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Research Article

A COMPARATIVE STUDY OF ULTRASOUND AND COMPUTED TOMOGRAPHY IN EVALUATION OF ACUTE AND CHRONIC PANCREATITIS, ASSOCIATED COMPLICATIONS AND PREDICTING SEVERITY AND PROGNOSIS

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ABSTRACT

Objectives: (1) The objective of the study was to determine the value of USG and computed tomography (CT) in early diagnosis of acute pancreatitis (AP). (2) The study aimed to compare which of the above two radiological investigations (USG/CT) provides the most important information of the disease process and to determine value of CT in evaluating complications, morbidity/severity, and predicting prognosis of AP using modified CT severity index (MCTSI).

Methods: This study included 50 patients diagnosed with pancreatitis, consisting of 38 cases of AP and 12 cases of chronic pancreatitis (CP). Both USG and contrast-enhanced CT (CECT) were used to visualize the pancreas, assess its size, detect peripancreatic inflammation and fluid collections, and identify the extent of necrosis and complications. The sensitivity and specificity of USG and CECT were compared. The severity of AP was classified using the MCTSI within 3 days of symptom onset. Clinical outcomes, including hospital stay duration, organ failure, systemic infection, and the need for surgical intervention, were recorded and correlated with MCTSI scores. Statistical Package for the Social Sciences 22.0 was used for statistical analysis and $p<0.05$ was taken as statistically significant.

Results: The mean age of patients was 37.92±12.14 years. USG had a sensitivity of 58% for detecting AP, significantly lower than the 95% sensitivity of CECT, primarily due to bowel gas interference. Both USG and CECT had high positive predictive values. The MCTSI effectively classified the severity of AP, with 41.5% of cases categorized as mild, 39% as moderate, and 19.5% as severe. Extrapancreatic complications were significantly correlated with adverse clinical outcomes and end-organ failure when included in the MCTSI scoring. USG was adequate for diagnosing CP through visualization of dilated ducts, calcifications, and atrophic pancreas, but CECT demonstrated higher specificity and accuracy, especially for rare forms like groove and mass-forming pancreatitis. The study showed a strong correlation between MCTSI scores and patient outcomes. The mortality rate was 2%, observed only in patients with severe AP.

Conclusion: The MCTSI is a valuable tool for accurately classifying the severity of AP and predicting clinical outcomes. CECT is superior to USG in diagnosing and managing pancreatitis, providing better visualization and assessment of complications. While USG is useful for diagnosing CP, CECT offers greater specificity and accuracy. The study supports the use of MCTSI in routine clinical practice to guide the management and predict outcomes in patients with AP.

Keywords: Pancreatitis, Ultrasound, Computed tomography, Modified computed tomography severity score.

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INTRODUCTION

Pancreatitis can present in acute and chronic, each with distinct clinical presentations, etiologies, and implications for patient management and prognosis. Acute pancreatitis (AP) is characterized by a sudden onset of severe abdominal pain, elevated pancreatic enzymes, and a spectrum of complications ranging from mild interstitial edema to severe necrotizing pancreatitis with systemic inflammatory response syndrome and multiorgan failure. Chronic pancreatitis (CP), on the other hand, is a progressive inflammatory disease resulting in irreversible morphological changes, characterized by chronic abdominal pain, malabsorption, and diabetes mellitus due to endocrine and exocrine insufficiency [1].

The clinical and biochemical parameters form a key factor in the diagnosis of AP. However, the history and clinical presentation may be misleading and the biochemical parameters (particularly serum amylase values) can be normal, particularly when the test is performed a few days after the initial attack [2]. To exclude other abdominal catastrophes and support the clinical suspicion of AP, conventional radiographs have been used. Radiographic studies are of limited value in patients suspected of having AP, both to support and exclude its diagnosis. Supine, lateral decubitus and erect films of the abdomen help exclude other diagnosis such as a perforated viscus. Non-specific findings are found in radiographs in patients with AP, including adynamic ileus or a sentinel loop. In addition, pancreatic calcifications may be found in patients with CP, and peripancreatic gas is seen uncommonly in patients with pancreatic abscess. These tests are rather insensitive and non-specific [3].

Imaging plays a crucial role in this context. Ultrasound (USG) and computed tomography (CT) are the primary imaging modalities employed for evaluating pancreatic diseases, each with its own advantages and limitations [4].

USG provides an initial radiological assessment of cases to give a clue about the extent of involvement and to evaluate other abdominal organs, being a non-invasive, cost-effective, and radiation-free method, although CT is the gold standard technique not only for the global picture of the pathology and complications but also the non-invasive method of evaluating the morphology of pancreas and peripancreatic regions in an acute situation [5].

Cross-sectional imaging with ultrasound and CT has afforded rapid, accurate, and non-invasive evaluation of the pancreas. Ultrasound

provided the first reliable, reproducible, cross-sectional view of pancreatic anatomy [6]. However, it has limitations in obese patients and in those with large amounts of bowel gas. CT offers a diagnostic method that does not have these limitations. However, CT is expensive, exposes patients to ionizing radiation, and has difficulty in defining tissue planes in lean patients. Modern ultrasound machines allow quick and comprehensive evaluation of the abdomen and the pancreas with its ductal system. Because the examination is inexpensive, non-invasive, and well accepted by the patient, it is currently one of the first imaging techniques performed for the evaluation of suspected CP [7].

The comparative evaluation of USG and CT in the context of pancreatitis involves dimensions such as diagnostic accuracy, ability to detect and characterize complications, utility in severity assessment, and prognostic capabilities. While USG remains a valuable tool for initial evaluation and certain follow-up scenarios, CT's comprehensive imaging capabilities often make it indispensable in the acute setting, particularly for severe cases and in chronic disease where detailed anatomical information is required [8].

In this comparative study, we aim to evaluate the effectiveness of USG and CT in diagnosing acute and CP, identifying associated complications, and predicting disease severity and prognosis.

METHODS

This was a prospective study in which 50 patients with acute or CP were included on the basis of a predefined inclusion and exclusion criteria. The study was conducted in the Department of Radio Diagnosis, Dr. B. R. Ambedkar Medical College and Hospital, Bangalore. Informed consent was obtained from patients. The sample size was calculated on the basis of a pilot study done on the topic of imaging studies in acute and CP. Assuming 90% power and 95% confidence interval, the sample size required was 50 patients; therefore, we included 50 patients in our study. The duration of the study was 2 years. All patients who met the study's inclusion criteria underwent a detailed history and physical examination to identify presenting clinical signs.

Demographic details will include age, gender, and medical history. A comprehensive history of symptoms, alcohol use, and family history of pancreatitis will be collected. Clinical examination will include abdominal tenderness and signs of systemic complications. Relevant investigations will include serum amylase, lipase levels, complete blood count, liver function tests, and imaging studies such as ultrasound (USG) and CT scans to assess the pancreas. In each patient, abdominal scan followed by a contrast-enhanced CT (CECT) scan of the abdomen and pelvis was done as per protocol. The pancreatic, peripancreatic, and retroperitoneal regions were thoroughly assessed, and a diagnosis was made. The pelvis and costophrenic recesses were also screened for any fluid evidence.

After completing all investigations, definitive management was administered, and radiological features were correlated with the clinical diagnosis. Patients were also evaluated regarding their duration of hospital/ICU stay, evidence of end-organ failure, systemic infection, and need for surgical intervention. Patients with persistent symptoms or worsening clinical conditions were followed up as required to detect any complications, including lethal ones.

Data were entered into a Microsoft Excel data sheet and analyzed using a Statistical Package for the Social Sciences 22 version software. Categorical data was represented in the form of frequencies and proportions. The chi-square test was used as a test of significance for qualitative data. Continuous data were represented as mean and standard deviation. Analysis of variance was the test of significance to identify the mean difference between more than two groups for quantitative data. p-value (Probability that the result is true) of <0.05 was considered as statistically significant after assuming all the rules of statistical tests.

Inclusion criteria

The following criteria were included in the study:

- Patients who presented with clinical features and positive laboratory findings (serum amylase and lipase) suggestive of acute or CP
- Patients who show sonological features of pancreatitis (acute and chronic) for detailed CT evaluation
- Patients in whom USG is findings were ambiguous
- Age of the patients above 18 years
- Those who gave informed and written consent to be part of study.

Exclusion criteria

The following criteria were excluded from the study: s

- Those who refused consent to be part of the study
- Patients with congenital deformities of pancreas
- History of recent abdominal trauma which is likely to affect the imaging features
- Presence of benign or neoplastic lesions of the pancreas
- Age <18 years.

RESULTS

In the study out of 50 studied cases, there were 34 (68%) males and 16 (32%) females. There was a male preponderance with M: F ratio being 2.1:1. In AP subjects, 31.6% were female, and 68.4% were in male. In CP subjects, 33.3% were female, and 66.7% were in male. Males constituted the majority of cases in both acute and chronic types amounting to 26 cases (68.4%) and 8 cases (66.7%), respectively. There was no significant difference in gender distribution with respect to type of pancreatitis (Table 1).

In the study, 6% of patients were below 20 years of age, 28% were in 21–30 years, 28% were in 31–40 years, 22% were in 41–50 years, 10% were in 51–60 years and 6% were above 60 years. The mean age in CP was 35.92±11.098 and in AP was 38.55±12.524. There was no significant difference in mean age distribution with respect to type of pancreatitis (Table 2).

The analysis of patients on the basis of etiology showed that out of studied cases, 46% were alcoholic, 30% had gallstones, 14% were

Table 1: Gender-wise distribution of acute versus chronic pancreatitis

Gender Distribution	Type of pancreatitis			
	Acute pancreatitis		Chronic pancreatitis	
	Count	%	Count	%
Sex				
Female	12	31.6	4	33.3
Male	26	68.4	8	66.7

p=0.91 (not significant)

Table 2: Age group-wise distribution of acute versus chronic pancreatitis

Age Groups	Type of pancreatitis			
	Acute pancreatitis		Chronic pancreatitis	
	Count	%	Count	%
Age				
<20 years	2	5.3	1	8.3
21–30 years	11	28.9	3	25.0
31–40 years	10	26.3	4	33.3
41–50 years	8	21.1	3	25.0
51–60 years	4	10.5	1	8.3
>60 years	3	7.9	0	0.0
Mean age	38.55±12.524 years		35.92±11.098 years	

p=0.518 (not significant)

idiopathic, 6% had hyperlipidemia, and 2% had drug-induced and autoimmune disease, respectively. Chronic alcohol use was the most common etiological factor for both types of pancreatitis accounting for 23 cases (46%) followed by gallstone disease (15 cases i.e., 30%) (Fig. 1).

Serum amylase and lipase which are commonly used biochemical markers in the diagnosis of AP were evaluated in the study. In our study, serum amylase was elevated in 32 out of 50 cases (64%), all of which were AP cases, and serum lipase was elevated in 38 cases (76%) which included 35 cases of AP and three cases of acute on CP. Remaining nine cases of CP showed no evidence of biochemical marker elevation (Table 3).

Analysis of ultrasound findings showed that a significant portion of cases exhibited a bulky pancreas (44%) and hypoechoic or heterogeneous echotexture (56%). Calcifications, intraductal or parenchymal, were present in 22% of cases, while duct dilatation was observed in 22% as well. Atrophic changes were seen in 18% of patients. Pancreatic or peripancreatic fluid collections were identified in 30% of cases, and ascites were noted in 32%. Pleural effusion was present in 18% of cases. In addition, 42% of patients had a fatty liver, and gallstones were found in 30%. In 22% of cases, the pancreas was obscured on ultrasound. Overall, these findings highlight the varied and frequent sonographic manifestations of pancreatitis (Table 4).

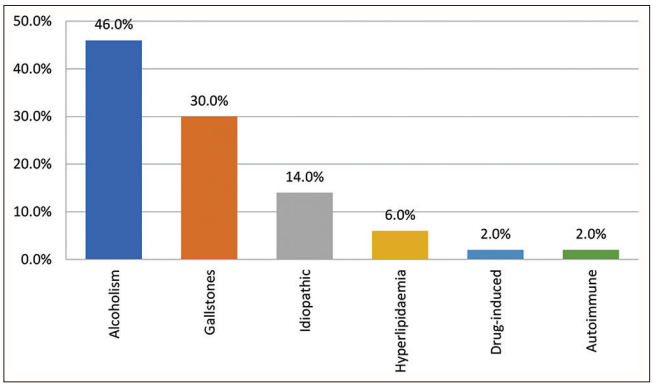

Fig. 1: Etiology distribution of cases with pancreatitis

Table 3: Distribution of biochemical markers

Biochemical marker	No (%)	Yes (%)
Serum amylase	18 (36)	32 (64)
Serum lipase	12 (24)	38 (76)

Table 4: Ultrasound findings in cases of pancreatitis

Ultrasound findings in cases of pancreatitis	No		Yes	
	Count	%	Count	%
Bulky	28	56.00	22	44.0
Hypoechoic/ heterogenous echotexture	22	44.00	28	56.0
Calcifications (intraductal/parenchymal)	39	78.00	11	22.0
Duct dilatation	39	78.00	11	22.0
Atrophic	41	82.00	9	18.0
Pancreatic/peripancreatic fluid collections	35	70.00	15	30.0
Ascites	34	68.00	16	32.0
Pleural effusion	41	82.00	9	18.0
Fatty liver	29	58.00	21	42.0
Gall stones	35	70.00	15	30.0
Obscured	39	78.00	11	22.0

Analysis of CT findings as per the modified CT severity index (MCTSI) showed that 2 patients (4.9%) had a normal pancreas. Intrinsic pancreatic abnormalities with or without inflammatory changes in peripancreatic fat were observed in 19 patients (46.3%), with six cases showing only peripancreatic fat strandings and a normal-sized pancreas. Among these 19 patients, three had parenchymal/intraductal calcifications and duct dilatation, indicating acute on CP. Pancreatic or peripancreatic fluid collections or peripancreatic fat necrosis were found in 20 patients (48.8%), with 17 cases showing a bulky pancreas. Most patients (80.5%) showed no pancreatic necrosis on CT, while 1 patient (2.4%) had <30% necrosis, and 7 patients (17.1%) had more than 30% necrosis. Extrapancreatic complications were absent in 23 patients (56.1%), whereas 18 patients (43.9%) had one or more complications, including ascites in 15 patients, left-sided pleural effusions in 9 patients (six of whom also had ascites), and splenic venous thrombosis associated with ascites in one patient. MCTSI grading was mild in 17 cases (41.5%), which constituted the majority of cases of AP (three of which were acute on CP cases), moderate in 16 cases (39%), and severe in 8 cases (19.5%) (Table 5).

In mild MCTSI grade, pancreatic inflammation was 0 in 11.8% and 2 in 88.2%. Necrosis was 0 in 100%. Extra pancreatic complications were 0 in 88.2% and 2 in 11.8%.

In Moderate MCTSI grade, pancreatic inflammation was 2 in 12.5% and 4 in 87.5%. Necrosis was 0 in 100%. Extra pancreatic complications were 0 in 50% and 2 in 50%. In severe MCTSI grade, pancreatic inflammation was 2 in 25% and 4 in 75%. Necrosis was 2 in 12.5%, and 4 in 87.5%. Extra pancreatic complications score 2 was seen in 100% of cases. There was a significant difference in the association of CT findings (pancreatic inflammation, necrosis, and extrapancreatic complications) with respect to MCTSI ($p<0.001$) (Table 6).

In this study, 11 patients of CP demonstrated intraductal/parenchymal calcifications. Dilatation of the main pancreatic duct was seen in 11 out of 12 patients CP in whom parenchymal/intraductal calcification was also a concomitant finding. The remaining 39 cases including 38 cases of AP and one patient of groove pancreatitis (a rare form of CP) showed no evidence of calcifications/duct dilatation. This was observed in two patients of CP, of which one was a case of pure groove pancreatitis and another one case had mass forming CP involving the pancreatic head, along with calcifications and mild duct dilatation (Table 7).

The duration of hospital stay in our study ranged from 2 to 25 days. The mean duration of hospitalization in mild, moderate, and severe classes of AP according to MCTSI was 3.94±0.97, 8.5±1.1,and 17.25±4.27 days,

Table 5: CT findings as per MCTSI

MCTSI	Count	%
Pancreatic inflammation		
0	2	4.9
2	19	46.3
4	20	48.8
Pancreatic necrosis		
0	33	80.5
2	1	2.4
4	7	17.1
Extra pancreatic complications		
0	23	56.1
2	18	43.9
Severity of pancreatitis on CT MCTSI		
Mild	17	41.5
Moderate	16	39.0
Severe	8	19.5
Total	41	100.0
Mean CT severity index score: 4.488±2.7850		

CT: Computed tomography, MCTSI: Modified CT severity index

Table 6: MCTSI grading distribution

MCTSI Grading	MCTSI						p-value
	Mild		Moderate		Severe		
	Count	%	Count	%	Count	%	
Pancreatic Inflammation							
0	2	11.8	0	0.0	0	0.0	<0.001*
2	15	88.2	2	12.5	2	25.0	
4	0	0.0	14	87.5	6	75.0	
Necrosis							
0	17	100.0	16	100.0	0	0.0	<0.001*
2	0	0.0	0	0.0	1	12.5	
4	0	0.0	0	0.0	7	87.5	
Extra pancreatic complications							
0	15	88.2	8	50.0	0	0.0	<0.001*
2	2	11.8	8	50.0	8	100.0	

MCTSI: Modified Computed Tomography Severity Index, *Significant

respectively. There was a significant difference of the mean duration of hospital stay with respect to severity classes of AP as per MCTSI (p<0.001) (Table 8).

In mild MCTSI grade, 5.9% had an infection, in Moderate MCTSI grade, 43.8% had organ failure, 25% had an infection, In severe MCTSI grade, 100% had organ failure, 87.5% had an Infection, and 62.5% underwent surgical necrosectomy. There was a significant difference in the association between organ failure, surgical interventions, Infection, with MCTSI grades (p<0.001) (Table 9).

In our study, one patient who had severe AP (score 10) based on MCTSI classification died due to multiple organ failure and sepsis. The same patient had undergone surgical necrosectomy and died on 26th day of hospitalization. The overall mortality rate in our study was 2%.

DISCUSSION

In the clinical assessment of AP, identifying patients who may develop severe disease is crucial for effective management and reducing associated morbidity and mortality. Traditional severity scoring systems like the Ranson score, Glasgow score, acute physiology and chronic health evaluation II, Marshall, and sequential organ failure assessment have been used to gauge clinical severity but are not entirely reliable for predicting adverse outcomes. Over the past two decades, the management of severe AP has shifted from aggressive surgical intervention to a more conservative approach, except in confirmed cases of infected necrosis. This shift underscores the importance of assessing the severity of AP and the presence of necrosis through CECT and severity indices [9].

In this study, mean age for AP was 38.55±12.524 years, with a range from 18 to 67 years, aligning with findings from Silverstein *et al*. In contrast, most patients with CP were aged 31–40 years, with a lower average age of 35.92±11.098 years. This is lower than the mean ages reported by Alpern *et al*. [10] and Luetmer *et al*. [11] The male-to-female ratio was approximately 2.1:1, with 68% of patients being male. The high prevalence of alcohol consumption among males contributed to this ratio. Similar male predominance was also reported by the authors such as Mortele *et al*. [12].

In the study, the pancreas was visualized in 27 patients (71%) through ultrasound, compared to the lower visualization rates reported by Silverstein *et al*. (20%) [13]. This improved visualization helped identify a bulky pancreas due to interstitial edema (edematous pancreatitis) in 22 patients (73%), including three acute on chronic cases. This rate was higher than the 33% reported by Jeffrey Jr. [14]. In addition, the pancreas appeared hypoechoic in 14 patients (51%), normal in echogenicity in 6 patients (22.2%), and heterogeneous in 7 patients (25%), reflecting findings by Finstad *et al*. [15] Duct

Table 7: CT features in cases of pancreatitis

CT features in cases of pancreatitis	No		Yes	
	Count	%	Count	%
Calcification	39	78.0	11	22.0
Duct dilatation	39	78.0	11	22.0
Other appearances of chronic pancreatitis	48	96.0	2	4.0

CT: Computed tomography

Table 8: Severity of pancreatitis and duration of hospital stay

	Duration of hospital stay			p-value
	Mean	Standard deviation	Median	
Modified computed tomography severity index				
Mild	3.94	0.97	4	<0.001*
Moderate	8.50	1.10	9	
Severe	17.25	4.27	17	

* Significant

dilatation and calcifications, observed in only three patients (all acute on chronic cases), varied significantly among patients. Pancreatic or peripancreatic fluid collections, seen in 13 patients (34%), were classified according to the revised Atlanta classification. These collections included acute peripancreatic fluid collections, pseudocysts, acute necrotic collections, and walled-off necrosis. Ultrasound detected debris in all severe/necrotizing pancreatitis cases (100% sensitivity), outperforming the 89% sensitivity reported by Morgan *et al*. [16] Additional findings included ascites in 15 patients (40%) and left-sided pleural effusions in 9 patients (23%), primarily in severe and moderate cases, similar to the ascites (18%) and pleural effusions (20%) reported by Maringhini *et al*. [17] fatty liver, indicating alcoholism, was seen in 16 patients (42%), and gallstones were present in 13 patients (35%), providing etiological clues.

CT scans were performed on all 38 patients with AP. In our study pancreas could be visualized in 100% of cases, a significantly higher rate than reported by Thoeni and Blankenberg [18] Using the MCTSI, the study assessed several parameters, including pancreatic inflammation, necrosis, and extrapancreatic complications. In terms of pancreatic inflammation, a normal pancreas was found in 2 patients (4.9%), compared to the 10% reported by Balthazar [19] intrinsic pancreatic abnormalities were observed in 19 patients (46.3%), including cases with peripancreatic fat strandings and calcifications, indicating acute on CP. This aligns with findings from Banday *et al*., which reported parenchymal changes in 58% of cases and peripancreatic inflammatory

Table 9: Correlation of MCTSI and complications in studied cases

MCTSI Grading and Complications	MCTSI						p-value
	Mild		Moderate		Severe		
	Count	%	Count	%	Count	%	
Organ failure							
No	17	100.0	9	56.2	0	0.0	<0.001*
Yes	0	0.0	7	43.8	8	100.0	
Surgical interventions							
No	17	100.0	16	100.0	3	37.5	<0.001*
Yes	0	0.0	0	0.0	5	62.5	
Infection							
No	16	94.1	12	75.0	1	12.5	<0.001*
Yes	1	5.9	4	25.0	7	87.5	

MCTSI: Modified Computed Tomography Severity Index, *Significant

changes in 88%. Pancreatic or peripancreatic fluid collections were seen in 20 patients (48.8%), 17 of whom also showed a bulky pancreas. These collections were more frequently detected by CT than by ultrasound, with common sites being the lesser sac and anterior or posterior pararenal spaces. Pancreatic necrosis was identified in only 1 patient (2.4%) with <30% necrosis and in 7 patients (17.1%) with more than 30% necrosis. This contrasts with the study by Raghuwanshi *et al.* [20] which reported necrosis in 50% of cases, with 14 patients having more than 50% necrosis according to CT severity index (CTSI). Extrapancreatic complications were present in 18 patients (43.9%), including pleural effusion, ascites, vascular complications, parenchymal complications, and gastrointestinal tract involvement.

In our study, extrapancreatic complications were significantly associated with adverse outcomes in AP, with patients exhibiting these complications having higher severity scores according to the MCTSI compared to the CTSI. This correlation aligns with findings from Mole *et al.* [21] and De Waele *et al.* [22] which highlighted the importance of extrapancreatic inflammation in assessing disease severity. Pancreatic necrosis was present in all eight patients with severe pancreatitis, correlating with worse clinical outcomes, consistent with Dugernier *et al.* [23] The MCTSI's classification of necrosis (none, <30%, >30%) avoids the limitations of the CTSI in quantifying necrosis. In addition, 24% of patients had systemic infections, with higher rates in those with moderate and severe pancreatitis, reflecting findings by Beger *et al.* [24] The study showed a 2% mortality rate, lower than the 6% observed by Lecesne *et al.* with the mean annual mortality rate for AP being 1.3/100,000 [25].

CONCLUSION

While both sonography and CT have improved pancreatic visualization, CECT outperforms USG in assessing pancreatic size, peripancreatic inflammation, fluid collections, and necrosis. The MCTSI proved highly effective in classifying the severity of AP and predicting clinical outcomes when used early. For CP, USG was adequate for diagnosing dilated ducts, calcifications, and atrophic pancreas, but CT was more specific and accurate, especially for rare forms such as groove and mass-forming pancreatitis. The study showed a strong correlation between MCTSI scores and patient outcomes; including hospital stay duration, organ failure, infection, and surgical intervention needs.

CONFLICTS OF INTEREST

None

REFERENCES

1. Ashraf H, Colombo JP, Marcucci V, Rhoton J, Olowoyo O. A clinical overview of acute and chronic pancreatitis: The medical and surgical management. Cureus. Nov 20 2021;13(11):e19764. doi: 10.7759/cureus.19764
2. Matull WR, Pereira SP, O'Donohue JW. Biochemical markers of acute pancreatitis. J Clin Pathol. 2006;59(4):340-4. doi:10.1136/jcp.2002.002923
3. Brizi MG, Perillo F, Cannone F, Tuzza L, Manfredi R. The role of imaging in acute pancreatitis. Radiol Med. 2021;126(8):1017-29. doi: 10.1007/s11547-021-01359-3
4. Wang SS, Lin XZ, Tsai YT, Lee SD, Pan HB, Chou YH, *et al*. Clinical significance of ultrasonography, computed tomography, and biochemical tests in the rapid diagnosis of gallstone-related pancreatitis: A prospective study. Pancreas. 1988;3(2):153-8. doi: 10.1097/00006676-198804000-00007
5. Ripollés T, Martínez MJ, López E, Castelló I, Delgado F. Contrast-enhanced ultrasound in the staging of acute pancreatitis. Eur Radiol. 2010;20(10):2518-23. doi: 10.1007/s00330-010-1824-5
6. Morgan DE, Baron TH. Practical imaging in acute pancreatitis. Semin Gastrointest Dis. 1998;9(2):41-50.
7. Bollen TL, Van Santvoort HC, Besselink MG, Van Es WH, Gooszen HG, Van Leeuwen MS. Update on acute pancreatitis: Ultrasound, computed tomography, and magnetic resonance imaging features. Semin Ultrasound CT MR. 2007;28(5):371-83. doi: 10.1053/j.sult.2007.06.002
8. Türkvatan A, Erden A, Türkoğlu MA, Seçil M, Yüce G. Imaging of acute pancreatitis and its complications. Part 2: complications of acute pancreatitis. Diagn Interv Imaging. 2015;96(2):161-9. doi: 10.1016/j.diii.2013.12.018
9. Rehan A, Shabbir Z, Shaukat A, Riaz O. Diagnostic accuracy of modified CT severity index in assessing severity of acute pancreatitis. J Coll Physicians Surg Pak. 2016;26(12):967-70.
10. Alpern MB, Sandier MA, Keilman GM, Madrazo BL. Chronic pancreatitis: Ultrasonic features. Radiology. 1985;155:215-219.
11. Luetmer PH, Stephens DH, Ward EM. Chronic pancreatitis: Reassessment with current CT. Radiology. 1989;171:353-7.
12. Mortele KJ, Zou KH, Banks PA, Silverman SG. A modified CT severity index for evaluating acute pancreatitis: Improved correlation with patient outcome. Pancreas. Nov 2004;29(4):363.
13. Silverstein W, Isikoff MB, Hill MC, Barkin J. Diagnostic Imaging of Acute Pancreatitis: Prospective study using CT and sonography. AJR. 1981;137:497-502.
14. Jeffrey RB Jr. Sonography in acute pancreatitis. Radiol Clin N Am. 1989;27(1):5-17.
15. Finstad TA, Tchelepi H, Ralls PW. Sonography of acute pancreatitis: Prevalence of findings and pictorial essay. Ultrasound Q. Jun 2005;21(2):95-104, quiz 150, 153-4. doi: 10.1097/01.ruq.0000165661.47910.4
16. Morgan DE, Baron TH, Smith JK, Robbin ML, Kenney PJ. Pancreatic fluid collections prior to intervention: Evaluation with MR imaging compared with CT and US. Radiology. 1997;203(3):773-778.
17. Maringhini A, Ciambra M, Patti R, Randazzo MA, Dardanoni G, Mancuso L, *et al* Ascites, pleural, and pericardial effusions in acute pancreatitis. A prospective study of incidence, natural history, and prognostic role. Dig Dis Sci. 1996 May;41(5):848-52. doi: 10.1007/BF02091521, PMid: 8625753.
18. Thoeni RF, Blankenberg F. Pancreatic imaging. Computed tomography and magnetic resonance imaging. Radiol Clin North Am. 1993;31(5):1085-113.
19. Balthazar EJ. Acute pancreatitis: Assessment of severity with clinical and CT evaluation. Radiology. 2002 Jun;223(3):603-13. doi: 10.1148/radiol.2233010680, PMid: 12034923
20. 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):TC0611. doi:10.7860/JCDR/2016/19849.7934

21. Mole DJ, McClymont KL, Lau S, Mills R, Stamp-Vincent C, Garden OJ, *et al*. Discrepancy between the extent of pancreatic necrosis and multiple organ failure score in severe acute pancreatitis. World J Surg. 2009;33:2427-32.
22. De Waele JJ, Delrue L, Hoste EA, De Vos M, Duyck P, Colardyn FA. Extrapancreatic inflammation on abdominal computed tomography as an early predictor of disease severity in acute pancreatitis: Evaluation of a new scoring system. Pancreas. 2007 Mar;34(2):185-90.
23. Dugernier TL, Laterre PF, Wittebole X, Roeseler J, Latinne D, Reynaert MS, *et al*. Compartmentalization of the inflammatory response during acute pancreatitis: Correlation with local and systemic complications. Am J Respir Crit Care. 2003;168:148-57.
24. Beger HG, Bittner R, Block S, Büchler M. Bacterial contamination of pancreatic necrosis. A prospective clinical study. Gastroenterology. 1986;91(2):433-8.
25. Lecesne R, Tourel P, Bret PM, Atri M, Reinhold C. Acute pancreatitis: Interobserver agreement and correlation of CT and MR Cholangiopancreatography with outcome. Radiology. 1999;211:727-35.