ORIGINAL ARTICLE

Diagnostic Accuracy of Transabdominal Ultrasound Versus Computed Tomography in Acute Pancreatitis: A Cross-Sectional Study

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ABSTRACT

Objective: To determine the diagnostic accuracy of transabdominal ultrasound versus contrast-enhanced computed tomography in acute pancreatitis.

Study Design: Prospective cross-sectional diagnostic accuracy study.

Place and Duration of Study: The study was conducted at the Department of Emergency Medicine, Combined Military Hospital (CMH), Rawalpindi, Pakistan, from 1st March 2022 to 30th June 2023.

Methods: This study enrolled 120 patients of both genders aged 15-55 years. Patients with acute pancreatitis of up to two weeks duration with abdominal pain, tachycardia, fever, and a serum amylase > 400U/L were included. Patients' age, gender, symptom duration, and BMI were recorded. Ultrasound of the abdomen (USG) was performed by expert radiologists and compared with contrast-enhanced computed tomography (CECT) results. The McNemar test was employed to assess the association between imaging tests.

Results: Ultrasound abdomen supported the diagnosis of acute pancreatitis in 61 (50.8%) patients. contrast-enhanced computed tomography findings were consistent with acute pancreatitis in 58 (48.3%) cases. Taking contrast-enhanced computed tomography (CECT) as reference, out of 120 patients, 44.2% (44.2%) were true negatives, 8 (6.6%) were false positives, 5 (4.1%) were false negatives, and 54 (44.6%) were true negatives. Overall, USG had a sensitivity 91.3%, a specificity 87.1%, a positive predictive value (PPV) 86.8%, a negative predictive value (NPV) 91.3%, a likelihood ratio positive (LR +) of 7.1, a likelihood ratio negative (LR –) of 0.1, a diagnostic accuracy 89.1%, and an AUC of 0.892.

Conclusion: Transabdominal ultrasound is a non-invasive modality for diagnosing acute pancreatitis, with high sensitivity, specificity, positive and negative predictive values, likelihood ratios, and diagnostic accuracy. A negative ultrasound abdomen virtually rules out acute pancreatitis.

Keywords: *Acute Pancreatitis, Tachycardia, Ultrasonography.*

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Introduction

Acute Pancreatitis (AP) is an acute pancreatic inflammation that is mainly caused by autodigestion of enzymes secreted by the pancreas, which cause the disintegration of the parenchyma, necrotizing vasculitis, and interstitial fat necrosis.[1] AP is a disease often presenting in the Emergency Department (ED) in both mild and severe conditions.[2] Worldwide, the incidence of AP is estimated to be around 20-40cases /100,000 population with an increasing trend. We do not have a relevant national database that determines the incidence of acute pancreatitis in our population, other than a limited number of local studies dealing with etiology and clinical presentation.[3] In England, the overall prevalence of this disease is 22.4 cases per 100,000 people, and every year, the rate of hospitalization is 9.6 per 100,000 people in the United Kingdom.[4] Mild Acute Pancreatitis (MAP) occurs more frequently and is

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often self-limiting, adapts quickly to conservative therapy, and has low mortality. However, 20% of patients with acute abdominal pain are diagnosed with Severe Acute Pancreatitis (SAP).[5] It may further develop into a Systemic Inflammatory Response Syndrome (SIRS) that causes septic systemic sequelae with substantial morbidity and mortality.[5]

Early detection of pancreatitis is crucial for accurate assessment, treatment of complications, and for an overall better prognosis for this life-threatening condition.[6] The introduction of different and diverse scoring systems for acute pancreatitis disease severity, complications, and prognosis makes it cumbersome to validate and compare.[7] Abdominal imaging is by far the most common, simple and non-invasive method to verify the AP diagnosis and prognosis.[8] Contrast-enhanced computed tomography (CECT) is an excellent technique with both sensitivity and specificity of 94% for the evaluation of AP. CECT should not be employed often in patients with AP since most of the patients have a mild/moderate, uncomplicated course, and they usually have an apparent diagnosis.[8] When evaluating AP cases, CECT is regarded as the gold standard radiological technique.[9] For the diagnosis of AP, Ultrasonography (USG) is a common diagnostic imaging tool because of its mobility, affordability, simplicity, and minimal radiation dose. According to local data, it has a sensitivity of 90% and specificity of 86% for the diagnosis of AP, taking CE CT Scan as the gold standard.[10] Given its retroperitoneal location with overlying structures and relatively modest size, pancreatic ultrasonography can be quite challenging.

The purpose of USG imaging in AP is to demonstrate the presence and extent of pancreatic necrosis, which are the detrimental effects of AP, and to make a diagnosis and assess for common aetiology, such as gallstones. Due to the paucity of data concerning the diagnostic efficacy of USG for the diagnosis of AP in the existing literature and the lack of local research in this area, this particular study aimed to evaluate the diagnostic accuracy of USG for the diagnosis of AP. Furthermore, in addition to providing local statistics, this study will also contribute to the existing knowledge pool. In addition to serum Amylase, in an uncomplicated patient of AP, it may be employed in place of a CECT scan to provide the patient with a straightforward, affordable, and economical diagnostic tool.

Methods

This prospective cross-sectional comparative diagnostic accuracy study was conducted at the Department of Emergency Medicine, Combined Military Hospital (CMH), Rawalpindi, Pakistan, from 1st March 2022 to 30th June 2023, after getting approval from the Institutional Review Board (IRB) vide reference number: 473, dated 24th February 2022. Informed written consent from all participants was recorded for their inclusion. In a prior study from a tertiary care center, the prevalence of AP was 71.5% in patients presenting with one or more revised Atlanta criteria, also recommended by the American College of Gastroenterology (ACG).[11-13] For sample size calculation, adopting a more conservative, generalizable approach, we set the prevalence of AP at 50% among patients presenting with one or more revised Atlanta criteria. With an estimated USG abdomen sensitivity and specificity of 85% each in AP diagnosis (based on a previous study), an expected disease prevalence of 50%, a precision of 10% (0.1), confidence level of 95%, taking dropout rate at 10%; the minimum sample size required was 110 patients, using Buderer's formula for diagnostic studies.[10-14] A non-probability, consecutive sampling technique was used.

This study included all cases of suspected acute pancreatitis, with symptoms such as fever over 101°F, acute abdominal pain, and tachycardia (heart rate greater than 120/min), and serum amylase level greater than 400 U/L, satisfying two out of three criteria based on the revised Atlanta criteria.[12] It included both genders between the ages of 15 and 55 years with a disease duration of at least 2 weeks. All the patients with a previous history of hypersensitive reactions to iodinated contrast media, a history of abdominal injury, and patients with Chronic Kidney Failure (CKF) (serum creatinine level >1.1mg/dl) were excluded from the study. Moreover, all claustrophobic patients and those who were unable or unwilling to undergo CECT examination or the study itself were also excluded.

After informed consent was obtained, transabdominal USG was performed by radiologists for the diagnosis of AP, who were blinded to the details of the patients' history, examination,

laboratory tests, and treatment. All the patients in the study also underwent a CECT scan, and their results were assessed by an expert radiologist. Findings from the patient's CECT and USG were compared. All demographic and clinical data were recorded on a pre-designed proforma. Descriptive statistics, such as duration of disease, age, and BMI, were presented as mean, standard deviation, and mean (SD), and categorical variables, such as AP on CECT and USG, and gender, were shown in the form of frequency and percentages.

Illness period, BMI, gender, and age were effect modifiers, managed via stratification. Patients who had AP on both a CECT exam and a USG were true positive. Patients were true negatives if neither a USG nor a CECT scan revealed AP. False positive cases were those who had AP on ultrasound but not on a CECT exam, whereas false negative cases were considered those who had no AP on USG but showed the disease on a CECT result.

With CECT scan as the reference method, a 2×2 contingency table was used to determine sensitivity, specificity, PPV & NPV, and diagnostic accuracy (DA), with 95% confidence intervals. Positive likelihood ratio (LR +), negative likelihood ratio (LR -), and AUC, area under the Receiver Operating Characteristic curve (ROC) analysis were carried out to assess USG in the diagnosis of AP. The McNemar test with continuity correction was employed to find the association between USG and CECT scan findings, as the paired categorical data were obtained from the same patient. This test used a two-sided exact binomial distribution, and a *P*-value < .05 was deemed statistically significant. Data were compiled in Microsoft Excel and subsequently analysed using Statistical Product and Service Solutions (SPSS) version 26.

Results

In the current study, 120 patients were enrolled. The mean age of the patients was 36.5 (9.43) years. Sixty-nine patients (57.5%) were between 36 and 55 years of age. Out of these 120 patients, 83 (69.2%) were males and 37 (30.8%) were females. The average duration of disease and BMI was 7.05±1.95 days and 26.35±3.23 kg/m^{2,} respectively (Table 1).

USG supported the diagnosis of AP in 61 (50.8%)

Table-1: Patients' demographic data and duration of symptoms

Study Parameters		N (%)
Age in Years	Mean (SD)	36.51 (9.43)
	15 – 35	51 (42.5%)
	36 – 55	69 (57.5%)
Gender	Male	83 (69.2%)
	Female	37 (30.8%)
BMI (kg/m^2)	Mean (SD)	26.35 (3.23)
	≤ 27	75 (62.5%)
	> 27	45 (37.5%)
Duration of Symptoms (days)	Mean (SD)	7.05 (1.95)
	≤ 7	47 (39.2%)
	> 7	73 (60.8%)

Table 2: 2 x 2 Ultrasonography and Computed Tomography scan results in diagnosing Acute Pancreatitis, McNemar Test for paired categorical data

Ultrasonography	Computed Tomography Scan			X^2	*P*-value
	Positive	Negative	Total		
Positive	53 (44.2%)	8 (6.6%)	61 (50.8%)		
Negative	5 (4.1%)	54 (44.6%)	59 (49.2%)	0.31	0.581
Total	58 (48.3%)	62 (51.2%)	120 (100.0%)		

Table 3: Diagnostic Accuracy of Ultrasonography in Diagnosing Acute Pancreatitis, taking Computed Tomography as the reference method

Diagnostic Parameters	**Point Estimate**	**95% CI**
Sensitivity	91.38%	81.02% to 97.14%
Specificity	87.10%	76.15% to 94.26%
Positive Predictive Value	86.89%	77.54% to 92.71%
Negative Predictive Value	91.53%	82.29% to 96.17%
Diagnostic Accuracy	89.17%	82.19% to 94.10%
Positive Likelihood (LR+)	7.1	-
Negative Likelihood Ratio (LR−)	0.10	-
AUC	0.892	-

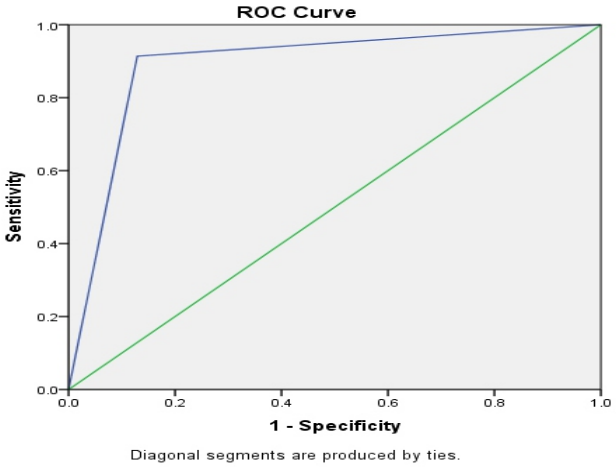

Fig 1: Receiver Operating Characteristic Curve Demonstrating Diagnostic Performance of Ultrasonography for Acute Pancreatitis

patients. CECT scan findings confirmed AP in 58 (48.3%) cases. Out of these 58 (48.3%) patients, 53 (44.2%) were true positive, and 5 (4.1%) were false negatives. In 62 patients in which CE CT scan did not confirm AP, 54 (44.6%) were true negatives and 8 (6.8%) were false positives. The McNemar test with continuity correction showed no statistically significant difference between ultrasonography and CT scan findings ($X^2 = 0.31$, df = 1, $P = 0.581$) (Table 2). Sensitivity, specificity, PPV, NPV, and DA of USG in diagnosing AP, using CECT as the reference method, were 91.38%, 87.10%, 86.89%, 91.53%, and 89.17%, respectively. The positive likelihood ratio was 7.1, indicating good ability to confirm disease, while the negative likelihood ratio was 0.10, suggesting excellent capability to exclude AP. The above results showed good concordance between the two imaging modalities (Table 3). ROC curve analysis further supported the diagnostic utility of USG, with an AUC of 0.892 (Figure 1).

Discussion

Pancreatitis usually involves the auto-digestion of the pancreas by its own pancreatic enzymes. AP is a medical condition in which the gland undergoes significant morphologic or physiological alterations.[15] Although the pancreas only makes up a mere 0.1 percent of the entire human body's weight, it can still produce enzymes that can digest nearly 13 times as much protein as the human body's weight.[16] Given its propensity to cause serious disease, it is imperative to diagnose AP early. Our study has shown that abdominal USG has superior diagnostic accuracy in AP with quite high sensitivity, specificity, predictive values, likelihood ratios, and AUC. The diagnosis of AP in a patient with classic epigastric pain or raised enzymes is a straightforward one. However, in patients with atypical abdominal pain and or borderline/asymptomatic raised pancreatic enzymes, a negative USG abdomen virtually rules out the diagnosis of AP due to its high sensitivity and negative predictive value. Not all patients can be subjected to a CE CT Scan of the abdomen.

Also, the ACG guideline does not recommend routinely performing a CE CT scan in AP. Along with MRI it should only be reserved for patients who fail to improve after 48-72 hours to look for complications such as necrosis. The ACG and other sources further recommend performing USG of the abdomen in all

patients to evaluate for biliary pancreatitis, given the high prevalence of cholelithiasis.[13,17] In addition to effective diagnosis, USG has advantages of being readily available, economical, noninvasive, requiring no intravenous contrast/radiation, offering triage and effective clinical decision-making, making it the ideal initial choice to confirm or exclude AP diagnosis. [18]

In the study by Irum R et al., USG confirmed AP in 71 (45.51%) patients, and CT supported the diagnosis in 81 (41.67%) patients.[10] In patients with positive USG results, 59 subjects had true positive results, while 12 subjects had false positive results. In subjects with negative USG results, 79 were true negatives while 6 were false negatives (*P*<.001). These outcomes are similar to those of the current study. Moreover, the predictive values, specificity, and sensitivity of this study were also comparable to those of the current study.[10]

In contrast, Khalid S et al. reported that USG abdomen has low diagnostic accuracy in AP diagnosis, taking CE CT Scan as the gold standard. In their study, the reported sensitivity and specificity of USG was 41% and 35%, respectively, for the diagnosis of AP.[19] This low diagnostic accuracy could be due to observer-related factors in performing USG abdomen.

Urooj T et al. studied 191 patients to determine the diagnostic accuracy of CECT for AP, using surgical findings as the gold standard. In their study, the mean symptom period was 85.61±6.41 hours, whereas in the current study, it was 7.05±1.95 days.[1] The CE CT scan had sensitivity 71.4%, specificity 87%, PPV 83.3%, NPV 76.9%, and diagnostic accuracy of 79.5%.[1]

Cai D et al. determined the diagnostic accuracy of Contrast-Enhanced Ultrasound (CEUS) and Conventional Ultrasound (CUS) in 196 patients of AP employing CECT as the gold standard, like the study cited earlier.[9,20] According to their findings, CEUS considerably outperformed CUS in terms of accuracy for AP and severe acute pancreatitis (SAP) diagnosis (*P*-value = .05).[20] Similar findings have been shown by a meta-analysis in which CEUS for the diagnosis of AP has a sensitivity of 92%, specificity of 84%, positive likelihood ratio of 5.38, and negative likelihood ratio of 0.13. The findings show that CEUS is a valid technique for AP and SAP monitoring and evaluation, and it appears that it may overrule CECT.[21]

In addition to its diagnostic role in AP and cholelithiasis, almost two-thirds of cases of acute pancreatitis identified using trans-abdominal ultrasonography exhibited signs of structural abnormalities in the pancreas.[22]

Bowel gas was a significant limitation of this study, which can be overcome with CECT. In both acute and chronic pancreatitis, CECT offers improved diagnostic data. This study was single-centred. For the future, multicenter studies with large sample sizes are recommended.

Conclusion

In alignment with the study's objective of evaluating diagnostic accuracy, the research affirms the pivotal role of transabdominal ultrasound in accurately diagnosing acute pancreatitis. The demonstrated precision of both imaging modalities underscores their significance in guiding clinical decisions, underscoring their indispensable role in optimizing patient care strategies for acute pancreatitis.

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Author Contributions

HR: Conception, design of the work, and approval for final submission
FAS: Manuscript writing for methodology design, investigation, and approval for final submission
TBT: Data acquisition, curation, statistical analysis, and approval for final submission
ZW: Validation of data, interpretation, write-up of results, and approval for final submission
SA: Revising, editing, supervising for intellectual content, and approval for final submission
IM: Writing the original draft, proofreading, and approval for final submission
HR is the nominated guarantor and takes full responsibility for the overall content and integrity of the work