



Diagnostic Accuracy of Ultrasound in Detecting Liver Abscess by Taking Computed Tomography Scan as Gold Standard

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ABSTRACT

Background: Liver abscess is an important and common infection causing serious sequelae, which is a challenge in developing countries. Imaging plays an important role in early diagnosis of liver abscess. Computed Tomography Scan is the gold standard for the diagnosis of liver abscess. However, its application is limited because of its high cost, radiation hazard, and lack of accessibility. Ultrasonography is used as a primary method of imaging, although its sensitivity for the diagnosis of liver abscess requires consideration. **Objective:** To determine the diagnostic accuracy of ultrasound in detecting liver abscess by using computed tomography scan as the gold standard. **Study Design:** Cross-sectional study. **Duration and Place of Study:** This study was conducted from October 2024 to April 2025 at the Department of Diagnostic Radiology, Liaquat University of Medical and Health Sciences, Jamshoro, Hyderabad. **Methodology:** A total of 60 patients aged 18 to 70 years of both genders with clinical suspicion of liver abscess were included. All patients underwent liver ultrasound followed by computed tomography scan. Imaging findings were compared by using computed tomography scan as reference standard. A two by two contingency table was used to calculate sensitivity, specificity, positive predictive value, negative predictive value, and diagnostic accuracy. **Results:** The mean age was 44.48 ± 15.85 years, with 60.0% males and 40.0% females. Ultrasound detected liver abscess in 13.3% cases, while computed tomography scan detected abscess in 15.0% cases. Sensitivity of ultrasound was 77.78%, specificity was 98.04%, and diagnostic accuracy was 95.00%. Positive predictive value was 87.50% and negative predictive value was 96.15%. **Conclusion:** Ultrasound is a reliable initial imaging tool for detection of liver abscess, showing high specificity and diagnostic accuracy when compared with computed tomography scan.

INTRODUCTION

Liver abscess is a serious form of liver infection that manifests as a localized purulent accumulation resulting from the invasion of bacteria, parasitic organisms and/or mixed infections.¹ More often the liver abscess develops as an effect of the progression of infection along the biliary channels, portal system, and/or bacteremia.² The disease appears to have a high prevalence level in developing countries and can result from factors such as poor sanitation, diabetes mellitus, malnutrition and immunodeficiency.³ Generally, the disease has the capacity to manifest itself through general and vague presentations of the infection, which include: fever, right upper quadrant pain of the abdomen, malaise, weight loss and rare occurrence of jaundice.⁴ If not properly and promptly identified and managed, liver abscess has the potential of causing serious complications, which can lead to mortality.⁵

However diagnosis of a liver abscess can only be made by a combination of clinical features, lab findings, and radiographic studies.⁶ Lab findings typically disclose leukocytosis, inflammation, and hepatic dysfunction but these are non-specific for a liver abscess.⁷ Radiographic studies play a crucial role in establishing a diagnosis and determining the extent of abscesses in terms of size, number and location.⁸ Computed tomographic studies are currently considered the definitive modality for a diagnosis of a liver abscess because they are highly sensitive even to a few abscesses and can provide a clear delineation of their boundaries, internal characteristics and complications.⁹ However computed tomography is associated with drawbacks like high cost, significant radiation exposure, and limited availability, so other modalities carry considerable significance.¹⁰ Ultrasound is widely used as an initial imaging technique for the diagnosis of liver abscesses due to its universal

availability, affordability, and non-ionizing properties.¹¹ A liver abscess on ultrasonography appears as a hypoechoic or mixed echo with irregular margins, Septa and posterior echo enhancement.¹² The advantages of ultrasound not only apply to diagnostic purposes but are also useful in aspirational procedures, thereby serving as a useful adjunct technique.¹³ Although its sensitivity is marginally less when compared to computed tomography, especially in smaller and posterior abscesses, its sensitivity is still acceptable. Numerous factors might affect the images, including operator expertise, body type of the patient and the effect of bowel gas.¹⁴

However, it is imperative that this study is carried out in Hyderabad because liver abscess is rather common in this region and patients also turn up late in hospital with complications. In Hyderabad, it is observed that it is rather difficult for most government and some private hospitals to have access to CT scanning due to financial and availability factors. Ultrasound is rather easily available and is also used as a modality for initial diagnosis; however, its accuracy is not quite clear for this region. Through this study where ultrasound is compared to CT scanning that is considered to be the gold standard for liver absorption measurement and detection, it is hoped that this study would be useful.

METHODOLOGY

This cross-sectional study was carried out from 10-10-2024 to 10-04-2025 in the Department of Diagnostic Radiology at Liaquat University of Medical and Health Sciences Jamshoro Hyderabad. Approval for the study was obtained from the institutional ethical review committee after acceptance of synopsis by CPSP (Ethical approval was granted under reference number LUMHS/REC/-962, dated 01-10-2024). Permission from the hospital administration was also taken before starting data collection, and the study was conducted according to ethical standards for human research. The sample size was calculated separately for sensitivity and specificity. For sensitivity, assumed value was 70%, prevalence was taken as 0.2%, margin of error was 25%, and confidence interval was 95%, which gave a required sample size of 46. For specificity, assumed value was 99%, prevalence was 0.2%, margin of error was 1%,^{15,16} and confidence interval was 95%, which resulted in a sample size of 333. As the incidence of liver abscess was low only 60 patients were included in the study. Patients were recruited using non-probability consecutive sampling technique. Patients aged 18 to 70 years of either gender presenting with clinical features suggestive of liver abscess and lesion size more than 5 cm were included. Only those willing to undergo both liver ultrasound and CT scan were enrolled. Patients who were already diagnosed cases of liver abscess with inconclusive histopathological findings were excluded. Those having obstructive jaundice, ascites, deranged blood profiles, organized abscess, abscess close to major vascular structures or pregnancy were also excluded from the study. Before data collection the purpose and procedure of the study were explained to each participant and written informed consent was obtained from all patients prior to inclusion. Demographic details including age, gender, height in meters, weight in kilograms, body

mass index in kg/m², residential status, socio-economic status and duration of symptoms were recorded. All enrolled patients underwent detailed history taking and physical examination. Clinical symptoms such as right upper abdominal pain, fever, chills, nausea, vomiting, weight loss, dyspnea, cough, dark-colored urine, clay-colored stool and diarrhea were assessed mainly through history. Laboratory investigations including complete hemogram, liver function test, kidney function test, coagulation profile with PT/INR, blood culture, urine culture, stool examination, amebic serology and microbiological culture from blood or aspirate were performed.

Ultrasound of liver was performed for all patients by a senior radiologist having more than 5 years of experience. After ultrasound examination CT scan of abdomen was done and findings were recorded. CT scan was considered as reference standard for comparison. Imaging findings were documented carefully before proceeding to data analysis. After completion of imaging procedures liver abscess was taken as presence of collection of purulent material within liver parenchyma due to infectious causes suspected clinically by presence of at least three symptoms including right upper abdominal pain with VAS more than 7, fever and chills of 2 weeks or less, nausea or vomiting, weight loss of 10 pounds or more in few weeks, dyspnea with cough, dark-colored urine, clay-colored stool, or diarrhea of 2 weeks or less, and confirmed on ultrasound by solitary or multiple collections of pus larger than 5 cm in liver. CT scan positive findings were taken as multiloculated thick-walled septated fluid collection mainly in right hepatic lobe with or without extension to liver dome and associated trace right pleural effusion. Data were entered and analyzed using SPSS Statistical Package of Social Sciences version 21. Mean and standard deviation were calculated for age, height, weight, BMI and duration of symptoms. Frequencies and percentages were calculated for gender, residential status and socio-economic status. A 2 × 2 contingency table was used to determine sensitivity, specificity, positive predictive value, negative predictive value and diagnostic accuracy of ultrasound by taking CT scan as gold standard.

RESULTS

The study included a total of 60 patients with mean age of 44.48 ± 15.85 years, mean weight was 70.91 ± 10.54 kg, and mean height was recorded as 1.66 ± 0.08 m. The mean BMI of participants were 26.48 ± 3.67 kg/m² and the duration of symptoms was having mean of 18.28 ± 7.98 days. Regarding gender distribution, males were 36 (60.0%) while females were 24 (40.0%). When residential status was analyzed, urban residents were 28 (46.7%) and rural residents were 32 (53.3%). In terms of socioeconomic status, lower class patients were 25 (41.7%), middle class were 27 (45.0%), and upper class were 8 (13.3%) (as shown in Table 1).

When overall results of ultrasound and CT scan in diagnosis of liver abscess was evaluated, ultrasound detected positive cases were 8 (13.3%) and negative cases were 52 (86.7%). CT scan showed positive cases were 9 (15.0%) and negative cases were 51 (85.0%) out of total 60 (100%) patients in both modalities (as shown in Table

2).

Table 1*Patient Demographics*

Demographics		Mean ± SD
Age (years)		44.48 ± 15.85
Weight (kg)		70.91 ± 10.54
Height (m)		1.66 ± 0.08
BMI (kg/m ²)		26.48 ± 3.67
Duration of Symptoms (days)		18.28 ± 7.98
Gender	Male n (%)	36 (60.0%)
	Female n (%)	24 (40.0%)
Residential Status	Urban n (%)	28 (46.7%)
	Rural n (%)	32 (53.3%)
Socioeconomic Status	Lower n (%)	25 (41.7%)
	Middle n (%)	27 (45.0%)
	Upper n (%)	8 (13.3%)

Table 2*Overall Results of Ultrasound and CT Scan in Diagnosis of Liver Abscess*

Liver Abscess	Ultrasound	CT Scan
Positive	8 (13.3%)	9 (15.0%)
Negative	52 (86.7%)	51 (85.0%)
Total	60 (100%)	60 (100%)

The comparison between ultrasound and CT scan findings revealed that when ultrasound was positive, CT scan confirmed 7 cases as true positive and 1 case as false positive, total 8 cases. When ultrasound was negative, CT scan identified 2 cases as false negative and 50 cases as true negative, making total 52 cases. Overall, CT scan detected 9 positive cases and 51 negative cases out of total 60 patients (as shown in Table 3).

Table 3*Comparison of Ultrasound versus CT Scan in Diagnosis of Liver Abscess*

Ultrasound	CT Scan		Total
	Positive	Negative	
Positive	7 (TP)	1 (FP)	8
Negative	2 (FN)	50 (TN)	52
Total	9	51	60

Key: TP=True positive FP=False positive FN=False negative TN=True negative

The diagnostic parameters of ultrasound in detecting liver abscess showed sensitivity was 77.78%, specificity was 98.04%, and diagnostic accuracy was 95.00%. The positive predictive value was calculated as 87.50% and negative predictive value was 96.15% (as shown in Table 4).

Table 4*Sensitivity, Specificity, Diagnostic Accuracy, PPV and NPV of Ultrasound in Diagnosis of Liver Abscess*

Diagnostic Parameter	Result
Sensitivity	77.78%
Specificity	98.04%
Diagnostic Accuracy	95.00%
PPV	87.50%
NPV	96.15%

DISCUSSION

The findings of this study demonstrated that ultrasound having sensitivity of 77.78%, specificity of 98.04%, and overall diagnostic accuracy of 95.00% when CT scan was used as gold standard. In current study, mean age of patients was 44.48 ± 15.85 years which indicating that liver abscess commonly affecting middle-aged population. This age distribution is logical because middle-aged individuals are having more exposure to risk factors like diabetes, alcoholism and biliary tract diseases which are predisposing factors for development of liver abscess. Male patients were 36 (60.0%) which was higher than females 24 (40.0%). The male predominance can be explained by higher rates of alcohol consumption and poor hygiene practices in males as compared to females, these factors are contributing to increased susceptibility for pyogenic and amebic liver abscess formation. The sensitivity of ultrasound was found 77.78% which showing that ultrasound can detect approximately 8 out of 10 cases of liver abscess. This moderate sensitivity occurs because it would be very difficult to identify small abscesses measuring less than 2 cm or those located in anatomically difficult sites, such as under the diaphragm or within the posterior segments of the liver. This high specificity of 98.04% supports that ultrasound imaging is a highly sensitive tool in excluding liver abscess. The high specificity can be explained by the specific sonographic appearance of a liver abscess, which includes hypoechoic or anechoic lesions that are irregularly walled with posterior acoustical enhancement. The high accuracy of 95.00% shows that ultrasound imaging is a highly reliable tool in the diagnosis of a liver abscess. The high accuracy percentage can be explained by this tool's ability to detect most cases of this condition while having a high false negative result due to its ability to show the typical morphological appearance of the abscess cavity.

The sensitivity of ultrasound in present study was 77.78% which is lower than several previous studies. Thimmaiah VT *et al.*¹⁷ reported sensitivity of 90.9% for liver abscess detection and Popescu A *et al.*¹⁸ found sensitivity of 92.7% using contrast-enhanced ultrasound. Similarly, Poddar S *et al.*¹⁹ demonstrated sensitivity of 87.23% for abscesses and Choudhary V *et al.*²⁰ reported diagnostic accuracy of 90% in their study of 100 liver abscess cases. The lower sensitivity in current study could be attributed to smaller sample size of 60 patients compared to these studies and possible inclusion of smaller abscesses which are difficult to detect on conventional ultrasound. Additionally, Popescu A *et al.*¹⁸ used contrast-enhanced ultrasound which having better detection capability than conventional ultrasound that was used in present study, this explaining the difference in sensitivity values. The specificity of 98.04% in present study is consistent with findings of Thimmaiah VT *et al.*¹⁷ who reported specificity of 93.0% and Popescu A *et al.*¹⁸ who found specificity of 93.0%. Poddar S *et al.*¹⁹ also demonstrated comparable specificity of 93.33% for liver abscesses. This high specificity across different studies is indicating that ultrasound is very reliable in excluding liver abscess when it is not present, this is because characteristic features of liver abscess on ultrasound are quite specific and easily distinguishable from normal liver parenchyma.

The male predominance 36 (60.0%) in current study is showing similar pattern to previous research. Choudhary V *et al.*²⁰ reported 92% male patients and Nagesh R²¹ found 92% male predominance in amoebic liver abscess cases. This consistent finding across studies is supporting the fact that males are having higher risk for liver abscess development due to lifestyle factors and higher exposure to predisposing conditions. The mean age of 44.48 ± 15.85 years in present study is correlating with findings of Choudhary V *et al.*²⁰ who reported highest incidence in 31-60 age group (71%) and Nagesh R²¹ who found peak incidence in 3rd to 5th decades (84%). This age distribution is logical because this age group is having maximum exposure to risk factors and also having higher prevalence of underlying conditions like diabetes and alcoholism. The diagnostic accuracy of 95.00% in current study is higher than Choudhary V *et al.*²⁰ who reported 90% accuracy and comparable to findings of Manish Tardeja²² who demonstrated 100% sensitivity and specificity for liver abscess in acute abdomen cases. However, Xu SSD *et al.*²³ achieved 88.375% accuracy using neural network-based classification system which is lower than present study. The high diagnostic accuracy in present study is indicating that ultrasound when combined with clinical findings is highly effective diagnostic tool for liver abscess detection

There are certain limitations in the current study that need to be acknowledged. First, the current research has been conducted on a sample of 60 patients in a single center, and therefore, it may not be very generalizable to all cases. This is because patients referred to tertiary-care hospitals are often those with complicated cases. This could result in selection bias in the current research as well. Third, the current research has been conducted on conventional US, whereas contrast US is generally more capable than

conventional US in terms of its ability to make accurate diagnoses.

CONCLUSION

Based on the present study, it can be concluded that ultrasound is a highly accurate diagnostic tool for liver abscess diagnosis when CT is considered the criterion standard. Ultrasound is a highly specific and accurate test and thus a reliable tool in ruling out liver abscess in patients. Although its sensitivity is moderate, it is indeed a useful first-line investigation technique in imaging because it is non-invasive and does not utilize ionized radiation.

Disclaimer

There is no disclaimer to mention.

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Ethical Permission

Approval for this research was taken from the ethical committee. The study was carried out by following the ethical rules and the principles mentioned in the Helsinki Declaration.

Patient Consent

Written consent was taken from all patient before including them in the study. Patients were informed that their personal information would be kept confidential and they were free to withdraw at any time.

Conflict of Interest

The author declare that this research has no conflict of interest.

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