ORIGINAL ARTICLE ASIAN JOURNAL OF MEDICAL SCIENCES

Radiological approach for early diagnosis of liver parenchymal disease

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Submission: 16-08-2024 Revision: 29-10-2024 Publication: 01-12-2024

ABSTRACT

Background: Diffuse liver parenchymal disease (LPD) encompasses a wide range of liver disorders characterized by extensive involvement of liver tissue, often resulting in significant morbidity and mortality. Early detection and accurate assessment of these diseases are crucial for effective management and improved patient outcomes. **Aims and Objectives:** This study aims to evaluate the efficacy of various imaging modalities in the early detection and monitoring of diffuse LPDs, specifically focusing on non-invasive techniques such as ultrasonography (USG), computed tomography (CT), and Fibroscan. **Materials and Methods:** A prospective observational study was conducted involving 362 patients presenting with clinical signs and symptoms of liver disease at Maharani Laxmi Bai Medical College, Jhansi. Patients underwent standardized imaging protocols, including US, CT, and Fibroscan, along with laboratory tests to confirm liver function abnormalities. Imaging findings were correlated with clinical and laboratory data to assess diagnostic accuracy and efficacy. **Results:** The study found that ultrasound, elastography, and CT provide a reliable, non-invasive method for assessing diffuse LPD at the early stage ultrasound along with Fibroscan and CT both have comparable diagnostic capabilities in assessing diffuse LPD. Ultrasound and Fibroscan being non-invasive and radiation-free should be used as initial investigations whereas CT further contributes to the detailed characterization of liver parenchyma. Integration of these imaging modalities significantly enhanced early diagnosis and disease monitoring. **Conclusion:** Integrating advanced imaging modalities, especially elastography, into routine diagnostic protocols for diffuse LPDs enables early detection and effective management. Non-invasive techniques such as US and CT improve patient outcomes by allowing timely intervention and continuous monitoring of disease progression, thus reducing the need for invasive procedures such as liver biopsy.

Key words: Diffuse liver parenchymal disease; Ultrasound; Computed tomography; Magnetic resonance imaging; Elastography; Hepatic steatosis; Hepatic fibrosis; Liver biopsy; Non-invasive diagnostics; Liver disease management

Access this article online

Website: http://nepjol.info/index.php/AJMS

DOI: 10.3126/ajms.v15i12.68853

E-ISSN: 2091-0576

P-ISSN: 2467-9100

INTRODUCTION

Diffuse liver parenchymal diseases (LPDs) represent a spectrum of liver disorders characterized by widespread involvement of hepatic tissue, often leading to significant morbidity and mortality. Early diagnosis and accurate assessment of these conditions are paramount for effective management and improved patient outcomes. The liver's critical functions, including detoxification, protein synthesis, and production of biochemicals necessary for digestion, make the timely identification of LPD essential to prevent irreversible damage and associated complications.[1]

In recent years, imaging modalities have played a crucial role in the early detection and monitoring of LPDs. Non-invasive techniques such as ultrasonography (USG), computed tomography (CT), and elastography have gained prominence due to their ability to assess liver tissue without the need for invasive procedures such as liver biopsy. Ultrasound, in particular, is frequently used as the first-line imaging tool owing

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to its accessibility, non-invasiveness, and cost-effectiveness. However, when ultrasound findings are inconclusive, CT scans provide more detailed imaging, helping to characterize liver parenchyma and detect subtle abnormalities. In addition, elastography techniques, including shear wave elastography and transient elastography, have emerged as reliable methods for assessing liver stiffness and fibrosis, offering sensitivity and specificity comparable to liver biopsy.[2]

Aims and objectives

- Role of imaging techniques in the early detection and follow-up of diffuse parenchymal liver diseases so as to manage early and correctly
- To classify LPDs
- To evaluate various causes of LPDs.

MATERIALS AND METHODS

Study design and population

This prospective observational study was conducted at the Department of Radiodiagnosis, Maharani Laxmi Bai Medical College, Jhansi, Uttar Pradesh, between May 2023 and June 2024. The study involved 362 patients who presented with clinical signs and symptoms suggestive of liver disease. These patients were selected based on specific inclusion and exclusion criteria.

Inclusion criteria

The following criteria were included in the study:

- Patients who provided informed consent for participation in the study
- Patients with altered liver function tests (LFT)
- Patients falling under 15–70 years age group
- Patients having clinical signs and symptoms of LPD
- Obese patients.

Exclusion criteria

The following criteria were excluded from the study:

- Patients who refuse to give consent to participate in our study
- Pregnant females (as cannot be evaluated on CT)
- Patients having an allergy to contrast media
- Patient known case of chronic liver disease.

Imaging modalities

All patients underwent standardized imaging protocols as part of their diagnostic workup, including ultrasonography (USG), CT, and Fibroscan. These imaging modalities were selected based on their availability, non-invasive nature, and ability to assess different aspects of LPD.

1. Ultrasonography (USG)
    - Performed using (GE-Vivid T8, E-SAOTE, BPL ALPINION, and KONICA AEROSCAN USG Machine)
    - The liver was assessed for size, echogenicity, echotexture, and the presence of any focal lesions. The spleen size, portal vein diameter, and splenic vein diameter were also measured. Ascites and periportal cuffing were noted when present.
2. Computed tomography
    - Conducted using (Philips Multidetector 16 slice and 128 slice CT Scan machines)
    - The study focused on liver parenchymal characteristics such as size, margins, surface irregularities, Hounsfield units (HU), and the caudate lobe to right lobe (C/RL) ratio. CT also assessed the presence of ascites, splenomegaly, and portal vein abnormalities.
3. Fibroscan
    - Performed using (AFFINITI 70)
    - Liver stiffness was measured in kilopascals to assess the degree of fibrosis. The results were compared to the findings from US and CT.

Data collection and analysis

Clinical data were collected from patient records, including demographic information, clinical presentations, and laboratory test results. Imaging findings were documented and correlated with clinical and laboratory data to assess the diagnostic accuracy of each modality.

The primary variables evaluated included liver size, echogenicity, echotexture, splenic size, portal and splenic vein diameters, and the presence of ascites. The diagnostic capability of each modality was determined by comparing imaging findings to clinical outcomes and laboratory results.

Statistical analysis

Data were analyzed in the Statistical Package for Social Sciences Version 11.0. Descriptive statistics were employed to summarize the demographic and clinical characteristics of the study population. The sensitivity, specificity, and diagnostic accuracy of each imaging modality were calculated. Comparisons between modalities were made using Chi-square tests for categorical variables and t-tests for continuous variables, with a $P<0.05$ considered statistically significant.

Ethical considerations

The study was approved by the Institutional Ethics Committee of Maharani Laxmi Bai Medical College, Jhansi, Uttar Pradesh (Certificate number 1086/IEC/1/2022-2023 dated June 18, 2023). Written informed consent was obtained from all participants before their inclusion in the study. The research was conducted in accordance with the Declaration of Helsinki and adhered to the highest standards of clinical research ethics.

RESULTS

Most patients were aged between 31 and 45 years (38.40%) and 46–60 years (30.66%), with a male predominance (58.29%) (Table 1). Liver size, echogenicity, and echotexture were the most assessed variables on ultrasound (USG), whereas CT scans provided more detailed assessments, particularly in terms of liver density (HU) and structural changes (Table 2). The most common clinical presentations were upper abdominal discomfort (58.56%) and abdominal pain (20.72%) (Table 3). Grading of LPD based on echogenicity, LFT, and CT findings, with more severe grades indicating greater liver dysfunction (Table 4). The diagnostic capability of ultrasound (USG) was 91.10%, while CT scans had a slightly higher capability at 92.06%, indicating that both modalities are highly effective for detecting liver parenchymal disease (Table 5). The diagnostic capabilities of USG, Fibroscan, and CT, demonstrated that CT scans alone (87.07%) had a slightly higher diagnostic accuracy than the combination of USG and Fibroscan (85.93%) (Table 6). The imaging findings revealed a coarse echotexture with nodules of varying sizes (Figure 1). In addition, non-contrast CT and contrast-enhanced CT of the abdomen demonstrated a marked reduction in liver attenuation (HU) (Figure 2). Hypertrophy of the caudate lobe was also observed, with a C/RL ratio >0.79 (Figure 3).

Table 1: Demographic data (n=362)

Age	Number of patients	Percentage
15–30 years	64	17.68
31–45 years	139	38.40
46–60 years	111	30.66
61–70 years	48	13.26
Sex		
Male	211	58.29
Female	151	41.71
Clinical presentation		
Asymptomatic	24	6.63
Upper abdomen discomfort	212	58.56
Abdominal pain	75	20.72
Abdominal distension	10	2.76
Jaundice	60	16.57
Other	54	14.92

DISCUSSION

In this study, the age distribution data reveal that the majority of patients (38.40%) fall within the 31–45 years age group, followed by those aged 46–60 years (30.66%). This age range is consistent with findings from other studies, such as Ghadimi et al.,[3] who noted that middle-aged adults are more prone to LPD due to factors such as long-term exposure to risk factors and cumulative liver damage. Dabholkar et al.[4] also found similar age distribution patterns in their study on fatty liver disease.

This study shows that the gender distribution indicates a higher prevalence of LPD in males (58.29%) compared to females (41.71%). This disparity aligns with findings from Gerstenmaier and Gibson[5] who reported that males have higher rates of liver disease, potentially due to higher alcohol consumption and different lifestyle factors.

Table 2: Variables used in each modality

Variable on USG	Normal	Abnormal	
Liver size	182	54	Normal cutoff • Liver size – 155mm • Spleen size – 120mm • Portal vein – <13mm • Splenic vein – <7mm • HU – <40 • C/RL – <0.65 • Kpa<6
Margin	218	18	
Echogenicity	32	204	
Echotexture/surface	198	38	
Spleen size	143	93	
Portal vein diameter with Doppler	216	20	
Splenic vein diameter	223	13	
Ascites	202	34	
Periportal cuffing	234	02	
Gallbladder thickness	217	19	
Variable on CT			
Liver size	99	27	
Margin	125	1	
Surface	126	0	
Housen field (HU)	12	114	
C/RL ratio	117	09	
Spleen size	95	31	
Portal vein diameter	118	8	
Splenic vein diameter	119	7	
Ascites	115	11	
Variable on fibroscan			
kPa	08	07	

CT: Computed tomography, C/RL: Caudate lobe to right lobe, kPa: Kilopascals

Table 3: Distribution of patients according to LPD grade based on echogenicity, echotexture, and LFT on USG

LPD grade	Echogenicity					Altered echotexture	LFT	
	Normal	Reduced	FLG1	FLG2	FLG3		Mean SGOT	Mean SGPT
1	00	02	147	00	00	00	49.43	59.09
2	00	00	00	28	00	00	70.21	61.60
3	11	00	08	07	12	38	52.83	83.33

LPD: Liver parenchymal disease, LFT: Liver function tests, SGOT: Serum glutamic oxaloacetic transaminase, SGPT: Serum glutamate pyruvate transaminase

Table 4: Distribution of patient according to LPD grade based on Liver HU, caudate lobe/right lobe ratio, and LFT on CT

LPD grade	Liver HU					C/RL>0.65	LFT	
	Grade 1 (35–39)	Grade 2 (30–35)	Grade 3 (20–30)	Grade 4 (06–20)	<6		Mean SGOT	Mean SGPT
1	53	00	00	00	00	00	36.68	44.04
2	00	36	00	00	00	00	38.85	51.26
3	04	00	18	04	01	09	39.0	73.6

LPD: Liver parenchymal disease, HU: Housen field, LFT: Liver function tests, CT: Computed tomography, C/RL: Caudate lobe to right lobe, SGOT: Serum glutamic oxaloacetic transaminase, SGPT: Serum glutamate pyruvate transaminase

Table 5: Diagnostic capability of primary modalities

Modalities	Positive	Negative	Diagnostic Capability (%)
USG	215	21	91.10
CT scan	116	10	92.06

CT: Computed tomography

Table 6: Combined diagnostic capability of primary and secondary modalities

Modalities	Positive	Negative	Diagnostic capability (%)
USG+fibroscan	226	52	85.93
CT scan	128	19	87.07

CT: Computed tomography

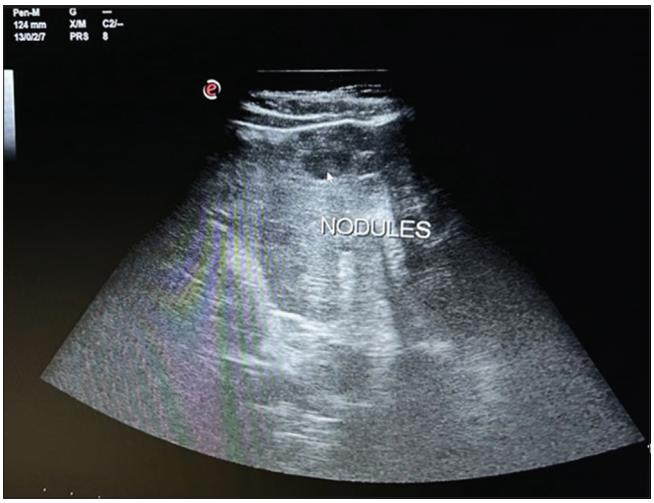

Figure 1: Coarse echotexture with variable size nodules

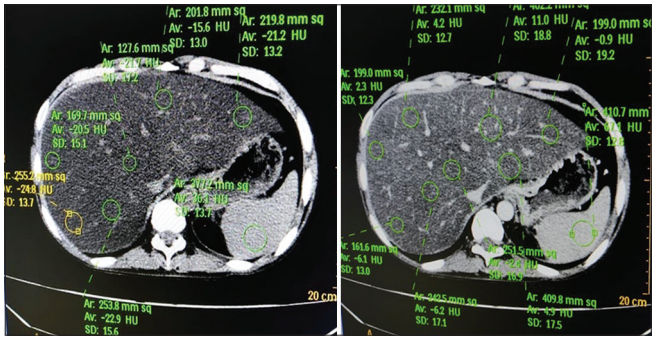

Figure 2: NCCT and CECT abdomen with marked reduced Liver HU

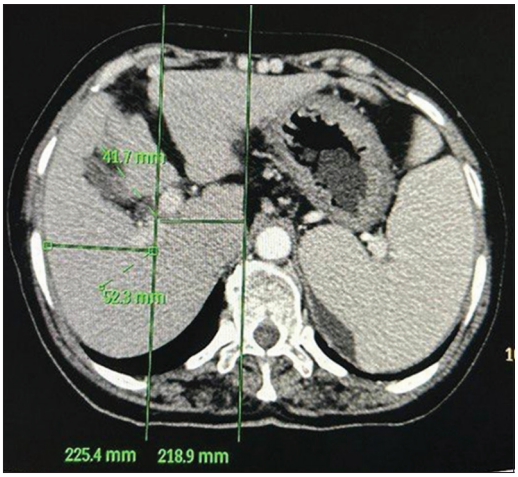

Figure 3: Caudate lobe hypertrophy (C/RL > 0.79)

This study shows that alcohol consumption (19.61%) is the most significant identifiable risk factor, followed by diabetes mellitus (7.73%) and obesity (7.46%). Notably, 65.19% of patients had no identifiable risk factors, suggesting other factors such as genetic predispositions or undiagnosed conditions. These findings are consistent with Cha et al.[6] who discussed similar risk factors in their study

on chronic liver disease, and Zeb et al.[7] who emphasized the multifactorial nature of liver disease development.

This study shows that upper abdominal discomfort (58.56%) is the most common symptom, followed by abdominal pain (20.72%) and jaundice (16.57%). A small percentage of patients (6.63%) are asymptomatic, highlighting the importance of imaging for early detection. Lee et al.[8] and Ghadimi et al.[3] also reported similar clinical presentations in their studies, emphasizing the need for comprehensive diagnostic approaches.

This study shows that ultrasound (USG) is used as the primary diagnostic modality in 65.19% of cases, highlighting its role as the first-line imaging tool due to its accessibility and non-invasiveness. CT scans are employed in 34.81% of cases for more detailed imaging. This aligns with the observations of Gerstenmaier and Gibson[5] who noted the widespread use of ultrasound for initial assessments and the complementary role of CT scans in providing detailed evaluations. Lee et al.[8] further emphasized the importance of CT and Fibroscan for follow-up assessments.

This study shows that ultrasound is the primary diagnostic modality for 65.19% of patients, reflecting its accessibility and cost-effectiveness. CT scans, used for 34.81% of patients, provide more detailed imaging, crucial for cases where ultrasound findings are inconclusive. Dabholkar et al.[4] and Gabkwet et al.[9] reported similar usage patterns of these imaging modalities in their studies.

This study shows that ultrasound is effective in detecting abnormalities in echogenicity and echotexture, indicative of hepatic steatosis and fibrosis. CT scans provide detailed information on liver density (HU) and structural changes, confirming liver pathology in cases where ultrasound is inconclusive. Nishiura et al.[10] and Cha et al.[6] highlighted similar diagnostic capabilities of these modalities.

This study shows that ultrasound identified 215 abnormal cases out of 236, whereas CT scans identified 116 abnormal cases out of 126. This highlights the effectiveness of both modalities in diagnosing LPD, with CT providing higher specificity. Nishiura et al.[10] and Lee et al.[8] also reported high diagnostic accuracy with these imaging techniques.

This study demonstrates the distribution of LPD grades based on echogenicity, echotexture, and LFT using ultrasound (USG). Grade 1 LPD shows the highest number of patients with FLG1 changes. Grades 2 and 3 show increased levels of SGOT and SGPT, indicating more severe liver dysfunction. Lee et al.[8] and Nishiura et al.[10] provided similar grading criteria and findings in their studies.

This study illustrates LPD grades based on liver HU, C/RL ratio, and LFT on CT. Grade 1 patients predominantly have liver HU values between 35 and 39, indicating mildly reduced liver attenuation. Grades 2 and 3 show marked reduced liver HU values, correlating with increased liver fibrosis and cirrhosis. Zeb et al.[7] and Dabholkar et al.[4] highlighted similar HU criteria and liver changes in their studies.

This study demonstrates that both modalities exhibit high diagnostic capability, with ultrasound achieving a 91.10% capability and CT scan slightly higher at 92.06%. These findings align with previous studies, such as those by Nishiura et al.[10] who emphasized the effectiveness of ultrasound in the early detection of liver fibrosis through simultaneous use of low and high-frequency probes. Similarly, Lee et al.[8] highlighted the accuracy of CT scans in quantifying hepatic parenchymal changes.

In this study, CT scan detected abnormalities in 57.14% of cases, whereas Fibroscan identified abnormalities in 46.67% of cases, and ultrasound in 14.81% of cases. Zeb et al.,[7] highlighted the sensitivity of CT scans in detecting liver abnormalities and the utility of Fibroscan in assessing liver fibrosis.

In this study, the majority of secondary evaluations identified Grade 1 LPD, particularly through CT scans and Fibroscans. This supports the findings of Ghadimi et al.[3] who emphasized the effectiveness of these modalities in detecting early stages of liver disease, aiding in timely intervention.

In this study, the combined diagnostic capability of primary and secondary modalities reveals a high level of accuracy in diagnosing LPD. Specifically, the combination of ultrasound (USG) and Fibroscan shows a diagnostic capability of 85.93%, whereas CT scan alone demonstrates a slightly higher diagnostic capability of 87.07%.

Limitations of the study

The study's limitations include operator dependency in ultrasound, limited access to advanced imaging tools, and not accounting for genetic predispositions or less common risk factors

CONCLUSION

This study provides a comprehensive analysis of the demographic, clinical, and diagnostic aspects of diffuse LPD. The findings highlight the significant prevalence of liver diseases among middle-aged adults and males, with alcohol consumption being a major risk factor. The

clinical presentations primarily involved upper abdominal discomfort and jaundice, emphasizing the need for routine screenings to detect asymptomatic cases.

The use of ultrasound as the primary diagnostic tool is validated by its widespread application and high diagnostic accuracy. However, CT scans and Fibroscans play crucial roles in detailed assessments and follow-up evaluations, offering high sensitivity in detecting liver abnormalities and fibrosis.

The study underscores the importance of a multimodal diagnostic approach to effectively identify and manage diffuse LPD. Future research should focus on uncovering unidentified risk factors and improving early detection methods to enhance patient outcomes. The insights from this study contribute to the existing knowledge base and offer practical implications for clinicians in managing liver diseases.

ACKNOWLEDGMENT

I would like to express my heartfelt gratitude to my guide, Dr. Rachna Chaurasia, for her invaluable guidance and support throughout this study. I am also deeply thankful to the Institutional Ethics Committee and the patients who graciously participated in this research.

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Authors' Contributions:
RC and S- Definition of intellectual content, literature survey, prepared the first draft of the manuscript, implementation of the study protocol, data collection, data analysis, manuscript preparation and submission of article, concept, design, clinical protocol, manuscript preparation, editing, and manuscript revision, design of the study, statistical analysis and interpretation, review manuscript, review manuscript, literature survey, coordination, and manuscript revision.

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Source of Support: Nil, **Conflicts of Interest:** None declared.