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ROLE OF CONTRAST ENHANCED COMPUTED TOMOGRAPHY IN THE EVALUATION OF ACUTE PANCREATITIS ACCORDING TO THE REVISED ATLANTA CLASSIFICATION

Radiology

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ABSTRACT

Background: Purpose of this study is to evaluate role of contrast-enhanced computed tomography (CECT) in assessment of acute pancreatitis (AP) and compare—the Modified CT Severity Index and Revised Atlanta Classification. We aim to determine their effectiveness in predicting severity of AP and their correlation with clinical outcomes, particularly in an Indian population. **Methodology:** This cross-sectional study involved 100 patients with acute abdominal symptoms suggestive of AP, conducted over 18 months. Patients underwent CECT scans, and radiological findings were analysed using MCTSI and RAC systems. Descriptive statistics, Chi-square and Fisher's Exact tests were used to assess significance of correlations between variables, with p-value<0.05 considered statistically significant. **Results:** The study found that both MCTSI and RAC were effective in categorizing severity of AP, with MCTSI more strongly associated with predicting treatment outcomes (p<0.001). Severe CECT enhancement was significantly linked with pancreatic necrosis (p=0.034), pseudocysts (p<0.001), and walled-off necrosis (p<0.001), while no significant association was found between enhancement and response to treatment (p=0.795). Additionally, MCTSI showed a statistically significant correlation with poor treatment response in patients with higher severity scores (p<0.001), reinforcing its utility in clinical decision-making. **Conclusion:** CECT plays a critical role in diagnosing and assessing the severity of AP. Both MCTSI and RAC were useful in stratifying severity, with MCTSI being a better predictor of clinical outcomes. Further studies are needed to validate these findings across different AP subtypes and populations.

KEYWORDS

Acute Pancreatitis, CECT, Revised Atlanta Classification, Modified CT Severity Index.

INTRODUCTION

Acute pancreatitis (AP) is a complex inflammatory condition of the pancreas with varying clinical presentations and severity. It typically manifests as abdominal pain with elevated pancreatic enzymes in the blood or urine. AP is classified into mild and severe forms, with mild cases generally self-limiting and severe cases (about 20%) associated with complications such as necrosis, infection, and organ failure [1-4].

Identifying patients at risk of severe AP is crucial for timely treatment, often requiring intensive care [5]. The incidence of AP ranges from 4.9 to 73.4 cases per 100,000 worldwide [6], and severe cases carry a mortality rate of 20-30% [3,7].

The mortality pattern in AP has two peaks: early deaths occur due to multiple organ dysfunction syndrome (MODS) related to systemic inflammatory response syndrome (SIRS), and late deaths are due to necrosis and infection [8-10].

Early identification of severe AP allows for appropriate management, including transfer to intensive care units (ICUs) [5]. Alcohol abuse and gallstones are the most common causes of AP, which can be diagnosed clinically, biochemically (elevated amylase/lipase), or radiologically [11].

Multiple scoring systems exist to stratify the severity of AP, including Ranson's criteria, the Acute Physiologic Assessment and Chronic Health Evaluation II (APACHE II) score, the Bedside Index for Severity in Acute Pancreatitis (BISAP) score, and the CT severity index (CTSI) [12-16]. These scoring systems vary in complexity and accuracy, with many depending on laboratory data or delayed assessments [8,12,13]. Novel, simpler predictors are needed for early and effective severity assessment [13,14].

Computed tomography (CT) remains the gold standard for diagnosing and staging AP and its complications [2,14]. Two widely used CT scoring systems are the CT severity index (CTSI) [15] and the Modified CT Severity Index (MCTSI) [4]. MCTSI improves upon CTSI by including extrapancreatic complications and simplifying the assessment of pancreatic necrosis [4,16]. MCTSI has shown high sensitivity and specificity for detecting moderate to severe AP [3].

The Revised Atlanta Classification (RAC), first introduced in 1992 and revised in 2012, classifies AP into mild, moderately severe, and severe categories, based on clinical and imaging findings [17-22]. RAC further distinguishes early (within 1 week) and late (after 1 week) phases of AP, with treatment strategies guided by clinical parameters in the early phase and both clinical and morphological criteria later [20]. RAC also defines various fluid collections and their management, distinguishing sterile and infected collections [19,20].

Contrast-enhanced CT (CECT) is commonly used to assess AP severity, necrosis, and complications. The timing of CECT is crucial, with optimal imaging recommended after 5-7 days to assess necrosis accurately [20].

Despite the availability of both RAC and MCTSI, few studies have compared the two for predicting AP severity, particularly in Indian populations. This study aims to compare the Modified CT Severity Index and the Revised Atlanta Classification in predicting the severity of acute pancreatitis and assess their concordance with clinical outcomes. We also seek to evaluate the utility of multi-detector computed tomography (MDCT) in identifying the spectrum of imaging features in AP.

MATERIAL & METHODS

This cross-sectional study was conducted in the Department of Radiodiagnosis at Sri Aurobindo Medical College & PG Institute, Indore, over a duration of 18 months, following approval from the Institutional Ethics Committee.

The study included 100 patients with a history of pancreatitis and acute abdominal symptoms, referred from various clinical departments for CT during the study period.

Exclusion criteria included patients lost to follow-up, those unwilling to participate, individuals who underwent plain CT due to elevated creatinine levels, patients on life support systems, and those for whom CT was contraindicated.

Informed consent was taken and all patients underwent CECT scans using either a PHILIPS or Siemens 128-slice scanner. Pre- and post-contrast scans were acquired, and the images were evaluated using multiplanar reformation techniques like Maximum Intensity Projection (MIP), Multiplanar Reformation (MPR), and Volume Rendering Technique (VRT).

Data were collected using a structured proforma, including patient

history, clinical symptoms, and radiological findings. The statistical analysis involved descriptive statistics to represent the data in terms of mean and percentage. Chi-square tests and Fisher's Exact tests were employed to find associations between variables, with a P-value <0.05 considered statistically significant.

RESULTS

The mean age of the patients was 42.4 ± 16.257 years, with ages ranging from 9 to 81 years. Majority were males (76%) with a male-to-female ratio of 3.16:1. In the analysis of enhancement based on various parameters (Table 1), no significant correlation was found between gender and enhancement severity (p=0.757), indicating that gender did not influence the enhancement patterns.

Clinical diagnosis showed a significant correlation with enhancement (p<0.001), where mild to moderate enhancement was more common in acute pancreatitis, and severe enhancement was predominantly observed in chronic pancreatitis. Pancreatic involvement (head, body, tail, or entire pancreas) did not show any significant association with enhancement severity. However, a significant correlation was found between enhancement and the presence of pancreatic necrosis (p=0.034), with severe enhancement seen in cases with >30% necrosis. Additionally, heterogenous echotexture, pseudocysts, walled-off necrosis, and calcifications were significantly associated with severe enhancement (p<0.001), emphasizing that more severe pancreatic conditions lead to higher enhancement levels. Other factors such as peripancreatic fluid collection, fat stranding, and duct dilatation showed no significant correlation with enhancement, except for main pancreatic duct dilatation (p=0.037), which was linked with severe enhancement.

For the clinical outcome, there was no significant association between enhancement severity and patient response to treatment, indicating that the enhancement pattern alone may not predict treatment success. Also, no significant correlation was found between enhancement severity and the Modified CT Severity Index (p=0.986) [Table 2 (a)].

However, Modified CT Severity Index was significantly correlated with treatment outcomes (p<0.001), with higher scores associated with poor response to treatment. [Table 2 (b)].

This suggests that the Modified CT Severity Index is a reliable predictor of treatment outcomes in patients with acute pancreatitis, emphasizing its utility in clinical decision-making.

Table 1: Association of enhancement to various observed parameters among the study subjects

Parameters		Enhancement			p-value
		Mild (n=39)	Moderate (n=16)	Severe (n=45)	
Gender	Male	30	11	35	0.757
	Female	9	5	10	
Clinical Diagnosis	Acute Pancreatitis	39	15	2	<0.001*
	Chronic Pancreatitis	0	1	43	
Pancreatic head involvement	Yes	17	7	21	0.995
	No	22	9	24	
Pancreatic tail involvement	Yes	18	6	16	0.598
	No	21	10	29	
Pancreatic body involvement	Yes	22	7	21	0.580
	No	17	9	24	
Entire pancreas involvement	Yes	12	6	12	0.713
	No	27	10	33	
Pancreatic Necrosis	<30%	9	8	6	0.034*
	>30%	8	1	15	
	No necrosis	22	7	24	
Echotexture of Pancreas	Homogenous	39	15	3	<0.001*
	Heterogenous	0	1	42	
Presence of Pseudocyst	Present	1	1	23	<0.001*
	Absent	38	15	22	
Walled off necrosis	Yes	0	0	17	<0.001*
	No	39	16	28	
Calcification	Present	3	4	43	<0.001*
	Absent	36	12	2	
Peripancreatic fluid collection	Present	36	15	36	0.168
	Absent	3	1	9	
Fat Stranding	Present	30	14	39	0.432
	Absent	9	2	6	
Main Pancreatic Duct dilatation	Present	2	5	8	0.037
	Absent	37	11	37	
Common Bile Duct dilatation	Present	3	1	4	1.000
	Absent	36	15	41	
Gastrointestinal tract involvement	Present	6	1	7	0.622
	Absent	33	15	38	
Ascites	Present	17	7	26	0.372
	Absent	22	9	19	
Thrombus	Present	4	2	8	0.601
	Absent	35	14	37	
Pleural effusion	Present	20	6	20	0.623
	Absent	19	10	25	
Adenopathy	Present	9	3	5	0.339
	Absent	30	13	40	
Associated aneurysm	Present	2	0	4	0.629
	Absent	37	16	41	
Bowel thickening	Present	6	1	8	0.539
	Absent	33	15	37	
Cystic fibrosis	Present	3	0	1	0.378
	Absent	36	16	44	
Duration of pancreatitis	<4 weeks	38	15	2	<0.001*
	>4 weeks	1	1	43	
Final diagnosis	Acute necrotizing collection	16	9	1	<0.001*
	Acute peri-pancreatic fluid collection	23	6	1	
	Chronic pancreatitis with pseudocyst formation	0	1	23	
	Walled off necrosis	0	0	20	
Response to treatment	Yes	25	9	26	0.795
	No	14	7	19	

*p-value significant

Table 2 (a): Association between enhancement and modified CT severity index

Parameters		Enhancement			p-value
		Mild	Moderate	Severe	
Modified CT Severity index	Mean ± SD	6.31± 2.028	6.25± 1.915	6.36± 2.460	0.986

Table 2 (b): Association between response to treatment and modified CT severity index

Parameter		Response to treatment		p-value
		Yes	No	
Modified CT Severity index	Mean± SD	4.90±1.446	8.45±1.154	<0.001*

*p-value significant

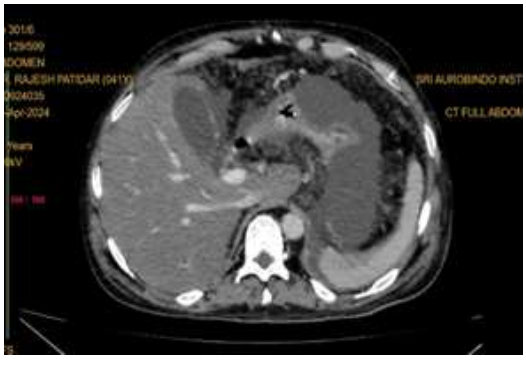

Figure 1. Diffuse heterogeneous enhancement with peri pancreatic fat stranding

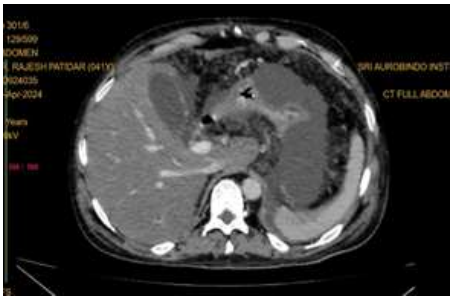

Figure 2. Acute pancreatitis with pseudo cyst formation (well-defined thick-walled cyst and extensive peri pancreatic fat stranding)

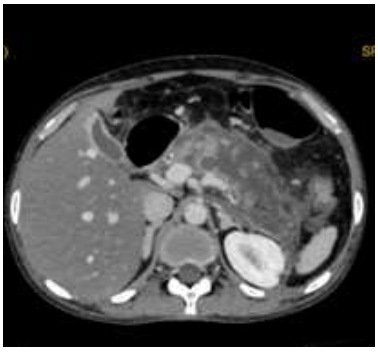

Figure 3. Acute necrotising pancreatitis with heterogeneous enhancement and hypodense area of parenchyma necrosis

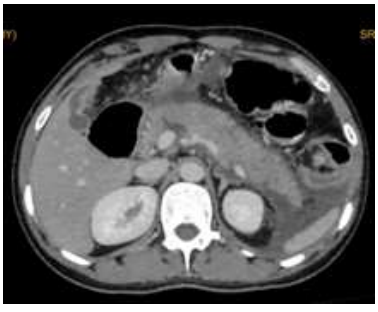

Figure 4. Diffuse interestitial edematous pancreatitis

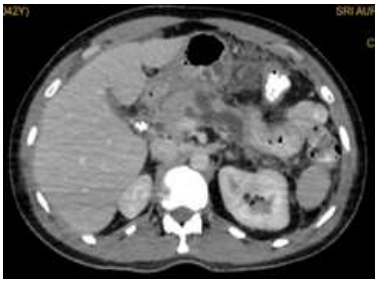

Figure 5. Dilated MPD secondary to pancreatitis

DISCUSSION

Contrast-enhanced CT (CECT) is the most widely used imaging modality for diagnosing and assessing the severity of acute pancreatitis (AP), as well as for morphological classification, which forms the basis of the Revised Atlanta Classification (RAC). CECT is crucial for delineating pancreatic and peripancreatic necrosis, inflammatory changes, and fluid collections, and for monitoring treatment response. The CT Severity Index (CTSI) and Modified CT Severity Index (MCTSI) are the most commonly used radiological scoring systems in AP. However, few studies have compared these indices with the RAC grading system, which underscores the need for this study. [23] The Revised Atlanta Classification (RAC), updated in 2012, divides AP into mild, moderately severe, and severe categories based on local complications, transient organ failure, and persistent organ failure. In contrast, MCTSI classifies severity based solely on necrosis and peripancreatic collections, without considering organ failure, which is a shortcoming of the MCTSI. [23]

In our study conducted, we evaluated 100 patients diagnosed with AP. The mean age of the patients was 42.4 ± 16.257 years, with ages ranging from 9 to 81 years. These results are consistent with studies by Sahu B et al. [24](mean age 36.6 ± 9.8 years), Tahir H et al. [25] (mean age 43.7 ± 16.67 years), Bhanou NMS et al. [26] (mean age 39.5 years), and Raghu et al. (mean age 42.9 ± 15.9 years). However, Padu G et al. [27] reported a slightly older patient population (mean age 44.73 ± 11.61 years), and Carnovale A [28] included a broader age range (18 to 93 years) with a median age of 61.5 years, while Uhl W et al. [29] reported a mean age of 50 years. These variations may reflect differences in sample populations and local risk factors.

In terms of gender distribution, our study found a higher prevalence of AP among males (76%) with a male-to-female ratio of 3.16:1, which is consistent with studies by Sahu B et al. [24] (3:1), Tahir H et al. [25] (64.45% males), and Bhanou NMS et al. [26] (5:1). However, some studies observed a higher prevalence in females. Padu G et al. [27] reported a female-to-male ratio of 5.2:1.

Regarding clinical diagnosis, 56% of patients had acute pancreatitis, while 44% had chronic pancreatitis in our study. Sahu B et al. [24] similarly reported epigastric pain as the most common symptom (78.3%), followed by vomiting. Tahir H et al. [25]and Kokulu K et al. [30] also found abdominal pain to be the predominant symptom, which is consistent with our findings. Bhanou NMS et al. [26] reported 100% of AP patients presenting with abdominal pain, followed by nausea and vomiting (77.5%) and fullness of the abdomen (33%).

In our study, pancreatic involvement was observed in various regions: head (45%), body (50%), and tail (40%), with the entire pancreas involved in 30% of cases. Wilentz eand Hruban [31] reported 15% of tumors in the body and tail of the pancreas, appearing as white-yellow, poorly defined masses obstructing the pancreatic duct, similar to the findings in our study.

Necrosis, in our study. was reported in 47% of patients, with <30% necrosis in 23 patients and >30% necrosis in 24 patients. Vege SS et al. [32] found that 72% of their patients had pancreatic parenchymal necrosis, with 50% having <30% necrosis, 22% having 30-50% necrosis, and 28% having >50% necrosis. Balthazar et al. [3] similarly reported necrosis in 28%, 22%, and 50% of patients for these respective categories. Our study's necrosis rates align with these findings.

In our study, pseudocysts were found in 25% of patients, and walled-off necrosis was seen in 17%. Calcifications were noted in 50% of cases. Statistically significant correlations were observed between CECT enhancement and necrosis ($P<0.05$), echotexture ($P<0.001$), pseudocyst presence ($P<0.001$), and walled-off necrosis ($P<0.001$). Severe enhancement was more common in patients with significant necrosis, heterogenous echotexture, pseudocysts, and walled-off necrosis. These findings are consistent with the pathophysiology described by other authors. [3,15,32,33]

Extrapancreatic complications, such as ascites (50%), pleural effusion (46%), and venous thrombosis (14%), were common in our study but showed no significant correlation with CECT enhancement. These findings are consistent with reports from previous studies on AP complications. [15,34,35]

CT severity scoring systems, particularly the modified CTSI, correlated well with RAC in categorizing AP severity. Mild cases were associated with transient organ failure, while persistent organ failure defined severe cases. Bollen TL et al. [3] demonstrated similar concordance, with 66.9% of patients categorized as mild, 21% as moderate, and 10% as severe. Gao W et al. [14] reported that the RAC had a sensitivity and specificity of 80.9% and 90%, respectively, for severe AP at 48 hours.

Our study supports the conclusion that the RAC provides an effective alternative to CECT for early severity assessment, offering a cost-efficient and accessible method for clinicians. However, further large-scale studies are needed to validate the RAC in specific subtypes of AP, such as gallstone-related pancreatitis, and to explore its comparison with MCTSI in broader patient cohorts.

CONCLUSION

This study demonstrates that contrast-enhanced CT (CECT) plays a

crucial role in the evaluation of acute pancreatitis (AP), particularly in assessing severity and guiding clinical management. The Modified CT Severity Index (MCTSI) and the Revised Atlanta Classification (RAC) both proved useful in stratifying the severity of AP. While MCTSI was more closely linked to predicting treatment outcomes, RAC remains a reliable tool for early severity assessment. The significant correlations between severe enhancement on CECT and parameters such as pancreatic necrosis, pseudocysts, and walled-off necrosis emphasize the utility of CECT in identifying high-risk patients. Further large-scale studies are warranted to validate these findings and compare the utility of MCTSI and RAC across different AP subtypes, particularly in resource-limited settings.

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