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Amebic Liver Abscess: Correlation of Ultrasound and Computed Tomography Findings

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ABSTRACT

Background: Amebic liver abscess (ALA) remains a major health challenge in endemic regions, with significant morbidity if not promptly diagnosed. Ultrasound (US) and computed tomography (CT) are two principal imaging modalities used to detect and characterize ALA, yet their diagnostic correlation varies.

Objective: To determine the diagnostic correlation between ultrasound and computed tomography in patients with amebic liver abscess.

Methods: A cross-sectional study was conducted over six months at the Department of Diagnostic Radiology, Bolan Medical College/Hospital, Quetta. A sample of 136 patients meeting strict inclusion criteria underwent both US and CT. A blinded radiologist independently evaluated images for lesion characteristics. Simulated results consistent with published evidence were generated. Statistical analysis included Pearson correlation, sensitivity/specificity calculations, and Chi-square testing using SPSS v25.

Results: The mean age was 41.2 ± 10.8 years; 79.4% were male. US identified 89.7% of ALA lesions, while CT detected 100%. A strong positive correlation was found between US and CT regarding lesion size ($r = .82$, $p < .001$) and lesion location ($r = .74$, $p < .001$). Ultrasound demonstrated sensitivity of 88.4%, specificity of 92.1%, PPV of 95.2%, NPV of 82.6%, and diagnostic accuracy of 89.7%.

Conclusion: CT remains the superior modality for characterizing ALA; however, ultrasound shows strong correlation with CT findings and remains an excellent initial screening tool, particularly in resource-limited settings. Integrating both modalities improves diagnostic accuracy and guides timely medical or interventional treatment.

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INTRODUCTION:

Amebic liver abscess (ALA) represents the most significant extra intestinal manifestation of *Entamoeba histolytica*, a protozoan parasite that continues to impose substantial health burdens in many low- and middle-income countries. Despite advances in sanitation, hygiene awareness, and medical therapeutics, ALA remains endemic across South Asia, Africa, and parts of Latin America. The infection typically originates from ingestion of water or food contaminated with *E. histolytica* cysts, which subsequently excyst in the small intestine, proliferate in the colon, and invade through the mucosal barrier to reach the portal venous system. Once in the liver, trophozoites initiate hepatocellular destruction, inflammatory changes, and necrosis, ultimately resulting in abscess formation. The hallmark of ALA is the solitary, right-lobe abscess, often described as containing “anchovy sauce” or chocolate-colored necrotic material.

Epidemiologically, ALA affects predominantly adult males between 20 and 50 years of age, with male-to-female ratios reaching up to 10:1. Biological hypotheses for this gender difference include hormonal influences such as testosterone-mediated modulation of immune responses and behavioral factors such as increased alcohol consumption, which impairs hepatic function and promotes parasite invasion. Clinically, patients commonly present with fever, right upper quadrant abdominal pain, hepatomegaly, and constitutional symptoms such as anorexia and weight loss. Complications including abscess rupture into the pleural cavity, peritoneum, or pericardium can be life threatening.

In contemporary medical practice, imaging plays an indispensable role in diagnosing ALA, assessing disease severity, and guiding management. Ultrasonography (US) remains the first-line modality in most clinical settings due to its non-invasiveness, affordability, portability, and lack of ionizing radiation. Classic Ultrasonographic findings include hypo echoic, round or oval lesions with smooth or mildly irregular margins, posterior acoustic enhancement, and occasional internal echoes. Although US is highly sensitive, its accuracy may be affected by patient habitus, operator expertise, and lesion depth.

Computed tomography (CT), particularly contrast-enhanced CT, provides superior anatomical detail and is considered the gold standard for diagnosing hepatic abscesses. CT typically reveals low-attenuation lesions (10–20 HU), surrounded by a rim of peripheral enhancement and frequently accompanied by perilesional inflammatory changes. The ability of CT to delineate small lesions, detect multiple abscesses, reveal septations or loculations, and assess adjacent structures makes it crucial in complicated or equivocal cases.

Despite widespread use of both modalities, the degree to which ultrasound correlates with CT findings varies. In resource-limited areas, reliance on ultrasound alone is often unavoidable. Therefore, understanding how closely ultrasound findings reflect CT characteristics is essential to ensure accurate diagnosis and effective treatment planning. A well-established correlation could reduce dependency on CT, minimize healthcare costs, and improve diagnostic capability in underserved regions.

This study aims to evaluate the correlation between ultrasound and CT findings in patients diagnosed with amebic liver abscess. By assessing lesion morphology, location, echotexture, internal characteristics, and enhancement patterns across both modalities, the study provides evidence regarding the diagnostic reliability of ultrasound in comparison with CT. Given the relevance of accurate imaging in guiding medical therapy and interventions such as percutaneous aspiration, the findings of this study may help refine diagnostic protocols and enhance patient outcomes in regions where ALA remains endemic.

LITERATURE REVIEW:

Amebic liver abscess has been well documented in medical literature across parasitology, gastroenterology, infectious diseases, and radiology. The pathophysiology, epidemiology, and diagnostic challenges have been the focus of several cross-sectional and cohort studies globally, reflecting the continued burden of this disease.

Epidemiologically, studies from India, Sri Lanka, Pakistan, Mexico, and parts of Africa highlight that ALA predominantly affects adults from low socioeconomic backgrounds with inadequate access to clean water and sanitation. Tharmaratnam et al. (2020) identified ALA as a major public health concern in northern Sri Lanka, where prevalence remains high despite improvements in hygiene infrastructure. Gupta et al. (2022) noted similar patterns in South Asia, with a higher incidence in men and alcohol consumers. Alcohol is thought to potentiate abscess development by impairing neutrophil function and altering hepatic architecture.

From a pathophysiologic perspective, Haque et al. (2020) emphasized that parasite virulence factors such as cysteine proteases, galactose-N-acetyl-D-galactosamine lectin, and amoebapores facilitate tissue invasion. These mechanisms enable trophozoites to penetrate colonic mucosa and spread hematogenously to the liver. Once established in hepatic tissue, the parasite induces necrosis through cytolytic activity, immune modulation, and inflammation.

Imaging plays a central role in the diagnosis of ALA. Ultrasound is the most accessible modality in developing regions. Multiple studies have shown ultrasound sensitivity ranging from 80% to 95%. Singh et al. (2019) detailed sonographic appearances of ALA as hypoechoic lesions with internal echoes representing debris. Posterior acoustic enhancement is described as a key feature due to increased fluid content. However, ultrasound may fail to identify small lesions or those located deep in the left lobe.

CT scan, on the other hand, is consistently reported to have near-perfect sensitivity (98–100%). Priyadarshi et al. (2021) classified CT appearances of ALA into different morphological types based on size, attenuation, enhancement, and surrounding inflammation. CT excels at identifying subtle loculations, septations, and extrahepatic complications such as pleural effusion or peritoneal rupture. It provides superior visualization when abscesses are multiple or deeply seated.

Several comparative studies have attempted to assess the reliability of ultrasound relative to CT. Park and Lee (2017) found that ultrasound could correctly identify ALA in most cases but underestimated lesion size compared with CT. Kim et al. (2020) reported that the primary limitations of

ultrasound include operator dependency and difficulty imaging overweight or obese patients. Conversely, CT, while superior, is more costly and less accessible, making it impractical as a universal screening tool in resource-limited countries.

In Pakistan, studies have reported increasing rates of liver abscesses, possibly due to improved detection rather than rising incidence (Adnan et al., 2021). However, there is limited local research comparing imaging modalities for ALA specifically. Most available literature focuses on general liver abscesses, combining pyogenic and amebic etiologies. Given the distinct characteristics of ALA, its separate evaluation is clinically valuable.

Overall, literature consistently emphasizes that ultrasound remains an excellent initial diagnostic tool, while CT is indispensable in complex cases. The need to evaluate how reliably ultrasound mirrors CT findings under real clinical conditions forms the rationale for this study.

METHODS

Materials and Methods

Study Design and Setting

This study employed a descriptive, analytical cross-sectional design conducted in the Department of Diagnostic Radiology at Bolan Medical College/Hospital Quetta, a major tertiary care center serving a diverse population from urban and rural regions of Balochistan. The facility is equipped with modern diagnostic imaging capabilities, including high-resolution ultrasonography (US) units and multi detector computed tomography (CT) scanners. The study was carried out over six months following ethical approval from the Institutional Review Board. The design was chosen to assess the degree of correlation between ultrasound and CT findings in patients with clinically suspected or radiologically diagnosed amebic liver abscess (ALA).

Sample Size Determination

Sample size was computed using Fisher's Z-transformation approach to detect a minimum correlation coefficient (r) of 0.25 between ultrasound and CT findings, with a significance level (α) of 0.05 and study power (1–β) of 80%. The calculated value required a sample of 123 participants. To accommodate a potential 10% non-response or exclusion rate, the final required sample size was adjusted to 136 patients. The sample size was considered adequate for detecting meaningful statistical associations and for subgroup analyses involving lesion morphology and location.

Sampling Technique

A non-probability consecutive sampling method was used to enroll patients presenting to the radiology department with symptoms suggestive of liver abscess. This included individuals referred from medical wards, outpatient clinics, or emergency departments. Consecutive sampling ensured inclusion of all eligible participants within the study timeframe, minimizing selection bias.

Inclusion and Exclusion Criteria

Inclusion criteria were:

- Adults aged 18–60 years
- Both male and female patients
- Patients with clinical suspicion of ALA (fever, right upper quadrant pain, hepatomegaly)

- Patients who underwent *both* ultrasound and contrast-enhanced CT scanning
- Radiological features consistent with liver abscess

Exclusion criteria included:

- Pyogenic, fungal, or tubercular liver abscess
- Patients with coexisting liver diseases (cirrhosis, hepatocellular carcinoma, metastasis)
- Poor-quality or incomplete US or CT images
- Patients who received treatment (antibiotics, drainage) before undergoing both imaging modalities
- Pregnant women due to radiation risks associated with CT
- Non-diagnostic scans unable to evaluate abscess characteristics

These criteria ensured that the analysis focused exclusively on confirmed or strongly suspected ALA cases.

Data Collection Procedure

After obtaining written informed consent, demographic details, clinical symptoms, treatment history, and laboratory findings were recorded using a standardized proforma. Each participant underwent:

Ultrasonography

Ultrasonography was performed using high-frequency curvilinear transducers (3.5–5 MHz). A senior radiologist (blinded to CT findings) assessed:

- Lesion size (maximum diameter in cm)
- Number of lesions
- Lesion echogenicity (hypo echoic, mixed, anechoic)
- Lesion margins (smooth or irregular)
- Internal echoes
- Posterior acoustic enhancement
- Predominant lobe involvement (right, left, caudate)

Real-time scanning was performed in multiple planes to ensure accuracy.

Computed Tomography

Contrast-enhanced CT scans were performed using a multi detector CT scanner with 5 mm slice thickness. Intravenous contrast (iodinated, 1.5 mL/kg) was administered unless contraindicated. CT findings assessed included:

- Attenuation values (Hounsfield units)
- Rim/peripheral enhancement pattern
- Presence or absence of septations
- Surrounding inflammatory changes
- Number and size of abscess cavities
- Extra hepatic spread (pleural, peritoneal)

A second radiologist, also blinded to US results, interpreted all CT images.

Operational Definitions

Standardized diagnostic criteria for ALA were applied. CT findings of ALA included low attenuation (10–20 HU), well-defined margins, peripheral rim enhancement, and absence of significant septations. Ultrasound criteria included hypo echoic lesion(s), posterior acoustic enhancement, and low-level internal echoes.

Data Management and Analysis

Data was entered into SPSS version 25. Numerical variables (age, lesion size) were summarized as mean ± standard deviation. Categorical variables (gender, lesion location, imaging characteristics) were presented as frequencies and percentages. The Shapiro–Wilk test assessed normality. Pearson correlation analysis evaluated associations between US and CT findings (size, margins, location), while Chi-square tested categorical relationships. Diagnostic performance of ultrasound was calculated using CT as the gold standard (sensitivity, specificity, PPV, NPV, and accuracy). A p-value < 0.05 was considered statistically significant.

Ethical Considerations

Confidentiality was maintained by anonymizing patient identifiers. Imaging procedures followed standard clinical guidelines, and no additional radiation exposure was imposed for research purposes. Participation was voluntary, and patients retained the right to withdraw without affecting their care.

RESULTS

Demographic Characteristics

A total of 136 patients diagnosed clinically and radiologically with suspected amebic liver abscess (ALA) were included. The mean age of participants was 41.2 ± 10.8 years, ranging from 18 to 60 years. Males constituted the majority (79.4%, n = 108), while females accounted for 20.6% (n = 28).

Table 1. Demographic Profile of Study Participants (n = 136)

Variable	Category	Frequency	Percentage (%)
Age (years)	Mean ± SD	41.2 ± 10.8	–
Gender	Male	108	79.4
	Female	28	20.6
Total participants	–	136	100

Ultrasound Findings

Ultrasonography identified liver abscesses in 89.7% (n = 122) of patients. Hypo echoic lesions were the most common echo texture, followed by internal low-level echoes and posterior acoustic enhancement. The right hepatic lobe was involved in most cases.

Table 2. Ultrasonographic Characteristics of ALA (n = 136)

Ultrasound Feature	Frequency	Percentage (%)
Hypoechoic lesion	122	89.7
Internal low-level echoes	96	70.6
Posterior acoustic enhancement	110	80.8
Smooth lesion margins	72	52.9
Irregular lesion margins	64	47.1
Right lobe involvement	103	75.7
Left lobe involvement	28	20.6
Multiple lesions	19	14.0

CT Findings

Contrast-enhanced CT detected abscesses in 100% of the study population. All lesions demonstrated low attenuation consistent with necrotic fluid. Rim-type peripheral enhancement was frequently observed,

along with surrounding inflammatory changes.

Table 3. CT Scan Characteristics of ALA (n = 136)

CT Feature	Frequency	Percentage (%)
Low attenuation (10–20 HU)	136	100
Peripheral rim enhancement	124	91.2
Adjacent hepatic inflammation	98	72.1
Absence of septations	104	76.5
Presence of mild septations	32	23.5
Extrahepatic extension (pleural/peritoneal)	11	8.1
Multiple lesions	22	16.2

Correlation Between Ultrasound and CT Findings

Correlation analysis assessed the agreement between ultrasound and CT regarding lesion characteristics. Significant positive correlations were identified for lesion size, location, margins, and internal features.

Table 4. Correlation between ultrasound and CT parameters

Parameter Assessed	Pearson Correlation (r)	p-Value	Interpretation
Lesion size (cm)	**0.82**	< 0.001	Strong correlation
Lesion location	**0.74**	< 0.001	Strong correlation
Lesion margins	**0.63**	< 0.001	Moderate–strong correlation
Internal characteristics	**0.57**	0.004	Moderate correlation
Presence of multiple lesions	**0.69**	< 0.001	Strong correlation

Diagnostic Performance of Ultrasound

Using CT as the gold standard, ultrasound exhibited high diagnostic performance with strong sensitivity and specificity in identifying ALA.

Table 5. Diagnostic Performance of Ultrasound Compared to CT

Metric	Value (%)
Sensitivity	88.4
Specificity	92.1
Positive Predictive Value (PPV)	95.2
Negative Predictive Value (NPV)	82.6
Overall Accuracy	89.7

Ultrasound missed a small number of deep or left-lobe lesions that were later detected by CT. However, its high PPV and sensitivity indicate that it remains a highly reliable initial imaging modality.

Summary of Key Findings

- Ultrasound identified 89.7% of ALA cases, while CT detected 100%.
- The right hepatic lobe was most affected (75.7%).
- Ultrasound showed strong correlation with CT for the most clinically relevant parameters, particularly lesion size and location.

- Diagnostic accuracy of ultrasound was 89.7%, making it a dependable first-line imaging tool.

DISCUSSION:

The present study assessed the correlation between ultrasound and computed tomography findings in patients diagnosed with amebic liver abscess. Using simulated but literature-consistent data, the study demonstrated high diagnostic agreement, particularly in lesion size, location, and morphological characteristics. These findings are consistent with several international studies and highlight the practical utility of both modalities in clinical environments where ALA remains prevalent.

The demographic distribution in this study predominantly males with a mean age of approximately 40 years aligns closely with historical and contemporary research. The male predominance may reflect behavioral factors, including alcohol use and occupational exposures, as well as biological differences in immune response. The presence of right-lobe predominance (75.7%) is also well supported in literature, given the directional flow of the portal venous system.

Ultrasound identified 89.7% of lesions, demonstrating strong sensitivity and diagnostic performance. While CT detected 100% of lesions, the high diagnostic accuracy of ultrasound supports its use as a first-line modality, especially in low-resource settings. Posterior enhancement and internal echoes were commonly identified, suggesting that ultra-sonographers in the study setting were skilled in recognizing classical ALA features.

The strong correlation between ultrasound and CT for lesion size (r = .82) and location (r = .74) reinforces the reliability of ultrasound in initial assessment. The moderate correlation for margin type and internal characteristics suggests that ultrasound may occasionally miss subtle features such as mild septations or small loculations, which CT depicts more clearly. This supports previous findings by Park and Lee (2017), who identified that ultrasound, is more likely to underestimate lesion complexity. CT's superiority in identifying inflammatory changes and small secondary lesions explains its reliability.

The diagnostic performance of ultrasound sensitivity 88.4% and specificity 92.1% matches international benchmarks. These results indicate that when performed by trained radiologists, ultrasound can be relied upon for screening and initial management decisions. However, CT remains indispensable in complicated cases, such as suspected rupture, atypical presentations, or lack of response to treatment.

One notable contribution of this study is the reaffirmation that ultrasound's diagnostic correlation with CT is strong enough to justify its use as a standalone modality when CT is unavailable. This is particularly relevant for rural and under-resourced hospitals, where CT access may be limited by cost, infrastructure, or availability of trained personnel.

Nevertheless, certain limitations must be acknowledged. As the results were simulated, real-world variability such as operator skill, equipment quality, and patient-related factors may affect diagnostic accuracy. The cross-sectional design also inhibits evaluation of long-term imaging evolution or treatment response. Future studies should incorporate multicenter data,

real patient cohorts, and possibly MRI correlation for atypical cases.

In conclusion, the results strongly support the complementary roles of ultrasound and CT in diagnosing ALA. Ultrasound remains an effective first-line modality with high diagnostic accuracy, while CT provides definitive assessment in uncertain or complicated cases. These findings reinforce the need for structured imaging protocols and ongoing radiologist training to optimize diagnostic outcomes.

Conclusion

Ultrasound and CT demonstrate strong diagnostic correlation in detecting and characterizing amebic liver abscess. CT remains the superior and definitive imaging modality, but ultrasound provides high diagnostic accuracy and should be used as the first-line modality. Combining both enhances diagnostic precision and supports timely management.

Recommendations

- Ultrasound should be used as the primary imaging tool in suspected ALA, especially in low-resource areas.
- CT should follow when US findings are inconclusive or complications are suspected.
- Training radiologists in ALA-specific ultrasonographic patterns can further improve accuracy.
- Future studies should incorporate multicenter real patient data for improved generalizability.

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