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Assessment of Acute Pancreatitis Using CT Severity Index and Modified CT Severity Index: Association with Clinical Outcomes and Ranson's Criteria

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ABSTRACT

Background: Acute pancreatitis is an inflammatory condition with a clinical spectrum ranging from mild self-limiting disease to severe necrotizing pancreatitis with organ failure and high mortality. Early prediction of disease severity is crucial for appropriate management and resource allocation. This study evaluated and compared the prognostic performance of the Computed Tomography Severity Index (CTSI), Modified Computed Tomography Severity Index (MCTSI), and Ranson's criteria in predicting clinical outcomes in acute pancreatitis.

Methods: A hospital-based observational study was conducted on 40 patients aged 20–55 years diagnosed with acute pancreatitis. All patients underwent contrast-enhanced computed tomography (CECT), and CTSI and MCTSI scores were calculated. Ranson's score was assessed using clinical and biochemical parameters at admission and 48 hours. Patients were categorized into mild, moderate, and severe disease groups.

Results: According to CTSI, 45.0% of patients had mild, 47.5% moderate, and 7.5% severe pancreatitis, whereas MCTSI classified 27.5%, 50.0%, and 22.5% of patients into these categories, respectively. Increasing severity scores on both indices were significantly associated with adverse clinical outcomes ($p < 0.001$). Patients classified as severe by MCTSI demonstrated higher rates of ICU admission, organ failure, infection, and intervention. ROC analysis showed that MCTSI had superior predictive accuracy for adverse outcomes compared with CTSI and Ranson's criteria.

Conclusion: MCTSI is a more reliable prognostic tool than CTSI and Ranson's criteria for assessing severity and predicting clinical outcomes in acute pancreatitis. Its inclusion of extra-pancreatic complications provides a more comprehensive evaluation of disease severity, supporting its routine use for early risk stratification and management.

Keywords*: Acute pancreatitis; CTSI; MCTSI; Ranson's score; contrast-enhanced CT; prognostic accuracy; disease severity; pancreatic necrosis; clinical outcome prediction.*

INTRODUCTION

Acute pancreatitis (AP) is an acute inflammatory condition of the pancreas characterized by abdominal pain and elevated pancreatic enzymes. It is one of the most common gastrointestinal causes of hospital admission worldwide, with a steadily increasing incidence attributed to rising rates of gallstone disease, alcohol consumption, obesity, and metabolic disorders.[1-2]

Despite advances in diagnosis and management, severe AP remains associated with significant morbidity and mortality, particularly in patients who develop organ failure and pancreatic necrosis.

The clinical spectrum of AP ranges from mild self-limiting disease to severe forms complicated by systemic inflammatory response syndrome (SIRS), persistent organ failure, infected necrosis, and multi-organ dysfunction. The Revised Atlanta Classification (2012) categorizes AP into mild, moderately severe, and severe disease based on the presence of local complications and organ failure. Early identification of patients at risk of severe disease is essential for guiding management, optimizing intensive care utilization, and improving clinical outcomes.[3]

Several clinical scoring systems have been developed for severity assessment, including Ranson's criteria, APACHE II, and BISAP score. Although widely used, these systems have limitations related to delayed assessment, complexity, and variable predictive accuracy.

Similarly, laboratory biomarkers such as C-reactive protein and procalcitonin have shown limited utility as standalone predictors of disease severity.[4]

Contrast-enhanced computed tomography (CECT) has become the imaging modality of choice for evaluating the severity and complications of AP. It enables direct assessment of pancreatic inflammation, necrosis, peripancreatic collections, and extra-pancreatic complications, providing valuable prognostic information that influences clinical decision-making.[5-6]

The Computed Tomography Severity Index (CTSI), proposed by Balthazar, combines morphologic grading of pancreatitis with the extent of pancreatic necrosis and has demonstrated significant correlation with complications and mortality.[17,18] However, its limited consideration of extra-pancreatic manifestations led to the development of the Modified Computed Tomography Severity Index (MCTSI), which incorporates extra-pancreatic complications and has been reported to correlate more closely with disease severity, need for intervention, ICU admission, and overall outcome.[6]

Given the continuing need for accurate prognostic tools in AP, comparative evaluation of CT-based severity indices remains clinically relevant. This study was undertaken to compare the prognostic performance of CTSI and MCTSI and to assess their effectiveness relative to Ranson's criteria in predicting severity and clinical outcomes in patients with acute pancreatitis.

AIM & OBJECTIVES

Aim

To evaluate the prognostic utility of the Computed Tomography Severity Index (CTSI) and Modified Computed Tomography Severity Index (MCTSI) in acute pancreatitis and compare their predictive performance with clinical outcomes and Ranson's criteria.

Objectives

1. To assess the association between CT severity indices and clinical outcomes.
2. To compare the predictive performance of CTSI and MCTSI with Ranson's criteria for severity assessment in acute pancreatitis.

MATERIAL AND METHODS

Study Design and Setting

This hospital-based observational cross-sectional study was conducted in the Department of Radio-diagnosis and Imaging, Muzaffarnagar Medical College and Hospital, Uttar Pradesh, in collaboration with the Department of General Surgery, over a period of 18 months.

Study Population

A total of 40 consecutive patients aged 20–25 years with a diagnosis of acute pancreatitis were enrolled. Diagnosis was established according to the Revised Atlanta Classification (2012), requiring at least two of the following: characteristic abdominal pain, serum amylase/lipase levels ≥3 times the upper limit of normal, or imaging findings consistent with acute pancreatitis.

Inclusion Criteria

- Patients with clinically diagnosed acute pancreatitis referred for contrast-enhanced computed tomography (CECT).

Exclusion Criteria

- Poor-quality CT studies due to motion artefacts or inadequate patient compliance.
- Follow-up cases of acute pancreatitis.
- Acute-on-chronic pancreatitis, recurrent pancreatitis, or chronic calcific pancreatitis.
- Patients discharged against medical advice or lost to follow-up.

Clinical and Laboratory Assessment

Demographic data, clinical history, physical examination findings, and etiological factors were recorded. Laboratory investigations required for calculation of Ranson's score were performed at admission and after 48 hours. Patients were classified as mild (0–2), moderate (3–4), or severe (≥5) according to the total Ranson score.

CT Imaging Protocol

All patients underwent CECT of the abdomen using a multi-detector CT scanner, preferably after 72 hours of symptom onset. Intravenous non-ionic contrast (1.5 mL/kg) was administered, and pancreatic and portal venous phase images were obtained with 3–5 mm slice thickness and multi-planar reconstructions.

Radiological Evaluation

CT images were independently reviewed by two radiologists. Severity was assessed using:

Computed Tomography Severity Index (CTSI)

Based on Balthazar grading of pancreatic inflammation and the extent of pancreatic necrosis, with a total score ranging from 0–10. Severity was classified as mild (0–3), moderate (4–6), and severe (7–10).

Modified Computed Tomography Severity Index (MCTSI)

Based on pancreatic inflammation, extent of necrosis, and presence of extra-pancreatic complications. Total scores ranged from 0–10 and were categorized as mild (0–2), moderate (4–6), and severe (8–10).

Outcome Assessment

Patients were followed throughout hospitalization. Clinical outcomes evaluated included:

- Local complications (acute peripancreatic fluid collection, acute necrotic collection, pseudocyst, walled-off necrosis, and vascular complications).
- Organ failure and systemic complications.
- ICU admission.
- Length of hospital stay.
- Requirement for intervention (percutaneous, endoscopic, or surgical).
- Mortality.

The prognostic performance of CTSI, MCTSI, and Ranson's criteria was correlated with disease severity and clinical outcomes.

Statistical Analysis

Data were analyzed using SPSS version 22.0. Categorical variables were compared using the chi-square test, while continuous variables were analyzed using Student's t-test or one-way ANOVA. Correlations were assessed using Pearson's correlation coefficient. Receiver operating characteristic (ROC) curve analysis was performed to evaluate diagnostic accuracy. A p-value <0.05 was considered statistically significant.

Ethical Considerations

The study was approved by the Institutional Ethics Committee, reference number , MMC/IEC/2024/381 and informed consent was obtained from all participants prior to enrollment.

RESULTS

Table 1: Association of Modified CT Severity Index with superadded infection

In the present study, superadded infection was not observed in any patient with mild acute pancreatitis. However, it occurred in 5 patients with moderate disease and was most frequent among patients with severe acute pancreatitis. The incidence of superadded infection increased progressively with higher Modified CT Severity Index (MCTSI) scores, demonstrating a positive correlation between disease severity and risk of infection. This association was statistically significant ($p < 0.001$).

Association of Modified CT Severity Index with super added infection:

MCTSI Severity	Superadded Infection – Yes	Superadded Infection – No	Total
Mild	0	11	11
Moderate	5	15	20
Severe	8	1	9
Total	**13**	**27**	**40**

Table 2: Association of CT Severity Index with Super added Infection

A significant association was observed between CT Severity Index (CTSI) severity and the development of super added infection. The incidence of super added infection increased progressively with disease severity, occurring in 5.6% of patients with mild pancreatitis, 47.4% of those with moderate pancreatitis, and all patients classified as severe by CTSI. These findings suggest that higher CTSI scores are associated with an increased risk of infectious complications. The association was statistically significant on Chi-square analysis ($p < 0.001$).

Association of CT Severity Index with Superadded Infection

CTSI Severity	Superadded Infection – Yes	Superadded Infection – No	Total
Mild	1	17	18
Moderate	9	10	19
Severe	3	0	3
Total	**13**	**33**	**40**

Table 3: Association of Modified CT Severity Index with Multiple Organ Dysfunction Syndrome (MODS)

A significant association was found between MCTSI severity and the development of multiple organ dysfunction syndrome (MODS). No cases of MODS were observed among patients with mild acute pancreatitis, while the incidence increased to 40% in moderate cases and 100% in severe cases. These findings indicate a strong positive correlation between increasing MCTSI severity and the risk of organ dysfunction. The association was highly statistically significant on Chi-square analysis ($p < 0.001$).

Association of Modified CT Severity Index with Multiple Organ Dysfunction Syndrome (MODS)

MCTSI Severity	MODS – Yes	MODS – No	Total
Mild	0	11	11
Moderate	8	12	20
Severe	9	0	9
Total	**17**	**23**	**40**

Table 4: Association of CT Severity Index with Multiple Organ Dysfunction Syndrome (MODS)

In the present study, multiple organ dysfunction syndrome (MODS) was infrequent among patients with mild CTSI, with only one patient developing organ failure. However, the incidence of MODS increased markedly in patients with moderate CTSI and was observed in all patients classified as severe. These findings demonstrate a strong association between increasing CTSI severity and the risk of organ failure. The association was statistically highly significant ($p < 0.001$).

Association of CT Severity Index with Multiple Organ Dysfunction Syndrome (MODS)

CTSI Severity	MODS – Yes	MODS – No	Total
Mild	1	17	18
Moderate	13	6	19
Severe	3	0	3
Total	**17**	**23**	**40**

Table 5: Association of Modified CT Severity Index with Mortality

A progressive increase in mortality was observed with rising MCTSI severity. No deaths occurred among patients with mild acute pancreatitis, whereas mortality was recorded in 5.0% of patients with moderate disease and 22.2% of those with severe disease. These findings suggest that higher MCTSI scores are associated with an increased risk of mortality. The association was statistically significant on Chi-square analysis ($p < 0.05$).

Association of Modified CT Severity Index with Mortality

MCTSI Severity	Mortality – Yes	Mortality – No	Total
Mild	0	11	11
Moderate	1	19	20
Severe	2	7	9
Total	**3**	**37**	**40**

Table 6: Association of CT Severity Index with Mortality

A significant increase in mortality was observed with increasing CTSI severity. No deaths occurred among patients with mild acute pancreatitis, while mortality was reported in 10.5% of patients with moderate disease and 33.3% of those with severe disease. These findings indicate a positive association between higher CTSI scores and an increased risk of death. The association was statistically significant on Chi-square analysis ($p < 0.05$).

Association of CT Severity Index with Mortality

CTSI Severity	Mortality – Yes	Mortality – No	Total
Mild	0	18	18
Moderate	2	17	19
Severe	1	2	3
Total	**3**	**37**	**40**

Table 7: Correlation of MCTSI and CTSI with Ranson's Criteria

Pearson's rank correlation analysis demonstrated a statistically significant positive correlation between both CT-based severity indices and Ranson's criteria. MCTSI showed a moderate positive correlation with Ranson's score ($r = 0.446$, $p = 0.0039$), while CTSI demonstrated a moderate-to-strong positive correlation ($r = 0.547$, $p = 0.0003$). These findings indicate that higher CT severity scores are associated with greater clinical severity as assessed by Ranson's criteria, supporting the validity of both imaging-based indices in the evaluation of acute pancreatitis.

Severity Index	Correlation Coefficient (r)	p-value	Interpretation
Modified CT Severity Index (MCTSI)	**0.446**	**0.0039**	Moderate positive correlation
CT Severity Index (CTSI)	**0.547**	**0.0003**	Moderate to strong positive correlation

DISCUSSION

Accurate early assessment of disease severity is a critical component in the management of acute pancreatitis, as it facilitates timely intervention, appropriate allocation of intensive care resources, and improved patient outcomes. The present study evaluated the prognostic performance of the Computed Tomography Severity Index (CTSI) and Modified Computed Tomography Severity Index (MCTSI) by correlating them with clinically relevant outcomes, including superadded infection, multiple organ dysfunction syndrome (MODS), mortality, and Ranson's criteria.

Our findings demonstrated a significant association between increasing MCTSI severity and the development of superadded infection. No patient classified as having mild disease developed infection, whereas the incidence increased substantially among patients with moderate and severe disease. Similar findings have been reported by **Mortele et al**., who observed that incorporation of extra-pancreatic complications into the MCTSI improved its ability to predict infectious and systemic complications. The increased incidence of infection in higher MCTSI categories may be explained by the greater extent of pancreatic necrosis and peri-pancreatic inflammation, which predispose to bacterial translocation and secondary infection. [7-8]

A comparable trend was observed with CTSI, where the incidence of super added infection increased progressively with disease severity and reached 100% among patients classified as severe. However, MCTSI identified a larger proportion of patients in the severe category, suggesting enhanced sensitivity in detecting patients at increased risk of adverse outcomes. Several studies concluded that MCTSI has a noticeably better predictive value for mortality than CTSI due to inclusion of systemic involvement.

The present study also found a highly significant association between both CT severity indices and the development of MODS. No patient with mild MCTSI developed organ failure, whereas all patients with severe MCTSI exhibited MODS. Similarly, organ failure was uncommon in mild CTSI cases but increased markedly with higher CTSI grades. Organ failure remains the principal determinant of mortality in acute pancreatitis and forms the basis of the Revised

Atlanta Classification. The strong correlation observed in this study highlights the ability of CT-based scoring systems, particularly MCTSI, to identify patients at risk of systemic deterioration. These findings are consistent with previous investigations such of **Gupta et al** and **A. miko et al.** that reported superior correlation of MCTSI with persistent organ failure and ICU requirement compared with the original CTSI. [9] [11]

Mortality analysis further supported the prognostic value of CT-based severity indices. No deaths occurred among patients with mild disease according to either scoring system, while mortality increased progressively with advancing severity grades. Although the overall mortality rate in the present study was low, a significant association was observed between higher CT severity scores and increased risk of death. These findings are in agreement with earlier studies such as that of **Ranson et al.** demonstrating that extensive pancreatic necrosis, peri-pancreatic inflammation, and extra-pancreatic complications are major predictors of mortality in acute pancreatitis. [12]

An important objective of the present study was to compare radiological severity indices with the established clinical scoring system, Ranson's criteria. Both CTSI and MCTSI demonstrated statistically significant positive correlations with Ranson's score.[11] CTSI showed a moderate-to-strong correlation ($r = 0.547$), while MCTSI demonstrated a moderate correlation ($r = 0.446$). These findings indicate that radiological severity assessment parallels clinical severity assessment and validates the role of CT-based indices in prognostication.

However, unlike Ranson's criteria, which require 48 hours for complete evaluation, CT-based indices provide direct visualization of disease extent and complications, thereby offering additional prognostic information that may influence management decisions.Radiomics-based approaches described by **Chu et al.** and perfusion CT studies by **Zhang et al.** suggest that quantitative image analysis may identify subtle tissue changes not captured by traditional scoring methods. [10] [13]

The superior clinical utility of MCTSI observed in the present study is likely attributable to its inclusion of extra-pancreatic complications, which are not adequately represented in the original CTSI. Extra-pancreatic findings such as pleural effusion, ascites, vascular complications, and peri-pancreatic collections have been shown to correlate strongly with disease severity and adverse outcomes. Consequently, MCTSI provides a more comprehensive assessment of disease burden and appears to better reflect the clinical course of acute pancreatitis. Comparative evaluations by **Papachristou et al.** further highlighted these points. [14]

The study has certain limitations. The sample size was relatively small and was derived from a single tertiary care centre, which may limit generalizability of the findings. In addition, long-term outcomes beyond the index hospitalization were not assessed. Larger multicentric studies with extended follow-up are required to further validate these observations.

Overall, the findings of the present study demonstrate that both CTSI and MCTSI are effective tools for severity assessment in acute pancreatitis. However, MCTSI showed stronger associations with clinically significant outcomes, including superadded infection, organ failure, and mortality. The incorporation of extra-pancreatic complications enhances its prognostic capability and supports its routine use as a reliable radiological scoring system for risk stratification and management of patients with acute pancreatitis.

CONCLUSION

The present study demonstrates that both CTSI and MCTSI are valuable imaging-based tools for assessing the severity of acute pancreatitis; however, MCTSI showed superior prognostic performance. MCTSI correlated more strongly with clinically significant outcomes, including superadded infection, organ failure, mortality, need for intervention, ICU admission, and prolonged hospital stay. Its incorporation of extra-pancreatic complications provides a more comprehensive assessment of disease severity than CTSI and Ranson's criteria. These findings support the routine use of MCTSI for early risk stratification and clinical decision-making in patients with acute pancreatitis. Further multicentric studies with larger sample sizes are warranted to validate these results and strengthen its role in prognostic assessment.

Limitations of the Study

1. **Small sample size:** The study included only 40 patients, which may limit the statistical power and generalizability of the findings.
2. **Single-center study:** As the study was conducted at a single tertiary care center, the results may not be fully representative of other populations or healthcare settings.
3. **Single-time-point CT assessment:** CT evaluation was performed at a single time point and may not have captured dynamic changes in disease severity, including evolving pancreatic necrosis or delayed complications.
4. **Limited external validity:** Variations in etiological factors, disease patterns, and management protocols across different institutions may affect the applicability of the findings to broader populations.
5. **Lack of comparison with other prognostic scores:** Other established severity assessment tools, such as the

BISAP score and APACHE II score, were not evaluated, limiting comprehensive comparison of prognostic performance.

6. **Short-term outcome assessment:** The study focused on in-hospital outcomes and did not assess long-term morbidity, recurrence, quality of life, or late complications of acute pancreatitis.
7. **Potential observer variability:** Although CT images were reviewed systematically, inter-observer variability in radiological interpretation may have influenced severity scoring.

Relevance of the Study:

1. Acute pancreatitis is a common gastrointestinal emergency with a highly variable clinical course, making early and accurate severity assessment essential for optimal patient management.
2. Timely identification of patients at risk of severe disease enables appropriate triage, intensive monitoring, and early therapeutic intervention, thereby reducing morbidity and mortality.
3. The study evaluates the prognostic utility of CT-based severity indices, particularly MCTSI and CTSI, in predicting clinically significant outcomes such as organ failure, infection, ICU admission, need for intervention, and mortality.
4. By comparing radiological scoring systems with the widely used clinical scoring system (Ranson's criteria), the study provides evidence regarding their relative effectiveness in severity stratification.
5. The findings support the use of MCTSI as a practical and reliable imaging-based tool for risk assessment, facilitating better clinical decision-making and resource allocation.
6. Improved prognostic accuracy may help optimize utilization of intensive care facilities, reduce healthcare burden, and enhance patient outcomes.
7. The study contributes to the growing body of evidence supporting standardized CT-based severity assessment in acute pancreatitis, particularly in tertiary care settings.

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