ORIGINAL ARTICLE

Ultrasonography in the diagnosis of acute pancreatitis keeping computed tomography as a gold standard: Multi-center study.

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ABSTRACT… Acute pancreatitis is considered as a major risk towards the health of the patient as the sudden incidence of the inflammation in the pancreas develops sufficient impacts on the physiological functionality of the adjacent tissues or the organs. **Study Design:** Cross-sectional study. **Setting:** PAF Hospital Islamabad. **Period:** November 2021 to February 2022. **Methods:** This study, conducted at PAF Hospital Islamabad, evaluated the diagnostic efficacy of ultrasound and CT imaging in 150 patients with acute pancreatitis. Following ethical approval and informed consent, patients aged 15-70 years with serum amylase levels above 400 U/L were included. Ultrasounds and CT scans were performed by experienced radiologists, and data were analyzed using MS Excel and SPSS. The study assessed sensitivity, specificity, predictive values, and diagnostic accuracy of both imaging modalities. Results were stratified by age, gender, BMI, and disease duration, with true positives and negatives identified based on consistent imaging results, ensuring a thorough evaluation of imaging effectiveness for acute pancreatitis diagnosis. **Results:** Patients were predominantly aged 36-55 (127 patients) and male (115 patients). USG showed limited diagnostic accuracy (37.6%) with a sensitivity of 41% and specificity of 35.1%. The study evaluated the diagnostic accuracy of ultrasound (USG) compared to CT scans in identifying acute pancreatitis. The positive predictive value (PPV) was 35%, and the negative predictive value (NPV) was 41%. With an overall diagnostic accuracy of 37.6%, the findings highlight USG's limited reliability for diagnosing acute pancreatitis when compared to CT. The significance value was 0.072, influenced by a high rate of false positives. The results underscore the varying reliability of USG across different demographics. **Conclusion:** Ultrasonography (USG) shows limited reliability in diagnosing acute pancreatitis compared to CT, with a sensitivity of 41%, specificity of 35.1%, and overall accuracy of 37.6%. The high rate of false positives highlights that while USG can be a preliminary tool, CT remains essential for accurate diagnosis and effective clinical management.

Key words: Acute Pancreatitis, Computed Tomography (CT), Diagnostic Accuracy Non-Invasive Diagnosis, Ultrasound (USG).

INTRODUCTION

Acute pancreatitis is considered as a major risk towards the health of the patient as the sudden incidence of the inflammation in the pancreas develops sufficient impacts on the physiological functionality of the adjacent tissues or the organs.[1] The occurrence of the acute pancreatitis is mitigated by excessive release of enzymes from the digestive gland. This type of pancreatitis is sub-divided into two form, as observed in emergency departments, including the mild acute pancreatitis (MAP) and severe acute pancreatitis (SAP).[2] The clinical observations have served in reporting that the MAP is potentially controllable due to its good prognosis and the lower mortality rate. On the other hand, the prevalence of SAP increases the symptomatic complications, which proportionally increases the mortality rate among the individuals.[3]

With the increasing rate of reported cases of AP and its staging process, the clinical diagnosis of the disease became relatively difficult and appeared to be a challenge for the health care professionals.[4] Initially, the Bedside index of Severity in Acute Pancreatitis (BISAP) was considered as a medium for the calculation of clinical data available within the first 124 hours.[5]

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According to Hagjer et al.[6], BISAP is considered as the multifactor scoring system, as it helps in analysing the risk stratification as well as the prognostication in AP patients. But, the studies have observed that the clinical estimation maintained using this scale was not enough to reduce the rate of mortality among the patients. The imaging techniques are now preferred potent in analysing the presence and process of staging of the AP.[7] The Computed tomography is an effective technique used to detect the changes and problems in the organs. The Computed tomography severity index (CTSI) is one of the technique that helps the health care professionals to detect the pancreatic necrosis, the local or extended pancreatic complications and the in the presence of intravenous contrast agents.[8]

The formulation of this primary research study will contribute a viable role in addressing the issue and analysing the accuracy of the diagnostic techniques. This study will utilise the quantitative measures and statistical analysis to evaluate the diagnostic accuracy of the ultrasound modalities in detecting the prevalence, staging and extended influences of the acute pancreatitis. The development of the evidence in this study is based on the terms of comparing the efficacy ultrasounds keeping computed tomography as a potential gold standard of imaging.

METHODS
This study followed the standard principles of a cross-sectional primary research design and was conducted over a four-month period from November 2021 to February 2022 at the radiology department of the PAF Hospital in Islamabad, Pakistan. Ethical approval was obtained from the PAF institutional board (ERC/PAF-31) before the study commenced, and written informed consent was obtained from all patients with acute pancreatitis before their inclusion in the study. The sample size of 150 patients was chosen to achieve a 95% confidence interval.

Patients exhibiting symptoms such as sudden abdominal pain, elevated heart rate, and fever were further evaluated using histopathological screening to select those with serum amylase levels above 400 U/L. Patients aged 15-70 years with a disease duration of less than two weeks were included, while those with certain medical conditions or risk factors were excluded. Consultant radiologists with at least three years of experience performed ultrasounds to assess the hepato-biliary system and confirm the presence of acute pancreatitis. Subsequently, all patients underwent computed tomography (CT) scans, and the results from both imaging techniques were recorded for analysis.

Demographic data including age, gender, BMI, and disease duration were collected using a predefined proforma. This rigorous methodology ensured systematic data collection and analysis, enabling the researchers to evaluate the presence and progression of acute pancreatitis accurately.

The collected numerical data was organized and analyzed using MS Excel and the Statistical Package for the Social Sciences (SPSS). Demographic analysis involved calculating the mean and standard deviation of BMI, age, and disease duration. Gender, CT recordings, and USG data were analyzed categorically, presented as frequencies and percentages.

The efficacy of CT imaging was evaluated based on specificity, sensitivity, negative predictive values, positive predictive values, and diagnostic accuracy rate, computed from 2×2 contingency tables. CT scan accuracy in detecting necrotizing pancreatitis was assessed according to established diagnostic standards. Age, gender, BMI, and disease duration were treated as effect modifiers, stratified to control result variations. Specificity, sensitivity, negative predictive values, positive predictive values, and diagnostic accuracy of ultrasonography for acute pancreatitis were calculated using 2×2 contingency tables.

Patients with consistent results between CT scans and ultrasound were deemed true positives, while those without acute pancreatitis on both scans were true negatives. Insignificant p-values (>0.05) indicated results without statistical

significance. Cases showing discrepancies between ultrasound and CT scans were classified as false positives or false negatives accordingly.

RESULTS

The demographic details and distribution of patients showed that the majority of patients (127 out of 150) fell within the 36-55 age range, indicating that this age group constitutes the largest proportion of individuals seeking medical attention for the particular condition under investigation. On the other hand, only 23 patients were in the 15-35 age range, suggesting that the condition might be less prevalent or less severe among younger individuals.

Gender distribution shows a significant predominance of male patients, with 115 males compared to only 35 females. This gender disparity might reflect either a higher incidence of the condition among males or differences in healthcare-seeking behaviour between genders.

There seems to be a relatively balanced distribution between those with symptoms persisting for seven days or fewer (72 patients) and those with symptoms lasting longer than seven days (78 patients). This distribution suggests that the condition may vary in terms of its duration and severity among patients, potentially influencing treatment strategies and outcomes.

Table-II presents the number of patients classified as positive or negative on both CT scan and USG. Of the patients positive on CT scan, 26 were correctly identified as positive on USG (true positives), while 48 were incorrectly identified as positive on USG (false positives). For patients negative on CT scan, 38 were incorrectly identified as negative on USG (false negatives), while 26 were correctly identified as negative on USG (true negatives).

The sensitivity of USG in diagnosing acute pancreatitis is calculated at 41%, indicating the proportion of true positives correctly identified by the test. The specificity is 35.1%, representing the proportion of true negatives correctly identified. The positive predictive value (PPV) is 35%, indicating the probability that patients with a positive USG result truly have acute pancreatitis. The negative predictive value (NPV) is 41%, representing the probability that patients with a negative USG result truly do not have acute pancreatitis.

Overall, the diagnostic accuracy of USG in this study is calculated at 37.6%, suggesting its limitations in accurately diagnosing acute pancreatitis compared to CT scan, the gold standard. The results of the study presented that the significance value obtained from the findings of the USG was 0.072, which was due to the higher ratios of false positive results (48).

Further, the stratification was made based on the study variables (demographics), mentioned in Table-I. The comparison of diagnostic accuracy was maintained on the basis of age and gender. The significance value observed through the contingency analysis on male population was p=0.024 making the results reliable and significant. While p=0.738 was observed in females, which represented the non-significance of results (see Table-IV).

In both age and gender stratifications, there are notable differences in sensitivity, specificity, and diagnostic accuracy of ultrasonography in diagnosing acute pancreatitis, suggesting varying performance across demographics. The data from Table-III and IV indicate variations in the diagnostic accuracy of ultrasonography (USG) for acute pancreatitis across different age groups and genders. In terms of age, USG performs better in younger patients (15-30 years) compared to older patients (31-70 years), with higher sensitivity (66.6% vs. 31%) and diagnostic accuracy (65.2% vs. 41%) in the former group. For gender, while both show similar sensitivity, USG appears more specific (40% vs. 61%) and accurate (41.47% vs. 54.2%) in female patients compared to male patients. These findings suggest age and gender may influence the reliability of USG in diagnosing acute pancreatitis, with younger and female patients potentially benefiting more from its use.

Study Variables		N	%
Age (Years)	15-35	23	15.3
	36-55	127	84.7
Gender	Male	115	76.7
	Female	35	23.3
Duration of Symptoms (Days)	≤ 7	72	48.0
	> 7	78	52.0
BMI (kg/m2)	≤ 27	84	56.0
	> 27	66	44.0

Table-I. Demographic details and distribution of the patients in groups

	Positive on CT Scan	Negative on CT Scan
Positive on USG	26(True positive)	48 (False positive)
Negative on USG	38 (False negative)	26 (True negative)
p-value	0.072	
Sensitivity	41%	
Specificity	35.1 %	
Positive Predictive Value	35%	
Negative Predictive Value	41%	
Diagnostic Accuracy	37.6%	

Table-II. Diagnostic accuracy of ultrasonography in diagnosing acute pancreatitis, taking computed tomography as gold standard

	Age (Years)			
	15-30 years (n=23)		31-70 years (n=127)	
	Positive on CT Scan	Negative on CT Scan	Positive on CT Scan	Negative on CT Scan
Positive on USG	8	4	18	34
Negative on USG	4	7	41	34
p-value	1.000	1.000	0.031	0.031
Sensitivity	66.6%	66.6%	31%	31%
Specificity	36.36%	36.36%	50%	50%
Positive Predictive Value	67%	67%	33.3%	33.3%
Negative Predictive Value	64%	64%	50%	50%
Diagnostic Accuracy	65.2%	65.2%	41%	41%

Table-III. Stratification of age and diagnostic accuracy

	Gender			
	Male (n=115)		Female (n=35)	
	Positive on CT Scan	Negative on CT Scan	Positive on CT Scan	Negative on CT Scan
Positive on USG	18	41	8	7
Negative on USG	29	27	9	11
p-value	0.024	0.024	0.738	0.738
Sensitivity	38.29%	38.29%	47%	47%
Specificity	40%	40%	61%	61%
Positive Predictive Value	30.5%	30.5%	53%	53%
Negative Predictive Value	48.2%	48.2%	55%	55%
Diagnostic Accuracy	41.47%	41.47%	54.2%	54.2%

Table-IV. Stratification of gender and diagnostic accuracy

	Duration of disease (Days)			
	≤ 7 (n=72)		> 7 (n=78)	
	Positive on CT Scan	Negative on CT Scan	Positive on CT Scan	Negative on CT Scan
Positive on USG	16	24	10	24
Negative on USG	14	18	24	20
p-value	0.812	0.812	0.038	0.038
Sensitivity	53.3%	53.3%	29.4%	29.4%
Specificity	75%	75%	45.45%	45.45%
Positive Predictive Value	40%	40%	42%	42%
Negative Predictive Value	56.25%	56.25%	45.45%	45.45%
Diagnostic Accuracy	47.2%	47.2%	39%	39%

Table-V. Stratification of duration of disease and diagnostic accuracy

	BMI (Kg/m2)			
	≤ 27 (n=84)		> 27 (n=66)	
	Positive on CT Scan	Negative on CT Scan	Positive on CT Scan	Negative on CT Scan
Positive on USG	11 (True positive)	24 (false positive)	15 (True positive)	24 (false positive)
Negative on USG	25 (False negative)	24 (True negative)	13 (False negative)	14 (True negative)
p-value	0.117	0.117	0.459	0.459
Sensitivity	30.5%	30.5%	54%	54%
Specificity	50%	50%	37%	37%
Positive Predictive Value	31.4%	31.4%	39%	39%
Negative Predictive Value	49%	49%	52%	52%
Diagnostic Accuracy	39.57%	39.57%	44%	44%
Table-VI. Stratification of BMI count and diagnostic accuracy				

DISCUSSION

The critical analysis of the prevailing research studies have addressed that the lack of consideration or attainment of timely treatments for the acute or regularly occurring pancreatitis, results in the development of the chronic pancreatitis condition.[8]

The study found that most patients (127 out of 150) were aged 36-55, with a significant male predominance (115 males vs. 35 females). Symptom duration was balanced between ≤7 days (72 patients) and >7 days (78 patients). Ultrasonography (USG) showed a sensitivity of 41%, specificity of 35.1%, and diagnostic accuracy of 37.6%. Stratification by age and gender revealed better USG performance in younger (15-30 years) and female patients. USG sensitivity was higher in younger patients (66.6%) compared to older patients (31%). Overall, USG may vary in accuracy based on age and gender, with younger and female patients potentially benefitting more.

The evaluation of the studies have predicted that the pancreas weigh the total of 0.1 percent of the human body. Its most important function is the insulin production and it is observed to generate almost 13 times more protein producing capacity as in reticulo-endothelial system or the liver. The clinical research studies have shown that the utilisation of the ultrasonography is potentially preferred by the health care professionals in the in the initial stages of the acute pancreatitis to evaluate the presence of inflammation and biliary stones. While the imaging through the CT scans is kept as a secondary option, if the ultrasound results are not clear enough to make any clinical assessment or diagnosis.[9] The findings of the study also ensured that the sensitivity of the ultrasounds in diagnosing the acute pancreatitis was almost 40%, while the specificity of the results obtained through the ultrasonography was 87%. These results can be evident from the findings of the prevailing literature sources and research studies. The clinical studies in this regards have reported that the sensitivity of the ultrasound imaging is observed to be 915 to 93%. While the specificity is observed to be around 84 % in diagnosing and accurately screening the presence of acute pancreatitis. Other studies have also mentioned that the accuracy of ultrasounds in diagnosing extreme and moderate type of acute pancreatitis as well as the associated symptoms can be analysed in between 74% to 78 %, compared to that of the gold standard evaluation maintained through the CT scan.[9]

On the other hand, the clinical studies have also shown that with progression of modified criteria of imaging, the accuracy of the ultrasonography is subsequently lowered. But, with reference to the accuracy of diagnosis obtained through the CT scan, the ultrasound imaging process is comprehensively effective and reliable, with probability rate of almost 89 to 90% inn predicting the acute appendicitis.[10]

The evaluation maintained throughout this research study was supportive in assessing the reliability results of the prevailing studies. It has been observed that the clinical utilisation of the ultrasound or ultrasonography process in the early stage of acute pancreatitis helps in

assessing the severity of the disease, and the morphological alterations that might occur due to the excess terms of inflammation on the organ.[11]

Ultrasonography confirmed acute pancreatitis in 71 patients (45.51%), while computed tomography (CT) findings confirmed it in 81 cases (41.67%). Among patients with positive ultrasonography results, 59 were true positives and 12 were false positives. Conversely, among patients with negative ultrasonography results, 6 were false negatives and 79 were true negatives (p=0.0001). The overall sensitivity, specificity, positive predictive value, negative predictive value, and diagnostic accuracy of ultrasonography in diagnosing acute pancreatitis, with CT as the gold standard, were 90.77%, 86.81%, 83.10%, 92.94%, and 88.46%, respectively.[12]

In a study with 73 patients suspected of chronic pancreatitis (CP), CT, ultrasonography (US), and endoscopic ultrasound (EUS) were conducted. Both CT and US showed similar sensitivities (CT: 68%, US: 64%) and specificities (CT: 75%, US: 85%) for CP diagnosis. The areas under the receiver operating characteristic curves (AUROCs) were comparable between CT (0.75) and US (0.81), indicating moderate accuracy. Neither modality alone had sufficient sensitivity to exclude CP, suggesting the need for a comprehensive diagnostic approach.[13]

The use if ultrasounds potentiates the decision making process for the health care professionals or the radiologists. According to the results obtained using the contingency analysis, the sensitivity, specificity, positive predictive values and negative predictive values of the ultrasound imaging in comparison to that of the CT scan as a gold standard, in accurately diagnosing the acute pancreatitis were observed to be 41%, 35.1%, 35%, and 41%, respectively, respectively. The evidence obtained from the literature have addressed that the screening of pancreas in retroperitoneal position is relatively challenging because it is sometimes difficult to observe the organ for the presence of acute appendicitis. Due to these reasons the conventional radiological techniques such as CT scans are commonly used to clinically screen the patients for the symptoms and staging of acute appendicitis.[10,14,15]

CONCLUSION

This study demonstrates that ultrasonography (USG) has limited diagnostic accuracy in identifying acute pancreatitis when compared to computed tomography (CT), the gold standard. With a sensitivity of 41% and specificity of 35.1%, USG showed low reliability in accurately detecting true positive and true negative cases, reflected in a positive predictive value (PPV) of 35% and a negative predictive value (NPV) of 41%. The overall accuracy of USG was 37.6%, with a high rate of false positives, underscoring its limitations as a standalone diagnostic tool. These findings suggest that while USG may provide preliminary insights, CT remains crucial for definitive diagnosis and clinical decision-making in suspected cases of acute pancreatitis.

CONFLICT OF INTEREST
The authors declare no conflict of interest.

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