

Systemic Inflammatory Response Index (SIRI) and Systemic Immuno-Inflammation Index (SII) in Strangulated Inguinal Hernia

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DOI: <https://doi.org/10.51244/IJRSI.2026.1308000251>

Received: 05 September 2026; Accepted: 10 September 2026; Published: 18 September 2026

ABSTRACT

Introduction: Inguinal hernia (IH) is a common condition that frequently leads to emergency visits. Incarcerated inguinal hernia (IIH) often requires surgery. The Systemic Inflammatory Response Index (SIRI) and Systemic Immuno-Inflammation Index (SII), derived from basic blood tests, are used to predict various diseases. This study aimed to assess their role in predicting hernial strangulation.

Materials and Methods: Patients admitted to the general surgery department with abdominal pain in this study. Data on demographics, fever, hernia type and side, hospital stay, chronic conditions, and laboratory results were collected. Group 1 had IIH without necrosis or ischemia, and Group 2 had strangulated hernias for comparative analysis.

Results: A total of 106 patients participated in our study. The SH group had median SII levels of 2503.83 (2919.12), whereas the median SII levels were 1063.14 in the IIH group ($p < 0.001$). The SH group had median SIRI levels of 8.65 (8.92), while the IIH group had median SIRI levels of 3.52 (3.45) ($p < 0.001$). SIRI and SII demonstrated greater predictive power. The SII had an AUC of 0.763.

Conclusions: The SIRI and SII are readily available and easily calculable inflammatory indices that may be useful as adjunctive biomarkers for predicting strangulation in patients with incarcerated hernia. Elevated SIRI and SII values were associated with the presence of strangulation and may assist in the early identification of patients at increased risk of intestinal ischemia or necrosis.

Keywords: Systemic Inflammatory Response Index, Systemic Immuno-Inflammation Index, incarcerated hernia, strangulation

INTRODUCTION

Inguinal hernias (IHs) are a prevalent clinical condition that commonly present to emergency departments and require surgical intervention worldwide [1]. Incarcerated inguinal hernias (IIHs) are also frequently encountered, and urgency often dictates immediate surgical intervention [2]. When IIH is not effectively treated, the regional blood supply to the intestine is reduced, leading to strangulation. In such cases, complications such as intestinal necrosis, perforation, and peritonitis can occur, potentially resulting in mortality [3]. Early diagnosis and prompt identification of patients is known to expedite the surgical plan before such complications transpire [4]. Various diagnostic methods and markers have been employed to facilitate the early recognition of complications, and there is a burgeoning interest in techniques that are cost-effective and easily applicable [5]. Several inflammatory markers, such as CRP, white blood cell count, sedimentation rate, neutrophil-lymphocyte ratio, and neutrophil-CRP ratio, have been applied in research to predict possible complications among IH patients [6,7].

In the medical literature, inflammatory markers have been utilized to anticipate complications across various illnesses. These markers, extracted from the basic hemogram parameters, are becoming progressively significant [8,9]. The Systemic Inflammatory Response Index (SIRI), derived from straightforward parameters such as

neutrophils, monocytes, and lymphocytes, has gained researchers' attention due to its predictive potential in diagnosing and forecasting various inflammatory illnesses, particularly cancer [10,11]. The Systemic Immuno-Inflammation Index (SII) is an objective marker obtained from hemogram parameters. It has been utilized for prognostication and diagnosis of various malignancies and gastrointestinal diseases [12, 13]. No definitive findings concerning the use of SIRI and SII exist in the literature for identifying complications in patients with IH. Thus, the purpose of this research was to showcase the predictability of SIRI and SII for detecting strangulation in patients with IH. The aim of this study was to evaluate the ability of the systemic inflammatory response index (SIRI) and systemic immune-inflammation index (SII) to differentiate strangulated hernias from incarcerated hernias without evidence of ischemia or necrosis.

MATERIALS AND METHODS

Patients and methods

Our research comprised adult patients who attended our A&E department complaining of abdominal pain and were subsequently admitted to the general surgery department at a tertiary university hospital during the period ranging from January 2020 to November 2022. Furthermore, all patients underwent surgery for incarcerated and strangulated hernias. In our study, we defined incarcerated inguinal hernia (IIH) as the impossibility of reducing a hernia, whereas strangulation was characterized by the existence of objective indications of ischemia and gangrene in combination with an irreducible hernia. An incarcerated hernia was defined as an irreducible hernia requiring operative management. Patients were classified as having a non-strangulated incarcerated hernia when no evidence of compromised tissue viability was identified during surgery. Strangulation was defined according to intraoperative evidence of compromised blood supply to the herniated contents. Operative findings used to establish strangulation included. The intraoperative surgical assessment served as the reference standard for classification into the non-strangulated and strangulated groups. Histopathological findings were [used/not used] to confirm intestinal necrosis in patients undergoing bowel resection. Patients who received surgery referrals to other hospitals, those with chronic illnesses that could affect hemogram parameters, individuals taking medications that could alter the parameters, those with systemic infection and sepsis, those who did not undergo surgery or experienced additional complications, and those without signs of incarceration were excluded as exclusion criteria. Following this process, the total number of eligible study participants was 116. 10 patients were subsequently excluded from the final analysis because of incomplete laboratory data, missing operative findings, unavailable medical records, or other prespecified exclusion criteria. Therefore, 106 patients were included in the final analysis.

Study population

The data for this study were acquired from the hospital's information system and patient records. The text adheres to standard language conventions with objective and value-neutral phrasing. Subject-specific vocabulary is employed when it is clear and accurate. Citations, footnotes, and formatting were consistent with the style guide. Biases and filler words are avoided in a balanced and concise document. Patients were excluded if they did not undergo surgical treatment and therefore lacked operative confirmation of the presence or absence of strangulation; had a pre-existing systemic infection or sepsis at presentation; had a known hematological, inflammatory, or other chronic condition considered capable of substantially affecting peripheral blood cell counts; were receiving medications known to alter hematological parameters; or had insufficient clinical, laboratory, or operative data for classification of the study outcome. Clinical complications that developed after the initial laboratory assessment or surgical intervention were not used as exclusion criteria. The recorded patient information included demographics, fever, hernia location, length of hospitalization, hernia type, chronic health conditions, and laboratory findings. Blood samples were collected for laboratory tests within an hour of patient arrival at the emergency department. Technical terms will be explained when they are first used. Language remains formal without the use of contractions, colloquialisms, or informal expressions. Routine hematological parameters, comprising WBC count, neutrophils, lymphocytes, monocytes, platelets, and biochemical parameters such as glucose, lactate, amylase, lipase, ALT, and CRP, were assessed. When calculating the SIRI, the neutrophil and monocyte products were divided by the lymphocyte count, whereas in the SII calculation, the neutrophil and platelet products were divided by the lymphocyte count. The patients were categorized into two groups. The multivariable logistic regression model requires substantially greater methodological detail. The

authors should explain how candidate predictors were selected, including whether age, sex, SIRI, and SII were prespecified on clinical grounds or selected according to univariable analyses. Other clinically relevant variables considered for adjustment should also be identified, and the rationale for their inclusion or exclusion should be provided. Particular attention should be given to the simultaneous inclusion of SIRI and SII. These indices are mathematically related and share neutrophil and lymphocyte counts in their formulas. Consequently, substantial correlation and redundancy between these predictors are possible. Group 1 comprised patients with IHH without any indications of ischemia or necrosis, whereas Group 2 comprised patients with strangulated hernias. Comparison was made between the two groups based on various parameters.

Statistics and ethics

Statistical analysis was performed on our study's data using SPSS 21.0. For patients diagnosed with IH, we used mean $\pm$ standard deviation to represent continuous variables and frequency and percentage (%) to represent categorical variables. Pearson's chi-squared and Fisher's exact tests were used to compare the appropriateness of categorical data between the IHH and SH groups. This study conducted a receiver operating characteristic (ROC) analysis to demonstrate the complications faced by IH patients, where higher AUC values indicated better diagnostic efficiency. A p-value of less than 0.05 was deemed to have statistical significance. Ethical approval for this study was obtained from the Human Research Ethics Committee of Antalya Trainnig and Research Hospital, Antalya, Turkey.

RESULTS

A total of 106 patients participated in our study having met the inclusion criteria, with 67 (63.2%) assigned to the IHH group and 39 (36.8%) to the SH group. In the IH group, the mean age of patients was 60.49 ± 16.42 , whereas in the SH group, it was 61.12 ± 19.05 . Of the patients with IHH, 61.2% were male, whereas in the SH group, the percentage was 41. The body temperature of patients in the SH group was significantly higher (37.4 ± 2.1) than that in the IHH group (36.5 ± 1.2 ; $p = 0.005$). The hernia was located on the right side in both groups. WBC, neutrophil, and CRP levels were significantly higher in the SH group than in the IHH group. The median SII levels were 2503.83 (2919.12) in the SH group, while 1063.14) in the IHH group (Figure 1; $p < 0.001$). Please see Table 1 for a comparison between the IHH and SH groups. The study found that SII (OR 1.052, 95% CI 0.933-1.195, $p = 0.010$) and SIRI (OR 1.001, 95% CI 1.00-1.008, $p = 0.027$) can predict the incidence of strangulation in patients with IH, as shown in Table 2. ROC curves were utilized to determine the efficacy of WBC, SIRI, SII, and CRP parameters in differentiating instances of strangulation, with WBC, SIRI, and SII demonstrating statistically significant results. SIRI and SII exhibited greater efficiency, as evidenced by their higher power [sensitivity of 73.5%, specificity of 79%, and area under the curve (AUC) of 0.779 for SIRI, $p < 0.001$; sensitivity of 64.7%, specificity of 85%, and AUC of 0.763 for SII, $p < 0.001$] (Table 3).

DISCUSSION

IH is a frequent surgical emergency, and IHH and SH are potentially fatal conditions that often result in emergency room admission. Avoiding the timely diagnosis of complications of this disease can result in life-threatening situations [14,15]. In the present study, SIRI and SII levels were significantly higher in patients with strangulated hernia than in those with incarcerated hernia without evidence of ischemia or necrosis. These findings suggest that increased systemic inflammatory activity, reflected by SIRI and SII, is associated with strangulation rather than mortality. ROC analysis further demonstrated that both indices had discriminatory ability for identifying strangulated hernia, with AUC values of 0.779 for SIRI and 0.763 for SII. Therefore, these readily available hematological indices may have potential value as adjunctive markers for identifying patients with incarcerated hernia who are at increased risk of strangulation and associated intestinal ischemia or necrosis.

Distinguishing between strangulated and incarcerated hernias when patients visit the emergency department is a crucial issue. Foreign materials that pass through the ischemic intestinal wall due to strangulation may cause inflammation. Therefore, it is necessary to promptly identify and diagnose hernias to prevent severe complications. This prolonged inflammatory state may result in sepsis, septic shock, and eventual death [16]. Thus, identifying markers or techniques capable of detecting unforeseen complications in advance has a significant clinical value. Accurately predicting strangulation in this time-sensitive condition can be difficult;

therefore, making prompt surgical decisions is vital [17]. Numerous studies in the literature have investigated markers of inflammation, such as WBC, sedimentation, and d-dimer, in IH patients [18,19].

Chemotherapy or radiotherapy, pregnancy, hematological diseases, comorbidities, and medication can affect investigations in patients with inflammatory diseases [20]. Peripheral blood parameters, such as lymphocyte, C-reactive protein, monocyte, neutrophil, and platelet counts, have been the focus of many studies in literature. The Systemic Inflammatory Response Index (SIRI) is applied for the prognostication of numerous inflammation-related ailments and oncological patients [20,21]. In cardiovascular patients, Dziedzic et al. illustrated SIRI's link between SIRI and coronary diseases [22]. Wang et al.'s research presented SIRI's function in stroke-associated pneumonia patients [10]. Chen and colleagues proposed SIRI as an autonomous prognostic indicator for individuals diagnosed with localized or locally advanced renal cell carcinoma [23]. Another publication cited the predictive significance of increased SIRI levels in patients [24]. In our research, we established the correlation between elevated SIRI values and mortality in patients with systemic hypertension.

SIRI, similar to SII, is a widely recognized inflammatory marker utilized in various diseases as a diagnostic tool and a predictor of mortality. Despite the limited literature on the correlation between IH and SII, Chen et al. [25] discovered its usefulness in determining bowel resection prerequisites in patients with IH. In numerous previous studies, SII has demonstrated its functionality in multiple tumorous diseases, including gastrointestinal tumors, lung cancer, and tongue cancer [26]. Huang et al. established a correlation between elevated SII levels and ischemic stroke severity, indicating that this biomarker could assist physicians in clinical decision-making [27]. In our study, we discovered a noteworthy association between a heightened SII and mortality in SH. We consider this factor significant in monitoring and treating SH, a condition that can lead to mortality. Its early significance makes it an important parameter for healthcare professionals.

LIMITATIONS

Our study had certain limitations. First, it was a single-center retrospective study. Moreover, inflammation is a dynamic process, and one of the foremost limitations is our inability to intermittently monitor these parameters from disease onset to diagnosis. Correspondingly, we could not compare our findings with markers such as interleukins, tumor necrosis factor, or integrin, which are inflammatory parameters. Further analysis of our study data calls for prospective, multicenter studies.

CONCLUSION

SIRI and SII were significantly elevated in patients with strangulated hernia compared with patients with incarcerated hernia without ischemia or necrosis. Both indices demonstrated discriminatory ability for strangulation and may serve as readily available adjunctive biomarkers for identifying intestinal ischemia or necrosis in patients presenting with incarcerated hernia. Further prospective, multicenter studies are required to validate their clinical utility and establish appropriate diagnostic cut-off values.

Conflict of Interest

This study did not receive any funding. All authors involved in this study declare that they have no vested interests. The study was conducted after approval by the Ethics Committee, in accordance with the Declaration of Helsinki, and patient confidentiality was emphasized.

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Table 1: Demographics and laboratory findings in patients with hernia

	Group 1 N= 67	Group 2 N= 39	P value
Age (years)	60,49±16,42	61,12±19,05	0,426
Gender (Male);n(%)	41(61,2%)	16(41%)	0,046
Temperature (°C)	36,5±1,2	37,4±2,1	0,005
Hernia side (right)	42 (62,69%)	22 (56,41%)	0,543
With chronic disease (present)			
Hernia type, n (%)			
Inguinal	32 (48,48%)	6 (%15,38%)	0,001
Femoral	15 (22,72%)	10 (25,64%)	
Others	19 (28,78%)	23 (58,97%)	
Laboratory tests			
WBC count ($\times 10^3/\text{mm}^3$)	9,83±2,95	12,68±9,06	0,004
Neutrophil	7,38±2,79	10,19±5,73	0,022

Lymphocyt	1,19±0,79	1,30±0,88	0,726
Platelet	234,23±80,84	267,76±94,74	0,166
CRP (mg/dL)	78,5 (117,5)	93,85(113,35)	0,104
ALT (U/L)(IQR)	19 (12)	15(11,5)	0,238
Amylase (U/L)(IQR)	51 (37)	40,5 (44,25)	0,578
Lipase(U/L)(IQR)	23 (25)	17 (32,5)	0,964
Glucose (mg/dl)	111,52±38,82	107,91±43,82	0,495
LDH(U/L)	223,81±91,49	235,95±119,73	0,808
SII	1063,14 (1029,449)	2503,83 (2919,12)	<0,013
SIRI	3,52 (3,45)	8,65 (8,92)	<0,001

Abbreviation: WBC: white blood cell; NLR: neutrophil lymphocyte ratio ; PLR:platelet lymphocyte ratio; IGC: Immature granulocyte count; IG%: Immature granulocyte percentage; CRP: C-reactive protein;ALT: Alanine Aminotransferase;AST: Aspartate aminotransferase; LDH: Lactate dehydrogenase

Table 2: Predictors of strangulated hernia on multivariable logistic regression analysis

Multivariate logistic regression			
Variable	OR	95% CI	P-value
Age	0,52	0,207-1,325	0,175
Sex	0,99	0,964-1,018	0,496
SIRI	1,052	0,933-1,195	0,410
SII	1,001	1,00—1,001	0,047

Table 3: The receiver operating characteristic curves for strangulated hernia

	Cut-off	AUC (95% CI)	Sensitivity (%)	Specificity(%)	P
WBC($\times 10^3/\text{mm}^3$)	11,11	0,647	0,5	0,73	0,13
SIRI	5,46	0,779	0,735	0,79	<0,001
SII	2140,97	0,763	0,647	0,85	<0,001
CRP (mg/dL)	67	0,600	0,735	0,46	0,088

Abbreviation: AUC: Area under the curve; CI: Confidence interval WBC: White blood cell; NLR: Neutrophil lymphocyte ratio ; IGC: Immature granulocyte count; IG%: Immature granulocyte percentage; CRP: C-reactive protein

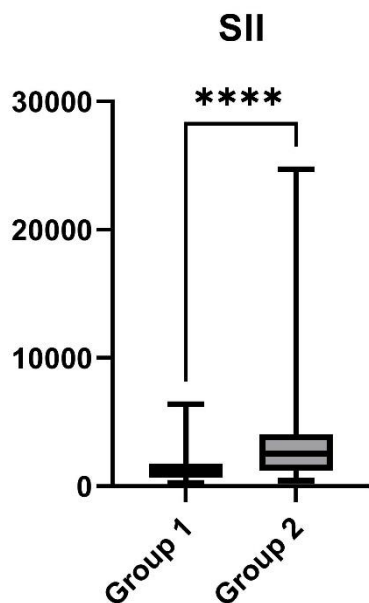


Figure 1. Receiver operating characteristic curves of systemic immune-inflammation index (SII) to predict the strangulated hernia /