Original Article

# Diagnostic Accuracy of Ultrasonography in Diagnosing Acute Pancreatitis, Taking Computed Tomography as Gold Standard

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**ABSTRACT**

**Objective:** To determine the diagnostic accuracy of ultrasonography (USG) in diagnosing acute pancreatitis taking computed tomography as gold standard.

**Methodology:** It was a cross-sectional study conducted from September 2020 to February 2021 at the Department of Radiology, Sharif Medical & Dental College, Lahore. A total of 156 patients of both genders between 15-55 years and with a duration of disease <2 weeks were included in the study. Patients presented with symptoms of acute pancreatitis like sudden onset abdominal pain, fever (>101F), tachycardia (heart rate >120/min), and serum amylase > 400U/L were taken as positive symptoms and included in this study. Patients with history of abdominal trauma, hypersensitivity history to iodinated contrast agent, chronic kidney failure, claustrophobic patients, and patients unable to undergo Computed Tomography (CT) scanning were excluded from the study. After taking informed consent, ultrasonography (USG) of hepatic-biliary system was performed by the consultant radiologist and was looked for presence or absence of acute pancreatitis as per-operational definition. All patients underwent CT scan and reports were interpreted by the radiologist. Ultrasonographic findings were compared with CT scan findings.

**Results:** Ultrasonography supported the diagnosis of acute pancreatitis in 71(45.51%) patients. Computed tomography findings confirmed acute pancreatitis in 81(41.67%) cases. In USG positive patients, 59 were true positive and 12 were false positive. Among 85 USG negative patients, 06 were false negative whereas 79 were true negative (p=0.0001). Overall sensitivity, specificity, positive & negative predictive value and diagnostic accuracy of ultrasonography in diagnosing acute pancreatitis taking computed tomography as gold standard was 90.77%, 86.81%, 83.10%, 92.94% and 88.46%, respectively.

**Conclusion:** Ultrasonography is a highly sensitive and accurate non-invasive method in diagnosing acute pancreatitis.

**Keywords**: *Acute pancreatitis. Ultrasonography. Sensitivity. Specificity.*

## INTRODUCTION

Acute pancreatitis (AP) is a sudden inflammation of the pancreas that can involve adjacent or farther-apart tissues and organs. It is caused by triggering of its own enzymes that causes digestion of the gland. Acute pancreatitis is a common presentation in the emergency department (ED), generally of mild and severe forms. Admission judgments by ED clinicians are done according to the severity of pancreatitis.[1,2]

Acute pancreatitis can be divided into mild acute pancreatitis (MAP) and severe acute pancreatitis (SAP). It is an inflammatory disorder of the pancreas that has been clinically defined as a common form of acute abdominal pain.[3] Mild acute pancreatitis has a good prognosis & few problems with low mortality. But, it is noted that severe acute pancreatitis that is followed by serious complications has a high mortality rate.[4,5] Early diagnosis of necrotizing pancreatitis is significant because it helps to select the proper therapy of this severe condition & improves clinical outcome, management, symptom, and prognosis.[6]

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Since the early 1980s, various clinical or radiological scoring systems have been developed to predict the incidence and outcome of acute pancreatitis. Validation & comparison of the different scoring systems are complicated by confusing and incompatible use of terminology and definitions of severity, complications, and outcome of the disease.[7]

Predicting the development of disease has remained a major challenge in managing of acute pancreatitis. The Bedside Index for Severity in Acute Pancreatitis (BISAP) is easy to calculate from the data available in the first124 hours.[8] The BISAP is a new, convenient, prognostic multifactor scoring system. The BISAP score may be a useful tool for risk stratification and prognostication in acute pancreatitis patients.[9] Computed tomography severity index (CTSI) requires the use of intravenous contrast agents to determine the presence and extent of pancreatic necrosis, as well as inflammatory changes and local and/or extra-pancreatic complications.[10] Computed tomography severity index is highly precise & sensitive than any other method in both diagnosing as well as demonstrating the extent of pancreatitis.[11]

Abdominal imaging is useful to confirm the AP diagnosis. For the diagnosis of AP, contrast enhanced computed tomography (CECT) has a high sensitivity and specificity of 94.4%.[12] Contrast enhanced computed tomography should not be used routinely in patients with AP because the diagnosis is obvious in many patients and the majority of them have a mild,

uncomplicated path.[13] Contrast Enhanced CT is considered to be the gold standard imaging modality in the assessment of patients with acute pancreatitis.[14]

Ultrasonography is a medical diagnostic imaging modality that is widely used for AP because of its simplicity, portability, low cost, and low radiation exposure.[15] In a study, Fei et al. has shown sensitivity and specificity of ultrasonography in diagnosing acute pancreatitis as 92.0% and 84.0%, respectively.[16] The imaging role is not only to diagnose acute pancreatitis but to demonstrate the presence & extent of pancreatic necrosis and the complications of acute pancreatitis. On searching the literature, it has been observed that limited information is available regarding the diagnostic accuracy of ultrasonography for detection of acute pancreatitis as well as no local study done in this regard, so this study was planned to determine the diagnostic accuracy of ultrasonography for detection of acute pancreatitis. This study will not only provide the local stats of the issue but will also be a useful addition in the existing literature. Furthermore, it may serve as an alternate to CT hence a simple, economical and cost effective diagnostic tool can be offered to the patient.

## METHODOLOGY

This cross sectional study was conducted from September 2020 to February 2021in the Radiology department of Sharif Medical & Dental College, Lahore after obtaining permission from the institutional board of the hospital (SMDC/SMRC/129-20, 06-08-2020). Informed written consent was obtained from the patients. A sample size of 156 was calculated with 95% confidence level by taking expected prevalence of acute pancreatitis as 85.20% and 5% desired precision for sensitivity and 15% for specificity of USG in diagnosing acute pancreatitis as 92.0% & 84.0%, respectively.[16]

All the patients presenting with clinical symptoms of suspected acute pancreatitis like sudden onset abdominal pain, fever (>101F), tachycardia (heart rate >120/min), and serum amylase >400U/L were taken as positive and were included in the study. Patients of both genders between 15-55 years and with a duration of disease <2 weeks were included in the study. Patients with history of abdominal trauma, history of hypersensitivity to iodinated contrast agent, chronic kidney failure (assessed on history and medical record (s/creatinine >1.1mg/dl), claustrophobic patients, and those who were unable to undergo CT scanning were excluded from the study.

After taking informed consent, ultrasonography of hepato-biliary system was performed by the consultant radiologist (at least 3 years of post-fellowship experience) and was looked for presence or absence of acute pancreatitis. All patients underwent CT scan and reports were interpreted by the consultant radiologist (at least 3 years of post-fellowship experience). Ultrasonography findings were compared with CT scan findings. All this data including the demographic data (age, gender, duration of disease, BMI) was recorded on a specially designed proforma.

## STATISTICAL ANALYSIS

Data was entered in Statistical Package for the Social Sciences (SPSS) version 25. Age, duration of disease, BMI were presented as mean & standard deviation. Categorical data like gender and acute pancreatitis on USG and CT were presented as percentage & frequencies. A 2×2 contingency table was used to calculate sensitivity, specificity, positive & negative predictive value and diagnostic accuracy of multi slice CT scan in diagnosing necrotizing pancreatitis, taking histopathology as gold standard. Effect modifiers like age, gender, duration of disease, and BMI were controlled by stratification. Post-stratification 2×2 contingency table was used to calculate specificity, sensitivity, positive & negative predictive value & diagnostic accuracy of USG in diagnosing acute pancreatitis. A p-value ≤0.05 was taken as significant. Patients with acute pancreatitis on ultrasonography as well as on CT scan were taken as true positive. Patients with no acute pancreatitis on ultrasonography as well as on CT scan were taken as true negative. The patients with acute pancreatitis on ultrasonography but absent on CT scan were considered as false positive and those with no acute pancreatitis on ultrasonography but present on CT scan were considered false negative.

## RESULTS

In our study, a total of 156 patients were included. The mean age of the patients was 43.98±7.01 years. One thirty seven patients (87.82%) were between 36 to 55 years of age. Out of these 156 patients, 97(62.18%) were males & 59(37.82%) were females with a ratio of 1.6:1. Average duration of disease and BMI was 7.27±3.35 days and 28.83±3.40 kg/m$^2$, respectively (Table 1).

Ultrasonography (USG) supported the diagnosis of acute pancreatitis in 71(45.51%) patients. CT findings confirmed acute pancreatitis in 81(41.67%) cases. In USG positive patients, 59 were true positive and 12 were false positive. Among 85, USG negative patients, 06 were false negative whereas 79 were true negative (p=0.0001) (Table 2). Sensitivity, specificity, positive, negative predictive value, and diagnostic accuracy of ultrasonography in diagnosing acute pancreatitis, taking computed tomography as gold standard was 90.77%, 86.81%, 83.10%, 92.94%, and 88.46%, respectively. Diagnostic accuracy stratification with respect to age group, gender, duration of disease &

BMI are shown in Table 3, 4, 5, and 6.

## DISCUSSION

Pancreatitis is an inflammatory process in which pancreatic enzymes auto digest the gland. The gland sometimes heals without any impairment of function or any morphologic changes; this process is known as acute pancreatitis. Pancreatitis can also recur on a regular basis, leading to the gland's functional and morphologic loss; this is referred to as chronic pancreatitis. The pancreas is just 0.1 percent of total body weight, but it has 13 times the protein-producing capacity of the liver and reticuloendothelial system, which together accounts for 4% of the total body weight.[15] In the primary phase of acute pancreatitis, abdominal USG is the main imaging technique for assessment of biliary stones as the cause of acute pancreatitis & for assessment of the biliary tract.[8]

This study was done to see how much is the diagnostic accuracy of ultrasonography in diagnosing acute pancreatitis, taking computed tomography as the gold standard. The mean age of the patients in our study was 43.98±7.01 years. Most of the patients, 137 (87.82%) were between 36 to 55 years of age. Ultrasonography supported the diagnosis of acute pancreatitis in 71 (45.51%) patients. Computed tomography findings confirmed acute pancreatitis in 81 (41.67%) cases. Fifty nine patients were true positive and 12 were false positive in USG positive patients. Six were false negative whereas 79 were true negative in USG negative patients (p=0.0001).

In our study, total sensitivity, specificity, positive &

**Table 1: Distribution of Patients According to Age, Gender, Duration of Symptoms and BMI**

| Study Variables | | Results |
|---|---|---|
| Age (Years) | Mean±SD | 43.98±7.01 |
| | 15-35 | 19(12.18%) |
| | 36-55 | 137(87.82%) |
| Gender | Male | 97(62.18%) |
| | Female | 59(37.82%) |
| Duration of Symptoms (Days) | Mean±SD | 7.27±3.35 |
| | ≤ 7 | 85(54.49%) |
| | > 7 | 71(45.51%) |
| BMI (kg/m$^2$) | Mean±SD | 28.83±3.40 |
| | ≤27 | 56(35.90%) |
| | >27 | 100(64.10%) |

**Table 2: Diagnostic Accuracy of Ultrasonography in Diagnosing Acute Pancreatitis, taking Computed Tomography as Gold Standard**

| | Positive on CT Scan | Negative on CT Scan |
|---|---|---|
| Positive on USG | 59(True positive) | 12(False positive) |
| Negative on USG | 06(False negative) | 79(True negative) |
| p-value | 0.0001 | |
| Sensitivity | 90.77% | |
| Specificity | 86.81% | |
| Positive Predictive Value | 83.11% | |
| Negative Predictive Value | 92.94% | |
| Diagnostic Accuracy | 88.46% | |

**Table 3: Stratification of Diagnostic Accuracy and Age**

| | Age (Years) | | | |
|---|---|---|---|---|
| | 15-35 (n=19) | | 36-55 (n=137) | |
| | Positive on CT Scan | Negative on CT Scan | Positive on CT Scan | Negative on CT Scan |
| **Positive on USG** | 10(True positive) | 01(False positive) | 49(True positive) | 11(False positive) |
| **Negative on USG** | 0(False negative) | 08(True negative) | 06(False negative) | 71(True negative) |
| **p-value** | 0.001 | | 89.09% | |
| **Sensitivity** | 100% | | 86.59% | |
| **Specificity** | 88.89% | | 86.59% | |
| **Positive Predictive Value** | 90.92% | | 81.67% | |
| **Negative Predictive Value** | 100% | | 92.21% | |
| **Diagnostic Accuracy** | 94.74% | | 87.59% | |

**Table 4: Stratification of Diagnostic Accuracy and Gender**

| | Gender | | | |
|---|---|---|---|---|
| | Male (n=97) | | Female (n=59) | |
| | Positive on CT Scan | Negative on CT Scan | Positive on CT Scan | Negative on CT Scan |
| **Positive on USG** | 41(True positive) | 04(False positive) | 18(True positive) | 08(False positive) |
| **Negative on USG** | 02(False negative) | 50(True negative) | 04(False negative) | 29(True negative) |
| **p-value** | 0.001 | | 0.001 | |
| **Sensitivity** | 93.35% | | 81.82% | |
| **Specificity** | 92.59% | | 78.38% | |
| **Positive Predictive Value** | 91.11% | | 69.23% | |
| **Negative Predictive Value** | 96.15% | | 87.88% | |
| **Diagnostic Accuracy** | 93.81% | | 79.66% | |

**Table 5: Stratification of Diagnostic Accuracy and Duration of Disease**

| | Duration of Disease (Days) | | | |
|---|---|---|---|---|
| | ≤7 (n=85) | | >7 (n=40) | |
| | Positive on CT Scan | Negative on CT scan | Positive on CT scan | Negative on CT scan |
| **Positive on USG** | 30(True positive) | 06(False positive) | 29(True positive) | 06(False positive) |
| **Negative on USG** | 06(False negative) | 43(True negative) | 00(False negative) | 36(True negative) |
| **p-value** | 0.001 | | 0.001 | |
| **Sensitivity** | 83.33% | | 100% | |
| **Specificity** | 87.76% | | 85.71% | |
| **Positive Predictive Value** | 83.33% | | 82.86% | |
| **Negative Predictive Value** | 87.76% | | 100% | |
| **Diagnostic Accuracy** | 85.88% | | 91.55% | |

**Table 6: Stratification of Diagnostic Accuracy and BMI ≤27 kg/m$^2$**

| | BMI (kg/m$^2$) | | | |
|---|---|---|---|---|
| | ≤27 (n=56) | | >27 (n=100) | |
| | Positive on CT scan | Negative on CT scan | Positive on CT scan | Negative on CT scan |
| **Positive on USG** | 21(True positive) | 04(False positive) | 38(True positive) | 08(False positive) |
| **Negative on USG** | 04(False negative) | 27(True negative) | 02(False negative) | 52(True negative) |
| **p-value** | 0.001 | | 0.001 | |
| **Sensitivity** | 84.0% | | 95.0% | |
| **Specificity** | 87.10% | | 86.67% | |
| **Positive Predictive Value** | 84.0% | | 82.61% | |
| **Negative Predictive Value** | 87.10% | | 96.30% | |
| **Diagnostic Accuracy** | 85.71% | | 90.0% | |

negative predictive value or diagnostic accuracy of ultrasonography in diagnosing acute pancreatitis, taking computed tomography as gold standard was, 90.77% sensitivity, which is the ability of USG to correctly identify those patients who had acute pancreatitis, 86.81% specificity which has the ability of USG to correctly identify those patients who did not have acute pancreatitis. Another study showed 92.0% sensitivity & 84.0% specificity of ultrasonography in diagnosis of patients with acute pancreatitis.[16]

In a study by Tenner et al., a total 110 consecutive patients with acute pancreatitis were included. In a patient with clinically serious acute pancreatitis, the probability of a positive ultrasound result was 89.60% (sensitivity). Ultrasound had a sensitivity of 77.80% in assessing moderate and extreme types of acute pancreatitis as defined at laparotomy. The low specificity of ultrasound was 44.00% in comparison with modified prognostic criteria, but high in comparison with CT (87.50%) & staging at laparotomy (85.69%). According to the author, the early ultrasound in acute pancreatitis is helpful in diagnosing the severity of the disease and also affect the decision making. As compared to our results, the sensitivity, specificity, positive & negative predictive value and diagnostic accuracy of ultrasonography in diagnosing acute pancreatitis, taking computed tomography as gold standard was 90.77%, 86.81%, 83.10%, 92.94%, and 88.46%, respectively.[17]

Ultrasonography of the pancreas is challenging, given its retroperitoneal position with overlying structures & comparatively small size. Initial works in the countries, describe the sign of pancreatic structural changes seen by trans-abdominal ultrasonography of around two-thirds in the diagnosed chronic pancreatitis cases.[18] Early diagnosis of acute pancreatitis is greatly modified after advent of USG & CECT scan because pancreas is a difficult organ to evaluate by conventional radiological techniques.

## CONCLUSION

Ultrasonography is a highly sensitive & accurate non-invasive method in diagnosing acute pancreatitis. It has not only improved ability of detection of acute pancreatitis but also better patient care by proper pre-operative planning and management of acute pancreatitis patients.

## LIMITATIONS & RECOMMENDATIONS

One of the limitations of the study was bowel gas, which can obscure the pancreas. These limitations are overcome by using CT, which provides more diagnostic information in the assessment of both acute and chronic pancreatitis pathologies. Sample size was small and the study was undertaken in a single center. Future studies should be multicentered. We recommend that USG should be used routinely for accurate detection of acute pancreatitis which will help in proper pre-operative planning for these particular patients in order to reduce the morbidity & mortality of such patients.

## REFERENCES


1. Kuo DC, Rider AC, Estrada P, Kim D, Pillow MT. Acute pancreatitis: what's the score? J Emerg Med. 2015; 48(6):762-70. doi:10.1016/j.jemermed .2015.02.018.
2. Urooj T, Shoukat S, Bokhari I, Mahmood T. Diagnostic accuracy of contrast enhanced computed tomography (CECT) in detection of necrosis in acute pancreatitis by taking surgical findings as gold standard. J Pak Med Assoc. 2020; 70(11):1930-3. doi:10.47391/JPMA.1070.
3. Bruno MJ, Group DPS. Improving the outcome of acute pancreatitis. Dig Dis. 2016; 34(5):540-5. doi:10.1159/000445257.
4. Werge M, Novovic S, Schmidt PN, Gluud LL. Infection increases mortality in necrotizing pancreatitis: a systematic review and meta-analysis. Pancreatology. 2016; 16(5):698-707. doi:10.1016/j.pan.2016.07.004.
5. Schepers NJ, Bakker OJ, Besselink MG, Ali UA, Bollen TL, Gooszen HG, et al. Impact of characteristics of organ failure and infected necrosis on mortality in necrotising pancreatitis. Gut. 2019; 68(6):1044-51. doi:10.1136/gutjnl-2017-314657.
6. Chen HZ, Ji L, Li L, Wang G, Bai XW, Cheng CD, et al. Early prediction of infected pancreatic necrosis secondary to necrotizing pancreatitis. Medicine (Baltimore). 2017; 96(30):e7487. doi:10.1097/ MD.0000000000007487.
7. Chandra S, Murali A, Bansal R, Agarwal D, Holm A. The Bedside index for severity in acute pancreatitis: a systematic review of prospective studies to determine predictive performance. J Community Hosp Intern Med Perspect. 2017; 7(4):208-13. doi:10.1080/20009666.2017.1361 292.
8. Valverde-Lopez F, Matas-Cobos AM, Alegria-Motte C, Jimenez-Rosales R, Ubeda-Munoz M, Redondo-Cerezo E. BISAP, RANSON, lactate and other biomarkers in prediction of severe acute pancreatitis in a European cohort. J Gastroenterol Hepatol. 2017; 32(9):1649-56. doi:10.1111/ jgh.13763.
9. Sahu B, Abbey P, Anand R, Kumar A, Tomer S, Malik E. Severity assessment of acute pancreatitis using CT severity index and modified CT severity index: correlation with clinical outcomes and severity grading as per the revised Atlanta classification. Indian J Radiol Imaging. 2017; 27(2):152-60. doi:10.4103/ijri.IJRI_300_16.
10. Raghuwanshi S, Gupta R, Vyas MM, Sharma R. CT evaluation of acute pancreatitis and its prognostic correlation with CT severity index. J Clin Diagn Res. 2016; 10(6):TC06-11. doi:10. 7860/JCDR/2016/19849.7934.
11. Parniczky A, Kui B, Szentesi A, Balazs A, Szucs A, Mosztbacher D, et al. Prospective, multicentre, nationwide clinical data from 600 cases of acute pancreatitis. PLoS One. 2016;11(10):e0165309. doi:10.1371/journal. pone.0165309.

12. Harshit Kumar A, Singh Griwan M. A comparison of APACHE II, BISAP, Ranson's score and modified CTSI in predicting the severity of acute pancreatitis based on the 2012 revised Atlanta classification. Gastroenterology report. 2018; 6(2):127-31. doi:10.1093/gastro/gox029.

13. Cai D, Parajuly SS, Wang H, Wang X, Ling W, Song B, et al. Accuracy of contrast-enhanced ultrasound compared with conventional ultrasound in acute pancreatitis: diagnosis and complication monitoring. Exp Ther Med. 2016; 12(5):3189-94. doi:10.3892/etm.2016.3760.

14. Fei Y, Gao K, Hu J, Tu J, Li WQ, Wang W, et al. Predicting the incidence of portosplenomesenteric vein thrombosis in patients with acute pancreatitis using classification and regression tree algorithm. J Crit Care. 2017; 39:124-30. doi:10.1016/j. jcrc. 2017.02.019.

15. Yu X, Ding Q, Hu C, Mu G, Deng Y, Luo Y, et al. Evaluating micro-optical coherence tomography as a feasible imaging tool for pancreatic disease diagnosis. IEEE J Sel Top Quantum Electron. 2018; 25(1):1-8. doi.org/10.1109/JSTQE.2018. 2827662.

16. Fei Y, Li W. Effectiveness of contrast-enhanced ultrasound for the diagnosis of acute pancreatitis: a systematic review and meta-analysis. Dig Liver Dis. 2017; 49(6):623-9. doi:10.1016/j.dld. 2017. 03.017.

17. Tenner S, Baillie J, DeWitt J, Vege SS. American College of Gastroenterology guideline: management of acute pancreatitis. Am J Gastroenterol. 2013; 108(9):1400-15. doi:10. 1038/ajg.2013.218.

18. Shah AP, Mourad MM, Bramhall SR. Acute pancreatitis: current perspectives on diagnosis and management. J Inflamm Res. 2018; 11:77-85. doi:10.2147/JIR.S135751.