Original Article

Hyponatremia and Thrombocytosis as Early Predictors of Complicated Appendicitis: A Prospective Observational Study

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Abstract

Background: Acute appendicitis is a leading cause of surgical emergencies worldwide. Distinguishing between uncomplicated and complicated appendicitis preoperatively remains a clinical challenge. Complex cases, such as those involving perforation or gangrene, are associated with increased morbidity, longer hospital stays, and higher healthcare costs. Simple, cost-effective biomarkers are needed to aid in early risk stratification. **Material and Methods:** A prospective observational study was conducted over 18 months at a tertiary care hospital. A total of 187 adult patients undergoing appendectomy for acute appendicitis were included. Data on demographics, clinical presentation, Alvarado score, and preoperative laboratory parameters—including serum sodium, platelet count, and white blood cell count—were collected. The final diagnosis of uncomplicated or complicated appendicitis was based on intraoperative findings and histopathological examination. Patients were categorized into uncomplicated and complex groups, and statistical analyses, including independent t-tests and Receiver Operating Characteristic (ROC) curve analysis, were performed. **Results:** Of the 187 patients, 62 (33.2%) were diagnosed with complicated appendicitis. Patients with complicated appendicitis had significantly lower mean serum sodium levels (134.6 ± 3.8 mmol/L) compared to those with uncomplicated appendicitis (137.27 ± 2.9 mmol/L; $p < 0.001$). The mean platelet count was higher in the complicated group (2.71 ± 0.8 lakh/µL vs. 2.63 ± 0.7 lakh/µL), but the difference was not statistically significant ($p = 0.509$). However, the neutrophil percentage was significantly higher in the complicated group (84.49% vs. 80.70%; $p = 0.012$). The Alvarado score demonstrated a moderate predictive ability for complicated appendicitis, with an area under the ROC curve of 0.617 ($p = 0.017$). **Conclusion:** Preoperative hyponatremia and an elevated neutrophil percentage are significant and readily available predictors of complicated appendicitis. While thrombocytosis showed a non-significant trend, serum sodium levels can serve as a valuable adjunct to clinical scoring systems for early identification of high-risk patients, potentially guiding surgical timing and management strategies.

Keywords: Appendicitis, Complicated Appendicitis, Hyponatremia, Thrombocytosis, Biomarkers, Alvarado Score.

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Introduction

Acute appendicitis (AA) represents the most common non-traumatic abdominal surgical emergency, with a lifetime incidence of 7–8%.[1] The clinical course of AA is highly variable, ranging from simple inflammation to complicated appendicitis (CA), which includes gangrene, perforation, and abscess formation. CA is not only associated with significantly higher rates of postoperative morbidity but also imposes a substantial economic burden through prolonged hospitalization and the need for more complex interventions.[2]

The early and accurate differentiation between uncomplicated (NCA) and complicated appendicitis is a cornerstone of effective management. Timely surgery in CA is critical to prevent progression to diffuse peritonitis and sepsis, while a select group of NCA patients may be safely managed with non-operative antibiotic therapy.[3] The diagnostic pathway often relies on clinical assessment, laboratory tests, and imaging. While computed tomography (CT) offers high diagnostic accuracy, its use is tempered by concerns over radiation exposure, cost, and availability, particularly in younger patients and resource-limited settings.[4] Furthermore, clinical scoring systems like the Alvarado score, though useful for confirming the diagnosis of AA, have consistently shown limited utility in predicting its severity, thereby creating a diagnostic gap.[5]

This gap has fueled the search for simple, objective, and inexpensive laboratory markers to improve preoperative risk stratification. Hyponatremia (serum sodium <135 mEq/L) has garnered significant attention. It has been identified as a marker of severe intra-abdominal infection, including gangrenous cholecystitis and perforated diverticulitis.[6] The underlying

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mechanism is believed to involve a systemic inflammatory response, where pro-inflammatory cytokines such as interleukin-6 (IL-6) induce a non-osmotic release of antidiuretic hormone (ADH), leading to dilutional hyponatremia.[7] Concurrently, thrombocytosis, an elevated platelet count, is a recognized acute-phase reaction. Since platelets are key mediators in inflammation and immunity, reactive thrombocytosis has been linked to adverse outcomes in various infectious states.[8] However, its specific predictive capacity for CA remains less defined.

Despite this promising background, few studies have prospectively evaluated the combined utility of these common laboratory tests. This study, therefore, aims to prospectively investigate hyponatremia and thrombocytosis as early, accessible predictors of complicated appendicitis in an adult population.

Materials and Methods

Study Design: This prospective observational study was conducted at the Department of General Surgery, JSS Medical College and Hospital, Mysuru, a tertiary care teaching institution in India. It lasted 18 months, from January 2023 to June 2024.

Study Population: Consecutive patients aged 18 years and older who presented to the emergency department with clinical features suggestive of acute appendicitis and subsequently underwent appendectomy were included in the study. Written informed consent was obtained from all participants or their legal guardians.

Inclusion Criteria:

1. Age ≥ 18 years.
2. Clinical diagnosis of acute appendicitis.
3. Willingness to provide informed consent.
4. Underwent appendectomy (laparoscopic or open).

Exclusion Criteria:

1. Patients with known chronic renal failure, chronic liver disease, or congestive heart failure.
2. Patients on diuretic therapy.
3. Pregnant patients.
4. Patients with a known malignancy or hematological disorder affecting platelet count.
5. Patients who were managed conservatively without surgery.

Data Collection and Procedure: Upon admission, a detailed clinical history was taken, and each patient underwent a thorough physical examination. The Alvarado score was calculated based on signs, symptoms, and initial laboratory findings. A preoperative blood sample was collected for a complete blood count (CBC) to determine the white blood cell (WBC) count, neutrophil percentage, and platelet count, as well as a renal function test (RFT) to measure serum sodium levels.

All patients underwent either open or laparoscopic appendectomy. The operating surgeon meticulously documented intraoperative findings. The excised appendix specimen was sent for histopathological examination (HPE).

Outcome Definition: Patients were categorized into two groups based on a combination of intraoperative and HPE findings:

1. **Uncomplicated Appendicitis (NCA):** The appendix was inflamed, erythematous, or phlegmonous, as confirmed by HPE.
2. **Complicated Appendicitis (CA):** Presence of a gangrenous appendix, visible perforation, or an associated periappendiceal or intra-abdominal abscess.

Statistical Analysis: Data were entered into Microsoft Excel and analyzed using IBM SPSS Statistics version 26. Categorical data were presented as frequencies and percentages. Continuous variables were expressed as mean ± standard deviation (SD). An independent samples t-test was used to compare the means of continuous variables (serum sodium, platelet count, WBC count, neutrophil percentage, and Alvarado score) between the NCA and CA groups. Receiver Operating Characteristic (ROC) curve analysis was performed to assess the predictive ability of the Alvarado score for CA. A p-value of <0.05 was considered statistically significant.

Results

One hundred eighty-seven patients met the inclusion criteria and were enrolled in the study. The mean age of the participants was 33.5 ± 11.2 years, and the majority were male (66.3%). Complicated appendicitis was confirmed in 62 patients (33.2%), while 125 patients (66.8%) had uncomplicated appendicitis. Laparoscopic appendectomy was the most common surgical approach, performed in 77.0% of cases. The demographic and clinical characteristics of the study population are summarized in [Table 1].

Table 1: Demographic and Clinical Characteristics of Study Participants (N=187)

Characteristic	Category	Frequency (n)	Percentage (%)
Age (years)	18–30	89	47.6%
	31–40	43	23.0%
	41–50	44	23.5%
	51–60	11	5.9%
Gender	Male	124	66.3%
	Female	63	33.7%
Type of Appendicitis	Uncomplicated	125	66.8%
	Complicated	62	33.2%
Type of Surgery	Laparoscopic	144	77.0%
	Open	43	23.0%

The comparison of preoperative laboratory parameters between the uncomplicated and complicated appendicitis groups revealed significant differences. The mean serum sodium level was significantly lower in the CA group (134.6 ± 3.8 mmol/L) compared to the NCA group (137.27 ± 2.9 mmol/L) ($p < 0.001$). The mean neutrophil percentage was

also significantly higher in patients with CA (84.49 ± 6.2%) compared to those with NCA (80.70 ± 7.5%) (p = 0.012). While the mean platelet count and total WBC count were higher in the CA group, these differences did not reach statistical significance (p=0.509 and p=0.079, respectively). These findings are detailed in [Table 2].

Table 2: Comparison of Preoperative Parameters between Uncomplicated and Complicated Appendicitis

Parameter	Uncomplicated (n=125)	Complicated (n=62)	Mean Difference	p-value
	Mean ± SD	Mean ± SD		
Serum Sodium (mmol/L)	137.27 ± 2.9	134.60 ± 3.8	-2.67	<0.001*
Platelet Count (lakh/µL)	2.63 ± 0.7	2.71 ± 0.8	0.08	0.509
WBC Count (cells/µL)	12486 ± 3950	13608 ± 4398	1122	0.079
Neutrophil (%)	80.70 ± 7.5	84.49 ± 6.2	3.79	0.012*
Statistically significant (p < 0.05)				

The mean Alvarado score was significantly higher in patients with CA (6.90 ± 0.98) compared to those with NCA (6.45 ± 1.18) (p = 0.010). An ROC curve analysis was performed to assess its predictive accuracy for CA. The study showed a statistically significant but moderate ability to discriminate between the two groups, as presented in Table 3.

Table 3: ROC Curve Analysis of Alvarado Score for Predicting Complicated Appendicitis

Parameter	Area Under the Curve (AUC)	95% Confidence Interval	p-value
Alvarado Score	0.617	0.524 – 0.691	0.017*
Statistically significant (p < 0.05)			

Discussion

The accurate and early prediction of complicated appendicitis is a critical goal in emergency general surgery. Our study contributes to this effort by demonstrating that preoperative hyponatremia and neutrophilia are significant, readily available predictors of complicated disease.

The principal finding of our research is the robust association between lower serum sodium levels and the presence of CA. This is consistent with a growing body of evidence, including a systematic review and meta-analysis by Giannis et al., which concluded that hyponatremia is a reliable marker for complicated appendicitis across adult and pediatric populations.[9] The pathophysiological basis for this phenomenon—a cytokine-mediated, non-osmotic release of ADH—positions serum sodium as a correlational finding and a plausible biological indicator of systemic inflammatory severity.[7] Interestingly, this association is not unique to adults; a prospective study by Pogorelić et al. established hyponatremia as a highly sensitive and specific predictor of appendiceal perforation in children, further solidifying its clinical relevance.[10]

In our cohort, thrombocytosis did not emerge as a statistically significant predictor, though a trend toward higher platelet counts in the CA group was observed. This finding contrasts with a study by Pérez-Soto et al., which identified thrombocytosis as a significant predictor.[11] This variance may be explained by differences in population demographics or the timing of blood sampling relative to symptom onset, as reactive thrombocytosis may not be fully established in the early stages of severe inflammation.

Our analysis also reaffirmed the diagnostic value of the leukocyte differential. While the total WBC count was not significantly different, the percentage of neutrophils was markedly higher in the CA group. This underscores neutrophilia is a more specific marker of the acute bacterial process driving complicated disease than total leukocytosis alone. This finding aligns with numerous studies incorporating neutrophilia into predictive AA models.[12,13]

Finally, while the Alvarado score was statistically higher in patients with CA, its moderate discriminatory power (AUC = 0.617) highlights its limitations as a standalone tool for predicting severity. This reinforces the need to supplement clinical scoring with objective biomarkers like serum sodium to improve risk stratification.[5]

The primary limitation of this study is its single-center design, which may affect the generalizability of our findings. We did not include other biomarkers like C-reactive protein (CRP) or procalcitonin in our analysis, which could have provided a more comprehensive comparative assessment.[14,15] Future multicenter research is needed to validate these results and to explore the development of a multiparameter predictive model.

Conclusion

This prospective study confirms that preoperative hyponatremia is a strong and statistically significant predictor of complicated appendicitis in adults. An elevated neutrophil percentage also serves as a reliable indicator of disease severity. These markers are part of routine laboratory investigations, making them simple, inexpensive, and universally available tools. Incorporating serum sodium levels and neutrophil percentage into the initial assessment of patients with acute appendicitis can enhance clinical judgment, aid in risk stratification, and help prioritize patients for urgent surgical intervention, potentially reducing the morbidity associated with this common surgical emergency.

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Conflicts of interest

There are no conflicts of interest.

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