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Research Article

Diagnostic Performance of Scoring Systems in Non-Biliary Acute Pancreatitis Prognosis: A Comparative Analysis of Ranson and Balthazar Scores

Nonbiliyer Akut Pankreatit Prognozunda Skorlama Sistemlerinin Tanısal Performansı: Ranson ve Balthazar Skorlarının Karşılaştırmalı Analizi

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Abstract

Aim: The Ranson score (RS) and the Balthazar Computed Tomography Severity Index (CTSI) are commonly used to predict the severity and prognosis of acute pancreatitis (AP). However, the diagnostic superiority of these scoring systems in predicting the prognosis of non-biliary AP remains unclear. Therefore, this study aimed to compare the RS and CTSI in predicting the prognosis of non-biliary AP.

Material and Methods: This retrospective study included 67 non-biliary AP patients who were followed at the Internal Medicine clinic of Hospital, between January 2021 and May 2023. The RS and CTSI were calculated based on the laboratory and radiological findings of the patients. The endpoints consisted of prolonged hospitalization (≥8 days), complications, and mortality.

Results: The mean age of the patients was 50.1±8.3 years, and the majority were male (59.7%). Complications developed in 11.9% of the patients, prolonged hospitalization occurred in 26.9%, and death occurred in 6%. In predicting the risk of prolonged hospitalization and complications, CTSI exhibited superior diagnostic performance compared to RS (the area under the curve (AUC) = 0.590 vs. 0.856, p <0.05 for prolonged hospitalization, 0.615 vs. 0.786, p <0.05 for complications), while RS showed superior diagnostic performance in predicting the risk of mortality (AUC = 0.952 vs. 0.698, p <0.05).

Conclusion: In the prognosis of non-biliary AP, both scoring systems have different diagnostic advantages compared to each other, and their combined use may provide more reliable results for the endpoints.

Keywords: Acute Pancreatitis, Balthazar score, Complication, Ranson score, Prognosis

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ÖZ

Amaç: Akut pankreatitli hastalarda ciddiyetin ve prognozunu tahmin edilmesinde Ranson skoru (RS) ve Balthazar Bilgisayarlı Tomografi Şiddet İndeksini (CTSI) yaygın olarak kullanılmaktadır. Ancak, bu skorlama sistemlerinin biliyer olmayan akut pankreatitin prognouzu tahmin etmedeki tanısal üstünlükleri belirsizliğini korumaktadır. Bu nedenle, bu çalışmada nonbiliyer AP'nin prognozunu tahmin etmede RS ve CTSI'yi karşılaştırmayı amaçladık.

Gereç ve Yöntemler: Bu retrospektif çalışmaya, Ocak 2021 ile Mayıs 2023 arasında İç Hastalıkları kliniğinde takip edilen 67 nonbiliyer AP hastası dahil edildi. RS ve CTSI, hastaların laboratuvar ve radyolojik bulgularına dayanarak hesaplanmıştır. Son noktalar, uzun süreli hastanede yatış (≥8 gün), komplikasyonlar ve mortaliteden oluşmaktadır.

Bulgular: Hastaların ortalama yaşı 50.1±8.3 yıl olup, çoğunluğu erkek (%59.7) idi. Hastaların %11.9'unda komplikasyon gelişti, %26.9'unda uzun süreli hastanede yatış meydana geldi ve %6'sında ölüm gözlendi. Uzun süreli hastanede yatış ve komplikasyon riskini tahmin etmede CTSI, RS'ye göre üstün tanısal performans sergiledi (uzun süreli hastanede kalma için eğri altındaki alan (AUC) = 0.590 vs. 0.856, p <0.05, komplikasyonlar için AUC = 0.615 vs. 0.786, p <0.05), ancak RS mortalite riskini tahmin etmede daha üstün tanısal performans gösterdi (AUC = 0.952 vs. 0.698, p <0.05).

Sonuç: Nonbiliyer AP'nin prognozunda her iki skorlama sisteminin birbirine göre farklı tanısal avantajları vardır ve bunların kombine kullanımı son noktalar için daha güvenilir sonuçlar sağlayabilir.

Anahtar Kelimeler: Akut Pankreatit, Balthazar skoru, Komplikasyon, Ranson skoru, Prognoz

Introduction

Acute pancreatitis (AP) is characterized by abdominal pain that radiates from the epigastrium to the back, representing the sudden and severe inflammation of the pancreas [1]. This condition is typically diagnosed through a combination of patient symptoms, elevated serum amylase and lipase levels, and imaging studies such as ultrasonography and computed tomography (CT) scans [2]. AP is known for its highly variable clinical course, posing significant risks for prolonged hospitalization, complications, and high mortality rates among patients [3]. Therefore, early-stage risk stratification and prognosis determination are crucial for planning appropriate treatment strategies and managing patient care effectively.

Various scoring systems have been developed to assess the severity and prognosis of AP. Among these scoring systems, the Ranson score (RS) and Balthazar CT severity index (CTSI) are widely employed for their diagnostic performance [4]. The RS consider clinical and laboratory findings at admission and within the first 48 hours to predict disease severity and mortality risk. Conversely, the CTSI is a scoring system based on the appearance of the pancreas and the extent of necrosis [5]. Both scoring systems aim to stratify patients according to their risk of complications and mortality, guiding clinical management and resource allocation.

Despite their widespread use, the diagnostic accuracy and prognostic performance of these scoring systems have been subjects of debate, prompting comparative analyses to ascertain their reliability and predictive value [6-9]. However, the diagnostic superiority of these scoring systems in predicting the prognosis of non-biliary AP, specifically regarding prolonged hospitalization, complications, and mortality risk, remains unclear. Therefore, this study aimed to compare the RS and CTSI in predicting the prognosis of non-biliary AP.

Material and Methods

This retrospective study was conducted on AP patients who admitted to the Internal Medicine clinic of the University of Health Sciences, Kartal Dr Lütfi Kırdar City Hospital, between January 2021 and May 2023. The study was approved by the University of Health Sciences, Kartal Dr Lütfi Kırdar City Hospital Ethics Committee (Date: 25.01.2023, Decision No: 2022/514/242/4) and was carried out in accordance with the relevant ethical guidelines and the Helsinki Declaration (2013 Brazil revision). Due to the retrospective design of the study, the local ethics committee waived the necessity for informed consent.

Study Population

In this study, 182 patients who were admitted to the Internal Medicine outpatient clinic of the hospital due to AP during the aforementioned years were retrospectively evaluated. The criteria for diagnosing AP included at least two of the following: (a) abdominal pain indicative of AP, characterized

by acute, severe epigastric pain that often radiates to the back; (b) serum amylase and/or lipase levels elevated to three times above the upper normal limit; and (c) diagnostic imaging showing characteristic AP features on CT [10]. The inclusion criteria were patients over 18 years of age, those with a documented diagnosis of non-biliary AP, and those with a compatible primary diagnosis. Patients with an undocumented diagnosis of AP, those with the presence of gallstones or biliary sludge in ultrasound or CT scans, those with any chronic illness, patients who died within 48 hours of admission, and those with incomplete data were excluded from the study. After applying the exclusion criteria, the study enrolled 67 patients diagnosed with non- biliary AP.

Assessments of Data

Demographic, clinical, and imaging findings for all patients were retrospectively collected from patient files or the hospital's patient information system. The imaging findings were obtained from ultrasound at the time of patient presentation and from contrast-enhanced CT images within the first 48 hours following the presentation.

The calculation of CTSI was performed based on findings of CT images [11]. This involved the synthesis of the Balthazar score, which rates the severity of pancreatitis from levels A to E, alongside an assessment of the extent of pancreatic necrosis. Specifically, the Balthazar rating system assigns a score ranging from 0 (A, indicating a normal pancreatic condition) to 4 (E, indicating multiple, ambiguous fluid collections around the pancreas). The scores are distributed as follows: 0 for a normal condition, 1 for pancreatic enlargement, 2 for signs of inflammation in the pancreatic and surrounding adipose tissue, 3 for the presence of a singular, undefined fluid collection around the pancreas, and 4 for multiple indistinct fluid accumulations. Additionally, the analysis includes categorizing the severity of pancreatic necrosis into four levels: no necrosis (scored as 0), necrosis covering up to 30% of the area (scored as 2), necrosis extending over 30% to 50% (scored as 4), and necrosis surpassing 50% of the pancreatic tissue (scored as 6) [11].

The total RS was calculated using data from the first 48 hours [12]. Initially, upon hospital admission, the assessment incorporates five parameters: age (>55 years), white blood cell count (>16,000 cells/mm3), blood glucose (≥200 mg/dL), aspartate aminotransferase (≥250 IU/L), and lactate dehydrogenase (>350 IU/L). After 48 hours, the remaining six parameters are as follows: a serum calcium level below 8.0 mg/dL, a drop in hematocrit of 10% or greater, arterial partial pressure of oxygen at or below 60 mmHg, an increase in blood urea nitrogen by 5 mg/dL or more despite receiving intravenous fluids, a base excess of 4 mEq/L or greater, and an accumulation of fluids exceeding 6 liters [12].

Definitions

For patients with a history of alcohol intake within 48 hours before symptoms began and no indications of other causes, the diagnosis was alcoholic AP. The diagnosis was considered as hypertriglyceridemic AP for patients whose serum triglyceride levels exceed 1000 mg/dL or who typically have an underlying dyslipidemia (Type I, IV, or V), and no indications of other causes. When a detailed examination of clinical and medication histories, along with initial tests, did not uncover causative factors, the etiology was classified as idiopathic.

The classification of AP severity followed the latest version of the Atlanta classification [10]. Accordingly, the absence of organ failure and local or systemic complications was defined as mild AP. The moderately severe AP characterized by temporary organ failure, the occurrence of local complications, or the exacerbation of comorbid conditions. Severe AP was identified by continuous organ failure lasting over 48 hours. The determination of organ failure involved obtaining a score of two or higher in any of the three systems (respiratory, cardiovascular, or renal) according to the modified Marshall scoring criteria [13]. A prolonged hospital stay was defined as a stay of 8 days or more.

Statistical analysis

All data were analyzed with IBM SPSS Statistics for Windows 20.0 (IBM Corp., Armonk, NY, USA). Numerical data determined to be normally distributed based on the results of Kolmogorov-Smirnov tests are given as mean ± standard deviation while non-normally distributed variables are given as median (min – max). Categorical variables are given as numbers and percentages. For comparing numerical variables between groups, depending on the normality of distribution, the Student's T-test or the Mann-Whitney U test was employed. For the comparison of categorical data, the Chi-square test and Fisher's exact Chi-square test were utilized. The diagnostic performance of scoring systems in predicting the prognosis of AP was evaluated using the area under the curve (AUC) in ROC Curve analysis. Threshold values were determined by the Youden index method. Significance was accepted at $P < 0.05$ (*) for all statistical analyses.

Results

The mean age of the patients was 50.1 ± 8.3 years (range: 33 – 64 years), and the majority were male (59.7%, n = 40). In terms of the etiology of AP, hyperlipidemia was the most frequently observed cause (34.3%), followed by alcohol (31.4%), and idiopathic (29.8%) etiologies. According to the Atlanta classification, forty-six (68.7%) patients were classified as "mild AP", 11 (16.4%) as "moderately severe AP", and 10 (14.9%) as "severe AP." The mean RS was 2.0 ± 1.7 (range = 0 to 10), and mean CTSI was 2.2 ± 1.4 (range = 0 to 5). According to the RS, the frequency of severe AP was 37.3%, while it was 16.4% according to the CTSI. The demographic and clinical characteristics of the patients were shown in Table 1.

Table 1. Demographic and clinical characteristics of patients with non-biliary acute pancreatitis.

Variables	All population n = 67
Age, years	50.1 ± 8.3
Male gender, n (%)	40 (59.7)
Tobacco use, n (%)	43 (64.2)
Alcohol use, n (%)	18 (26.9)
Etiology, n (%)	
Hyperlipidemia	23 (34.3)
Alcoholic	21 (31.4)
Idiopathic	20 (29.8)
Others	3 (4.5)
Laboratory finding	
Hematocrit, %	38.5 ± 7.2
Amilaz, U/L	1658.1 ± 1211.3
Lipase, IU/L	1840.5 ± 1548.6
AST, U/L	263.6 ± 210.8
ALT, U/L	233.7 ± 201.2
BUN, mg/dL	28.2 ± 14.6
Severity of AP	
Moderately severe	11 (16.4)
Severe	10 (14.9)
Scoring systems	
Ranson score	2.0 ± 1.7
Mild, n (%)	42 (62.7)
Severe, n (%)	25 (37.3)
CTSI	2.2 ± 1.4
Mild, n (%)	56 (83.6)
Intermediate, n (%)	11 (16.4)

Numerical variables were shown as mean ± standard deviation. Categorical variables were shown as numbers (%). ALT: alanine aminotransferase; AST, aspartate aminotransferase; AP, acute pancreatitis; BUN, blood urea nitrogen; CTSI, computed tomography severity index.

Regarding complications associated with AP, acute renal failure was observed in 3.0% of patients (n = 2), while abscess, sepsis, pseudocyst, ascites, and hematoma each occurred in 1.5% of patients (n = 1 for each condition). The total rate of complications was identified as 11.9%. The mean duration of hospitalization was 6.4 ± 4.8 days (range = 2-22 days) and prolonged hospitalization occurred in 26.9% of the patients. Exitus occurred in 6% of the patients (n = 4) (Table 2).

Table 2. Complication, length of stay and survival findings in patients with non-biliary acute pancreatitis.

Variables	All population n = 67
Complication, n (%)	8 (11.9)
ARF	2 (3.0)
Abscess	1 (1.5)
Sepsis	1 (1.5)
Cholangitis	1 (1.5)
Pseudocyst	1 (1.5)
Ascites	1 (1.5)
Hematoma	1 (1.5)
Length of stay, days	6.4 ± 4.8
< 8 days	49 (73.1)
≥ 8 days	18 (26.9)
Mortality, n (%)	4 (6.0)

Numerical variables were shown as mean ± standard deviation. Categorical variables were shown as numbers (%). ARF, acute renal failure.

According to the RS, although the mortality ratio was higher in the severe group compared to the mild group (16.0% vs. 0%, p = 0.018), the rate of prolonged hospitalization and complications did not show a significant difference. According to the CTSI, although the mortality ratio in the moderate group did not significantly differ compared to the mild group (9.1% vs. 5.4%, p = 0.218), the rate of prolonged hospitalization (63.6% vs. 19.6%, p = 0.006) and complications (36.4% vs. 7.1%, p = 0.218) were higher in the moderate group (Table 3).

No significant relationship was found between RS and CTSI (r = 0.016, p = 0.715). The diagnostic performance of the Ranson score and CTSI for outcome endpoints was evaluated using ROC Curve analysis. In predicting the risk of prolonged hospitalization and complications, CTSI exhibited superior diagnostic performance compared to RS (AUC: 0.590 vs. 0.856, p < 0.05 for prolonged hospitalization, 0.615 vs. 0.786, p < 0.05 for complications), while RS showed superior diagnostic performance in predicting the risk of mortality (AUC: 0.952 vs. 0.698, p < 0.05) (Figure 1).

Table 3. Distribution of complication and survival findings according to the severity of the Ranson's and Balthazar's scoring systems.

Variables	Ranson score		p	CTSI		p
	Mild group n = 42	Severe group n = 25		Mild group n = 56	Moderate group n = 11	
Age, years	49.2 ± 8.6	50.8 ± 7.8	0.490	50.5 ± 8.2	49.8 ± 8.3	0.365
Gender, n (%)						
Female	15 (35.7)	12 (44.0)	0.325	23 (41.1)	4 (36.4)	0.773
Male	27 (64.3)	13 (52.0)		33 (58.9)	7 (63.6)	
Length of stay, days						
< 8 days	32 (76.2)	17 (68.0)	0.571	45 (80.4)	4 (36.4)	0.008*
≥ 8 days	10 (23.8)	8 (32.0)		11 (19.6)	7 (63.6)	
Complication, n (%)	3 (7.1)	5 (20.0)	0.238	4 (7.1)	4 (36.4)	0.021*
Mortality, n (%)	0	4 (16.0)	0.032*	3 (5.4)	1 (9.1)	0.999

Numerical variables were shown as mean ± standard deviation. Categorical variables were shown as numbers (%). CTSI, computed tomography severity index

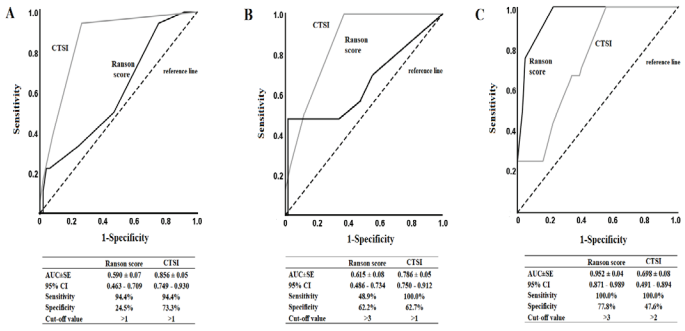

Figure 1. Diagnostic performance of Ranson's score and Balthazar computed tomography severity (CTSI) in predicting prolonged hospitalization, complications, and mortality.

Discussion

The results of this study demonstrate that the RS shows superior diagnostic performance in predicting the risk of mortality in patients with non-biliary AP, while the CTSI offers better predictive capabilities for prolonged hospitalization and complications. These findings indicate that scoring systems in non-biliary AP prognosis can exhibit different diagnostic performances for various endpoints.

In this study, hyperlipidemia was the leading cause in the etiology of non-biliary AP. Hyperlipidemia accounts for a broad spectrum ranging from 1-38% in patients suffering from AP [14-17]. It is known that advancing age, being male, and the use of tobacco and alcohol are potential risk factors for hyperlipidemia [18]. In this study, the mean age of the patients was in the early fifties, and the majority being male, with a significant portion also using tobacco and alcohol. Although no gender predominance is found in the etiology of AP, male individuals may be more susceptible to alcoholic and hyperlipidemia etiologies due to alcohol and tobacco use [19]. Furthermore, male gender has been reported as a significant risk factor associated with the formation of pancreatic pseudocysts in AP [20]. On the other hand, the prevalence of AP is notably variable across different demographic features of patients, particularly increasing among middle-aged and elderly cohort [21]. Therefore, etiological differences of non-biliary AP may be associated with the characteristic features of the patients.

There were no significant differences in age and gender based on the severity of RS and CTSI. Also, no significant correlation was found between RS and CTSI. There are conflicting findings in the current literature regarding the correlation between the RS and the CTSI. Some studies have reported a positive correlation between RS and CTSI, whereas other studies have indicated the absence of a significant relationship [22, 23]. There may not be a significant correlation between radiological findings and the presence of organ dysfunction [24]. CTSI classifies the severity of AP based on morphological findings and inflammatory changes, whereas RS are based on laboratory and clinical findings [11, 12]. The various components utilized in computing the RS and CTSI can significantly impact both their correlation and the differences in the diagnostic performance regarding the severity and outcomes of AP.

In their investigation into the efficacy of predictive markers for severe AP, Cho et al. [23] have reported that the RS and the CTSI possess similar AUC values (0.69 vs. 0.69, $p > 0.05$), indicating comparable overall diagnostic performance between the two scales. However, they elucidated distinct strengths in each scoring systems: the RS demonstrated superior sensitivity (85.7% vs. 66.7%), making it more effective in identifying patients who are likely to develop severe AP, whereas the CTSI exhibited greater specificity (44.3% vs. 67.1%), thus providing a more accurate exclusion of non-severe cases [23]. Although the CTSI is considered superior to other scoring systems in identifying necrotic tissue and predicting the severity of AP, the RS has a better performance in terms of predicting

organ failure [7, 25]. The presence of non-perfused areas in the pancreas on contrast-enhanced CT scans is indicative of pancreatic necrosis and is associated with a poor prognosis in AP. It has been reported that the CTSI has a better diagnostic performance in predicting local complications compared to the RS [25, 26]. However, conflicting results have been reported regarding the diagnostic performances of both scoring systems in outcomes such as prolonged hospital stay and mortality. In a retrospective study conducted on 121 AP patients, a significant relationship was reported between prolonged hospitalization, mortality and CTSI, but no relationship with RS [27]. A prospective study involving 185 AP patients demonstrated that RS had a superior diagnostic performance compared to CTSI in predicting both the severity of AP (AUC values: 0.94 for RS vs. 0.84 for CTSI, $p < 0.05$) and mortality (AUC values: 0.95 for RS vs. 0.83 for CTSI, $p < 0.05$) [28]. In another retrospective study involving 100 AP patients, it was reported that there is a significant association between mortality and severe RS, and a significant relationship between pancreatic necrosis and severe CTSI [29]. These studies demonstrate that these scoring systems may exhibit different diagnostic performances for various endpoints of AP.

There was a study indicating that there is no significant relationship between mortality and the RS in patients with non-biliary AP, however, the CTSI was not included in the study [30]. In the current study, patients with non-biliary acute pancreatitis who had a severe experienced a higher mortality rate, whereas no significant relationship was found between a severe CTSI and mortality. Additionally, in predicting mortality, RS exhibited higher AUC and specificity compared to the CTSI, but their sensitivities were similar. This suggests that for outcomes of AP, both scoring systems could exhibit different threshold values. In predicting mortality, the threshold value for the RS score was determined to be >3, consistent with severity classification, while it was identified as >2 for the CTSI. A previous study indicated that a CTSI ≥5 is linked with prolonged hospital and higher mortality rates [27]. In this study, the CTSI scoring system displayed superior diagnostic performance in predicting prolonged hospitalization and complications, while no significant relationship was found between these endpoints and the RS. The RS, a composite marker comprising clinical and biochemical parameters, reflects the systemic status of the patient and thus serves as a reliable indicator of mortality. This score is determined at the time of diagnosis and within the first 48 hours, a period during which the development of parenchymal necrosis is not yet complete. This could explain its lesser predictive value for complications compared to the CTSI, which assesses severity based on local complications [29].

Limitations

This study had some significant limitations. This study utilized a single-center, retrospective design, which may lead to variations in etiological and severity of AP. Additionally, in this study, other prognostic scoring systems for AP such as the Systemic Inflammatory Response Syndrome (SIRS), Bedside Index of Severity in AP (BISAP), Acute Physiology and Chronic Health Evaluation (APACHE)-II score, and Sequential Organ Failure Assessment (SOFA) were not evaluated [31, 32]. Finally, there was no access to data on the long-term follow-up of the patients. In light of these limitations, there is a need for studies with a multicentric, prospective design that incorporates more comprehensive scoring systems.

Conclusions

This study reveal that while both RS and CTSI scoring systems provide valuable insights into non-biliary AP patient outcomes, they exhibit differing strengths in prognostic prediction. All fatalities occurred in patients categorized under the severe RS group. Additionally, the RS score exhibited superior diagnostic performance in predicting mortality risk compared to CTSI. Conversely, the CTSI was found to be more effective in predicting the likelihood of prolonged hospitalization and the occurrence of complications. In the prognosis of non-biliary AP, both scoring systems have different diagnostic advantages compared to each other, and their combined use may provide more reliable results for the endpoints.

Conflict of Interest/ Funding

The study received no financial support from any individual or organization, and the authors declare no conflict of interest.

Ethics Approval

The study was performed in accordance with the Declaration of Helsinki, and was approved by the University of Health Sciences, Kartal Dr Lütfi Kırdar City Hospital Ethics Committee (Date: 25.01.2023, Decision No: 2022/514/242/4).

Informed Consent

The need for informed consent was waived under the approval of the Hospital Ethics Committee due to the retrospective design.

Availability of Data and Material

The data that support the findings of this study are available on request from the corresponding author, [N.A.].

Authors' contribution

Concept – N.A., Design- N.A., Data collection and/or processing – N.A., M.K.T., and S.A., Analysis and/or interpretation - N.A., M.K.T., and S.A., Writing – N.A. Critical review- M.K.T., and S.A. All authors read and approved the final version of the manuscript.

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