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Comparative Study Between Modified Computed Tomography (CT) Severity Index and Ranson Score in Predicting Severity of Acute Biliary Pancreatitis

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ABSTRACT

Objective: To compare the accuracy of the Modified CT Severity Index(mCTSI)and Ranson score for predicting severity of acute biliary pancreatitis.

Study Design: Comparative Observational Study.

Place and Duration of Study: Department of Surgery, Combined Military Hospital, Rawalpindi Pakistan from Sep 2024 to Aug 2025.

Methodology: Patients aged 18 to 60 years of age, with acute biliary pancreatitis were included. Ranson score and Modified CT severity Index were calculated. The Revised Atlanta Classification was used as reference standard for true severity assessment, categorizing patients into mild, moderately severe and severe acute pancreatitis. Measures of diagnostic accuracy of the Ranson Score and Modified CTSI in predicting severe pancreatitis as defined by the Revised Atlanta Classification were assessed. Receiver operating characteristic (ROC) curves were generated and area under the curve (AUC) was calculated for both scoring systems.

Results: A total of 140 patients with acute biliary pancreatitis were included, with a median age of 41.00 (IQR 14.00) years. For predicting severe acute pancreatitis, the mCTSI demonstrated better performance, with a sensitivity of 84.4%, specificity of 92%, and accuracy of 87.1%, compared with Ranson score, which showed a sensitivity of 84.4%, specificity of 54%, and accuracy of 73.6%. ROC curve analysis yielded an AUC of 0.76 (95% CI: 0.677–0.842; $p<0.001$) for Ranson's score and 0.95 (95% CI: 0.918–0.983; $p<0.001$) for mCTSI.

Conclusion: The Modified CT Severity index had better diagnostic accuracy in predicting severity of disease, complications and mortality.

Keywords: Acute biliary pancreatitis, Modified CT Severity index, Ranson score, Revised Atlanta Classification.

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INTRODUCTION

Acute biliary pancreatitis is a subtype of acute pancreatitis caused by obstruction of the common bile duct or the ampulla of Vater, typically due to gallstones or biliary sludge.[1] Overall global prevalence of asymptomatic gall stones is reaching up-to 80% which accounts for approximately 60% of all acute pancreatitis cases.[2] The incidence of biliary pancreatitis in Pakistan in some studies is as high as 45.2% amongst all cases of pancreatitis presenting to surgical departments.[3] Diagnosis is supported by elevated liver enzymes, particularly alanine aminotransferase (ALT) along with raised bilirubin, alkaline phosphatase (ALP), and gamma-glutamyl transferase (GGT).[4] Early recognition is critical, as timely ERCP or cholecystectomy may be required to prevent recurrence and complications of biliary pancreatitis.[5] Globally, the incidence of acute pancreatitis ranges from 13 to 45 cases per 100,000 population annually.[6]

The disease ranges from mild inflammation to life-threatening pancreatic necrosis. Various scoring systems have been developed to assess severity. The Ranson score evaluates clinical and biochemical parameters in two phases—five criteria at admission and six within the first 48 hours.[7] The Revised Atlanta Classification further categorizes pancreatitis as mild, moderately severe, or severe based on organ failure and local complications.[8] Radiologically, the modified Computed Tomography Severity Index (mCTSI) is widely used and combines pancreatic inflammation and necrosis extent on contrast-enhanced CT, usually done 72 hours after onset of symptoms to accurately assess necrosis.[9] Higher CT Severity Index score correlates with increased risk of local as well as systemic complications and mortality.[10]

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This study aimed to compare the predictive efficacy of the Modified CTSI and Ranson score specifically in acute biliary pancreatitis. By evaluating their performance in predicting disease severity, this study would aid clinicians in making timely decisions regarding imaging, intervention, and overall management strategy of biliary pancreatitis, given the variability in disease presentation and prognosis.

METHODOLOGY

This study was done as a comparative observational study at the Department of Surgery, Combined Military Hospital Rawalpindi Pakistan involving patients diagnosed with acute biliary pancreatitis. The study was conducted over a period of 1 year, from Sep 2024 to Aug 2025 following permission from the hospital ethical review committee prior to commencement of the study (ERC:CMH/675/dated22Aug2024). The sample size was calculated using OpenEpi online sample size calculator taking confidence interval 95%, margin of error 5% and reported prevalence of 10.2% patients diagnosed as severe acute pancreatitis amongst all the patients presenting with pancreatitis as reported by Edu *et al*.[11] The estimated sample size was calculated to be 139 patients. A non-probability consecutive sampling technique was used to enroll eligible patients. All patients admitted with clinical suspicion of acute pancreatitis underwent baseline investigations and abdominal ultrasound. Those with findings consistent with biliary pancreatitis, were screened for inclusion after obtaining informed consent.

Inclusion Criteria: Patients of either gender, aged 18-60 years, diagnosed with acute biliary pancreatitis based on clinical, biochemical, and sonographic findings, presenting within 72 hours of symptoms onset and willing to undergo contrast-enhanced CT scan were included.

Exclusion Criteria: Patients with recurrent pancreatitis, having contraindications to IV contrast (e.g., renal dysfunction, hypersensitivity), immunocompromised and pregnant patients were excluded from the study.

Data collection involved assessment of Ranson score parameters, including five admission-based variables (age, white blood cell count, blood glucose, AST, and LDH) and six variables assessed within 48 hours (hematocrit fall, BUN rise, serum calcium, arterial oxygen saturation (pO_2), base deficit, and fluid sequestration). These investigations were advised as part of routine evaluation. A contrast-enhanced CT (CECT) was performed after 72 hours of symptom onset to accurately assess pancreatic necrosis and inflammation. The Modified CTSI was calculated by evaluating the extent of pancreatic inflammation (graded A to E) and the percentage of non-enhancing necrotic tissue. Necrosis is graded based on the percentage of non-enhancing tissue: 0%, <30%, 30–50%, and >50%, yielding a total score between 0 and 10.[12] All CECT scans were interpreted and reported by a consultant radiologist with at least five years of post-fellowship experience, blinded to the Ranson score.

The Revised Atlanta Classification (2012) was used as the reference standard for true severity classification, categorizing patients as having mild, moderately severe, or severe pancreatitis based on the presence and duration of organ failure and complications. The Ranson score and Modified CTSI were compared against this classification.

All data were entered into a structured proforma and analyzed using Statistical Package for Social Sciences (SPSS v25.00). The variables of age, Ranson score, mCTSI, Atlanta score were summarized using median (IQR), while categorical variables such as gender, severity grade were reported as frequencies and percentages. Diagnostic accuracy of the Ranson Score and Modified CTSI was assessed by calculating sensitivity, specificity, positive predictive value (PPV), negative predictive value (NPV) and accuracy in predicting severe pancreatitis according to the Revised Atlanta Classification. Receiver operating characteristic (ROC) curves and area under the curve (AUC) was generated for both scoring systems. Additionally, Cohen's Kappa statistic was calculated to assess the level of agreement between each scoring system and the Revised Atlanta Classification. An unweighted Kappa was used, and values were interpreted using standard benchmarks. A *p*-value≤0.05 was considered statistically significant.

RESULTS

A total of 140 patients with acute biliary pancreatitis were included with median age of 41.00(14.00) years including 66(47.1%) males and 74(52.9%) females. According to the Revised Atlanta Classification, 21 (15%) cases were mild, 29(20.7%) were moderately severe, and 90(64.3%) were severe. Ranson scores differed across Atlanta categories, with median (IQR) value of 1.00(1.00) in mild, 1.00(2.00) in moderately severe, and 5.00(5.00) in severe disease (*p*<0.001). A similar pattern was observed for mCTSI,

with median (IQR) values of 2.00(1.00) in mild, 5.00(1.00) in moderately severe, and 8.00(1.00) in severe disease (p<0.001) (Table-I).

Table-I: Distribution of Ranson and mCTSI scores Across the Revised Atlanta categories (n=140)

	Revised Atlanta Category			*p*-value
	Mild (n=21)	Moderate (n=29)	Severe (n=90)	
Ranson Score [median (IQR)]	1.00 (1.00)	1.00 (2.00)	5.00 (5.00)	<0.001
mCTSI [median (IQR)]	2.00 (1.00)	5.00 (1.00)	8.00 (1.00)	<0.001

mCTSI: Modified CT Severity Index

Spearman correlation analysis was performed and it showed a significant positive monotonic association between Ranson score and Atlanta severity (Spearman's ρ=0.442, p<0.001) and between mCTSI and Atlanta severity (Spearman's ρ=0.79, p<0.001). Ranson and mCTSI were also correlated assessed by Spearman's correlation (ρ=0.543, p<0.001).

For prediction of severe acute pancreatitis, ROC analysis yielded an AUC of 0.76 (95% CI: 0.677 – 0.842, p<0.001) for Ranson and 0.95 (95% CI: 0.918 – 0.983, p<0.001) for mCTSI. The optimal thresholds by Youden's Index were ≥2 for Ranson and ≥7 for mCTSI (Figure-1).

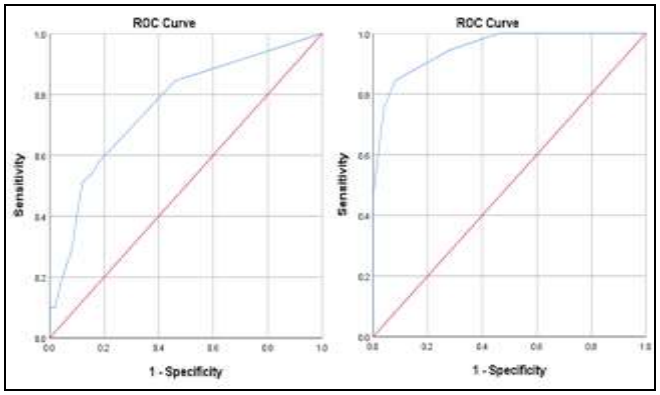

Figure-1: ROC curves for Ranson and mCTSI scores Predicting Severe Acute Pancreatitis

Using these thresholds against the Atlanta severe/non-severe gold standard, Ranson score demonstrated an approximate sensitivity of 84.4%, a specificity of 54%, and an accuracy 73.6%; whereas, mCTSI showed an approximate sensitivity of 84.4%, a specificity of 92% and accuracy 87.1%. (Table-II)

Agreement analyses using weighted Cohen's kappa showed κ = 0.335 (95% CI 0.206–0.464, p<0.001) between Ranson score cut off and Atlanta category (mild/moderate/severe), and κ = 0.732 (95% CI 0.618–0.846, p<0.001) between mCTSI score cut off and Atlanta category. Agreement between Ranson and mCTSI cut offs for severe pancreatitis was κ = 0.449 (95% CI 0.316–0.582, p<0.001). (Table-III)

Table-II: Diagnostic Performance of Ranson and mCTSI for Severe Disease

Score	Sensitivity (%)	Specificity (%)	PPV (%)	NPV (%)	Accuracy (%)	Youden J
Ranson`s	84.4	54.0	76.9	65.6	73.6	0.384
mCTSI	84.4	92.0	95.0	76.5	87.1	0.764

mCTSI: Modified CT Severity Index

Table-III: Kappa Agreement Among Classification Systems of Acute Pancreatitis

Comparison	Kappa (κ)	95% CI	*p*-value	Agreement level
Ranson Score vs Atlanta Category	0.335	0.206-0.464	<0.001	Fair
mCTSI vs Atlanta category	0.732	0.618-0.846	<0.001	Substantial
Ranson Score vs mCTSI	0.449	0.316-0.582	<0.001	Moderate

mCTSI: Modified CT Severity Index

Clinically, ICU admission occurred in 99(70.7%) overall and were 100% in the Atlanta severe group than in non-severe groups (0% and 31% for mild and moderate pancreatitis, p<0.0001). Mortality was 18(25%) in severe cases versus non-severe, 4 (23.5%) in mild and 1(3.5%) in moderate cases (p<0.001). (Figure-2)

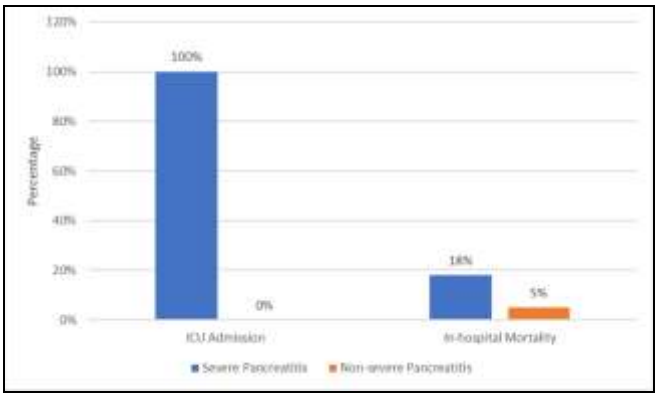

Figure-2: Bar charts of ICU admission and mortality by Atlanta severity category

Ranson (categorized at ≥2) was associated with ICU admission 48(92.3%) (p<0.001) but not with mortality, 9(39.1%), (p=0.818); mCTSI (categorized at ≥7) showed similar and even higher association with 78(97.5%) admitted to ICU but not with mortality, 13(56.5%), (p=1.00).

DISCUSSION

In this study, severity burden was high, and the performance profile of the two scores diverged meaningful as mCTSI showed superior discrimination

and calibration with clinical severity. Previous studies highlighted the strong association of mCTSI with the clinical outcome and predictive value of acute biliary pancreatitis for interventions.[12-13] In contrast to our study where we compared the two scores for predicting severity of acute pancreatitis, mortality and its outcomes, Ashrathi B and Murulya compared the two scores with regards to prognosis and found that Ranson score was useful in predicting early mortality whereas mCTSI detects local complications better. It was observed that modified CTSI had higher predictive value for complications of pancreatitis like pancreatic necrosis (AUC 0.943, sensitivity 99.8%) than 48-hours Ranson score (AUC 0.884)[14] This was corroborated in our study as Ranson lower specificity at its chosen threshold suggested it was better as an early screening signal rather than a definitive classifier.

Similarly, Tarique *et al*. reported that Ranson score was statistically insignificant in predicting mortality (p=0.371), however, it has significant predictive value in predicting severity and complications of pancreatitis (p<0.001).[15] Although, not the focus of our study, Miko *et al*. have suggested that APACHE-II score is the most accurate predictor of mortality but CTSI has advantages with regards to both severity and mortality prediction.[16]

Given that mCTSI depends on imaging typically obtained after initial stabilization, a staged strategy emerged: use Ranson early to flag risk and prioritize timely imaging; then use mCTSI to refine prognosis and guide disposition, which is especially relevant in a cohort where ICU utilization and adverse outcomes clustered with higher severity.

With an operational threshold of ≥7, high specificity of mCTSI supports confident "rule-in" decisions for escalation (e.g., ICU monitoring, early multidisciplinary input). This has also been well documented by Shaikh *et al*. in a study based in Dow Medical university.[17] Similar conclusion has been reported by Ahmed *et al*., where modified CTSI had higher significant value in predicting severity as compared to Ranson score and Balthazar CTSI.[18] Similarly Konedekar *et al*., concluded that mCTSI was simpler and more accurate scoring tool in predicting severity having strong correlation with clinical outcome and mortality than Ranson and Balthazar CT Severity Index.[19]

In this study, AUC of mCTSI was markedly higher than Ranson (0.95 vs 0.76), with substantially better specificity (92% vs 54%) at comparable sensitivity (both ~84%). The overall accuracy was higher (87.1% vs 73.6%). Yang *et al*., reported that mCTSI had higher sensitivity in predicting complications and mortality as compared to Ranson score (90% vs 79%) and (86% vs 77%) respectively.[20] Similar findings were reported by Manjunath *et al*., where AUC for mCTSI was 0.865 with 64% sensitivity and 98% specificity for predicating clinical outcome.[21]

The results of current study showed concordance with the clinical reference was also stronger for mCTSI (weighted κ = 0.732, substantial agreement) than for Ranson (κ = 0.335, fair), mirrored by a tighter monotonic association with severity (Spearman's ρ = 0.79 vs 0.442). Apisarthanarak *et al*. also observed strong agreement between CTSI and modified CTSI with clinical severity assessment (Spearment`s ρ=0.0.97, p<0.001).[22]

Together, these findings indicate that mCTSI more reliably separates severe from non-severe disease and aligns more closely with the downstream clinical picture captured by the Atlanta framework. This complementary sequencing leverages each tool's strengths, timeliness for Ranson, accuracy and agreement for mCTSI while minimizing over- or under-triage.

LIMITATIONS OF STUDY

Conducting the study at a single center and a limited sample size are amongst the major limitations of the study. Other scores of pancreatitis severity are not studied and compared with Ranson and mCTSI score in current study. Non-biliary causes of pancreatitis were not included in this study for diagnostic accuracy of these scores. Therefore, further studies including RCTs are required which include larger sample size and are done in multi-center setting before implementing results on general population.

CONCLUSION

The Ranson score and Modified CTSI both are useful tool in assessing severity and complications of acute biliary pancreatitis. However, Modified CTSI demonstrated superior predictive accuracy and agreement with disease severity, making it a more reliable tool for clinical practice and devising treatment plan.

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Authors' Contribution

Following authors have made substantial contributions to the manuscript as under:

FN & SI: Data acquisition, data analysis, critical review, approval of the final version to be published.

IS & HS: Study design, data interpretation, drafting the manuscript, critical review, approval of the final version to be published.

MFUM & MSH: Conception, data acquisition, drafting the manuscript, approval of the final version to be published.

Authors agree to be accountable for all aspects of the work in ensuring that questions related to the accuracy or integrity of any part of the work are appropriately investigated and resolved.

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