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ORIGINAL ARTICLE

Correlation of Modified CT Severity Index with Complications of Acute Pancreatitis

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ABSTRACT

Objective: To determine the correlation between the Modified CT Severity Index (MCTSI) and complications of acute pancreatitis and to evaluate its predictive ability for clinical outcomes.

Methodology: An analytical cross-sectional study was conducted at Pakistan Aeronautical Complex (PAC) Hospital, Kamra, and Pakistan Air Force (PAF) Hospital, Islamabad, between October 2024 and September 2025. Non-probability consecutive sampling of patients with acute pancreatitis yielded a sample of 50. All patients underwent a contrast-enhanced computed tomography scan of the abdomen (CECT) and were classified by MCTSI. An assessment for local and systemic complications, ICU admission, requirement for intervention, and length of hospital stay were all assessed of each patient. Fisher's exact test, Spearman correlation coefficient, and ROC curve analysis were used to analyze statistical data.

Results: The patient's mean age was 35.7±10.5 years. The percentage of patients receiving admission to the ICU increased progressively by severity of acute pancreatitis: 33% for mild severity and 100% for severe cases. Local complications were observed in 24% (pseudocyst) and 2.6% (abscess) of patients and were predominantly identified among grade 3 and 4 MCTSI. Systemic complications occurred in 6% of patients and were significantly associated with severe acute pancreatitis ($p<0.001$). MCTSI was found to have a strong correlation with the total number of complications ($r=0.68$, $p=0.001$). ROC analysis showed a good predictive accuracy of the MCTSI for complications (AUC 0.83, 95% CI 0.72-0.94) with sensitivity of 81% and specificity of 78% at MCTSI cut-off value of ≥6.

Conclusion: MCTSI is associated with complications of acute pancreatitis and provides a reliable prediction of adverse clinical outcomes, supporting its use in early identification of risk and clinical decision-making.

Keywords: Intensive Care Units, Length of Stay, Pancreatitis Acute Necrotizing, Prognosis, ROC Curve, Severity of Illness Index, Tomography, X-Ray Computed.

Authors' Contribution:
[1,2]Conception; Literature research; manuscript design and drafting; [3,6]Critical analysis and manuscript review; [4,5,7]Data analysis; Manuscript Editing.

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Introduction

Acute pancreatitis (AP) is a commonly observed inflammatory disorder involving the pancreas. Its clinical course varies significantly, with cases varying from mild, self-limited illness to more severe presentations that lead to serious morbidity and mortality. Approximately 15-20% of cases develop into severe AP. Severe AP is usually associated with developing localized complications (such as local necrosis) and developing organ failures and/or the systemic inflammation/inflammatory response syndrome (SIRS).[1,2] The development of local complications, especially necrotizing pancreatitis, is associated with poor clinical outcomes and significantly increased mortality in patients with AP.[3]

Early assessment of disease severity is essential for the optimal management of AP, as it facilitates risk stratification and guides clinical decision-making. Several clinical and laboratory-based scoring systems have been developed to predict disease severity and identify patients at risk of adverse outcomes. In addition to these tools, advances in imaging techniques, particularly contrast-enhanced computed tomography (CT), have significantly improved the evaluation of pancreatic morphology and disease extent. CT not only enables accurate detection of pancreatic and extra-pancreatic complications but also provides valuable information for planning therapeutic and interventional procedures. Consequently, CT has become an integral component in the assessment and management of AP.[4,5]

The CT severity index (CTSI) developed by Balthazar et al attempts to provide a standardized way for comparing the anatomic findings of inflammation and necrosis in the setting of an acute pancreatitis episode.[6] Although there are several limitations to the use of CTSI (inadequate evaluation of extra-pancreatic complications, variability in interpretation), it has been widely used in research and in clinical practice.[7] The Modified CT Severity Index (MCTSI) was developed using both pancreatic inflammation and necrosis in conjunction with the evaluation of extra-pancreatic complications to improve the correlation between anatomic assessment with clinical outcomes.[8] Although there have been studies that have assessed MCTSI as a predictor of local and systemic complications associated with the treatment of AP, there have been inconsistencies in the results of these studies and very few studies have evaluated the efficacy of MCTSI on diverse patient populations.[9,10] Additionally, there is limited evidence regarding the performance of MCTSI in low- and middle-income countries, where variations in healthcare resources, access to specialized care, and treatment practices may affect the clinical outcomes of AP.

Due to the clinical significance of early-risk stratification and very limited local data, it is important to investigate whether the MCTSI can be used to correlate to complications in patients with AP. This information could potentially aid in triaging, managing, and allocating resources for patients. This study aimed to determine how well the MCTSI scores correlate to complications due to AP.

Methodology

This analytical cross-sectional study was carried out at Pakistan Aeronautical Complex (PAC) Hospital, Kamra, and Pakistan Air Force (PAF) Hospital, Islamabad, from October 2024 to September 2025. In total 50 patients diagnosed with acute pancreatitis (AP) were enrolled using non-probability consecutive sampling. Patients aged 20–60 years regardless of gender were eligible if they fulfilled at least two of the Revised Atlanta criteria for AP, defined by typical abdominal pain along with serum amylase and/or lipase levels at least threefold elevation above normal values, or radiological evidence suggestive of AP. Patients with chronic pancreatitis, pancreatic malignancy, prior pancreatic surgery, significant comorbid conditions such as pre-existing renal, hepatic, or cardiac disorders, as well as pregnant women were excluded.

Sample estimation was performed using power analysis for correlation to detect a significant association between the MCTSI and complications of AP. Drawing on findings from a recent study that demonstrated a moderate correlation ($r \approx 0.40$) between CT severity indices and clinical outcomes, a minimum sample was estimated using a two-tailed test with a 95% CI ($\alpha = 0.05$) and 80% power ($\beta = 0.20$).[11] The calculated sample was 50 patients were ultimately enrolled.

All participants underwent abdominal contrast-enhanced computed tomography (CECT) using a standardized imaging protocol. Scans were obtained with 5-mm slice thickness from the diaphragm to the pubic symphysis, including arterial and portal venous phases. Imaging was performed after 72–96 hours of onset of symptoms to allow optimal assessment of pancreatic necrosis. The CT scans were assessed independently by experienced radiologists unaware of the patients' clinical outcomes. Disease severity was evaluated using the Modified CT Severity Index (MCTSI), which incorporates pancreatic inflammation (0–4), degree of necrosis (0–4), and associated extra-pancreatic complications (0–2 points), yielding an overall score between 0 and 10. Participants were categorized into three groups according to their total scores from the MCTSI; mild (2-4), moderate (6), and severe (8-10).

For both independent and dependent variables, the primary independent variable is the MCTSI score. The dependent variable is classified into local and systemic complications. Local complications comprised peripancreatic fluid collections, pseudocysts, pancreatic necrosis (sterile or infected), and walled-off necrosis. Systemic complications comprised organ failure, sepsis, and shock. Organ failure includes the following three major organ systems based on the Modified Marshall Criteria: respiratory failure ($PaO_2/FiO_2 \leq 300$), renal failure (≥ 1.9 mg/dL), and cardiovascular failure (systolic BP < 90 mmHg and/or requiring vasopressors). Organ failure lasts longer than 48 hours, while transient organ failure resolves within 48 hours. Infected necrosis was diagnosed as gas detected within necrotic tissue on imaging or by positive cultures. Hospital stay duration was calculated as the number of days between admission and discharge.

Structured proforma was used to collect various demographic, clinical, laboratory, and radiological data about patients. Patients were monitored throughout hospitalization to document complications and outcomes. The primary outcome was to evaluate the correlation between the MCTSI and the development of complications as a result of AP, although the study had secondary outcomes to investigate the relationship with organ failure, length of hospital stay, and mortality in-hospital.

Statistical analysis was performed using SPSS version 26. Continuous variables (age/hospital stay) were expressed as mean ± SD, while categorical variables (sex/severity categories/complications) were described in terms of frequency and percentage. The association between MCTSI categories and complications was assessed using Fisher's exact test. Spearman's correlation coefficient was applied to establish a correlation between MCTSI scores and both the severity and number of complications. A Kruskal-Walli's test was used to compare hospital stays across severity groups. Binary logistic regression was performed to determine predictors of developing a complication. ROC curve analyses were performed to assess the predictive value of the MCTSI for complications, and 95% CI for the AUC were calculated. The optimal cutoff value was identified using the Youden index, with corresponding sensitivity and specificity calculated. A p value of ≤0.05 was taken as statistically significant.

Ethical approval was obtained from the Ethical Board of Pakistan Aeronautical Complex (PAC) Hospital, Kamra (Ref. No. 003/2024, Dated: 23/09/2024), and informed consent was secured from all participants

Results

In this study, 50 patients were included with AP, whose mean age was 35.7±10.5 years, mostly male. The demographic and clinical profile of the participants is presented in Table 1.

Longitudinal increase in severity of patients (based on MCTSI) is correlated with progressively worse clinical outcomes, with a significant trend between incrementing severity of MCTSI and frequency of admission to the ICU, local complications, systemic complications, and requirement for intervention (p for trend = 0.001) (Table 2). Furthermore, increasing severity of MCTSI corresponds to increasing burden from complications and increasing amount of resources utilization by patients.

Table I: Demographics and clinical profile at baseline (n=50)	
Variable	**Frequency (%)**
Age Groups	
20–30 years	14 (28)
31–40 years	18 (36)
41–50 years	10 (20)
51–60 years	8 (16)
Gender	
Male	32 (64)
Female	18 (36)
Etiology of Acute Pancreatitis	
Gallstones	20 (40)
Alcohol	15 (30)
Hypertriglyceridemia	6 (12)
Idiopathic	9 (18)
Severity Based on MCTSI	
Mild (2–4)	20 (40)
Moderate (6)	20 (40)
Severe (8–10)	10 (20)

Table II: Distribution of MCTSI grades and their association to clinical outcomes

CT Grade	No. of patients	ICU Admission	Pseudocyst formation	Abscess formation	Intervention necessity	Systemic complications
2	9	3 (33%)	0	0	0	0
4	11	5 (45%)	0	0	0	0
6	20	13 (65%)	8 (40%)	0	0	0
8	4	3 (75%)	1 (25%)	1 (25%)	0	0
10	6	6 (100%)	3 (50%)	2 (33%)	4 (66%)	3 (50%)

Fisher's exact test (trend across severity): p = 0.001

Table III: Correlation of length of stay with MCTSI score (Mean ± SD, days)

CT grade group	ICU stay (days)	Ward stay (days)	Hospital stay (days)
2 and 4	0.75±0.38	6.45±1.27	7.65±1.30
6	3.03±1.40	8.25±1.06	11.25±2.09
8 and 10	14.11±3.51	17.4±3.4	30.4±5.01
Kruskal–Walli's test: p = 0.0001 for all comparisons			

Table IV: Distribution of local and systemic complications by MCTSI

Complication Type	Mild (2–4) n=20	Moderate (6) n=20	Severe (8–10) n=10	p-value
Pseudocyst	0 (0%)	8 (40%)	4 (40%)	0.001
Abscess	0 (0%)	0 (0%)	3 (30%)	0.001
Systemic complications	0 (0%)	0 (0%)	3 (30%)	0.002
Intervention required	0 (0%)	0 (0%)	4 (40%)	0.001

Table V: Correlation between MCTSI score and clinical outcomes

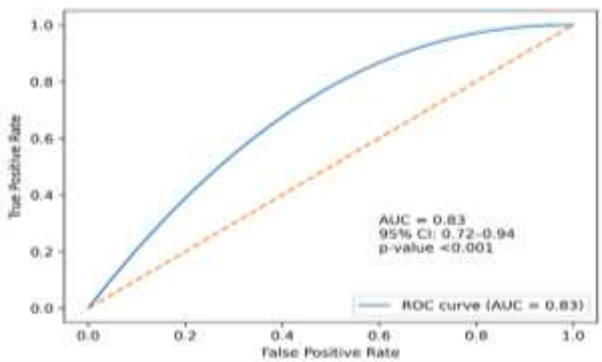
Outcome Variable	Correlation coefficient (r)	p-value
Total complications	0.68	0.001
ICU stay	0.72	0.001
Ward stay	0.69	0.001
Total hospital stay	0.75	0.001

The relationship between MCTSI grades and duration of ICU stay, ward stay, and total hospital stay is presented in Table 3. There was a strong positive relationship between severity of disease and length of stay for hospital admission (p=0.0001 for each comparison).

Further stratification of complications into local and systemic categories across MCTSI groups is shown in Table IV, demonstrating a significant increase in complication rates with higher severity grades.

Spearman correlation analysis of MCTSI score and clinical outcomes demonstrates strong positive correlation of complication burden and length of stay; (p=0.001) (Table 5). On multivariable logistic regression, MCTSI remained an independent predictor of complications after adjustment for age and gender (Adjusted Odds Ratio [AOR] = 2.61, 95% CI: 1.48–4.59, p = 0.001).ROC curve analysis, illustrated in Figure 1, demonstrated good predictive performance of MCTSI for complications, with an AUC of 0.83 (95% CI: 0.72–0.94, $p = 0.001$). An optimal cutoff value of MCTSI ≥6 predicted complications with a sensitivity of 81% and specificity of 78%. Positive and negative predictive values were 53.7% and 92.9%, respectively.

Figure 1: ROC curve a



Analysis of MCTSI for predicting complications

Discussion

In this study, cases were assessed using CECT, and the observed results were compared with the patients' clinical outcomes. No statistically significant association was observed between age, gender, and the severity of pancreatitis in this study. Similar demographic patterns have been reported in recent literature, where age and gender were not found to be independent predictors of disease severity in acute pancreatitis (AP), suggesting that morphological severity on imaging is more reliable than baseline demographic variables for risk stratification.[12] MCTSI scoring categorized patients into grades of 2, 4, 6, 8, and 10.[13] These grades were subsequently grouped as mild (2 and 4), moderate (6), and severe (8 and 10). Previous investigations have classifying grade 2 as mild, grades 4–6 as moderate, and grades 8–10 as severe.[7,10] This simplified grouping is consistent with contemporary radiological practice, where MCTSI is increasingly used as a stratification tool rather than a purely descriptive score.

In total 60% patients diagnosed with pancreatitis required admission to the ICU. The relationship between increasing MCTSI scores and incidence of ICU admission demonstrates that a 33% of mild patients with mild pancreatitis having an ICU admission, which rises to 100% in patients with severe MCTSI scores. This strongly supports the prognostic utility associated with MCTSI. Moreover, there are a number of multicenter studies that indicated higher MCTSI correlates with both increased in ICU requirement, and thus underlying systemic inflammation, and early organ dysfunction in the presence of severe AP.[14,15]

There is an important relationship between the duration of the stay in the ICU and the severity grading of pancreatitis. A significant association was seen between the CT grade of patients and the overall duration of their hospitalization. In a study, it was found that there was a noteworthy association between the grade of pancreatitis as determined by the MCTSI and the duration of hospitalization.[7] More recent evidence from large cohort analyses has also confirmed that MCTSI is positively correlated with hospital stay duration, supporting its role in healthcare resource prediction and triage planning.[16]

The study detected some local problems, including the production of pseudocysts and abscesses. In our investigation, a pseudocyst was observed in 24% of patients, which is comparable to previously reported rates ranging from 18% to 45% in moderate to severe AP cohorts.[17] An abscess was identified in one patient, representing a prevalence of 2.6%, which is consistent with the lower incidence of infected collections reported in early-stage imaging-based studies. The study found a favorable correlation between the presence of local problems and CT grade. There were no observed instances of local consequences in patients diagnosed with mild pancreatitis. A significant proportion of patients diagnosed with intermediate pancreatitis (31%) and severe pancreatitis (42%) exhibited the occurrence of local consequences.[18] This graded increase in complications reflects the pathological progression of pancreatic necrosis and peripancreatic inflammation described in the revised Atlanta classification framework.[12]

In our investigation, an intervention in the form of surgical debridement was required for 4 patients exhibiting grade 10 of AP. Three patients (6%) required radiological intervention. This finding is clinically important as it demonstrates a clear escalation in invasive management with increasing MCTSI severity. Contemporary existing evidence suggests that individuals with higher MCTSI scores are significantly more likely to require percutaneous or surgical intervention due to necrosis progression and infected collections.[15,19] Therefore, individuals requiring an intervention exhibit higher levels of severity in their CT grades. This finding aligns with previous literature study, which provided evidence that the severity of pancreatitis is highly correlated in relation to the development of local complications and the requirement for medical intervention.[10]

Three patients (6%) had development of systemic complications. Significant associations were seen between the presence of systemic problems and a CT grade of 10 in individuals. A study observed a noteworthy association between the severity grading of AP and the occurrence of systemic complications.[10] Recent evidence also highlights that systemic complications, particularly organ failure, are the strongest determinants of mortality in acute pancreatitis, and imaging severity scores such as MCTSI are increasingly being used as early predictors of systemic deterioration.[14]

Pancreatic necrosis was observed in seven patients, constituting 18% of the research population. Necrosis was not observed in 32 cases, accounting for 82% of the total sample. Necrosis was observed in 18% and 15% of individuals with AP, as reported in separate studies.[7,10] These findings are consistent with published literature indicating necrosis rates between 15% and 25% in hospitalized AP patients. The presence of necrosis remains a central determinant of disease severity and is a key component of MCTSI scoring, reinforcing its predictive validity.

ROC curve analysis in the present study demonstrated good predictive performance of MCTSI for complications, with an AUC of 0.83. This indicates that MCTSI has good discriminatory ability in distinguishing complicated from uncomplicated acute pancreatitis. An AUC above 0.80 is considered clinically useful in prognostic scoring systems. The optimal cutoff value of MCTSI ≥6 demonstrated a sensitivity of 81% and specificity of 78%, indicating strong ability to correctly identify patients at risk of complications. Importantly, the high negative predictive value suggests that lower MCTSI scores are reliable in excluding clinically significant complications. Similar ROC-based evaluations in recent studies have reported AUC values in the range of 0.78–0.86, supporting the reproducibility of MCTSI as a robust imaging-based prognostic tool in AP.[15,16]

Our investigation did not notice any instances of fatality resulting from pancreatitis. A study observed a mortality rate of 6% among patients, whereas another study reported a mortality rate of 1.5% among the patients in their study.[7,10] The absence of mortality in the present cohort may be attributed to early imaging, timely supportive management, and relatively smaller sample, as recent literature suggests that mortality in AP is highly dependent on persistent organ failure and infected necrosis rather than imaging severity alone.[11,14]

The findings of this study reinforce the value of MCTSI as a consistent radiological predictor of local complications, systemic complications, need for intervention, and healthcare utilization in acute pancreatitis. The consistent increase in complication rates with increasing MCTSI score, together with superior ROC performance, suggests that MCTSI may be able to be incorporated into routine radiological reporting for use in stratifying risk early.

Conclusion

In the current study, it is shown that MCTSI has strong correlations to both local and systemic complications; the need for procedural interventions and length of hospital stay. A positive graded association was observed, whereby increasing MCTSI scores were associated with worsening clinical outcomes and greater utilization of healthcare resources. A ROC analysis confirms the diagnostic utility of MCTSI, with good predictive power relative to complications, with an AUC of 0.83, with acceptable sensitivity and specificity at an optimal cut-off of ≥6. The high negative predictive value of MCTSI also makes lower MCTSI score useful for ruling out clinically significant complications. Thus, MCTSI is a reliable and useful imaging-based prognostic tool for assisting in early risk stratification, clinical decision making and optimal resource allocation for patients with AP.

Limitations*:* The current study has a number of limitations that should be considered. First, the study was conducted in a single tertiary care hospital using consecutive non-probability sampling, which may introduce selection bias and limit the generalizability of the findings. Second, the relatively small sample reduces the statistical power of the study, particularly for detecting less frequent outcomes such as severe systemic complications and mortality. Third, inter-observer variability in CT scan interpretation could not be completely eliminated despite adherence to standard reporting guidelines for MCTSI assessment. Finally, the study was limited to in-hospital outcomes only; therefore, long-term outcomes such as late complications, readmissions, and chronic pancreatic changes could not be evaluated.

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