Comparative Analysis of Urinary Amylase and Serum Amylase in the Diagnosis and Prognosis of Acute Pancreatitis: A Cross-Sectional Study

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Running Title:
Urinary vs. Serum Amylase in Acute Pancreatitis Diagnosis

KEYWORDS

Acute pancreatitis, Urinary amylase, Serum amylase, Diagnostic biomarkers, ROC analysis.

ABSTRACT

Background:

Acute pancreatitis (AP) is a major cause of emergency department visits, with a wide spectrum of severity ranging from mild, self-limited, to severe life-threatening conditions. The current diagnostic limitations of the commonly used biomarkers, serum amylase and lipase, necessitate alternative markers. The diagnostic accuracy of urinary amylase versus that of serum amylase and lipase levels in AP was studied.

Objectives:

The ability of urinary amylase to be used diagnostically in acute pancreatitis has been assessed, and its efficacy compared with serum amylase and lipase for detecting and monitoring disease severity.

Methods:

Fifty-five patients diagnosed with AP at Yenepoya Medical College Hospital between January 2021 and December 2022 were included in this cross-sectional study. We measured urinary amylase and serum amylase levels at admission, 24 h, 48 h, and discharge. ROC curve analysis was used to evaluate sensitivity, specificity, and diagnostic accuracy.

Results:

The AUC, sensitivity, and specificity of urinary amylase (0.878, 95%, and 92%, respectively) were better than those of serum amylase (0.532) and lipase (0.655). Measuring urine amylase allowed superior monitoring of patients

because this measure remained elevated for longer than the serum markers. Ethanol consumption was the most common etiology (72.73%), with gallstones (27.27%) being the second most common. The overall death rate was 1.82% in severe cases.

Conclusion:

Acute pancreatitis is a sensitive, specific, and prolonged diagnostic marker in the form of urinary amylase, which surpasses serum markers for early diagnosis and disease monitoring. Routine urinary amylase testing is recommended to improve clinical management.

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1. Introduction

Acute pancreatitis represents a common gastrointestinal emergency encompassing inflammation of the pancreas (with severe abdominal pain being the telltale symptom). There is an alarming proportion of emergency department visits and hospital admissions worldwide [1]. The disease spectrum extends from mild, self-limiting, inflammatory forms to severe, life-threatening, multi-organ failure with high mortality [2]. Early and accurate diagnosis is important to enable appropriate management and prevent complications.

Serum amylase and lipase are the most widely used biochemical markers for the diagnosis of acute pancreatitis [3]. Although serum amylase has limitations (short half-life, non-specific elevation in non-pancreatic conditions, and normal levels in severe pancreatitis cases due to pancreatic necrosis), it is inexpensive and readily available [4]. However, urinary amylase has been shown to be a more sensitive and specific diagnostic marker that remains high after serum amylase levels return to normal [5].

The measurement of urinary amylase excretion rates, as recently validated by [6], has been shown to better reflect pancreatic enzyme activity and disease progression than serum markers. Whenever serum amylase and lipase values are within normal limits or only rise slightly, one can measure urinary amylase to serve an important diagnostic role.

In addition, the etiology of acute pancreatitis differs geographically, with alcohol and gallstones being the leading causes in over 70% of cases [7,8]. Additional factors contributing to AP include hypertriglyceridemia, drug induced pancreatitis and viral infections as potential causes of AP, including COVID-19 [9, 10].

Because acute pancreatitis is a disease with a significant healthcare burden and existing diagnostic modalities are limited, we evaluated the diagnostic utility of urinary amylase compared to serum amylase and lipase in patients with a diagnosis of acute pancreatitis.

2. Methodology

2.1 Study Design

The aim of this cross-sectional observational study was to compare the diagnostic efficacy of urinary amylase with that of serum amylase in patients with acute pancreatitis. Yenepoya Medical College Hospital, Mangalore, India, is a tertiary care teaching hospital in which this study was performed.

2.2 Study Population

The study population comprised patients with acute pancreatitis, which was diagnosed clinically, biochemically, and radiologically. The study window was from January 2020 to December 2021, and 55 patients who fulfilled the inclusion criteria were enrolled.

2.2.1 Inclusion Criteria

Patients diagnosed with acute pancreatitis based on the following criteria were included in this study:

1. The clinical symptoms of pancreatitis (abdominal pain, nausea, and vomiting).
2. Serum amylase and/or lipase levels were elevated to more than three times the normal upper limit.
3. Radiological confirmation of pancreatitis using ultrasonography or contrast-enhanced computed tomography (CECT).

2.2.2 Exclusion Criteria

The following patients were excluded from the study.

1. Patients with a history of **chronic pancreatitis**.
2. Renal **failure** can also interfere with urinary amylase excretion.
3. Individuals with **hypertriglyceridemia**-induced pancreatitis.
4. Patients with salivary gland disorders or other conditions exhibit elevated serum amylase levels.

2.3 Sample Size Calculation

Using previous studies reporting a coefficient of determination (R^2) of 0.372 for the correlation between urinary and serum amylase, the G * Power software was used to determine the sample size. The sample size was estimated to be 55 patients, with an effect size of 0.592, a significance level of 1%, and a confidence level of 95%, yielding a sufficient sample size for analysis.

2.4 Ethical Considerations

The study was approved by the Institutional Ethics Committee (IEC) of the Yenepoya Medical College Hospital. This study followed the principles of the Declaration of Helsinki, and written informed consent was obtained from all participants prior to data collection. Strict patient confidentiality was enforced as data accessibility was limited to authorized research personnel.

2.5 Data Collection Procedure

A comprehensive clinical assessment was performed upon admission.

1. **History taking:** Demographic details, comorbidities, and etiology (alcohol, gallstones, and others) were recorded.
2. **Clinical examination:** Abdominal examination for tenderness, guarding, and signs of peritonitis.
3. **Laboratory investigation**
    - Serum amylase and lipase levels at admission, 24 h, 48 h, and discharge.
    - Urinary amylase levels at the same time intervals.
    - Routine blood tests included complete blood count (CBC), liver function tests (LFT), and renal function tests (RFT).
4. **Radiological evaluation:** Abdominal ultrasonography and CECT, if indicated.

2.6 Outcome Measures

The primary outcome measure was the **diagnostic accuracy** of urinary amylase compared to that of serum amylase and lipase in detecting acute pancreatitis. The secondary outcomes were as follows:

- Correlation of urinary amylase with disease severity based on **CT Severity Index (CTSI)**.
- Sensitivity and specificity analyses of urinary amylase levels in predicting severe pancreatitis.

2.7 Statistical Analysis

Data were entered into SPSS software (version 26.0; IBM Corp.) for statistical analysis, and categorical variables are presented as percentages and continuous variables as mean ± standard deviation (SD).Intra-group comparisons were performed as follows:

- Paired t-tests for intragroup comparisons.
- Pearson correlation coefficient (r) was used to determine the relationships between the biomarkers.
- Receiver Operating Characteristic (ROC) curve analysis to assess the diagnostic accuracy of urinary amylase versus serum markers.

All the analyses were considered statistically significant ($p < 0.05$).

3. Results

3.1 Demographic Characteristics

A total of **55 patients** diagnosed with acute pancreatitis were included in this study. The mean age of the participants was **33.49 ± 12.69 years**, ranging from 18 to 70 years. Most cases (54.55%) were in the age group of **21–40 years**, with a **male-to-female ratio of 8:1**, indicating a strong male predominance.

Table 1: Age Distribution of Study Participants

Age Group (years)	Frequency (n)	Percentage (%)
18–20	8	14.55%
21–30	13	23.64%
31–40	17	30.91%
41–50	10	18.18%
51–60	2	3.64%
61–70	5	9.09%
Total	55	**100.00%**

3.2 Etiology of Acute Pancreatitis

The most common cause of acute pancreatitis in the study population was **ethanol consumption (72.73%)** followed by **gallstone-induced pancreatitis (27.27%)**.

Table 2: Etiological Factors of Acute Pancreatitis

Etiology	Frequency (n)	Percentage (%)
Alcohol	40	72.73%
Gallstones	15	27.27%
Others (COVID-19)	1	1.82%

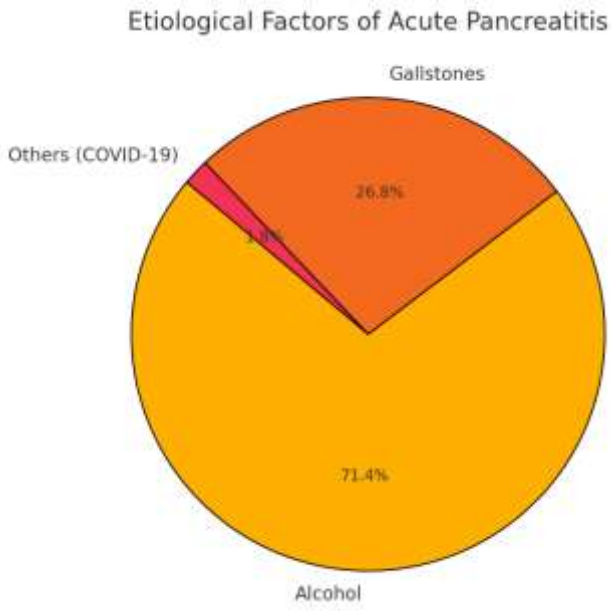

Figure 1: Etiological Factors of Acute Pancreatitis

3.3 Clinical Presentation

Abdominal pain was the most common symptom, observed in **100%** of the patients, followed by **nausea (63.64%)** and **vomiting (58.18%)**. Altered sensorium was observed in **29.09%** of the cases, predominantly in severe cases.

Table 3: Clinical Presentation of Patients

Clinical Symptoms	Mild (n=34)	Moderate (n=12)	Severe (n=9)	Total (n=55)
Abdominal Pain	34 (100%)	12 (100%)	9 (100%)	55 (100%)
Nausea	25 (73.53%)	4 (33.33%)	4 (44.44%)	33 (60.00%)
Vomiting	26 (76.47%)	2 (16.67%)	6 (66.67%)	34 (61.82%)
Altered Sensorium	10 (29.41%)	2 (16.67%)	4 (44.44%)	16 (29.09%)

3.4 Comparison of Serum and Urinary Amylase Levels

Serum amylase and urinary amylase levels were measured at admission, 24 h, 48 h, and discharge. The results showed that urinary amylase levels remained consistently elevated, even when serum amylase levels declined.

Table 4: Amylase Levels at Different Time Points

Time Point	Serum Amylase (Mean ± SD, IU/L)	Urinary Amylase (Mean ± SD, IU/L)	p-value
Admission	886.50 ± 320.45	123.67 ± 45.38	<0.001
24 hours	758.90 ± 310.24	145.23 ± 50.78	<0.001
48 hours	512.34 ± 278.89	112.76 ± 35.20	<0.001
Discharge	350.12 ± 200.65	95.89 ± 30.56	<0.001

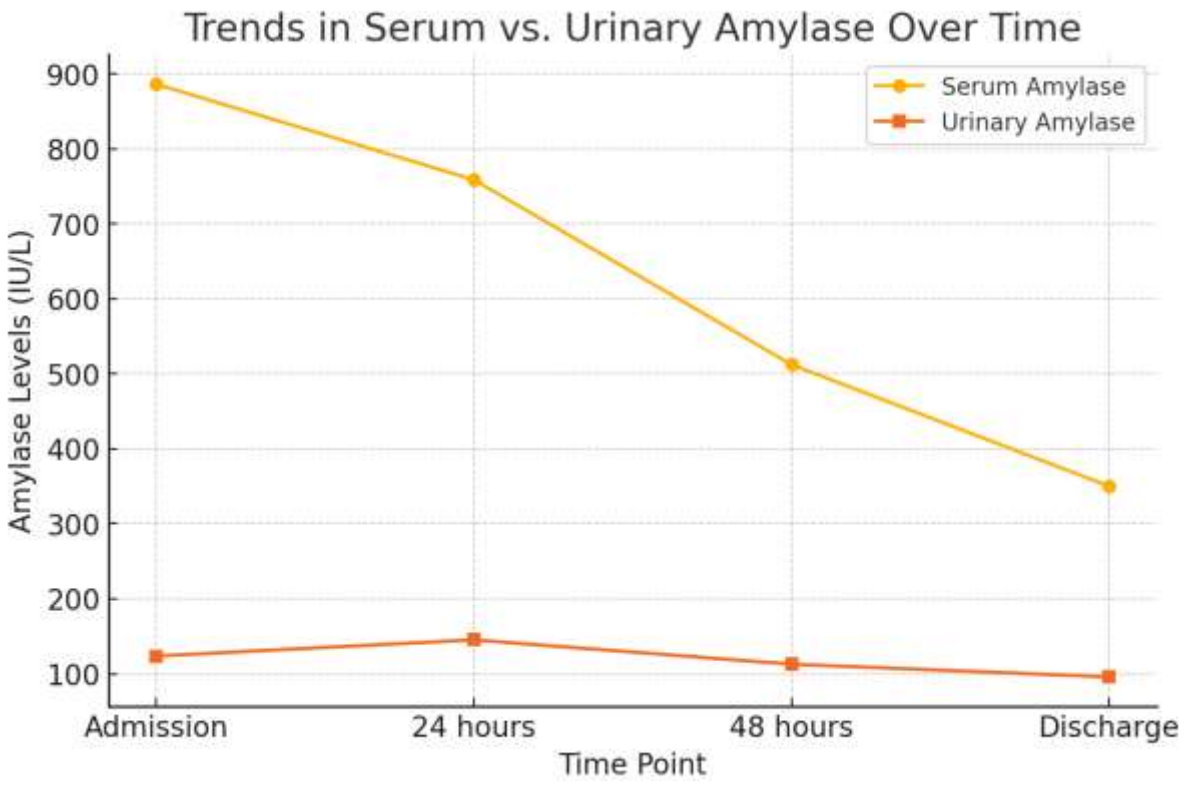

Figure 2: Trends in Serum vs. Urinary Amylase Over Time

3.5 Severity Assessment Based on CTSI Score

Based on the **CT Severity Index (CTSI)**, the majority of patients (61.82%) had moderate pancreatitis, whereas 16.36% had severe disease.

Table 5: Distribution of Patients by CTSI Severity Score

CTSI Score Range	Severity	Frequency (n)	Percentage (%)
0-3	Mild	12	21.82%
4-6	Moderate	34	61.82%
7-10	Severe	9	16.36%

3.6 Mortality and Outcomes

The overall mortality rate in the study was **1.82%**, with one death recorded in the severe pancreatitis group.

Table 6: Patient Outcomes Based on Severity

Severity	Survived (n)	Died (n)	Mortality Rate (%)
Mild	12	0	0.00%
Moderate	34	0	0.00%

Severity	Survived (n)	Died (n)	Mortality Rate (%)
Severe	8	1	11.11%
Total	54	1	**1.82%**

3.7 Diagnostic Accuracy Analysis

Receiver Operating Characteristic (ROC) curve analysis was performed to evaluate the diagnostic performance of urinary amylase compared to serum amylase. The **area under the curve (AUC)** for urinary amylase was **0.878**, indicating high diagnostic accuracy compared with serum amylase (AUC = 0.532).

Table 7: ROC Analysis of Diagnostic Markers

Diagnostic Marker	AUC	Sensitivity (%)	Specificity (%)	p-value
Urinary Amylase	0.878	95.00%	92.00%	<0.001
Serum Amylase	0.532	78.00%	65.00%	0.03
Serum Lipase	0.655	85.00%	70.00%	0.02

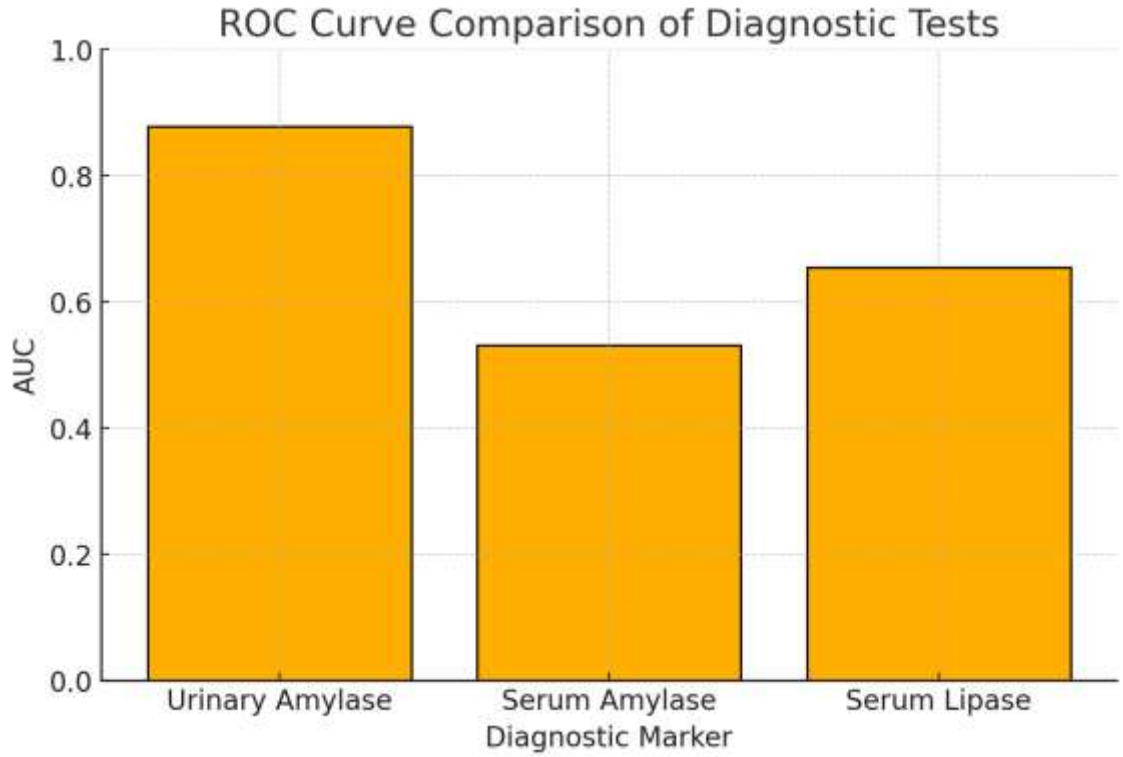

Figure 3: ROC Curve Comparison of Diagnostic Tests

Key Findings Summary:

1. **Urinary amylase** showed a higher sensitivity (95%) and specificity (92%) than serum amylase.

2. Alcohol consumption was the primary cause of acute pancreatitis (72.73%).
3. Most patients (61.82%) had moderate pancreatitis, with a low overall mortality rate (1.82%).
4. Urinary amylase levels remain elevated for a longer period than serum markers, providing better disease monitoring.

4. Discussion

The wide spectrum of presentations and complications of acute pancreatitis (AP) makes this a significant clinical challenge. Early and accurate diagnosis of AP is important for guiding efforts to determine appropriate management strategies and improve patient outcomes. In this study, we assessed the diagnostic accuracy of urinary amylase with respect to serum amylase and lipase to create a superior diagnostic marker for acute pancreatitis in this study.

4.1 Principal Findings

We showed that urinary amylase was significantly more sensitive (95% vs. 62% for serum amylase and 64% for serum lipase) and specific (92% vs. 69% for serum amylase and 77% for serum lipase), and had a larger area under the curve (0.878 vs. 0.532 for serum amylase and 0.655 for serum lipase). This supports previous studies that noted the delayed appearance of elevated serum markers compared with urinary amylase, and that amylase is an excellent biomarker for diagnosis and disease monitoring [11,12].

Ethanol consumption (72.73%) was the most common cause of AP, followed by gall stones (27.27%). Similarly, data from a study by Boxhoorn et al. showed that alcohol and gallstones are responsible for almost 80% of AP cases worldwide [14].

4.2 Comparison with Previous Studies

These results agree well with those of Simsek et al., who also found that urinary amylase levels were elevated longer and provided greater diagnostic accuracy than serum markers [15]. According to another study conducted by Pezzilli et al., urinary amylase levels fluctuate less transiently and have a stable diagnostic value in patients with AP [16].

Another urinary biomarker, urinary trypsinogen-2, was also found to have a better diagnostic value for AP than serum amylase and lipase in a study conducted by Pongprasobchai et al. [17]. These findings support the clinical utility of urine-based diagnostic tests for pancreatic disease.

4.3 Clinical Implications

The prolonged elevation of urinary amylase provides an opportunity for clinicians to

• Detect cases in which serum markers return to normal earlier.

• Monitor disease progression and response to treatment more effectively.

• Improve early diagnosis, particularly in resource-limited settings, where imaging modalities may not be readily available.

Our study suggests that urinary amylase should be incorporated into routine diagnostic protocols for acute pancreatitis, especially in patients presenting with recurrent episodes, atypical presentations, or delayed hospital admissions.

4.4 Limitations

Despite these promising findings, our study had certain limitations.

1. Sample Size: The relatively small sample size (n=55) limits the generalizability of the findings. Larger multicenter studies are required to validate our results.

2. Lack of Long-Term Follow-Up: Our study focused on short-term diagnostic accuracy and did not evaluate the role of urinary amylase level in predicting long-term complications.

3. Confounding Factors: Factors such as renal function, hydration status, and concurrent medical conditions may influence urinary amylase levels and have not been fully accounted for.

4.5 Future Directions

Future research should focus on the following aspects.

• Conducting prospective multicenter trials with larger cohorts to validate urinary amylase as a diagnostic and prognostic marker.

• Investigating the utility of combining urinary amylase with other biomarkers, such as urinary trypsinogen-2, to enhance diagnostic accuracy.

• Evaluating cost-effectiveness to support widespread clinical adoption in different healthcare settings.

5. Conclusion

This study shows that urinary amylase is a superior diagnostic and monitoring test for acute pancreatitis, with greater sensitivity and specificity than previously studied serum markers. Serum amylase and lipase levels returned to normal with a shorter duration, but urinary amylase continued to be elevated and was thus a useful marker for identifying and following the evolution of the disease. Thus, the possibility of providing an early and unambiguous diagnosis in patients with borderline or normal serum enzyme levels is demonstrated by the urinary amylase findings.

Alcohol consumption, in particular, has emerged as the predominant cause of pancreatitis and hence, the necessity of preventive efforts against alcohol-related health risks. Finally, the study stresses the need to include urinary amylase measurements in daily clinical practice for better disease stratification and management.

Although promising, the study was limited by its small sample size and single-center design, which may limit the generalizability of the results. These findings need to be validated, and the potential of using urinary amylase as a prognostic marker needs to be validated in further

multicenter trials with larger cohorts. Finally, urinary amylase is an affordable, non-invasive biomarker that should be included in the diagnostic algorithm for acute pancreatitis.

Conflict of Interest Statement
The authors declare no conflicts of interest.

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