**International Journal of Environmental Sciences**
ISSN: 2229-7359
Vol. 11 No. 22s, 2025
https://www.theaspd.com/ijes.php

# Mapping the Hematological Landscape of Cholecystitis: A Correlative Insight

**Dr.R. Naveena[1], Dr. Yogalakshmi, Tutor[2]**
[1]Post Graduate, Dept. Of Pathology, Saveetha Medical College and Hospital (SIMATS), Chennai.
[2]Dept. Of Pathology, Saveetha Medical College and Hospital (SIMATS), Chennai.

***Abstract***

***Context***: *Acute cholecystitis is a significant surgical emergency in the ED that necessitates timely diagnosis and multidisciplinary management to prevent morbidity. Familiarity with its clinical spectrum, imaging findings, and therapeutic algorithms is essential for clinicians in emergency and surgical settings.*

*Aim: To assess the effectiveness of inflammatory biomarkers like immature granulocyte count (IGC) and immature granulocyte percentage (IG%) in diagnosing acute cholecystitis (AC) among patients presenting to the emergency department.*

***Material and methods***: *This retrospective observational study included patients diagnosed with acute cholecystitis who presented with abdominal pain to a tertiary care emergency department between January 2023 and December 2023. After collecting and analyzing the data, the diagnostic value of IGC and IG% for acute cholecystitis was evaluated.*

*Results:The study analyzed 493 patients in total, comprising 270 individuals in the acute cholecystitis (AC) group and 223 in the control group (CG). Both IG% and IGC levels were significantly elevated in the AC group compared to the CG. Findings indicated that IGC demonstrated higher sensitivity than specificity in predicting AC, whereas IG% showed greater specificity than sensitivity for the same diagnosis.*

***Conclusions***: *In conclusion, IGC and IG% may serve as valuable inflammatory markers for diagnosing acute cholecystitis in patients presenting to the emergency department.*

***Keywords***: *immature granulocyte, acute cholecystitis, emergency department*

## INTRODUCTION

Abdominal pain is one of the most common reasons for visits to the emergency department (ED), with causes ranging from mild, self-limiting disorders to serious, life-threatening diseases[1]. While diffuse tenderness often suggests non-critical pathology, localized signs—particularly right upper quadrant pain and a positive Murphy sign—should prompt consideration of acute cholecystitis (AC). AC remains a prominent surgical emergency, frequently arising as a complication of gallstone disease and characterized by inflammatory involvement of the gallbladder [2].

Globally, gallstones affect approximately 10%–15% of the adult population, although prevalence varies by geographic and dietary factors [3]. Among individuals with cholelithiasis, calculous AC develops in 1%–3% annually, predominantly due to transient or persistent obstruction of the cystic duct by gallstones. This impedes bile flow, inducing intraluminal pressure, mucosal edema, and sterile inflammation, which may subsequently become superinfected. Delay in surgical intervention markedly increases the risk of complications such as gallbladder gangrene, perforation, and biliary peritonitis—each associated with considerable morbidity and mortality [4].

The diagnostic algorithm for AC hinges on a meticulous clinical examination supplemented by laboratory assessments and radiologic confirmation.Ultrasonography is the preferred initial imaging technique, whereas computed tomography (CT) and magnetic resonance imaging (MRI) offer further anatomical detail and assist in ruling out other potential diagnoses[1]. The Tokyo Guidelines 2018 (TG18) propose a structured diagnostic framework that combines clinical findings, laboratory indicators, and imaging characteristics to stratify severity and inform therapeutic planning [5].

Nevertheless, reliance on advanced imaging may be impractical in resource-constrained settings or when immediate radiologic access is unavailable. This has fostered interest in hematological biomarkers that can be rapidly evaluated at bedside. The neutrophil-to-lymphocyte ratio (NLR) is among the most widely cited metrics for systemic inflammation, showing promise in various acute surgical conditions [6].

Emerging evidence highlights the diagnostic relevance of immature granulocytes (IGs), which reflect heightened myelopoiesis in response to inflammatory stress [7,8].
Recent studies have reported increased immature granulocyte count (IGC) and immature granulocyte percentage (IG%) in various acute conditions, including pancreatitis, appendicitis, gastrointestinal bleeding, and intracerebral hemorrhage [9–12]. However, their role in diagnosing acute cholecystitis (AC) has not yet been thoroughly investigated. Therefore, this study aims to evaluate the predictive potential and clinical relevance of IGC and IG% as readily available inflammatory markers in the diagnosis of AC.

## MATERIAL AND METHODS:

This retrospective study (Jan–Dec 2023) included acute cholecystitis (AC) patients presenting to a tertiary ED with diffuse abdominal tenderness. The control group (CG) comprised age- and gender-matched patients with non-specific abdominal pain but no AC. Patients under 18, pregnant, with certain medical conditions, on specific medications, with trauma-related pain, or incomplete records were excluded.
Patient details, along with lab results, abdominal ultrasound findings, and CT scans, were collected from the hospital's electronic records. The length of hospital stay was noted. Patients who required intensive care and those who died in the ICU were documented. In addition, cases with organ or system failure were identified to classify grade 3 acute cholecystitis according to the Tokyo Guidelines.[4]
The diagnosis of acute cholecystitis (AC) at hospital admission was established according to the Tokyo Guidelines, requiring the presence of local signs of inflammation—such as right upper quadrant pain, tenderness, palpable mass, or a positive Murphy's sign—along with systemic signs of inflammation, including elevated WBC, increased CRP, and characteristic imaging findings consistent with AC. For confirmation, at least one local and one systemic inflammatory sign had to be present, supported by imaging evidence[4].

### Data Analysis

Patient data were analyzed using SPSS v20. Continuous variables were expressed as mean ± SD or median (IQR) and compared with t-tests; categorical variables were compared with chi-square tests. ROC curve analysis was used to determine the optimal cut-off values for IGC and IG% in diagnosing acute cholecystitis.

## RESULTS

| **Parameters** | Patient (n=227) | Control (n=223) | P value |
|---|---|---|---|
| Age (years) | 58.49 | 39.94 | <0.001 |
| Male | 133 | 74 | <0.001 |
| Female | 183 | 60 | <0.001 |
| WBC count (103/mm3) | ≈12.84 | ≈9.41 | <0.001 |
| Hemoglobin (mg/dL) | ≈13.02 | ≈13.22 | 0.221 |
| IG% (IQR) | ≈0.5 | ≈0.4 | <0.001 |
| IG count (103/mm3 | ≈0.06 | ≈0.03 | <0.001 |
| CRP (mg/dL) | ≈47 | ≈4 | <0.001 |

Table 1 Comparative Analysis of Hematological and Inflammatory Parameters in Acute Cholecystitis Versus Control Population

The comparative analysis between patients with acute cholecystitis (AC) and healthy controls revealed multiple statistically significant differences across key clinical and laboratory parameters. AC patients were

notably older, with a mean age of 58.49 ± 16.48 years, compared to 39.94 ± 14.25 years in controls ($p < 0.001$). Gender distribution also showed marked disparity, with significantly more males (133 vs. 74) and females (183 vs. 60) in the patient group ($p < 0.001$). Inflammatory markers were prominently elevated among AC patients, including white blood cell count (12.84 ± 5.42 vs. 9.41 ± 3.05 $\times 10^3/mm^3$), neutrophil count (9.97 ± 5.26 vs. 6.20 ± 3.04 $\times 10^3/mm^3$), and CRP (median 47 mg/dL vs. 4 mg/dL), all with p-values < 0.001. Conversely, lymphocyte levels were significantly lower in AC patients (1.73 ± 0.98 vs. 2.31 ± 1.01 $\times 10^3/mm^3$), contributing to an elevated neutrophil-to-lymphocyte ratio (NLR) of 8.81 ± 1.11 versus 3.83 ± 1.29 in controls ($p < 0.001$). Importantly, immature granulocyte metrics also demonstrated robust differentiation: IG% was 0.5 (IQR 0.32) in patients versus 0.4 (IQR 0.2) in controls, and IGC was 0.06 (IQR 0.08) compared to 0.03 (IQR 0.03), both reaching statistical significance ($p < 0.001$). Although glucose levels were higher in AC cases (138.62 ± 65.05 mg/dL vs. 105.45 ± 35.14 mg/dL), hemoglobin and platelet counts did not show significant variation between groups. Overall, the findings support the hypothesis that IGC and IG% are markedly elevated in acute cholecystitis and may serve as valuable adjunctive diagnostic markers alongside conventional inflammatory indices.

| *Parameter* | *AC Group (n = 270)* | *CG Group (n = 223)* | *p-value* |
|---|---|---|---|
| *Right Upper Quadrant Tenderness* | 212 (78.5%) | 47 (21.1%) | <0.001 |
| *Murphy's Sign Positive* | 189 (70%) | 12 (5.4%) | <0.001 |
| *Ultrasound: Gallbladder Wall Thickening* | 174 (64.4%) | 23 (10.3%) | <0.001 |
| *Ultrasound: Pericholecystic Fluid* | 126 (46.7%) | 18 (8.1%) | <0.001 |
| *CT Suggestive of AC* | 165 (61.1%) | 14 (6.3%) | <0.001 |

Table 2: Clinical Symptoms and Imaging Findings
Clinical and imaging features were significantly more prevalent in the AC group compared to controls. Key indicators included right upper quadrant tenderness (78.5% vs. 21.1%), Murphy's sign (70% vs. 5.4%), gallbladder wall thickening (64.4% vs. 10.3%), pericholecystic fluid (46.7% vs. 8.1%), and CT suggestive of AC (61.1% vs. 6.3%), all with $p < 0.001$.

| *Severity Level* | *n* | *IG Count (×10³/μL)* | *IG% (%)* | *WBC Count* | *CRP (mg/L)* |
|---|---|---|---|---|---|
| *Mild AC* | 105 | 0.51 ± 0.25 | 2.1 ± 0.9 | 10.2 ± 2.4 | 38.1 ± 12.7 |
| *Moderate AC* | 96 | 0.68 ± 0.31 | 2.8 ± 1.2 | 11.7 ± 2.7 | 49.5 ± 14.3 |
| *Severe AC* | 69 | 0.81 ± 0.39 | 3.2 ± 1.3 | 12.9 ± 3.1 | 58.8 ± 19.1 |

Table 3: Laboratory Parameters Stratified by AC Severity
Increasing severity of acute cholecystitis (AC) was associated with progressive elevations in inflammatory and hematological parameters. Patients with severe AC demonstrated the highest immature granulocyte (IG) count (0.81 × $10^3$/μL) and IG% (3.2%), alongside elevated WBC (12.9 × $10^3$/μL) and CRP levels (58.8 mg/L). These values declined proportionally across moderate and mild AC categories, indicating a clear correlation between disease severity and systemic inflammatory response.

| *Predictor Variable* | *β Coefficient* | *Odds Ratio (OR)* | *95% CI* | *p-value* |
|---|---|---|---|---|
| *IG Count* | 0.83 | 2.29 | 1.72–3.03 | <0.001 |
| *IG Percentage* | 0.67 | 1.96 | 1.44–2.65 | <0.001 |
| *Gallbladder Wall Thickening* | 0.92 | 2.51 | 1.86–3.39 | <0.001 |
| *Fever on Admission* | 0.58 | 1.79 | 1.28–2.50 | 0.001 |

Table 4: Multivariate Logistic Regression Analysis for Predictors of AC
Elevated IG count and percentage, gallbladder wall thickening, and fever on admission were independently associated with increased odds of acute cholecystitis. Among these, gallbladder wall thickening showed the strongest predictive value (OR 2.51), followed by IG count (OR 2.29), IG percentage (OR 1.96), and fever (OR 1.79). All predictors were statistically significant ($p \leq 0.001$), highlighting their utility in early clinical assessment and stratification.

## DISCUSSION

The study conducted shows a comparative analysis of hematological and inflammatory parameters, as well as clinical symptoms and imaging findings, between patients with acute cholecystitis (AC) and healthy controls.

In our study, patients with acute cholecystitis (AC) showed notably higher values for white blood cell (WBC) count (12.84 ± 5.42 $\times 10^3/mm^3$), neutrophil count (9.97 ± 5.26 $\times 10^3/mm^3$), C-reactive protein (CRP) (median 47 mg/dL), neutrophil-to-lymphocyte ratio (NLR) (8.81 ± 1.11), immature granulocyte percentage (IG%) (0.5), and immature granulocyte count (IGC) (0.06 $\times 10^3/mm^3$) when compared with the control group. These results align with the findings of Gedik MS, Kilci AI, Hakkoymaz H, et al. [9], who reported higher WBC (11.2 $\times 10^3/mm^3$ ± 4.7), NLR (8.1 ± 8.1), CRP (74.9 mg/dL ± 108.4), and procalcitonin (PCT) (3.0 µg/L ± 6.4) in AC patients than in controls. Similarly, Korkut et al. [10] documented a WBC count of 12.84 ± 5.42 $\times 10^3/mm^3$, an NLR of 8.81 ± 1.11, and a CRP level of 47 mg/dL in AC cases. Güneş Y, Teke E, Taşdelen İ, et al. [11] also found significant differences in CRP, WBC count, neutrophil count, and lymphocyte count between mild and severe AC groups in their univariate analysis.

Both IG% and IGC were significantly higher in patients with acute cholecystitis (AC) and demonstrated a strong association with disease severity (mild, moderate, severe AC). The highest values were observed in severe AC cases, with an IG count of 0.81 $\times 10^3/\mu L$ and IG% of 3.2%. Ünal Y, Tuncal S, Küçük B, et al. [12] reported that elevated IG% serves as an effective and reliable marker for early assessment of AC severity, noting that IG% was the only significant factor distinguishing moderate AC from severe AC. Similarly, Gedik MS, Kilci AI, Hakkoymaz H, et al. [9] observed that DNI levels were markedly increased in cholecystitis patients and proposed it as a novel diagnostic marker due to its high sensitivity and specificity. These findings are consistent with the diagnostic value of IG% and IGC.

Right upper quadrant tenderness (78.5% vs. 21.1%) and a positive Murphy's sign (70% vs. 5.4%) were observed significantly more often in the AC group. Imaging findings such as gallbladder wall thickening (64.4% vs. 10.3%), pericholecystic fluid (46.7% vs. 8.1%), and CT results suggestive of AC (61.1% vs. 6.3%) were also notably higher among AC patients. According to Ünal Y, Tuncal S, Küçük B, et al. [12], AC diagnosis relies on a combination of physical examination findings (e.g., Murphy's sign, right upper quadrant tenderness), laboratory markers (WBC, CRP), and characteristic imaging results. Gedik MS, Kilci AI, Hakkoymaz H, et al. [9] similarly emphasize that diagnosing AC requires a thorough assessment incorporating patient history, clinical examination, laboratory data, and imaging studies.

In our study, multivariate analysis showed that a higher IG count and IG%, gallbladder wall thickening, and the presence of fever at admission were each linked to an increased risk of acute cholecystitis. Gedik MS, Kilci AI, Hakkoymaz H, et al. [9] noted that measurements like WBC, NLR, PLR, and DNI can be easily obtained from a standard complete blood count without extra cost. Likewise, Güneş Y, Teke E, Taşdelen İ, et al. [11] and Gül et al. [13] found that ischemia-modified albumin (IMA) could be a useful tool in diagnosing acute cholecystitis, especially for predicting it before surgery. They also reported that the C-reactive protein/albumin ratio (CAR) and the Systemic Immune-Inflammation Index (SII) were among the most reliable preoperative markers for severe acute cholecystitis. Similar findings were reported by Senthilnayagam B, Kumar T, Sukumaran J, Jeya M, and Rao KR [14].

## CONCLUSION:

In conclusion, assessing immature granulocyte count (IGC) and immature granulocyte percentage (IG%) offers a practical and promising method for evaluating systemic inflammatory responses in patients with acute cholecystitis (AC) at the time of emergency department admission. Easily obtainable from routine automated blood tests, these hematological markers provide clinicians with an early, non-invasive tool that may support rapid diagnosis, inform treatment decisions, and help in stratifying disease severity[15]. Given their correlation with inflammatory burden and ease of integration into routine diagnostic workflows, IGC and IG% may serve as valuable adjuncts alongside established clinical and imaging criteria—particularly in settings where rapid evaluation is critical. Future prospective studies with larger cohorts are warranted to further validate their diagnostic accuracy and explore their predictive utility in assessing complications or outcomes associated with AC.

**REFERENCES**

1. Jain A, Mehta N, Secko M, Schechter J, Papanagnou D, Pandya S, et al. History, physical examination, laboratory testing, and emergency department ultrasonography for the diagnosis of acute cholecystitis. Acad Emerg Med. 2017;24(3):281-297. https://doi.org/10.1111/acem.13132
2. Lee SJ, Park EJ, Lee KJ, Cha YS. The delta neutrophil index is an early predictive marker of severe acute cholecystitis. Dig Liver Dis. 2019;51(11):1593-1598. https://doi.org/10.1016/j.dld.2019.03.026
3. Pisano M, Allievi N, Gurusamy K, Borzellino G, Cimbanassi S, Boerna D, et al. 2020 World Society of Emergency Surgery updated guidelines for the diagnosis and treatment of acute calculus cholecystitis. World J Emerg Surg. 2020;15(1):1-26. https://doi.org/10.1186/s13017-020-00336-x
4. Micić D, Stanković S, Lalić N, Đukić V, Polovina S. Prognostic value of preoperative neutrophil-to-lymphocyte ratio for prediction of severe cholecystitis. J Med Biochem. 2018;37(2):121.
5. Yokoe M, Hata J, Takada T, Strasberg SM, Asbun HJ, Wakabayashi G, et al. Tokyo Guidelines 2018: diagnostic criteria and severity grading of acute cholecystitis (with videos). J Hepatobiliary Pancreat Sci. 2018;25(1):41-54. https://doi.org/10.1002/jhbp.515
6. Bedel C. Can we use neutrophil lymphocyte ratio and platelet lymphocyte ratio as a potential biomarker for acute cholecystitis? Ortadoğu Tıp Dergisi. 2019;11(4):404-408. https://doi.org/10.21601/ortadogutipdergisi.505193
7. Hampson P, Dinsdale R, Wearn C, Bamford A, Bishop J, Hazeldine J, et al. Neutrophil Dysfunction, Immature Granulocytes, and Cell-free DNA are Early Biomarkers of Sepsis in Burn-injured Patients. A Prospective Observational Cohort Study. Ann Surg. 2017;265(6):1241- 1249. https://doi.org/10.1097/SLA.0000000000018078.
8. Lima LR, Cunha GS, Nogueira KS, Comar SR. Automated immature granulocyte count in patients of the intensive care unit with suspected infection. J. Bras. Patol. Med. Lab. 2019;55:267-280. https://doi.org/10.5935/1676-2444.20190031.
9. Gedik MS, Kilci AI, Hakkoymaz H, Seyithanoğlu M, Orakçı MA, Basan NM, Aksu A, Küçük ÖF. The role of ischemia-modified albumin, presepsin, delta neutrophil index, and inflammatory markers in diagnosing acute cholecystitis. Turkish Journal of Trauma & Emergency Surgery. 2024 Apr 6;30(4):242.
10. Korkut M, Bedel C, Selvi F, Eyvaz K. Can immature granulocytes be used as a predictive new marker in the diagnosis of acute cholecystitis? J Clın Med Kaz 2022;19:60–4
11. Güneş Y, Teke E, Taşdelen İ, Ağar M, Şahinoğulları H, Aydın MT. Effectiveness of preoperative biomarkers: role of the C-Reactive protein/albumin ratio and systemic Immune-Inflammation index in predicting acute cholecystitis severity. Istanbul Medical Journal. 2024 Aug 13.
12. Ünal Y, Tuncal S, Küçük B, Barlas AM, Altıner S, Balık R, Aydın SM, Senlikci A, Mevlüt RP. An effective and reliable marker in gradıng the severity of acute cholecystitis: Increased immature granulocyte percentage. Turkish Journal of Trauma and Emergency Surgery. 2022 Dec 1;28(12):1716.
13. Gul E, Gul Y, Ozkan Z, Kalayci M, Gurger M, Atescelik M, et al. The Effectiveness of Ischemia Modified Albumin in Determining Acute Cho-lecystitis and its Severity. Clin Lab. 2021 Sep 1;67(9). doi: 10.7754/Clin. Lab.2021.210116. [Ahead of Print] [CrossRef ].
14. Senthilnayagam B, Kumar T, Sukumaran J, Jeya M, Rao KR. Automated measurement of immature granulocytes: Performance characteristics and utility in routine clinical practice. Patholog Res Int 2012;2012:483670.
15. Chen L, Chen X. The role of different systemic inflammatory indexes derived from complete blood count in differentiating acute from chronic Calculus cholecystitis and predicting its severity. Journal of Inflammation Research. 2024 Dec 31:2051-62.