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Diagnostic Accuracy of MRI and CT Scan in Non-Invasive Evaluation of Liver Cirrhosis

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ABSTRACT

Liver cirrhosis is a chronic, non-reversible disease which results from fibrosis of the healthy liver tissue and compromise of its functioning. Adequate diagnostic procedures that do not involve invasive procedures are necessary for early diagnosis of cirrhosis to minimize the risk of complications. Even though liver biopsy is considered the gold standard, this procedure is invasive and thus, non-invasive imaging studies, including Megnatic Resonance Imaging and Computed Tomography scan must be further emphasized. **Objective:** To determine the diagnostic accuracy of combination imaging techniques MRI and CT scan in the non-invasive assessment of liver cirrhosis taking histopathology as gold standard. **Methods:** This cross-sectional study was conducted at the department of Gastroenterology, Hayatabad Medical Complex, Peshawar, during the period 1st July 2023 till 30th June 2024. Male and female patients aging 18 to 80 years with suspected liver cirrhosis on ultrasound were enrolled. MRI and CT scan of the liver were carried out and the findings were compared with histopathology to draw the diagnostic accuracy. **Results:** The study comprised of 75 (58.6%) male and 53 (41.4%) female. The mean age was 55.4 ± 7.2 years. Liver morphology in patients with cirrhosis had sensitivity of 96.8% and specificity of 100%, with the PPV of 100% and NPV of 33.3%. For vascular features the sensitivity was 88.9% and a specificity of 30.0% respectively, with the PPV of 93.7% and an NPV of 18.7%. As an imaging finding, ascites had a sensitivity of 46.0% and a specificity of 59.6%, with a PPV of 62.5% and an NPV of 43.0%. **Conclusion:** Combining non-invasive imaging modalities like MRI and CT scan enhances the diagnostic accuracy in detecting liver cirrhosis and the degree of fibrosis.

INTRODUCTION

Liver cirrhosis is a chronic and progressive disease of the liver in which healthy liver cells are replaced by fibrotic tissue and is therefore a non-reversible disease [1]. This disease has become a global threat to human life and affects mortality and socio-economic costs in the delivery of health care services. Early diagnosis of liver cirrhosis is important since it enables the practitioner to take actions that will help to control the development of complications like portal hypertension, ascites, and hepatocellular carcinoma [2-4]. Traditionally, liver biopsy has been considered as the reference method in the diagnosis and staging of liver cirrhosis. However, because of invasiveness, it has certain risks and limitations, and therefore, there has been a transition to non-invasive imaging [5, 6]. The new techniques in imaging, especially the MRI and CT have shown promises in offering structural and functional information from anatomical perspective, but without the necessity of invasive procedures [7-9]. As these imaging modalities seem very promising, there is still a lack of published data comparing the efficacy of these imaging techniques in diagnosing liver cirrhosis without biopsy. Several studies have pointed out that MRI and CT are useful in detecting various diseases. Still, insufficient evidence shows which modality is more accurate, and no significant difference is observed between modalities [10, 11]. It is critical to have accurate and timely diagnosis of

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liver cirrhosis through non-invasive techniques as it is a major burden to healthcare systems in the world, [12]. This research will therefore seek to establish the specificity and sensitivity of MRI and CT in the diagnosis of liver cirrhosis using histopathology as the gold standard.

This study aimed to address the gaps found in the local literature arising from scarcity of studied on this topic and inconsistencies in studies carried out on western population.

METHODS

This cross-sectional study was carried out at Gastroenterology Unit of Hayatabad Medical Complex during the period 1st July 2023 till 30th June 2024. Ethical approval for the study was obtained from the Research Review Board of Hayatabad Medical Complex (Approval No: 1529). Consent to participate in the study was sought before they were recruited to the study. Male and female patients in the age range 18 to 80 years with clinical suspicion of liver cirrhosis (patients having jaundice, ascites or variceal bleed) and laboratory findings (platelet count <150,00cells/mm3, albumin <3.5gm/dl or INR >1.2) and ultrasound features of liver cirrhosis (coarse shrunken liver with irregular margins) were included. Patients with hepatic encephalopathy, active upper or lower gastrointestinal bleed, severe cardiopulmonary compromised patients, patients with platelets count less than 50,000 cells/mm3, patients unable to undergo liver biopsy or MRI or CT scan were excluded. Total sample size was 128 which was calculated taking the anticipated prevalence of liver cirrhosis as 26.0% with 7.6% margin of error and 95% confidence level. Patients were enrolled using non-probability consecutive sampling technique. Relevant clinic data were recorded including patient characteristics and medical history. Tests like liver function tests, blood tests for pertinent viral serological markers. All enrolled patients underwent both MRI and CT scanning with hepatobiliary protocol. Contrast-enhanced sequences for each modality (CT and MRI) were utilized in evaluating the liver parenchyma. The imaging results were examined by qualified radiologists who were blinded to clinical information. The severity of liver cirrhosis was classified based on recognized criteria, namely using the Child-Pugh classification. Imaging findings were compared with liver biopsy findings which was considered as gold standard. Image guided liver biopsy was performed by consultant interventional radiologist and sent to hospital laboratory for assessment of fibrosis by consultant histopathologist blinded to clinical data. Imaging findings for liver cirrhosis were compared with biopsy findings to draw the diagnostic accuracy. The efficacy of these approaches was evaluated in terms of their capacity to provide quantitative assessments of liver stiffness and fibrosis. Diagnostic accuracy was recorded as sensitivity, specificity, positive predictive value, and negative predictive value. Descriptive statistics were used to present demographic and clinical data. Continuous data were presented as means and standard deviation while categorical data were presented as frequency and percentages. 2x2 table was used to draw the diagnostic accuracy of combined CT and MRI recorded as sensitivity, specificity, positive predictive value and negative predictive value. p-value≤0.05 was considered statistically significant. Data were analyzed using SPSS (version 25). The participants were also explained about the study and the procedures that will be followed, the risks that may be encountered and the participant's right to withdraw from the study at any time without any reason being given. All data collected were kept confidential and used solely for research purposes.

RESULTS

The study included 128 patients, with demographic characteristics indicating that 58.6% were male and 41.4% were female, with a mean age of 55.4 ± 7.2 years. The age distribution showed that the largest group (35.16%) was aged 50-59 years, followed by those aged 60-69 years (29.67%)(Table 1).

Table 1: Frequency and Percentages of Patients According to Demographic Parameters,(n=128)

Demographic Characteristic		N(%)
Gender	Male	75(58.6%)
	Female	53(41.4%)
Age (years) Mean ± SD		55.4 ± 7.2
40-49 Years		25(19.53%)
50-59 Years		45(35.16%)
60-69 Years		38(29.67%)
70 and above		20(15.64%)

In terms of clinical signs, 71.9% of patients exhibited symptoms suggestive of cirrhosis, including jaundice, ascites, variceal bleed, and spider nevi. Serological markers for both HBV and HCV were positive in 81.3% of patients(Table 2).

Table 2: Frequency and Percentages of Patients According to Presenting Features (Clinical, Laboratory and Ultrasound Parameters)

Presenting Characteristics	N(%)
Symptoms Related to Cirrhosis (Like Jaundice, Ascites, Variceal Bleed, Spider Nevi)	92(71.9%)
Deranged Liver function Tests (Albumin <3.5gm/dl and INR>1.2)	116(90.6%)
Serological Markers (HBV and HCV Markers)	104(81.3%)
Ultrasound Findings (Coarse Shrunken Liver with Irregular Margins)	43(33.6%)

Out of all patients, MRI imaging revealed that 93.8% of the patients in terms of liver morphology, shrunken liver,

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coarse parenchyma and irregular margins. Also, changes in the vascular architecture were noted in 82.0% cases as shown in table 3.

Table 3: Imaging Findings – Magnetic Resonance Imaging (MRI)

MRI Findings	N (%)
Liver Morphology (Shrunken Liver, Coarse Parenchyma, Irregular Margins)	120 (93.8%)
Vascular Architecture (Portal Vein Diameter >15mm, Collaterals Formation, Cavernous Transformation)	105 (82.0%)
Ascites	32 (25.0%)

The examination of CT scans revealed the same with MRI in terms of liver morphology changes with 95.3% of the patients, vascular abnormities in 80.5% of the patients, whereas the presence of ascites was noted in 27.3% as reported in table 4.

Table 4: Imaging Findings - Computerized Tomography (CT) Scan

CT findings	N (%)
Liver, Morphology (Shrunken Liver, Coarse Parenchyma,Irregular Margins)	122 (95.3%)
Vascular Architecture (Portal Vein Diameter >15mm, Collaterals Formation, Cavernous Transformation)	103 (80.5%)
Ascites	35 (27.3%)

Table 5 summarizes the diagnostic accuracy of various imaging features (CT + MRI) in relation to liver biopsy. Liver morphology had a sensitivity of 96.8% and specificity of 100%, with a PPV of 100% and an NPV of 33.3%. For vascular features, sensitivity was 88.9%, specificity was 30.0%, with a PPV of 93.7% and an NPV of 18.7%. Ascites demonstrated a sensitivity of 46.0% and specificity of 59.6%, with a PPV of 62.5% and an NPV of 43.0%.

Table 5: 2x2 Table for Diagnostic Accuracy According to Various Features (CT + MRI)

Imaging findings (CT + MRI)	Imaging findings (CT + MRI)			Diagnostic Accuracy
	Yes	No	Total	
Liver Morphology Consistent with Cirrhosis	122 (99.1%)	03 (18.8%)	128 (100.0%)	Sensitivity = 96.8% Specificity = 100.0% PPV = 100%, NPV = 33.3%
	04 (66.7%)	02 (33.3%)	06 (100.0%)	
	126 (98.4%)	02 (1.6%)	128 (100.0%)	
Vascular Features Consistent with Cirrhosis	105 (93.7%)	07 (6.3%)	112 (100.0%)	Sensitivity = 88.9% Specificity = 30.0%PPV = 93.7%, NPV = 18.7%
	13 (81.2%)	03 (18.8%)	16 (100.0%)	
	118 (92.1%)	10 (7.9%)	128 (100.0%)	
Ascites	35 (62.5%)	21 (37.5%)	56 (100.0%)	Sensitivity = 46.0% Specificity = 59.6% PPV = 62.5%, NPV = 43.0%
	41 (56.9%)	31 (43.1%)	72 (100.0%)	
	76 (59.3%)	52(40.7%)	128 (100.0%)	

DISCUSSION

The results of the study provide an insight about diagnostic performance of various imaging features in relation to histopathology. On the demographic level, majority of patients were male (n = 75, 58.6%) with mean age of 55.4 years, which is in concordance with Basha *et al.*, who noted that patients with cirrhosis was more frequent in male patients (n = 134, 55.8%). The mean age of participants in the later study was 61.5 years which was slightly higher compared to our study [13]. The variation in mean age may be because of overall difference in life expectancy of patients belonging to different ethnicities. Majority of our patients were in sixth decade of life. Basha *et al* didn't report age related sub-group analysis hence comparison cannot be drawn in this regard. In a retrospective analysis of 300 patients by Wang G *et al*, the mean age of patients was 43.46 years which was considerably lower than our cohort of patients. [14]. The difference may be due to selection of patients with hepatocellular carcinoma on background of liver cirrhosis as compared to our patients where patients with cirrhosis and cirrhosis related complications were included. Thought the overall proportion of male patients were slightly higher in study by Wang G and colleagues, the higher prevalence of cirrhosis in male patients compared to female was like our findings [14]. In this study, the sensitivity, specificity, positive predictive value and negative predictive value of CT scan and MRI for the detection of cirrhosis, in relation to liver biopsy were 96.8%, 100%, 100% and 33.3% respectively for morphological presentation of cirrhosis, 88.9%, 30.0%, PPV, 93.7%, 18.7% respectively for cirrhosis related vascular changes and 46.0%, 59.6%, 62.5% and 43.0% for portal hypertension leading to ascites on the background of chronic liver disease. Imaging results showed that MRI and CT scans were highly sensitive in showing features of cirrhosis and MRI identified liver changes in 93.8% of patients and CT in 95.3%. Kim et al, concluded that MRI was superior to ultrasound in radiological assessment of cirrhosis and complications of cirrhosis. The diagnostic accuracy for various findings could be increased by combining the two modalities. Moreover, accuracy of MRI was further enhanced using contrast techniques, at the cost of expenses [15]. Basha and colleagues showed that, taking histopathology as gold standard, the sensitivity, specificity and overall accuracy for MRI and CT scan alone were 85.3%, 86.3%, 83.6% and 67.6%, 54.1% and 91.3% respectively. Combining the two modalities, the values obtained were 91.2%, 90.7% and 92.1% which were better than either technique alone similar to our observations [13]. Higaki *et al*, segregated patients based on Child Pugh Score and assessed morphological changes using radiological techniques. MRI was found more sensitive for soft tissue changes including nodular changes in liver parenchyma, focal lesion and vascular alternations and thrombosis compared to CT or ultrasound, however, additional measures were required for better visualization of vascular changes like contrast enhancement.The

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accuracy for complications such as ascites was like CT scan [16]. Wang and colleagues retrospectively analyzed CT and MRI based vascular models for assessment of cirrhosis related hepatic vascular changes. It was concluded that venous pressure gradients are better evaluated using CT and MRI with both modalities carrying similar diagnostic accuracy [17]. Among the morphological changes in liver parenchyma in cirrhosis, regenerative nodules are the hallmark of persistent fibrosis. It is important to establish the benign and malignant nature of nodules radiologically. Triphasic techniques differentiate the two with better accuracy. The reported sensitivity of triphasic CT in the regard is 50% to 96% and specificity of 75% to 96%. Diagnostic accuracy was shown to decrease as nodule size decreases below 2 cm. No such discrepancy was reported with MRI [18]. Accuracy of CT is also compromised with fat containing lesions exhibiting mass like appearance yielding diagnostic dilemma [19]. Such effect is not observed with protein deposition while cirrhosis resulting from fibrosis of liver is governed by proteins deposition [20].

CONCLUSIONS

Imaging studies, particularly the MRI and CT scans have been identified to play a crucial role in diagnosis of liver cirrhosis in the present study. Liver morphology in patients with cirrhosis had sensitivity of 96.8% and specificity of 100%, with the PPV of 100% and NPV of 33.3%. For vascular features the sensitivity was 88.9% and a specificity of 30.0% respectively, with the PPV of 93.7% and an NPV of 18.7%. As an imaging finding, ascites had a sensitivity of 46.0% and a specificity of 59.6%, with a PPV of 62.5% and an NPV of 43.0%. Although ascites may be a complication of liver cirrhosis, it cannot be used as a single marker for diagnosing liver cirrhosis.

Authors Contribution

Conceptualization: SHH, SA, AK, R
Methodology: SHH, MS
Formal analysis: SHH, FMK, MY, MS
Writing, review and editing: SA, MI, R

All authors have read and agreed to the published version of the manuscript

Conflicts of Interest

All the authors declare no conflict of interest.

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