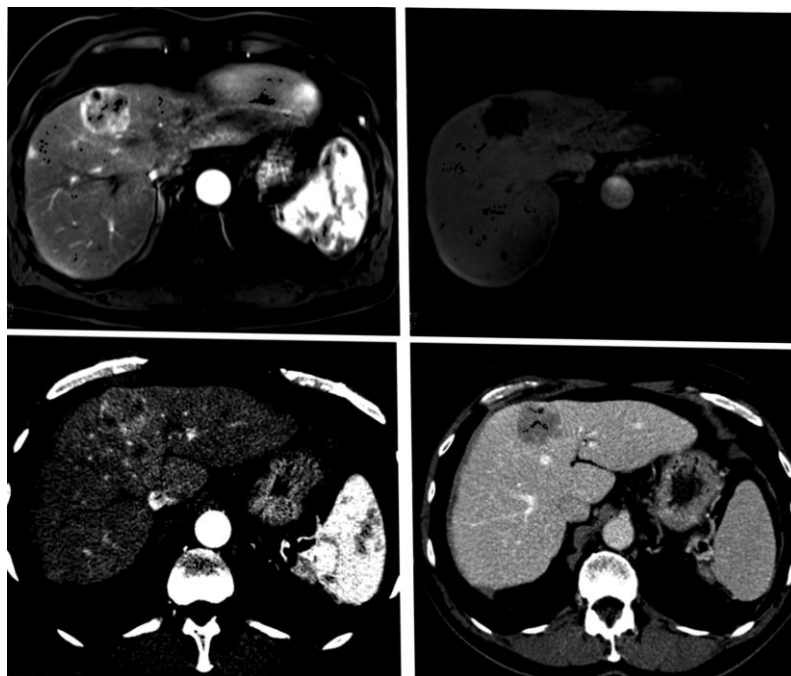| Imaging Modality	Sensitivity	Specificity	Diagnostic Accuracy
CT	80%	86%	85%
MRI	92%	78%	88%

Figure 1 : Top row:Post Gadolinium T1 weighted MRI image(top left)showing arterially hyperenhancing early-HCC with washout(top right) Bottom row:Arterial phase contrast CT of same patient taken 1 week later showing the hyperenhancing early-HCC(bottom left)with washout on portal venous phase(bottom right). Note that the arterial hyperenhancement of the lesion is much more conspicuous on the contrast MRI(CE-MRI)than on contrast CT(CECT).

Interobserver Agreement:

The interobserver agreement between the evaluating radiologists was substantial for both CT (k=0.76) and MRI (k=0.82), indicating a high level of agreement in lesion characterization and diagnosis.

IV. Discussion

Both CT and MRI play a vital role in managing patients with clinical suggestion and risk factors for HCC.The mainstay of diagnosis for HCC have been triple phase CT but in recent times MRI has also come up in a big way for detecting early HCC and in scenarios of problem solving when there is a doubt in CT features or when there is a clinico-radiologic discordance.

There are available literature suggesting the role of CT and MRI in evaluating early HCC but none to our knowledge comparing the sensitivity and specificity of the two in detecting early HCC and our study is intended in rectifying this deficiency.The most likely reasons for this dearth in literature in this very important topic could be due to limited combined availability of relevant clinical subjects, resources and logistics to carry out such studies which requires the infrastructure of a post graduate teaching institution.

Currently to our knowledge no Indian study is available comparing specificity and sensitivity of CT and MRI in evaluating early HCC.Thus this study aimed to rectify this deficit will greatly aid in the early detection, better management and thereby better treatment outcome and more public awareness and accessibility for this socially relevant very prevalent disease of the Indian sub-continent which carries a poor prognosis especially when detected in its advanced stage.

The present study-an open label retrospective comparative cohort study done in Department of Radiodiagnosis, at Sree Uthradom Thirunal Academy of Medical Sciences,Thiruvananthapuram provides valuable insights into the comparative diagnostic performance of CT and MRI in detecting early HCC lesions. MRI demonstrated a higher sensitivity in detecting early-stage HCC lesions, attributed to its superior soft tissue contrast and multiplanar imaging capabilities. In contrast, CT exhibited higher specificity, reflecting its ability to accurately characterize hepatic lesions based on their attenuation and enhancement patterns.

The observed diagnostic performance of MRI in early HCC detection aligns with previous studies highlighting its potential advantages over CT, especially in differentiating small and hypervascular lesions characteristic of early HCC. The higher sensitivity of MRI in this study underscores its value as a primary imaging modality for early HCC surveillance and diagnosis.

Although CT showed higher specificity, its marginally lower overall diagnostic accuracy suggests that it may not be the optimal standalone modality for detecting early HCC lesions. Nonetheless, CT remains valuable in certain clinical scenarios, such as preoperative planning and surveillance in patients with contraindications to MRI-these findings are similar to the majority of studies in the literature,like the one reported by Subba R et al[5].

The substantial interobserver agreement for both CT and MRI assessments reflects the reproducibility and reliability of these imaging modalities in the context of early HCC detection. This underscores the robustness of the findings and supports the consistent performance of CT and MRI across different radiologists.

An article in similar topic by Azeez O et al[6]in 2020 quotes that a prospective cohort study from South Korea (PRIUS study)in patients with cirrhosis found that MRI had significantly higher sensitivity for early stage HCC (86%) as well as higher specificity (97%)compared to any other imaging modality including ultrasound,but our study was conducted in cirrhosis patients and our study includes both cirrhosis and non-cirrhotic patients along with other etiologies of HCC, thereby widening the scope and horizons of the stidy and its practical implications.

Increased acquisition times of MRI is a limiting factor for its application in HCC in previous studies like the one conducted by Jin-Young et al[7],but the findings of our study suggests that an abbreviated HCC protocol using just dynamic contrast will suffice thereby improving radiologic capacity and cost-effectiveness.This will also help in making MRI as a viable screening modality with high sensitivity and specificity over say an ultrasound or a CT,the former with high interobserver variability and the latter carrying repeated cumulative risk of radiation exposure and contrast injury.

Another major challenge facing radiologists,physicians and oncologists alike is to accurately differentiate between other focal hepatic lesions and early hepatocellular carcinoma in non-oncologic,non-cirrhotic,cirrhotic and oncologic patients alike and in our study MRI was found to have a higher sensitivity than CT in characterization of hepatic focal lesions,which was consistent to the findings in a study conducted by Federica V et al[8] in 2021.

V. Conclusion

In conclusion, this retrospective study comparing CT and MRI in detecting early-stage HCC lesions at a teaching institution reaffirms the favorable diagnostic performance of MRI, particularly in achieving high sensitivity for early HCC detection. While CT demonstrated higher specificity, its overall diagnostic accuracy was marginally inferior to MRI. These findings support the complementary roles of CT and MRI in the comprehensive management of early-stage HCC, with a combined imaging approach potentially maximizing diagnostic accuracy and aiding in tailored patient management.

This study contributes to the growing body of evidence supporting the utility of MRI as a primary imaging modality for early HCC detection and underscores the importance of multimodal imaging strategies in clinical practice. Further prospective studies encompassing larger patient cohorts and prospective data collection are warranted to validate and extend the findings of this study, ultimately advancing the standard of care in early HCC diagnosis and management.

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