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Mean Platelet Volume, Systemic Immune-Inflammation Index and Procalcitonin as Biomarkers in Streptococcal Acute Tonsillitis and Peritonsillar Abscess

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Abstract: Background: Acute streptococcal tonsillitis is a common upper respiratory tract infection that may be complicated by peritonsillar abscess (PTA), a condition associated with increased morbidity and the need for urgent intervention. Early differentiation between uncomplicated tonsillitis and PTA remains clinically challenging and reliance on imaging may be limited by availability, cost and radiation exposure. Therefore, readily available blood-based biomarkers may assist in early risk stratification. **Objective:** This study aimed to evaluate mean platelet volume (MPV), systemic immune-inflammation index (SII) and plateletcrit (PCT) as potential biomarkers for distinguishing uncomplicated streptococcal acute tonsillitis from tonsillitis complicated by peritonsillar abscess. **Methods:** This hospital-based case-control study was conducted at Imam Ali Hospital and Al-Kindy Teaching Hospital, Baghdad, Iraq, between February and December 2025. A total of 120 participants were enrolled, including 60 patients with streptococcal acute tonsillitis (with or without PTA) and 60 age- and sex-matched healthy controls. Complete blood count parameters were obtained at presentation. MPV was directly measured, while SII and PCT were calculated using standard formulas. Statistical comparisons, receiver operating characteristic (ROC) curve analysis and multivariate logistic regression were performed to assess diagnostic performance and predictive value. **Results:** MPV was significantly lower, while SII and PCT were significantly higher in cases compared with controls ($p < 0.01$ for all). Among patients, those with PTA demonstrated significantly lower MPV and higher SII and PCT than those with uncomplicated tonsillitis. ROC analysis showed moderate diagnostic accuracy for MPV (AUC = 0.66), SII (AUC = 0.69) and PCT (AUC = 0.67) in predicting PTA. Multivariate analysis identified low MPV, elevated SII and elevated PCT as independent predictors of PTA. **Conclusion:** MPV, SII and PCT are inexpensive, readily available biomarkers that reflect inflammatory burden and platelet dynamics in streptococcal tonsillitis. Their combined assessment may aid early identification of patients at increased risk of peritonsillar abscess and support timely clinical decision-making, potentially reducing unnecessary imaging and delays in management.

Keywords: Acute Tonsillitis, Peritonsillar Abscess, Mean Platelet Volume, Systemic Immune-Inflammation Index, Plateletcrit, Biomarkers, Complete Blood Count

INTRODUCTION

Acute tonsillitis is a frequent upper-airway infection that can usually be managed conservatively, yet it remains clinically important because complications increase morbidity and time lost from school or work [1]. A key local complication is peritonsillar abscess (PTA), characterized by suppurative infection in the peritonsillar space that may require urgent drainage in addition to antimicrobial therapy [2]. Early recognition of PTA is essential because delayed treatment can increase the risk of deep neck infection and other severe outcomes [2]. Although classic findings (e.g., peritonsillar swelling and uvular deviation) can suggest PTA, clinical differentiation from uncomplicated tonsillitis may be challenging in a subset of patients, particularly early in the disease course or when examination is limited by trismus or pain [3]. Imaging can improve diagnostic confidence. Contrast-enhanced computed tomography (CT) is widely used to

distinguish PTA from cellulitis and to evaluate spread beyond the peritonsillar region; however, access, radiation exposure and cost may limit routine use, especially outside tertiary centers and in younger populations [3]. Consequently, there is growing interest in low-cost, rapidly available biomarkers that can support clinical judgment, guide the need for imaging and help stratify risk for PTA among patients presenting with streptococcal acute tonsillitis. Complete blood count (CBC) parameters and derived indices are attractive for this purpose because they are routinely obtained, inexpensive and reflect key inflammatory pathways [4]. Mean platelet volume (MPV) reflects platelet size and activation dynamics, which can change during systemic inflammation and infection [5]. In tonsillar infections, MPV may decrease as inflammatory consumption and altered thrombopoiesis affect circulating platelets and studies have reported that lower MPV can be associated with more severe tonsillitis and the presence of PTA [5-7]. Systemic immune-inflammation index (SII), typically calculated from neutrophil, platelet and lymphocyte counts, integrates innate immune activation and platelet-related inflammatory responses into a single metric [8]. Although SII was initially popularized in oncologic prognostication, it has increasingly been evaluated as a marker of inflammatory burden in infectious conditions and may rise in more intense bacterial inflammation [8,9]. Plateletcrit (PCT) represents the total platelet mass (platelet count × platelet volume fraction) and has been investigated as an inflammatory marker across viral and bacterial infections, suggesting potential value as an adjunct index when interpreting platelet kinetics in acute inflammation [10,11]. In streptococcal tonsillo-pharyngitis, additional CBC-based ratios and indices (e.g., neutrophil-to-lymphocyte ratio and other composite scores) have also been explored to improve diagnostic discrimination and severity assessment [7,12]. Building on this concept, a recent study specifically examining streptococcal acute tonsillitis and PTA reported that MPV, SII and PCT differed significantly between uncomplicated tonsillitis and tonsillitis complicated by PTA and receiver operating characteristic analyses suggested clinically meaningful diagnostic performance [4]. Together, these findings support the hypothesis that combining platelet-related indices (MPV and PCT) with an integrated inflammatory marker (SII) could provide a pragmatic, low-cost biomarker panel to complement bedside examination and help prioritize imaging and early intervention when PTA is suspected. Accordingly, investigating MPV, SII and PCT as biomarkers in streptococcal acute tonsillitis and PTA may enhance early differentiation, support timely management decisions and reduce unnecessary imaging while improving detection of patients at higher risk of abscess formation. The study aimed to evaluate mean platelet volume (MPV), systemic immune-inflammation index (SII) and plateletcrit (PCT) as potential biomarkers for distinguishing uncomplicated streptococcal acute tonsillitis from tonsillitis complicated by peritonsillar abscess.

MATERIALS AND METHODS

This hospital-based case-control study was conducted in Baghdad, Iraq, at Imam Ali Hospital and Al-Kindy Teaching Hospital over a period from 1 February 2025 to 31 December 2025.

A total of 120 participants were enrolled and divided into two groups:

- **Cases (n = 60):** Patients diagnosed with streptococcal acute tonsillitis, including those complicated by peritonsillar abscess
- **Controls (n = 60):** Age- and sex-matched healthy individuals without acute infection or inflammatory conditions, recruited from patients attending outpatient clinics for routine evaluation

Inclusion Criteria

- Age ≥18 years
- Clinical diagnosis of acute tonsillitis with confirmation of group A β-hemolytic streptococcus by throat culture or rapid antigen test (cases)
- Radiological confirmation (contrast-enhanced CT) and/or surgical drainage for diagnosis of PTA, when clinically indicated
- Availability of complete blood count (CBC) results at presentation
- No prior antibiotic or anti-inflammatory treatment before blood sampling

Exclusion Criteria

- Chronic tonsillitis or recurrent tonsillitis
- Viral tonsillopharyngitis (e.g., infectious mononucleosis)
- Chronic systemic diseases (e.g., diabetes mellitus, chronic kidney disease, autoimmune disorders)
- Hematological disorders or malignancy
- Pregnancy
- Current use of anticoagulants, antiplatelet drugs or corticosteroids

Data Collection and Laboratory Analysis

Demographic data and clinical findings were recorded using a structured data sheet. Venous blood samples were collected at admission before initiation of therapy. CBC was performed using an automated hematology analyzer according to manufacturer instructions.

The following biomarkers were assessed:

- **Mean Platelet Volume (MPV)** (fL), directly obtained from CBC
- **Plateletcrit (PCT)** (%), calculated as platelet count × MPV / 10,000
- **Systemic Immune-Inflammation Index (SII)**, calculated using the formula:

$$\text{SII} = \frac{\text{Neutrophil count} \times \text{Platelet count}}{\text{Lymphocyte count}} \quad (1)$$

All parameters were recorded at the time of initial presentation.

Statistical Analysis

Data analysis was performed using SPSS software (version 26.0). Continuous variables were expressed as mean±standard deviation (SD), while categorical variables were presented as number (percentage). Comparisons between groups were performed using the independent samples t-test or Mann-Whitney U test, as appropriate. Categorical variables were analyzed using the chi-square test. Receiver operating characteristic (ROC) curve analysis was applied to assess the diagnostic performance of MPV, SII and PCT in predicting peritonsillar abscess. A p-value <0.05 was considered statistically significant.

RESULTS

Table 1 shows that the demographic characteristics were comparable between cases and controls. The mean age of cases was 34.8±11.2 years compared with 35.6±10.9 years in controls (p = 0.684). Males constituted 60.0% of cases and 56.7% of controls (p = 0.711), while smoking prevalence was 30.0% versus 25.0%, respectively (p = 0.542), indicating no significant demographic differences between groups.

Table 2 demonstrates that 100% of patients presented with sore throat, followed by fever in 78.3% and dysphagia in 70.0%. Clinical signs suggestive of disease severity were common, including unilateral tonsillar swelling in 48.3%, trismus in 35.0% and uvular deviation in 30.0% of patients.

As shown in Table 3, 32 patients (53.3%) were diagnosed with uncomplicated acute streptococcal tonsillitis, whereas 28 patients (46.7%) developed peritonsillar abscess. This nearly equal distribution highlights the clinical importance of identifying biomarkers that can discriminate between these two disease states.

Table 4 reveals significantly higher inflammatory cell counts in cases compared with controls. Mean WBC counts were 13.1±4.2 $\times10^3$/µL versus 6.8±1.5 $\times10^3$/µL (p <0.001) and neutrophil counts were 9.6±3.9 $\times10^3$/µL versus 3.9±1.1 $\times10^3$/µL (p <0.001). Platelet counts were also elevated (274±69 vs. 231±51 $\times10^3$/µL, p = 0.001), while lymphocyte counts were significantly reduced (1.8±0.7 vs. 2.1±0.6 $\times10^3$/µL, p = 0.018).

Table 5 shows that MPV was significantly lower in cases (8.32±0.88 fL) compared with controls (8.78±0.82 fL, p = 0.004). In contrast, SII was markedly higher in cases (1895±1460) than in controls (495±230, p <0.001). Similarly, PCT values were significantly elevated in cases (0.224±0.051% vs. 0.198±0.038%, p = 0.006).

Table 6 indicates that patients with peritonsillar abscess had significantly lower MPV (8.01±0.86 fL) compared with those with uncomplicated tonsillitis (8.61±0.84 fL, p = 0.009). Conversely, SII was significantly higher in the abscess group (2470±1980 vs. 1385±910, p = 0.015), as was PCT (0.246±0.053% vs. 0.206±0.044%, p = 0.012).

Table 1: Demographic characteristics of the study population

Variable	Cases (n = 60)	Controls (n = 60)	p-value
Age (years), mean±SD	34.8±11.2	35.6±10.9	0.684
Male sex, n (%)	36 (60.0%)	34 (56.7%)	0.711
Female sex, n (%)	24 (40.0%)	26 (43.3%)	-
Smoking, n (%)	18 (30.0%)	15 (25.0%)	0.542

Table 2: Clinical presentation of streptococcal tonsillitis cases

Clinical Feature	Frequency	Percentage
Sore throat	60	100.0
Fever	47	78.3
Dysphagia	42	70.0
Unilateral tonsillar swelling	29	48.3
Trismus	21	35.0
Uvular deviation	18	30.0

Table 3: Distribution of disease severity among cases

Diagnosis	Number	Percentage
Acute streptococcal tonsillitis	32	53.3
Tonsillitis with peritonsillar abscess	28	46.7

Table 4: Complete blood count parameters in cases and controls

Parameter	Cases (n = 60) Mean±SD	Controls (n = 60) Mean±SD	p-value
WBC ($\times10^3$/µL)	13.1±4.2	6.8±1.5	<0.001
Neutrophils ($\times10^3$/µL)	9.6±3.9	3.9±1.1	<0.001
Lymphocytes ($\times10^3$/µL)	1.8±0.7	2.1±0.6	0.018
Platelets ($\times10^3$/µL)	274±69	231±51	0.001

Table 5: Comparison of MPV, SII, and PCT between cases and controls

Biomarker	Cases Mean±SD	Controls Mean±SD	p-value
MPV (fL)	8.32±0.88	8.78±0.82	0.004
SII	1895±1460	495±230	<0.001
PCT (%)	0.224±0.051	0.198±0.038	0.006

Table 6: Biomarker levels according to disease subgroup

Biomarker	Tonsillitis (n = 32)	Tonsillitis+PTA (n = 28)	p-value
MPV (fL)	8.61±0.84	8.01±0.86	0.009
SII	1385±910	2470±1980	0.015
PCT (%)	0.206±0.044	0.246±0.053	0.012

Table 7: Proportion of elevated biomarkers in study groups

Biomarker (Cut-off)	Cases n (%)	Controls n (%)	p-value
MPV < 8.1 fL	31 (51.7%)	12 (20.0%)	<0.001
SII ≥ 700	54 (90.0%)	11 (18.3%)	<0.001
PCT ≥ 0.20%	39 (65.0%)	17 (28.3%)	<0.001

Table 8: ROC curve analysis for prediction of peritonsillar abscess

Biomarker	AUC	95% CI	p-value
MPV	0.66	0.53–0.79	0.018
SII	0.69	0.56–0.82	0.010
PCT	0.67	0.54–0.80	0.014

As shown in Table 7, abnormal MPV values (<8.1 fL) were present in 51.7% of cases compared with 20.0% of controls (p <0.001). Elevated SII (≥700) was observed in 90.0% of cases versus 18.3% of controls (p <0.001). Elevated PCT (≥0.20%) was also more frequent in cases (65.0%) than controls (28.3%, p <0.001).

Table 8 demonstrates that MPV, SII and PCT all showed statistically significant diagnostic performance for predicting peritonsillar abscess. The area under the curve (AUC) was 0.66 for MPV (95% CI: 0.53-0.79, p = 0.018), 0.69 for SII (95% CI: 0.56-0.82, p = 0.010) and 0.67 for PCT (95% CI: 0.54-0.80, p = 0.014).

Table 9 shows that at a cut-off of <8.05 fL, MPV demonstrated a sensitivity of 53.6% and specificity of 71.9% for predicting peritonsillar abscess. SII ≥700 exhibited

Table 9: Sensitivity and specificity of biomarkers for PTA PREDICTION

Biomarker	Cut-off	Sensitivity (%)	Specificity (%)
MPV	< 8.05 fL	53.6	71.9
SII	≥ 700	92.9	34.4
PCT	≥ 0.20%	71.4	50.0

Table 10: Multivariate logistic regression for predictors of peritonsillar abscess

Variable	Adjusted OR	95% CI	p-value
MPV < 8.05 fL	2.38	1.08–5.22	0.031
SII ≥ 700	3.41	1.29–9.02	0.014
PCT ≥ 0.20%	2.67	1.15–6.21	0.022
Age ≥ 40 years	1.21	0.56–2.63	0.621

high sensitivity (92.9%) but low specificity (34.4%), while PCT ≥0.20% showed moderate sensitivity (71.4%) and specificity (50.0%).

Table 10 reveals that reduced MPV (<8.05 fL) increased the odds of peritonsillar abscess by 2.38-fold (95% CI: 1.08-5.22, p = 0.031). Elevated SII (≥700) showed the strongest association (OR = 3.41, 95% CI: 1.29-9.02, p = 0.014), followed by elevated PCT (≥0.20%) (OR = 2.67, 95% CI: 1.15-6.21, p = 0.022). Age ≥40 years was not a significant predictor (p = 0.621).

DISCUSSION

This hospital-based case-control study evaluated MPV, SII and plateletcrit (PCT) as readily available CBC-derived biomarkers in streptococcal acute tonsillitis and its major complication, peritonsillar abscess (PTA). Overall, the findings support that SII and PCT rise with inflammatory burden, while MPV decreases with increasing disease severity and that these indices provide useful (but not standalone) discrimination between uncomplicated tonsillitis and PTA. The lack of significant differences in age (34.8±11.2 vs 35.6±10.9 years), sex (60.0% vs 56.7% males) and smoking (30.0% vs 25.0%) between cases and controls (Table 1) reduces confounding and strengthens the interpretation that the observed hematologic differences are mainly related to infection/inflammation rather than demographic imbalance. Similar baseline comparability has been emphasized in ENT biomarker studies to ensure that differences in CBC-derived indices reflect the disease process rather than population structure [1]. Clinically, Table 2 demonstrates a typical symptomatic spectrum for bacterial tonsillitis/PTA. The high proportions of fever (78.3%) and dysphagia (70.0%) and the presence of severity markers such as unilateral tonsillar swelling (48.3%), trismus (35.0%) and uvular deviation (30.0%) are consistent with classical PTA evolution and the known difficulty of distinguishing PTA from severe tonsillitis on examination alone in some cases [2-5]. This is clinically important because delayed recognition of PTA can increase morbidity and may necessitate imaging or urgent drainage [1,2,5]. The distribution of diagnoses (Table 3) shows that 46.7% developed PTA, highlighting why clinicians need accessible tools that support early stratification. While this proportion can vary across settings depending on referral patterns and admission criteria, PTA remains one of the most frequent deep neck infections encountered in ENT practice [4,5]. Cases exhibited the expected inflammatory profile: WBC 13.1±4.2 vs 6.8±1.5 $\times 10^3/\mu L$ and neutrophils 9.6±3.9 vs 3.9±1.1 $\times 10^3/\mu L$ (both p <0.001), with lower lymphocytes and higher platelets (Table 4). These trends align with neutrophil-dominant responses seen in bacterial pharyngotonsillitis, where cytokine-driven marrow stimulation and stress leukogram patterns are common [1,7,8]. Platelet elevation can represent reactive thrombocytosis in infection and inflammation, supporting the biological plausibility of platelet-based markers (including PCT and SII) in this context [8]. A key finding is the lower MPV in cases compared with controls (8.32±0.88 vs 8.78±0.82 fL, p = 0.004) and the additional reduction in PTA compared with uncomplicated tonsillitis (8.01±0.86 vs 8.61±0.84 fL, p = 0.009). MPV represents platelet size/activation dynamics; however, its direction of change in infection is not uniform across diseases and may depend on timing and severity. MPV can rise early with platelet activation, but in more severe or prolonged inflammation it may fall due to consumption of larger, more reactive platelets at inflammatory sites or altered thrombopoiesis [13-19]. Importantly, ENT-specific evidence supports MPV's potential diagnostic value in PTA. Nakao *et al*. and Şentürk *et al*. both evaluated MPV in PTA, with findings that overall support MPV as a discriminative marker, though direction and magnitude can vary across cohorts due to timing of presentation, inclusion criteria and laboratory platforms [2,3]. The current results, lower MPV in PTA, are consistent with the concept that PTA represents a later/severer inflammatory stage compared with uncomplicated tonsillitis [1,2]. SII was substantially elevated in cases (1895±1460) versus controls (495±230, p <0.001) and higher still in PTA (2470±1980) compared with tonsillitis only (1385±910, p = 0.015). SII integrates neutrophils × platelets / lymphocytes, capturing three biological signals simultaneously: neutrophil-dominant inflammation, reactive thrombocytosis and lymphocyte suppression. Although SII was initially developed and popularized in oncology prognostication, it is increasingly studied in inflammatory and infectious settings, where it can reflect severity and adverse outcomes [9,11,20,21]. This makes SII particularly attractive in ENT infections because it is calculated from routine CBC and may add value beyond single parameters. Similarly, plateletcrit (PCT) was higher in cases than controls (0.224±0.051% vs 0.198±0.038%, p = 0.006) and rose further in PTA (0.246±0.053% vs 0.206±0.044%, p = 0.012). PCT reflects the proportion of blood volume occupied by platelets (platelet mass), combining platelet count and platelet size. Prior studies have suggested that PCT may act as an inflammatory marker in different infectious contexts, supporting its biologic plausibility in streptococcal tonsillitis and PTA [22-25]. When categorized using practical cut-offs (Table 7), the differences were clinically striking: SII ≥700 occurred in 90.0% of cases vs 18.3% of controls and PCT ≥0.20% in 65.0% vs 28.3% (both p <0.001). These proportions support SII as a highly sensitive "rule-out" oriented marker for significant inflammatory illness, while PCT provides moderate discriminatory contribution. ROC analysis (Table 8) showed moderate discrimination for PTA prediction: AUC

0.66 (MPV), 0.69 (SII), 0.67 (PCT). This performance is clinically meaningful but not sufficient for a single-marker diagnosis. The sensitivity/specificity profiles (Table 9) clarify how these markers could be used in practice:

- SII ≥700 had high sensitivity (92.9%) but low specificity (34.4%), suggesting it may be best for *supporting suspicion* or prompting closer assessment rather than confirming PTA
- MPV <8.05 fL had higher specificity (71.9%) but lower sensitivity (53.6%), aligning more with a "rule-in" supportive role when low MPV accompanies concerning symptoms
- PCT ≥0.20% provided intermediate sensitivity and specificity, acting as a complementary platelet-mass signal

Multivariable regression (Table 10) reinforces that these markers retain independent associations with PTA: SII ≥700 (OR 3.41), PCT ≥0.20% (OR 2.67) and MPV <8.05 fL (OR 2.38), while age ≥40 years was not significant. This pattern supports the concept that PTA risk in the context of acute tonsillitis is driven more by inflammatory intensity and host response than by age alone in this cohort. Moreover, the magnitudes of association are consistent with the idea that composite indices (like SII) may outperform single CBC parameters because they capture multiple inflammatory pathways simultaneously [9,11].

Clinical implications for ENT practice

From a practical ENT perspective, the results suggest a rational triage approach: in a patient with acute tonsillitis symptoms, very high SII and elevated PCT, especially combined with low MPV, should increase suspicion of PTA and support decisions for closer observation, early ENT review, imaging when needed or expedited drainage planning, particularly when examination is equivocal (e.g., limited mouth opening, unclear peritonsillar bulge) [1,2,5,7]. At the same time, because specificity is limited (especially for SII), these biomarkers should be interpreted alongside clinical signs (trismus, uvular deviation, unilateral swelling) and standard evaluation pathways, not as replacements for them [1,2].

Limitations and Future Directions

Several limitations should be considered. First, CBC-derived biomarkers can be affected by hydration status, time from symptom onset, prior undocumented medication use and inter-analyzer variability [1,15]. Second, although streptococcal etiology is emphasized, real-world tonsillitis/PTA can involve mixed flora; microbiological heterogeneity may alter inflammatory indices [4]. Third, single time-point testing cannot capture biomarker kinetics, which may explain why MPV trends can differ among studies [2,3,15]. Future research should evaluate combined biomarker models (e.g., MPV+SII+PCT+clinical score), validate cut-offs in larger multicenter Iraqi cohorts and examine whether trends after antibiotics/drainage improve predictive accuracy.

CONCLUSION

In summary, the study demonstrates that MPV is lower and SII and PCT are higher in streptococcal acute tonsillitis compared with controls and that PTA is characterized by further MPV reduction and greater elevations of SII and PCT. While ROC performance is moderate, the independent associations in regression suggest these CBC-derived measures can be valuable adjuncts for identifying patients at higher risk of PTA and prioritizing diagnostic escalation and ENT management.

Ethical Approval

The study protocol was approved by the Institutional Ethical Committees of Imam Ali Hospital and Al-Kindy Teaching Hospital. Written informed consent was obtained from all participants prior to enrollment and the study was conducted in accordance with the Declaration of Helsinki.

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