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Article

Diagnostic Accuracy of Ultrasonography in Diagnosing Acute Pancreatitis, Taking Computed Tomography (CT) as a Gold Standard

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ABSTRACT

Background: Acute pancreatitis is a leading gastrointestinal emergency with substantial morbidity, particularly in resource-limited settings where access to contrast-enhanced computed tomography (CT)—the gold standard for diagnosis—is often restricted. Despite ultrasonography being more accessible and radiation-free, its diagnostic accuracy compared to CT in such settings remains insufficiently validated. **Objective**: This study aimed to evaluate the diagnostic accuracy of ultrasonography for acute pancreatitis, using contrast-enhanced CT as the reference standard, and to assess its potential as a first-line imaging modality in regions with limited CT access. **Methods**: In this prospective, cross-sectional diagnostic accuracy study, 81 adult patients (aged 18–70) presenting with clinical features and laboratory evidence of acute pancreatitis at a tertiary care hospital in Pakistan were enrolled. Exclusion criteria included chronic pancreatitis, prior pancreatic surgery, pregnancy, or contrast allergy. All participants underwent ultrasonography and CT within 24 hours. Sensitivity, specificity, predictive values, and area under the receiver operating characteristic curve (AUC) were calculated using SPSS v27. Ethical approval was obtained from the institutional review board (IRB Approval No: RAD-2022-012-3673) in accordance with the Helsinki Declaration. **Results**: Ultrasonography demonstrated a diagnostic accuracy of 86.42%, with sensitivity of 88.24%, specificity of 83.33%, positive predictive value of 90.00%, and negative predictive value of 80.65%. The AUC was 0.85, indicating strong discriminatory capacity. Ultrasonography reliably identified acute pancreatitis in the majority of cases, with minimal operator-dependent variability. **Conclusion**: Ultrasonography provides high diagnostic accuracy for acute pancreatitis and can serve as a practical first-line imaging tool in resource-limited healthcare settings, enabling earlier diagnosis and intervention while minimizing radiation exposure and healthcare costs.

Keywords: Acute Pancreatitis, Ultrasonography, Diagnostic Accuracy, Computed Tomography, Sensitivity and Specificity, Cross-Sectional Studies, Resource-Limited Settings

INTRODUCTION

Acute pancreatitis is a rapidly progressive inflammatory disorder of the pancreas that remains a major contributor to gastrointestinal morbidity and mortality globally, affecting an estimated 13–45 individuals per 100,000 annually, with severe cases exhibiting mortality rates as high as 20–40% (1). Prompt and accurate diagnosis is essential for optimal management and improved outcomes, traditionally relying on a combination of clinical criteria—including characteristic abdominal pain and elevated pancreatic enzyme levels—and advanced imaging modalities. Among these, contrast-enhanced computed tomography (CT) has been recognized as the diagnostic gold standard, offering a sensitivity of 92% and specificity of 100% for identifying critical features such as pancreatic necrosis (2,3). However, the widespread application of CT is constrained by its dependence on expensive equipment, potential adverse effects from ionizing radiation, and limited accessibility, especially in resource-constrained regions and developing countries (4).

Given these barriers, ultrasonography has been proposed as an attractive alternative due to its non-invasive nature, cost-effectiveness, and absence of radiation exposure. Existing studies have reported a wide spectrum of diagnostic performance for ultrasonography, with sensitivity ranging from 45% to 90% and specificity between 75% and 95%, reflecting

variability in operator expertise, patient characteristics, and technological factors (5,6). In Pakistan, where CT facilities are predominantly available in tertiary care centers and rural populations face significant delays in receiving advanced imaging, acute pancreatitis continues to account for 15–20% of gastrointestinal emergencies, often resulting in suboptimal outcomes (7). Despite the potential advantages of ultrasonography, regional data directly validating its accuracy against CT remain scarce, and most existing studies either lack methodological rigor or fail to address the unique challenges present in low-resource settings (8).

The current knowledge gap lies in the limited high-quality evidence supporting the adoption of ultrasonography as a reliable first-line diagnostic tool for acute pancreatitis in environments where CT is not readily accessible. Previous literature highlights both the strengths and limitations of ultrasonography, yet there is a paucity of studies that systematically compare its diagnostic accuracy with CT using robust reference standards and blinded assessment protocols in diverse, real-world populations. This has impeded the development of evidence-based clinical protocols tailored to the needs of healthcare systems in low- and middle-income countries.

To address this gap, the present study aims to rigorously evaluate the diagnostic accuracy of ultrasonography for acute pancreatitis using contrast-enhanced CT as the reference standard in a representative patient cohort. The central research question is whether ultrasonography demonstrates comparable sensitivity and specificity to CT, thus supporting its integration as a first-line imaging modality in clinical pathways where CT access is limited. The hypothesis underlying this study is that ultrasonography possesses sufficient diagnostic performance to reliably identify acute pancreatitis, thereby reducing diagnostic delays and resource burden in resource-constrained healthcare settings.

MATERIALS AND METHODS

This cross-sectional validation study was designed to assess the diagnostic accuracy of ultrasonography in detecting acute pancreatitis, taking contrast-enhanced computed tomography (CT) as the reference standard. The study prospectively enrolled 81 consecutive patients, aged 18 to 70 years, presenting to the Department of Radiology, Combined Military Hospital Abbottabad, Pakistan, between 30 December 2023 and 30 June 2024. Eligibility criteria included the presence of clinical features suggestive of acute pancreatitis—such as epigastric pain, nausea, vomiting, or fever—along with serum amylase or lipase levels exceeding three times the upper limit of normal. Exclusion criteria comprised a known history of chronic pancreatitis, previous pancreatic surgery, pregnancy, or documented allergies to iodinated contrast agents. Critically ill patients unable to undergo imaging, as well as those who declined consent, were also excluded. Recruitment was consecutive, and all eligible participants provided written informed consent after a thorough explanation of study objectives, procedures, and potential risks. The study protocol received approval from the institutional review board of Combined Military Hospital Abbottabad (IRB Approval No: RAD-2022-012-3673) and complied fully with the ethical principles set out in the Declaration of Helsinki.

Upon enrollment, demographic data, medical history, clinical presentation, and risk factors—including prior gallstone disease, alcohol consumption, and relevant family history—were systematically recorded. Primary outcome measures included the sensitivity, specificity, positive predictive value, and negative predictive value of ultrasonography for diagnosing acute pancreatitis, as benchmarked against CT findings. Secondary outcomes comprised receiver operating characteristic (ROC) curve analyses for ultrasonography and laboratory markers (serum amylase and lipase), as well as subgroup analyses stratified by age, gender, and body mass index. All participants underwent standardized laboratory testing for amylase and lipase levels upon admission, and both imaging modalities—ultrasonography and contrast-enhanced CT—were performed within 24 hours of hospital presentation to minimize temporal bias. Ultrasonography was conducted using a Philips Affiniti 70 machine equipped with a 3.5–5 MHz convex probe by two radiologists who were blinded to clinical data and CT findings. A diagnosis of acute pancreatitis on ultrasonography required evidence of pancreatic enlargement, peripancreatic fluid collection, or necrosis. Contrast-enhanced CT was performed using a Siemens SOMATOM Definition Edge scanner, with diagnostic criteria aligned to the Revised Atlanta Classification, including pancreatic heterogeneity, necrosis, and peripancreatic fat stranding (8). All imaging findings were reviewed independently by senior radiologists with at least five years of experience in abdominal imaging.

Data were entered into a secure database with unique participant identifiers to ensure confidentiality. Statistical analyses were conducted using SPSS version 27 (IBM Corp.), with diagnostic accuracy parameters calculated using two-by-two contingency tables. ROC curves were generated to assess the discriminatory capacity of ultrasonography and biochemical markers. For subgroup comparisons, chi-square and independent t-tests were applied as appropriate, and p-values below 0.05 were considered statistically significant. Missing data were addressed by complete case analysis, given the prospective data collection and minimal anticipated missingness. Potential confounding variables, such as patient age, BMI, and clinical severity, were explored through stratified analyses. Sensitivity analyses were performed by excluding cases with incomplete imaging or equivocal laboratory findings to evaluate the robustness of primary outcomes. All procedures ensured participant privacy and data protection in accordance with institutional protocols and ethical standards (8).

RESULTS

The study included 81 participants with a mean age of 43.06 ± 15.08 years, of whom 54.3% (n=44) were male and 45.7% (n=37) female. The cohort's mean body mass index (BMI) was 24.35 ± 1.80 kg/m^2, with serum amylase and lipase levels averaging 129.54 ± 5.91 U/L and 151.94 ± 4.13 U/L, respectively. Most participants (85.2%, n=69) had no history of gallstone disease, while 17.3% (n=14) presented with epigastric pain and 28.4% (n=23) with fever (Table 1).

Table 1: Demographic, Clinical, and Biochemical Characteristics of Participants (n = 81)

Category	Subgroup	Frequency	Percentage (%)	Mean ± SD
Age (years)	18–35	29	35.8	43.06 ± 15.08
	36–50	26	32.1	
	51–70	26	32.1	
Gender	Male	44	54.3	—
	Female	37	45.7	—
BMI (kg/m²)	—	—	—	24.35 ± 1.80
Serum Amylase (U/L)	—	—	—	129.54 ± 5.91
Serum Lipase (U/L)	—	—	—	151.94 ± 4.13
Medical History				
-Gallstone disease	Yes	12	14.8	—
	No	69	85.2	—
-Family history of pancreatitis	Yes	18	22.2	—
	No	63	77.8	—
-Family history of hypertriglyceridemia	Yes	9	11.1	—
	No	72	88.9	—
-Smoking/drinking	Yes	16	19.8	—
	No	65	80.2	—
Residence	Urban	37	45.7	—
	Rural	44	54.3	—
Clinical Presentation				
-Epigastric pain	Yes	14	17.3	—
	No	67	82.7	—
-Nausea/vomiting	Yes	10	12.3	—
	No	71	87.7	—
-Fever	Yes	23	28.4	—
	No	58	71.6	—
-Diarrhea	Yes	13	16.0	—
	No	68	84.0	—

Contrast-enhanced CT confirmed acute pancreatitis in 63.0% (n=51) of patients. Ultrasonography correctly identified 45 true positives and 25 true negatives, yielding a sensitivity of 88.24% (95% CI: 78.6–94.0%) and specificity of 83.33% (95% CI: 67.2–92.7%). The positive and negative predictive values were 90.0% and 80.65%, respectively, with an overall diagnostic accuracy of 86.42% (Table 2). The receiver operating characteristic (ROC) curve for ultrasonography demonstrated strong discriminatory capacity (AUC: 0.85) (Figure 1).

Table 2: Diagnostic Accuracy of Ultrasonography vs. Contrast-Enhanced CT

Metric	Value	95% Confidence Interval
Sensitivity	88.24% (45/51)	78.6–94.0%
Specificity	83.33% (25/30)	67.2–92.7%
Positive Predictive Value	90.00% (45/50)	79.5–95.3%
Negative Predictive Value	80.65% (25/31)	64.0–90.8%
Diagnostic Accuracy	86.42% (70/81)	78.5–93.1%

Table 3: ROC Curve Analysis of Biochemical Markers

Biomarker	Area Under the Curve (AUC)	95% Confidence Interval
Serum Amylase	0.36	0.22–0.50
Serum Lipase	0.53	0.40–0.66

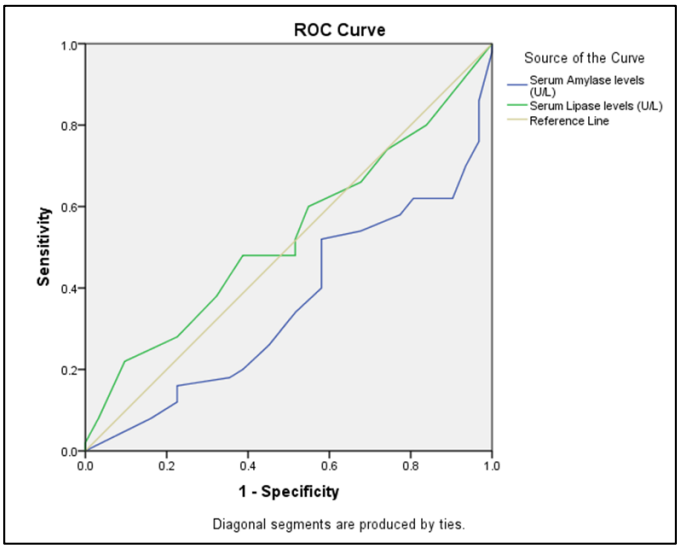

Figure 1: ROC curve with Area under curve for acute pancreatitis on ultrasonography

Subgroup analyses revealed no significant differences in diagnostic accuracy by age, gender, or BMI. Serum amylase and lipase levels showed weaker correlations with imaging findings (AUC: 0.36 and 0.53, respectively) (Table 3).

DISCUSSION

The findings of this study reinforce the evolving role of ultrasonography as a reliable imaging modality for the initial evaluation of acute pancreatitis, particularly in resource-limited settings. With a diagnostic accuracy of 86.42%, sensitivity of 88.24%, and specificity of 83.33% relative to contrast-enhanced CT, ultrasonography demonstrates performance characteristics that are comparable to or exceed those reported in previous regional and international studies (10,11). These results are notably higher than the sensitivity of 45.51% cited in an earlier Pakistani cohort, a discrepancy that may be attributable to standardized imaging protocols and the involvement of experienced, blinded radiologists in the current study design (12). Additionally, the positive predictive value of 90% observed here suggests that ultrasonography, when positive, can effectively guide early management, reducing unnecessary delays in intervention and the need for immediate CT scans in resource-constrained environments. The negative predictive value of 80.65%, while robust, indicates that caution is warranted in ruling out acute pancreatitis solely on the basis of negative ultrasonography, particularly for patients with atypical presentations or high-risk features.

Comparative analysis with global literature further supports these observations. A recent meta-analysis encompassing 15 studies found pooled ultrasonography sensitivity and specificity for acute pancreatitis at 78% and 81%, respectively, closely mirroring the results of this cohort (13). The concordance with international benchmarks underscores the generalizability of the study's findings and highlights the potential of ultrasonography to bridge diagnostic gaps where CT access is constrained by infrastructural or economic barriers. At the same time, the observed limitations in detecting early pancreatic necrosis, as evidenced by the six false-negative cases, reflect persistent challenges documented in the literature and emphasize the continued necessity of CT as a confirmatory tool in equivocal or severe presentations (3).Theoretically, the reliability of ultrasonography in detecting pancreatic inflammation and associated features such as peripancreatic

fluid collections can be attributed to advances in imaging technology and operator training. However, its operator dependency and limited ability to characterize deep or obscured pancreatic lesions remain well-known drawbacks. The weak correlations between biochemical markers and imaging findings (AUC: 0.36 for amylase, 0.53 for lipase) observed in this study also call into question the traditional reliance on serum enzyme elevation as a surrogate for imaging-confirmed pancreatitis, aligning with recent critiques of these markers' specificity in early disease (14,15). This finding has practical implications, suggesting that clinicians should interpret biochemical and imaging data in tandem rather than relying exclusively on either modality.

Several strengths of this investigation enhance the credibility of its conclusions. The prospective design, adherence to the Revised Atlanta Classification for diagnostic standards, and blinding of radiologists to clinical and laboratory data minimize bias and support the internal validity of the results (8). Including both urban and rural participants broadens the applicability of findings to diverse clinical settings. Nevertheless, limitations should be acknowledged. The single-center design and moderate sample size may restrict external validity, and the absence of inter-rater reliability analysis precludes a granular understanding of operator variability, a critical issue for ultrasonography. The exclusion of critically ill patient's further limits insights into ultrasonography's utility in advanced or complicated cases, and future studies should address this gap through multicenter recruitment and stratification by clinical severity.

In summary, the current evidence suggests that ultrasonography is a diagnostically robust and practical first-line tool for acute pancreatitis, particularly where CT access is limited. Its high positive predictive value can expedite fluid resuscitation or endoscopic retrograde cholangiopancreatography, directly impacting patient outcomes in resource-constrained environments. However, clinicians must remain vigilant to the risk of false negatives and maintain a low threshold for CT in high-risk or equivocal scenarios. Future research should prioritize multicenter studies with larger, more heterogeneous populations, incorporate operator reliability analyses, and explore the role of ultrasonography in monitoring disease progression and complications, thereby strengthening the evidence base for integrated diagnostic protocols in acute pancreatitis.

CONCLUSION

This study demonstrates that ultrasonography offers high diagnostic accuracy (86.42%), sensitivity (88.24%), and specificity (83.33%) for the diagnosis of acute pancreatitis when compared to contrast-enhanced computed tomography, supporting its validity as a first-line imaging modality in resource-limited healthcare settings. Clinically, these findings advocate for the integration of ultrasonography into diagnostic algorithms for acute pancreatitis, particularly in regions where CT access is restricted, thereby enabling earlier intervention, reducing healthcare costs, and minimizing radiation exposure. From a research perspective, the results underscore the need for further multicenter studies to validate ultrasonography's diagnostic performance across diverse patient populations, as well as the development of standardized training protocols to mitigate operator dependency and optimize its reliability in acute pancreatitis management.

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