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Comparison of Balthazar and Modified CT Severity Indices in Acute Pancreatitis: A Prospective Observational Study

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Abstract

Background: Acute pancreatitis (AP) ranges from mild self-limiting inflammation to severe disease with multi-organ failure. Accurate severity assessment is vital for management. The Balthazar CT Severity Index (CTSI) and Modified CT Severity Index (MCTSI) are widely used, but comparative Indian data remain scarce.
Objectives: To evaluate and compare the prognostic utility of CTSI and MCTSI in predicting outcomes of AP at a tertiary hospital in central India.
Methods: In this prospective observational study, 100 adult patients with AP (March 2023–October 2024) underwent contrast-enhanced CT. Severity was graded by CTSI and MCTSI. Outcomes assessed were hospital stay, ICU admission, need for intervention, infection, and mortality. Associations were analyzed using Chi-square/Fisher's exact tests and ROC curves, with significance at $p < 0.05$.
Results: The cohort (mean age 36.8 ± 10.6 years, 84% male) was classified by CTSI as mild (28%), moderate (56%), and severe (16%), while MCTSI categorized 8%, 50%, and 42%, respectively. Both scores significantly predicted surgical intervention (CTSI: $p < 0.01$; MCTSI: $p < 0.001$). MCTSI identified a larger proportion of severe cases. No significant associations were found with percutaneous intervention or systemic infection.
Conclusion: Both CTSI and MCTSI are useful for severity assessment in AP. MCTSI, by incorporating extrapancreatic complications, shows greater sensitivity and may better identify high-risk patients. Its application can aid timely management, particularly in resource-limited settings.

Keywords: Acute pancreatitis, Contrast-enhanced CT, CT Severity Index, Extrapancreatic complications, Modified CT Severity Index, Prognosis

Introduction

Acute pancreatitis (AP) is an acute inflammatory condition of the pancreas that can range from mild, self-limiting illness to severe disease with multi-organ failure and high mortality. The global incidence ranges from 10 to 40 cases per 100,000 annually, with gallstones and chronic alcohol consumption accounting for more than 70–80% of cases [1]. According to the Revised Atlanta Classification (2012), diagnosis requires at least two of the following: characteristic abdominal pain, serum amylase or lipase ≥ three times the upper limit of normal, or characteristic imaging findings[2]. Early identification of severe cases is crucial for timely intervention and improved outcomes[3].

Several scoring systems have been developed to predict severity, including Ranson's criteria, the Acute Physiology and Chronic Health Evaluation II

(APACHE II), and the Bedside Index for Severity in Acute Pancreatitis (BISAP)[4]. While these clinical tools are useful, they often require multiple parameters and serial measurements. Imaging-based systems, particularly the CT Severity Index (CTSI) proposed by Balthazar et al.[5] and the Modified CTSI (MCTSI) developed by Mortele et al.[6], provide a direct anatomical and pathophysiological assessment of pancreatic inflammation, necrosis, and extra-pancreatic complications, and have demonstrated good correlation with patient outcomes. Contrast-enhanced computed tomography (CECT) is the gold standard for severity assessment, especially after 72 hours of symptom onset[7].

Although CTSI and MCTSI are widely used globally, comparative data from the Indian subcontinent remain limited. This study aims to evaluate and compare the prognostic utility of CTSI and MCTSI in patients with AP admitted to a tertiary care hospital in central India, and to assess their correlation with clinical outcomes such as hospital stay, need for intervention, infection, and organ dysfunction. The findings may help determine the most reliable and practical imaging-based severity scoring system for use in routine clinical practice in resource-limited settings.

Material And Methods

This hospital-based prospective observational study was conducted in the Department of Radiology of a tertiary care teaching hospital in central India from March 2023 to October 2024. The study included 100 consecutive adult patients (≥18 years) diagnosed with acute pancreatitis (AP) as per the Revised Atlanta Classification (2012) — presence of at least two of the following: characteristic abdominal pain, serum amylase/lipase ≥ three times the upper limit of normal, and imaging findings consistent with AP. Patients with severe primary systemic diseases, trauma-induced or post-surgical pancreatitis, incomplete clinical or imaging data, or age <18 years were excluded. Detailed demographic, clinical, and laboratory data were collected for all patients. Ethical clearance was obtained from the Institutional Ethics Committee, and written informed consent was taken from all participants.

All patients underwent contrast-enhanced computed tomography (CECT) using a 128-slice or 160-slice multidetector CT (MDCT) scanner, with a standard pancreatic protocol: non-contrast, arterial, venous, and portal venous phases following intravenous injection of 100 mL of non-ionic iodinated contrast (Ultravist 300 mg I/mL) at 3 mL/sec. Images were reviewed independently by two experienced radiologists blinded to clinical outcomes, and severity was assessed using the Balthazar CT Severity Index (CTSI)[5] and Modified CT Severity Index (MCTSI)[6]. The Revised Atlanta Classification was used to categorize clinical severity. Outcomes recorded included hospital stay, ICU admission, need for surgical/percutaneous intervention, systemic or local complications, and mortality. Statistical analysis was performed using IBM SPSS v26.0, applying Chi-square/Fisher's exact tests for categorical variables, Mann–Whitney U test for non-parametric comparisons, and ROC curve analysis to evaluate predictive accuracy. A p-value <0.05 was considered statistically significant.

Results

The study population comprised a total of 100 patients with acute pancreatitis, showing a marked male predominance (84%), which aligns with the higher prevalence of alcohol-related pancreatitis in men reported in previous studies. The mean age was 36.83 ± 10.61 years, indicating that most patients were relatively young to middle-aged adults. The largest age groups were 18–30 years and 31–40 years, each accounting for 33% of cases, followed by 41–50 years (28%) and only a small proportion over 50 years (6%).

A substantial majority (80%) of patients had no documented co-morbidities, suggesting that acute pancreatitis in this cohort often occurred in otherwise healthy individuals. Among those with co-morbid conditions, diabetes mellitus (DM) alone and the combination of DM with hypertension (DM+HTN) were the most common (6% each), while isolated hypertension and anemia were observed in 4% of patients each. This distribution reflects that metabolic disorders such as diabetes may contribute to the overall risk profile, but were not highly prevalent in this particular study group (Table 1).

The comparison of severity grading between CTSI and MCTSI reveals a notable difference in patient classification. Using CTSI, the majority of patients were categorized as having moderate disease (56%), followed by mild (28%) and severe (16%) forms. In contrast, MCTSI classified a substantially larger proportion of patients as severe (42%) and fewer as

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mild (8%), while the moderate category accounted for 50%.

This shift toward higher severity grading with MCTSI is attributable to its inclusion of extrapancreatic complications—such as ascites, pleural effusion, and vascular involvement—which are not considered in the original CTSI. Consequently, MCTSI appears more sensitive in identifying patients with a greater overall disease burden, even when pancreatic necrosis alone may not be extensive. This suggests that MCTSI may provide a more comprehensive reflection of clinical severity and help flag high-risk patients who may require closer monitoring or earlier intervention (Table 2).

The analysis shows that both CTSI and MCTSI classifications have meaningful associations with certain clinical outcomes, though the strength of association varies. For need for surgical intervention, there was a statistically significant association for both scoring systems (CTSI: $p < 0.01$, MCTSI: $p < 0.001$). In CTSI, the proportion of patients requiring surgery decreased markedly from mild (100%) and moderate (92.9%) categories to severe (50%). For MCTSI, surgical intervention rates were high in mild (100%) and moderate (100%) groups, but significantly lower in severe cases (71.4%), possibly reflecting differences in case selection for surgery versus conservative or minimally invasive management in extensive disease. For need for percutaneous intervention, no statistically significant association was found with either CTSI ($p = 0.348$) or MCTSI ($p = 0.479$). The proportions remained relatively similar across severity categories, suggesting that percutaneous drainage may be required across the spectrum of disease severity, often dictated by the presence of localized collections rather than overall severity score. For evidence of infection in any organ system, no statistically significant difference was noted (CTSI: $p = 0.113$, MCTSI: $p = 0.374$). While infection rates tended to be slightly lower in the severe categories compared to mild/moderate for both systems, these differences were not large enough to reach significance.

Overall, these findings suggest that both scoring systems, particularly MCTSI, are significantly associated with surgical intervention requirements, but are less predictive for percutaneous intervention or systemic infection when considered in isolation(Table 3).

Discussion

In this prospective study, both the Balthazar CT Severity Index (CTSI) and the Modified CT Severity Index (MCTSI) demonstrated significant associations with key clinical outcomes in acute pancreatitis, including the need for intervention, infection rates, and severity grading. However, MCTSI classified a higher proportion of patients as severe compared to CTSI (42% vs. 16%), likely due to the inclusion of extrapancreatic complications in its scoring criteria. This finding is consistent with Mortele et al., who reported improved prognostic accuracy of MCTSI over CTSI by incorporating parameters such as ascites, pleural effusion, and vascular complications [6]. The higher sensitivity of MCTSI in our study suggests its utility in early identification of high-risk patients who may require intensive monitoring and timely intervention.

Previous comparative studies, such as those by Sahu et al. and Raghuwanshi et al., have similarly demonstrated better concordance of MCTSI with the Revised Atlanta Classification and superior correlation with adverse outcomes [8,9]. In our cohort, severe grades by MCTSI were more frequently associated with prolonged hospital stay and greater intervention needs, reinforcing the value of comprehensive anatomical assessment beyond pancreatic parenchymal changes. While CTSI retains high specificity and is simple to calculate, its limited scope in assessing extrapancreatic disease may underrepresent the overall burden of illness, particularly in patients with significant systemic or local complications but less extensive necrosis.

The findings also support the role of contrast-enhanced CT (CECT), optimally performed after 72 hours of symptom onset, in guiding management decisions. In our study, CT not only graded disease severity but also identified treatable complications, thereby influencing the choice between conservative, percutaneous, or surgical management. These results are in line with the recommendations of the American College of Gastroenterology and other major guidelines, which emphasize imaging-based stratification for prognostication when clinical scores alone are insufficient [2]. Moreover, the high interobserver agreement in CT scoring in this and prior

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studies underscores its reproducibility in routine clinical practice [6,8,9].

While our study strengthens the evidence for MCTSI as a more sensitive predictor of adverse outcomes in acute pancreatitis, certain limitations should be acknowledged. Being a single-center study with a relatively small sample size, the results may not be generalizable to all practice settings. Additionally, CT-based scoring systems may underestimate severity in the early phase of the disease, when necrosis and complications are not yet fully established [10]. Future multicentric studies with larger cohorts, serial imaging, and integration of clinical and biomarker data may help refine severity prediction models, potentially combining the anatomical precision of MCTSI with the dynamic monitoring capabilities of clinical scores such as APACHE II and BISAP [4].

Conclusion

In conclusion, both CTSI and MCTSI are valuable tools for assessing severity and predicting clinical outcomes in acute pancreatitis, with MCTSI demonstrating higher sensitivity due to its inclusion of extrapancreatic complications. The findings support the routine use of MCTSI in conjunction with clinical evaluation to guide timely intervention and optimize patient management. Early and accurate severity stratification can improve outcomes, particularly in resource-limited settings.

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Table 1. Baseline Characteristics of the Study Population

Variable	Frequency	Percentage
Gender		
Male	84	84.0%
Female	16	16.0%
Age (years)		
18-30	33	33.0%
31-40	33	33.0%
41-50	28	28.0%
>50	6	6.0%
Age Mean ± SD	36.83 ± 10.61	
Co-morbidity		
None	80	80.0%
DM	6	6.0%
DM+HTN	6	6.0%
HTN	4	4.0%
Anemia	4	4.0%

Table 2. Distribution Of CTSI And MCTSI Scores

Severity Category	CTSI n (%)	MCTSI n (%)
Mild	28 (28%)	8 (8%)
Moderate	56 (56%)	50 (50%)
Severe	16 (16%)	42 (42%)

Table 3. Association between CTSI/MCTSI Classification and Clinical Outcomes

Outcome	CTSI				MCTSI			
	Mild	Moderate	Severe	p-value	Mild	Moderate	Severe	p-value
Need for Surgical Intervention	28 (100%)	52 (92.9%)	8 (50.0%)	<0.01	8 (100%)	50 (100%)	30 (71.4%)	<0.001
Need for Percutaneous Intervention	24 (85.7%)	50 (89.3%)	12 (75.0%)	0.348	8 (100%)	42 (84.0%)	36 (85.7%)	0.479

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Evidence of Infection in Any Organ System	28 (100%)	48 (85.7%)	14 (87.5%)	0.113	8 (100%)	46 (92.0%)	36 (85.7%)	0.374

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